ELECTRICAL EQUIPMENT

DIESEL-ELECTRIC LOCOMOTIVE

WHITCOMB LOCOMOTIVE CO.

G.O. CG-63044 - S.O. 15-T-235

DESCRIPTION, OPERATION AND MAINTENANCE

Instruction Book 5443-230

August, 1943

Westinghouse Electric & Manufacturing Company

East Pittsburgh, Pa.

INDEX

INDEX

Section IV

Traction Motors

Section V

Miscellaneous Control Details

INDEX

Section VI

Maintenance and Inspection

AMs
Rev.

P R E F A C E

These pages are written particularly for the benefit of those who will have to care for Fuel-Electric equipments, but who are not familiar with electrical apparatus. They illustrate and describe the general construction of the various pieces, briefly explain their function, and call attention to the points which require special care.

CAUTION

DUE CAUTION SHOULD BE EXERCISED NOT TO COME IN CONTACT WITH THE GENERATOR TERMINALS, OR ANY PART OF THE MAIN CIRCUIT WHILE THE ENGINE IS IN OPERATION. THE VOLTAGE EMPLOYED ON THE GENERATOR AND TRACTION MOTOR CIRCUITS IS SUFFICIENTLY HIGH TO GIVE A VERY SEVERE SHOCK.

Observance of the following simple precautions may prevent serious shocks or burns.

(1) Do not attempt to make adjustments on the Generator while it is in operation.

(2) Do not operate the "Traction Motor Switches" or "Reverser" by hand while the engine is running.

(3) In general, the switch cabinet doors should not be opened when the engine is in operation.

The electrical circuits which lead to the devices whereby the operator controls the locomotive carry low-voltage battery current.

In testing equipment having pneumatic apparatus, use compressed air from some external source or pump up the reservoirs by running engine, but be certain to shut down engine before testing circuits.

SECTION I

GENERAL

GENERAL DESCRIPTION

OF

THE DIESEL-ELECTRIC LOCOMOTIVE EQUIPMENT

ESSENTIAL ELEMENTS:

The equipment of a diesel-electric locomotive comprises a single or double unit power plant, each power plant consisting essentially of two elements:

(a) A diesel engine to supply the power.

(b) An electrical equipment to transmit the power from the engine to the locomotive axles.

The electrical drive provides an effective means of transmitting the power from the engine to the locomotive wheels, with a flexibility superior to any known form of mechanical drive.

The electrical drive automatically produces the equivalent of a smooth gradual change in gear ratio as the locomotive speeds up, and does away with jerky, uncertain gear changes.

GENERAL DESCRIPTION OF EQUIPMENT:

The electrical equipment of the locomotive consists of standard railway apparatus adapted to meet the particular requirements of this class of service.

The principal parts of the electrical equipment per locomotive comprise a generator element, electric motor or motors driving the locomotive axles, and switching devices for controlling the flow of current from the generators to the motors and auxiliaries.

The electrical energy is supplied by a main generator which is directly connected to the engine and mounted on a common support.

The current generated by this main power element is governed and controlled by the control equipment, and operates the traction motor or motors which are geared to the axles and perform the actual duty of propelling the locomotive.

The speed of the locomotive and the governor setting of the engine are controlled by a throttle lever connected to the engine governor and the control circuit. A controller consisting of a selector drum provides "forward", "off" and "reverse" positions for the selection of locomotive direction of movement.

Engine Starting

The engines are started by the main generators operating as motors on power from the locomotive battery. Connections to the generator are automatically made simply by closing the "engine start" buttons.

Battery Charging

The battery is charged from automotive type auxiliary generators. Refer to instructions issued by the manufacturer.

LIST OF EQUIPMENT

Item	Req	Type or Style No.	Apparatus	Outline
1	2	189-R7	Main generators.	11-A-7539
2	2	1445-A	Traction motors.	1-D-1159
3	1	TC-485-A	Controller	2-D-1019
4	1	XR-382-M	Pneumatic reverser	44-D-563
5	5	UMJ-134-A	Magnetic contactors, G, G1, G2, M1, M2. G1, G2 with interlock S#1068567 (1 in - 1 out).	1-D-9853
6	2	UMA-275-A	Magnetic contactors, P1, P2. Each with interlock S#1168969 (1 in - 1 out).	1-D-9834
7	1	UV-56-H	Field shunt relay panel. . . .	4-D-2797
8	2	TM	Main generator field resistors, Ass'y #32	L-12795
9	2	M	Motor field shunt resistors, Ass'y #2	53-B-860
10	1	496-R	Battery switch	840168
11	1	XC-131	Throttle switch	4-D-2759
12	2	655	Terminal boards	88-D-599
13	1	HD	Pushbutton station	98-B-838
14	8	KJ	Motor lead connectors, S#588102	813307
15	1	S#999002	Control circuit breaker. . . .	88-D-596
16	100	S#51410	Marking tags	-
17	1	Lot	Miscellaneous terminals. . . .	-
18	1	Lot	Cable consisting of:- 175 ft. motor and generator, 259x.0286, PDS-6439-2. 250 ft. control, 19x.0147, PDS-6439-2	

Locomotive schematic wiring diagram 8-B-9672

8-B-9672

See Envelope in Back of Book

SECTION II

OPERATION

SEQUENCE TEST OF CONTROL EQUIPMENT

In order to test for the correct functioning of each switch contactor and relay, and to determine if the operation of each unit is in proper sequence with the other units the following outline is given:-

1. Preliminary
   (a) Insulate the contacts of the G switch.
   (b) With engine dead, close the battery switch.
   (c) Charge the air system and see that air is furnished to the pneumatic apparatus.
   (d) Place the controller in "off" and the throttle in "idle".

2. Starting Sequence Check
   (a) Close the control switch.
   (b) Close "No. 1 start "button. G1 closes, followed by G. Release button. G1 and G open.
   (c) Close "No. 2 start "button. G2 closes, followed by G. Release button. G2 and G open.

3. Main Circuit Sequence Check.
   (a) Move the controller to "forward" and open the throttle. P1, P2 close.
   (b) Close T1 by hand. M1 closes.
   (c) Close T2 by hand. M2 closes.
   (d) Release T1 and T2. M1, M2 open.
   (e) Note that the starting switches cannot be closed when the throttle is open and the controller in "forward" or "reverse".
   (f) Repeat (a) to (e) with the controller in "reverse". Note that the controller cannot be moved while the throttle is open.

PREPARING UNIT FOR SERVICE

ELECTRICAL EQUIPMENT

All bearings, gears and other parts of the motors, generators, and control equipment should be properly lubricated. Bolts and nuts should be inspected and tightened if necessary. Control fingers and contacts on the controller and reverse drums should be given a light lubrication with a cloth moistened with oil. All fuses should be in place and in good condition.

Check the height of solution in the battery, and the specific gravity, using a tested hydrometer. Be sure all connections to the generator unit and battery are complete, tight and clean. Follow instructions issued by the battery manufacturer for the particular battery on the Locomotive.

MECHANICAL PARTS

Examine the mechanical parts to see that everything is in running order. Check lubrication of brake rigging and journal boxes. See that there are no persons working on the trucks or in any position where they are liable to be injured when the electric circuits are energized or the unit is moved.

AIR SYSTEM

Make sure that all drain cocks on the air reservoirs, air lines, etc., are closed. See that the main reservoir cutout cock, brake cylinder cutout cocks and distributing valve cutout cock are open.

Complete information covering the operation of the various units in the air brake system will be found in separate instruction books furnished by the manufacturer of the equipment concerned.

OIL, WATER AND SAND SUPPLIES

The engine should never be started unless there is sufficient circulating cooling water, and lubricating oil in the respective systems.

The lubricating oil lever in the engine base reservoir should be above the "MIN" mark on the gauge rod. Check fuel and water levels by the gauges in the respective tanks. Follow instruction issued by engine builder.

Fill the sand boxes with dry, clean sand provided by the railway system.

PREPARATORY TO STARTING ENGINE

Before starting the engine, the operator should see that no tools, bolts, nuts, or other materials are lying around the engine or generator where they could possibly get caught or fall into any of the working mechanism.

Control Switches

The battery switch should be closed.

Lubricating Oil System

Valves and system should be set properly.

Fuel Oil System

Valves and system should be set properly.

STARTING THE COMBUSTION ENGINE

1. Place the controller or reverser, where no controller is used, main handle in "Off" and throttle handle in "Idle" position. Close control switch. Throttle may be advanced a few notches for starting.

2. Press engine starting push button and hold until the engine fires. Release when engine fires.

3. Do not attempt to start both engines simultaneously.

4. During the first few minutes of engine operation the engine lubricating oil pressure should be watched to see that normal pressure is maintained.

TESTING MOTOR ROTATION

Every time the traction motor leads or the power terminals to the reverser are disconnected the motors should be tested for correct rotation when reconnected.

This test is very important and it should be carefully made as it is possible for a locomotive to apparently operate correctly in either direction and still have been incorrectly connected which may eventually produce serious and costly motor trouble. For example, if a field and armature lead of a motor are interchanged the motor would operate correctly when the car or locomotive was moved in one direction but in the opposite direction the motor field would be cut out by the action of the reverser. If this condition were to continue in service for some time before being found it would probably result in a "roasted out" motor.

To make this test, operate the locomotive on the least possible number of motors. This may mean opening cutout switches or shutting down a power plant.

If the locomotive can be operated with only one motor the test is very simple. Run the locomotive in the forward direction for a short distance, reverse it and operate in the reverse direction. If the locomotive operates approximately the same in both directions, the connections are correct. Repeat with all other motors on the locomotive operating them one at a time.

If it is impossible to operate on one motor at a time the following procedure should be followed. Oil the track on which the locomotive is to operate spreading the oil on both rails. Then operate the locomotive (on as few motors as possible) on this section of track in the forward and reverse directions until each of the motors operating has slipped its wheels in both directions. Repeat this same test on the other motors (if any) until all motors have slipped their wheels in both directions.

The following combinations are the ones most likely to be encountered in making these tests.

(1) The motor or motors operate the locomotive in the direction indicated by the reversing lever. This indicates the connections are correct.

(2) The motor or motors operate the locomotive in the opposite direction to that indicated by the reversing lever. This can be caused by the reversal of leads to the reverser or by the motor being hung on the opposite side of the axle from that assumed on the diagram. If the reverser leads are interchanged, correct at the reverser. If the latter interchange the motor field leads at the motor lead connectors and repeat tests.

(3) One motor tending to drive its axle in one direction and another trying to drive in the opposite direction. If reverser wiring agrees with the diagram, interchange the field leads of the proper motor so the locomotive will operate according to the reverser handle position.

(4) A motor may operate the locomotive correctly in one direction but slowly or not at all in the opposite direction. This is usually caused by the interchanging of an armature and field lead. Such an error will give correct operation in one direction but will cut the field out of the circuit entirely in the opposite direction. If the two motors are tested at one time, this motor may act as a brake and try to keep its axle from turning. Check the diagram and correct at the proper place.

In correcting any of the above troubles, check with the diagram and correct the circuit at the proper point. This will avoid future confusion caused by the locomotive wiring not agreeing with the diagram.

OPERATING THE LOCOMOTIVE

(1) Watch engine temperature.

(2) Test the air brakes and do not attempt to move the locomotive until the brake pipe gauge hand indicates full brake pipe pressures.

(3) To Start Locomotive and Regulate Speed

After the engines are running, close the run buttons (if used), place the controller or reverser handle for the desired locomotive direction, and notch out on the throttle handle. Opening the throttle handle increases the speed of the engine to increase the voltage across the traction motors and accelerates the locomotive.

Motor field shunting is automatically obtained at a predetermined main generator voltage. A voltage relay controls this transition to close and open the field shunting contactors.

CAUTION: Great care must be exercised to avoid overspeeding the traction motors. Determine the maximum permissible locomotive speed from the wheel size, gear ratio and maximum permissible motor rpm. and do not exceed that speed.

As there are no resistors in series with the traction motor, any notch on the throttle control may be used as a running position, depending on operating conditions. To decrease speed, notch back the main handle.

(4) To Stop Locomotive

Move the throttle to the "Idle" position and apply the air brakes in the usual manner.

(5) To Reverse Locomotive

With the throttle handle in "Idle", throw controller or reverser handle to the position required.

CAUTION: With the locomotive in motion, power should never be applied with the controller or reverser handle in the position opposite to the direction of locomotive motion. If recourse to such action is necessary to stop the locomotive abruptly, it must be remembered that serious damage to the motors is liable to result.

LEAVING THE LOCOMOTIVE

1. Stop engines by operating engine shut down valves.
2. Pull out run buttons if used and open control switch.
3. Place controller or reverser handle in "Off" (Remove to lock-controller.)
4. Open battery switch.
5. Set hand brake.
6. Water system must be properly protected in cold weather.

POSSIBLE TROUBLES AND REMEDIES

If the purpose and proper function of each part of the equipment is learned it will assist in the quick location and remedy of trouble.

(1) GENERATOR FAILS TO CRANK ENGINE

If instructions for starting the engine have been observed and the engines fail to start, the trouble may be due to the following:

(a) Low Battery Voltage:

This is indicated by failure of the starting contactors to close or by failure of the starting motor to bring the engine up to firing speed; check battery charge and examine for corroded terminals.

(b) Failure of Contactors to Close:

If fuses are good and battery is charged, check for open circuits in the control wiring. Also check the contacts on the push button.

(c) Starting Switches Close But Engine Does Not Start

Check for open circuit in wiring, inspect switch contacts and fuse.

(2) FALLING OFF OF POWER

A decrease in engine power should become manifest to the operator by failure to obtain the usual speed with a given load on a given part of the run, or by character of engine noise or by meter indication.

The falling off of power may be due to any of the following causes:

(a) Engine Condition

For remedy see engine builders instruction book.

(3) LOSS OF POWER INDICATED BY OVERSPEEDING OF ENGINE

(a) May be due to failure of the field contactors to operate properly. Check for open circuits in wiring or poor or dirty or corroded contacts on switches.

(b) Check for broken or loose wiring at resistors. Check closing of battery charging contactor.

(c) Check wiring and fingers at terminal boards, controller, if used, throttle device, etc.

(3) LOSS OF POWER INDICATED BY OVERSPEEDING OF ENGINE - Cont'd.

(d) Check line switches to insure that they close properly with good contacts. Failure of line switches to close may be due to poor finger or interlock contact at reverser or controller or failure of reversal to throw to correct position.

(4) COMPLETE FAILURE OF ELECTRICAL POWER

(a) No Voltage on Main Generator: The cause may be due to the failure of the field switches to close, burned out resistors in the main or auxiliary generator field circuits or open circuits elsewhere in the field circuit.

(b) Failure of Reverser to Throw (Pneumatic Types): Throw reverser by hand.

(c) Open Circuit in Control Wires: Check fingers on controller, interlock fingers on the reverser and control wiring connections.

(d) Faulty Contactor Operation: May be due to too wide an air gap on magnetic switches, or binding to prevent free movement and good contact.

(5) MISCELLANEOUS TROUBLES CAUSING APPARENT LOSS OF POWER

If the engine is running at full speed and load, and the car or locomotive does not make its usual speed, the trouble may be due to: dragging brakes, air brake not fully released, head winds, or hot truck journal bearings, or traction motor axle or armature bearings.

(6) FAILURE OF BATTERY CHARGING:

As indicated by the battery ammeter, trouble may be due to:

(a) Blown charging fuse
(b) Improper voltage regulator operation
(c) Burned-out auxiliary generator field resistor
(d) Open circuits in wiring
(e) Improper reverse-current relay operation.

(7) COMPRESSOR FAILS TO PUMP UP AIR:

If the compressor does not operate properly the cause may be as follows:

(a) Compressor Operates but Fails to Maintain Air Pressure

Check angle and drain cocks, piping, air hose, magnet valves, safety valves and other points for leakage. If still unable to maintain the proper pressure, report to Maintainer.

(7) COMPRESSOR FAILS TO PUMP UP AIR: - Continued

(b) Faulty compressor valve operation can cuase failure to maintain pressure excessive operation of compressor and overheating.

(8) MISCELLANEOUS TROUBLES:

(b) Lubricating and Cooling Systems:

Refer to sections devoted to these subjects. Do not operate with inadequate lubrication oil or water excessive temperatures low pressures diluted lubricating oil hot bearings or other abnormal conditions that may result in serious damage.

(9) GENERAL

A general study of this book and the actual equipment will enable the operator to diagnose and care for many minor cases of trouble. Some troubles can be corrected by the Operators but some obviously have to be remedied by the Maintainers. In general, the equipment should not be operated under conditions that will result in serious damage tp parts. All troubles should be promptly corrected to obtain the longest life of all parts.

(10) COMMON CAUSES OF FAULTY OPERATION:

Some of the most common causes of faulty operation of swtiches, control and motors of the auxiliary and main apparatus are:

(a) Improper contact at interlocks and control fingers caused by dirt gummy surface due to use of heavy oil burning (oxide) and improper adjustment.

(b) Contactors

Too wide an air gap (contact opening) resulting in an unnecessarily high closing voltage, binding at bearings loose shunts or loose springs. Low control pressure or leaky valves on remotely operated devices.

(c) Motors

Bearing troubles due to improper lubrication assembly or excessive wear; brushholders loose broken too close to commutator; brushes greatly worn binding improper grade; loose connections; broken springs; chaffed leads.

(d) General

Excessive vibration causing breakage; loose connections at terminals fuses, etc; blown fuses.

SECTION III

MAIN GENERATOR

THE GENERATOR

General Description

The generator is a shunt-wound direct-current machine of standard Railway Construction having a single housing-supported anti-friction bearing at the front end. It is arranged to be directly connected, through a flexible coupling, to the engine flywheel. The machine is self-ventilated, air being drawn through openings in the front housing, circulated through the armature ducts and around the field coils, and discharged by a fan through air outlets in the flywheel housing.

In addition to the commutating and main shunt fields, an auxiliary field and a series field are mounted on the main field poles. The auxiliary field is energized from a battery source, to provide separate excitation for the generator, thus assuring a rapid and positive build-up of generator voltage and improving the voltage regulation for application to this particular class of service. The series field is supplied to be available for starting service in those cases where the generator is used as a motor in starting the engine.

MAINTENANCE

GENERAL INFORMATION

Keep the generator clean and dry. Keep the generator free from dust by occasionally blowing it out with dry compressed air or hand bellows. If high air pressure is used, the nozzle of the air hose should not be held too close to the windings, as the pressure may damage the insulation tape.

BEARINGS AND LUBRICATION:

The generator is equipped with a ball bearing at the commutator end. To insure continued satisfactory operation of this bearing it must be properly lubricated and all dirt or other foreign matter excluded from contact with the bearing. The lubricant which is grease, is held in the bearing chamber around the bearing by two steel labyrinth seals, one at each side of the bearing. The bearing is provided with an overflow for excess grease. It is best to avoid over-lubricating of these bearings as well as under lubrication. It is recommended that one ounce of grease, Westinghouse M-7280-1 be added to the bearing after one month of service and every six months thereafter. If grease leakage or overflow is noticed, a period longer than six months between greasings should be allowed.

Fittings should be thoroughly cleaned before adding any grease. At periods ranging from one to three years, the outer bearing cap should be taken off and the old grease removed from the bearing and grease chamber by a wash consisting of equal parts of kerosene and denatured alcohol; all caked or hardened grease will be removed. The cleansing liquid should then be removed by washing with a hot, light oil before repacking the bearing with new grease.

BRUSHES AND COMMUTATOR

The brushes are set on a neutral position at the factory. The brushes and brushholders should be inspected at least once a month to be sure that the presence of grit or dirt has not caused any of the brushes to stick in the brushholders and that the proper spring tension is maintained at the value specified on the General Data Sheet. Brush pressure can be readily measured by using a small spring balance attached to the pressure finger directly over the brush and pulling straight up in a line with the brush travel until the finger is just lifted clear of the brush.

If the brush pressure is incorrect, remove the brushholder and adjust as follows:-

1 - With the brushholder clamped in a vise, insert a screwdriver in the end of the slotted pin and relieve the tension on the cotter pin.
2 - Remove the cotter pin, increase or decrease the tension as required, and replace the cotter pin.

When a brushholder is to be put back in place, care should be taken that the brushholder box is kept a distance of 1/8 of an inch from the commutator. It is necessary to maintain this in order to keep the brushes from chattering and breaking. A sheet of 1/8 inch fibre provides a convenient gauge.

See that the tap bolts which clamp the brushholder pins are kept tight and that the "pigtail" shunts on the brushes are securely fastened under the screws provided for this purpose on the brushholder castings.

Keep the commutator clean, wiping it at frequent intervals with a clean canvas cloth free from lint. A commutator that is taking on a polish and shows no signs of wear requires no other attention, but if it is roughened or badly worn it should be repaired by turning, or preferably, by grinding or stoning. Never use emery cloth or emery paper on the commutator.

INSTRUCTIONS FOR DISMANTLING AND REASSEMBLING GENERATOR

TOOLS

To facilitate dismantling of the generator the shop should be equipped with a set of special tools which may be made according to the tool drawing included in this section or may be purchased from Westinghouse Electric & Manufacturing Company.

DISMANTLING GENERATOR FROM ENGINE

In case it is necessary to make internal repairs to armature, bearing, or field coils, the following procedure should be followed in taking the generator apart.

1. Electrical connections should first be removed between the generator and other apparatus.
2. Remove the bolts holding coupling discs to flywheel,
3. Remove the bolts holding generator frame to engine bell housing.
4. Remove the bolts holding generator supporting feet to the mountings.
5. Slide the generator away from the engine and insert wedges between armature and poles to prevent the armature rubbing the poles.
6. The complete generator may now be lifted from its mountings and removed from the locomotive.

REMOVING ARMATURE

1. If necessary to remove the armature from the generator, first dismantle the generator from the engine as described in a preceding paragraph.
2. Lift the brushes far enough out of the brush box that they will not slide back on the commutator.
3. Protect the commutator by wrapping it with heavy fish-paper.
4. Remove the bolts holding the coupling discs to the generator coupling flange. This allows the coupling disc and fan assembly to be removed and permits handling the armature with ropes without damage to the discs.
5. Remove the Alemite fitting from the bearing cap at the front end and remove the four 1/2" bolts that hold the front bearing cartridge in the housing.

6. Insert the two armature removal studs in two of the four tapped holes in the cartridge. These studs are not furnished with the generator, but can be made similar to the long 1/2" studs shown on the tool drawing. These studs help to keep the commutator from striking the brushholders.

7. The armature can now be removed from the generator by passing a heavy rope around the armature and moving the armature slowly toward the coupling end of the generator. A piece of pipe will be needed over the shaft extension at the commutator end to permit sliding the armature through far enough that it can be handled entirely from the other end. Care must be taken that the armature does not rub the poles during this operation, and that the commutator does not rub the brushholder box.

REMOVING ARMATURE BEARING

1. Remove the armature from the generator as described in a preceding paragraph and block in a horizontal position.

2. Remove the six bolts which hold the outside bearing cap to the bearing cartridge and remove the cap.

3. Straighten the lock washer and remove the bearing lock nut using the special spanner wrench.

4. Use the special puller tool shown on the attached tool drawing. Screw the studs into the bearing cartridge: place against the shaft the steel plate with holes drilled in at the same spacing as the tapped holes in the bearing cartridge and tighten the nuts on the outside of the plate until the bearing assembly is pulled off the shaft.

5. To remove the bearing from the cartridge, tap the cartridge with a rawhide mallet and slip the bearing out. Do not pry or hammer on the bearing.

6. Wrap the bearing in a protective covering, the bearing to be cleaned and inspected before re-assembly. The grease in the bearing will serve to prevent rusting.

Assembling Armature Bearing

Refer to the bearing assembly drawing as a guide for proper bearing assembly.

1. Place the armature preferably in a vertical position. A hole a little larger than the armature diameter cut in a low wooden table or bench together with some wooden wedges to keep the armature from dropping through serves very well.

2. Clean all parts thoroughly before starting to assemble. Carefully inspect the bearing for cracks, pitting, or excessive wear.

   Caution: Care must always be taken to keep all dirt and grit away from ball bearings.

3. Place the bearing, cartridge, and grease thrower in a high temperature oil such as compressor oil or Westinghouse PD #2268 oil at a temperature of 100 C. (212 F). Support all parts approximately 2 inches above the bottom to allow dirt to drop below the bearing and to prevent the heat from striking the bearing directly.

4. Remove the bearing cartridge from the hot oil, wipe off the excess oil and drop into place over the shaft.

5. Remove the grease thrower from the hot oil, wipe off excess oil and shrink on the shaft with the chamfered side out and hold in place solidly against the shoulder on the shaft until it has cooled.

6. Fill the grease pocket in the bearing cartridge half full of Westinghouse Grease M-7280-1.

7. Remove the bearing from the hot oil, wipe off the inner and outer fits and immediately drop into place while the cartridge bore is still expanded. Do not force this assembly - the bearing must slip into place. Hold the bearing solidly in place against the grease thrower until tight.

8. Apply the bearing lock washer and lock nut and lock securely.

9. Fill the spaces between the balls in the bearing with Westinghouse Grease M-7280-1.

10. Fill the grease pocket in the outer bearing cap half full with Westinghouse Grease M-7280-1. Bolt the cap with its gasket in place to the bearing cartridge.

    Note: Some portion of the grease in the bearing cap should make contact with the bearing when assembled.

11. Check to make sure that the alemite fitting is not damaged.

ASSEMBLING GENERATOR

1. Assemble the generator in a horizontal position.

2. Protect the commutator by wrapping it with heavy fish-paper.

3. When placing the armature back in the frame, the two armature removal studs inserted in the taped holes of the bearing cartridge act as a guide to bring the bearing cartridge into position lining up with the bolt holes in the housing.

4. Lift the armature with a heavy rope around the core and move it slowly into the frame. Use a piece of pipe over the shaft extension at the commutator end to guide the armature into place. Take care that the armature does not rub the poles and that the commutator does not rub the brushholder boxes.

5. When it is found that some force is needed to pull the bearing cartridge into place in the commutator end housing, it is advisable to use two 1/2" bolts, longer than the four 1/2" bolts regularly used for holding the cartridge to the housing. These two longer bolts can be inserted through the holes in the housing and used to pull the bearing cartridge close enough to its final position in the housing that the four regular bolts can be put in and tightened.

6. Replace alemite fitting in bearing cap.

7. Replace coupling disc and fan assembly.

8. Remove fishpaper around commutator and lower brushes.

AMy-25

INSTRUCTIONS FOR LINING UP SINGLE BEARING GENERATOR WITH ENGINE

1. See that the contact faces of the generator coupling discs, the engine flywheel and the bell housing fits are clean with no burrs or rough spots.

2. Check the coupling face of the engine flywheel to make sure it is perpendicular to the axis of the crankshaft. This is best done by fixing a surface gage rigidly to the engine bedplate and recording the total eccentricity shown by the gage on the flywheel face in one complete revolution. The total eccentricity should not exceed .0005 inch.

3. Support the armature on the lower main pole pieces by strips of fibre 3/32" thick, so placed that they can be withdrawn from the generator as it is assembled on the engine.

4. The generator should now be adjusted until it is concentric with the engine shaft. The generator fan will now freely enter the engine bell housing.

5. Move the generator toward the engine until the coupling fits are just engaged but with the frame free of the engine bell housing. Insert the coupling bolts and screw in until just snug.

6. Remove the fibre strips that were used to support the armature.

7. Engage the frame and flywheel fits and insert all frame bolts.

8. Gradually tighten bolts, alternating between coupling and frame fits until all bolts are tight, taking precautions so that fits enter without being forced.

The frame and bell housing fit must not be pulled home by the coupling bolts. The bell housing bolts must be tightened at the same time that the coupling bolts are being tightened.

TYPE 189-R-7 GENERATOR

GENERAL DATA

Operating Limits

Maximum Safe R.P.M.	2500
Maximum Volts	400
Maximum Amperes	650
Maximum Shunt Field Amperes	12.0
Maximum Battery Field Amperes	4.0

Brushes (See Renewal Parts Data for Ordering Information)

Number of Brush Arms	4
Brushes per Arm	2
Grade of Brushes	National AX-5
Size of Brushes (Shunted)	3/4" x 1-7/8" x 2-1/4"
Brush Tension with Full Length Brush	8 to 9 lbs.

Bearings (See Renewal Parts Data for ordering Information)

Type-Railway, Free Fit Ball Bearing.

Lubrication-Use Westinghouse Ball and Roller Bearing Grease M-7280-1.

Normal Pole Bores At Center of Poles

Main Poles	11.188 Inches
Commutating Poles	11.560 Inches

Weights

Armature	400 lbs.
Complete Generator	1350 lbs.

Resistance of Windings at 25°C:

Armature	.012 ohms
Commutating Field	.009 ohms
Main Shunt Field	9.6 ohms
Battery Shunt Field	3.8 ohms
Series Field	.0034 ohms

Reference Drawings

Outline	11-A-7539
Bearing Assembly	4-B-3110
Field Wiring Diagram	6-D-5027
Armature Winding Diagram	31-D-96
Armature Winding Materials	36-B-657
Tool Drawing	34-A-1023

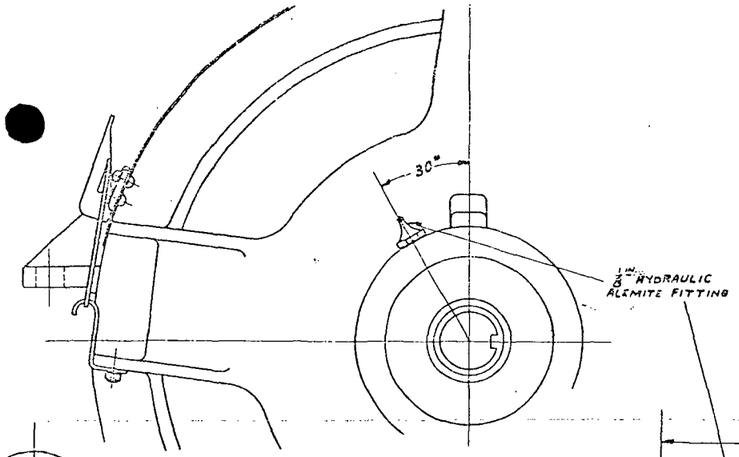
WESTINGHOUSE ELECTRIC & MFG. CO., EAST PITTSBURGH, PA., U.S.A.

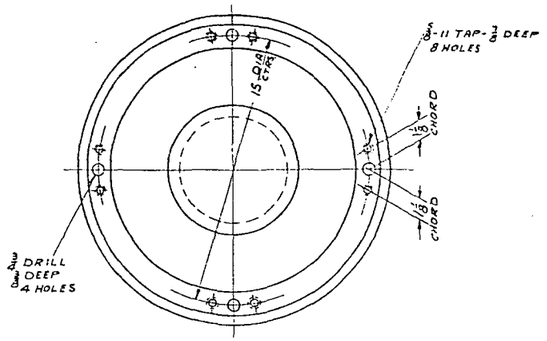
TRANSPORTATION GENERATOR D.C. NO. 189-R7

OUTLINE

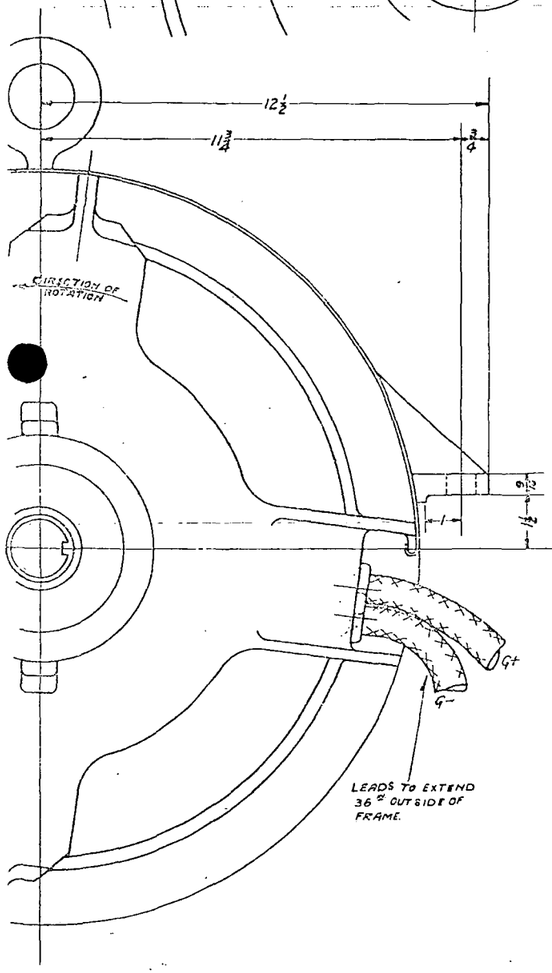
DIMENSIONS IN INCHES — SCALE NONE

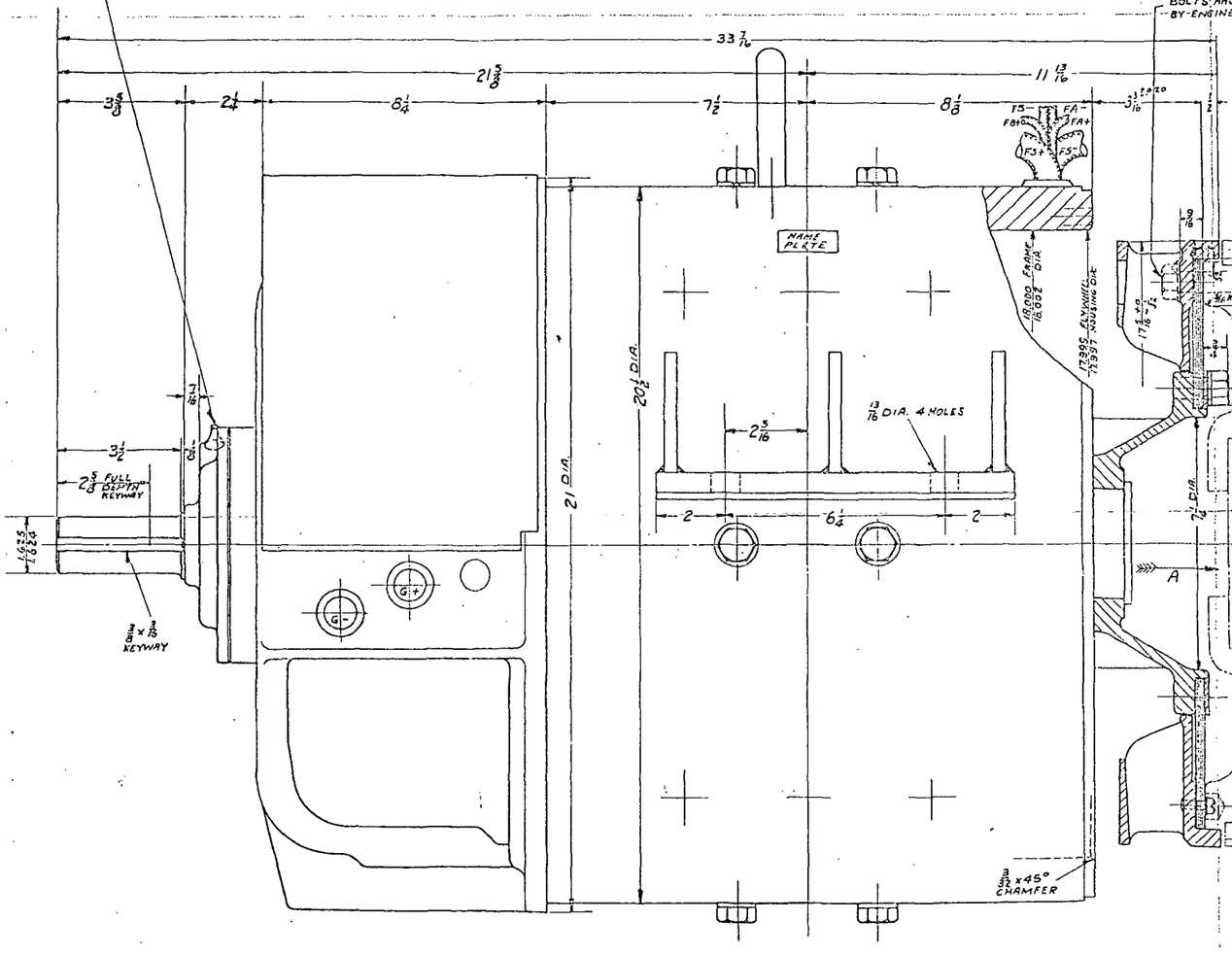
DWG. NO. 11-A-7539 — SUB. NO. 12

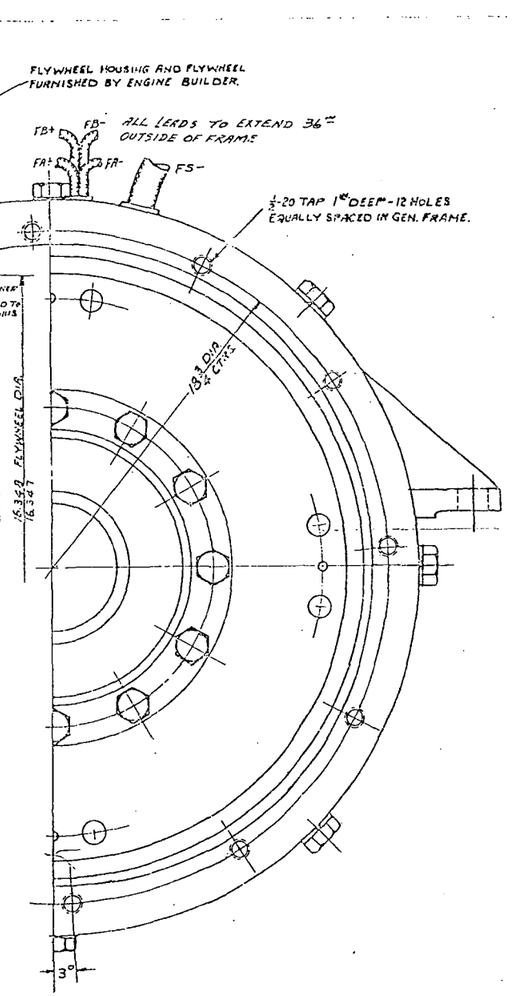




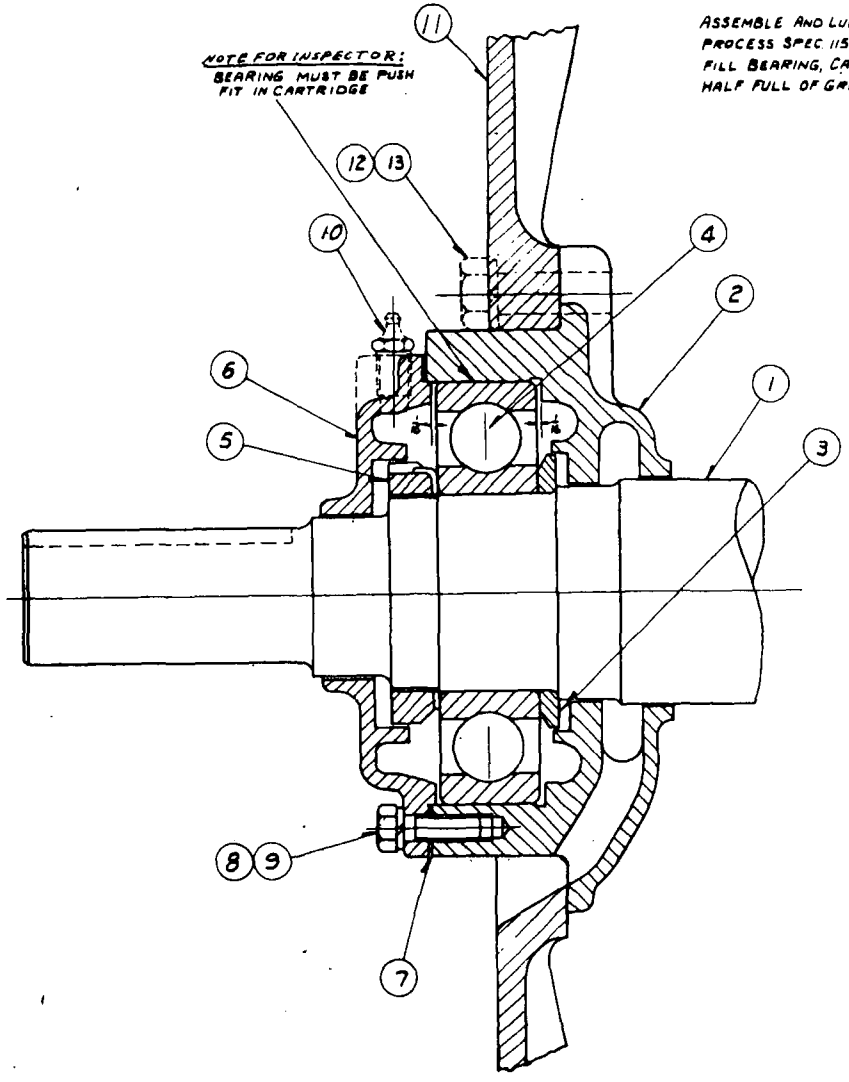
VIEW OF FLYWHEEL LOOKING IN DIRECTION OF ARROW "A"







Type 189-R-7 Generator - Outline
Dwg. 11-A-7539-2



ASSEMBLE AND LUBRICATE BEARING AS PER PROCESS SPEC. 115416 PART III. EXCEPT FILL BEARING, CARTRIDGE AND BEARING CAP HALF FULL OF GREASE M-7280

Item	Description-Material-Ref. Dwg.	Stock No.	Part No.	Req.
1	SHAFT ITEM 1 DWG. 4-B-3102			
2	BEARING CARTRIDGE ITEM 2 DWG. 18-9632			
3	OIL THROWER ITEM 4 DWG. 76-D-582	1042677		1
4	60 mm MEDIUM SERIES POS(F) BALL BEARING PD SPEC. 4622-1			1
5	60 mm STD B.B. LOCK NUT & LOCK WASHER			
6	OUTER CAP ITEM 1 DWG. 18-9636			
7	GASKET ITEM 2 DWG. 18-9636			
8	3/8-18 x 1 HEX. HD. S. BOLT			6
9	3/8" LOCK WASHER			6
10	ALEMITE FITTING (HYDRAULIC)	782785		1
11	HOUSING DWG. 7-A-1122			
12	1/2-13 x 1 1/2 HEX. HD. S. BOLT			4
13	1/2" LOCK WASHER			4
14	4 1/2 OZ. GREASE #M-7280			1

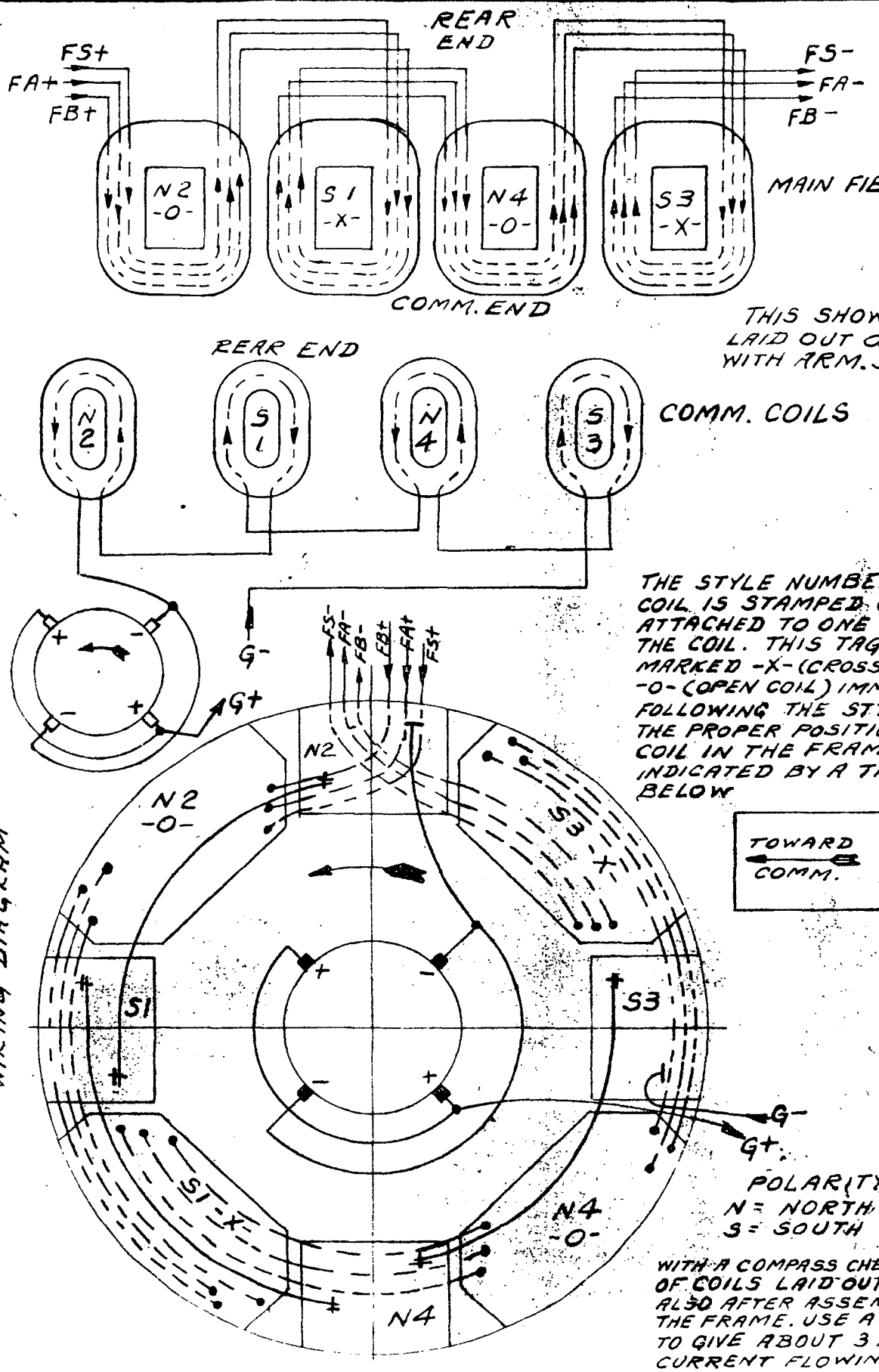
Type 189-R-5 Generator Bearing Assembly
Dwg. 4-B-3110-1

Dates 5/1/61 4/14/42 9.16.42

WESTINGHOUSE ELECTRIC & MFG. CO., EAST PITTSBURGH, PA., U. S. A.

DIMENSIONS IN INCHES TRANSPORTATION GENERATOR-D.C.-NO.189-A7 DWG. NO. 6-D-5027

WIRING DIAGRAM



VIEW LOOKING AT COMM. END

THIS SHOWS COILS LAID OUT ON BENC WITH ARM. SIDE UP

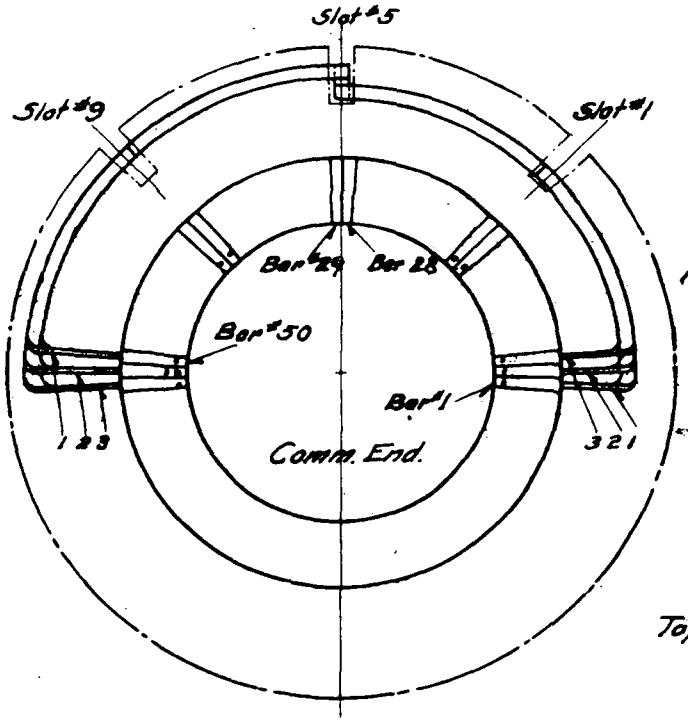
THE STYLE NUMBER OF EA COIL IS STAMPED ON A TAG ATTACHED TO ONE SIDE OF THE COIL. THIS TAG IS ALS MARKED -X- (CROSS COIL) C -O- (OPEN COIL) IMMEDIATE FOLLOWING THE STYLE NUM. THE PROPER POSITION OF T COIL IN THE FRAME IS INDICATED BY A TAG SHOW BELOW

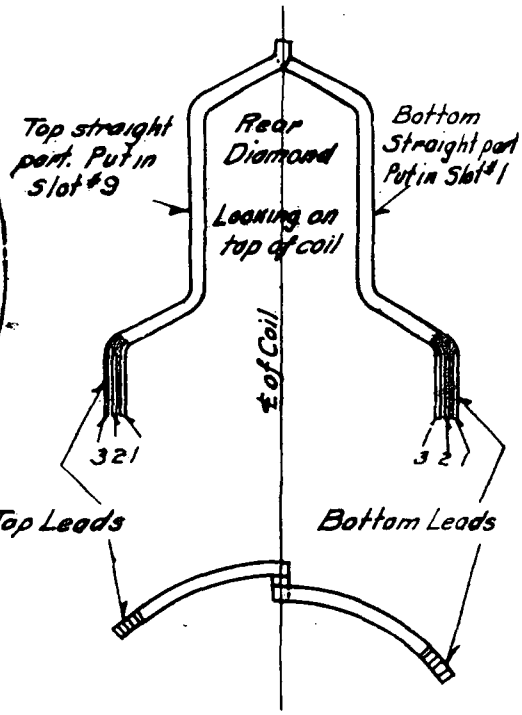
POLARITY TEST
N = NORTH POLE
S = SOUTH POLE

WITH A COMPASS CHECK POLAR. OF COILS LAID OUT ON A BE AL SO AFTER ASSEMBLED IN THE FRAME. USE A RESISTO TO GIVE ABOUT 3 AMPERE CURRENT FLOWING IN THE DIRECTION SHOWN BY THE ARROWS

6-D-502

℄ of Coil on ℄ of Slot #5 and on
℄ of Mica between Bars #28 and #29





Laying off Windings.

1-The center line of starting coil is on center line of Slot #5 and on center line of mica between bars #28 and #29.
2-Starting at bar #28 count back (clockwise) to bar #1 and in this bar place lead #1, from bottom leads of starting coil.
3-Count from bar #1 forward (counter clockwise) to bar #50 and in this bar place lead #1 from top leads of starting coil.

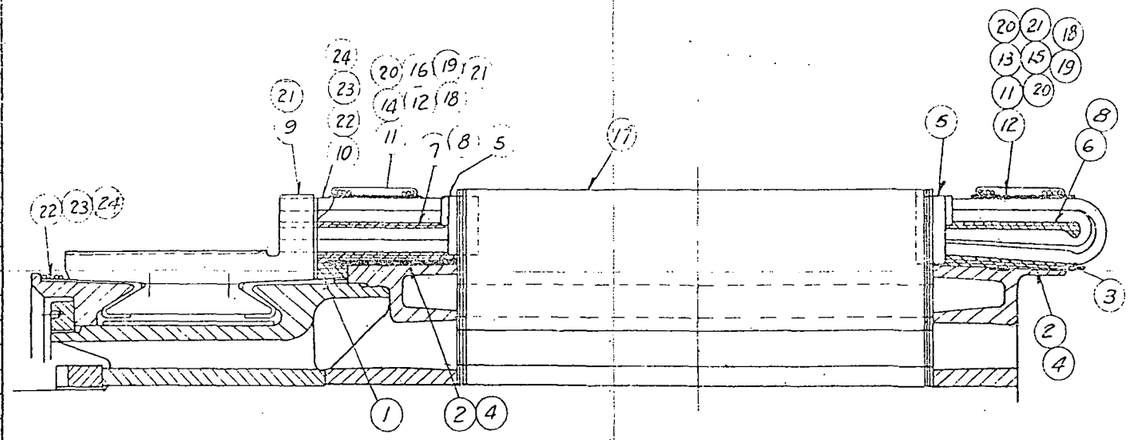
Winding Data

Number of Armature Slots - 33
Number of Commutator Bars - 99
Coils lie in Slots #1 and #9
Leads connect to bars #1 and #50

Commutator Center Punched on end
∴ Locates top leads from starting coil.
∴ Locates bottom leads from starting coil
∴ Locates starting coil in slots #1 and #9

Armature Winding Diagram for Main Generator
Drawing 31-D-96-1

ITEM	DESCRIPTION AND MATERIAL	PDS M#	STYLE NO.	REQ.	DRAWING	ITEM	ROUT-ING	APPLICATION

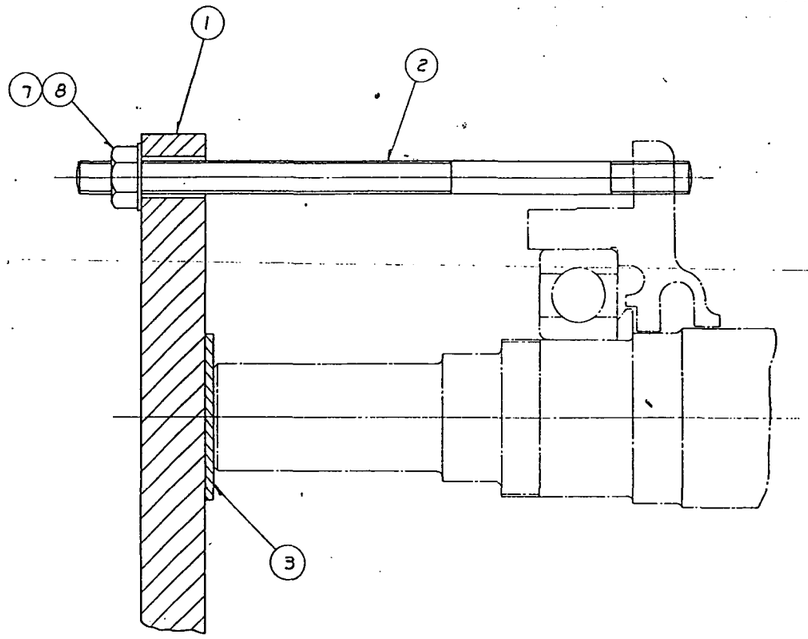


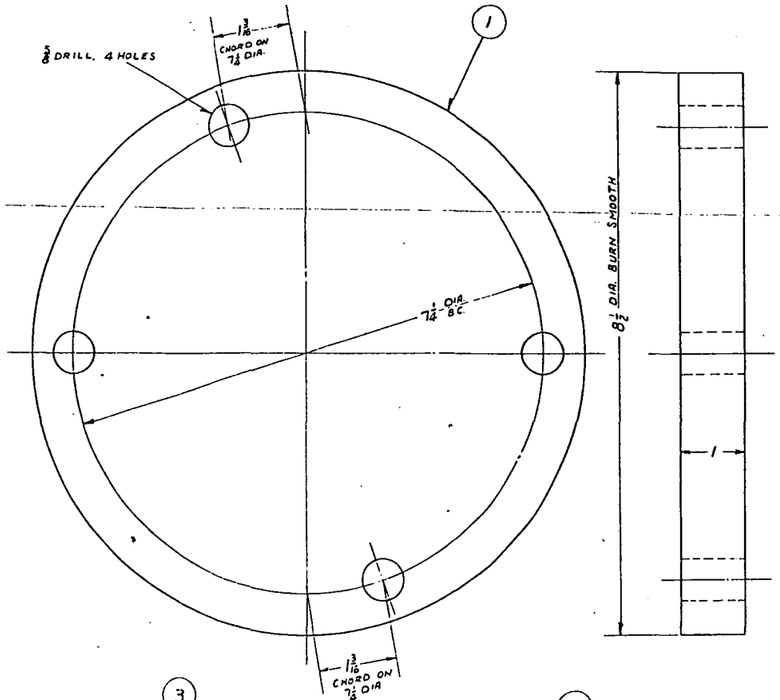
ITEM	DESCRIPTION AND MATERIAL	PDS M#	STYLE NO.	REQ.	DRAWING	ITEM	ROUT. LNG	APPLICATION
+ 1	1½ LBS. OF CEMENT	677						FILL BACK OF COM.
+ 2	MOULDED MICA RING	251		2	778960	8		FRONT AND REAR COIL SUPPORT
3	HOOD FROM 36 x 6 OF .017 DRILLING	1724	510374	1	821585	5		REAR COIL SUPPORT
+ 4	15 YDS OF .010 x 1" TR CLOTH TAPE	1219		1				OVER ITEM 2
5	FISH PAPER U PIECE	1545	844416	66	28-D-366	1		END OF SLOTS
6	STRIP 36 x 2 3/4" OF .012 FISHPAPER AND MICA	232	510031	2	821589	14		BETWEEN REAR COIL ENDS
7	STRIP 36 x 2 5/8" OF .012 FISH PAPER AND MICA	232	508426	2	821589	4		BETWEEN FRONT COIL ENDS
+ 8	STRIP 70 x 7½" OF .024 FRICTION CLOTH	1725		1				TO MAKE PADS OF 6 AND 7
+ 9	FILLER 1" OF .125 x .129 COPPER	1467	180409A	99	266300	1		TOP OF COM NECK
+ 10	1 LB. OF CEMENT	677		1				BETWEEN TOP LEADS
+ 11	15 YDS. OF .010 x 1" TR. CLOTH TAPE	1219		1				LEVEL UNDER BANDS
+ 12	75 YDS OF MACHINE THREAD	1828		1				ASSIST IN BANDING
13	STRIP 36 x 2 1/4" OF .012 FISH PAPER AND MICA	232	581510	2	821589	24		UNDER REAR BANDS
14	STRIP 36 x 2" OF .012 FISH PAPER AND MICA	232	508425	2	821589	3		UNDER FRONT BANDS
15	STRIP 36 x 2 1/4" BIAS CUT ASB. CLOTH	1250	709218	1	897186	6		UNDER REAR BANDS
16	STRIP 36 x 2" BIAS CUT ASB. CLOTH	1250	709217	1	897186	5		UNDER FRONT BANDS
17	WEDGE 5 1/4" x .648 OF 5/32" TK MICARTA	256	1194874	66	1-D-3886	5		HOLD COILS IN SLOTS
18	CLIP 1" x 4" OF .022 TINNED STEEL		303490	18	411665	6		UNDER BANDS
+ 19	2 LBS. OF .064 BANDING WIRE	1474		1				TEMPERORY BANDS
+ 20	2 LBS. OF .072 BANDING WIRE	6593		1				FINAL BANDS
+ 21	1 LB. OF TIN SOLDER	2290		1				BANDS AND COM.
+ 22	35 YDS OF 1/16 I.D SLEEVING	7842-1		1				V RING AND OVER
+ 23	1/16 PT OF CEMENT	8113-1		1				TOP LEADS BACK
+ 24	1/16 PT. OF CEMENT	672		1				OF COMMUTATOR
+ 25	1/2 QT OF VARNISH	2227		1				DIP AND BAKE

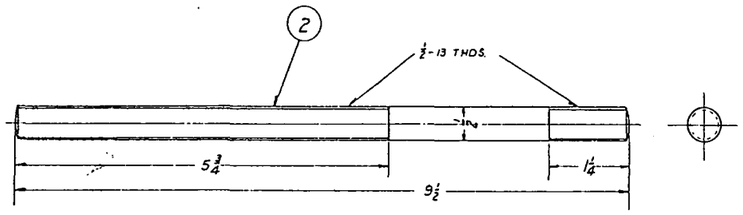
+ THESE ITEMS ARE NOT INCLUDED IN STYLE NUMBERED SETS BUT SHOULD BE PURCHASED IN BULK OR SEPARATELY.

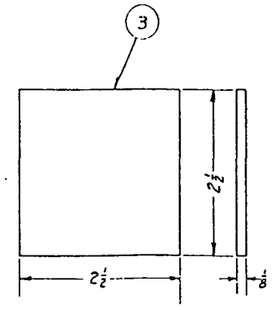
CLASS	DESCRIPTION	STYLE NO.	ITEMS
A	CUT COIL INSULATION	844711	3
B	SLOT AND END INSULATION	844712	5-6-7-17
C	CUT CONNECTING MATERIAL		
D	CUT BANDING MATERIAL	844713	13 TO 16-18
1	CUT WINDING INSULATION	844714	3-5-6-7-13 TO 18
2	COMPLETE WINDING MATERIAL	844715	1-3 TO 8-10 TO 25
3	COMPLETE WINDING MATERIAL PLUS		
	MOULDED MICA AND MECHANICAL PARTS		ALL

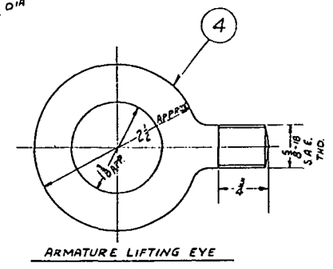
Type 189-K-3 Generator Winding Material
Dwg. 36-B-657-3



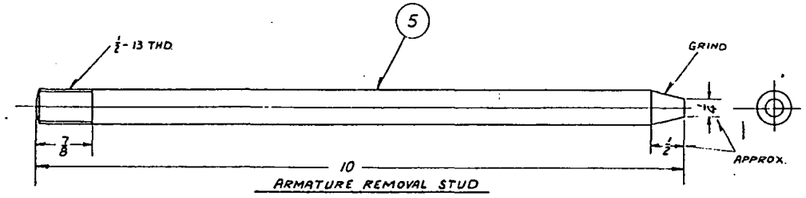




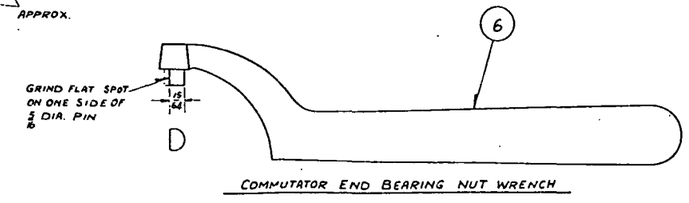




ARMATURE LIFTING EYE



ARMATURE REMOVAL STUD



COMMUTATOR END BEARING NUT WRENCH

WESTINGHOUSE ELECTRIC & MFG. CO., EAST PITTSBURGH, PA., U. S. A.

TRANSPORTATION GENERATOR D.C. NO. 189-53

TOOLS

DIMENSIONS IN INCHES — SCALE 1:1

DWG. 4-A-1023 SUB. 1 — BILL OF MATERIAL — FINISH CHART

Item	Description-Material-Ref. Dwg.	Pat. Cust. Use No.	Style No.	Pat. No.	Req.	Tool Record Space. No. in ◯ = Item No.
*1	PLATE FROM 1" TK. S. PLATE #2001				1	
2	STUD ITEM 2 DWG. 4-A-1012				1	
3	BRASS CUSHION ITEM 6 DWG. 4-A-1012				1	
+4	LIFTING EYE FROM 3/8 PLAIN EYE BOLT BLANK		1154452		2	
5	STUD - ITEM 5 DWG. 4-A-1015		1154489		2	
6	WRENCH FROM J.H. WILLIAMS & Co. WRENCH CAT. NO. 480		1154493		1	
7	1/2"-13 HEX. S. NUT				4	
8	1/2" WASHER		3223		4	

*443-A PLATE ITEM 1 DWG. 4-A-1012 MAY BE USED.

+PURCHASE BLANK FROM J.H. WILLIAMS & Co. CAT NO 7

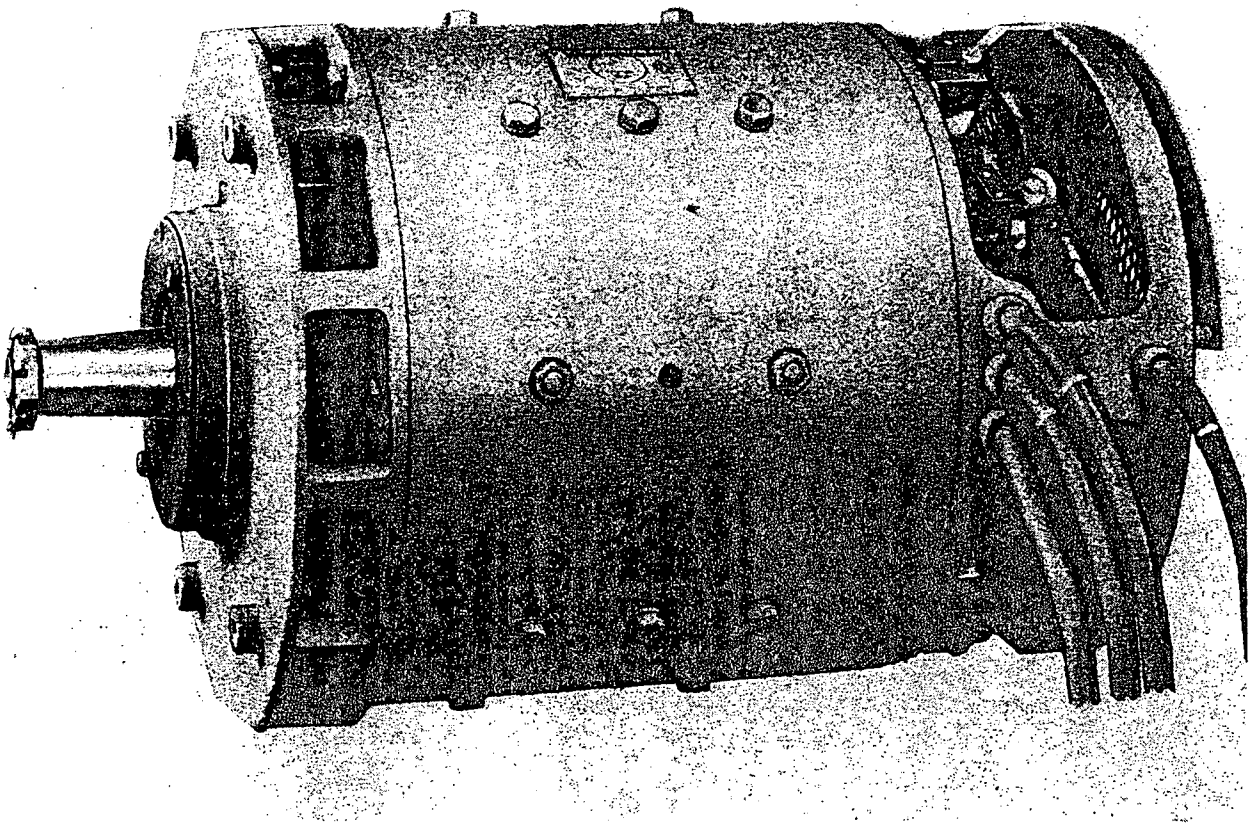
COMPLETE BEARING PULLER STYLE 1154491 = 1 OF ITEMS 1-7-8 THIS DWG. + 1 OF ITEMS 2-6 DWG. 4-A-1012.

DO NOT PRINT BELOW THIS LINE — IF NECESSARY, START NEW BILL OF MATERIAL ACCORDING TO THE DRAWING SYSTEM

4-A-1023

SECTION IV

TRACTION MOTORS



Type 1443-A Traction Motor
Photo 271212-A

Awr-2
Rev.

TYPE 1443-A TRACTION MOTOR

GENERAL DESCRIPTION

The Westinghouse Type 1443-A Motor is a four-pole direct-current commutating pole, series-wound motor arranged for self-ventilation by means of a fan bolted to the coupling end of the armature.

MAINTENANCE

BEARINGS AND LUBRICATION

The bearings are standard railway motor type bearings. Replacements should be ordered according to information given in the Renewal Parts Data. The bearing at the pinion end is of the roller type and is lubricated by the o l in the gear case. The bearing at the commutator end is a ball bearing and is arranged for grease lubrication. Westinghouse Grease M-7280-1 is recommended by the bearing suppliers and has been found by operating experience to perform satisfactorily in these bearings. Under normal conditions the commutator end bearing should not require lubrication more thanonce every three months. The amount of grease to be added will be from 1/2 to 1 ounce per bearing at each lubrication.

The correct amount of grease for proper bearing lubrication depends upon the severity of service and the number of hours of operation. A definite greasing schedule should be followed. A careful check of the bearings whenever the motor is dismantled for repairs or for routine inspection will determine whether the greasing schedule has been satisfactory or should be changed in the future.

Overgreasing of bearings may be as harmful as insufficient greasing and should be avoided. Overgreasing of bearings is easily evident as indicated by leakage of excess grease out through the labyrinth seals into the motor where it gets onto the commutator, brushes, brushholders and windings. If grease leakage is noticed, the time interval between greasings is too short and should be lengthened or the amount of grease added at each greasing should be decreased until further leakage is prevented.

BRUSHHOLDERS

The pressure of the brushes on the commutator is maintained by means of flat clock type springs which exert a force on the top of the brush. The force can be measured by attaching a small spring balance to the pressure finger directly over the brush and pulling straight up in a line with the brush travel until the finger is just lifted clear of the brush. Refer to General Data Sheet for Recommended Brush Pressure.

Incorrect Brushholder spring pressures can be discovered with the brushholders in place in the motor by lifting the brush fingers one at a time and comparing the feel of the tension of all fingers.

The procedure to be observed in adjusting brushholder springs is as follows:-

1. Remove brushholder from frame and place in a vise.

2. Insert screw driver in slotted end of pin and relieve tension on cotter pin.

3. Remove cotter pin.

4. Increase or reduce tension as needed and replace cotter pin.

5. Replace brushholder in frame maintaining 1/8-inch clearance between brushholder and commutator to minimize the possibility of brush breakage. A sheet of 1/8-inch fibre provides a convenient gauge.

6. Tighten the tap bolts which clamp the brushholder pins and connect the cable lead.

7. The clearance between the brushholder and the commutator and the tightness of the tap bolts which clamp the brushholders should be checked even if brushholders are not removed from frame.

CARBON BRUSHES

Under no circumstances should a carbon brush be permitted to wear down so far that the brushholder finger bears on the carbon box. Any brush which may wear to such an extent that the finger will be within 1/8 of an inch at the end of its travel before the next inspection should be replaced.

The thickness of the carbon brush is important and the clearance of a new brush in a brushholder should be approximately .004 to .010 inch. If it is less, the carbon will tend to stick in the box and if greater than .025 of an inch the brush may rattle, wear away the sides, and break or chip. The width of the brush is less important. A clearance between brush and the end of the box as much as 1/16 inch may be permitted without causing serious trouble.

In replacing brushes, the new brush should be fitted to the commutator by sanding with a good grade of medium sandpaper drawn between the brush and the commutator in the direction of rotation only. Lift the brush when pulling against the direction of rotation. Keep the sandpaper against the commutator as much as possible to avoid rounding the edges of the brush. Never use emery cloth or emery paper on brushes or commutator.

COMMUTATOR

A commutator which is taking on a polish and shows no signs of wear does not require any attention.

If the commutator is roughened, badly worn, or burned, the armature should be removed and placed in a lathe, and the commutator ground or stoned to give a uniform surface, after which the mica must be re-grooved with special saws.

The mica insulation between the copper segments is grooved or undercut initially to a depth of 3/64 inch, as the commutator wears, or if it is turned, the groove should be maintained since high mica will spoil the brush fit and cause sparking. The undercutting can be done to the best advantage by the use of one of the small power-driven saws which are built for this purpose. After the commutator has been turned or undercut the burrs which are formed on the edges of the bar during the process, should be carefully removed with a three-cornered tool, the ends of the commutator bars rounded, the slots cleaned out and the commutator finally polished with fine sand paper and blown off with compressed air. The brushes should always be lifted when smoothing a commutator in a motor and not replaced until all grit has been removed. Never use emery cloth or emery paper on a commutator.

The leads from the armature winding are soldered into the ends (necks) of the commutator bars which should be carefully inspected when examining the armature. If the armature has been overheated and the solder thrown out, the leads should be resoldered.

It is unnecessary to use any lubricant on the commutator as there is a certain amount of graphite in the brushes which supplies all the lubrication required.

DISMANTLING AND ASSEMBLING TRACTION MOTORS

TOOLS

Special tools required when dismantling the traction motor are shown on the Tool Drawing. The shop should be supplied with a set of the Special Tools which may be made from the drawing supplied or they may be purchased from Westinghouse Electric & Manufacturing Company.

REMOVAL OF ARMATURE FROM MOTOR

If it is necessary to remove the armature from the motor, the following procedure is to be followed:

1. Take off the pinion nut to provide means of lifting the armature. Pull the pinion if the pinion end bearing is to be dismantled.

2. Remove commutator covers and lift brushes far enough out of brush box that they will not slide back against commutator.

3. Protect the commutator by wrapping it with heavy fish-paper.

4. Remove the 1/2" bolts holding the bearing cartridge to the housing at the commutator end.

5. Turn the motor so that the shaft is in a true vertical position with the pinion end up.

6. Remove the bolts holding the pinion end housing to the frame.

7. Insert three 1/2" bolts in the three tapped holes equally spaced around the housing. Tightening up on these bolts pulls the housing out of the frame fit.

8. Screw the special lifting nut on the pinion end of the shaft and lift the armature out of the frame with both bearing assemblies intact.

REMOVAL OF BEARINGS

The armature may be clamped in a wooden saddle in a horizontal position or it may be placed on a bench and wedged at the sides for stability.

A. Removal of the Commutator End Bearing

The commutator end ball bearing is pulled off as shown on the tool drawing. The procedure is as follows:

1. Remove the bolts which hold the outside cap to the bearing cartridge and remove the cap.
2. Remove the two set screws in the bearing lock nut and remove the lock nut using the special wrench.
3. Remove the bearing cartridge, bearing, and oil thrower by applying the puller as shown on the tool drawing.
4. Wrap the bearing and oil thrower in a protective covering, the bearing to be cleaned and inspected before re-assembly. The grease in the bearing will serve to prevent rusting.

B. Removal of Pinion End Bearing

The Pinion and Roller bearing is removed as shown on the tool drawing. The procedure is as follows:

1. Remove the bearing shield.
2. Remove the housing, bearing, and oil thrower by applying the puller as shown on the tool drawing.
3. To remove the outer bearing race from the housing, tap the housing with a rawhide mallet and slip the bearing out. Do not pry or hammer on the bearing. If it is too tight in the housing to be removed in the above manner, heat the outside rim of the housing with a flame. The heat will flow in toward the hub, expanding it enough so that the bearing can be slipped out.
4. Place the inner race in the bearing and wrap in a protective covering, the bearing to be cleaned and inspected before re-assembly. The grease in the bearing will serve to prevent rusting.

REMOVING AND REPLACING FIELD COILS

A commutating field coil may be removed by loosening the two adjacent commutating poles and coils, in addition to the one to be removed, to permit the leads to be moved away from the main coil so that the connections to the defective coil leads may be unsoldered. Next remove the through bolts which hold the pole and coil in place and lift them out.

When replacing the coil, the above procedure is reversed. Check to see that the commutating coil washer is between the coil and the pole tip. Check for proper polarity according to the field wiring diagram.

A main field coil may be removed by loosening the two adjacent main poles and coils, in addition to the one to be removed, to permit the leads to be moved away from the end of the commutating coil so that the connection to the defective coil may be unsoldered. Next lift the main pole out and slide the coil out lengthwise.

When replacing the coil, the above procedure is reversed. Check for proper polarity according to the field wiring diagram.

REMOVING TRACTION MOTOR PINIONS

Pinions are most easily removed by means of a pinion puller made especially to fit the pinion. A suitable pinion puller of this type may be obtained from the Westinghouse Electric & Mfg. Company.

If desired, a simple "one man" puller that will meet all requirements can be made from the special tool drawing included in the rear of this section, the puller should be applied as shown on the assembly drawing. In a fully equipped shop, a "power puller" may be available and can be used, if adaptable.

Care should be exercised when removing motor pinions - the following precautions should be observed:

1. Do not try to remove the pinion by driving wedges between the pinion and the motor housing or oil thrower else considerable damage will result to the motor.

2. In order to prevent damage to anti-friction bearings, avoid all blows with a sledge hammer on the pinion or pinion puller.

3. Never apply a flame to a pinion that is to be put back in service as there is great danger of destroying the heat treatment.

In removing worn pinions that are to be scrapped and are very hard to pull, it may be necessary to apply heat with a torch to expand the pinion and relieve the fit. When an old pinion is heated, great care must be taken to protect the shaft and housing from the heat to prevent their damage.

APPLYING TRACTION MOTOR PINIONS

The following instructions cover the method to be used in applying pinions to Railway Motor shafts with a taper fit.

Preliminary Precautions:

a. The seat on the shaft and in the pinion bore should be checked and all burrs, enlargements and galled spots removed.

b. The pinion fit on the shaft should be checked with Prussian blue. Scrape or stone the pinion bore until at least 75 percent of the area is in contact. The best way to check the fit is to blue the shaft, place the pinion on the shaft about one inch from its final position and then give a quick shove home. The pinion can be removed by driving a metal wedge between the pinion face and the oil thrower or the motor housing. This should only be done with pinions applied on the shaft cold.

c. On pinions with a keyway the key should be a tight fit in the keyway of the shaft. The keyway in the pinion may be .002" larger but not smaller than the key. The clearance between the top of the key and the bottom of the keyway in the pinion must be at least 1/64". Round the corners of the key to prevent cutting into the fillet of the keyway. Round the corners on the lead of the key and the lead of the pinion keyway to prevent galling. The pinion should be tried on the shaft cold to make sure that the key will not bind and prevent the pinion from moving to its proper position.

Cold Standoff:

Clean the shaft and the pinion bore thoroughly with benzol to remove all traces of oil and Prussian blue. With the pinion and the shaft at the same temperature, place the pinion on the shaft about one inch from its final position and then give a quick shove home. Measure the distance the pinion stands off from the end of the shaft with a micrometer depth gauge. Mark the points of measurement and mark across the end of the shaft so that after heating the pinion, it can be mounted in exactly the same angular position on the shaft and measurements made from the same points. Remove the pinion from the shaft by driving a wedge between the pinion face and the oil thrower or motor housing.

Heating:

Heat the pinions uniformly and for a sufficient length of time to soak thoroughly. The pinions should be heated about 10° above the application temperature given on the motor General Data Sheet. This allows sufficient time to remove the pinions from the oven, clean the bore and check the temperature before applying.

The approved methods of heating pinions in the order of preference are given below:

a. Induction Heater
b. Electric Oven
c. Gas Oven
d. Oil (only as a last resort)

If oven facilities are not available, a Westinghouse Electric roaster will work satisfactorily on all pinions up to an outside diameter of 12 inches.

If oil is used to heat the pinions, they must be thoroughly cleaned with benzol and dry rags to remove all traces of oil from the pinion bore before applying to the shaft. Pinions must never be heated above 200 degrees Centigrade.

Application:

Remove the pinion from the oven and place near the shaft to which it is to be applied. Clean the shaft and pinion bore very thoroughly with clean dry rags to remove all traces of oil. Check the pinion temperature with an electric pyrometer as close to the pinion bore as possible. As soon as the pinion temperature comes down to the application temperature given on the motor General Data sheet, the pinion should be applied on the shaft in exactly the same angular position and in the same manner as for the cold stand-off. The same man who applied the pinion cold should apply the pinion hot in order to obtain the same force or push. Measure the hot standoff of the pinion from the end of the shaft in the same manner and the same position the cold standoff was taken. The difference between the hot and cold standoff gives the advance of the pinion on the shaft. This advance must fall within the limits given on the motor General Data sheet. The application temperature given on the motor data sheet is estimated only and may have to be adjusted by experience to maintain the advance within the proper limits. If the advance is not within the proper limits, the pinion should be pulled and re-applied.

Fastening:

If the pinion is equipped with a nut, the lock washer and nut should be applied as soon as the hot advance is taken. Screw the pinion nut home tightly with a wrench having a purchase lever arm of 4 to 6 feet.

BEARINGS

Cleaning and Inspection

1. Clean bearings in gasoline and by means of dry compressed air.

2. Final cleaning should be in clean gasoline after which the bearings should be blown by dry compressed air. Hold the cage and rotate the outer race while directing the compressed air around the rollers and cage. Next hold the outer race and rotate the cage.

3. If bearing is not to be re-assembled immediately, it should be greased and wrapped in a protective covering to keep out dirt and moisture.

4. In handling bearings, during overhaul there should be a liberal use of clean lintless cloths for keeping both the hands and the bearings clean. Do not use waste on the bearings.

5. Before re-assembling bearings, they should be carefully inspected for:

   (a) Cracked races
   (b) Cracked or pitted rollers
   (c) Excessive wear of cage
   (d) Loose cage rivets

Heating of Bearings in Oil for Assembly. The oil container for heating the bearings and details must have a perforated support approximately 2 inches above the bottom to allow dirt to drop below the bearings and to prevent the heat from striking the bearings directly. This container must be kept clean. Use a high temperature oil such as compressor oil or Westinghouse P.D. #2268 oil.

Assembly and Dis-assembly. If for any reason a bearing inner or outer race does not pull readily from its fit, do not use a flame on the bearing. Instead, pour hot oil over the inner race, housing or cartridge to expand them enough to ease the fit and permit pulling.

ASSEMBLY OF COMMUTATOR END BALL BEARING

Refer to the bearing assembly drawing as a guide for proper bearing assembly.

1. Place the armature preferably in a vertical position. A hole a little larger than the armature diameter cut in a low wooden table or bench together with some wooden wedges to keep the armature from drooping through serves very well.

2. Clean all parts thoroughly before starting to assemble. Carefully inspect the bearing for cracks, pitting, or excessive wear.
   Caution: Care must always be taken to keep all dirt and grit away from ball bearings.

3. Place the bearing, cartridge, and grease thrower in a high temperature oil at a temperature of 100 degrees centigrade (212°F).

4. Remove the bearing cartridge from the hot oil, wipe off the excess oil and drop into place over the shaft.

5. Remove the grease thrower from the hot oil, wipe off the excess oil and shrink on the shaft with the chamfered side out and hold in place solidly against the shoulder on the shaft until it has cooled.

6. Fill the grease pocket in the bearing cartridge half full of Westinghouse Grease M-7280-1.

7. Remove the bearing from the hot oil, wipe off the inner and outer fits, and immediately drop in place while the cartridge bore is still expanded. Do not force this assembly - the bearing must slip into place. Hold the bearing solidly in place against the grease thrower until tight.

8. Apply the bearing lock nut and tighten the set screws. Strike the bearing nut with a hammer, again tighten the set screws and peen nut to lock the screws securely.

9. Fill the spaces between the balls in the bearing with Westinghouse Grease M-7280-1.

10. Fill the grease pocket in the outer bearing cap half full with Westinghouse Grease M-7280-1. Bolt the cap with its gasket in place to the bearing cartridge.
    Note: Some portion of the grease in the bearing cap should make contact with the bearing when assembled.

11. Check to make sure that the alemite fitting is not damaged.

ASSEMBLY OF PINION END ROLLER BEARING

Refer to the Bearing Assembly Drawing as a guide for proper bearing assembly.

1. Place the armature in a vertical position. A hole a little larger than the armature diameter cut in a low wooden table or bench together with some wooden wedges to keep the armature from dropping through serves very well.

2. Clean all parts thoroughly before starting to assemble. Carefully inspect the bearing for cracks, pitting, or excessive wear.
   Caution: Care must always be taken to keep all dirt and grit away from roller bearings.

3. Place the grease thrower and inner bearing race in a high temperature oil at a temperature of 100 degrees Centigrade (212°F).

4. Heat the housing on a hot place to 100 degrees centigrade.

5. Place the housing over the shaft.

6. Remove the grease thrower from the hot oil, wipe off excess oil, and shrink on the shaft with the groove in and hold in place solidly against the shoulder on the shaft with the bucking-up tool until it has cooled.

7. Remove the inner race from the hot oil, wipe off the excess oil and apply to the shaft using the bucking-up tool as before.

8. Fill the spaces between the rollers in the bearing with Westinghouse Grease M-7280-1.

9. Drop the bearing in place while the housing is still expanded. Do not force this assembly - the bearing must slip into place.

10. Apply the outer bearing shield, bolt in place and bend the lock washers over the bolt heads.

11. As soon as the housing and bearing have cooled, check the internal radial clearance of the bearing (see bearing assembly drawing for proper clearance).

AXi-3
Rev.

ARMATURE ASSEMBLY INTO FRAME

1. It is important that the frame be placed so that it is in the true vertical position. Otherwise the commutator end bearing cartridge and the fan end housing will enter their respective frame fits in a "cocked" position.

2. If not already on, wrap a piece of fishpaper - or other protecting material - around the commutator and secure with friction tape. This serves to protect the commutator from the brushholders when dropping the armature in place.

3. Screw the two Armature Removal Studs into the commutator end cartridge to be used as a guide in lining up the cartridge holes with those in the housing.

4. Pick up the armature, using the special Armature Lifting Eye, and lower into the frame, being careful not to score the commutator and to get the studs entered in the proper housing holes.

5. Put the pinion end housing bolts in place.

6. Put in the commutator end cartridge bolts, removing the studs.

7. Pull the commutator end cartridge fit and the fan end housing fit into the frame at the same time.

8. Remove the protective paper from the commutator and turn armature by hand to make certain it is free.

9. Check for proper clearance of 1/8 inch between brushholders and commutator.

10. Lower the brushes and fit to the commutator using a medium grade of sandpaper.

11. Blow out carbon dust with dry compressed air.

12. Replace the commutator covers.

HANDSOLDERING OF ARMATURE COILS IN COMMUTATOR

General Information

1. - Cleaning and Tinning

It is assumed that the armature is in good condition for soldering, that is, that the tinned surfaces of the armature coil leads and commutator slots have been cleaned and fluxed to prevent oxidation before re-winding the armature.

2. - Solder

Use pure tin solder P.D.S. #2290. Pure tin solder has a higher melting point than alloy solders but flows more freely when molten which is desired for use with strap coils where clearances are very small. It is desirable to obtain the solder in thin strips cut to convenient lengths of 10 to 12 inches.

3. - Solderin Flux

Use Westinghouse Flux P.D.S. 751. A satisfactory flux can be made by mixing 1-1/2 pounds of resin in a quart of ether or de-natured alcohol. Such a fluxing compound contains no acid and has no injurious effects on the armature insulation. After the liquid flux dries, it forms a thin protective coating over the surface to be soldered.

4. - Soldering Irons

Two or three pound irons of the type heated in a gas flame can be used. Prepare two irons so that one iron can be heating while the other iron is being used. Electrically heated irons as well as other types with a self-contained heater can be used if they have sufficient heat capacity.

Prepare the iron by drawing it out to a chisel shape having a thickness of 1/8 of an inch at the point. Keep the iron cleaned and well tinned on the upper side and at the point only. File the lower side of the iron free of any tin - this is done to keep the solder from flowing under the iron and dripping off instead of filling up the slot in the commutator neck.

AXi-1
Rev.

SOLDERING PROCEDURE

1. Face the commutator necks in a lathe to get a smooth surface and a bright finish.

2. Flux the commutator necks immediately after facing so that the copper will not become oxidized because of the heat produced by facing.

3. Preheat the armature to a temperature of 110° to 125°C and prepare to solder before it cools.

4. Place the armature in a near horizontal position with the pinion end raised approximately 3 inches so that excess solder will tend to flow to the front end of the slots thereby reducing the possibility of a short-circuit back of the commutator risers.

5. Keep the commutator hot (125°C) with a gas torch or electric heating element placed ahead of the soldering iron.

6. Coat the commutator necks with flux #751 just before soldering. Allow time for the alcohol in the flux to evaporate before soldering to minimize the danger of fire.

7. Rotate the armature so that the slot being soldered is always slightly above the horizontal center line of the commutator. Butt the tip of a well-tinned iron against the front of the riser to be soldered and heat the parts thoroughly. Feed solder to the top and front edge of the slot as soon as possible in order to avoid baking of the flux. Care should be taken to see that the joint is hot enough to cause the solder to flow freely and not merely warm enough to cause the solder to adhere only to the outside of the slot.

8. Turn the excess solder off the commutator face and risers.

9. Inspect the faces of the commutator risers for signs of poorly soldered armature leads and resolder if necessary.

10. Test armature on a growler for shorts back of the risers. Check any short to make sure that it is not produced by solder in the commutator undercutting.

DIPPING AND BAKING

Dipping and baking of armatures and stators should be done in the following manner:

Preparation for Dipping

1. If an armature, remove the fan to eliminate cleaning after dipping and to avoid disturbing its balance by having on it an uneven thickness of varnish.

2. If a stator, remove the commutator end bracket.

3. Thoroughly clean the apparatus by first flowing off the loose dirt with dry compressed air, then clean with benzine or other approved solvent. This may be brushed or sprayed on.

4. Dry in oven for at least 12 hours at 125°C. (257°F). If the apparatus is damp or has low insulation resistance, the drying process should be continued until the insulation resistance rises above the minimum allowable value. See Section on Testing for minimum value of insulation resistance before dipping and baking.

5. Loosen stator pole bolts to permit penetration of the varnish under the pole tips.

6. Plug all taped holes in the stator frame to prevent the entrance of varnish.

Dipping and Draining

Use Westinghouse #335 varnish at a specific gravity of 850. Thin with benzine when necessary.

1. Apparatus may be dipped hot but temperature should not exceed 60°C (140°F).

2. Dip apparatus in a vertical position with commutator end of armature up or brushholder end of stator up. Do not immerse commutator.

3. Soak apparatus in varnish until all bubbling ceases which will require at least 10 to 20 minutes.

4. Remove from varnish and allow to drain in same position as when dipped. Drain until dripping ceases.

5. Clean machined fits with approved solvent and cover to protect during baking from further draining.

Baking

1. Before baking tighten poles and check spacing if they were loosened prior to dipping.

2. Bake in a ventilated oven with controlled temperature at 115° to 125°C. (239° to 257°F) for 24 hours. It is preferable to bake the armature in a vertical position with the commutator up. If this cannot be done, the armature should be turned frequently during baking.

Additional Treatment

1. Two treatments are preferable.

2. For the second dip, the poles need not be loosened.

3. The second dip should be made with apparatus cold..

4. Dipping and baking procedure and temperatures should otherwise be same as for the first treatment.

TYPE 1443-A TRACTION MOTOR

General Data

OPERATING LIMITS

Maximum Volts	400.
Maximum Amperes	650.
Maximum Safe RPM	4500.

BRUSHES

Number of Brush Arms	4.
Brushes Per Arm	2.
Recommended Grade	National AX 5
Size of Brushes	3/4" x 1-7/8" x 2-1/4
Brush Pressure with full length brush	8 to 9 lbs.

(See Renewal Parts Data for ordering information)

NORMAL POLE BORES AT CENTER OF POLES

Main Poles	11.560 in.
Commutating Poles	12.050 in.

WEIGHTS

Motor with Pinion	1425. lbs.
Armature Complete	450. lbs.

RESISTANCE OF WINDINGS AT 25°C.

Armature	.0132 ohms
Commutating Fields	.0095 ohms
Series Fields	.0193 ohms

ARMATURE BEARINGS

Type - Pinion End	Roller Bearing
Commutator End	Ball Bearing
Lubrication - Pinion End	From Gear Case
Commutator End	Westinghouse Grease M-7280-1

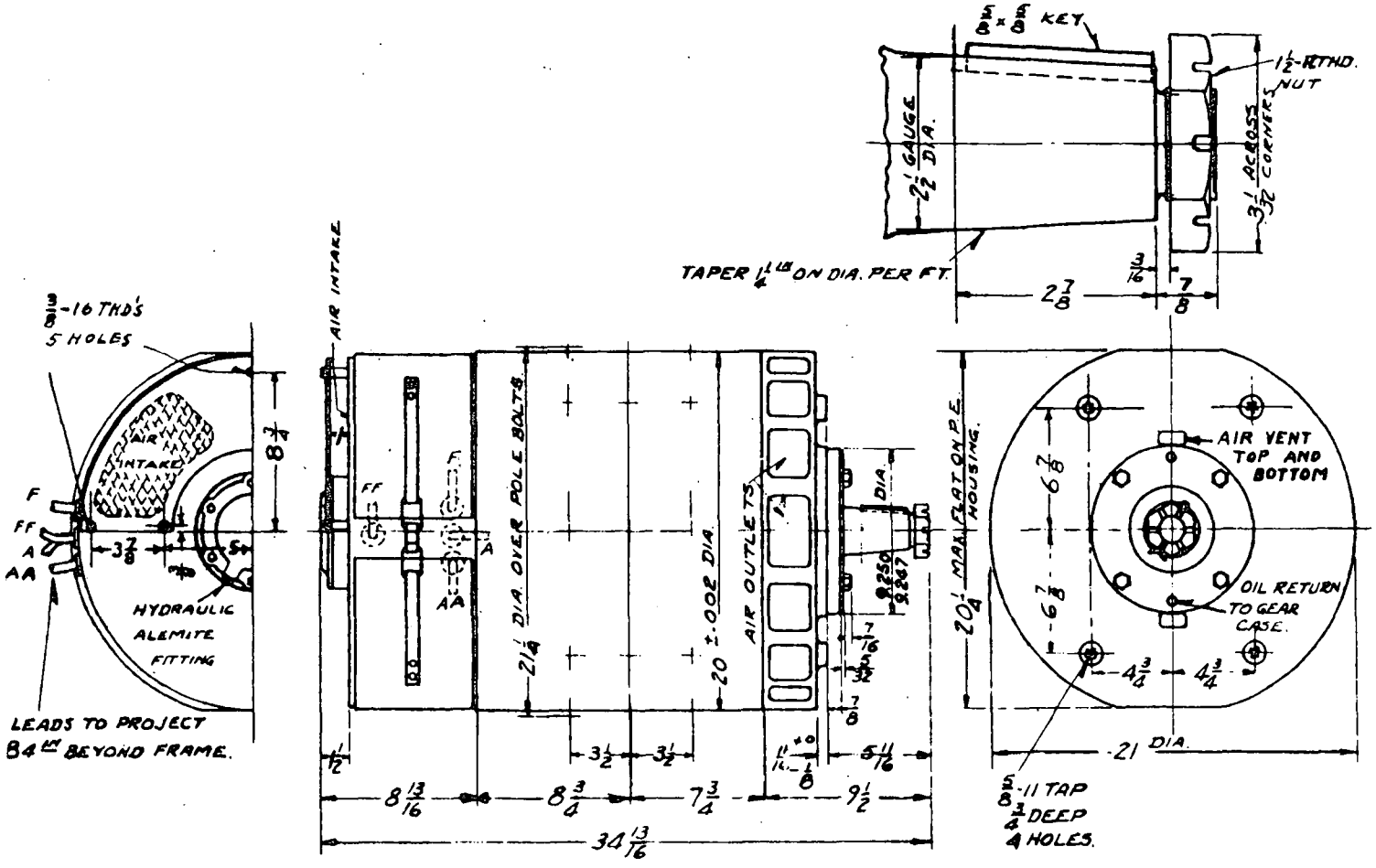
PINION APPLICATION

Application Temperature	(Obtain from Pinion Supplier)
Advance Limits, Max. Min.	(Obtain from Pinion Supplier)

REFERENCE DRAWINGS

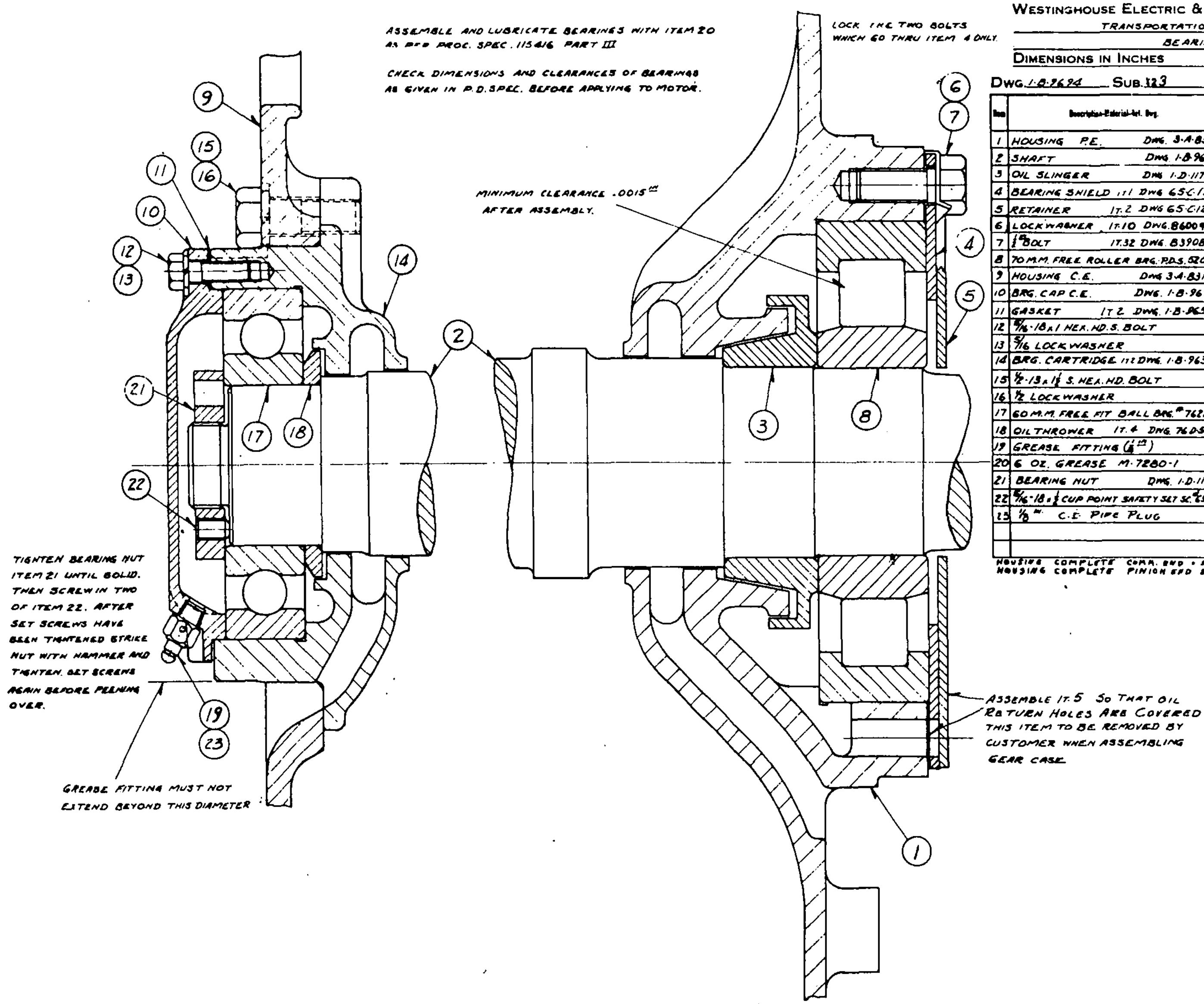
Outline	1-D-1159
Bearing Assembly	1-B-9694
Field Wiring Diagram	1-D-1176
Armature Winding Diagram	812 183
Armature Winding Materials	1-B-9686
Tools	4-A-1012

DIMENSIONS IN INCHES



Type 1443-A Traction Motor Outline
Drawing 1-D-1159-7

Type 1443-A Motor Bearing Assembly
Dwg. 1-B-9694-3



WESTINGHOUSE ELECTRIC & MFG. CO., EAST PITTSBURGH, PA., U. S. A.

TRANSPORTATION MOTOR D.C. #1443-A

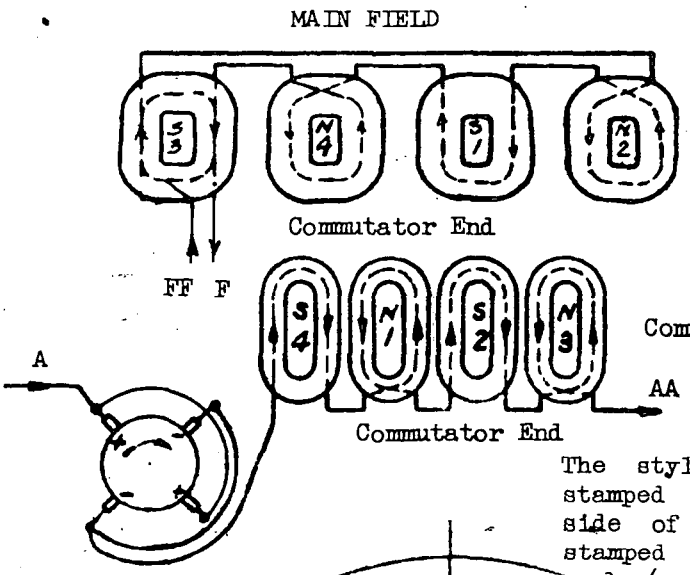
BEARING ASSEMBLY

DIMENSIONS IN INCHES SCALE 1:1

DWG. 1-B-9694 SUB. 123 BILL OF MATERIAL FINISH CHART 10026

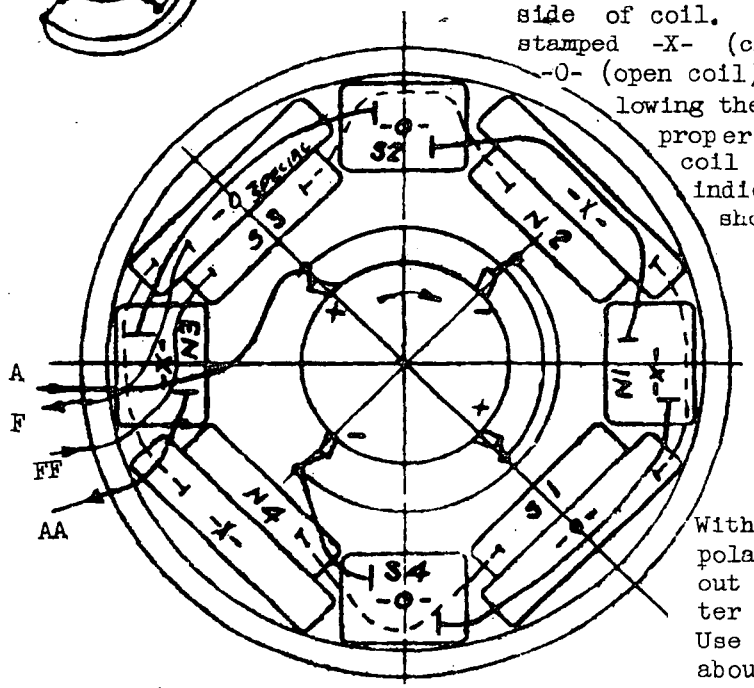
Item	Description-Material-Ref. Dwg.		Style No.	Pat. No.	Req.
1	HOUSING P.E. DWG. 3-A-8319				—
2	SHAFT DWG. 1-B-9688				—
3	OIL SLINGER DWG. 1-D-1178		1133133		1
4	BEARING SHIELD IT.1 DWG. 65-C-125		1133134		1
5	RETAINER IT.2 DWG. 65-C-125		1133135		1
6	LOCKWASHER IT.10 DWG. 860098		883678		4
7	1/2" BOLT IT.32 DWG. 839085		516219		4
8	70 M.M. FREE ROLLER BRG. P.D.S. 5201-3				1
9	HOUSING C.E. DWG. 3-A-8316				—
10	BRG. CAP C.E. DWG. 1-B-9691				-
11	GASKET IT.2 DWG. 1-B-9636		1133132		1
12	5/16-18 x 1 HEX. HD. S. BOLT				6
13	5/16 LOCKWASHER				6
14	BRG. CARTRIDGE IT.2 DWG. 1-B-9632				—
15	1/2-13 x 1 1/2 S. HEX. HD. BOLT				4
16	1/2 LOCKWASHER				4
17	60 M.M. FREE FIT BALL BRG. #7622-1				1
18	OIL THROWER IT.4 DWG. 76-D-582		1042677		1
19	GREASE FITTING (1/8")		1133170		1
20	6 OZ. GREASE M-7280-1				1
21	BEARING NUT DWG. 1-D-1156				—
22	5/16-18 x 1/2 CUP POINT SAFETY SET SC. #5963				2
23	1/8" C.E. PIPE PLUG				1

HOUSING COMPLETE COMM. END - S# 1153182 - SEE STYLE CARD.
HOUSING COMPLETE PINION END S# 1153183 = 1 OF IT. 4 TO 7 AND 1 OF IT. 1 DWG. 3A-8319



Coils laid out on bench with armature side up.

The style number of each coil is stamped on a tag attached to one side of coil. This tag is also stamped -X- (crossed coil) and -O- (open coil). Immediately following the style number, the proper position of each coil in the frame is indicated by a tag shown below.



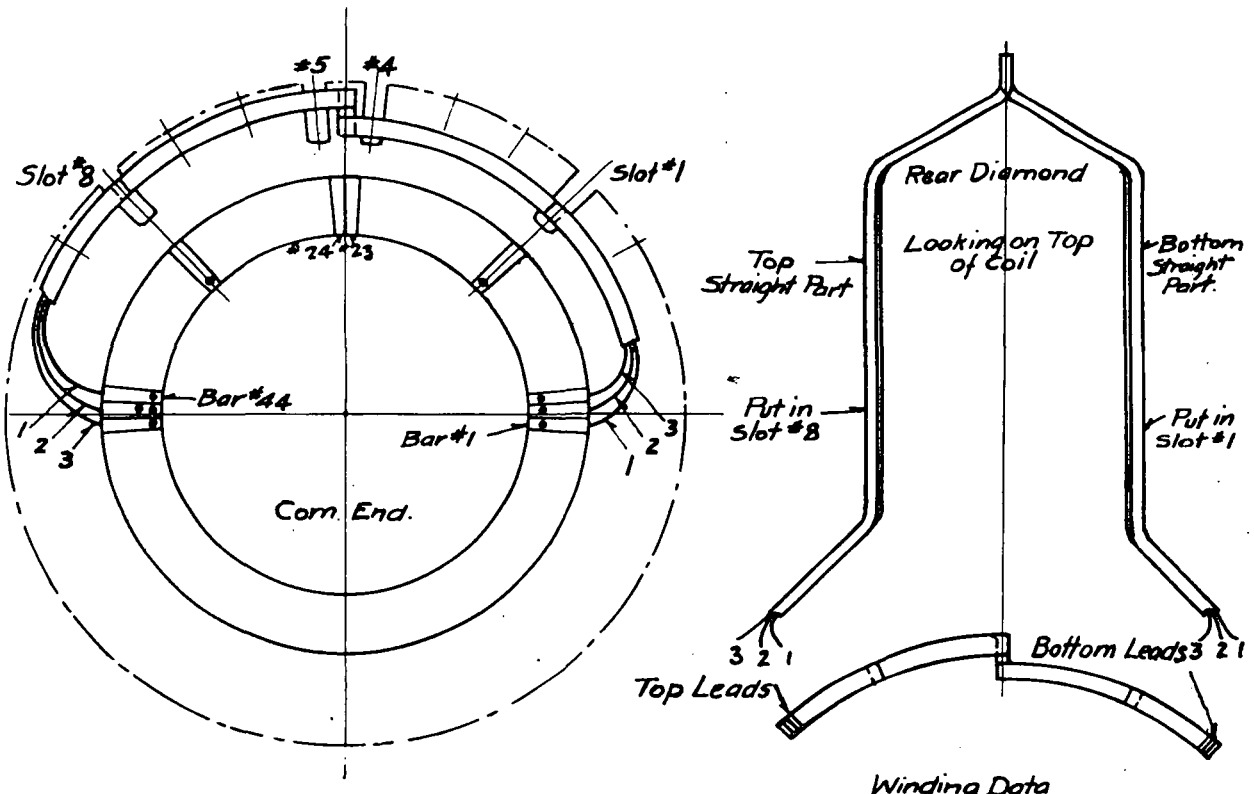
View Looking at Com. End
Dotted Lines Show Connections at Rear End

POLARITY TEST
N - North Pole
S - South Pole

With a compass check polarity of coils laid out on bench. Also after assembled in frame. Use a resistor to give about 3 amps. current flowing as shown by arrows.

DIMENSIONS IN INCHES

Field Wiring Diagram
Drawing 1-D-1176-1



Laying off Windings

1- Center line of starting coil on center line of tooth between slots #4 and #5, and on center line of mica between Bars #23 & #24.

2- Starting at bar #23, count back (clockwise) to bar #1 and in this bar place lead #1 from bottom leads of starting coil.

3- Count from bar #1 forward (counter clockwise) to bar #44 and in this bar place lead #1 from top leads of starting coil.

Winding Data

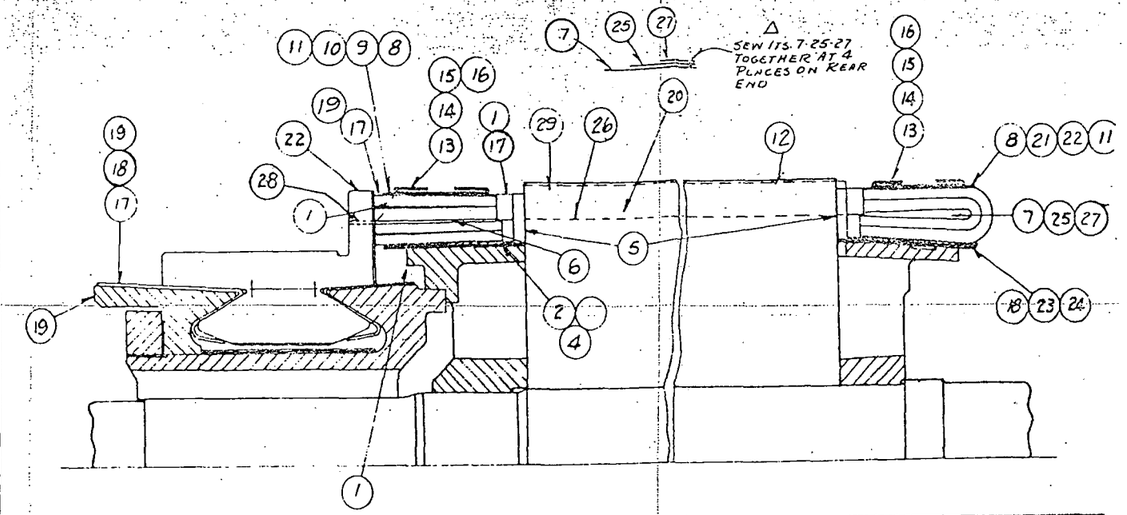
Number of Armature Slots - 29
Number of Commutator Bars - 87
Coils lie in slots #1 and #8
Leads connect to Bars #1 and #44
Commutator center punched on end.
••• Locates top leads from starting coil.
••• Locates bottom leads from starting coil
• Locates starting coil in Slots #1 and #8.

Type 1443-A Motor Armature Winding Diagram
Dwg. 812183

ITEM	DESCRIPTION AND MATERIAL	PDS M#	STYLE NO.	REQ.	DRAWING	ITEM	ROUTING	APPLICATION

* THESE ITEMS ARE NOT INCLUDED IN STYLE NUMBERED SETS BUT SHOULD BE PURCHASED IN BULK OR SEPARATELY

CLASS	DESCRIPTION	STYLE NO.	ITEMS
A	CUT CORE INSULATION	1133110	2-24-26
B	SLOT AND END INSULATION	1133111-A	5-6-7-12-25-27-29
C	CUT CONNECTING MATERIAL		
D	CUT BANDING MATERIAL	1133112	9-10-15-21-22
I	CUT WINDING INSULATION	1133113-A	2-5-6-7-9-10-12-15-25-26-24-27-29
2	COMPLETE WINDING MATERIAL	1133114-A	1 TO 20-24 TO 29
3	COMPLETE WINDING MATERIAL PLUS		
	MOULDED MICA AND MECHANICAL PARTS		ALL ITEMS



ITEM	DESCRIPTION AND MATERIAL	PDS M#	STYLE NO.	REQ.	DRAWING	ITEM	ROUTING	APPLICATION
* 1	3 LBS. CEMENT	677		1				OVER REAR "V" RING & BETWEEN TOP LEADS
2	FLEX. MICA 36 x 2 3/4 OF .010	237	1133109	5	30D452	11		FRONT COIL SUPPORT
* 3	8 YDS OF .010 x 1 TR. CLOTH TAPE	1225		1				FRONT COIL SUPPORT
* 4	40 YDS OF .010 x 3/4 ASB. TAPE TREATED	1277		1				OVER ITEM 2
5	F.B. U-PIECE	1545	1133100	58	3A8305	11		ENDS OF SLOT
6	TR ASB STRIP 36 x 2 1/4 x .045	1241	1133108	1	863392	17		BETWEEN FRONT COIL ENDS
△ 7	TR. ASB. STRIP 36 x 2 1/4 x .045	1241	1133108	1	863392	17		BETWEEN REAR COIL ENDS
* 8	36 YDS OF .010 x 3/4 TR. ASBESTOS TAPE	1277		1				LEVEL UNDER BANDS
9	FP & MICA STRIP 36 x 2 1/2 x .012	324	531510	2	821589	24		UNDER FRONT BANDS
10	TR ASB. STRIP 36 x 2 1/4 x .035	1230	709218	1	897186	6		UNDER FRONT BANDS
* 11	80 YDS. OF MACHINE THREAD	1828		1				ASSIST BANDING
12	WEDGE	256	1133101	29	3A8305	14		IN SLOTS
* 13	2 LBS. OF .064 BAND WIRE	1474		1				TEMPORARY BANDS
* 14	2 1/2 LBS. OF .072 BAND WIRE	5797		1				FINAL BANDS
15	TINNED CLIP .022 x 1/2 x 4"		303490	25	411665	6		BANDS
* 16	2 LBS. OF SOLDER (TIN)	2290		1				BANDS
* 17	75 YDS OF 1/16 I.D. SLEEVING	7842		1				V RING AND OVER LEADS
* 18	1/4 PT. OF CEMENT	672		1				BACK OF COMMUTATOR
* 19	1/8 PT. CEMENT	8113-1		1				COM. V RING AND OVER LEADS BACK OF COMM.
* 20	1 QT. VARNISH			1				DIP AND BAKE
21	FP & MICA STRIP 36 x 2 1/2 x .012	324	508426	2	821589	4		UNDER REAR BANDS
22	TR. ASB. STRIP 36 x 2 1/2 x .035	1250	709219	1	897186	7		UNDER REAR BANDS
23	MOULDED MICA RING	251	1123584	1	1-D-1158	1		REAR COIL SUPPORT
* 24	HOOD 36 x 4 1/2 x .019 FRICTION CLOTH	1725		1				REAR COIL SUPPORT
△ 25	TR. ASB. STRIP 36 x 1 1/2 x .045	1241	579354	1	863392	4		BETWEEN REAR COIL ENDS
* 26	FILLER 4.06 x 10 1/4 x .010 MICA	251		29				BETWEEN COIL IN SLOTS
△ 27	TR. ASB. STRIP 36 x 3/4 x .045	1241	579351	1	863392	1		BETWEEN REAR COIL ENDS
28	FILLER - 1/2 OF .102" x .129" C. WIRE	1467	319610-A	87	268300	19		SUPPORT TOP LEADS OF ARM'D. COIL COMM. END
29	WEDGE	256	1128090	29	3A8305	15		IN SLOTS

Type 1443-A Motor Winding Material
Dwg. 1-B-9686-5

WESTINGHOUSE ELECTRIC & MFG. CO. EAST PITTSBURGH, PA., U. S. A.

TRANSPORTATION MOTOR D.C. Nº 1443-A

TOOLS

DIMENSIONS IN INCHES SCALE 1:1 & 1:2

DWG. 4-A-1012 SUB. 1 BILL OF MATERIAL

Item	Description-Material-Ref. Dwg.	Stock Size	Style No.	Pat. No.	Req.
1	PLATE-FROM 12" TK ST PLATE "2001				1
2	STUD-FROM 9¾" OF 1" DIA S BAR "2162				4
3	SPACER-FROM 1¾ OF 12" X-STRONG STEEL PIPE "7493-2				1
4	CUSHION-2¾ x 2¾ x .01125 TK. "BRASS SHEET & LEATHER				1
5	RING-FROM 23¾ OF ¾ x 13. BAR "1555				1
6	PULLER-FORGED FROM H.S. BILLET "2085				1
7	STUD-FROM 7¾ OF 1" DIA S BAR "2162				2
8	STUD-ITEM 5 DWG 4-A-1015		1154489		2
9	LIFTING EYE-ITEMS 10-11 DWG 897166		1152177		1
10	WRENCH-ITEM 2 DWG. 80-A-654		1042806		1
11	WRENCH-ITEMS 6-7 DWG. 80-A-654		1042805		1
12	¾"-13 HEX S. NUT				4
13	¾" WASHER		3223		4
14	1"-8 HEX. S. NUT				4
15	1" WASHER		575397		4

FINISH CHART

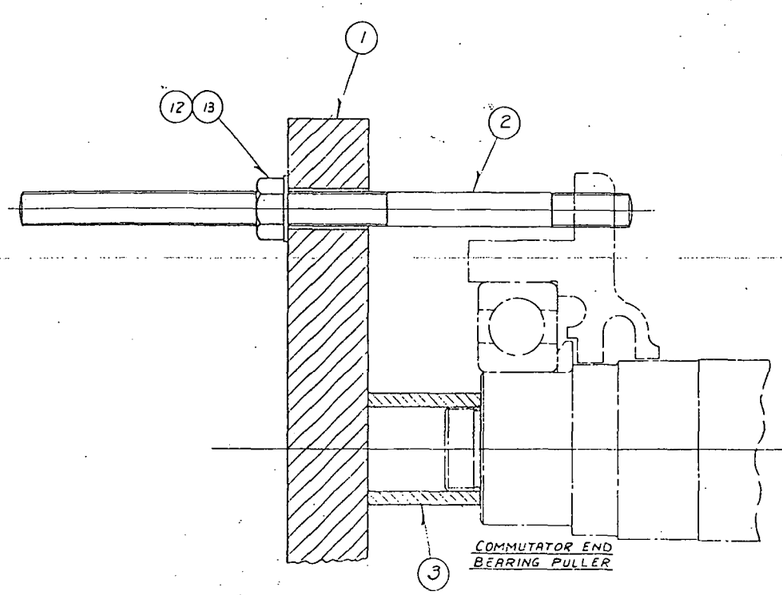
Tool Record Space. No. in ○ = Item No.

& WILLIAMS & CO. WRENCH NO. 434 MAY BE SUBSTITUTED.

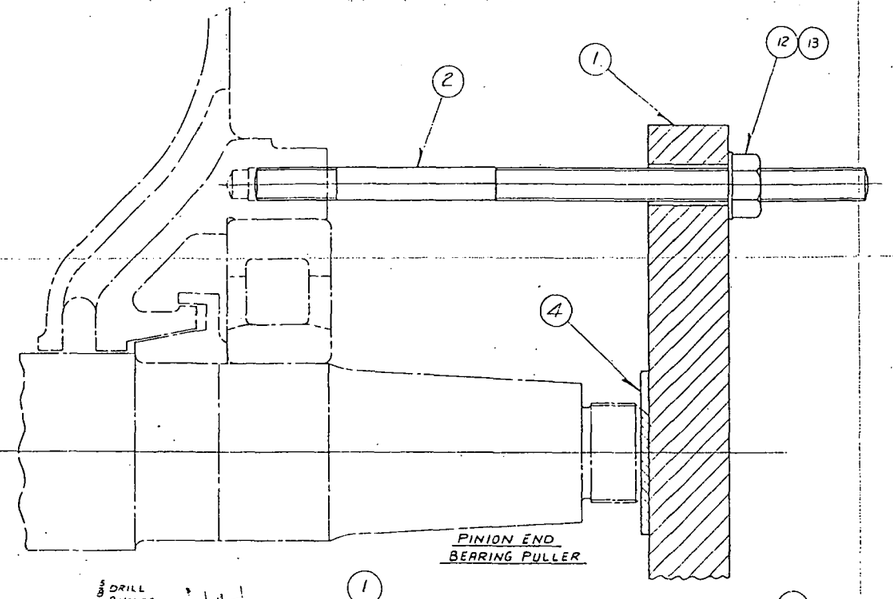
COMPLETE BEARING AND PINION PULLER S"1154490 = 1 OF ITEMS 1 TO 7-12 TO 15.

% TREAT AS PER PROC. SPEC. 115036-4

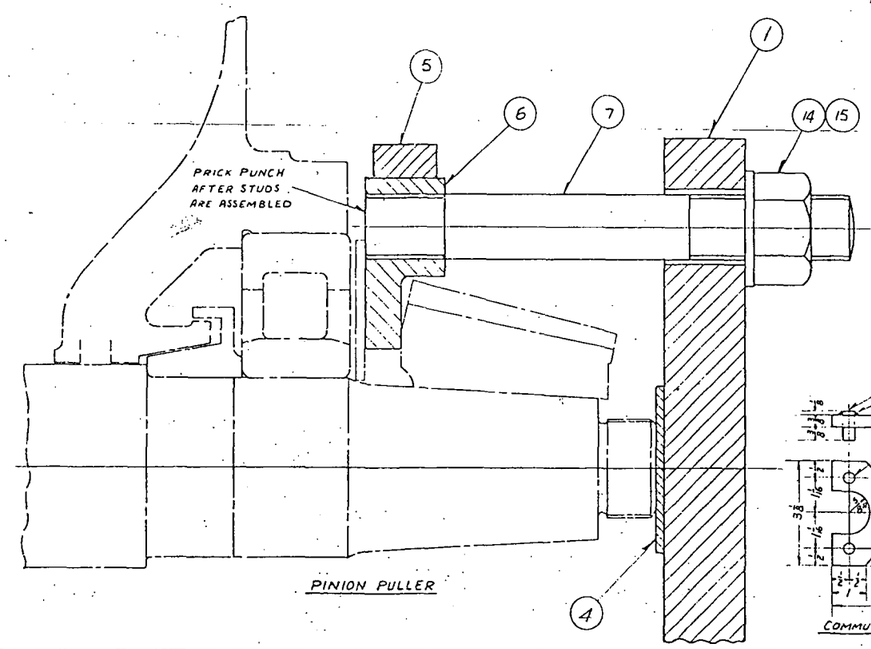
DO NOT SCALE FROM THIS DWG. IF NECESSARY, STATE HOW FULL OF MATERIAL ACCORDING TO THE DRAWING STATUS



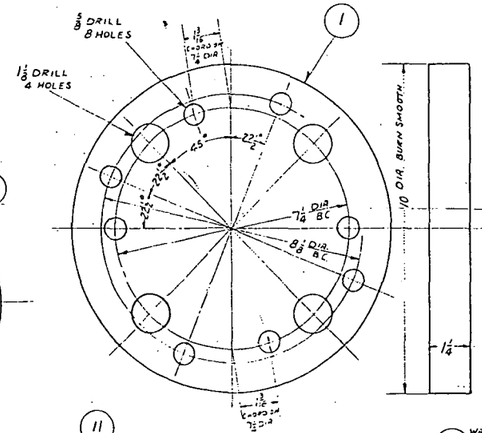
COMMUTATOR END BEARING PULLER

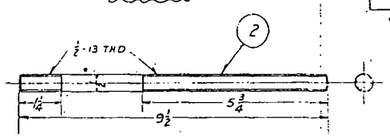


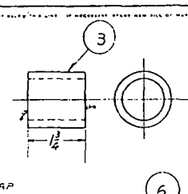
PINION END BEARING PULLER

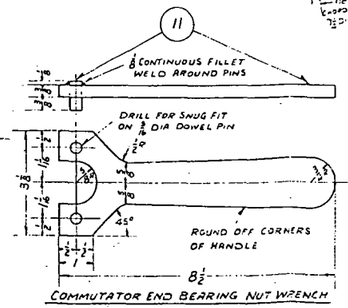


PINION PULLER

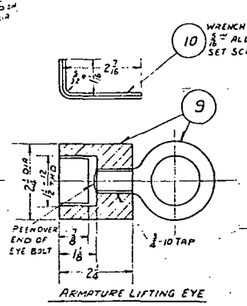




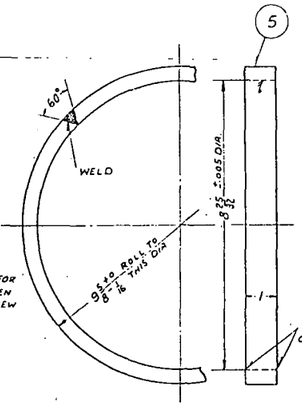


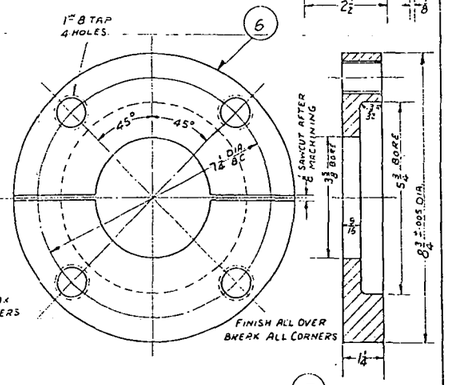


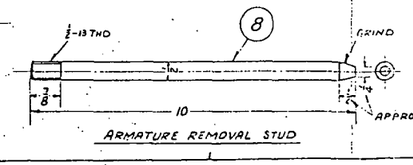
COMMUTATOR END BEARING NUT WRENCH



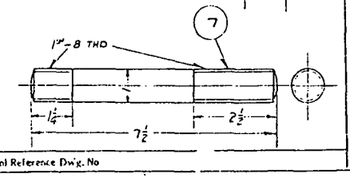
ARMATURE LIFTING EYE







ARMATURE REMOVAL STUD



Tool Reference Dwg. No

4-A-1012

SECTION V

MISCELLANEOUS CONTROL DETAILS

TYPE TC CONTROLLER

GENERAL DESCRIPTION:

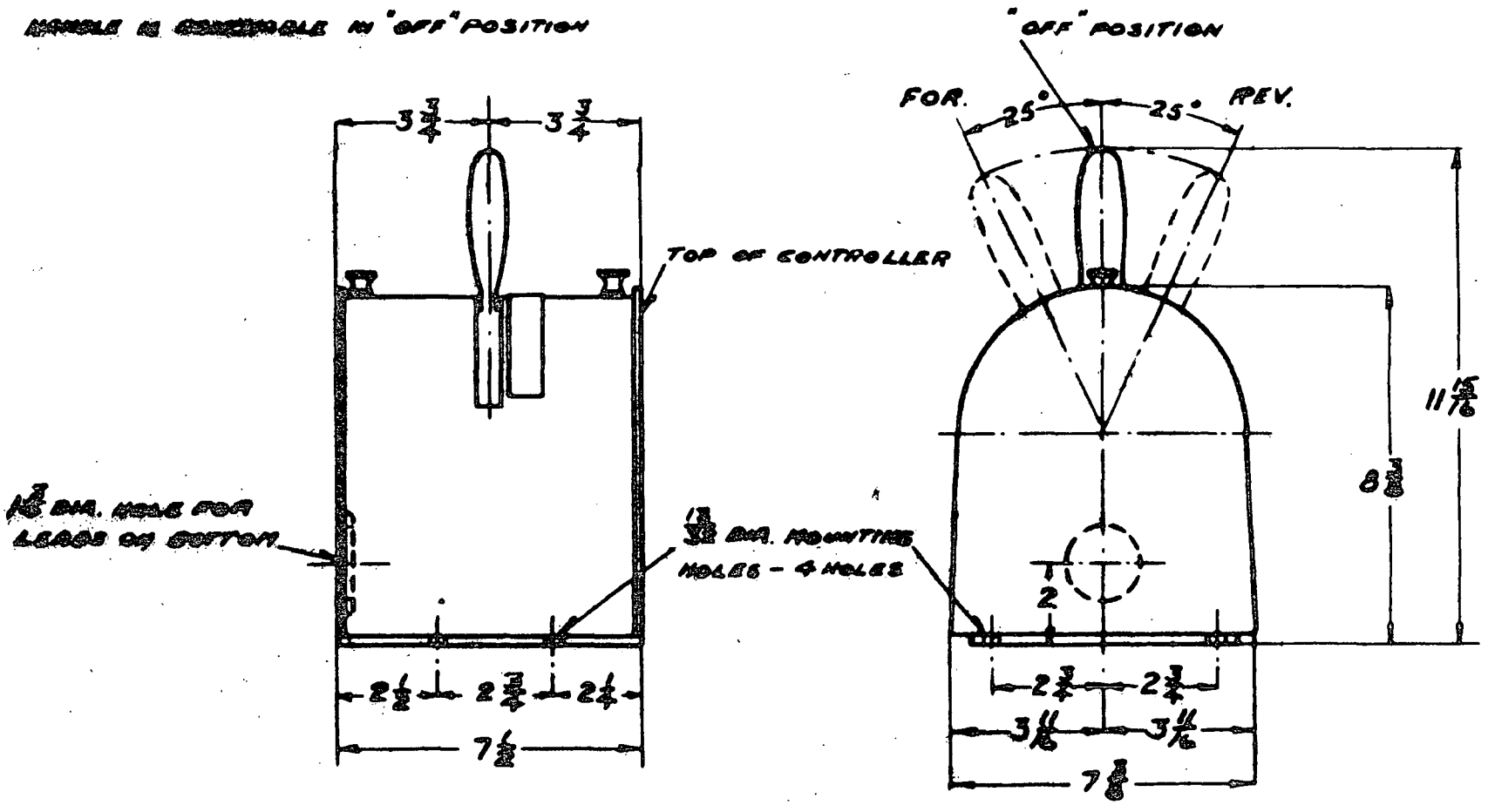
The controller is used for selecting the direction of motion of the locomotive. It is provided with a single handle which is removable in the "off" position.

Stationary fingers mounted on insulated supports make contact with copper segments on the insulated drum and complete the control circuits through the operating coils of the switching devices.

The controller should be examined at regular inspection periods to make sure that the connections are tight and that the fingers are making good contact. The fingers should give approximately 1-1/2 to 2 lbs. pressure on the drum segments.

The drum segments should be kept clean and occasionally a few drops of oil should be spread over their surfaces and wiped off with a clean cloth. Do not use any more oil than is necessary to keep the segments from cutting.

The bearings and other working surfaces should occasionally be lubricated with a few drops of light machine oil.



Type TC-285-A Controller Outline
Dwg. 2-D-1019-2

REVERSER

DESCRIPTION:

The reverser functions to reverse the connections between the fields and armatures of the traction motors and prescribe movement of the car or locomotive either "forward" or "backward".

The reverser is provided with an insulating drum, mounted on a steel shaft that is carried in two bearings which are supported on an insulating base. Strips of copper which are mounted on the drum surface "make" contact with stationary spring fingers that are mounted on the reverser base, and establish the proper connections. The drum is revolved to either one of two positions by the action of two air cylinders: admission of compressed air to the cylinders is controlled by two electro-magnetically operated valves.

To operate the reverser it is only necessary to complete the circuit from the battery through one of the magnet coils. The current in the coil magnetizes the core to pull down the armature and open the valve, thus admitting air to one of the cylinders to turn the drum.

The reverser drum is divided into two parts; the larger section, which handles the main motor current, is provided with heavy copper segments which make contact with stationary fingers mounted at each side of the drum. The smaller section, which handles only the low voltage control circuits, is provided with light copper segments which make contact with small fingers on each side. The object of these interlock fingers, as they are called, is to provide an interlock between the reverser drum and the circuit for operating the power switches.

A handle is provided on the reverser shaft so that it can be operated by hand in cases of emergency or during inspection.

The interlocking of the control circuits with the reverser is such that the drum contacts do not break the motor current. Any sign of arcing on the drum indicates either weak finger pressure or faulty operation. The drum contacts should be kept clean and smooth with the aid of fine sandpaper. The contacts should be wiped perfectly clean after they are smoothed, and particular care should be exercised to see that no grit is lodged under the fingers.

For the care of Magnet Valves, see Section on "Control Magnet Valves".

FINGERS:

The pressure of the fingers on the contacts should be approximately 8 to 10 pounds for the main contacts and 1 to 2 pounds for the interlock fingers. The finger pressure can be measured by means of a small spring balance attached to a piece of bent metal strap which can be slipped under the finger.

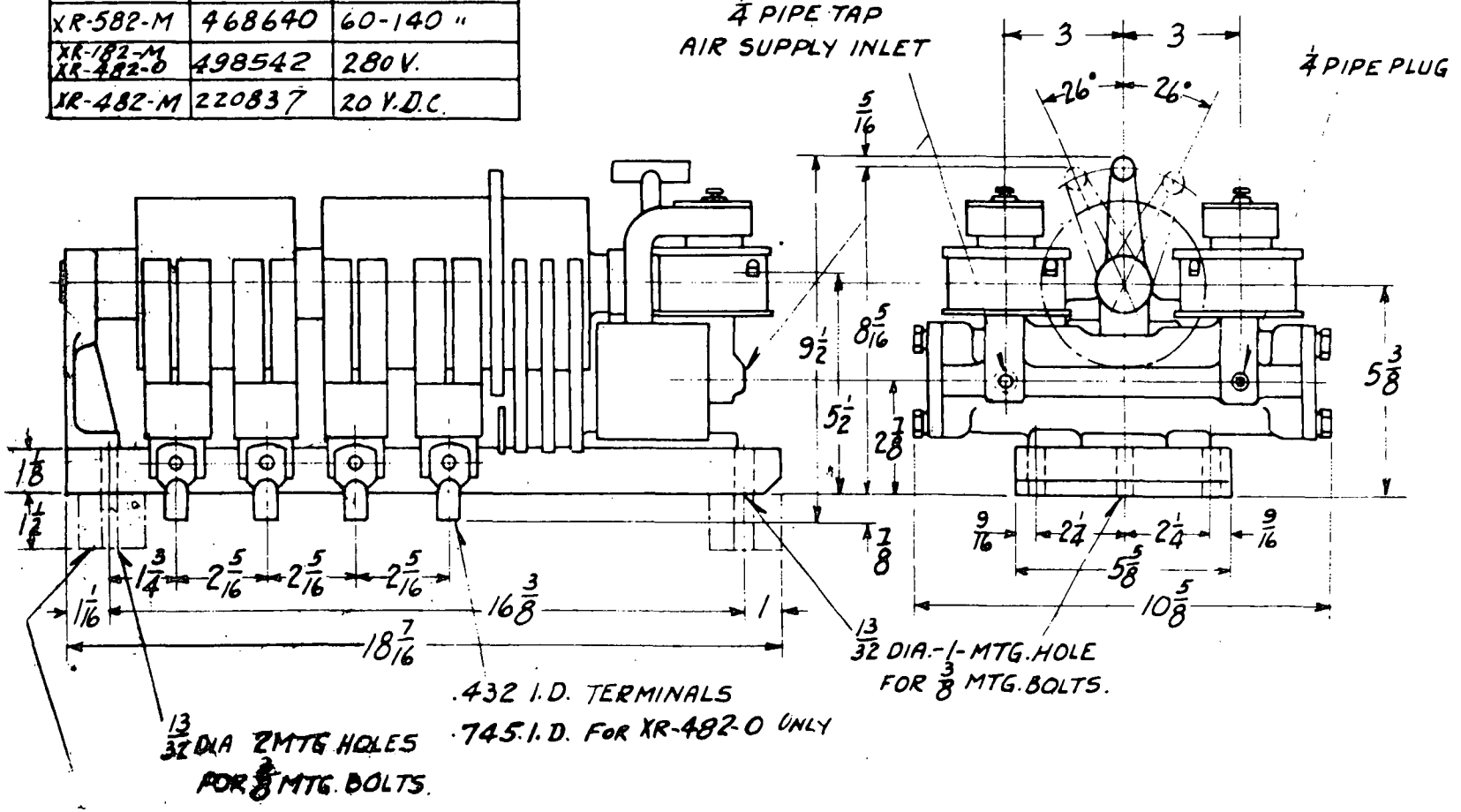
If the contact fingers and drum segments are allowed to operate completely dry they will start to cut in a comparatively short time. A little light machine oil should be spread occasionally over the drum contacts with a piece of cloth, and the drum should then be operated a few times; any surplus oil around the contacts or segments should be wiped off. The drum bearings should be oiled at intervals with a light oil.

CYLINDER MAINTENANCE:

Pistons are properly oiled when the reversers are assembled at the Factory and ordinarily will function for a long period (six months or a year) before they will require any additional lubrication. When lubrication is necessary, only HL oil, as supplied by the Westinghouse Company for this particular purpose, should be used. The use of unsuitable oil will lead to trouble from gummed pistons which will cause sluggish action or sticking.

In order to remove the piston rod and pistons, it is necessary to first remove the four tap bolts which hold the drum bearings in place and lift out the drum. Next the tap bolts in each cylinder head should be taken out and the head removed, care being exercised not to injure the paper gaskets which are under them. The nut and lock washer on one end of the piston rod should now be removed, after which the piston rod with one piston attached can be shoved out of the cylinder by pushing on the end of the piston rod with a screw driver. The remaining piston in the cylinder can easily be pushed out from the other end. It is not advisable to push the piston past the opening in the center of the cylinder as the leather may be injured.

TYPE	COILS	RATING
XR-382-M	68787	20-50 VOLTS
XR-532-M	127860	35-95 "
XR-582-M	468640	60-140 "
XR-182-M XR-482-O	498542	280 V.
XR-482-M	220837	20 V.D.C.



WHEN MOUNTING REVERSERS
ON PANEL USE 1/2 HIGH MTG. BLOCKS

Types XR-482-M & O, XR-329-M,
XR-532-M, XR-582-M & XR-182-M Reversers
Outline - Dwg. 44-D-563-4

CONTROL MAGNET VALVES

GENERAL DESCRIPTION

Electro pneumatically operated devices are provided with magnet valves which govern the admission of air to and the exhaustion of air from the air-operated cylinders. Magnet valves fall naturally into two general classifications as to operating principle: namely Standard and Inverted Valves.

The Standard Valve when energized, admits air from the pressure line through a small port or seat allowing the air to pass through the valve and into the air cylinder which actuates the complete piece of apparatus. In this valve the full pressure of the air line or reservoir acts continuously in the cylinder, as long as the magnet coil is energized, while another valve on another seat prevents the air from escaping through the magnet valve exhaust port.

The Inverted Valve when energized, acts to shut off the air from the supply line and allows air to escape from the cylinder through an exhaust port in the magnet valve. Sequence switches usually use both types of valves at the same time, due to the opposed direction of travel of the pistons in the air cylinder, the magnet valves being alternately energized or de-energized depending upon the direction of motion necessary.

Figure Dg. which follows, illustrates the general principle of magnet valves, using a typical cross section of a standard valve, the chief distinction between the standard and inverted valves being that in a standard valve one bushing with two seats (upper and lower) and two valve stems are used, while in an inverted valve two bushings and one floating valve with two faces actuated by a pushrod and operating between the bushings are used. The construction of corresponding valve parts is similar and the following description, therefore, applies to all the valves.

In Figure Dg which follows is shown the diagrammatic cross-sectional view of a standard magnet valve with the operating parts in the position which they occupy when there is no current passing through the coil. Under this condition the spring (a) pushes the valve (b) up against the seat (c) and prevents any air from passing from the control air supply to the operating cylinder. The spring (a) not only closes the valve (b) but at the same time lifts the valve (d) off its seat (e) and leaves a clear opening for the escape of air from the operating cylinder through the passage (j) and (f) to atmosphere. When the magnet coil is energized the armature (h) pushes down on the stem (k), opens the valve (b) and admits air from the supply to the operating cylinder through the passage (p), and at the same time closes the exhaust valve (d).

Several mechanical adaptations of magnet valves have been made throughout the many years during which air-operated control systems have been used. Fortunately for the operator

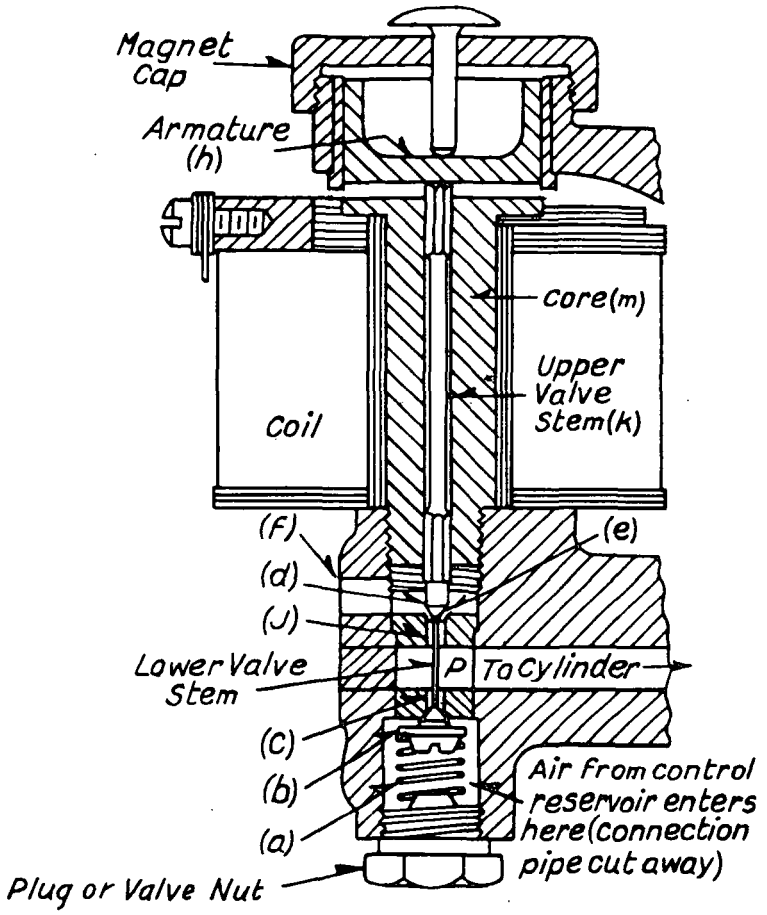


Fig. Dg(1) - Cross Section of Westinghouse Open-Coil Type Standard Magnet Valve

the maintenance procedure for all valves is practically the same and reference is made to the following double-page sheet of "Tools and Instructions for Servicing Magnet Valves" for the special instructions which apply to the valves on a particular equipment.

INLET VALVE LEAKAGE:

Occasionally a valve will "blow" (i.e. give out a hissing sound) due to leakage of air, if this occurs when the magnet coil is de-energized and the air blows out of the magnet exhaust port (f), it is an indication that the lower (inlet) valve is not seating properly. This trouble is caused generally by the presence of a little dirt on the valve seat and in most cases can be "cured" by pressing down the pinion the top of the magnet valve and releasing it quickly several times. If the blowing persists, shut off the air from the apparatus and unscrew the plug at the bottom of the magnet valve. Carefully lower the plug straight down and the spring and lower valve will drop down with it. Wipe the valve perfectly clean and with a small stick and piece of cloth also clean the valve seat.

When replacing the lower valve, spring, plug or valve nut, first remove the cap over the armature so that in case the valve stem does not properly enter the hole in the stem (k), it is free to be lifted by the advancing stem instead of being damaged. If the inlet or exhaust valve is not tight, the difficulty can sometimes be overcome by inserting a small screw-driver in the top slot and spinning it a few times on the seat.

EXHAUST VALVE LEAKAGE:

In case a standard valve "blows" through the exhaust port when the coil is energized it is a sign that the exhaust valve (d) is not seating properly on the seat (e). This may be due to any one of the following causes which are mentioned in the order of their usual liability of occurrence.

(1) Dirt on the valve seat (e).

(2) Weak battery or low voltage applied to coil.

(3) Dirt under the magnet armature (h).

(4) Valve stem (k) worn down so that armature strikes the core (m) before the valve seats.

To remove the stem (k) it is not necessary to shut off the air. First remove the cap over the armature and lift out the armature which is not fastened in any way. Next place a finger of one hand over the magnet valve exhaust port (f) and press down on top of the valve stem with a finger of the other hand and then raise the finger quickly. The valve stem will be raised by the air pressure and can be readily lifted out and the end of the valve wiped clean.

EXHAUST VALVE LEAKAGE - Continued

A weak battery will sometimes give a sufficient pull to unseat the lower valve but not enough to close the exhaust. The obvious remedy is to charge the battery.

Another possible cause of a blowing exhaust valve, i.e. worn down stem (k), is very unlikely to occur until after the equipment has been in service for several years. If this stem is found to be too short it can be slightly stretched by "peening" the shank.

Dj-1

MAGNET VALVE INSPECTION & MAINTENANCE

VALVE GAUGING:

In order to obtain satisfactory operation from the electro pneumatic valves, it is necessary to maintain the "travel of the valve" and the final gap between the magnet armature and the core, within certain limits.

After a considerable period of service the valves wear down and it is necessary to refit or replace them. In order to accurately determine their condition a simple gauge, Style No. 754434, is employed. This gauge is used for both standard and inverted valves by turning it over, depending on type of valve to be checked.

STANDARD VALVES:

Gauge, S#754434, is used to check and adjust the final gap and the length of new upper valve stems. See Fig. 1 of double sheet following. Remove the magnet cap and insert the gauge as shown. Flat-file the top of the upper stem until the ".056 gauge will admit air to the cylinder with a slight leak out the exhaust and the ".052 gauge will close the exhaust valve tight. The final air gap is then between the two, or approximately ".054. New stems have excess length and should be ground to a tight seat before adjusting the gap. Directions for grinding are included in a later paragraph.

In service, it is permissible to allow the upper stem and seat to wear until the final gap is approximately ".032. The ".066 gauge will at this point fail to unseat the lower valve to admit air to the cylinder and the upper stem must be stretched by peening or a new stem used.

The same gauge S#754434 is used, after the upper valve stem has been adjusted, to adjust the travel and the length of the lower valve stem. Use the ".088 gauge. This will probably cause the valve to unseat and blow due to excess length of the lower stem. The upper end of lower stem should then be flat-filed until the ".088 gauge will not touch but the ".070 gauge will unseat the lower stem. The total gap is then approximately ".086 and the travel is ".086 minus ".054 or ".032. In service, it is permissible to allow the lower stem to wear as long as the condemning gauge ".066 makes the lower valve blow when the upper stem is new. If it does not, the travel has then reached ".012 and the lower stem must also be stretched by peening or a new stem used.

INVERTED VALVES:

Gauge, S#754434, is used to check and adjust the final gap and the length of new pushrods. See Fig. 6 of double sheet following. Remove the magnet cap and insert the gauge as shown. Flat-file the top of the pushrod until the ".052 gauge discharges the cylinder with a slight leak out the exhaust and the ".049 gauge will discharge the cylinder with the inlet valve tight.

The final air gap is then between the two, or approximately ".050. New pushrods have excess length and valves should be ground to a tight seat before adjusting the gap. Directions for grinding are included in a later paragraph.

The same gauge S#754434 is used to check the travel of the floating valve. This travel is set at the factory between ".017 and ".027, by proper machining of the bushings and floating valve. To check this travel, the ".079 gauge will close the lower port and should not make the valve blow, the ".066 gauge should cause a slight leak; both checks being made with the cylinder charged.

In service, it is permissible to allow the pushrod to wear until the final gap is approximately ".032. Some magnet cores (used with "clapper" type armatures) are made with bronze residual stops, ".020 in height above the core face. Obviously, on cores using these pins, the final air gap setting would be ".012 more than the height of the residual pins. The ".056 gauge will at this point fail to unseat the exhaust port to discharge air from the cylinder and the pushrod must be stretched by peening or a new rod used. No adjustment of the floating valve is possible, therefore when the maximum travel exceeds the limit of approximately ".012, a new valve must be ground in.

GRINDING VALVES:

It is occasionally necessary to grind in leaky valves. Use prepared grinding compound for this purpose, or make a thin paste of very finely ground pumice and machine oil. Apply a little grinding compound on the valve seat, put valve in place and spin back and forth with a screw driver.

W When grinding the lower valve, the upper stem or pushrod should be in place to act as a guide. After grinding, the stems and valve seats should be thoroughly cleaned, by using a little gasoline and blowing out with air.

For detailed instructions and convenient tools for use in grinding or servicing valves see the double sheet of "Tools and Instructions for Servicing Magnet Valves," which follows.

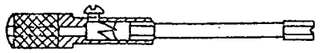
CONTROL MAGNET VALVE TOOLS

(Conventional Type Valves)

The following list of control magnet valve tools covers those generally needed to facilitate work on the apparatus. See double sheet following on "Tools and Instructions for Servicing Magnet Valves".

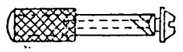
TOOL	STYLE NO.	DRAWING
Valve Seat Scraper (".215 dia. Shank)	223680	323629
Valve Seat Scraper (".309 dia. Shank)	822840	439381
Valve Seat Scraper (".375 dia. Shank)	896110	439381
Valve Seat Scraper (".434 dia. Shank)	326392	439381
Valve Seat Set (".215 dia. Shank)	223681	323629
Valve Seat Set (".309 dia. Shank)	822839	439381
Valve Seat Set (".375 dia. Shank)	896109	439381
Valve Seat Set (".434 dia. Shank)	326393	439381
Upper Valve Stem Scraper (".218 dia. Stems)	223683	323629
Upper Valve Stem Scraper (".313 dia. Stems)	822841	439381
Upper Valve Stem Scraper (".377 dia. Stems)	896111	439381
Upper Valve Stem Scraper (".435 dia. Stems)	326394	439381
Scraper for Standard Lower Valve only	223682	323629
Guide Nut (".218 dia. hole 5/8-18 thread)	523034	323629
Guide Nut (".328 dia. hole 5/8-18 thread)	757465	10-B-334
Guide Nut (".437 dia. hole 3/4-16 thread)	523033	439381
Tool Adapter for Grinding Lower Bushing in Inverted Valve (".437 Hole)	326396	439381
Core Spanner Wrench (".206 Center Pin, 29/32" Spanner)	1 086871	10-B-334
Core Spanner Wrench (".314 Center Pin, 29/32" Spanner)	757466	10-B-334
Core Spanner Wrench (No Center Pin, 7/8" Spanner	94211	170010
Core Spanner Wrench (No Center Pin, 1-1/8" Special Spanner	514516	170010
Valve Grinder with Handle Grip, for grinding Floating Valve with ".127 stem (4"lg. ".210 dia.)	249746	323629
"Whirligig" Valve Grinder	414800	617092
Bit for "Whirligig" Grinder 5/32"	414804	617092
Bit for "Whirligig" Grinder 7/32"	414802	617092
Bit for "Whirligig" Grinder 5/16"	757468	617092
Bit for "Whirligig" Grinder 25/64"	414803	617092
Extension Bit for "Whirligig" Grinder for Grinding Floating Valve with 1/8" stem (3-1/2" long ".308 dia.)	757472	617092
Magnet Valve Gauge	754434	624990
Socket Wrench (".242 Hex. Nut)	466807	732452
Socket Wrench (21/64" Sq. Hd. Bolt)	1 016513	70-D-421
Socket Wrench (25/64" Sq. Hd. Bolt)	1 019795	70-D-448

Screw Driver, Socket Wrenches and other Standard tools as required.



Style No. 223683 (".218 stem)
Style No. 326394 (".435 stem)
Style No. 822841 (".313 stem)
Style No. 896111 (".377 stem)

SCRAPER FOR UPPER VALVE STEM



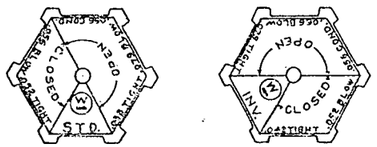
Style No. 223682

SCRAPER FOR STANDARD LOWER VALVE

To be used for reseating worn valves before regrinding. New valves do not require scraping.

ADDITIONAL BENCH TOOLS

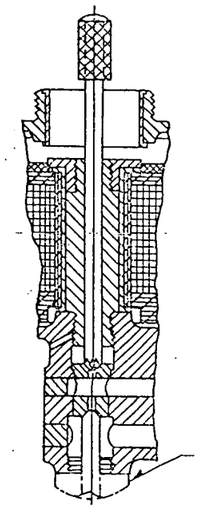
Whirligig or Valve Grinder --------	Style No.	414 800
Bit for 5/32" Valves --------	Style No.	414 804
Bit for 7/32" Valves --------	Style No.	414 802
Bit for 5/16" Valves --------	Style No.	757 468
Bit for 25/64" Valves --------	Style No.	414 803
Extension Bit (".308 Dia.) for Floating Valves --------	Style No.	757 472
Core Wrench for ".325 Core Stems --	Style No.	757 466
Core Wrench for ".218 Core Stems --	Style No.	1 086 871



Style No. 754434

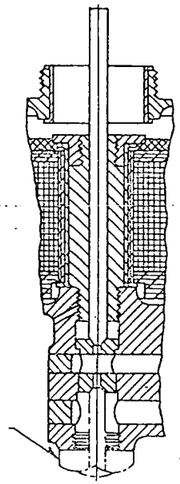
VALVE SETTING GAUGE

FIGURE 1



GUIDE NUT

Style No. 523034 ".218 Hole
Style No. 757465 ".328 Hole



Style No. 223680 (".215 Dia. Shank)
Style No. 822840 (".309 Dia. Shank)

SCRAPER FOR VALVE BUSHING

Style No. 233681 (".215 Dia. Shank)
Style No. 822839 (".309 Dia. Shank)

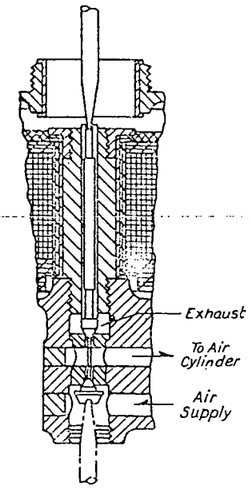
SET FOR VALVE BUSHING

To be used before grinding in new valve bushings and also for reseating worn valve bushings before regrinding.

New bushings are supplied with small drilled hole for ports, which must be drilled out to same size as old bushings after new bushing is in place.

Drill clearance hole for scraper in a lover valve nut as shown and use this as a guide for scraper and drill.

FIGURE 2

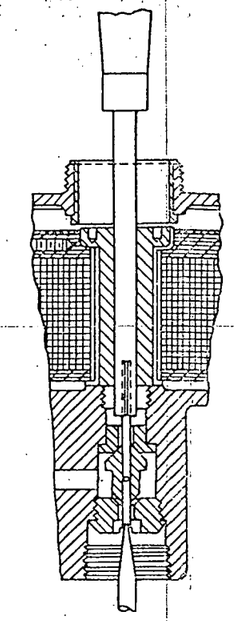


METHOD OF GRINDING STANDARD VALVE

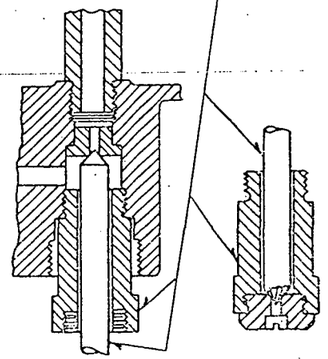
Cover the surface of valve seat with a mixture of powdered pumice stone and oil, and spin the valve on the bushing with a screw driver until seat is tight.

The pumice should be removed before testing for a leaking valve.

FIGURE 3



SCRAPER.....".375 Dia...STYLE NO. 896110
SCRAPER.....".434 Dia...STYLE NO. 326392
SET TOOL.....".434 Dia...STYLE NO. 326393
SET TOOL.....".375 Dia...STYLE NO. 896109
TOOL ADAPTER.....STYLE NO. 326396

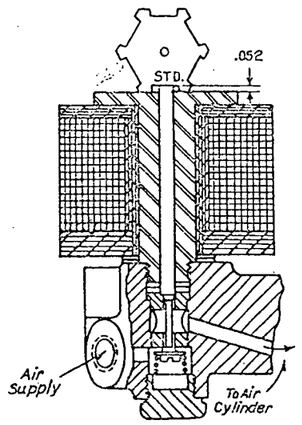


METHOD OF GRINDING INVERTED VALVE

Spin valve with tool Style No. 249746 for grinding lover seat and with screw driver for upper seat.

METHOD OF SETTING AND SCRAPING INVERTED MAGNET VALVE BUSHINGS FOR RESEATING WORN VALVE BUSHINGS BEFORE REGRINDING.

FIGURE 4



METHOD OF CHECKING AND ADJUSTING AIR GAPS AND VALVE LENGTHS FOR NEW VALVES WITH GAUGE STYLE NO. 754434 STANDARD VALVES

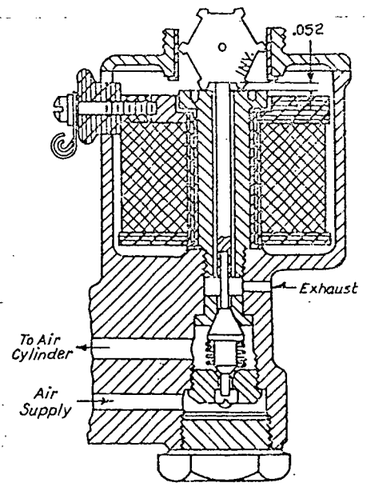
With new valve stems, both upper and lover, there is excess length. Grind both to a tight seat as per Figures 1, 2 and 3.

To adjust the final air gap, flat-file the top of the upper stem until the ".056 gauge will operate the cylinder but the valve will blow slightly and the ".052 gauge will close the valve tight. The final gap is then between ".052 and ".056, or approximately ".054.

To adjust the travel and the length of the lover valve use gauge ".088. This will probably cause the valve to unseat and blow due to excess length of the lover stem, which should be flat-filed until the ".088 gauge will not touch but the ".079 gauge will unseat the lover stem. The total gap is then approximately ".086 and the travel is ".086-".054, or approximately ".032.

In service, it is permissible to allow the upper valve stem and seat to wear until the final gap is ".032 instead of ".054, the lover valve stem to wear until the travel is ".012 instead of ".032. To check worn valves, the ".066 gauge should make the valve blow. If it does not, either the upper or the lover stem is approaching the limit of wear and should be stretched by peening or replaced in line with instructions for new stems.

FIGURE 5



METHOD OF CHECKING AND ADJUSTING TRAVEL AND LENGTH OF PUSH ROD WITH GAUGE STYLE NO. 754434 INVERTED MAGNET VALVES

Grind valve to a tight seat as per Figure 4. To adjust the final air gap, flat-file the top of the push rod until the ".052 gauge discharges the cylinder but the valve blows slightly and the ".049 gauge discharges the cylinder with the valve tight. The final air gap is then between ".049 and ".052.

The travel is set at the factory as between ".017 and ".027 by proper machining of the bushings and of the floating valve. To check the travel, the ".079 gauge should not make the valve blow but the ".066 gauge should make it blow slightly, both with the cylinder charged.

In service, it is permissible to allow the push rod to wear until the final gap is ".032 instead of ".050. To check worn push rod, use the ".056 gauge. This should make the valve blow with the cylinder charged. If it does not, the push rod should be stretched by peening or replaced in line with the above instructions for a new valve.

FIGURE 6

(1) GENERAL DESCRIPTION OF MAGNETIC CONTACTORS

Magnetic contactors are magnetically operated switches used for the purpose of closing and opening auxiliary or power circuits; they are operated by low voltage from the battery circuit.

Each contactor comprises a stationary and movable contact, an electro-magnet for bringing the contacts together, a "blowout coil" to extinguish the arc, and arc shields to protect the metal portions of the switch.

The stationary and moving contacts are made of hard drawn copper of sufficient section to give long life. Burning at opening and closing occurs only at the tips of the contacts and does not affect the current-carrying surfaces; a slight wiping action when closing insures a clean, low-resistance contact area. A steel compression spring insures positive contact pressure, regardless of wear, and also causes quick-opening of the contacts.

The arc shields are made of moulded heat resisting material and are hinged so that they may be easily rotated by hand for inspection of contacts.

(2) MAINTENANCE OF MAGNETIC CONTACTORS

No oil or other lubricant should be used on the copper contacts. The contacts normally wear to give the best contact surface without any attention; roughened appearance is no indication that good contact is not being obtained. Clean the contact surfaces with fine sandpaper when the wear on the faces causes excessive roughness.

(a) The copper contacts should be renewed when the tips are burned away to the extent that the current-carrying surfaces are materially affected. Contacts may be removed by taking out a single screw; neglect of contact renewal may allow the arc to burn the contact screw making it difficult to remove or may otherwise damage the contactor.

Contacts sometimes wear quickly as the result of too small a travel and very little wiping action. This may be caused by a bent hinge pin, insufficient free movement of the armature, or too strong a finger spring.

(b) The bearings of the hinge pin and armature shaft require no lubrication; oil quickly collects dust and, unless parts are frequently cleaned, will interfere with the operation.

The bearings and hinge pin should be kept in perfect condition; decreased contact pressure may result from a worn hinge pin or a weak finger spring; in either case the defective part should be renewed promptly.

MAINTENANCE OF CONTACTORS - Continued

(c) Arc shields should be renewed before the moulded material is burned away sufficiently to expose the metal poles; the shield may be removed easily by taking out a single bolt.

(d) The flexible copper shunt should always be held tight. If it becomes loose, there is danger of the shunt burning at that point.

(e) The operating coil may be removed readily by lowering the armature, disconnecting the terminal leads and removing a screw. Coils are designed to operate the contactor successfully at from 80 per cent to 110 per cent of normal voltage and to stand 110 per cent voltage continuously without overheating; coils are impregnated to make them resistant to moisture and oil.

(f) The sealing surfaces of the magnet core and armature should be kept clean.

(g) The interlocks should be properly adjusted so as to make contact at the correct point.

(h) After the car or locomotive has been run an inspection can be made immediately upon shutdown of contactor condition by feeling the temperatures of the contacts and interlocks by hand. The warmer ones should be adjusted. This same method of inspection can be applied to other contacts.

(i) The "pull-in" voltage of the contactor should be determined at overhaul and the contactor set to "pull-in" at not more than 80 per cent of normal voltage.

(j) Faulty or erratic operation may occur due to too high a "pull-in" voltage or binding at bearing or other points.

(k) The arcing shield or chute which surrounds the main contacts can be released readily and slid out from its position; it is provided for the purpose of directing the arc and preventing it from coming in contact with the blowout poles and other metal parts of the switch. The parts of the arc chute are all made of arc-resisting, insulating material but they will gradually wear away occasional renewing. The sides should be renewed before they have burned away sufficiently to expose the metal pole pieces.

(l) The copper shunt which carries the current from the lower contact to the contactor terminal should be securely fastened, and if broken or badly worn, it should be replaced promptly.

ACy
Rev.

INTERLOCKS

An interlock is an auxiliary switch, mounted on a main circuit electro-pneumatic switch or electro-magnetic contactor, which establishes or disconnects a control circuit at the time of operation of its particular switch. There are two general classes; the "IN" interlock, which completes a control circuit when the main contacts of the switch are closed; and the "OUT" interlock which establishes a control circuit when the main contacts are opened. A single main switch or contactor can be equipped with "IN" interlocks, "OUT" interlocks or a combination of both depending on the sequence required.

There are three general types, the Butt Type commonly used on magnetic contactors and the Sliding Type and Cam Types usually used on pneumatic switches. With the butt type a small metal arm is attached to the armature of the switch. The arm actuates a pivoted insulated block on which are mounted spring supported contacts. As the switch operates, the contacts bridge control terminals and thus establish the circuit. With the sliding type, the control wires are terminated at compensated fingers mounted on the base of the switch. An insulated block, which carries small conducting segments, is attached to the piston arm of the switch. As the switch operates the segment slides under two fingers to complete the circuit. With the cam type, the control wires are terminated at the stationary and spring fingers mounted on the base of the switch. A block attached to the piston arm carries small cams. As the switch operates, the cams close or open the spring fingers to make or break the circuit to the stationary fingers.

Interlocks have a very important function in the overall performance of the apparatus. The failure of an important interlock is sufficient to prevent operation. Trouble can be avoided by periodic inspection.

INSPECTION:

The following examination of the interlocks should be made at inspection periods:

(1) See that the control terminals are tight.

(2) See that the interlock contacts are clean and not worn or burned.

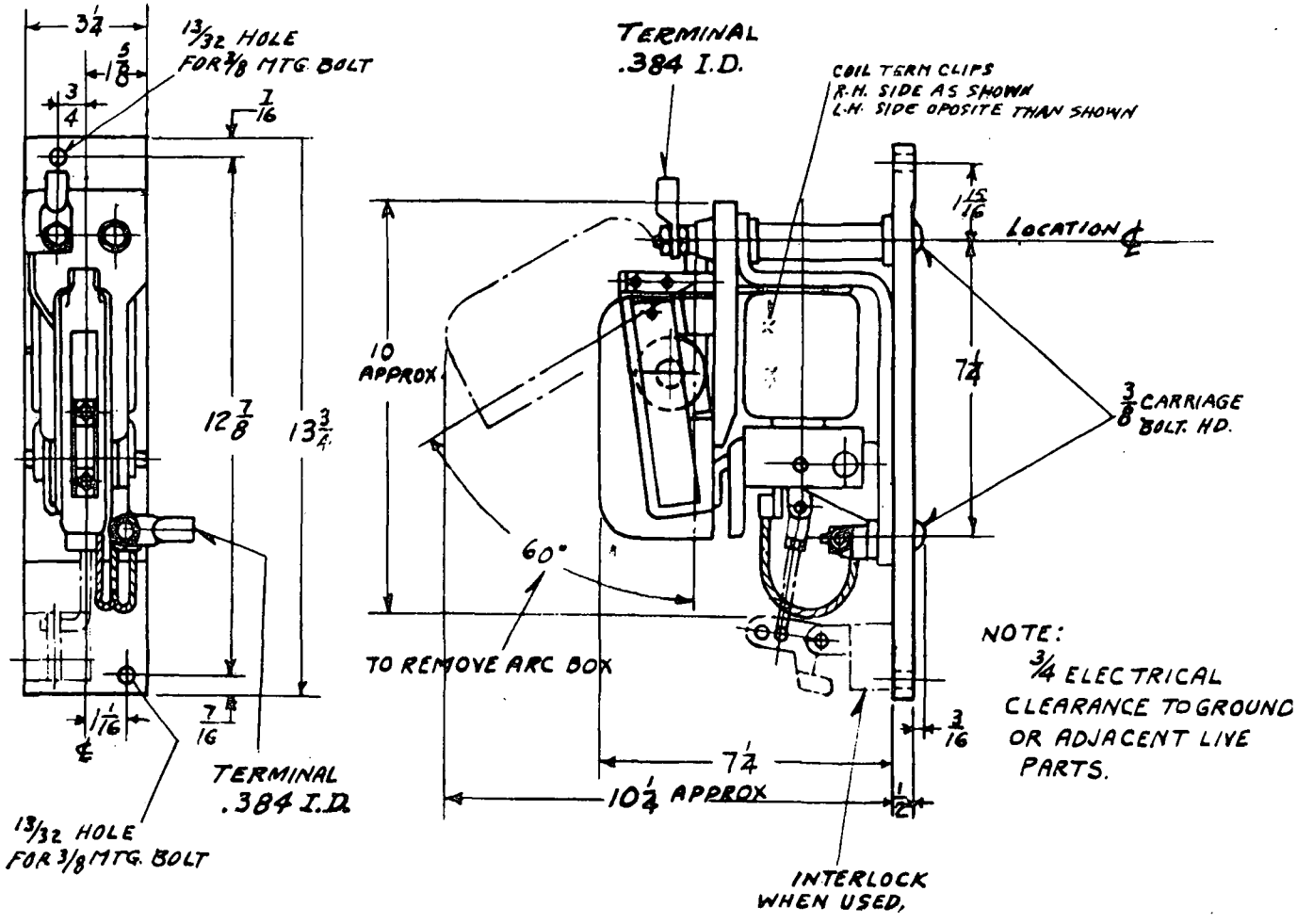
(3) See that there is a deflection of the spring in the interlock finger or bar when the contact is made.

a. On the butt type this can be obtained by adjustment of the length of the interlock arm.

b. On the sliding type this can be accomplished by putting a slight set in the finger.

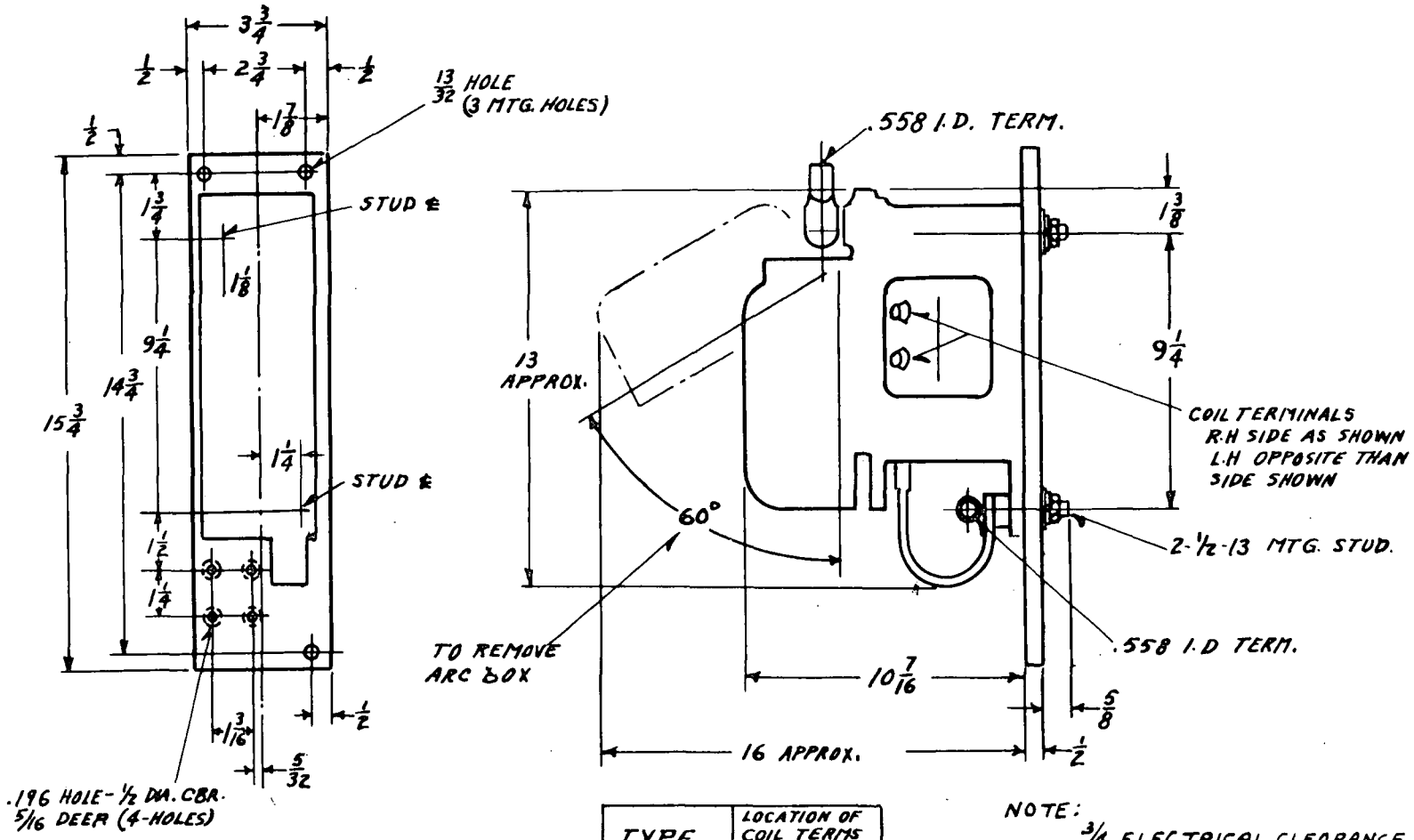
c. On the cam type this can be accomplished by adjustment of the gap between fingers. This should normally be 1/8" when open.

TYPE	POSITION OF TERM CLIPS R.H.	L.H.
UMJ-34-A		2
UMJ-134-A		2
UMJ-234-A		2
UMJ-334-A		2



Types UMJ-34-A, UMJ-134-A, UMJ-234-A & UMJ-334-A Contactors
Outline--Dwg. 1-D-9853

Types UMA-225-A, UMA-275-A, UMA-325-A, UMA-375-A Contactors
Outline--Dwg. 1-D-9834



TYPE	LOCATION OF COIL TERMS R.H. OR L.H. SIDE
UMA-225-A	L.H
UMA-275-A	R.H
UMA-325-A	L.H
UMA-375-A	L.H.

NOTE:
3/4 ELECTRICAL CLEARANCE TO GROUND OR ADJACENT LIVE PARTS.

THROTTLE SWITCH

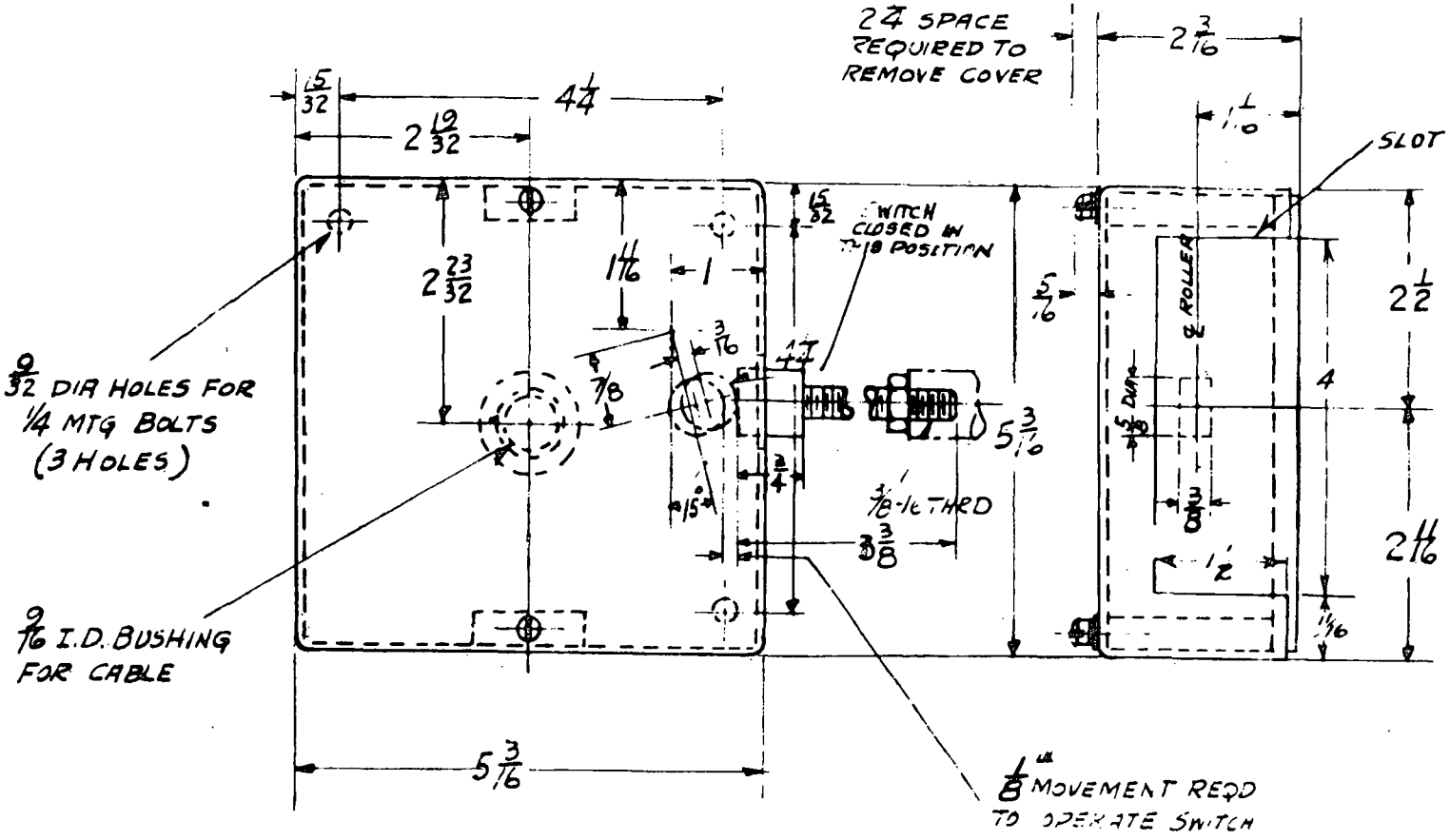
This switch is controlled by the lever which operates the engine throttle valve in such a way that the first movement of the throttle from the "Idle" position closes "Run" contacts establishing circuits to the reverse drum through which the traction motor contactors and main generator contactors are energized. The "Run" contacts remain closed until the throttle is returned to the "Idle" position.

The throttle switch should be cleaned and inspected for loose terminals, poor contacts and broken springs at regular inspection periods.

The opening and closing of the switch should also be checked to insure that it pulls in before the engine speeds above idling.

The cover should be removed and the spring action checked for quickness of action.

Types XC-31, 131, 181, 231 Throttle Switches-Outline Dwg. 4-D-2759-4



TYPE UV-56 RELAY PANEL

These relay panels consist of either two relays and two resistor tubes on an insulating base or one relay and a resistor tube on a base. The relays are exactly alike in mechanical details and coils but may be adjusted to operate at different voltages. The correct operating voltages are indicated on the wiring diagram. Each coil is connected in series with one of the resistor tubes.

The relay is a clapper type device mounted on hardened pivot bearings which are covered by a felt washer to exclude dust and dirt.

The pivot points are used to minimize friction and a counter weight is attached to the armature to balance the moving parts and minimize the effect of vibration. The moving and stationary contacts have contacts with silver tips.

These relays are adjusted to two voltages. One is the so-called pickup voltage which is the voltage at which the coil overcomes the pull of the spring and pulls in the armature. The other voltage is the dropout which is the voltage at which the tension of the spring overcomes the pull of the coil and pulls the armature back away from the coil.

Three adjustments are required to calibrate these relays One is the tension of the spring, the second is the air gap when the relay is closed, the third is the air gap when the relay is open or de-energized. These adjustments have been made at the factory and should not need to be changed. These adjustments have all been soldered so that the vibration on the locomotive will not change them.

The effect on the pickup and dropout voltages of the three adjustments are as follows:-

(a) Increasing the tension of the spring raises both the pickup and dropout voltages. Decreasing the tension lowers both the pickup and dripout voltages.

(b) With the relay de-energized, increasing the air gap (by means of the stop screw) raises the pickup voltage and does not affect the dropout. Decreasing this air gap lowers the pickup voltage without affecting the dropout.

(c) With the relay picked up, decreasing the air gap (by means of the residual screw) lowers the dropout voltage without affecting the pickup. Increasing this air gap raises the dropout voltage without affecting pickup.

Another adjustment (which may or may not be used) is the jumper on the resistor tube but this adjustment is determined at the factory and must not be changed. If a new resistor tube

is installed, care should be taken that it be assembled with the identification band at the lower end of the relay panel and the position of the jumper on the old tube should be noted. After replacing with a new tube the jumper should be installed on the tap corresponding to the tap on the old tube.

If possible the relay panel should be removed to a bench with a source of variable voltage with a range covering the pickup and dropout voltages. It is possible to adjust these relays on the locomotive if the circuit to the traction motor is broken or it may be possible to adjust them while the locomotive is in operation.

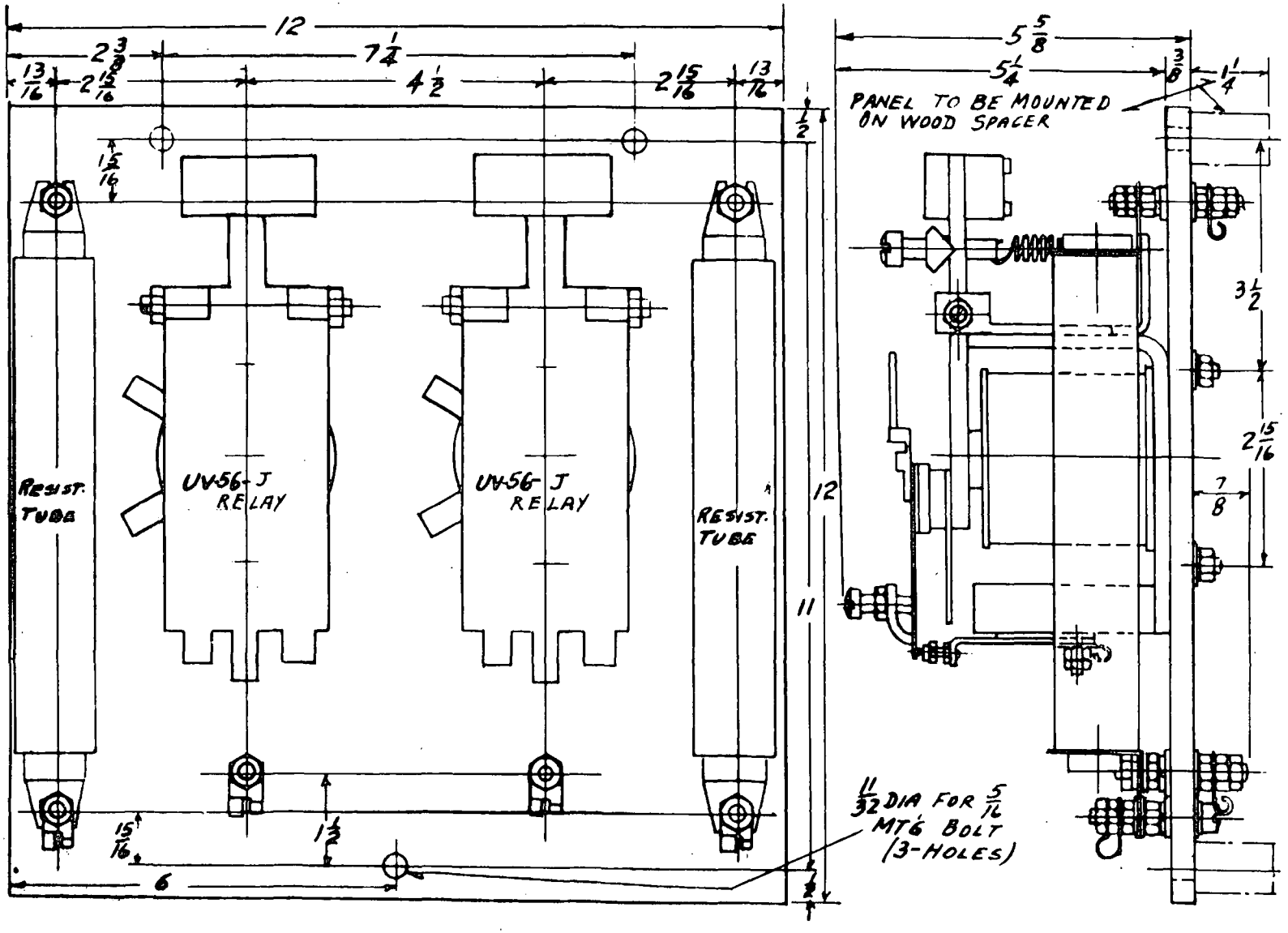
Maintain the pickup and dropout voltages shown on diagram by changing the proper adjustment. This will only be required at infrequent intervals provided the adjustments are resoldered to prevent locomotive vibration from affecting them. The fingers should be kept in adjustment as they wear. The fingers should deflect 1/16 inch when in contact with their studs. The air gap between finger and contact stud should not be less than 3/32 inches and relay should not "float" either in or out.

WESTINGHOUSE ELECTRIC & MFG CO. EAST PITTSBURGH, PA. U. S. A.

DIMENSIONS IN INCHES

TRANSPORTATION CONTROL - TYPE UV-56 H RELAY PANEL
OUTLINE

DWG. NO. 4-D-2797



TYPE M RESISTORS

Type M resistors are used in the circuits where large resistor capacity is required. This resistor is built of tubular units having steel center supports insulated by sections of porcelain. A resistance ribbon is wound edgewise in the form of a helix about the sections of porcelain. The units are mounted on insulated tie rods supported on a strap steel frame. Each unit may be removed easily without disturbing any of the other units.

The resistors limit the amount of current flow through the respective circuits and thus have an important part in the overall performance of the equipment. Electrical characteristics of the equipment can be upset by the adjustment of a resistor in an important circuit. All resistance values are properly adjusted when the unit is first put in service. Adjustments should only be made by one who is thoroughly familiar with the performance of the complete equipment.

At light and heavy inspections the complete resistor assembly should be examined for broken porcelains and resistance ribbons. Check that all connections are tight and properly made and that the resistance ribbon is properly and securely clamped in the end terminals. The mounting insulators and frame terminal bar should be cleaned.

At general overhauls, in addition to the above inspections, the mounting bolts should be tightened and the insulating terminal bar should be cleaned, then painted with insulating varnish.

When replacing a resistor tube, care should be taken to have the terminal clamps and resistor ribbon clean, smooth and bright before making connections. It is preferable to use new terminal clamps when replacing the tubes.

CONTROL RESISTORS

The control resistors, which carry only low values of current, consist of resistance wire wound on tubes. The tubes are of various ohmic values as specified on the wiring diagram.

The control resistors also have an important function in the overall operation of the electrical apparatus. The characteristics of the equipment can be disturbed by changing the values of the control resistors in important circuits. The resistors are properly adjusted when the equipment is first placed in service and should not be tampered with. Adjustment should be made only by one who is thoroughly familiar with the performance of the complete equipment.

At light and heavy inspections the resistor panel should be examined carefully for loose connections. The resistor tubes should be taken from the panel and checked for broken or open circuited tubes. Care should be exercised in replacing the tubes and making the proper connections.

Replace broken or damaged tubes only with tubes having identical style number.

AHc
Rev.

MISCELLANEOUS SWITCHES AND FUSES

All hand switches and fuses (if used), should be regularly inspected to cover:

1 - Switch jaws, fuses and fuse clips making good contact.

2 - Leads firmly soldered, terminals and bolts tight.

3 - Panels or bases clean, free from oil and dust.

4 - Correct fuses in use, spare fuses available, and auxiliary apparatus tested if one fuse blows frequently.

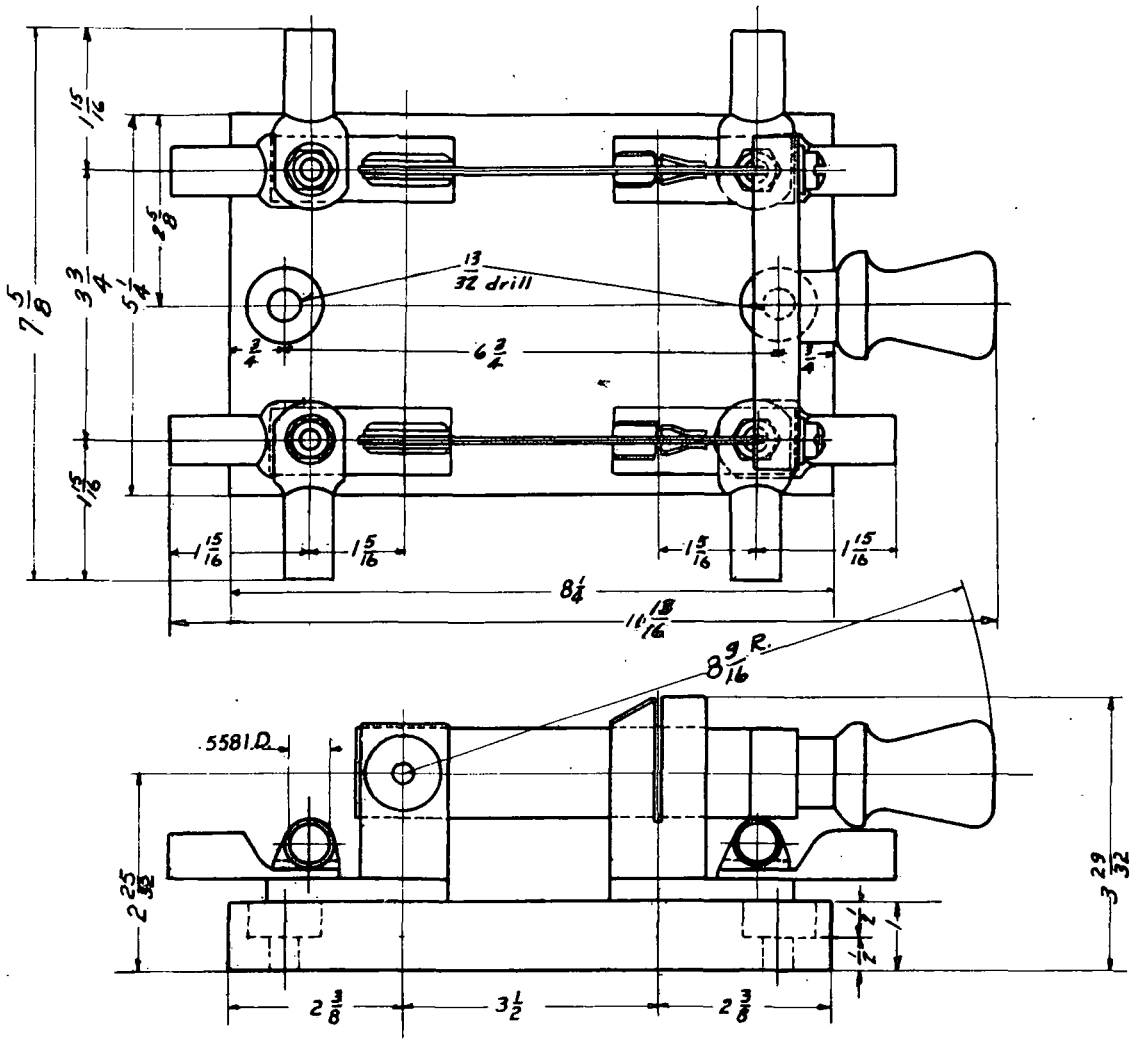
5 - Any springs correctly in place and operating.

6 - Apparatus tested for proper operation.

7 - Contacts clean and smooth.

This inspection should cover all items (where provided) such as control and miscellaneous switches and fuses, traction motor cutout switches, weight transfer and sander foot switches, buttons for engine stop or other circuits, headlight hand switches and fan or traction blower switches.

DIMENSIONS IN INCHES



Type 496-R Battery Knife Switch Outline
Drawing 840168-2

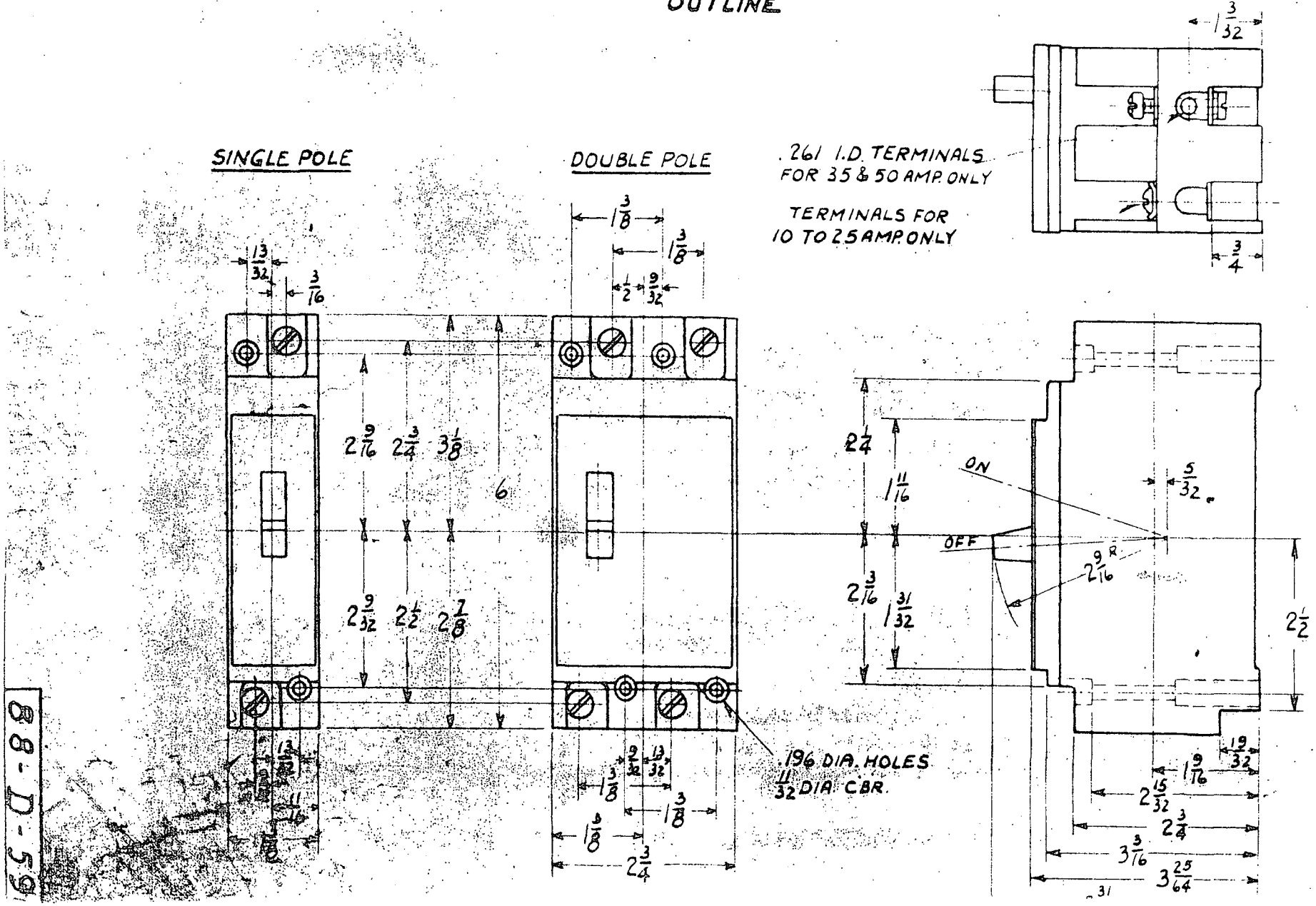
THIS SPACE RESERVED FOR SIDE BINDING

WESTINGHOUSE ELECTRIC & MFG. CO. EAST PITTSBURGH, PA., U. S. A.

DIMENSIONS IN INCHES

RAILWAY CONTROL
TYPE AB CIRCUIT BREAKER
10 TO 50 AMP. 125-250 V.
OUTLINE

DWG. NO. 88-D-596



88-D-596

SECTION VI

MAINTENANCE AND INSPECTION

WESTINGHOUSE DIESEL-ELECTRIC EQUIPMENT

For the successful operation of self-propelled equipments:

(1) The maintainers should be thoroughly familiar with the apparatus and follow definite inspection schedules.

(2) The engineers should be familiar with the purpose of the apparatus, normal operation limitations and the proper method of operation. Only qualified men should handle the equipment without supervision.

(3) An adequate supply of protecting parts should be kept on hand by the operating company.

The Westinghouse Company supplies apparatus data for the instructing of maintainers; and parts data information for ordering necessary equipment. These instructions are the result of experience on many different equipments and are for the guidance of the operating company.

Local operating conditions will govern maintenance work. It frequently happens that scheduled maintenance work can be performed when the equipment is out of service due to operating conditions, such as, wheel turning or some other such cause. A carefully arranged maintenance schedule results in efficiency availability and low operating costs. Study the operating conditions to eliminate useless work, combine work and inspection when possible but do not neglect the essential work at its proper time. Follow the recommended schedule until sufficient experience is obtained to justify a change.

ABb
Rev.

INSPECTION SCHEDULES

1. These schedules indicate work that should be done on the equipment. Necessary data and detail information on the apparatus is contained in the instructions for individual equipment elsewhere in this book.

2. It is recommended that the customer give particular attention to all parts when the equipment is placed in service in order to insure successful operation, and that the maintainers become familiar with the equipment.

3. Inspections should be as follows:

Class A -- Daily, or during refueling periods.

Class B -- Every 1500 miles on cars.
Every 150 hours on switcher locomotives,

Class C -- Every 6000 miles on cars.
Every 600 hours on switcher locomotives.

Class D -- Every 18000 miles on cars.
Every 1800 hours on switcher locomotives.

Class E -- Every 54000 miles on rail cars,
Every 5400 hours on switcher locomotives.

Class F -- Every 108000 miles on rail cars.
Every 10800 hours on switcher locomotives.

4. With operation at 30 miles per hour schedule, it will be noted that car inspection periods are at 50, 200, 600, 1800 and 3600 hours. Where grades and trailing loads cause schedules lower than 30 miles per hour, the hourly basis for rail cars should be used instead of the mileage basis.

5. To obtain the best use of the equipment the maintenance program should be very definitely laid out and followed. It is best to arrange the inspections of the particular pieces at different times, as then little time out of service will be required except for the Class E or heavy overhaul. Records should be kept to insure all pieces receiving proper attention.

6. The oil engine, the mechanical and the electrical equipments are separated in this schedule to simplify the instructions. Maintenance instructions for the engine should be procured from the engine builder.

ABc

GENERAL

Daily reports by the operator serve as the only means for indicating the proper functioning of the equipment. These reports should be thorough and required from every man regularly operating the unit.

The report should cover any special features noticed, such as air leaks, tight brakes, improper functioning of meters and gauges, unusual engine noises, exhaust leaks and exhaust appearance, oil leaks, lubricating oil added, any work done, engine oil and water temperatures (maximum and average), lubricating oil pressure (idling and full speed), trailing load and engine cylinder temperatures of pyrometers are installed, etc.

These reports are valuable and each item should be followed by the maintainer and the trouble remedied immediately. Abnormal variations in engine water and oil temperatures, quantities of oil used, engine noises, exhaust pipes overheating, excess current, flashovers, etc., should be investigated at once.

While the form submitted here is only a guide for the operating company to follow in preparing a schedule adapted to his particular operating conditions and the making of proper reports by their maintenance man, it is also believed that these forms can be followed out very closely. The operating company, of course, will make its own blank forms on their official paper.

Successful operation of internal combustion engine equipments depends, to a great extent, upon immediate correction of little troubles. If this is done, the overall expense for maintenance will be low.

ABd

Engineman's Daily Report on Equipment No._____

Service_____ Date_____

Total Hours_____ Rev. Miles_____ Yard Miles_____

Trailers_____ Gals. Fuel Oil Used_____ Gals.Lub.Oil Used_____

Gallons Fuel Oil Added During Day _____

Gallons Lub. Oil Added During Day _____

Maximum Temperature Jacket Water _____ Ave.Temp.Jacket_____

Maximum Temperature Oil_____ Ave. Temp. Jacket Oil_____

Equipment Detentions, Time, and Cause:

_____

_____

_____

Check the following items if O.K.; if not, mark with cross and explain below in detail.

Check Here

1. ( ) Are all cylinders firing properly

2. ( ) State the engine lubricating oil pressure at (a) Idling speed_____(b) Full speed_____

3. ( ) Check color of exhaust gas: black,_____ blue_____, gray_____, colorless_____

4. ( ) Is exhaust system in satisfactory condition. Report leaks or abnormal temperatures under remarks. Report exhaust temperatures where pyrometers are used.

Note:- If anything unusual occurs to apparatus during trip, a complete statement of same must be made on the other side of this sheet under Remarks.

Signed_____

_____
Engineer

All above adjustments and repairs have been made except as noted.

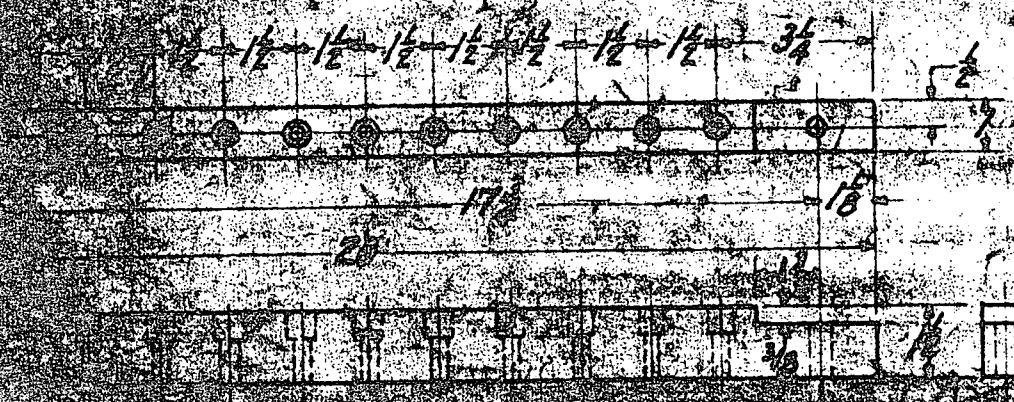
Signed_____
Maintainer

Date

Co., U. S. A.

Dwg. No. AB-D-599

TYPE A55 TERMINAL BOARD
OUTLINE



CLASS A INSPECTION

ELECTRICAL APPARATUS

(1) Correct items on engineman's report as necessary.

(2) Check batteries on new equipments until data indicates charging is correct, and afterwards as often as necessary. Do not set charging rate to keep battery overcharged or abnormal deterioration of the batteries will result. Excessive use of water usually indicates overcharging.

(3) Check supply of replacement fuses.

(4) Check meters, gauges, etc., to insure proper functioning.

(5) Leave no loose rags, especially waste in the engine room, as this may catch on rotating apparatus or go into the generator.

(6) Where train control is used, it may be necessary to test for grounds daily.

(7) Check all lights.

CLASS B INSPECTION

ELECTRICAL APPARATUS

Do work under the Class A inspection as necessary and in addition:

(1) See section on traction motors for lubrication of bearings.

(2) If necessary, apply lubricating compound to traction motor gears.

(3) Check the oil level of the air compressor motor. (If used)

(4) Flush batteries as necessary.

ABi-1
Rev. (2)

CLASS C INSPECTION

ELECTRICAL APPARATUS

Do work under Class B inspection as necessary and in addition:

(1) Traction Motors

(a) Check bearing wear by use of air gap gauges for armature bearings, feelers for axle bearings and measure armature end play. Where anti-friction armature bearings are used bearing wear or end play need not be checked.

(b) Remove all brushes from holders, clean the brush and holder and examine for end and side wear. Renew as necessary.

(c) Check Brush Tension.

(d) Inspect armature and field windings for indication of oil or excessive dirt. Correct the cause if oil is getting into the motor.

(e) Examine motor leads inside and outside of motor for chafing. Correct if insulation is being damaged in any way, Replace damaged leads.

(f) Blow out motors with clean, dry air using care not to damage the insulation with the jet. See that drain holes are open. Wipe out any heavy dirt within the motor. Use rags, not waste on electrical apparatus. Local operating conditions will govern frequency of cleaning motors.

(g) Clean commutator Wiring insulation at end of commutator. Place in first class condition by shellacking if necessary.

(h) Tighten axle cap bolts, if necessary, and see that all motor covers and bolts are tight. Note: On motors that are provided with Summer and Winter covers do not forget to change the covers with the season. (Nov. 15 and April 1 approximately).

(i) On motors with nose suspension examine the suspension for clearance, wear, and condition of spring and retaining pins.

(j) Clean motor frame and stop and holes that may be permitting oil to get on the motor from the engine room.

(2) Generator and Auxiliary Generator

(a) Do the same as for the motors, where above instructions apply.

(b) Inspect all connections at the terminal board.

(c) Tighten all coupling connecting bolts and studs,

(3) Compressor Motor and Governor (when used).

(a) Do the same as for the motors and generators where above instructions apply. Use air gap gauge for determining bearing wear.

(b) Inspect, clean, tighten connections, and, if necessary smooth the contacts of the compressor governor. Check the setting. Check insulation and renew if necessary.

(4) Blower Motor (when used).

(a) Do the same as for the generator, where the instructions apply.

(5) Auxiliary Motors such as Oil Clarifier, Fuel Pumps, Heating System, etc. Do the same as on other rotating apparatus, where the instructions apply.

(6) Control Apparatus

(a) Tighten all connections on the apparatus as necessary, at the terminal boards, at the controllers, thermostat switches, blower switches, junction boxes, resistors, regulators, etc. See that all connections are securely locked.

(b) Test for grounds on the control and rotating apparatus.

(c) Clean all cabinets, panels, controllers, etc., with clean dry air and wipe out any heavy dirt accumulations.

(d) Clean all main contacts on line switches and contactors.

(e) Inspect and adjust interlocks where necessary on all apparatus to insure proper wipe and operations.

(f) Renew contacts and interlocks that will not last to the next Class C inspection.

(g) Clean all segments on reverser, controllers, switch interlocks, etc.

(h) Examine and lubricate the linkage of the throttle mechanism. Remove excess looseness. Clean all parts and inspect all connections.

(i) Check tension and pressure of fingers on segments of all apparatus such as controllers, reversers (main and interlocks), switch interlocks, etc.

ABk

(j) Where lamp regulators are used, inspect all connections, renew broken or burned carbons, measure regulations as often as practice is standard, and tighten all nuts and connections.

(k) Where torque governors or other load regulating devices are used, tighten all nuts and connection; see that springs are securely locked, replace badly worn contacts and see that contacts are in the proper position.

(l) Examine control air valves and piping at switches, reverser and the throttle mechanism for leaks, breaks, etc.

(m) See that contact springs on all switches are adequate, and give good contact pressure.

(7) Compressor

Test pump according to I.C.C. rules as necessary, check governing device, oil as necessary.

AB1-1

CLASS D INSPECTION

ELECTRICAL APPARATUS

Perform work of Class C inspections as necessary and in addition:

(1) Generator.

(a) Grease the bearing with the proper lubricant. If too much grease has been added, it will be necessary to wipe off the excess grease accumulating on the machine.

(2) Blower motor (when used).

(a) Grease the bearing with proper lubricant.

(3) Control.

(a) Check sequence of switch operation.

CLASS E INSPECTION

ELECTRICAL APPARATUS

Perform work of Class D inspections as necessary and in addition:

(1) Control

(a) Tests for grounds

(b) All resistors should be examined carefully for burns or breaks, renewing if necessary. (Clamps should not pinch the ribbon).

(c) Test switches at reduced voltage to insure their operating with low battery.

(d) Test all battery cells and determine maximum voltage drop across battery when starting engine. If voltage is low, determine which cells should be replaced.

(e) See that fingers on switches, controllers, etc., do not over-travel the segment due to wear of stops, contacts, or other parts, and set to insure correct operation to the next Class D inspection.

(f) Use a few drops of 3179* oil on all the leather pistons on electro-pneumatic units such as the reverser, line switches, throttle mechanism, reset, engine trip, etc. Inspect operation of these units to insure fast and proper functioning.

(2) Traction Motors

(a) See section on traction motors for lubrication of bearings.

(b) Dismount gear case and dust guards. Check thrust and radial wear of axle bearings.

(c) Check back lash of gears.

(d) Renew any worn or chafed leads inside or outside of motor.

(3) Compressor Motor (when used)

(a) The oil should be the proper grade of winter or summer oil and should be changed twice a year.

(4) Battery

(a) Observe instructions of battery manufacturer for overhaul of battery.

---

* Westinghouse PDS-3179.

ABp-1
Rev.
3

CLASS F INSPECTION

ELECTRICAL APPARATUS

Inspect and do all work listed for previous inspections and the following additional work.

(1) Traction Motors

(a) Remove from truck. Check radial and total end play allowed by armature bearings. Dismantle motor and check for end play at each end. For armature bearings of the sleeve type determine whether maximum wear is on shaft thrust surface or bearing thrust surface and if correction of this detail will bring the clearance to a reasonable tolerance. For ball and roller-bearing motors, see instructions in motor section of this book. Bearings should be renewed if they will not last to the next heavy overhaul.

(b) True shaft and grind journal surfaces to next standard undersize if necessary. Install new shaft if necessary to reduce oil journal diameter as much as 3/16 inch below standard. Install new oil thrower at commutator end and thrust ring at pinion end if necessary due to wear (For sleeve type armature bearings).

(c) Inspect armature bearings and replace if clearances or condition will not permit operation till next Class E inspection. Do the same on axle bearings. Use shims on new axle bearings.

(d) Clean armature bearing housings and check for leaks in casting, tightness of bearing shell, condition of grease or oil filling pipes. Do the same for the axle caps.

(e) Replace brush box if wear is excessive. Renew springs, contact tip and shunt as necessary. Check all parts for tightness. Check box and assembly for correct alignment. Renew brushholder insulators and insulation as necessary. Note: The clearance between the brushholder and the commutator should be checked even if brushholders are not removed from the frame. See section on traction motors for the required clearance.

(f) Remove field coils and number as removed. Clean thoroughly and bake, dip or cover with air-drying varnish.

(g) Clean all parts of the frame. Reassemble the field coils and install new wiring around frame as necessary. Test polarity of fields.

(h) Install new external motor leads and bushings as necessary.

(i) Overhaul the covers as necessary.

(j) Secure external lead cleats to frame adequately.

(k) Inspect commutator mica insulation and replace commutator if necessary. Tighten commutator, re-surface old commutator and undercut mica.

(l) Clean the armature thoroughly, reband if necessary after cleaning and inspecting the coils.

(m) Dip and bake complete armature or cover with air drying insulating varnish.

(n) Make complete insulation test on armature and reassemble the motor. Test complete motor if facilities are available.

(2) Generator and Auxiliary Generator.

(a) If the condition of these machines justify it, dismantle them and make same thorough inspection and check all of parts as for the motors. Remove ball-bearing and wash out bearing and housing. Bearings must be kept absolutely clean. Grease after assembly.

(3) Blower Motor. Do the same as for the generator.

(4) Compressor. Do the same as for the generator.

(5) Control.

(a) Renew worn segments on controllers, switches, interlocks, reverser, etc.

(b) Inspect air valves on unit switches, reverser, throttle, mechanism, reset, trip, etc., for wear, and renew or correct where necessary.

(c) Inspect pistons and parts on all electro-pneumatic units.

(d) Clean all parts thoroughly and inspect cable at all points.

(e) Renew worn contacts and fingers. Test switches for proper closing, wipe, contact pressure and seating.

(6) Battery.

(a) Observe instructions of battery manufacturer for overhaul of the battery.

Methods and Materials Used for Cleaning Grease, Oil, Dirt, Etc. from Electrical Apparatus.

Of the grease solvents, benzene (petroleum naphtha) and gasoline have the least corrosive action on the insulating varnishes. Either of these may be used where there are no fire hazards. It should be remembered that these solvents are very inflammable and that their vapors mixed with air may be explosive. They may be used in a steel building where the ventilation is good. If satisfactory ventilation does not exist, it should be provided before the solvents are used. Care should be taken to avoid getting the cleaning fluids on the clothing of the workmen.

Cleaning

Wipe as much as possible of grease, dirt or oil from the windings with a dry cloth. Cleanse with rags moistened with the solvent. Dry the windings thoroughly with clean, dry cloths. Parts which are inaccessible to the hand, may be cleaned with a swab moistened with a solvent.

AHp

INSULATION TESTS

NEW EQUIPMENT

The main generator armature circuit, including the commutating field, and the traction motor circuits and apparatus connected thereto, when assembled on a new equipment should withstand an insulation test of 2500 volts, alternating-current, for a period of 60 seconds to ground.

All control and auxiliary generator circuits, and apparatus connected thereto except meters and storage battery on new equipment should withstand 800 volts, alternating-current, for 60 seconds to ground.

OLD EQUIPMENT

On equipments which have been in service, it is not considered necessary or advisable to apply the same insulation tests as on new equipments and the following tests are commonly used:

Main Circuits	900-1000 volts, A-C., 60 seconds
Control Circuits	500 volts, A-C., 60 seconds