FORM 23673 C

INSTRUCTIONS

INSTALLATION, OPERATION AND MAINTENANCE

OF

ELECTRICAL CONTROL EQUIPMENT

FOR

100 HP AV DRIVE

FOR

FARELL BIRMINGHAM-CONSOLIDATED MACHINE

TOOL CO.

50" SELLERS WHEEL LATHE

INSTRUCTION BOOK 5600-AV-181

OCTOBER 1958

WESTINGHOUSE ELECTRIC CORPORATION
MOTOR & CONTROL DIVISIONS, BUFFALO PLANT, BUFFALO, N.Y.

INDEX

I.L. 5600-AV-181

DESCRIPTION OF APPARATUS

The apparatus described in this book consists of an adjustable speed drive for a 50 inch Sellers Car Wheel Lathe. The drive is an AV 100 - 100 horsepower complete drive with controls and a-c to d-c motor generator set enclosed in a sheet steel cabinet. All devices in the cabinet are conveniently mounted on removable panels and are suitably marked for easy identification. The motor generator set is accessible for routine maintenance and is cooled by filtered air drawn from one end of the cabinet and exhausted out of the other. All components and devices are of the industrial type and are adequate for the functions they will perform.

SPECIFICATIONS

Supply Voltage	550V 5% - 3 Phase - 60 Cycles
D.C. Motor	100 HP - 350 AMP. - 100 to 500 RPM by adjustable voltage; 500 to 1600 RPM by field control.
M.G. Set	
A.C. Motor	125 HP - 1750 RPM - 550V - 3 PH - 60 Cycles 124 AMPS.
D.C. Generator	1750 RPM - 230 volts - 350 Amps

FORM BU-322

APPLICATION								
L-SPEC. 384202				S.O. 16-B-2211				
H.P. KW 100		VOLTAGE 230			AMPERES 350			
RPM 500 1600				FRAME NO. 151-L				
CIRCUIT	TERMINAL MARKING	RES. 75°C.	TURNS PER COIL		FIELD AMPS	RPM VOLTAGE N.L.	RPM VOLTAGE F.L.	AT/PR POLES
SHUNT	F1-F2	75	1500		.47	1480	1600	
SERIES	S1-S2	.00126	2		.5	1860	1500	
COMM.	A1-A2	.0028	13		1.51	801	750	
ARM.		.0142			3.15	530	503	

APPLICATION								
L-SPEC. 515862				S.O.				
H.P. KW AV-100		VOLTAGE 230			AMPERES 360			
RPM 1750				FRAME NO. 143 L				
CIRCUIT	TERMINAL MARKING	RES. 75°C.	TURNS PER COIL		FIELD AMPS	RPM VOLTAGE N.L.	RPM VOLTAGE F.L.	AT/PR POLES
SHUNT	F1-F2	98	1430	2.03		50		900
SERIES	S1-S2						50	1300
COMM.	A1-A2	.00367	17			100	72	1800
ARM.		.016	105X1			150	112	2675
			2CKT				154	3725
* SER IN 2 PAR CKTS.						230	180	4400
MB 15 1/4						280	230	5800
CB 15 1/2 + 020 BR						300	252	6500
						503	50	

DIAGRAM LIST

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DEVICES

I.L. 5600-AV-181

DEV.	FUNCTION
MA & MB	Reduced voltage linestarter for M.G. set.
ML	Linestarter for Lube Pump motors.
MX	Auxiliary contactor to MA & MB.
MHC	Linestarter for Hydraulic Chuck motor.
MSR	Linestarter for Right Slide motor.
MSL	Linestarter for Left Slide motor.
TSF & TSR	Reversing Linestarter for Tailstock motor.
B	Regenerative braking - Holds "F" Contactor closed while generator volta is decreasing when stop button is pressed.
P	Anti-Plugging relay to prevent starting when generator voltage is too high.
1OL	Overload relay to stop drive if d-c motor or generator is overloaded.
TR	Time delay relay to prevent applying of anode voltage to thyratron tubes before Cathodes have been sufficiently heated.
1CR	Master Control relay for running "Forward".
JCR	Jogging control relay for supplying correct low speed voltage signal to thyratron tubes.
F	"Forward" contactor to apply excitation to the generator shunt field in the forward direction.
FX	Auxiliary relay to "F" to connect speed signal voltage to the accel-decel circuit.
R	"Reverse" contactor to apply excitation to the generator shunt field in the reverse direction.

DEV.	FUNCTION
PR	Pressure relay which stops drive when lube pressure fails.
1M	Main d-c armature contactor.
FLR	Field loss relay to stop drive if motor shunt field excitation is lost.
1T	Transformer to reduce line voltage to 115 volts for linestarters MA, MB & ML.
2T	Transformer to supply anode power to thyratron tubes.
3T	Transformer to reduce line voltageto 115 volts for control circuits.
1REC	Selenium rectifier to convert a-c voltage to d-c for contactor "1M".
SS #1	Selector switch for tailstock clamping solenoids.

DESCRIPTION OF OPERATION

A copy of the schematic diagram will aid the reader to follow this section of the instruction book. Elsewhere in this book, are instruction leaflets dealing in detail with the electronic package panels. A full description of their operation will not be given here except where such a description will aid the reader to understand better the intra-operation of the units.

It is also recommended that the reader become familiar with the functions of the various devices used for sequencing. These devices and their functions are shown in tabular form in another section of this book.

1. Starting the M.G. Set

(a) Close the main circuit disconnect switch which will connect the 3 phase a-c power to the primary winding of the step down transformer, 1T. The secondary winding of the transformer provides 115 volts control voltage for the coils if linestarters, MA, MB & ML and an auxiliary relay, MX.

(b) Press the "Start" button on the end of the cabinet and:

1. Linestarters MA & MB will be energized and connect the a-c motor of the M.G. set to the a-c line and the

M.G. set will start.

2. Linestarter, ML, will be energized to start the lube pump motors.

3. Relay MX will be energized to connect the primary windings of transformers, 2T and 3T to the a-c line.

2. Starting the Drive

(a) Set-up proceedure.

1. Press the Hydraulic Chuck pump motor "Start" button to energize linestarter, MHC. This builds up hydraulic pressure and closes the Hydraulic Pressure limit switch.

2. Position the Tailstock as desired.

3. Turn the Tailstock clamp selector switch to the "Clamp" position.

(b) Press the "FWD" pubhsutton.

1. Relays 1CR and JCR will become energized provided that:

(a) Time delay relay, TR, has timed out and has applied anode voltage to the motor field thyratrons so that the field loss relay, FLR, has been energized.

(b) The lube pressure switches are closed to energize relay, PR.

(c) The hydraulic pressure switch is closed.

(d) Relay, P, is de-energized indicating that there is a safe minimum voltage across the motor armature.

(e) The Tailstock Clamping solenoid selector switch is in the "Clamp" position.

2. Relay, 1CR, will cause the generator field contactor, F, to to become energized. 1CR will also energize the main armature contactor, 1M, to connect the motor armature to the generator. The Headstock motor will now begin to rotate.

3. After 1M has closed an auxiliary contact in series with a 1CR contact will enrgize relay, FX, to connect the Speed Control potentiometer, 1P, to the electronic accel-decel circuit.

4. A normally closed contact of 1M opens to remove the short circuit across the timing capacitors, 1C & 2C, in the cathode follower panel.

5. Relay, JCR, closes at the same time as relay, 1CR. A normally closed contact opens to disconnect the input voltage signal to the thyratrons from the jog speed potentiometer, 2P. A normally open contact closes to connect the accel-decel circuit to the cathode follower circuit.

6. The Headstock motor will now accelerate at a predetermined rate to a speed which is determined by the setting of the speed control potentiometer, 1P.

3. Stopping the Drive

1. Press the "Stop" button

(a) Relays 1CR & JCR dropout.

(b) Relay JCR disconnect the main speed control potentiometer from the accel-decel circuit and transfers to the "Jog Speed" potentiometer. The Headstock meter will decelerate by regenerative braking the rate of which is controlled by the decel circuit.

When the generator voltage has decreased to a preset value, relay "B" will drop out and open the holding in circuit thru the "Jog Fwd" buttons and the "F" contact to drop out F and FX.

(c) The F contactor opens the generator shunt field and also sets the M contactor drop out to open the armature circuit.

(d) Relay, FX, will disconnect the accel-decel circuit from the cathode follower circuit.

4. Jogging

A. Forward

1. Press the "Jog Fwd" button and contactor, F, will be energized. This will excite the generator shunt field

and at the same time energize the main armature contactor 1M. The Headstock motor will run at a low speed determined by the setting of the "Jog Speed" potentiometer, 2P. Jogging is accomplished without use of the accel-decel circuit. The motor will run only so long as the "Jog" button is held depressed.

B. Reverse

1. Press the "Jog Rev" button and the Headstock motor will operate in the reverse direction. The sequencing will be the same as for forward jogging except that contactor, R, will operate instead of F.

5. Adjustments

In the precedeing sections of this book, reference has been made to speeds at which the Headstock motor will run. In this section, instructions will be given for setting and charging these speeds as required.

A. Master Running Speed Settings

This drive has been designed to cover a speed range by both armature and motor field control. Running speed is determined by the setting of the speed control potentiometer, 1P, which will permit operation over the entire speed range. The maximum and minimum speeds are set by means of

potentiometers, 2P and 3P, in the cathode follower panel. These potentiometers should be adjusted so that minimum speed is obtained when the main speed control potentiometer, 1P, is at minimum and maximum speed should be obtained when the potentiometer is set at maximum.

To set the minimum and maximum speeds, proceed as follows:

(a) Set the speed control potentiometer, which is separately mounted, to the minimum speed position. Start the drive and allow the motor speed to come up to a steady state condition which will be determined by the accel-decel panel. NOTE: For these tests it would be more convenient to set the accel-decel times to the minimum in order to reduce the delay in observing the speeds to which the motor will rise. Check the speed of the motor if it is running above the required minimum, adjust the minimum speed potentiometer in the cathode follower circuit in a decreased direction until such speed as is required is reached. Conversely if it is running to slowly, adjust the speed potentiometer in the increased direction until the proper speed is reached.

With the speed control potentiometer still set at the minimum position, adjust the maximum speed potentiometer toward the minimum speed position or as far as possible in the decreased direction. Now move the speed control potentiometer to the maximum speed position and gradually move the maximum speed setting potentiometer in the increased direction until maximum running speed is reached. In the event that either the maximum or minimum speeds cannot be obtained by means of the maximum and minimum speed potentiometers, adjust the bias potentiometer as follows. If minimum speed cannot be obtained move the bias potentiometer in the increased direction. If the maximum speed cannot be obtained move the bias potentiometer in the decreased direction. Caution should be observed in the setting of this bias potentiometer because too much movement in either direction can prevent the obtaining of either the maximum or minimum speeds.

B. Jogging Speed Settings

Stop the drive as previously explained, then press the "Jog Fwd" button. The Headstock motor will rortate at a slow speed while the button is held depressed. The speed may be adjusted over a small range

by means of the "Jog Speed" potentiometer, 2P. The "Jog" speed is independent of the main speed control potentiometer, 1P, but it is affected by the setting of the bias potentiometer. Therefore, once the bias potentiometer has been set for running speeds, it should not be further adjusted.

POWER AMPLIFIER

DESCRIPTION

The power amplifier is an 8 by 12 inch panel size packaged unit. It consists of either one or two grid controlled tyratron circuits complete with a phase shift network for the a-c grid voltage component, and a filament and grid a-c supply transformer.

The power amplifier is used for supplying the d-c control current to control windings such as motor, generator, and reactor fields.

The anode a-c supply voltage is supplied from a power transformer mounted externally.

The power amplifier can be connected for either full wave or half wave conduction. For the half wave connection one thyratron is connected across the inductive load such that during negative half cycles of anode supply voltage, the thyratron will conduct due to the induced load voltage, giving a continuous flow of load current. The current capacity of the half wave is the same as that for the full wave for the same type of thyratron.

OPERATION

Figure 1 is a simplified schematic diagram of the power amplifier when connected as a half wave rectifier. Figure 2 is the approximate power amplifier characteristics when supplying an inductive field as a load and with an anode supply voltage of 860 rms volts.

The d-c output is controlled by varying the firing angle of thyratron 1TU. The a-c phase shift network, made up of 1R, 1C, and the 100 volt secondary of 1T, gives an a-c component of grid voltage that lags the anode supply voltage by approximately 90 degrees. Resistors 2R and 3R form a voltage divider so that one half of the phase shifted voltage (25 volts rms) is used for the grid of 1TU. The anode transformer is connected such that the instantaneous voltage at point 1 is in phase with the instantaneous voltage at X3. When the d-c input signal is zero, thyratron 1TU fires at approximately 90 degrees of the anode voltage positive half cycle. This is equal to approximately one half of the total d-c output. By increasing the d-c input voltage such that 7 is positive with respect to 4, the firing angle is increased to 180 degrees, which is maximum output. By increasing the d-c input voltage such that 7 is negative with respect to 4, the firing angle is decreased to zero, which is cutoff.

Figure 3 is a simplified schematic diagram of the power amplifier when connected as a full wave rectifier. Figure 4 is the approximate characteristics of the full wave rectifier when supplying an inductive load and with an 860 volt center tap anode supply voltage.

The operation of the full wave rectifier is the same as for the half wave rectifier except that for the full wave connection two thyratrons are controlled to give conduction for both positive and negative half cycles of anode voltage. The full wave power amplifier has approximately twice the gain as the half wave power amplifier.

If a rectifier is connected across the inductive load on the full wave rectifier similar to the connection of 2TU across the load for the half wave connection, the characteristics of the full wave rectifier will be the same as those for the half wave rectifier of Figure 1.

Double Rectifier - Power Amplifier

The double rectifier power amplifier consists of two thyratron rectifiers on an 8 by 12 inch panel size packaged unit. These two rectifiers are identical except that one of the thyratron circuits contains an overlap control. Figure 5 is a simplified schematic diagram of the thyratron rectifier with overlap control connected for half wave with thyratron discharge. The overlap control can only be used with the half wave connection. Figure 6 shows the rectifier characteristics for three different values of overlap voltage setting.

The overlap control is used on systems where it is required to transpose from controlling one thyratron rectifier to another from a single regulating source. The overlap setting established a positive bias on the grid of 3TU so that a certain d-c input voltage is required before control of 3TU begins.

Overlap is usually used for the transposition from armature voltage to field weakening in speed regulating systems that have a speed range by armature and field voltage control.

When the power amplifier is connected as a full wave rectifier, the overlap control is left in the maximum position where it is effectively out of the circuit.

Testing and Trouble Shooting

A multitest meter with 1000 ohms per volt a-c and 10,000 to 20,000 ohms per volt d-c should be used for taking voltage measurements in the grid circuit.

The following procedure should be followed to see if trouble is arising in power amplifier and for testing the unit.

1. Check thyratrons by replacing with new thyratrons to see if tubes are defective.

2. Check anode voltage and 115 volt a-c supply voltage at the terminal block of the power amplifier.

3. Check d-c input voltage and compare with thyratron rectifier characteristics. (Power amplifier may be all right but input signal may be responsible for peculiar performance.)

4. Measure grid a-c supply voltage at the transformer windings (X3 to X5) and the tube filament voltage at the tube sockets. Compare with voltage values on schematic diagram. Check grid voltage at X4 to 6 for approximately 50 volts.

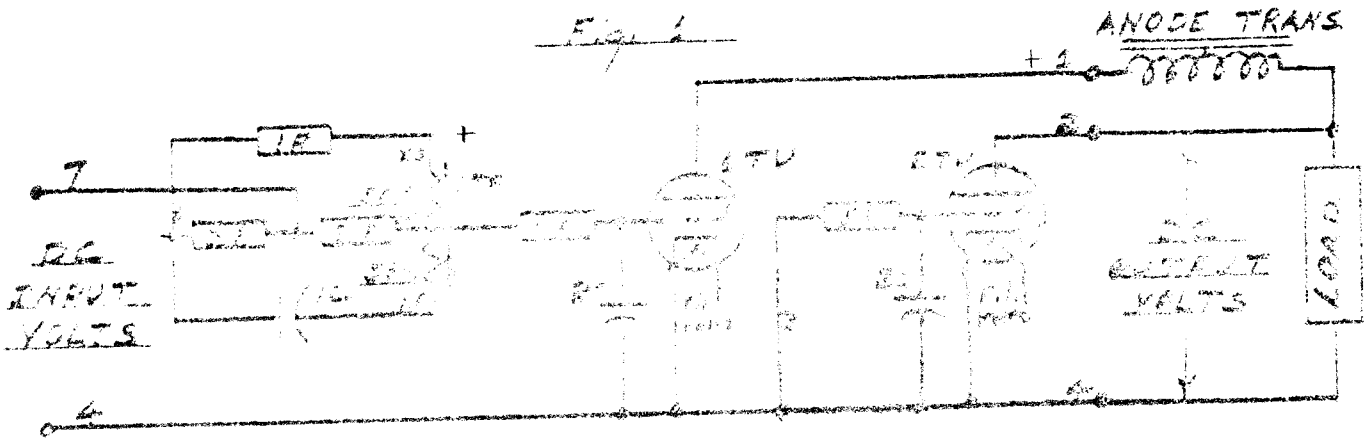
If the above procedure does not locate the trouble, capacitors 2C and 3C should be checked to see if shorted. Check for other shorts and defective components.

NOTE: The above reference points for testing refer to the thyratron rectifier circuit without overlap (Figure 1 and Figure 3). When testing power amplifier circuit with overlap (Figure 5) use corresponding points.

All transformer voltages need be only within approximately ± 10 per cent of the shown values.

I.L. 11361

Fig. 1



POWER AMPLIFIER CONNECTED AS A HALF-WAVE RECTIFIER - IONIZATION DISCHARGE.

Fig. 2

HALF WAVE CHARACTERISTICS WITH AN INDUCTIVE LOAD AND 660 VOLT ANODE SUPPLY

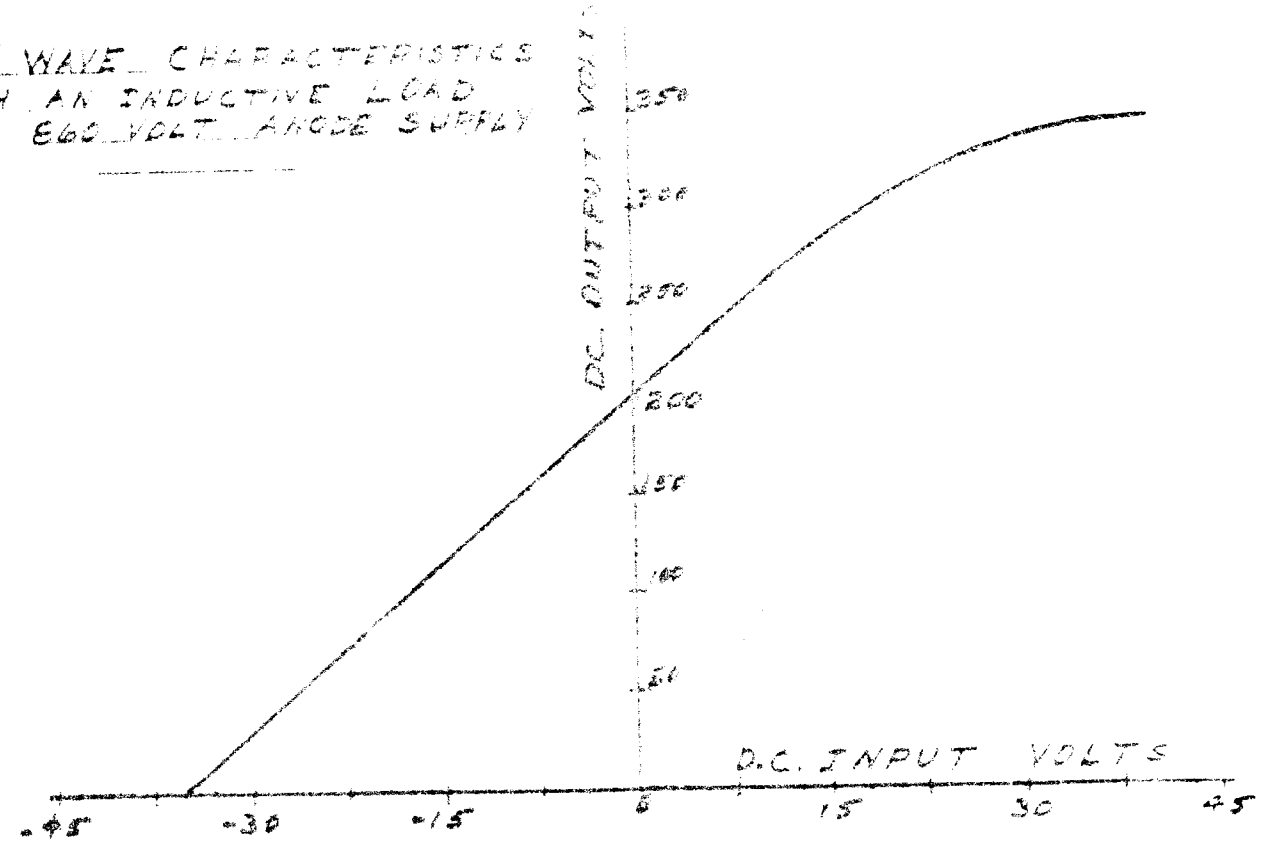


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Fig. 1

POWER AMPLIFIER CONNECTED AS A
FULL-WAVE RECTIFIER

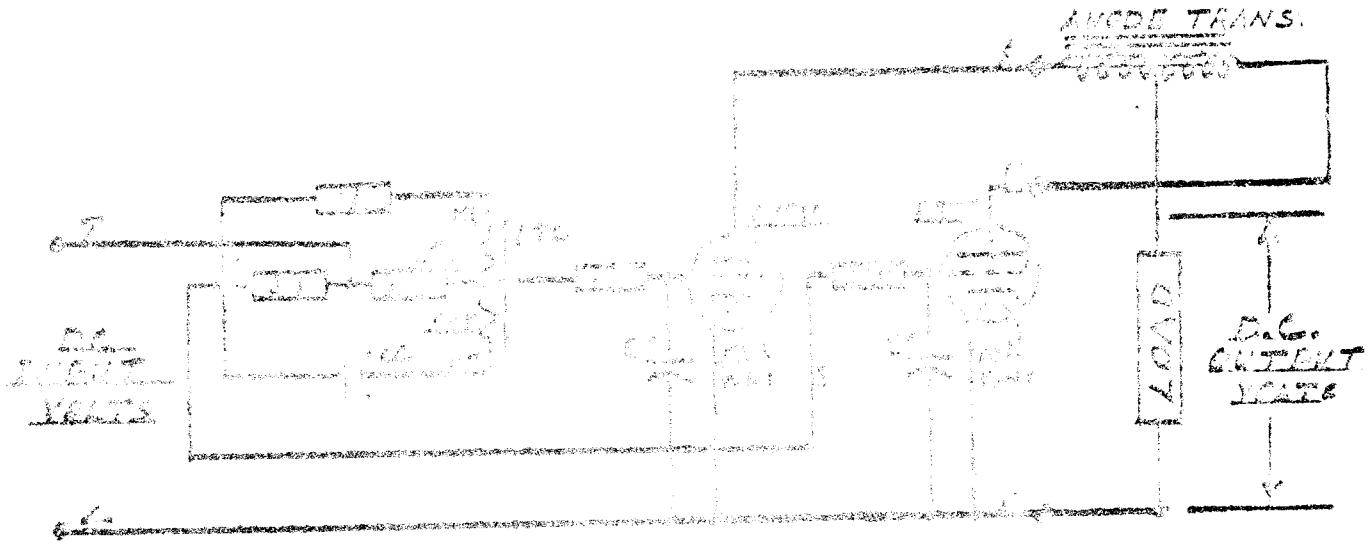
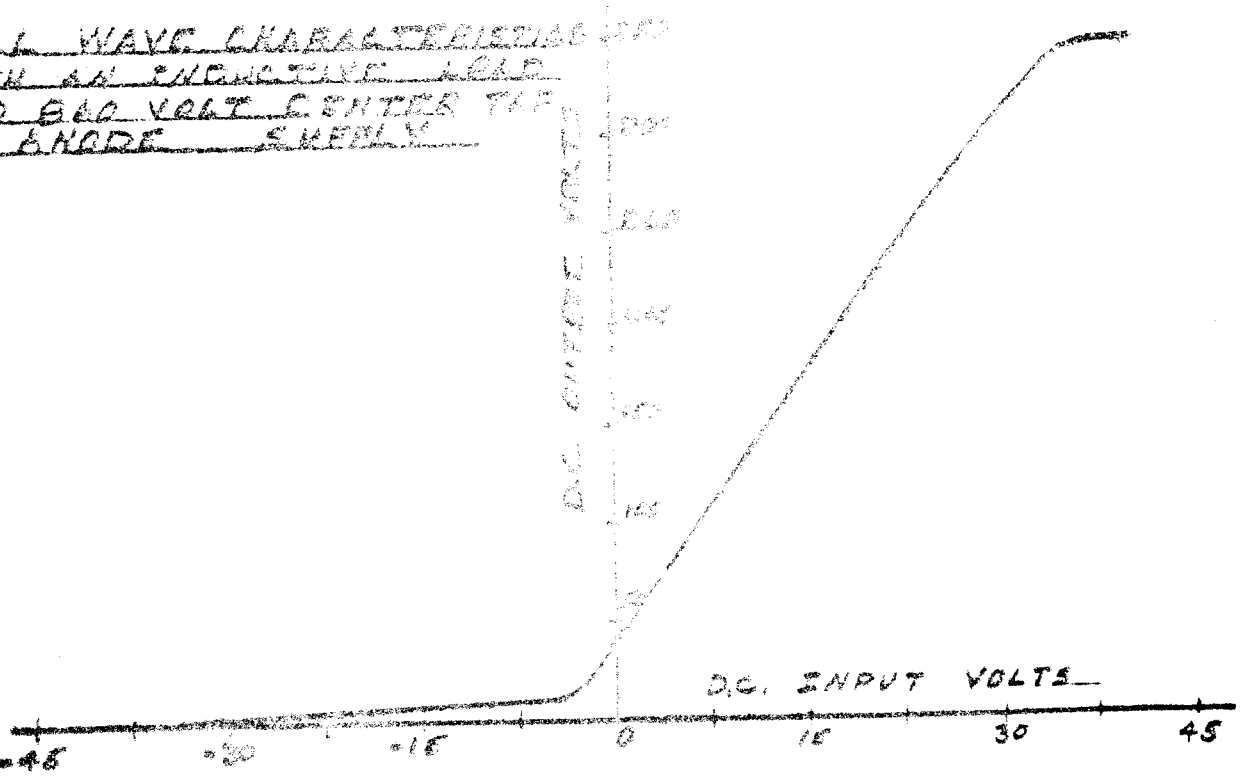
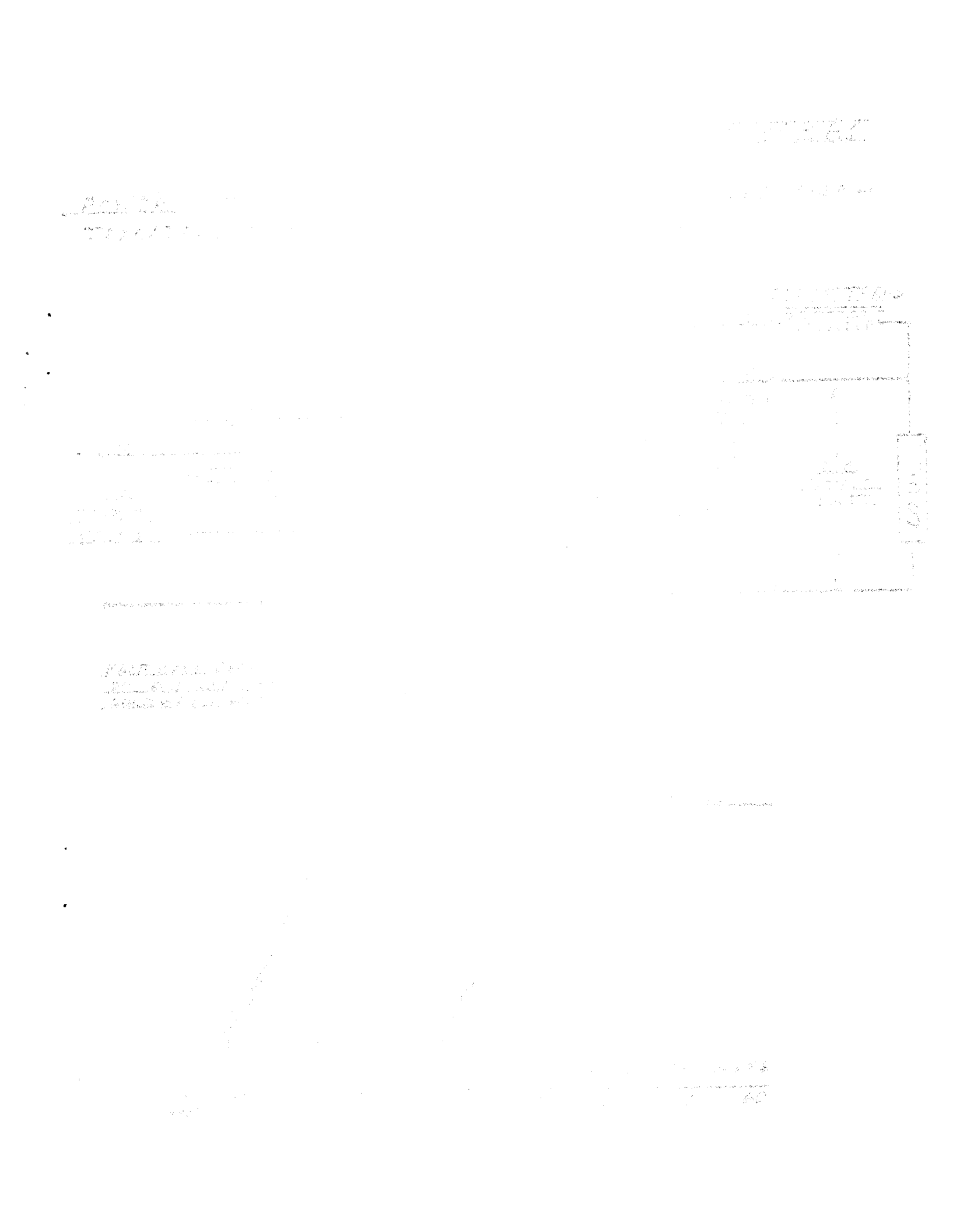


Fig. 2

FULL WAVE CHARACTERISTIC WITH AN INDUCTIVE LOAD AND 640 VOLT CENTER TAP ANODE SUPPLY





V.R. TUBE REFERENCE

Packaged Unit - 8 x 6 x 4"

DESCRIPTION

The V.R. tube reference is a DC voltage supply unit that may be used in regulated or unregulated control systems. This unit provides 2 values of DC reference voltage - approximately 150 volts at 20 milliamps maximum current, and 105 volts at 25 milliamps maximum current. The 105 volt reference is from across voltage regulator tube 3TU which is in cascade with voltage regulator tube 2TU, and therefore provides the better regulated reference with less ripple.

The two 6.3 volt windings supplied with this unit are used for filament voltages on accompanying units, when needed.

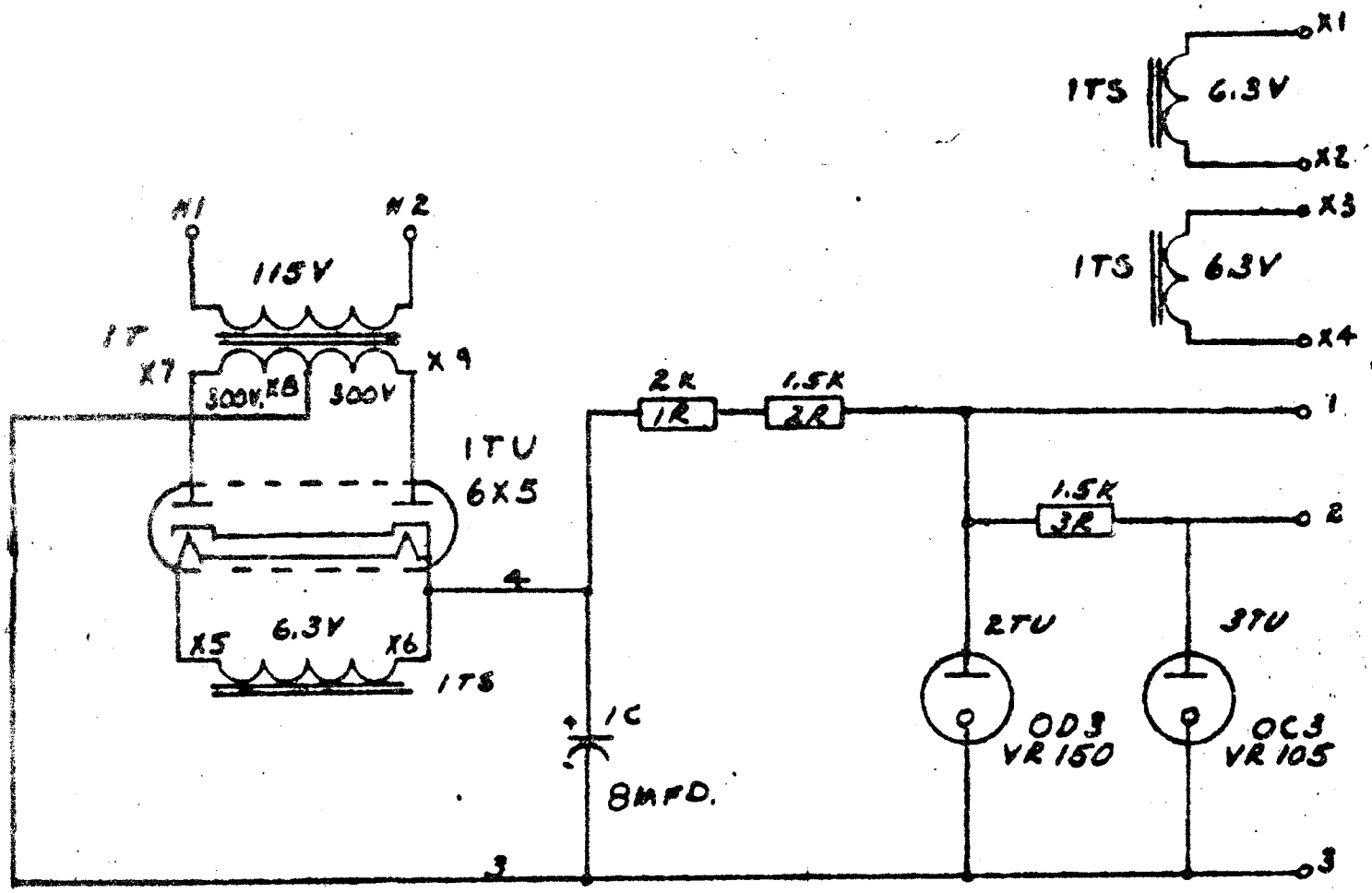
OPERATION

The full wave rectifier made up of 1T, 1TU and 10 supplies an unfiltered, unregulated DC voltage between point 4 to 3. Voltage regulator tubes 2TU and 3TU are of the glow-discharge type which maintains a constant arc voltage between plate and cathode. Any change in DC voltage between 4 to 3 will appear as a change in voltage across 1R and 2R and is accompanied by a change of current through 2TU. Likewise, any change in voltage across 2TU will appear as a voltage change across 3R and is accompanied by a change in current through 3TU.

SERVICE ANALYSIS DATA

Tabulated below are the approximate component DC voltage values. Transformer voltage should check within approximately ± 5% of the values shown on the schematic diagram.

Component	DC Voltage
1C	340 (± 10%)
1R & 2R	210 (± 15%)
2TU	150 (± 5%)
3R	42 (± 5%)
3TU	105 (± 5%)


X1
1TS
6.3V
X2
X3
1TS
6.3V
X4
N1
N2
115V
1T
X7
300V.
X8
300V
X9
1TU
6X5
2R
1R
1.5K
2R
1
1.5K
3R
2
4
2TU
3TU
X5
6.3V
X6
1TS
1C
8MFD.
0D3
VR 150
0C3
VR 105
3
3

ACCEL-DECEL TIME UNIT

Packaged unit, size 8 x 6 x 4 inches.

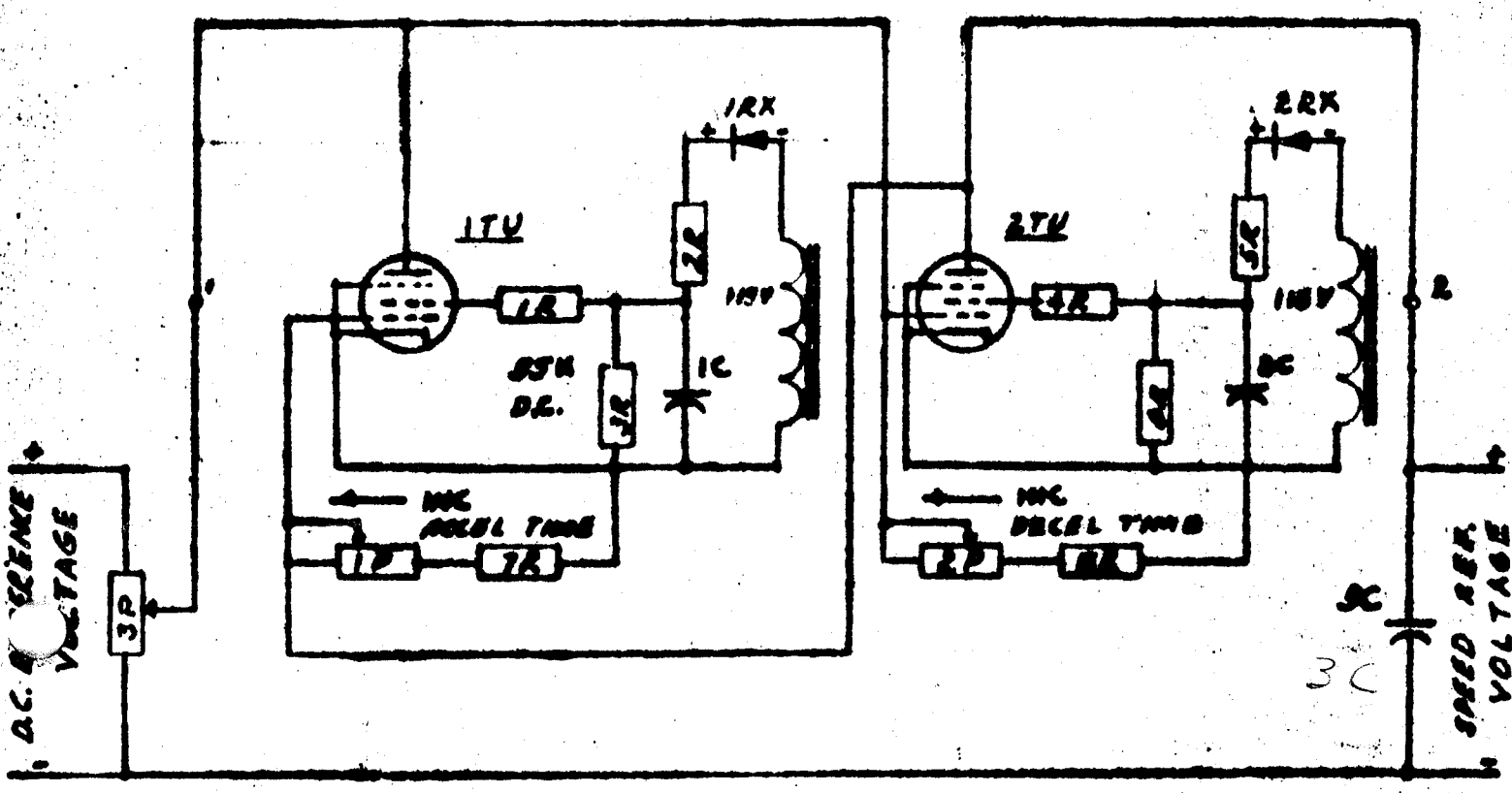
APPLICATION: Obtaining acceleration and deceleration time rates for adjustable speed drives.

OPERATION: Pentodes 1TU and 2TU control the charging and discharging current of capacitor 3C, respectively. The pentodes, having constant current characteristics, holds this charging and discharging current to a constant value, therefore, giving a linear rate of speed reference voltage change which determines the acceleration or deceleration time. The value of 3C and the maximum speed reference voltage determines the maximum acceleration or deceleration time obtainable. (3P and 3C are not components of the timing unit but are used for demonstrating operation). The setting of potentiometers 1P and 2P fixes the bias on 1TU and 2TU, respectively, and determines the charging or discharging current of 3C which gives the time rate for which the speed reference voltage changes.

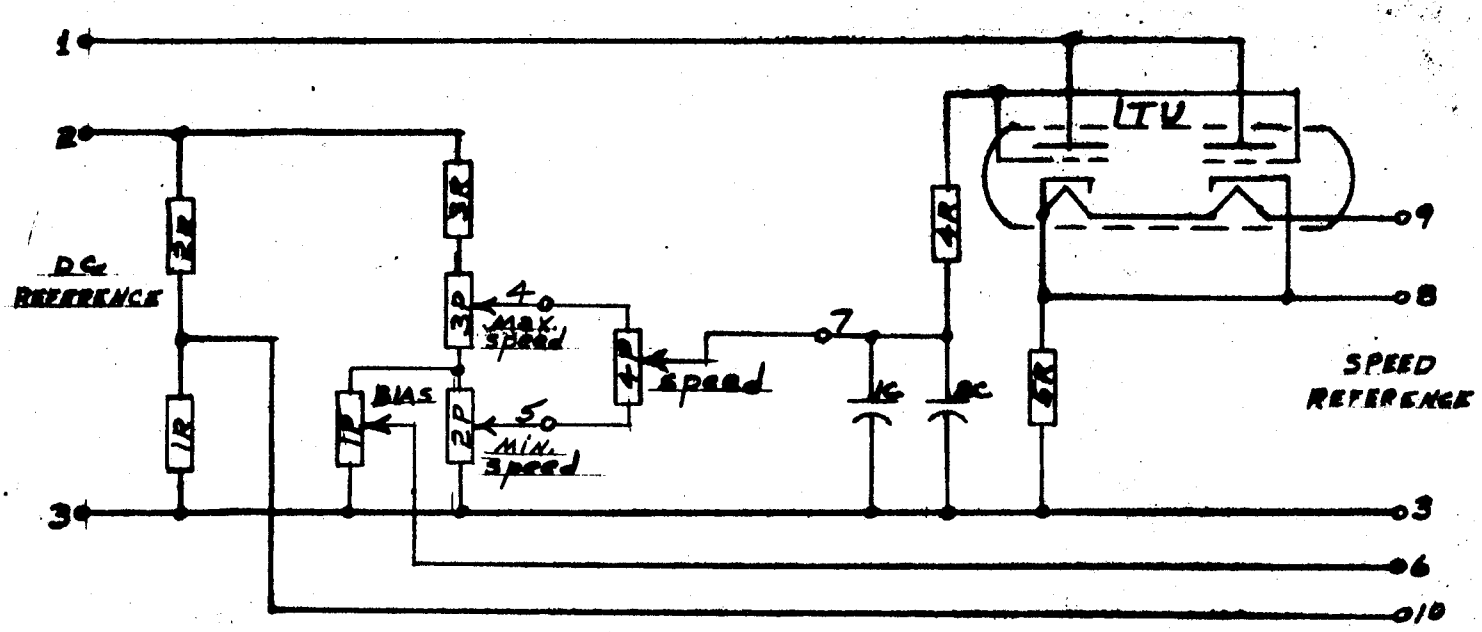
TROUBLE SHOOTING & TESTING

1. Check transformer voltages for plus or minus 10% of values shown on the schematic diagram.
2. Check screen grid voltages across 1C and 2C for approximately 10,000 ohms/volt DC meter.)
3. Test or replace tubes to eliminate possibility of defective tube.
4. Check for shorted terminals, open connections, or defective components.

ACCEL-DECEL TIME UNIT



CATHODE FOLLOWER



Packaged Unit - 8 x 6 x 4"
Schematic & Wiring Diagram 21-0-6153

DESCRIPTION The cathode follower is a control unit for adjustable speed drives. It consists of a cathode follower circuit and control potentiometers for obtaining speed and bias adjustments. This unit is used with regulated or unregulated control systems.

The cathode follower is also used with the accel-decel time unit. The accel-decel time unit is connected in series with number 7 lead and controls the charging and discharging current of 1C and 2C as the speed reference is varied. Extra capacitance may be paralleled with 1C and 2C for obtaining longer acceleration or deceleration time.

OPERATION In the cathode follower circuit made up of 1TU and 5R, the voltage across 5R stays approximately equal to the voltage across 1C and 2C. The speed reference is controlled by 4P

(4P is not a part of the cathode follower unit and is shown only for explaining circuit operation). 3P and 2P determine the maximum and minimum speed reference voltage respectively. For DC tachometer and CEMF regulated drives the output speed reference voltage is between 8 and 6. For unregulated drives the speed reference is from 8 to 10.

The cathode follower tube 1TU isolates the grid circuit of which the speed reference voltage controls from 1C and 2C. This isolation prevents grid conduction from changing the voltage across 1C and 2C when using acceleration and deceleration time control.

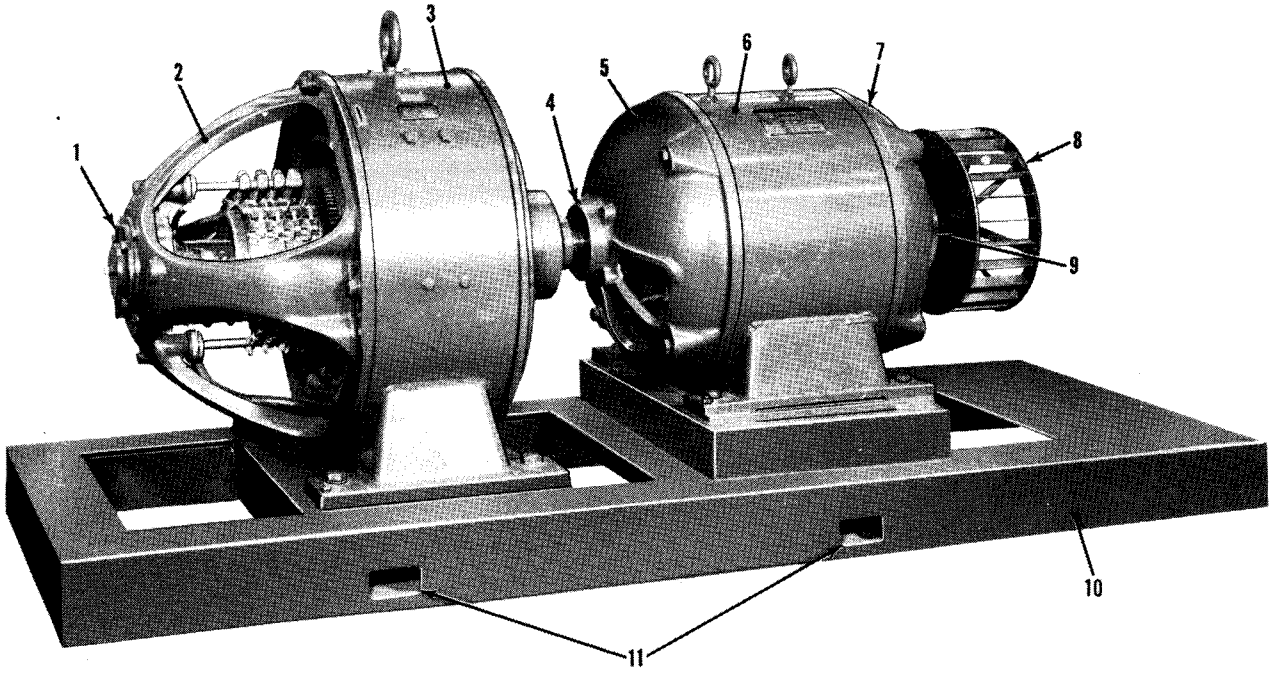
The dc reference voltage is supplied to the control unit externally.

OPERATION • MAINTENANCE • ASSEMBLY

INSTRUCTIONS

WESTINGHOUSE A-C TO D-C M-G SETS

SIZES AV-60 TO AV-200 (60 CYCLE) AND AV-50 TO AV-200 (50 CYCLE)



1. Bearing
2. Generator end bracket
3. Generator frame
4. Bearing
5. Motor end bracket
6. Motor frame
7. Motor end bracket
8. Blower
9. Bearing
10. Bedplate
11. Lifting holes

FIG. 1. Typical Construction of Three Bearing M-G Sets

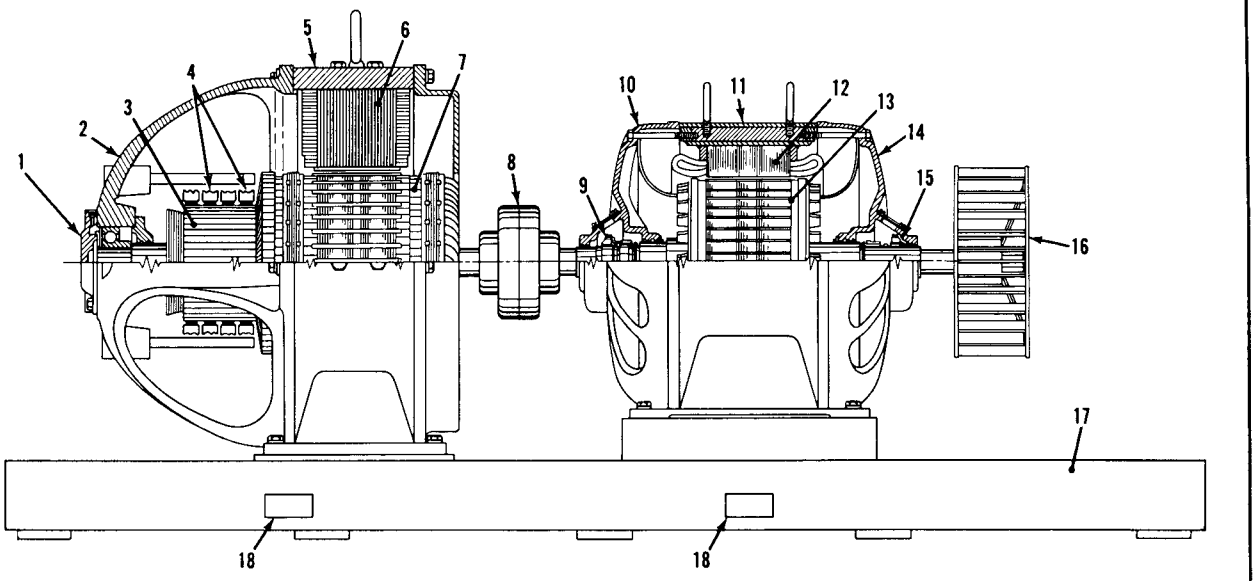
GENERAL

WESTINGHOUSE M-G Sets, 50 to 200 hp—50 cycle, and 60 to 200 hp—60 cycle, are two unit sets. The a-c motor and the d-c generator are coupled together and mounted on a common bedplate. In these sizes, the ventilating blower is attached to a motor shaft extension. Four bearing construction is used, except in AV-75 and AV-100—60 cycle, and AV-60 and AV-75—50 cycle, which are three bearing sets. (See Figure 1). Three bearing sets have two bearings in the a-c motor and one bearing in the d-c generator, with a rigid coupling between the two machines. All LIFE-LINE® machines have sealed for life pre-lubricated ball bearings. The larger machines have greasable bearings.

A-C Motor. The motor is a WESTINGHOUSE squirrel cage induction motor. Sealed, pre-lubricated bearings are used in LIFE-LINE® ratings through AV-100, 60 cycle.

Standard sets use 3500 RPM motors for 60 cycle supply for sizes through AV-15. All others use 1750

® Registered Trade-Mark



1. Greasable bearing
2. Generator frame
3. Commutator
4. Brushholders and brushes
5. Generator frame
6. Field coils
7. Armature
8. Rigid coupling
9. Bearing
10. End bracket
11. Motor frame
12. Stator Windings
13. Rotor
14. End bracket
15. Bearing
16. Blower
17. Bed plate
18. Lifting eyes

FIG. 2. Cutaway View

RPM, 60 cycle motors. Special sets are available for other speeds. Connection information as well as voltage and frequency ratings is given on the nameplate of each motor. Successful operation is guaranteed only when voltage variations do not exceed 10 percent and frequency variations 5 percent of the nameplate rating.

The motors may be started across the line without reduced voltage starting equipment unless local requirements demand special starting arrangements. Refer to the installation instructions.

D-C Generator. The generator is a standard type SK lightly compounded shunt generator. The standard voltage is 230 volts, but some generators are supplied with other voltage ratings. Check the nameplate data for the rating of a particular machine. Brushholders and brushes are readily accessible through the opening in the end bracket.

The photograph and sectional view shows the external and internal construction features of typical 3 bearing M-G sets. The generator has only one bearing in the 3 bearing set. (See Figure 2.) Generator bearings are of the greasable type. (See comments under "Maintenance," page 3.)

OPERATION

Before Starting. Make certain that the motor nameplate data matches the voltage and frequency of the electrical supply system. Be sure that all installation instructions have been complied with, and that all connections are properly made. (Installation instructions are provided in the cabinet leaflet.)

Examine the brushes and brushholders. The brushes should be free to slide in the holders and should bear against the surface of the commutator. Replace any broken brushes. See instructions under "Maintenance," page 5.) The holders should provide approximately 2½ pounds of pressure per square inch and should be located 1/16 to 1/8 of an inch from the commutator surface. If the brush rig has been disturbed during installation, it should be returned to the correct position as marked by a dowel bolt. The bracket is doweled in position at the factory and should not require further adjustment.

Examine the air gaps and remove any foreign material. See that the shaft turns freely without obstruction.

Starting. Open the generator load switch. Turn the field rheostat to the "all in" position (minimum field current). Close the a-c line contactor to start the motor.

Note the direction of rotation and compare it with the arrow on the frame of the generator; they should be the same. If not, reverse the direction of rotation by reversing two of the a-c motor line connections. With the unit rotating in the correct direction, check for excessive vibration, noise, or other indications of trouble.

Turn the generator field rheostat to increase the voltage. Check the polarity. (The polarity can be reversed in a separately excited machine by reversing the field connections.) Adjust the field rheostat to obtain the desired voltage, and close the load switch. The generator should carry its rated load with little sparking at the commutator. If sparking occurs, see comments under "Maintenance," page 3. If the generator fails to build up voltage, check the connections in the field circuit.

Running. Unusual noise or excessive vibration, sparking, heating, or low voltage are indications of trouble. In case of noise or vibration, check for loose mounting bolts. For other trouble, see instructions under "Maintenance," page 3.

When stopping the M-G set, reduce the load on the generator as much as possible before opening the load switch. After the d-c load has been removed open the a-c line to stop the set.

MAINTENANCE

To obtain long, satisfactory service from rotating electrical equipment, it is necessary to operate it correctly, and to follow a few simple maintenance procedures. When properly used, the equipment should require very little care other than periodic inspections. The most important factor is to keep the apparatus clean and free of oil, water, dirt, and other foreign material. The following maintenance suggestions will help you get the maximum service life from the equipment.

1. Lubrication. A-c motors of 125 hp and smaller are equipped with WESTINGHOUSE LIFE-LINE® pre-lubricated ball bearings. No provision is made for greasing or oiling these bearings, and they require no care during their life. A grease having high stability is sealed in the bearing by the manufacturer. Both laboratory tests and years of actual service have proved that this grease will give long service. Several manufacturers supply bearings for LIFE-LINE® motors. For a given size motor, the bearings of all suppliers are interchangeable.

The d-c generators and larger motors are equipped with greasable type ball bearings. When shipped from the factory, grease lubricated ball and roller bearing machines have sufficient grease of the right grade to last for a limited period. However, a charge of grease should be added soon after the machine is put into operation, and thereafter at suitable intervals as determined by experience. As a guide, it is suggested that grease should be added every three months of operation in amounts as indicated in the following table. If experience indicates that these quantities result in a surplus of grease in the bearing, the quantity should be reduced or the greasing period lengthened, or both. The ideal condition is that the bearing housing should be from one-third to one-half full of grease.

Do not overlubricate. Too much grease will cause churning, overheating and grease leakage. If grease leakage occurs, the bearing has been overfilled, or the grease used in sot suitable. Ordinary cup greases are not satisfactory because of a tendency to deteriorate under the severe churning action of the bearings. Use only WESTINGHOUSE grease which can be ordered as follows:

8 oz tube—No. 1360 876
1 lb can —No. 1248 911
5 lb can —No. 1248 912
10 lb can —No. 1248 913
25 lb can —No. 1360 877

As the shaft extension diameter is easily measured and is roughly proportional to the bearing size, the following table for grease additions is given on the basis of shaft size:

Shaft extention Diameter		Amount of Grease to be Added
¾ to 1¼ inches	—	1 cu. in.
1¼ to 1⅞ inches	—	1¼ cu. in.
1⅞ to 2⅜ inches	—	2½ cu. in.
2⅜ to 3 inches	—	4 cu. in.
3 to 4 inches	—	7 cu. in.
4 to 5 inches	—	10 cu. in.

(1 oz equals 1¼ cu. in.)

When a surplus grease sump is supplied below the bearing, it should never be allowed to fill up.

Even a small amount of dirt can damage ball or roller bearings. When necessary to disassemble the bearing housing, thoroughly remove dirt from adjacent parts so it does not fall into bearing or bearing housing. It is desirable for the most satisfactory service to open the bearing housing once a year, or after every 5000 hours operation, to check the condition of the grease and the bearing itself. If grease deterioration has occured, or if dirt has gain-

DISASSEMBLY AND ASSEMBLY

Before beginning any disassembly of the machines, take special care to remove dirt or dust accumulated on or near the machine which might fall into the machine as work proceeds. When reassembling, guard against the introduction of dirt or foreign matter.

Two machine M-G sets may be uncoupled and disassembled separately. The three bearing and four bearing sets differ only in that the three bearing set has a rigid coupling and only one generator bearing. Otherwise the disassembly procedure is the same.

Motor Disassembly. Remove the blower on the motor shaft extension. Uncouple the two machines. Loosen the coupling flange on the motor shaft. Remove the bolts that hold the inner bearing caps to the bearing housing on both ends of the machine. Remove the bolts holding the end bracket farthest from the generator. Bump the bracket at the indentations provided for this purpose at the ends of the frame. With the bracket off, the rotor may be removed from the machine.

Generator Disassembly. Uncouple the two machines. Loosen the coupling flange on the generator shaft. Remove the brushes from the brushholders. Remove the bolts that hold the inner bearing caps to the bearing housing at both ends of the machine. (One end only for 3 bearing sets.) Disconnect the brush rigging leads and mark carefully so they may be replaced in the original position. Remove the bolts holding the end bracket farthest from the motor. Remove the bracket. The armature can now be removed.

If the generator is removed from the bedplate, it will be easier to remove armature from the opposite end without disturbing the brush rigging connections.

Removal of Machines from Bedplate. Remove the dowel in the feet of the machine by tightening the nut on the dowel until the entire dowel can be removed. There should be two dowels per frame located diagonally opposite each other.

Remove the hold-down bolts in the feet, being careful to observe and maintain correct shims under each foot for reassembly.

When reassembling, start hold-down bolts but do not tighten. Install dowel bolts and drive them down as far as possible. Tighten the hold-down bolts, and then drive dowels all the way in.

REASSEMBLY

The machines are reassembled in the reverse order of disassembly.

Caution: Bearings must never be subjected to axial pressure, especially hammer blows. Any pressure will damage the bearings, and therefore, this pressure must be taken by supporting the opposite end of the shaft against a stop.

RENEWAL PARTS AND ADDITIONAL MAINTENANCE INFORMATION

When ordering parts, be sure to specify exactly the parts required and give the complete nameplate identification of the machine. Parts and additional service information are available from the nearest WESTINGHOUSE Sales Office.

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Printed in U.S.A.

ed entrance to the housing, thoroughly clean the bearing and housing parts and add new grease. After cleaning with a suitable solvent, flush the bearing and housing with a good lubrication oil. Then new grease can be applied over and between the balls or rollers. Do not use more than the amount specified in the table.

2. Bearings. Symptoms such as overheating, noise, and vibration may indicate bearing failure. If such failure is suspected, first check the rotor for end play. There should be approximately 1/32 to 1/16 of an inch end play to allow for expansion. If this is not present, determine the reason and correct it. (Check the end brackets for distortion or misalignment. Also check the bearing brackets for proper alignment.) If the end play is satisfactory, it may be necessary to disassemble the machine and inspect the bearings. (See instructions under "Disassembly," page 6.)

If the bearing shows discoloration from heat, feels rough in turning, or makes a crackling noise when turned, it must be removed and replaced. It is very important that the new bearing be the same type as the original. Be sure to include the serial number of the machine when ordering replacement parts and specify on which end of the machine the bearing is located.

Remove the faulty bearing by using a puller engaged at the back side of the inner race. Do not pull by the outer race. When installing the new bearing, be sure that the bearing seat is free of dirt, scale, nicks, or burrs. Heat the bearing in an oven for half an hour at a temperature of approximately 190°F, but not exceeding 212°F. Slip the hot bearing on the shaft and hold in place until the bearing has cooled appreciably. Do not assemble to bracket until bearing has cooled to room temperature.

Note: Do not heat permanently lubricated bearings in an oil bath.

When reassembling, look for bracket distortion or any other fault which may have contributed to the original failure. After assembly is complete, free turning of the rotor and satisfactory end play are the best indications of a proper assembly.

3. Insulation. Protect the insulation from dirt, oil, and moisture as much as possible during operation and storage of the equipment. When assembling or disassembling the machines, be sure never to bump or jam the windings with the rotor or other objects, as this will cause damage.

Normal brush and commutator wear will produce a conducting dust that should not be allowed to accumulate in the windings. This dust is preferably removed by suction, or by wiping with a clean dry cloth. Blowing with compressed air is not recommended as it may drive the dust into the windings.

If grease or oil are present, wipe with a cloth moistened (but not dripping) with a safety type petroleum solvent such as Stoddard solvent or a similar type. When an accumulation of dirt is present, carbon tetrachloride is more effective than petroleum solvents.

Warning: Be sure to observe proper precautions when using carbon tetrachloride or other volatile or inflammable cleaning agents.

Moisture reduces the insulation resistance of the winding insulation and this can lead to serious damage. Before starting a machine which has been subjected to excessive moisture conditions, check the insulation resistance with a 500-volt megger. The resistance should be at least one megohm. If less, the windings must be dried out in an oven, or by circulating warm air through the machine, or by allowing a low current to pass through the windings until the insulation resistance rises above one megohm.

Revarnishing the windings when the machine is overhauled will lengthen the life of the windings.

Replacement of generator field coils may be necessary if one becomes open or shorted. Always carefully check all associated rheostats, switches, and other devices in the field circuit before concluding that the winding itself is defective. Improper voltage, poor commutation, and overheating are symptoms of field coil failure. An ohmmeter or Wheatstone bridge may be used to check the field circuit for grounds to the frame as well as for a short circuit or an open circuit. If this produces no results, and the field circuit is still suspected as a source of trouble, comparative resistance measurements should be made of the individual coils and compared with the resistance of a similar coil which is known to be good. Such measurements should be made when the coils are near normal operating temperature. Expansion due to temperature rise is sometimes the cause of short circuits between turns.

To replace a field coil, disconnect the coil from the adjacent coils and remove the bolts which secure the pole piece to the frame. Remove the pole piece with its coil and install a new one in its place. Use care in replacing the pole and coil and be sure that the same steel liners between the frame and the back of the pole are replaced to ensure the same air gap as in the original assembly. The new coil must be reconnected so that it produces a field of the proper polarity. This can be checked with a small compass, which should indicate alternate north and

south poles all the way around the stator when the poles are properly connected.

4. Brushes. The correct brush position has been located at the factory and the bracket has been doweled in position. The brush position should not require further adjustment. The brushholder should be approximately 1/16 of an inch from the face of the commutator.

Make frequent inspections to see that:

a. Brushes are not sticking in holders.

b. Shunts are properly attached to brushes and holders.

c. Tension is changed as brush wears. Maintain a pressure of approximately 2½ pounds per square inch.

d. Worn out brushes are replaced before they reach their limit of travel and break contact with commutator.

e. Copper particles are removed from face of brush.

When necessary to replace brushes, use only brushes recommended as exact replacements. The face of a new brush should be fitted to the commutator so that it makes good contact over the entire brush face. This can best be accomplished after the brushholders have been adjusted and the brushes inserted. Lift a set of brushes sufficiently so that a sheet of sandpaper can be inserted between brushes and commutator. Draw the sandpaper in the direction of rotation under the brushes, releasing the pressure as the paper is drawn back. Be careful to keep the ends of the paper as close to the commutator surface as possible to avoid rounding the edges of the brushes. Use sandpaper of medium grit for the roughing out and fine grit for the final fit. Carefully clean away all particles of sandpaper and brush material before operating the machine. Never use emery paper, emery cloth, or any abrasive paper made of conducting material fitting the brushes.

5. Commutator. Under normal conditions the commutator should require very little attention. However, it should be frequently inspected to ensure trouble-free operation. Normally, after a few weeks operation, the commutator will become dark and highly polished and will remain unchanged for years. Lubricants should never be used on the commutator.

If the commutator becomes roughened through neglect or accident, it can be smoothed by using fine sandpaper; never emery cloth or paper. If very badly roughened, it will be necessary to remove the rotor and turn the commutator down on a lathe. When reassembled, sandpaper can be used to smooth the surface. Raise the brushes when performing this operation and clean the commutator thoroughly before operating the generator.

All commutators are thoroughly baked and tightened before they leave the factory, but if a bar should work loose it must be tightened at once.

Trouble sometimes occurs from the burning out of mica insulation between the commutator segments. This is generally caused by allowing the mica to become oil soaked, or by loose commutator bars. When this burning does occur, it may be stopped by scraping out the burned mica and filling the space with a solution of sodium silicate (water glass), or other suitable insulating cement.

Sometimes "high mica" develops and starts sparking, which burns away the copper and makes the condition worse. In this case, the mica must be cut away to a depth of 1/16 of an inch below the adjacent copper. This is usually done by means of a small high speed circular saw about 0.003 of an inch thicker than the nominal thickness of the mica.

Excessive sparking may be due to one of the following brush or commutator conditions:

a. Brushes may be off neutral.

b. Brushes may be wedged in brushholder, or may have reached their limit of travel.

c. Brushes may be improperly fitted to commutator.

d. Brush pressure may be too low.

e. Brush faces may be burned.

f. Commutator may be rough.

g. A commutator bar may be loose, or project above the others.

h. Commutator may be dirty, oily, or worn out.

i. Brushes may be of an unsuitable grade of carbon.

j. Brushes may be unequally spaced.

k. Brushes may have unequal pressures, causing some brushes to take too much of the load.

l. High mica.

m. Loose brushholder.

n. Incorrect brush angle.

Localized sparking may be due to an open circuit or loose connection in the armature, or between the armature and commutator. This trouble usually is noted as a bright spark which appears to pass completely around the commutator.

TYPE SK BALL BEARING D-C. MOTORS AND GENERATORS

INSTRUCTIONS

Installation

Inspection — After unpacking, make sure that the machine was not damaged during shipment. See that the nameplate reading agrees with the voltage and current provided for the machine. (The machine is guaranteed for successful operation only with voltage variation within 10% of the nameplate rating.)

Mounting—The machine should be located in a well ventilated, easily accessible place, where the external air temperature will not exceed 40°C. or 104°F. The foundations must be rigid enough to prevent excessive vibration.

For wall or ceiling horizontal mounting turn the brackets through 90 or 180 degrees to keep the surplus grease sump below the shaft. Rotation of the brackets is not required on machines without grease sumps.

Electrical Connections

Connect the **motor and starter** by referring to the diagrams furnished with the starter and as given in diagrams 1, 2, 3 or 4.

Connect the **generator and field rheostat** by referring to diagrams furnished with the field rheostat as given in diagrams 5 and 6.

Install all wiring and fusing in accordance with the National Electric Code, and local requirements.

A conduit box is supplied, but conduit and conduit fittings are not furnished with the machine. These items may be purchased from any Electrical Dealer, or Plumber's Supply House.

When the machine is mounted on a bedplate, or on slide rails for belt adjustment, flexible metallic conduit should be used to protect the leads. In making this connection a squeeze connector should be used for attaching the flexible conduit to the conduit box, as shown in Fig. 1.

Squeeze connectors may be straight, 45°, or 90°.

In order to connect a squeeze connector to the conduit box first remove the cover of the box. Run a locknut well down the threads of the connector and place the connector in the hole in the bottom of the conduit box. Screw a conduit bushing over the end of connector, swing the connector to the desired position and draw the locknut up tight against the box. Follow the same procedure with rigid conduit or reducing bushing.

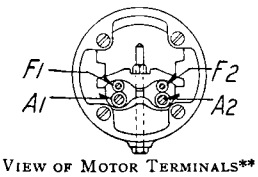
Operation

Motor

Run the motor without load to check the connections, and direction of rotation. To start or stop the motor, refer to the instructions furnished with the starter.

Motor Connections—Rotation Facing Commutator End

DIAGRAM No. 1—SHUNT WOUND MOTOR, WITHOUT COMPENSATING COILS

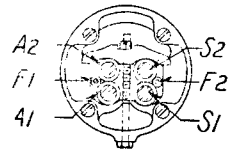


VIEW OF MOTOR TERMINALS**

CLOCKWISE ROTATION
Connect A1 and F2 to — line
Connect A2 to starting resistance, then to + line
Connect F1 to + line

COUNTER-CLOCKWISE ROTATION
Connect A2 and F2 to — line
Connect A1 to starting resistance, then to + line
Connect F1 to + line

DIAGRAM No. 2—SHUNT WOUND MOTOR, WITH COMPENSATING COILS, AND COMPOUND WOUND

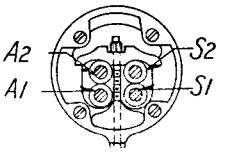


VIEW OF MOTOR TERMINALS**

CLOCKWISE ROTATION
Connect S2 and F2 to — line
Connect A1 to S1
Connect A2 to starting resistance, thence to + line
Connect F1 to + line

COUNTER-CLOCKWISE ROTATION
Connect S2 and F2 to — line
Connect A2 to S1
Connect A1 to starting resistance, thence to + line
Connect F1 to + line

DIAGRAM No. 3—SERIES WOUND MOTOR

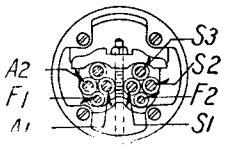


VIEW OF MOTOR TERMINALS**

CLOCKWISE ROTATION
Connect S2 to — line
Connect A1 to S1
Connect A2 to starting resistance, thence to + line

COUNTER-CLOCKWISE ROTATION
Connect S2 to — line
Connect A2 to S1
Connect A1 to starting resistance, thence to + line

DIAGRAM No. 4—TYPE SK ELEVATOR MOTOR COMPOUND WOUND—CLASSES II AND III (See note)
(for class I motors use diagram No. 1)



VIEW OF MOTOR TERMINALS**

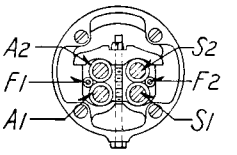
CLOCKWISE ROTATION
Connect S2 and F2 to — line
Connect A1 to S1
Connect A2 to starting resistor, thence to + line
Connect F1 to + line

COUNTER-CLOCKWISE ROTATION
Connect S2 and F2 to — line
Connect A2 to S1
Connect A1 to starting resistor, thence to + line.
Connect F1 to + line

Diagram indicates connection for starting, the full series field being in circuit. Under normal running conditions the series field is short circuited. In classes II and III motors, the series field may be cut out in two steps by short-circuiting S2 and S3, then S1 and S3.

Generator Connections

DIAGRAM No. 5—COMPOUND WOUND GENERATOR

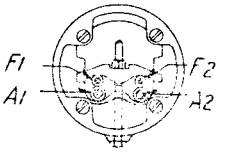


VIEW OF GENERATOR TERMINALS**

CLOCKWISE ROTATION
Connect A2 to + line
Connect A1 and F2 to S2
Connect S1 to — line
Connect F1 to field rheostat, thence to + line.

COUNTER-CLOCKWISE ROTATION
Connect A1 to + line
Connect A2 to F2 to S2
Connect S1 to — line
Connect F1 to field rheostat, thence to + line.

DIAGRAM No. 6—SHUNT WOUND GENERATOR



VIEW OF GENERATOR TERMINALS**

CLOCKWISE ROTATION
Connect A2 to + line
Connect A1 and F2 to — line
Connect F1 to field rheostat, thence to + line

COUNTER-CLOCKWISE ROTATION
Connect A1 to + line
Connect A2 to F2 to — line
Connect F1 to field rheostat, thence to + line.

Above terminal locations are for leads out right hand side looking at commutator end. When leads are out left hand side looking at commutator end, location and markings will be upside down."

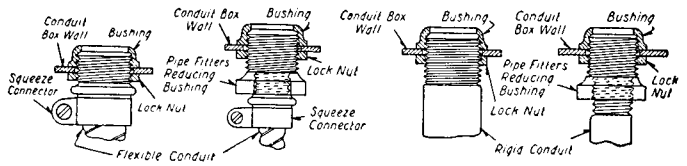


FIG. 1—METHOD OF CONNECTING MOTOR TO LINE

TYPE SK BALL BEARING D-C. MOTORS AND GENERATORS

INSTRUCTIONS—Continued

OPERATION—Cont.

Generator

Starting—Make certain that all instructions for installing have been complied with and that the connections have been properly made. Then observe the following instructions in the order named.

(1) Start each generator with the circuit breaker or the line switch open and all the resistance of the field rheostat in the field circuit.

(2) When the generator is up to full speed, adjust the voltage to the proper value by means of the field rheostat.

(3) Close the circuit breaker or switch connecting the generator to the switchboard, and then close any other switches necessary to apply the load.

When starting a generator for parallel operation, the voltage of the generator must be made to agree in direction and strength with that of the bus bars of the generator already in operation; then close the circuit breaker, the equalizer switch and the load switch. The equalizer switch and load switch are sometimes combined in a three pole switch; if single pole equalizer switches are used, the generator must not be connected in parallel until the equalizer circuit is complete. On closing the switch connecting the generator to the bus bars, adjust the field rheostat again until the generator takes up its share of the load, as shown by the ammeters.

Failure to generate full voltage may be due to (1) slow speed; (2) open shunt field circuit, caused by faulty connections, or a burned out coil or rheostat; (3) open armature or series field circuit; (4) incorrect brush setting; (5) reversed series or shunt coils; (6) poor brush contact due to dirty commutator or brush sticking in holders; (7) loss of residual magnetism.

Stopping—Reduce the voltage (and consequently the load) of the generator by adjusting the field rheostat and when the load is small, open the circuit breaker and the generator switch, then stop the prime mover, or release clutch.

CAUTION—Generators should be connected shunt wound when used to excite the fields of synchronous motors or generators. If the generator is compound wound omit the series field winding from the circuit.

Further operating suggestions and construction details will be furnished upon request by the nearest District Office of this Company.

Method of Drive

Belt Drive—Mount the machine on the slide rails or bedplate which allows for adjusting the belt tension. Mount the pulley close to the bearing housing, allowing sufficient clearance for rotor end play. Align the pulleys so that the belt runs true, and tighten the belt just enough to prevent slippage. Use a belt wide enough to carry the load without excessive tension. The machine should be moved towards the driven unit as far as the slots in the rails or bedplate permit.

Chain Drive—Mount the machine on the slide rails or bedplate which allows for adjusting the chain tension. Mount the machine sprocket close to the bearing housing, allowing sufficient clearance for rotor end play, and align the sprockets accurately.

Gear Drive—Mount the machine and driven unit so as to maintain accurate alignment. The gears must mesh accurately to prevent vibration. Mount the machine gear close to the bearing housing to minimize the overhang allowing sufficient clearance for rotor end play. Dowel the machine to the base.

Direct Drive—The machine shaft and the driven shaft must be in line, except for a slight allowance with flexible couplings. Dowel the motor to the base.

Maintenance

Brushes—The correct brush position is the same for both directions of rotation. The bracket is doweled in position before the machine leaves the Works and the brushes should not require further adjustment.

Use only those brushes recommended by this Company. These brushes are recommended on the basis of extensive tests which have proven their reliability for this service. Brushes should have only sufficient clearance in the box to slide easily.

Care of Commutator and Brushes—Keep the commutator clean, wiping it at frequent intervals with a clean canvas cloth free from all lint. The brushes should fit the commutator making the contact over the entire surface.

A commutator that is taking on a polish and shows no signs of wear requires no other attention, but a rough, raw, copper colored commutator should be smoothed with a piece of sandpaper or sandstone ground to fit and then polished with No. 00 sandpaper. Always lift brushes when polishing commutator and do not replace them until all grit has been removed. Never use emery cloth or emery paper on the commutator.

In General — Keep the machine clean and dry. Tools, bolts, oil cans, etc., must not be allowed to lie around the machine or on the frame. Keep the machine free from dust by occasionally blowing it out with compressed air or hand bellows.

Operation and Care of Ball and Roller Bearings

Quietness and life of ball and roller bearings depends largely on cleanliness and proper lubrication.

Inspection

1. When the machine is installed make certain that the rotor turns easily, particularly if the machine is not installed until some months after being shipped.

2. Never open the bearing housing under conditions which would permit entrance of dirt.

3. External inspection of the machine at the time of the first greasing soon after it is put into operation will determine whether the bearings are operating quietly and without undue heating. Further inspection will not be necessary except at frequent intervals, probably at greasing periods.

4. If practicable, it is desirable for the most satisfactory service, to open the bearing housings once a year, or after every 5,000 hours' operation, to check the condition of the bearings and grease. If difficult to inspect the pulley or pinion end bearing, the condition of the bearing at the opposite end will usually be representative of both.

5. If grease deterioration has occurred or if dirt has gained entrance to the housing, the bearing and housing parts should be thoroughly cleaned out and new grease added.

Lubrication

Oil Lubrication—When oil is required as on certain high speed or vertical machines, instructions furnished with the machines will so state or the lubrication fittings furnished will indicate that oil is to be used.

Oil lubricated machines are shipped without oil. Before starting see that the drain plugs are tight and fill to overflow or gauge level with best quality clean engine oil having a viscosity of 185 to 212 seconds, Saybolt at 100° F. This corresponds to the viscosity of S.A.E. #10 oil.

Grease Lubrication

1. Grease is generally used as a lubricant. Ordinary cup greases are not satisfactory because of great tendency to deteriorate under the severe churning action of the bearings. To be suitable for ball or roller bearing lubrication a grease should be compounded from a pure mineral oil and a sodium base soap. It should be free from dirt and fillers, such as powdered mica, flake graphite, etc. It should be free from acid or alkali or from ingredients which will form these compounds. It should not melt at the highest operating temperature of the bearings and it should maintain a fairly uniform consistency over a large temperature range. Westinghouse grease meets these requirements. Keep grease clean by using only closed containers.

Do Not Over Lubricate

2. A small amount of lubricant is essential, sufficient to maintain a film of lubricant over the surface of the balls and races. Too much grease will cause churning, overheating and grease

TYPE SK BALL BEARING D-C. MOTORS AND GENERATORS

INSTRUCTIONS—Continued

leakage. If grease leakage occurs the bearing has been over filled, or the grease used is not suitable for the particular application.

If high pressure guns are used, great care should be used to avoid over lubrication.

When shipped from the factory, grease lubricated ball and roller bearing machines have sufficient grease of the right grade to last for a limited period. However, a charge of grease should be added soon after the machine is put in operation. and thereafter at suitable intervals, as determined by experience. As a guide, it is suggested that grease should be added every three months of operation in amounts as indicated in the following table. If experience indicates that these quantities result in a surplus of grease in the bearing, the quantity should be reduced or the greasing periods lengthened or both. The ideal condition is that the bearing housing be from ⅛ to ½ full of grease.

As the shaft extension diameter is easily determined and is roughly proportional to the bearing size the following table for grease additions is prepared on this basis.

Shaft Extension Diameter	Amount of Grease to be added.
¾ to 1¼″	1 cu. in.
Above 1¼ to 1⅞″	1¼ cu. in.
Above 1⅞ to 2⅜″	2½ cu. in.
Above 2⅜ to 3″	4 cu. in.
Above 3 to 4″	7 cu. in.
Above 4 to 5″	10 cu. in.

1 oz. = 1¼ cu. in.

3. When surplus grease sump below bearing is supplied, this should be kept empty at all times.

Regreasing

4. When the bearing housing has been disassembled and the bearing thoroughly cleaned with a suitable solvent it should be immediately regreased with Westinghouse grease after first spraying or flushing with good lubricating oil. Apply the new grease either from a tube or by hand, over and between the balls or rollers. Do not use more than the amount specified in the table.

Westinghouse Grease—Ordering Data

8 oz. tube—Style No. 1360876
1 lb. can—Style No. 1248911
5 lb. can—Style No. 1248912
10 lb. can—Style No. 1248913
25 lb. can—Style No. 1360877

Refer to the nearest district office of the Company for Westinghouse Grease packed in larger containers.

Cleanliness

Ball and roller bearings are especially sensitive to even a small amount of dirt. Hence, they must be protected from it at all times. If necessary to disassemble the bearing housing, first thoroughly remove dirt from all adjacent parts so that dirt will not fall into bearing or interior of housing.

If impossible to immediately reassemble housing, cover bearing and exposed interior of housing with clean wrapping materials. If dirt or deteriorated grease is found in the bearing or housing, the parts should be thoroughly cleaned with carbon tetrachloride (avoid allowing this liquid to remain on adjacent machine windings). In some cases, it may be necessary to entirely remove the bearing from the shaft in order to clean it properly.

If special seals are used to prevent dirt entering housing be sure that these are carefully replaced when housing is re-assembled.

Mechanical Damage

1. In mounting or removing bearings, pressure should be applied only against the inner race, always using a sleeve or other intermediate piece if mounting or removal is accomplished by hammer blows. Cover bearing carefully during these operations if there is danger of flying particles getting in among the balls or rollers. Never attempt to remove a ball or roller bearing by exerting pressure against the outer race, as the bearing may be seriously damaged.

2. In mounting or removing pulleys, couplings or pinions, the bearing must not be subjected to axial pressure, especially hammer blows as when these accessories are driven on to the shaft with a mallet. Any pressure of this kind should be taken by supporting the opposite end of the shaft against a stop of some kind.

3. If the bearings overheat, the cause is probably one of the following: (1) Excessive belt tension; (2) too much lubricant causing churning; (3) poor alignment causing excessive vibration or binding; (4) dirt in the bearing; (5) bent shaft; (6) excessive end thrust due to gearing, flexible couplings, etc. If a bearing becomes excessively hot, first slacken the belt (if used). If relief is not thus afforded shut down the machine.

4. For additional information, methods of locating and correcting troubles and making repairs, apply to the nearest Westinghouse District Office.

To Disassemble Machine

Non-cartridge type machines are disassembled by removing bolts clamping bearing housing covers to bracket, also the bolts securing the bracket to the frame, withdrawing it axially and leaving the ball bearing mounted upon the shaft. The armature can then be readily withdrawn from the frame. Cartridge type machines may be disassembled by removing the bolts securing the cartridge or housing to the bracket. The brackets may then be withdrawn axially and the armature with ball bearings still enclosed may be withdrawn from the stationary part.

Westinghouse Electric Corporation

Buffalo, N. Y.

Printed in U.S.A. (Rep. 3-58)


WESTINGHOUSE

DESCRIPTION • INSTALLATION • MAINTENANCE

INSTRUCTIONS

Life-Linestarter*

Class 11-200N.1 **Three Pole** **Type N, SPEC.**

TYPE N, LIFE-LINESTARTER will give protection against overloads (but not against short-circuit currents) when wired in accordance with Fig. 2 and provided with overload heaters selected from the Heater Application Tables.

The starter should be protected against short circuits by fuses not exceeding four times the rated motor current, by a time limit circuit breaker set at not more than four times the full load motor current, or by an instantaneous trip circuit breaker.

COIL STYLE IDENTIFICATION

VOLTS	CYCLES	COIL STYLE
110	60	1470 241
110	25	1470 242
208	60	
220	60	
220	25	1470 243
380	50	
440	60	
480	60	
550	60	1470 244
600	60	1470 245
110	50	1470 246
220	50	1470 247
440	50	1470 248
550	50	1470 249
440	25	1470 250
550	25	1470 251

OVERLOAD RELAYS

The overload relay is furnished set for Hand reset operation. The relay may be set for Automatic reset, Hand reset, or Hand reset with no manual means of opening the contacts. The type of operation is determined by the position of the control spring in the notched pushrod; the respective positions (as illustrated in Fig. 1) are indicated by "Auto", "Hand" and "No Stop". The positions are indicated as follows; "Hand", "No Stop" by alignment of spring arm with the ribs on the base, the "Auto" by the spring arm against the upper shoulder of the base. Automatic reset should not be used with two-wire master switch.

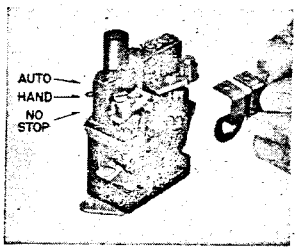


FIG. 1. Thermal Overload Relay, Showing Heater and Installation Method

INSTALLATION

1. Clean the magnet surfaces.

2. Operate the armature by hand to be sure that all moving parts move freely.

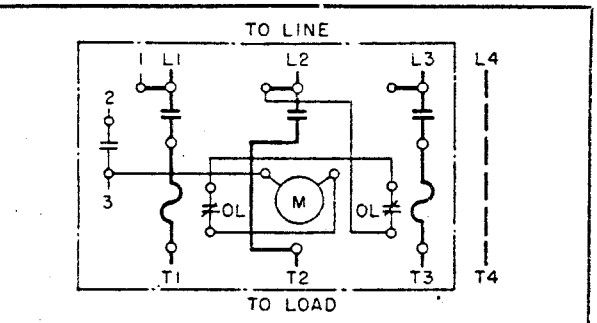
3. Install heater as shown in Fig. 1, making sure that heater mounting screws are tight.

4. Installation of the starter on a properly drilled and tapped mounting panel has been facilitated by providing two open mounting slots at the bottom of the starter base and a captivated screw at the top

of the base. The two open slots should be made to engage screws started in the mounting surface; this will support the starter weight and also help position the captive screw so that it may be driven into the mounting surface. If a screw of different length is required, the captive screw may easily be removed from its spring retainer.

ELECTRICAL INTERLOCKS

This starter comes equipped with one normally open interlock mounted on the left hand side. A second interlock may be obtained by ordering either S# 1314 884, normally open, or S# 1314 885, normally closed. A third or fourth interlock may be obtained by ordering either S# 1314 886, normally open, or S# 1314 887, normally closed. The above normally open interlocks may readily be installed as normally closed interlocks per instructions enclosed with each interlock.



NOTE:
1. When used on single-phase circuit, connect line leads to L1 and L2, load leads to T1 and T2.
2. When used on 2-phase, 3-wire circuit, make L2 the common lead.
3. When used on 2-phase, 4-wire circuit run fourth wire direct to load where local codes permit. Connect one phase to L1 and L2, T1 and T2; connect other phase to L3 and L4, T3 and T4.

FIG. 2. Wiring Diagram

SEPARATE CONTROL CIRCUIT

If it is desired to operate the coil from a separate control circuit, disconnect control lead at "L2" and at lower right O.L. relay terminal (Fig. 2) and remove. Connect one side of separate control circuit to relay terminal where lead was removed and the other side to isolated terminal on top of left O.L. relay. To this point connect terminal "1" of P.B. station or master switch; in other respects connect per Fig. 2.

To eliminate a coil change, it is recommended that S# 1577 240 be ordered when separate control voltage is 110 volts and main line voltage is 600 volts or less.

MAINTENANCE

The sealing surfaces on the magnet frame and armature should be kept clean.

Do not lubricate the contact tips or bearings. Fine silver contacts need no dressing throughout their life.

To Remove Contactor Coil, remove the three round head magnet mounting screws and withdraw the coil and magnet.

When Installing Contactor Coil, make sure that round head magnet mounting screws are securely tightened.

The bi-metallic disc trip unit of the overload relay has been carefully calibrated at the factory and should not be disturbed. In case of damage remove complete relay unit and replace with complete unit.

PRINCIPAL RENEWAL PARTS

Moving Contact.....S# 1314 985
Stationary Contact.....S# 1314 986
Contact Spring.....S# 1314 961
Overload Relay Complete.....S# 1577 761
For other parts refer to Renewal Parts Catalog.

HEATER APPLICATION TABLES

HEATER STYLE NUMBER	HEATER CODE MARKING	TABLE 15 RELAY AMBIENT APPROX. SAME AS MOTOR AMBIENT		TABLE 16 RELAY AMBIENT APPROX. 15° ABOVE MOTOR AMBIENT	
		125% Overload Protection Full Load Current of Motor (Amperes) @ 40°C	Heater Current Rating (Amperes) @ 40°C	125% Overload Protection Full Load Current of Motor (Amperes) @ 40°C	Heater Current Rating (Amperes) @ 40°C
1129 372	X .49	0.45 to 0.49	.56	.39 to .43	.49
1129 373	Y .55	0.50 to 0.56	.63	.44 to .49	.55
1129 374	Z .63	0.57 to 0.62	.72	.50 to .56	.63
966 465	AA .71	0.63 to 0.71	.79	.57 to .65	.71
966 466	AB .82	0.72 to 0.79	.90	.66 to .73	.82
966 467	AC .93	0.80 to 0.89	1.00	.74 to .81	.93
966 468	AD 1.0	0.90 to 0.99	1.13	.82 to .92	1.00
966 469	AE 1.1	1.00 to 1.07	1.25	.93 to 1.02	1.16
966 470	AF 1.2	1.08 to 1.18	1.31	1.03 to 1.11	1.29
966 471	AG 1.4	1.19 to 1.32	1.49	1.12 to 1.21	1.35
966 472	AH 1.5	1.33 to 1.49	1.66	1.22 to 1.36	1.53
966 473	AI 1.7	1.50 to 1.71	1.88	1.37 to 1.53	1.71
966 474	AK 1.9	1.72 to 1.89	2.15	1.54 to 1.76	1.93
966 475	AL 2.1	1.90 to 2.09	2.37	1.77 to 1.95	2.22
966 476	AM 2.5	2.10 to 2.35	2.63	1.96 to 2.15	2.44
966 477	AN 2.7	2.36 to 2.65	2.95	2.16 to 2.42	2.71
966 478	AO 3.0	2.66 to 2.98	3.32	2.43 to 2.73	3.02
966 479	AP 3.4	2.99 to 3.35	3.74	2.74 to 3.07	3.42
966 480	AR 3.8	3.36 to 3.75	4.20	3.08 to 3.45	3.85
966 481	AS 4.3	3.76 to 4.21	4.73	3.46 to 3.86	4.32
966 482	AT 4.8	4.22 to 4.71	5.28	3.87 to 4.33	4.87
966 483	AU 5.4	4.72 to 5.33	5.91	4.34 to 4.85	5.43
966 484	AW 6.1	5.34 to 5.94	6.67	4.86 to 5.49	6.09
966 485	AX 6.8	5.95 to 6.63	7.44	5.50 to 6.13	6.86
966 486	AY 7.7	6.64 to 7.52	8.30	6.14 to 6.83	7.65
966 487	AZ 8.5	7.53 to 8.51	9.41	6.84 to 7.74	8.54
966 488	BA 9.6	8.52 to 9.31	10.6	7.75 to 8.75	9.69
966 489	BB 11	9.32 to 10.5	11.64	8.76 to 9.57	10.96
966 490	BC 12	10.6 to 11.5	13.09	9.58 to 10.7	11.90
966 491	BD 13	11.6 to 12.4	14.50	10.8 to 11.8	13.50
966 492	BE 14	12.5 to 13.4	15.6	11.9 to 12.8	14.90
966 493	BF 16	13.5 to 14.9	16.9	12.9 to 13.8	16.10
966 494	BG 18	15.0 to 17.5	18.7	13.9 to 15.4	17.40
966 495	BH 19	17.6 to 18.2	20.3	15.5 to 16.8	19.25
966 496	BI 21	18.3 to 19.5	22.5	16.9 to 18.4	20.90
966 497	BK 23	19.6 to 20.5	23.9	18.5 to 20.1	23.18
966 498	BL 25	20.6 to 22.6	25.9	20.2 to 21.3	24.60
966 499	BM 27	22.7 to 25.7	28.4	21.4 to 23.3	26.7
1040 588	BN 29	25.8 to 28.4	32.5	23.4 to 24.9	29.0
974 084	BO 31	28.5 to 32.7	35.5	25.0 to 28.4	31.0
1040 589	BR 36	32.8 to 37.1	41.4	28.5 to 32.2	36.0
1040 590	BS 40	37.2 to 42.5	46.5	32.3 to 36.2	40.0

Note: Use Next Lower Code No. Heater for 115% Protection

DESCRIPTION • OPERATION • MAINTENANCE

INSTRUCTIONS

REVERSING Life-Linecontactor*

TYPE N 130 CLASS 15-815 N.1 3 POLE, SIZE 1

THE TYPE N-130 REVERSING LIFE-LINE CONTACTOR has been designed primarily to provide reversing operation for AC motors, and consists of two 3-pole non-reversing contactors mechanically interlocked to prevent both contactors from being closed at the same time. Up to three electrical interlocks per contactor (total of 6 on complete unit) may be mounted on this device depending upon circuit requirements (See Electrical Interlocks). This reversing contactor is complete with Line, Load, Control Terminals, main cross wiring, one normally open electrical interlock and one normally closed electrical interlock per contactor (total of 4 on complete unit).

For a typical application of a reversing contactor showing Line, Load and Control Connections refer to Fig. 1. Customer connections are shown in dashed lines. The reversing pushbutton station shown in Fig. 1 is furnished separately.

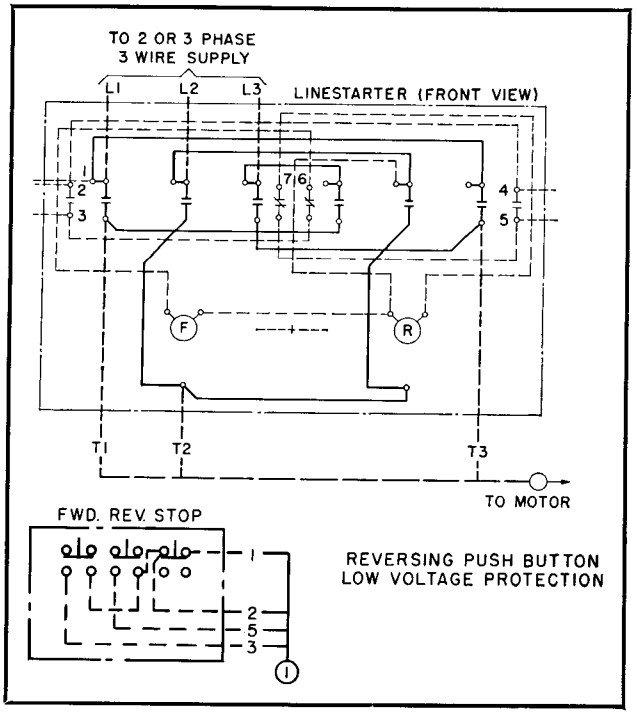


FIG. 1. Wiring Diagram

This reversing contactor unit is intended to be applicable to numerous simple control schemes (See Fig. 1) and also as a part of large control panels. Thus, to obtain maximum application flexibility for the unit, terminal marking and control wiring have been omitted but main cross wiring has been included. Ratings are shown in the following table:

MAXIMUM A-C RATINGS

Open—25 Amperes	Enclosed 22½ Amperes	
Volts	HORSEPOWER	
	Polyphase	Single Phase
110	3	1½
208-220	5	3
440-600	7½	5

CONSTRUCTION

This Reverser employs two 3-pole non-reversing contactors of the inverted clapper type with knife edge bearing and having positive action through the use of a compression kick-out spring. This construction provides maximum accessibility for servicing and maintenance and allows coil change to be a simple operation. All current carrying parts are of high conductivity copper or copper alloy of large cross section resulting in high electrical efficiency. Long life and low contact drop are assured by fine silver contacts with large area of bond for current conduction and heat transfer.

Pressure-type connectors on main and control terminals permit the use of either solid or stranded wire without soldered joints.

INSTALLATION

1. Clean the magnet surfaces.

2. Operate the armature by hand to be sure that all parts move freely.

* Trade-Mark

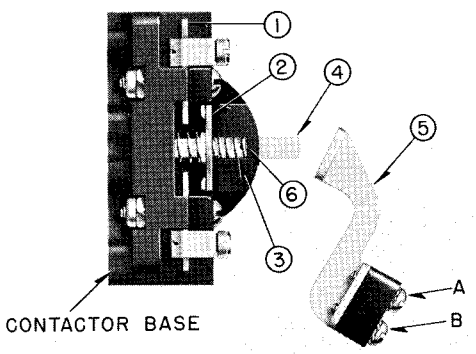


FIG. 2. Normally Open Interlock

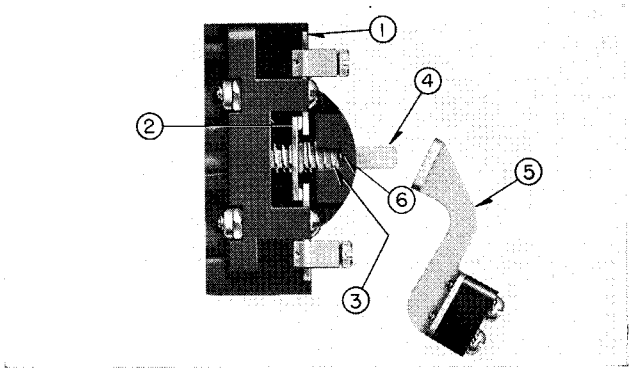


FIG. 3. Normally Closed Interlock

ELECTRICAL INTERLOCKS

This reversing unit comes equipped with one normally open interlock and one normally closed interlock on each contactor. By removing the interlock, shown in Fig. 2, and reassembling parts 1, 2 and 3 per Fig. 3, the interlock is changed from normally open to normally closed contact. The following procedure is recommended:

1. Swing arm (5) out of way by removing screw A and loosening screw B. (See Fig. 2).

2. To detach upper spring (3) from plunger (4) compress inturned end of spring against contact bar (2) and rotate spring until it disengages hole (6).

3. Operate reassembled interlock by hand to check freedom of moving parts before reassembling arm (5) into original position.

A third interlock per contactor may be obtained by ordering either S# 1314 886, normally open, or S# 1314 887, normally closed. The above normally open interlocks may readily be installed as normally closed interlocks per instructions enclosed with each interlock.

MAINTENANCE

The sealing surfaces on the magnet frame and armature should be kept clean.

Do not lubricate the contact tips or bearings. Fine silver contacts need no dressing throughout their life.

To Remove Contactor Coil, remove the three round head magnet mounting screws and withdraw the coil and magnet.

When Installing Contactor Coil, make sure that round head magnet mounting screws are securely tightened.

CONTACTOR IDENTIFICATION

This reversing contactor unit complete is iden tified by style number (shown on the carton and as listed in Price List) and consists of two basic parts: (1) the reversing contactor unit without coils and (2) the coils.

The style number of the reversing contactor unit (without coils) is S# 1577 894 and appears on the metal nameplate attached to the unit.

The coil style is marked on the coil itself along with its voltage and frequency rating.

Complete style identification for use in order- ing either a complete reversing contactor unit or individual coils is given in the following table:

STYLE IDENTIFICATION

VOLTS	CYCLES	COIL STYLE	COMPLETE STYLE
110	60	1470 241	1578 120
110	25		
208	60	1470 242	1578 121
220	60		
220	25		
380	50	1470 243	1578 122
440	60		
480	60		
550	60	1470 244	1578 123
600	60	1470 245	1578 124
110	50	1470 246	1578 125
220	50	1470 247	1578 126
440	50	1470 248	1578 127
550	50	1470 249	1578 128
440	25	1470 250	1578 129
550	25	1470 251	1578 130

PRINCIPAL RENEWAL PARTS

Moving Contact.....S# 1314 985
Stationary Contact.....S# 1314 986
Contact Spring.....S# 1314 961
For other parts refer to Renewal Parts Catalog.

WESTINGHOUSE ELECTRIC CORPORATION
BEAVER PLANT • STANDARD CONTROL DIVISION • BEAVER, PA.
(Rep. 5-55) Printed in U.S.A.

Supersedes Issue
Dated June, 1948

INSTRUCTION LEAFLET 3487-C
Filing No. 15-800

JUNE, 1950 WESTINGHOUSE INDUSTRIAL MOTORS AND CONTROLLERS

Type TI-2 Relay

INSTRUCTIONS

Application

The type TI-2 relay is a panel mounted, single pole D-C. overload relay. It has a single spring closed contact, which trips with thermal time delay on low and medium overloads, and trips instantaneously on high overloads, to open the coil circuits of magnetic contactors which open the power circuit. The relay can be set to latch out after operating if desired. It can be provided with an auxiliary shunt connected magnet for electric reset. By reversing the mounting of this magnet, it may be arranged to reset either by energizing or by deenergizing the magnet.

Type TI-2 relays are applied according to the rule that the minimum tripping current for the relay is approximately 120% of the continuous motor rating or of the nominal current rating of the motor when it is applied on intermittent loads above its continuous rating. Time delay curves for a typical application according to this rule are shown in Fig. 1. The contacts will open D-C. magnet circuits carrying .2 ampere at 250 volts or .1 ampere at 600 volts.

Construction

The relay is made up of magnetic and mechanical parts mounted on a moulded base to form a unit which is common to all ratings, on which are assembled coils and heaters which vary with the rating.

The relay operates according to a combination of magnetic and thermal principles. A clapper type magnet is magnetized by a series coil and carries a horizontal armature, the free end of which may take an upper or lower position depending on the magnetic and thermal conditions. The armature is normally biased to its lower position where it is held by the magnetic attraction of a strip of nickel-iron alloy called "Invar". Under tripping conditions, the lockout effect of the Invar strip is neutralized or overpowered and the armature is drawn to its upper position by the magnetic attraction of an upper pole formed by the bent end of the rear frame. In moving upward, the armature lifts a push rod which opens a normally closed contact at the top of the relay. A spring is arranged to engage a notch in the push rod in its upper position and thus hold the contact open for "Hand Reset" operation until the latch is disengaged by depressing the Reset Push Button. If "Automatic Reset" operation is wanted the spring latch is permanently held out of engagement by depressing the Reset push button and giving it one-quarter turn clockwise.

The time delay features of the relay depend on the special physical property of Invar by which it loses its magnetic permeability at a temperature of about 240°C. This property is utilized by connecting the Invar lockout strip or "heater" in series or parallel to the coil and passing the load current or a fraction of it through the heater. On moderate sustained overloads the internally generated heat is sufficient to raise the temperature of the heater to its demagnetization point, and the lockout effect of the heater is **neutralized** allowing the relay to trip. For overloads which exceed the "Instantaneous Trip" setting of the relay, a vertical auxiliary armature, attracted toward the coil, strikes the horizontal armature, raises it from the Invar $\frac{1}{32}$ to $\frac{1}{16}$ inch, which is sufficient to break the lockout, allowing it to trip.

Adjustment

The relay has two adjustments—(1) to vary the rating and (2) to vary the instantaneous tripping current.

The adjustment for rating is made by turning an adjusting plate attached to the horizontal armature, so that the lockout pin registers with a hot spot (low current rating) at the right or with a cool spot (high current rating) at the left of its motion. The change of current rating which may be expected between "low" and "high" adjustments is about 12% for large current heaters and 20% for small ones. A change of this adjustment is accomplished by loosening a screw as shown in Fig. 2.

A nut adjustment is provided for varying the spring tension on the auxiliary armature to vary the percent overload at which instantaneous trip occurs. The adjustment is set at the factory to give instantaneous trip at 300 to 400%.

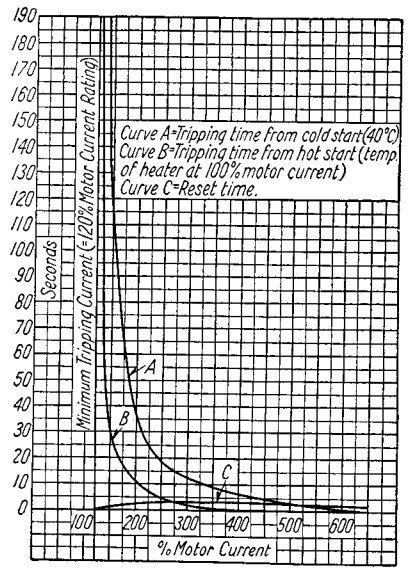


FIG. 1—RATING CHARACTERISTICS

Maintenance

The heater should be kept free from dust accumulations which might interfere with proper seating of the armature. All joints must be maintained clean and tight to avoid local heating which would change the tripping range of the relay. In case it is necessary to remove the coils the front frame with armature attached can be removed by removing the core bolt and the coils and heaters are then easily removable.

When installing or replacing heaters mount the heater with the style marking to the left and upward.

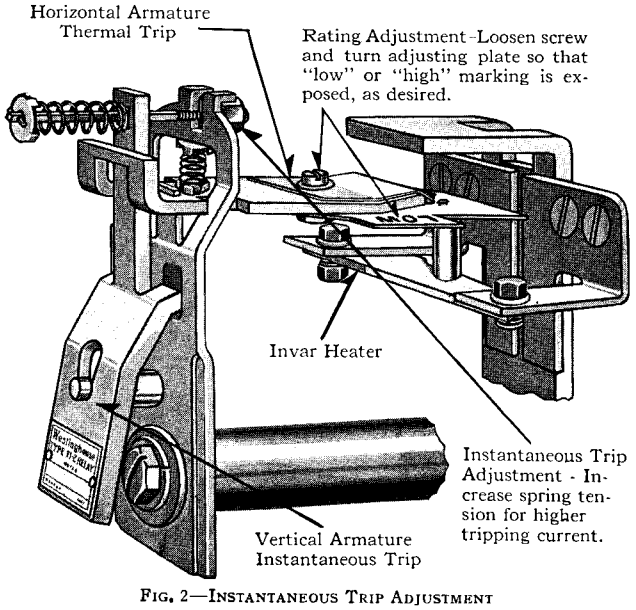


FIG. 2—INSTANTANEOUS TRIP ADJUSTMENT

Westinghouse Electric Corporation
Buffalo, N. Y.

Printed in U.S.A. (Rep. 5-58)

INSTRUCTIONS

CONTROL RELAY, TYPE NH
CLASS 15-820NH

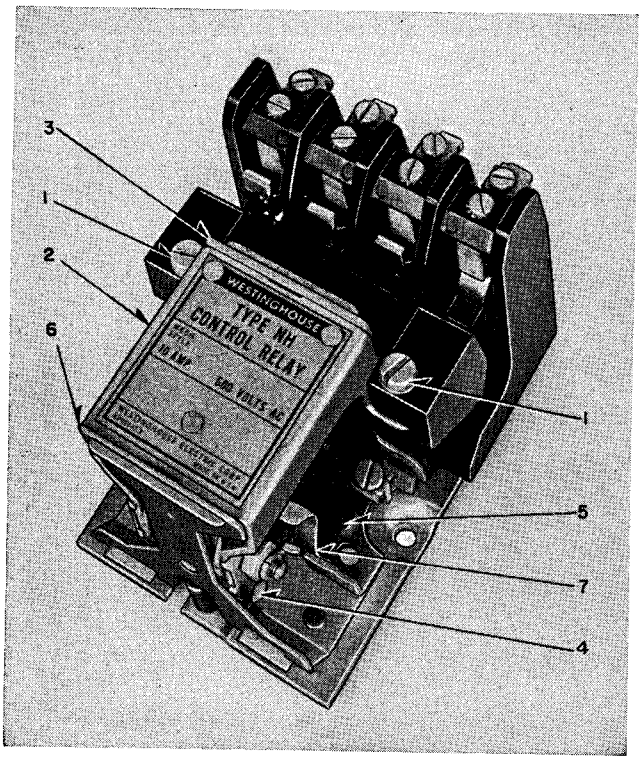


FIG. 1. Type NH Control Relay

TYPE NH CONTROL RELAY is an a-c multipole contactor actuated by a vertical operating, spring loaded, rocker-type magnet mechanism, using hardened knife-edge bearings, which provide a smooth, free action. Positive contact opening is assured by kickout-spring loading of the operating mechanism. Easy inspection and maintenance is afforded by the unique assembly of the moving parts.

These contactors are available in 2 to 6 pole forms with any complement of normally open and normally closed contacts required.

Contacts may be easily changed from N.O. (normally open) to N.C. (normally closed) and vice-versa so that stock relays may be readily converted by the user for special applications.

Pressure-type connectors on all terminals permit the use of either solid or stranded wire without soldered joints or looped wire.

RATINGS

Maximum Amps	10 Amperes
Maximum Volts	600 Volts
A-C Interrupting Capacity	7500 Volt-Amperes
D-C Interrupting Capacity (Inductive Load 1 Amp Max.)	50 Volt-Amperes

MAINTENANCE

The sealing surfaces of magnet and armature should be kept clean and free from greasy deposits which might cause the relay to stick in the closed position. No lubrication is required and the solid silver contacts do not require filing; discoloration and slight pitting of contacts is a normal condition.

Changing Coils. (Refer to Fig. 1) — After disconnecting leads to coil terminals, remove crossbar mounting screws (1) and remove crossbar assembly complete with moving contacts. Next, disengage armature bracket (2) from upper bearing arm (3) by applying pressure with thumbs to upper part of nameplate until the tongue on the bearing arm is freed from the hole in the armature bracket. The armature bracket (2) can then be swung outward and downward until the center leg of the armature (4) clears the coil (5).

The armature bracket (2) and the lower bearing arm (6) may now be disengaged by applying pressure to lower part of the nameplate until the tongue on the bearing arm (6) is freed from the hole in the armature bracket as before. The coil retaining springs (7) may now be swung outward allowing the coil to be removed.

Reassembly follows the same procedure except in reverse order.

Changing Contacts From N.O. To N.C. (Refer to Figs. 2 and 3) — To change N.O. contact, Fig. 2, to N.C. position per Fig. 3, first remove crossbar mounting screws (1) and withdraw crossbar (8). Second, remove front stationary contact mounting screw (9) and front stationary contact (10). Third, remove contact saddle mounting screw (11); invert the complete moving contact assembly and secure it in place in the molded contact base per Fig. 3 using the same screw (11) as before. Replace the front stationary contact (10) and operate the contact manually a few times to make sure it is free. Replace the crossbar assembly (8) and screws (1).

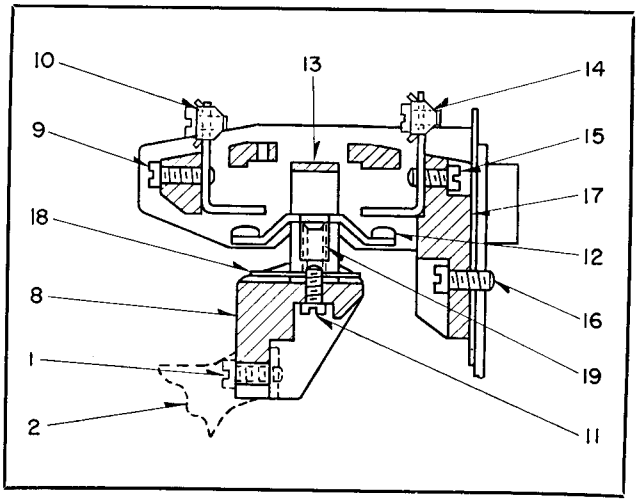


FIG. 2. Typical Normally Open Contact in De-Energized Position

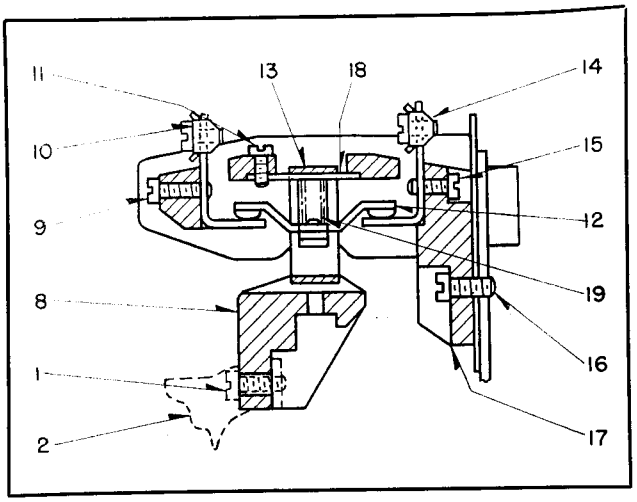


FIG. 3. Typical Normally Closed Contact in De-Energized Position

This completes the changeover from N.O. to N.C. position. The change back to N.O. position is accomplished by following the same procedure in reverse order with this special precaution:

Important. Be sure to tighten the moving contact saddle mounting screw (11) securely to avoid loosening in service.

INSPECTION

Normally Open Contacts. (See Fig. 2) Inspection of N.O. contacts is accomplished by removing the two crossbar mounting screws (1), whereupon the crossbar (8), complete with the moving contacts, may be removed and all contacts are accessible.

The moving contacts (12) are removed from the moving contact saddle (13) by twisting and sliding the contact endwise. The stationary contacts (10) and (14) are secured by screws (9) and (15) and before the rear stationary contacts can be removed, it is necessary to remove contact base mounting screws (16) and contact base (17).

Normally Closed Contacts. (See Fig. 3) Inspection of N.C. contacts is accomplished by first removing the crossbar mounting screws (1) and the molded crossbar (8) complete with any moving contacts that may be attached thereto. Next, the front stationary contact (10) and its mounting screw (9) are removed and screw (11) is removed, allowing the complete moving contact assembly to be taken out for inspection.

Removal of the rear stationary contact (14) is accomplished by first removing the base mounting screws (16) and the molded contact base (17) whereupon the contact mounting screws (15) become accessible for removal.

PRINCIPAL RENEWAL PARTS

Renewal Contact Kit (1 Pole).....S# 1739 593
Stationary Contact—Front (10).....19C1154P3
Stationary Contact—Rear (14).....19C1154P3
Moving Contact Assembly complete .....S# 1739 594
Moving Contact (12).....S# 133A107G01
Contact Saddle (13).....S# 206B225G02
Saddle Guide (18).....S# 206B225H04
Contact Spring (19).....S# 1632 179

For other parts, refer to Renewal Parts Catalog.

RELAY IDENTIFICATION

The relay complete with coil is identified by style number (which appears on carton label and in price form) and consists of the mechanical parts (identified by style number which appears on relay nameplate) plus the appropriate coil for the voltage and frequency of operation.

The coil style appears on the coil label along with the voltage and frequency rating of the coil.

Complete styles and coil styles listed in the following table may be used in ordering either the complete relay with coil or the coils only for all standard voltages and frequencies.

Caution: When ordering relay, specify contact arrangement.

STYLE IDENTIFICATION

COIL STYLES

VOLTS	CYCLES	1 TO 4 POLE COIL STYLE	5 AND 6 POLE COIL STYLE
110	60	1720 611	1739 601
208 220	60 60	1720 612	1739 602
380 440 480	50 60 60	1720 613	1739 603
550	60	1720 614	1739 604
600	60	1720 615	1739 605
110	50	1720 616	1739 606
220	50	1720 617	1739 607
440	50	1720 618	1739 608
550	50	1720 619	1739 609
440	25	1720 620	1739 610
550	25	1720 621	1739 611
110	25	1740 714	1740 716
220	25	1740 715	1740 717

COMPLETE RELAY STYLES

VOLTS	CYCLES	TYPE	COMPLETE RELAY
110	60	NH 20	1739 613
110	60	NH 30	1739 646
110	60	NH 40	1739 690
110	60	NH 50	1739 745
110	60	NH 60	1739 811

For complete listing of N.O. and N.C. contact combinations with various coil ratings, refer to Style Number Index 15-820 NH or nearest Westinghouse Office.

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Westinghouse

Type NR CONTACTOR—2, 3, 4 AND 5 POLES

Class 15-826 N.3 Size 3 A-C SPECIAL
Class 15-826 N.4 Size 4 A-C SPECIAL

MAINTENANCE

1. Keep the De-ion arc box in place at all times that the contactor is in operation. Remove when necessary for inspection of the contacts by removing two screws. Replace with care, seating the arc box in the recess provided for it in the base.

2. Do not lubricate the bearings, contacts or any other parts.

3. Do not dress the contacts unless unusually severe pitting occurs. The surfaces are of silver and discoloration is not harmful. Replace the contacts when the silver faces become reduced to about 1/32 inch in thickness.

4. Do not file or dress connectors or other current-carrying parts lest the protective plating be removed. Surface discoloration is not harmful.

5. To remove the operating coil first disconnect the leads, then remove the three magnet screws and lift the magnet and coil clear. The coil will then slide freely from the magnet.

Mount the new coil with its terminals toward the front and to the left. Reassemble the parts, making sure that the three magnet screws are tightened *as far as they will go.*

ELECTRICAL INTERLOCK

As many as four electrical interlocks may be obtained for mounting on the contactor.

Order by style number as follows:

S# 1490455 for 1st or 2nd electrical interlock
S# 1490456 for 3rd or 4th electrical interlock

Both interlocks provide normally-open or normally-closed operation. Mounting hardware and instructions are included.

PRINCIPAL RENEWAL PARTS

NAME OF PART	STYLE NUMBER	
	Size 3	Size 4
Coil (S# marked on coil)	.....	.....
Arc Box (2 pole)	1490 469	1490 469
Arc Box (3 pole)	1490 468	1490 468
Arc Box (4 pole)	1600 430	1600 430
Arc Box (5 pole)	1600 429	1600 429
Moving Contact	1490 414	1490 426†
Stationary Contact	1490 415	1490 425†
Contact Spring	1490 419	1490 424

† Stamped with numeral "4"

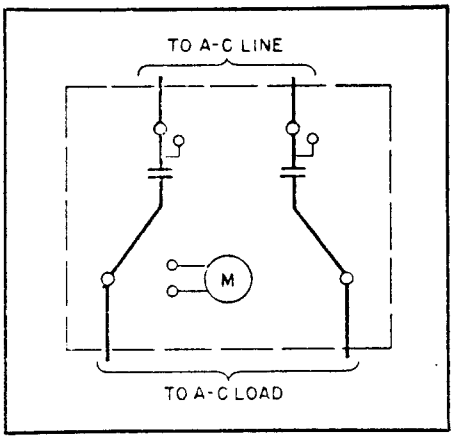

FIG. 1. Wiring Diagram for Two-Pole Contactor (Front View)

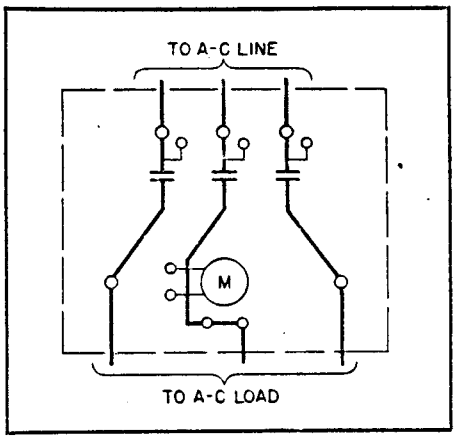

FIG. 2. Wiring Diagram for Three-Pole Contactor (Front View)

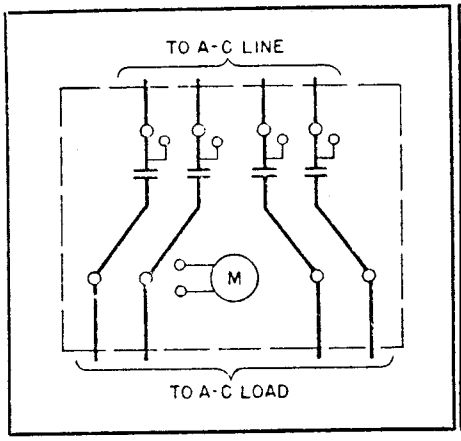

FIG. 3. Wiring Diagram for Four-Pole Contactor (Front View)

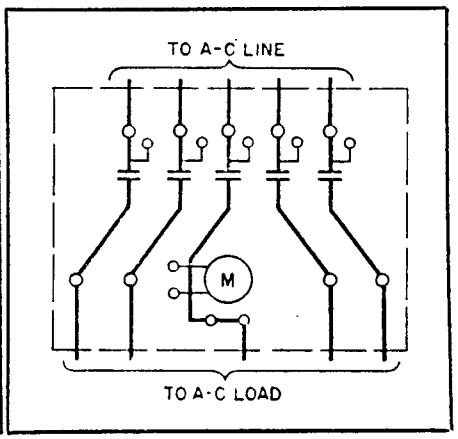

FIG. 4. Wiring Diagram for Five-Pole Contactor (Front View)

DESCRIPTION • OPERATION • INSTALLATION

INSTRUCTIONS

TYPE MW-31 and MW-41 OVERLOAD RELAYS

For Use With

Size 3 and 4 Life-Linestarters

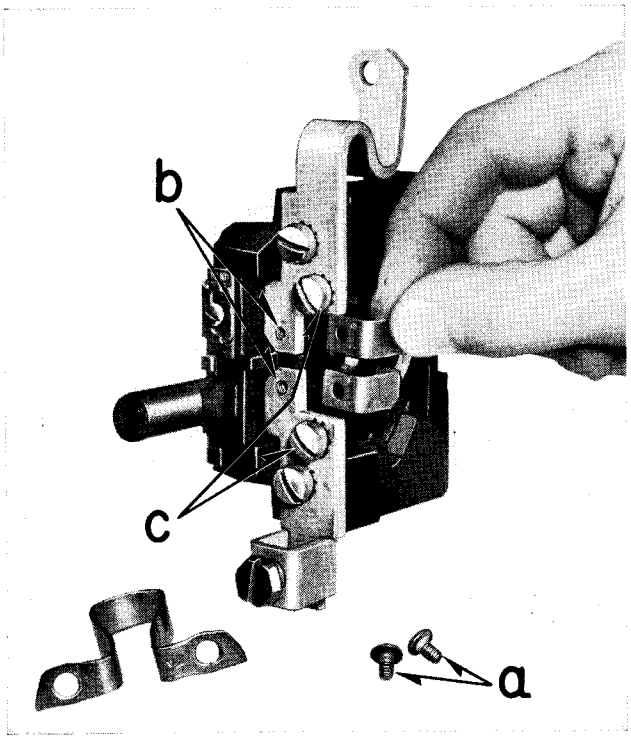

FIG. 1. Install "B" code heater in the relay, using screws "a" threaded into holes "b". The "C" code heater (shown below relay) is held by larger screws "c". Be sure the looped portion enters the recess in the relay.

THE TYPE MW-31 OVERLOAD RELAY is designed for the Size 3 Life-Linestarter, while the MW-41 Overload Relay is designed for the Size 4 Life-Linestarter. It is the purpose of these relays to detect and then protect a load from overloading currents by automatically disconnecting the power. The performance of the relays are such that they will allow motor starting currents to flow during the starting period, but will trip when subject to smaller but long-continued overloads. They will provide protection against abnormal load conditions to current values exceeding locked rotor current.

The MW relays feature a bi-metallic disc which insures the same accuracy and uniformity obtained in precision thermostats. This convex bi-metallic disc after heating snaps to reverse its convexity, thus insuring a quick-break action of the contacts.

In accordance with the National Electric Code the relay should be protected against short circuits by fuses rated at not more than four times the rated motor current, or by a time limit circuit breaker set at not more than four times the rated motor current.

Ratings. The MW-31 and MW-41 relays are used on circuits of not more than 600 volts, and have contacts which will carry and break a-c currents of the contactor coil up to 2 amperes. The contacts will also handle 50 volt-amperes at a maximum of 1 ampere in a d-c circuit. With heaters properly selected from the heater application table, the relays may be used on circuits from 14.9 to 173 amperes. For special applications there are heaters available for circuits of lower and higher ratings.

The time required for the relay to trip depends upon the size of the overload, the greater the overload the shorter being the time to trip. This is indicated in the Time Characteristic Curve, Fig. 2, of a relay operating in a 40°C. (104°F.) ambient temperature. The curve applies in general when the relay is operated in any ambient temperature as long as the currents are expressed in percentages of the minimum tripping current at that ambient temperature. The minimum tripping current changes with the ambient temperature in approximately the same ratio as the change in load capacity of the motor.

OPERATION

The MW overload relay has a heater (a calibrated resistor element) placed in series with the load. During an overload

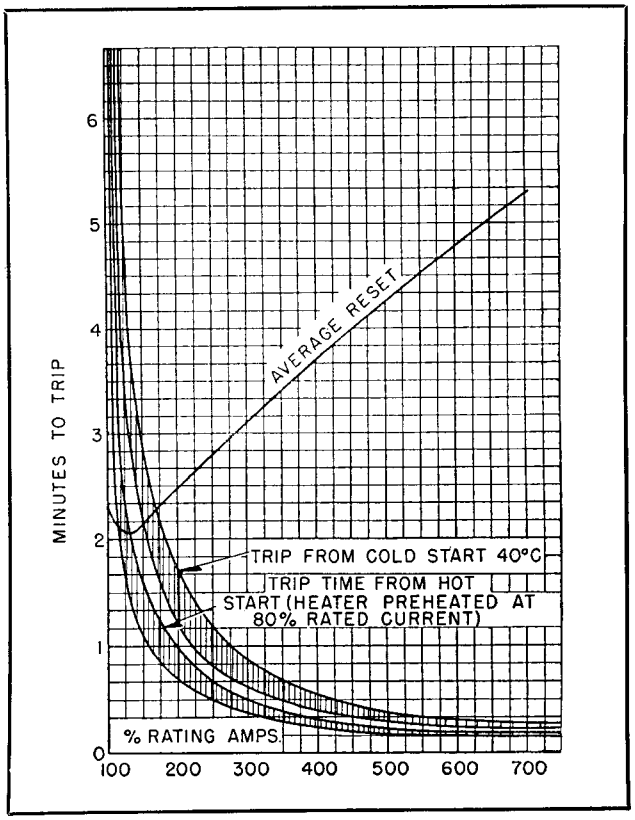

FIG. 2. Average Time Current Curve

HEATER APPLICATION TABLE

HEATERS		OPEN				LARGE ENCLOSURES				UNIT ENCLOSURES			
CODE MARKING	STYLE NUMBER	MW-31 Table 25.3 I.S. 10701	FULL LOAD CURRENT OF MOTOR 125% Overload Protection AMPERES	CURRENT RATING AT 40°C ROOM TEMP. AMPERES	MW-41 Table 25.4 I.S. 10704	MW-31 Table 26.3 I.S. 10702	FULL LOAD CURRENT OF MOTOR 125% Overload Protection AMPERES	CURRENT RATING AT 40°C ROOM TEMP. AMPERES	MW-41 Table 26.4 I.S. 10705	MW-31 Table 27.3 I.S. 10703	FULL LOAD CURRENT OF MOTOR 125% Overload Protection AMPERES	CURRENT RATING AT 40°C ROOM TEMP. AMPERES	MW-41 Table 27.4 I.S. 10706
BE 14	966 492	X	14.9 to 16.5	18.6	X	X	13.4 to 14.4	16.8	X	X	11.4 to 12.8	14.90	X
BF 16	966 493	X	16.6 to 17.3	20.7	X	X	14.5 to 15.5	18.1	X	X	12.9 to 13.8	16.10	X
BG 18	966 494	X	17.4 to 19.1	21.7	X	X	15.6 to 17.2	19.5	X	X	13.9 to 15.4	17.40	X
BH 19	966 495	X	19.2 to 20.7	24	X	X	17.3 to 18.7	21.6	X	X	15.5 to 16.8	19.25	X
BI 21	966 496	X	20.8 to 23.1	26	X	X	18.8 to 20.8	23.5	X	X	16.9 to 18.4	20.90	X
BK 23	966 497	X	23.2 to 24.7	29	X	X	20.9 to 22.1	26.7	X	X	18.5 to 19.5	23.18	X
BL 25	966 498	X	24.8 to 27.1	31	X	X	22.2 to 24.2	27.8	X	X	19.6 to 21.3	24.60	X
BM 27	966 499	X	27.2 to 29.5	34	X	X	24.3 to 26.3	30.4	X	X	21.4 to 23.3	26.70	X
BN 29	1040 588	X	29.6 to 32.7	37	X	X	26.4 to 28.7	33	X	X	23.4 to 24.9	29	X
BO 31	974 084	X	32.8 to 36.7	41	X	X	28.8 to 32.7	36	X	X	25.0 to 28.4	31	X
CR	1780 725	X	36.8 to 40.7	46	X	X	32.8 to 35.9	41	X	X	28.5 to 32.2	36	X
CS	1780 726	X	40.8 to 45.5	51	X	X	36.0 to 40.7	45	X	X	32.3 to 36.2	40	X
BT 47	1265 536	X	45.6 to 51.9	57	X	X	40.8 to 46.3	51	X	X	36.3 to 40.9	46	X
BU 54	1265 537	X	52.0 to 58.3	65	X	X	46.4 to 52.7	58	X	X	41.0 to 46.5	52	X
BX 61	1265 538	X	58.4 to 65.4	73	X	X	52.8 to 58.3	66	X	X	46.6 to 51.9	59	X
BY 65	1265 539	X	65.5 to 73.4	82	X	X	58.4 to 64.7	73	X	X	52.0 to 56.7	65	X
BZ 71	1265 540	X	73.5 to 81.5	92	X	X	64.8 to 72.7	81	X	X	56.8 to 63.9	71	X
CA	1597 771	X	81.6 to 91 1	102	X	X	72.8 to 81.9	91	X	X	64.0 to 73.4	80	X
CB	1597 772	X	91.2 to 101	114	X	X	82.0 to 90.4	103	X	X	73.5 to 79.9	92	X
CC	1597 773	X	102 to 110	127	X	X	90.5 to 98.4	113	X	X	80.0 to 86.3	100	X
CD	1597 774		111 to 120	139	X		98.5 to 106	123	X	X	86.4 to 93.5	108	X
CE	1597 775		121 to 131	152	X		107 to 115	134	X	X	93.6 to 100	117	X
CF	1597 776		132 to 144	165	X		116 to 126	145	X		101 to 108	126	X
CG	1597 777		145 to 160	181	X		127 to 137	158	X		109 to 116	136	X
CH	1597 778						138 to 150	172	X		117 to 125	146	X
CI	1597 779										126 to 137	157	X
CJ	1597 780										138 to 148	173	X

X Indicates heater is used on this relay size.

he flow of heat from the heater causes an adjacent convex bi-metallic disc at a definite temperature to suddenly snap, reversing its convexity. The movement of the disc opens double-break silvered contacts connected in series with the operating coil of the contactor, and thus disconnects the power from the load. Once the heater and bi-metallic disc cool sufficiently the disc will snap back to its original shape. The contacts are now free to close, except for action of a push-rod. The relay is designed to operate these contacts in any one of three positions, "Auto", "Hand", and "No Stop". A marked slide controls the action of the push-rod.

When the slide is in the "Hand" position at the time the bi-metal snaps open the contacts, the "Reset-Stop" push-rod moves to engage and retain the contacts in the open position. After the disc has cooled the push-rod may be depressed to reset the contacts to the closed position. The push-rod may also serve as a stop button by depressing it further to open the contacts.

The "No Stop" position of the slide is similar to the "Hand" position except that a projection now prevents the push-rod from being depressed as a stop button.

When the slide is in the "Auto" (Automatic) position the push-rod is prevented from holding the contacts in the open position, hence when the disc cools off the contacts will automatically close and re-energize the circuits. The push-rod again may serve as a stop button.

INSTALLATION

The heater is supplied separately, and is to be mounted as indicated in Fig. 1.

Set the slider at "Auto", "Hand", or "No Stop", as desired. DO NOT use the "No Stop" setting if the push-rod is to be used as part of a built-in or local stop button.

All connections must be clean and tight.

For relay without main terminals order S# 1776902.

HEATERS

Each heater is identified by a code marking stamped on one terminal near the mounting hole. The Heater Application Table indicates the range of full load motor current to which a given heater may be applied on a Size 3 or Size 4 Life-Line starter. This range is so selected that the current to produce ultimate tripping of the relay will be approximately 115% to 125% of the rated motor current.

These tables are based on motors having 40°C continuous ratings. For 50°C or 55°C motors, select heaters approximately one size smaller, but always with a rating higher than the full load motor amperes. When the room temperature surrounding the motor exceeds that at the starter, assume a decreased motor current of 1% for each degree C difference in temperature and select heaters accordingly. When the room temperature at the starter exceeds that at the motor, assume an increased motor current of 1% for each degree C difference in temperature and select heaters accordingly.

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DESCRIPTION • INSTALLATION • MAINTENANCE

INSTRUCTIONS

TYPE M MAGNETIC CONTACTORS

Frames 310, 410, 510, 610 and 710

Single Pole **Direct Current** **Magnet Closed**

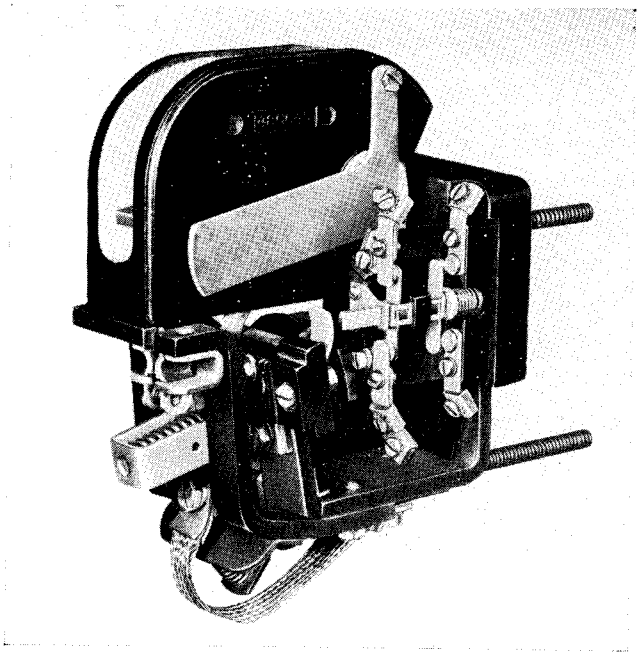

FIG. 1. Type M-410 Rear Connected Contactor With Type L-61 Electrical Interlock

TYPE M CONTACTORS are heavy duty magnetic contactors designed primarily for steel mill and general purpose applications. The contactors have the ratings listed in Table No. 1.

Type M contactors are insulated for 600 volts maximum. The operating coils are rated for continuous duty and will operate the contactors at 80% to 110% of their rated voltage. Marine coils with maximum temperature rise of 55°C are available for frames 310, 410 and 510.

DESCRIPTION

The contactors are of unit construction with all parts assembled on a common frame. The armature hinges on a knife edge bearing which has an extremely long life and requires little maintenance.

Kickout springs hold the contacts open even when the contactor is tilted at an angle of 30 degrees with the vertical.

The arc shield, which is supported by the blowout pole pieces, is capable of being swung upward for inspection of the contacts. It may be removed altogether by simply withdrawing the bolt at the top rear of the arc box.

An arc horn in the arc shield relieves the moving contact of excessive burning. The arc which is drawn between the contacts when the contactor opens moves outward under the influence of the magnetic blowout field and transfers from the moving contact to the arc horn.

The latter is maintained at the potential of the moving contact by connection to the stop bracket through a blade which projects from the bottom of of the arc shield. Electrical contact to the blade is maintained, when the arc shield occupies its lowered, operating position, by a pair of silver alloy faced jaws.

The moving contact support is hinged on the armature in a nitrided steel knife edge bearing so that the moving contact slides as the armature closes. The amount of slide is sufficient to keep the contacts free of oxides and scale, a provision essential to maintaining good contact with copper surfaces.

A pad of non-magnetic steel is brazed to the stop bracket to serve as a wearing pad and as an air gap to prevent magnetic "lockout" of the armature.

Table No. 1. RATINGS

CONTACTOR TYPE	M-310	M-410	M-510	M-610	M-710
Voltage Rating	600	600	600	600	600
8 Hour Ampere Rating	100	150	300	600	900
1 Hour Ampere Rating	133	200	400	800	1200

The contactors are held to the panel by three mounting studs, the upper and lower of which make provision for electrical connections.

Connections are normally made behind the panel. Should it be desired to make the connections in front of the panel, the contactor can be supplied with a pair of connecting straps and studs, the latter to be positioned on the insulating panel below the contactor.

The contactors are suitable for mounting only on insulating panels, up to 3 inches thick. As the frame is of the same potential as the moving contact, special insulating precautions must be taken if a contactor is to be mounted on a conducting surface.

Electrical Interlocks. The contactors will accomodate a total of two Type L-61 electrical interlocks either of which may be selected to have the following:

a. One normally open contact.

b. One normally closed contact.

c. One normally open and one normally closed (independent) contact.

d. Two normally open independent contacts.

e. Two normally closed independent contacts.

The Type L-61 electrical interlock, shown in Fig. 1, comprises a contact assembly which is mounted as a unit on the molded base of the contactor, and an operating finger which is carried by an insulating block secured to the contactor armature.

For more complete information refer to instruction leaflet I.L. 15-829-1.

Mechanical Interlock. A Type M-27 mechanical interlock may be employed to safe-guard a pair of contactors against the closing of one if the other is already closed. Another version can be used to interlock three contactors against the closing of either or both of two contactors if one is already closed.

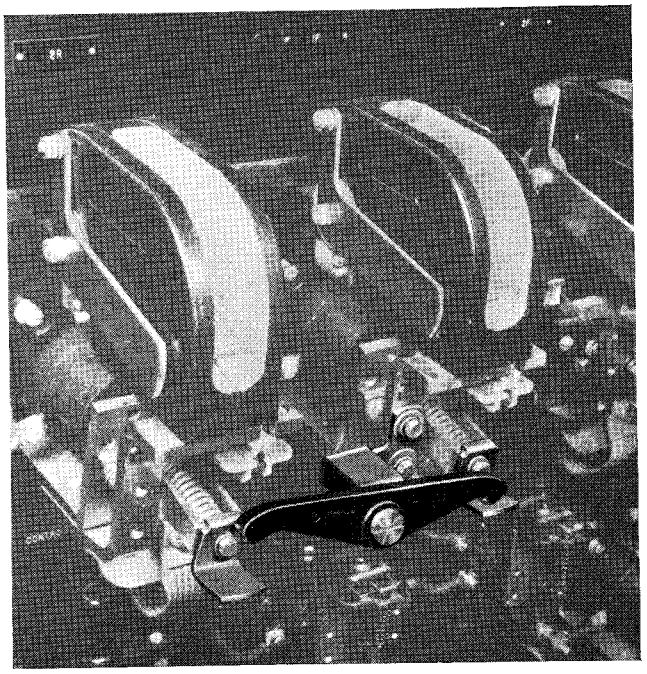

FIG. 2. Type M-27 Mechanical Interlock Assembled on Two Type M-410 Contactors

Interlocks must be selected in accordance with the frame size of the contactor as tabulated in Table No. 2.

The mechanical interlock is mounted on the stop bracket of the contactor and requires no additional panel drilling. The interlock will operate satisfactorily at either of two contactor spacings as indicated in the table. Adjustment is obtained by moving the interlock mounting bracket. With one contactor energized and the other de-energized, all vertical play of the operating arm should be removed. Check the interlocking action to make sure that no binding occurs.

INSTALLATION AND MAINTENANCE

Arc Shield. The arc shield and its arc horn are essential to the performance of the contactor

Table No. 2. TYPE M-27 MECHANICAL INTERLOCK DATA

FRAME	FOR TWO CONTACTORS		FOR THREE CONTACTORS	
	STYLE NUMBER EITHER SPACING	C TO C CONTACTOR SPACING	STYLE NUMBER EITHER SPACING	C TO C CONTACTOR SPACING
M-310-410	1486 669	5¼ or 6 in.	1486 670	5¼ or 6 in.
M-510	1486 671	6 or 7 in.	1486 672	6 or 7 in.
M-610-710	1486 673	7½ or 9 in.	1486 674	7½ or 9 in.

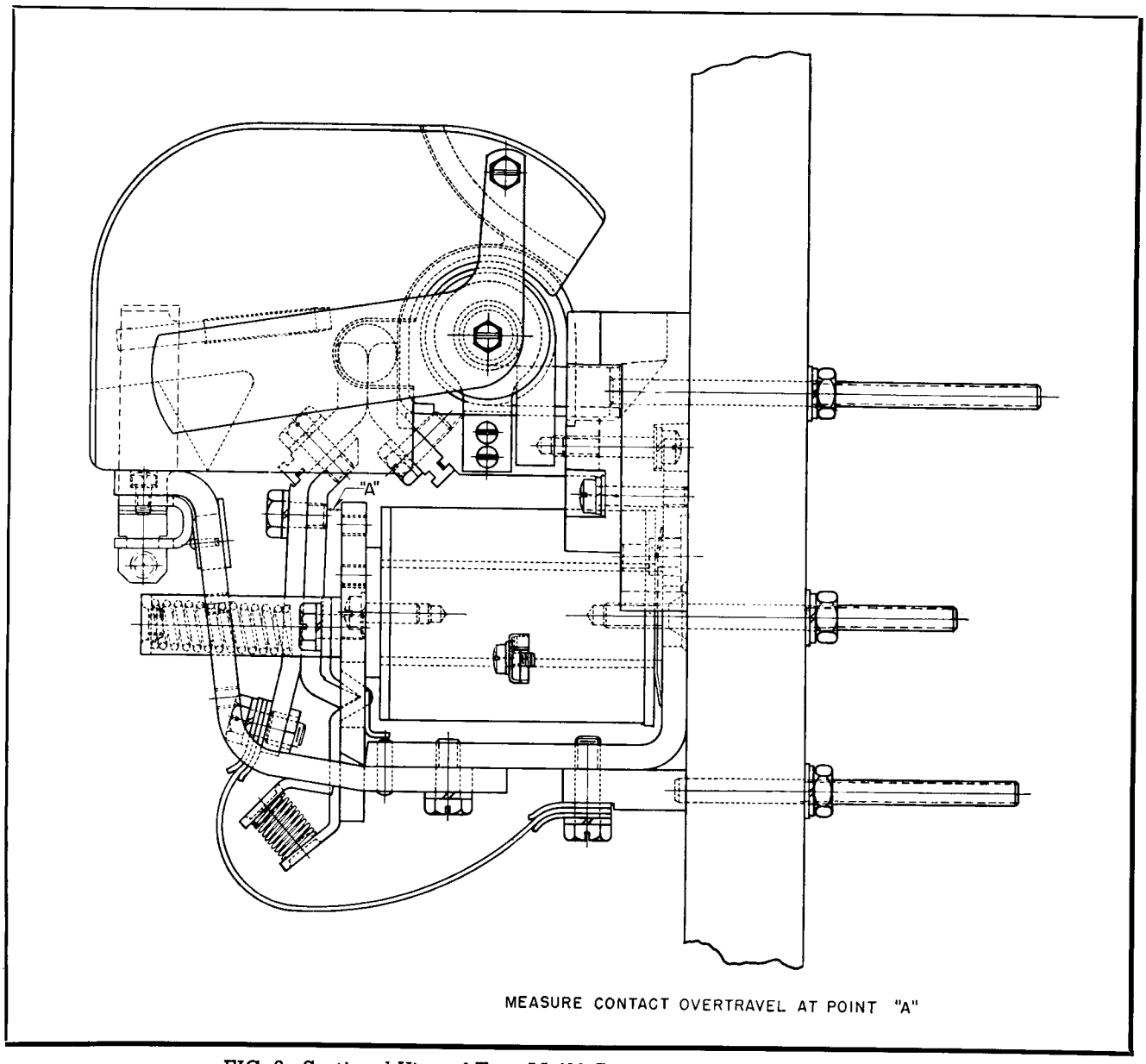

FIG. 3. Sectional View of Type M-410 Contactor with Armature Closed

and these parts should always be in place. The arc shield should always be pushed down so that it rests on the stop bracket. This insures proper engaging of the knife blade with the connector switch jaws.

The arc shield may be removed by first removing the arc shield retaining bolt, which is located at the top of the L shaped side plates, then raising the arc shield until the knife blade clears the stop bracket. Pull the arc shield forward, clear of the contactor.

In replacing the arc shield care must be taken that the pole piece plugs are aligned with the recesses in the arc shield walls to permit proper reassembly. The arc box retaining bolt is made of non-magnetic material. A steel bolt used in this location will short circuit the magnetic blow-out field and impair interruption of the arc.

Armature and Bearing. The knife-edge bearing requires no maintenance. A shelf is provided on the armature plate to prevent falling dust and dirt collecting between the armature and frame. Oil should not be used at any point on this contactor.

On Types M-310, 410 and 510 the magnet pole face is secured to the core by means of a non-magnetic bolt having a head that projects forward

Table No. 3. OPERATING COILS

COIL VOLTS	M-310/M-410	M-510	M-610/M-710
	COIL STYLE NO.	COIL STYLE NO.	COIL STYLE NO.
115	1419 539	1419 547	1419 561
230	1419 540	1419 548	1419 562
550	1419 541	1419 549	1419 563

into a hole in the armature. When properly assembled this bolt head is centered in the hole.

Operating Coil. When a new operating coil is installed the identification label should be examined to make certain that the voltage rating and coil style number are correct for the application. The more commonly used coils are listed in Table No. 3. Marine coils are available for the frames M-310, M-410 and M-510 contactors.

The M-310, M-410 and M-510 contactors have class A coils. The M-610 and M-710 contactors have class H coils which operate at a temperature rise of approximately 150°C. The surface temperature of the latter coils will be higher than that of the class A coils.

Steps to follow in removing operating coil are:

1. Raise arc shield.

2. Remove the two bolts securing the stop bracket to the underside of the contactor frame and allow the assembly to hang by the shunt.

3. Remove the bolt holding the pole face to the core of the magnet.

4. Disconnect the coil leads and slide the coil forward until it is clear of the contactor.

Contacts. Oil or other lubricants should not be used on the copper contacts. Filing and dressing the contacts is unnecessary and harmful.

When the contacts are new and the armature is closed either electrically or mechanically the gap between the contact support bracket and the top of the armature plate, Dimension "A", Fig. 3 should be as shown in Table No. 4. Change contacts when this dimension is reduced to 1/32 inch.

The moving and stationary contacts may be removed by removing the bolts holding the contacts to their respective supports. The bolt heads are slotted to permit use of a screwdriver.

Table No. 4 shows the proper contact gap, contact overtravel, and contact forces with new contacts.

To measure the final contact force, close the contactor and by means of a spring scale hooked to a loop of wire measure the force necessary to separate the contacts. Consideration must be given the thickness of the wire used in comparing values read with the tabulated values in this leaflet.

If after new contacts are installed, the forces are not correct, it may be necessary to replace the contact spring, or adjust the number of spring shims in the spring seat.

Failure of the magnet to close the contactor may result from an open circuited operating coil, from a circuit condition in which the voltage is excessively low, from excessive contact spring forces, or from friction between parts. Failure of the contactor to open may be caused by friction or by defective kickout springs.

Table No. 4. CONTACT FORCE, GAP AND OVERTRAVEL DATA

CONTACTOR TYPE	CONTACT FORCE IN POUNDS		*CONTACT OVERTRAVEL	CONTACT GAP
	INITIAL	FINAL		
M-310 M-410	2¾ to 3¼	4½ to 6	3/16	5/8" ± 1/16
M-510	6 to 7	13½ to 16½	13/64	25/32 ± 1/16"
M-610 M-710	13½ to 15½	36 to 44	11/32	7/8 ± 1/16

* Dimension "A" of Fig. 3.

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BUFFALO PLANT • MOTOR AND CONTROL DIVISION • BUFFALO 5, N.Y.
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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE AV RELAYS

Adjustable Voltage—Direct Current

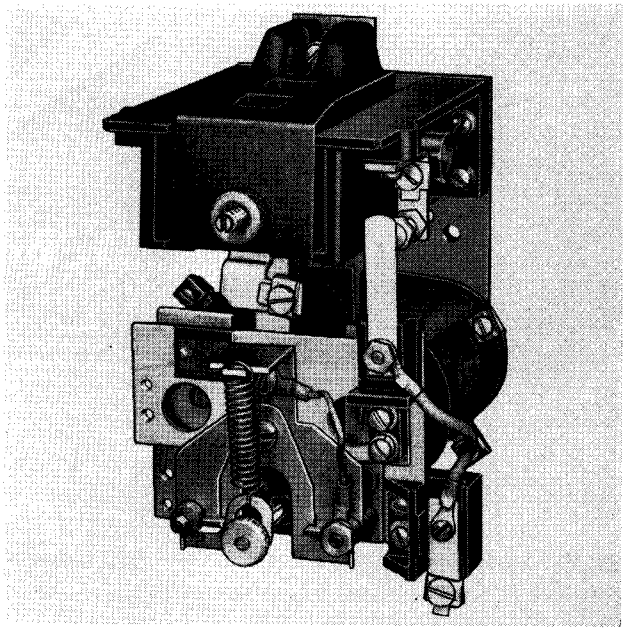

FIG. 1. Type AV Relay with One Auxiliary Interlock

TYPE AV RELAYS are for general use where it is desired to open or close electrical circuits after a relatively small change in current or voltage in the relay circuit. The relays will respond to current or voltage changes as low as ten percent depending upon the setting of the individual relay.

The ratings of the main and auxiliary contacts are shown in Table No. 1. The main contact is of the single pole transfer type. The auxiliary contacts may be normally open or normally closed, as desired.

The magnet is designed for operating on direct current only. The operating coils are rated for continuous duty at the currents or voltages indicated in Table No. 3.

Mounting. The relay may be mounted on insulating panels only, using the two mounting holes in the base plate. The relay must be mounted in the vertical position with the arc box at the top.

OPERATION

The armature is supported by a bearing plate resting on two annular grooved pins which provide a frictionless knife-edge bearing and armature air gap adjustment. The operating spring is arranged so that the spring moment rather than the spring tension is varied by turning the adjusting nut.

The arc box is adjustable so that it may be moved to conform to the armature adjustment. The front contact may be adjusted to provide a contact gap of 1/16 to 5/16 of an inch.

Two ceramic permanent magnets provide the blowout for the main contacts. Since the contacts are of the transfer type, the ratings shown in Table No. 1 can only be applied to the contact on which the arc is blown upward.

The auxiliary contacts may be converted from normally open to normally closed by dismounting and reassembling the stationary contact (see Fig. 2); adjust the stationary contact accordingly. The moving contact must be reversed so that the silver contact buttons mate.

Table No. 1. CONTACT RATINGS

APPLICATION	INTERRUPTING RATING MAIN CONTACTS (Direct Current)		NOTE:
CONTACT — LINE E	230 V.	600 V.	Main contact wiring must be connected so that arc is blown upward.
	5 Amps.	2 Amps.	
CONTACT — R_D — R — LINE E	230 V.	600 V.	
	10 Amps.	4 Amps.	
	FRONT CONTACT		BACK CONTACT
LINE E	230 V.	600 V.	230 V. / 600 V.
	5 Amps.	2 Amps.	1 Amp. / .4 Amp.

INTERRUPTING RATING—AUXILIARY CONTACTS (Direct Current)	
230 Volts—.5 Amp.	600 Volts—.15 Amp.

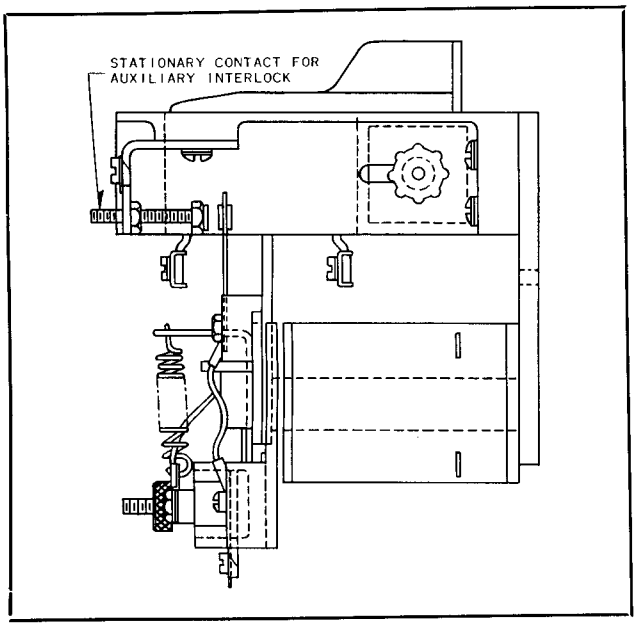

FIG. 2. Type AV Relay with Stationary Contact Assembled for Normally-Closed Position

ADJUSTMENT

To adjust the relay to pick-up and drop-out at given current or voltage values, proceed as follows:

1. Select the coil or coil combinations which will produce the pick-up and drop-out ampere turn values for the application (see Table No. 3).

2. Consult Table No. 2 to determine the armature gap and contact travel values.

3. Loosen the screw securing the armature bearing retaining plate and place armature bearing plate in the annular grooves in the bearing pins at the selected armature gap. Tighten the retaining plate screw.

4. Holding the armature in the closed position, adjust the arc box so that the armature plate is parallel to the pole faces. Tighten the arc box retaining nut with the fingers; do not use tools to tighten this nut.

5. Loosen the front contact retaining nut and adjust the front contact to obtain the contact travel desired. Use of a gauge, inserted from the under side of the arc box between the contacts, expedites this adjustment. Tighten the contact retaining nut.

6. Electrically operate the relay and adjust the operating spring adjustment screw accordingly.

7. Check to see that the moving contact is centrally located in and does not rub against the sides of the arc box.

MAINTENANCE

1. Failure of the armature to close may be caused by an open coil circuit, a power failure, mechanical interference or improper adjustment of the relay for the operating ampere turns applied to the coils. The operating spring specified must be used with this relay.

2. The one-piece molded arc box may be readily removed for inspection or servicing by removing the two screws at the top center of the arc box. The arc box may be lifted vertically from between the two molded supports. It may be advisable to loosen the arc box adjusting nut before proceeding as above.

3. The main contact may be replaced by first unhooking the operating spring from the bearing bracket. Remove the two binding head screws in the center of the armature plate. This frees the

Table No. 2. OPERATING CHARACTERISTICS

ARMATURE GAP	CONTACT GAP (Inches)										ADJUSTING SCREW TURNS*
	1/16		1/8		3/16		1/4		5/16		
	Pick-up Ampere Turns	Drop-out Ampere Turns	Pick-up Ampere Turns	Drop-out Ampere Turns	Pick-up Ampere Turns	Drop-out Ampere Turns	Pick-up Ampere Turns	Drop-out Ampere Turns	Pick-up Ampere Turns	Drop-out Ampere Turns	
1/16	150-380	100-275	150-450	100-275	150-500	100-275	160-550	100-275	170-600	100-275	0-35
3/16	225-725	200-640	250-800	200-640	260-825	200-640	270-880	200-640	280-920	200-640	0-30
5/16	340-1000	300-900	350-1070	300-900	360-1100	300-900	370-1150	300-900	370-1220	300-900	0-26
7/16	550-1380	520-1250	560-1450	520-1250	570-1550	520-1250	580-1650	520-1250	600-1750	520-1250	0-20
9/16	660-1800	600-1600	670-1900	600-1600	680-2000	600-1600	690-2200	600-1600	710-2400	600-1600	0-17

* Adjusting nut is flush with end of screw at 0-turns (zero) setting.

main contact. Reassemble the new main contact making sure the upper end is centrally located in the arc box before final tightening of the screws.

OPERATING COILS

A wide variety of shunt and series coils are available for the relay. Selection of coils is entirely dependent upon the application of the relay. (See Table No. 3).

Coil Replacement. In order to replace the coils, remove the two pole face mounting screws by inserting a screwdriver through the two holes provided in the armature plate. This permits removal of the pole face, bearings, armature, and moving contact assembly as a unit, without affecting any of the adjustments.

Remove and replace the coils; then reassemble the armature unit, making sure that the pole face screws are securely tightened. Check to see that the moving contact is centrally located in and does not rub against the sides of the arc box.

Table No. 3. OPERATING COILS

WIRE WOUND COILS		
Style Number	Coil Turns	Continuous Rating
1419 532	46,500	310 Volts
1419 531	37,000	230 Volts
1419 530	24,100	150 Volts
1745 841	19,700	125 Volts
1745 842	9,760	62.5 Volts
1754 306	7,850	50 Volts
1754 307	6,260	40 Volts
1754 300	2,500	.72 Amps.
1754 301	2,000	.90 Amps.
1745 843	1,600	1.14 Amps.
1754 302	1,250	1.44 Amps.
1754 303	1,150	1.56 Amps.
1745 844	860	2.10 Amps.
1745 823	720	2.50 Amps.
1745 824	650	2.70 Amps.
1745 845	540	3.30 Amps.
1745 825	480	3.80 Amps.
1745 846	390	4.50 Amps.
1745 826	308	5.70 Amps.
1745 847	280	6.30 Amps.
1745 827	210	8.70 Amps.
1745 848	176	10.20 Amps.
1745 828	140	12.90 Amps.
1745 849	112	16.20 Amps.
1745 829	100	18.00 Amps.
1745 830	88	21.00 Amps.
1745 850	66	27.00 Amps.

STRAP WOUND COILS			
Style Number	Coil Turns	Reference to Note	Continuous Rating
1745 831	56	③	26 Amps.
1745 832	36	③	41 Amps.
1745 833	30	③	49 Amps.
1745 834	26	③	58 Amps.
1745 835	20	③	78 Amps.
1600 861	18	③	90 Amps.
1600 860	14	③	107 Amps.
1600 859	12	③	125 Amps.
1600 858	10	③	150 Amps.
1600 857	8	③	188 Amps.
1600 856	6	③	250 Amps.
1600 855	5	③	300 Amps.
1600 854	4	③	375 Amps.
1600 853	3	②	500 Amps.
1600 852	2	②	750 Amps.
1600 850	1	③	375 Amps.
1600 851	1	②	750 Amps.
1745 035	1	①	1,000 Amps.

NOTE: Two studs are required for the above strap wound coils.

①S# 1170 460 Reg. 2

②S# 1600 870 Reg. 1
S# 1600 871 Reg. 1

③S# 1600 867 Reg. 1
S# 1600 868 Reg. 1

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WESTINGHOUSE

GENERAL INFORMATION

COMMUNICATIONS

Should communications be desirable or necessary regarding the installation covered by this instruction book, or an individual device included in the installation, replies will be greatly facilitated by citing the General Order (G.O.) Number for the complete equipment, and the nameplate readings, in detail, of the apparatus involved.

Should particular information be desired, please be very careful to state clearly and fully the question for consideration, and the associated conditions.

Communications should be addressed to the nearest Westinghouse Electric Corporation Sales Office. Local Sales Engineering or service representatives are usually available for quick consultation.

DAMAGE IN SHIPMENT

Before accepting the shipment from the transportation company, examine the crate to determine whether damage has occurred in transit. If the crate is damaged, the machine may be damaged. If so, immediately notify the transportation company and also notify the nearest Westinghouse District Sales Office, giving as much information as possible concerning the nature of the damage. Keep written records of all actions taken in connection with such incidents.

STORAGE

If the apparatus is not to be installed immediately, store in a heated, ventilated building in a location free of excessive dust or vapors. The AV drive crates may be skidded when they are to be moved. Holes are provided in the bed plate for lifting the drive. Use spreader bars at the top of the cabinet between sling ropes.

UNPACKING

In cold weather, the machine should not be uncovered immediately after removal to a warm place. This would cause the windings to become wet with moisture condensed from the air.

The bedplate of the drive is bolted to the skid, and crating encloses the entire cabinet. When removing the crate, great care should be used to avoid damage to any part of the unit. After removal of the crate, the front doors should be opened and all front and rear panels removed. This will give access to 4 bolts which fasten the bedplate to the skid. When these bolts have been removed, the lifting hooks can be used to lift control from the skid.

It is strongly urged and necessary that all relays, contactors, and Linestarters be investigated to see that the armatures are free to move.

GENERAL INSPECTION

1. Examine apparatus to make sure it is not damaged in any way.

2. Check the nameplates on the wall of the cabinet below the pushbutton station and on the ac motor to see that the ratings agree with the voltages and frequency of the power supply.

3. Make certain that the MG set rotor and motor armature turn easily, particularly if the machine is not installed until some months after having been received.

4. All power connections should be installed in accordance with standard practice as outlined in the applicable electrical codes.

LOCATION

The AV drive control unit need not be placed near the drive motor, since they will be connected together only by wiring. The control unit must be mounted on a firm, level foundation that is free of excessive vibration.

The control cabinet should be mounted in a well ventilated location where the ambient temperature will not rise above 40°C. The installation must be made in a clean, dry place not exposed to dripping moisture, oil vapor or steam, and not exposed dirt from coal, ashes, or any other dusty material. The filters in the cabinet will eliminate a large portion of the dust, however, the dusty locations will cause filters to clog up more rapidly. The control should never be placed in a room where any hazardous process is used, or where inflammable gases or combustible materials may float in the air. If such conditions exist, explosion proof motor should be used and the AV drive control unit should be placed in a separate room where ventilating air is controlled to prevent explosions.

If mounted near a wall, leave at least 24 inches spacing between the back of the cabinet and the wall. This space is necessary for removing back covers for servicing the control.

The holes in the bed plate that were used to bolt it to the skid can be used as mounting holes for securing the cabinet in its permanent position. This equipment is designed for indoor installation.

The usual precautions should be observed in the installation of the motor. See that the armature can be turned freely by hand. If the motor is geared or direct coupled, correct alignment is very important. Flat or V-belt drives should be accurately aligned and proper belt tension maintained. The motor should have a suitable degree of enclosure against dust and moisture for the condition of the application.

WIRING

The motor is to be wired to the control unit as indicated by the external connection diagram. Correct size leads should be used for the rated armature current of the motor. Check motor nameplate data for rated current.

The remaining connections carry only control currents and should be wired with a flexible type of wire of about #14 size.

Refer to instruction tag (1F10977) to make sure that the correct voltages and frequency are used with the AV drive.

CAUTION

Adjustable resistors have been preset at the factory and will probably not require adjustment. If any adjustments are needed, they can be made during the initial run in accordance with specifications on the elementary diagram.

Many of the circuits on this unit are high voltage, high power. Always open the primary circuit before changing any connections.

The power transformer, a-c motor, and Linestarter coil must be connected to the same a-c supply voltage. On drives, which use 110 volt control for the Linestarter, the control transformer must be connected to the same a-c supply voltage as the power transformer and a-c motor.

Generator rotation should be per rotation nameplate.

Do not remove any tubes or tubes connections when either the drive motor or MG set is running.

SAFETY FOR PERSONNEL

To insure maximum safety for personnel, it is suggested that the recommendations of the National Electrical Code, National Safety Code, and all applicable local safety regulations be thoroughly fulfilled in the installation and operation of this equipment. The following precautions should be carefully observed.

1. Make certain the equipment is properly connected before any attempt is made to operate the controls.

2. Do not operate the equipment as a complete unit without first testing the operation of the individual units as thoroughly as possible.

3. Never operate contactors or relays by hand without first making certain the power is completely disconnected.

MAINTENANCE

General

A regular inspection and maintenance procedure is valuable in minimizing "down" time by detecting potential troubles before they occur.

Remove dust from all parts of the control with a soft brush or an air hose. If an air hose is used, the supply must be free from dirt and water.

Use fuses of the same size as originally furnished. The fuses provide short circuit protection and minimize fire hazard. When fuses "blow" it is an indication of trouble in the control and not an indication that the fuse is too small.

Average voltage across the control bus will decrease as the selenium ages. This voltage should be kept near to the voltage given on the elementary diagram, by use of the extra transformer taps.

It is best to study the control when it is new and operating normally and this inspection may then be used as a guide in the location of trouble.

SERVICING HINTS

General Remarks

1. Check the a-c line power supply and all connections to see that they are made in accordance with the external connection diagram.

2. Check the transformer secondary voltages to determine if they are approximately as given on the elementary diagram.

Motor Fails to Start

1. Check fuses and overload relays for closed circuits.

2. Check contactors and relays to make sure their contacts are closing properly. Check for an open armature circuit.

3. Check voltage of transformer secondary.

Motor Stops Suddenly

1. Check fuses.

2. Check overload relay. Before resetting the overload relay, time must be allowed for the relay to cool. Check armature circuit for consistent overload.

3. Check for failure of main power supply.

No Field Current

1. Check for an open field rheostat.

2. Check to be sure that 230 volts d-c is available across the field circuit.

3. Check for open field circuits or open motor field windings.