WESTINGHOUSE

TYPE RR-6 REGISTER REGULATION

INSTALLATION, OPERATION AND MAINTENANCE

INSTRUCTION BOOK **5670-31**

(10-46)

WESTINGHOUSE ELECTRIC CORPORATION

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INDEX

ILLUSTRATIONS

INSTALLATION, OPERATION AND MAINTENANCE

I General Application Requirements

(1) The photo-electric control equipment described in this instruction book may be applied to control the cutting of paper or other material which by means of a pair of feed rolls, is being continually fed to a rotary cutter, so that the cut will always have a definite position in relation to any printed design on the paper. The photo-electric indication of the paper position is obtained by means of light reflected from or transmitted through a spot printed on the paper. In applying the device, it should be borne in mind that the photo-electric control equipment is not a cure-all for any erratic paper cutter machine, and in new applications therefore, the performance and the mechanical features of the paper cutter machine should be given serious consideration.

(2) The basic requirement for successful operation of the photo-electric control equipment is that the position of the paper in relation to the cutter be controlled instead of the speed of the paper. Position control is usually obtained by connecting a mechanical differential between the feed rolls and the cutter as shown in Fig. 2. By operating the stationary part of this mechanical differential, it is possible to temporarily increase or decrease the speed of the feed rolls and thus change the position of the paper in relation to the cutter. The basic paper speed with this scheme remains constant so long as the photo-electric equipment does not give any indication that the paper is out of position; as soon as this occurs, however, the mechanical differential gets an impetus to advance or retard the paper dependent upon whether the cut is ahead or behind the proper position.

(3) Many paper cutter machines are equipped with a variable speed transmission between the cutter and the feed rolls. This variable speed device will usually prove adequate for manual control of the paper position; it should, however, not be attempted to use these means alone for automatic control of register cutting, since such an attempt most likely would result in considerable hunting caused primarily by lost motion and slippage in the variable speed transmission. When a mechanical differential is being used to control the position of the paper it should be realized that the differential can only correct for a definite range of change in paper speed, determined by the mechanical characteristic of the differential. If variations in average paper speed exceed this range, due to varying slip between the feed rolls and the paper, it becomes necessary to either change the tension on the paper, or the change the speed ratio between the rotary cutter and the feed rolls in order to keep within the control range. If speed ratio control by means of a variable speed transmission is chosen it will be found convenient in most applications when infrequent speed ratio adjustment is required, to arrange the variable speed control for manual adjustment. Where frequent adjustment is required, the speed ratio control is most conveniently effected by means of the photo-electric control device, so that automatic control is obtained as a combination of position control and speed control.

In order to obtain stable operation of the control equipment, it is essential that the range of mechanical differential control be limited so that the position of the paper will not be changed more than 3/32 inch if either of relays I and II of the control cabinet is closed during a 1 second interval. If a wider range of control is attempted, in most installations, hunting will be experienced, and the result will be decreased sensitivity, and excessive wear on the equipment due to unnecessarily frequent operation.

II Description of Parts

(4) ITEM 1 RR-6 REGISTER REGULATOR

115 volts, 60 cycle, Style 966593
115 volts, 25 cycle, Style 1018745

Style number does not include Thyratron tubes. Order Thyratron tubes per paragraph 21.

The RR-6 register regulator shown in Fig. 1 with outline drawing in Fig. 5 consists of an assembly of three thyratron tubes, a transformer, four relays and various rectox rectifiers, capacitors and resistors. The equipment is assembled on a micarta panel which is mounted in a sheet metal case.

(5) ITEM 2 SCANNER

Scanner for reflected light, with lamp, without tubes, Style - 974400.
Scanner for transmitted light, with lamp without tubes, Style - 974402.
Additional parts to change reflected light scanner to transmitted light scanner, Style - 974401.

The scanner shown in Fig. 1 with outline Fig. 7 for reflected light application, and Fig. 8 for transmitted light application, consists of a type RJ-571 amplifier tube, a type SK-60 phototube, a lamp, a capacitor and two resistors. A cable with connector plug is supplied with the scanner.

Order transmitted light scanner, amplifier tube, Type RJ-571, phototube type SK-60. In order to change a reflected light scanner to a transmitted light scanner the additional parts Style 974401 should be supplied. Style 974400 plus style 974401 equals style 974402.

(6) ITEM 3 SELECTOR SWITCH Style No. 920789

The selector switch shown in Fig. 6 consists of one solid bronze ring and two split rings. The smaller segments of the split rings are electrically connected to the center solid ring. Three brushes are arranged to ride on the three rings. The arm supporting the brushes may be rotated so that the position of the brushes in relation to the rings may be changed. The relative position of the two split rings may also be varied in order to change the length of the neutral non-conducting zone between the two conducting segments of the discs.

(7) ITEM 4 PUSH BUTTON STATION
Style No. 1018733

As shown in Fig. 3 a four station push button, described in Fig. 11 should be used. When connected according to the diagram this push button will give manual control of the reversing linestarter, or the solenoids in connection 2, in both the "OFF" and "ON" position, but will give automatic control only in the "ON" position.

(8) ITEM 5 REVERSING LINESTARTER

A reversing linestarter, type DN, is used in connections 1, 3 and 4 of Fig. 3. A single phase reversing linestarter described in I.L. 2342 is used in connection 1. A 2-phase 4-wire or 3-phase reversing linestarter described in I.L. 2329 is used on connections 3 and 4. Connection 2 may be used if solenoid current does not exceed values given in paragraph 23.

(9) ITEM 6 INDICATING LAMP

As shown in Fig. 3 lamps are used to indicate the operation of the control equipment. These lamps may be either 15 watts Mazda lamps or Neon glow lamps.

III Operation

(10) In Fig. 4 is shown the schematic diagram for the type RR-6 register regulator and associated equipment. A rectox rectifier connected to transformer winding 18 - 19 supplies d-c voltage to the resistor connected across 3-28 and a similar rectifier supplies d-c. voltage to leads 21-26. The RJ-571 amplifier tube is connected in series with resistor 10-28 so that current flows from the positive terminal 28 of the d-c. supply to 10 - 4 - anode - cathode - 1 - 3 which is the negative terminal. The RJ-571 tube consists of an anode connected to 4, a cathode connected to 1, a screen grid connected to 2, a control grid, and a heater connected to 5 and 6. When the voltage of the control grid is made more negative in relation to the cathode the current between the anode and the cathode is decreased, therefore, if the voltage drop between 1 and 3 is increased by turning potentiometer 1-3 (called the RJ-571 potentiometer) counterclockwise the current through resistor 10-28 is decreased and terminal 10 is made more positive in relation to lead 21.

In the scanner connection for dark spot operation a phototube is shown connected between 2 and 3 in series with resistor 39-3. The resistance of this phototube increases if the illumination on the phototube is decreased. For a decrease in illumination, therefore, terminal 39 becomes less positive relative to terminal 3 and capacitor C_1 discharges from 39 to 3 to 38. This discharge causes a current to flow from 3 to 38 so that the grid 38 of the RJ-571 tube becomes more negative in relation to the cathode, thus decreasing the amount of current flowing through the tube and making lead 10 more positive in

relation to lead 21. It should be noted that the amount of voltage drop across 3-38 is proportional to the change in illumination on the phototube and is also proportional to the rate of change of illumination. If, therefore, the illumination on the phototube is changed quickly a larger change in voltage will obtain across resistor 10-28 than if the illumination were changed more slowly.

From this explanation it may be evident that if the illumination on the phototube is decreased when the moving spot on the paper intercepts the beam of light a voltage impulse will result and momentarily the voltage of lead 10 is made highly positive in relation to lead 21, which is connected to the cathodes of the Thyratron tubes. In the "light spot" scanner connection which should be used when the indicating spot is of lighter color than the paper, the phototube is connected between 3-39 so that an increasing negative voltage will result between 38 and 3 when the illumination on the phototube is momentarily increased.

(11) Considering particularly tube I and starting out from the positive terminal 26 of the d-c. source 26-21, the tube circuit may be traced from 26 to 36-35-33 (anode) - cathode - 21. Tube I is a Thyratron tube consisting of an anode 33, a cathode connected to 20-22 and a grid. The tube is non-conducting if the voltage between the grid and the cathode exceeds approximately 4 volts negative. If the grid voltage is less negative than 4 volts the tube becomes conducting and remains so until the d-c. anode voltage is disconnected by the operation of relay IV. Assuming now that the illumination on the phototube is varied by the passage of the spot and that lead 10 momentarily becomes more positive relative to lead 21, then tube I will discharge if the selector switch is closed across 10-11. If circuits 10-11 is open tube I will not operate.

If the selector switch is closed across 9-10, when the amplifier impulse occurs, tube II becomes conducting and remains so until relay IV operates to disconnect the d-c. supply voltage.

(12) The timing tube III is connected in series with relay IV to transformer winding 21-23. When contacts III are closed lead 30 is connected to 2 and the grid of tube III is, therefore, highly negative in relation to the cathode 21. When contacts III open capacitor C_2 starts to charge up in circuit 21 - 29 - 30 - C_2 - 500 ohms resistor - 2. After a definite time depending upon the adjustment of potentiometer 29-30 the voltage drop across 21 - 30 becomes sufficiently low to cause tube III to become conducting and operate relay IV. Operation of relay IV disconnects the d-c. voltage from tubes I and II, and the equipment is ready for another operating sequence.

(13) Referring to Figure 3 it will be seen that the control device works on the principle of synchronizing the spot on the paper with a selector switch coupled or geared to the rotary cutter. The contact segments of the selector switch are so adjusted that if the paper is in the proper position the spot on the paper intercepts the light beam when circuits 9-10 and 10-11 are open and no regulator action results. If, however, the paper is slightly out of position in relation to the cutter knife, one or the other of the selector circuits is closed and the grid of tubes I or II is connected to terminal 10 with the following breakdown of the tube. Supposing that the paper is advanced in relation to the cutter, the contacts between 9 and 10 are closed at the instant of phototube impulse and relay II and relay III are caused to operate due to the breakdown of tube II. Relay II is connected to control the reversing linestarter, which operates the mechanical differential so that the paper is retarded in relation to the cutter knife. Relay III in closing initiates the operation of timing tube III, so that after a definite time delay relay IV opens it back contacts. In doing so the d-c. supply voltage for tube II is disconnected, and relay II and the reversing linestarter opens. If the paper is still leading, the operation is repeated until the cut again is made at the proper position. If the paper is retarded in relation to the cutter, tube I operates in the same manner, and the mechanical differential operates to advance the paper.

IV Application Data

(14) A-C SUPPLY VOLTAGE

The equipment is designed for operation from an a-c. source, 105 to 125 volts. The frequency should be within ± 10 per cent of

name plate rating. As shown in Fig. 3 the transformer is equipped with a tap on the primary winding. If connections are made to terminals 15 and 16 the maximum a-c. variations must not exceed 105 to 119 volts. If connections are made to terminals 15 and 17 the a-c. supply voltage must not exceed limits 110 to 125 volts. It should be noted that the a-c. supply voltage limits given above apply only if the voltage is changing gradually. If the voltage changes quickly over a wide range the sudden variation in lamp voltage may cause incorrect operation of the equipment.

To obtain best performance, therefore, the voltage across L_1-L_2 in Fig. 3 should be as constant as possible, and it is recommended that the lighting circuit be used as power supply. It is preferable to run L_1 and L_2 directly to the load center and to have no other variable load connected to this circuit.

The maximum permissible instantaneous line voltage variation depends upon the color of the spot. If there is a considerable difference between the spot color and the paper color a large variation may be permitted. For the average application a sudden voltage variation of 4 per cent will be found to be quite satisfactory. As a general rule it may be stated that if the voltage variations are sufficiently slow so that they are not noticeable on a 100 watt Mazda lamp the voltage supply is suitable for the RR-6 regulator. Attention is called to the fact that even though a voltage dip may occur occasionally, exceeding the 4 per cent range, it would hardly affect the register of the paper to a noticeable degree. If the equipment is used to operate from a spot whose color differs slightly from the paper color, as for example a red spot on white paper, and if there are frequent sudden voltage variations exceeding 2 per cent, it is recommended that the Lamp voltage be supplied by a constant voltage regulating transformer with 7.5 volts, 4 amperes output. The volt-ampere load of the RR-6 regulator is 120.

(15) TRANSMITTED OR REFLECTED LIGHT

When the register regulator is applied to exclusively control the register of cellophane or glassine paper, it is recommended to use a transmitted light scanner, as shown in Fig. 8. If both cellophane and ordinary opaque paper is used on the same machine, a reflected light scanner, shown in Fig. 7 is recommended. In order to use the reflected light scanner in connection with cellophane, either a dark spot should be printed on the cellophane, and the cellophane sheet should be arranged to slide on top of a white tile plate so that ample reflection of the light is obtained when the printed spot does not intercept the light beam, or a white spot should be printed on the cellophane and no reflecting plate used on the reverse side of the cellophane.

(16) SIZE AND POSITION OF SPOT

It is recommended to use a spot 1/8 inch wide in the direction of travel of the paper although a spot 1/16 inch wide can be used. The spot may be made wider than 1/8 inch if desired. The length of the spot should be at least 1/4 inch plus the maximum sideways travel of the paper. If, for example, the lateral travel of the paper is 1/4 inch, the spot should be made 1/2 inch long. It is preferable to arrange the spot so that there is no other printing between the spots. Under no circumstances must there be any printing within a distance from the spot corresponding to 10 per cent of the length of cut.

(17) COLOR OF SPOT

(a) Reflected Light - In reflected light applications it is essential that care be exercised in selecting the color of the indicating spot. Since the color sensitivity of the phototube is not equivalent to the color sensitivity of the human eye it will frequently be found that no phototube response is obtained from a spot even though considerable contrast is apparent between the spot and the paper when viewed with the eye. It is recommended to use a black, dark blue or dark green spot (although other dark hue colors may be used,) if the paper color is light, and to connect the scanner for "dark spot" operation. If the color of the paper is dark blue, black, grey or green, a yellow, white or red spot may be used. In that case the scanner should be connected for "light spot" operation. The glossiness of the spot affects the phototube response to some extent, so that increased glossiness tends to increase the response from the phototube. For this reason it is desirable to print the spot

with ink to give minimum glossiness if the equipment operates from a dark spot on a light colored paper, and to arrange a glossy spot if the phototube is connected to operate from a light colored spot on a dark colored paper. In order to test whether a spot can be used proceed as outlined in paragraph 34.

(b) Transmitted Light - If transmitted light is used, the density of the spot is more important than the color. A white spot on cellophane will thus give satisfactory operation with a scanner connected for "dark" spot operation. To get reliable operation, the difference between the transmittancy of the spot and the capacity of the paper should be at least 5 per cent.

If, for example, the paper transmits 80 per cent of the light the spot should transmit 75 per cent or less.

When a watermark is used as an indicating spot it is preferable to use a watermark with higher transmittancy than the paper, i.e., a spot which is less dense than the paper. The minimum difference in transmittancy between the paper and the watermark should be 5 per cent as defined above. In order to test whether a spot can be used proceed as outlined in paragraph 34.

(18) SENSITIVITY

The sensitivity is ±1/32 inch or better. This means that the equipment will operate either of relays I and II if the paper moves 1/32 inch off the neutral register position. Whether or not the register will be kept within the ±1/32 inch range depends upon the mechanical characteristic of the machine. If the friction is varying widely, sudden variation in paper position exceeding ±1/32 inch may result, and obviously the register regulator cannot start correction before the change in position has occurred.

(19) PAPER SPEED

The maximum paper speed depends upon the relative color of the spot and the paper. If a black or dark blue spot on white paper is used, satisfactory operation at speeds up to 3000 feet per minute can be obtained. If the difference between spot color and paper color is slight, the maximum operating speed is 500 feet per minute.

(20) TEMPERATURE

The RR-6 register regulator when equipped with type KU-627 Thyratron tubes will operate with ambient air temperatures between 50° F. and 110° F. If KU-636 tubes are used the temperature limits are 0°F. to 150°F. The scanner can be used in ambient air temperatures between 0°F. and 150°F.

(21) TUBES

Depending upon temperature limits as given in paragraph 20, use either KU-627 or KU-636 tubes. The KU-627 have longer life and should be used if temperature variations are within the specified limits 50°F. to 110°F. Amplifier tube RJ-571, Phototube SK-60, Lamp S*-1014663.

(22) DIMENSIONS OF LIGHT SPOT

Approximately 1/16" x 5/16". (Also see paragraph 16)

(23) RELAY CONTACT CAPACITY

110 Volts A-C.	220 Volts A-C.	440 Volts A-C.
20	12	7

125 Volts D-C.	250 Volts D-C.
2	0.7

Current carrying capacity - 10 amperes continuous.

V Installation

(24) MOUNTING

(a) RR-6 Register Regulator - The register regulator should be mounted with the panel in a vertical position, preferably in a location with no excessive mechanical vibrations. The registor regulator should be mounted within 10 feet of the scanner.

(b) SCANNER

(1) Reflected Light - For reflected light applications the scanner assembly shown in Fig. 7 should be used. The paper should be arranged to slide on the bottom of the housing as indicated by the line marked "Reflecting Surface". The scanner must be mounted so that the base of the lamp is in the same

horizontal line or lower than the lamp filament.

(2) Transmitted Light - For transmitted light applications the assembly shown in Fig. 8 should be used. The paper should be arranged to slide on top of the circular glass window. The scanner mounting must be arranged so that the lamp is in the same horizontal line or lower than the lamp filament.

(c) SELECTOR SWITCH

The selector switch should be geared or coupled to the cutter shaft so that a ratio of 1:1 is obtained. It is preferable to couple the selector directly to the cutter shaft by means of a flexible coupling. If direct coupling cannot be accomplished, a gear connection may be resorted to. The number of teeth of the gears should, however, be chosen so that the lost motion in the gears does not exceed 1 degree.

(d) PUSH BUTTON STATION

The push button station should be installed within easy reach of the machine operator, and preferably arranged with the "fast" push button in the direction of travel of the paper.

(e) SIGNAL LIGHTS

As shown in Fig. 3, it is recommended that the customer supplies and installs to signal lamps to indicate the operation of the equipment. Mazda lamps, 110 volts, 15 watts or Neon glow lamps may be employed for this purpose.

(25) CONNECTIONS (See Fig. 3)

(a) Grounding: Ground terminal 1 and the scanner housing to a reliable ground, preferably a water pipe.

(b) Scanner Connections - Connect scanner cable to terminals 1 to 6, using color code given in Fig. 3. Connect the grounded lamp terminal to 7, the ungrounded lamp terminal to 8. Run cable and lamp leads in grounded conduit. Use cable with cross section 10,000 circular mills or more for lamp connections.

The scanner is connected for operation from a spot darker than the paper. If operation from a light spot is needed, reconnect leads 2, 3, 39 and resistor 3-39 as shown in Fig. 4.

(c) Selector Switch - Use cable P.D.S. 7129 to connect the selector switch to terminals 9, 10, and 11. Run cable in separate grounded conduit. The switch should be connected so that the leading segment, i.e. the segment which first engages a brush when the switch rotates, is connected to terminal 9. The lagging segment brush should be connected to 11. The solid contact ring to 10.

(d) Limit Switch - Connect the limit switch as shown so that the reversing switch control is disconnected when the machine is stopped.

VI Placing Into Service

(26) A-C. VOLTAGE

Measure the a-c. voltage across L_1 - L_2 and make sure that L_2 is connected to terminal 16 or 17 as outlined in note in Fig. 3.

(27) TUBES

With a-c. power off insert the tubes and the lamp in their sockets. Then apply a-c. voltage.

(28) SCANNER ADJUSTMENT

(a) Reflected Light - With the paper sliding against the bottom of the scanner housing, adjust the position of the lamp by moving it towards or away from the lens to give a clearly focused light spot, approximately 1/16" x 5/16".

(b) Transmitted Light - When transmitted light is used it is necessary to make sure that the illumination on the phototube is not too high. Too high illumination will increase the phototube current and decrease the voltage across the phototube so that the sensitivity of the equipment is materially reduced. The scanner is equipped with a fixed aperture 1/32" x 1/4". By adjusting the distance between the housing and the lamp (dimension A Fig. 8) the maximum amount of light may be varied so that the maximum phototube sensitivity for different paper transmittancies may be obtained. If, for example, cellophane is used it will be found that the maximum sensitivity is obtained if dimension A is either 1/2 inch or 1-1/2 inches. The

reason for this is that the illumination on the 1/32" x 1/4" aperture is decreased when the lamp is adjusted up or down from the focused position and the illumination at A = 1/2" is approximately equal to the illumination at A = 1-1/2". This adjustment will give satisfactory operation with cellophane or paper with transmittancy from 100 per cent to 60 per cent. For paper with lower transmittancy the lamp position should be adjusted to give higher illumination on the aperture. It is immaterial whether the dimension A = 1/2" or A = 1-1/2" be used, however A = 1/2" is recommended unless for operating reasons it is desirable to have more clearance between the scanner and the lamp.

(29) RJ-571 TEST

With the selector switch in a position so that the brushes do not engage the segments, operate the RJ-571 current switch to left and turn the RJ-571 potentiometer to position 100. The RJ-571 current should now be 0.7 MA or more. Turn the potentiometer toward zero until the RJ-571 current is 0.4 MA. By turning the potentiometer 15 divisions more toward zero from this setting, the RJ-571 current should decrease to 0.2 MA or less. If this does not obtain the RJ-571 tube should be replaced.

(30) PHOTOTUBE TEST

Adjust the RJ-571 current to 0.6 MA. Move the spot in front of the light beam. When the spot is moved quickly into the light, the RJ-571 current should momentarily decrease from 0.6 toward zero. If transmitted light is used it will be found that the deflection of the milliampere meter will vary if the lamp is moved so as to vary the illumination on the aperture. The lamp adjustment which gives maximum deflection should be used.

(31) TIMING TEST

Adjust the timing potentiometer to zero and close relay III by hand. Tube 3 should glow and operate relay IV approximately 1/10 second after closure of relay III. With the timing potentiometer in position 100, repeat this test. The time delay should now be approximately 3 seconds.

(32) OPERATION TEST

Operate the selector switch so that the leading segment is in contact with its brush. Terminals 9 and 10 should not be short circuited. Turn the RJ-571 potentiometer from position 100 toward zero until tube II breaks down and energizes relay II and III, which in turn should energize reversing switch 5-2. The RJ-571 current should be approximately 0.3 to 0.4 MA when relay II operates. Make sure that the reversing switch 5-2 is connected to retard the paper. Adjust the RJ-571 current to 0.6 MA and move the spot to intercept the light beam. This should cause relay II and III, and after the proper time delay, relay IV to operate. Observe that when relay IV operates, relays II and III are de-energized. Turn the selector switch to short circuit leads 10 and 11 and repeat the above test, observing that reversing switch 5-1 operates to advance the paper.

(33) SELECTOR SWITCH ADJUSTMENT

Loosen the nut clamping the rings and rotate the two outside rings to give a neutral zone between the rings of approximately 1/16". Within this zone, the brushes do not engage either of the segments. The mechanical displacement of the segments is 1/16" plus the width of the brushes.

Adjust the arm supporting the brushes in the middle up position. Arrange the paper, so that the spot intercepts the beam of light and turn the cutter so that the knife touches the paper. Loosen the coupling between the selector shaft and the driving shaft and turn the selector switch shaft until the brushes are in the neutral zone between the segments. Tighten the set screws on the selector shaft coupling.

(34) COLOR OF SPOT

To test whether the color of the spot gives sufficient contrast to operate reliably, adjust the RJ-571 current to 0.65 MA and turn the selector switch so that one of the outside brushes engages its segment. Slide the paper with the printed spot back and forth in front of the scanner. If this causes the relays to operate, the spot color is satisfactory.

(35) OPERATION

(a) Start up the machine under manual control and adjust the variable speed transmission so that the paper speed is correct. Run the machine for several minutes to obtain stable operation.

(b) Apply a-c. voltage to the register regulator and after one minute adjust the RJ-571 current to 0.65 MA. Adjust the timing potentiometer to position 40, then operate the "on" push button.

(c) Adjust the position of the selector brushes until the cut is made in the correct position.

(d) Adjust the timing potentiometer to give the most suitable timing adjustment which will depend upon the mechanical characteristic of the machine, but will in most applications be between 0.5 and 1.0 second. On a properly adjusted machine, the register regulator need not operate more frequently than 8 to 10 times per minute. If the equipment operates more frequently, the machine should be inspected for mechanical deficiencies, and the neutral zone on the selector switch should be widened slightly. If the register varies, and adjustment of the timing potentiometer does not improve operation, the neutral zone between the selector segments should be made narrower.

(e) See paragraph 36 (b) regarding final adjustment of RJ-571 current.

VII Routine Operation

(36) (a) Close the a-c. switch and operate the machine five minutes under manual control while the tubes are warming up.

(b) Adjust the RJ-571 current to 0.65 MA and transfer to automatic control. If the color of the spot contrasts the paper considerably, it will be found that satisfactory operation is also obtained if the RJ-571 potentiometer is moved further clockwise than required to give a current of 0.65 MA. Under these conditions it may be desirable to turn the potentiometer further clockwise until the equipment fails to operate. Observe the position of the potentiometer, then turn the potentiometer counterclockwise to give 0.4 MA RJ-571 current, and observe the new position. For final adjustment choose a potentiometer position midway between the two observed positions, but under no circumstances use a potentiometer position which gives an RJ-571 current less than 0.65 MA.

(c) Watch the indicating lamps, and adjust the variable speed transmission if only one lamp is operating.

(d) Operate the RJ-571 switch to right to short circuit milliampere meter.

(e) Make sure that the thumb screw on the scanner is securely tightened. This screw is used to ground the scanner housing to lead 1 and faulty operation will result if the screw is not tight.

VIII Testing

(37) If the equipment fails to operate properly test as follows:

(a) Tubes - Inspect the Thyratron tubes and the RJ-571 amplifier tube to see that the cathode or filament is glowing. The RJ-571 tube has an indirectly heated cathode and a glow is visible only when looking at the tube axially from the top. If a tube does not show a heated cathode replace the tube. Test the RJ-571 tube as outlined in paragraph 29. Test the phototube per paragraph 30. Test the Thyratron tubes per paragraphs 31 and 32.

(b) Relays - Make sure that the relays move freely and that the back contacts engage when the relay is de-energized. If the relays remain sealed in after the relay coil is de-energized inspect the residual pin on the relay core. If the residual pin is worn down replace the core. If necessary bend the right hand stationary relay contacts outwards so that the moving contact is deflected at least 3/32 inch when the relay armature is sealed against the core.

(c) Selector Switch - Disconnect leads 9, 10 and 11 at the selector switch and measure with a megger the resistance between each disc and ground. This resistance should be at least 10 million ohms. Measure the resistance between the center disc and each segment of the outside discs. This resistance should be at least 10 million ohms. If the resistance is too low clean the switch and blow out carbon dust with an air hose. Reconnect leads 9, 10 and 11.

(d) Grounding - Make sure that the scanner and terminal 1 are grounded to a reliable ground, preferably a water pipe.

(e) Circuit Tests - D-C VOLTAGES

Test the d-c. voltages which should be within the following limits:

	Leads	Volts Maximum	Minimum	
*	21-26	280	240	(tubes I and II de-energized)
	1-2	100	80	RJ-571 current
	2-21	62	48	potentiometer
	21-28	100	80	in position
	3-28	240	200	100.

* Readings taken with voltmeter having resistance 1000 ohms per volt.

A-C Voltages - Measure the a-c. transformer voltages, which should be within 5 per cent of the values given in the diagram Fig. 4, provided the a-c. supply voltage is correct.

(f) Trouble Shooting -

Trouble	Probable Cause
(1) Milliampere meter reads high regardless of position of RJ-571 potentiometer.	(a) RJ-571 potentiometer is short-circuited. (b) Grid lead 38 of RJ-571 tube is grounded or connected to a point with high positive polarity. (c) RJ-571 tube is defective. Replace tube. (d) Capacitor C_1 is short-circuited. (e) Resistor 3-38 is open circuited.
(2) Milliampere meter indicates current when RJ-571 tube is removed from socket.	(a) Lead 4 is grounded.
(3) Milliampere meter reads zero or below 0.5 regardless of potentiometer position.	(a) RJ-571 milliampere meter switch is closed. (b) RJ-571 tube is defective. (c) Connection between middle tap of RJ-571 potentiometer and lead 1 is open circuited. (d) Lead 2 to scanner is open circuited. (e) Resistor 10-28 is open circuited. (f) Capacitor C_1 is short circuited. (g) Milliampere meter is open circuited.
(4) RJ-571 current is changed permanently when phototube illumination is varied.	(a) Capacitor C_1 is short-circuited or leaky (i.e. low resistance.)
(5) Variations in phototube illumination does not give momentary variation in RJ-571 current.	(a) Phototube is defective. (b) Capacitor C_1 is open circuited. (c) Resistor 3-38, 3-39, or 2-39 is open circuited. (d) Lead 2 is open circuited. (e) Phototube contacts are short circuited.
(6) Tubes I or II do not operate.	(a) Tubes are defective. (b) Back contacts of relays I, II and IV do not close when relays are de-energized. (c) Coil of relays I, II or III is open circuited. (d) Selector switch circuits 9-10 or 10-11 are open.
(7) Tubes I and II operate regardless of RJ-571 current adjustment.	(a) Tubes are defective. (b) Grid resistors or resistors 2-9 and 2-11 are open circuited. (c) Leads 9 and 11 are grounded.
(8) Tube III operates without timing interval.	(a) Tube is defective. (b) Grid resistor is open circuited. (c) Back contact of relay III does not close when relay is de-energized. (d) Capacitor C_2 is open. (e) Leads 21-30 short-circuited.
(9) Tube III does not operate.	(a) Tube is defective. (b) Capacitor C_2 is short-circuited. (c) Resistor 21-29 or potentiometer 29-30 is open.

IX Weekly Maintenance

(38) (a) Blow out carbon dust from selector switch.

(b) Clean lenses on light source and wipe off phototube and RJ-571 amplifier tube.

X Spare Parts

(39) Keep in stock the following parts:

2 - KU-627 or KU-636 Thyratron tubes. (See paragraph 21).
1 - SK-60 phototube.
1 - RJ-571 amplifier tube.
1 - Lamp S# 1014663.
3 - Carbon brushes S# 832403.

XI Renewal Parts

RR-6 REGISTER REGULATOR

Name of Part	Style
Transformer for 60 cycle	966 578
Transformer for 25 cycle	971 513
Milliampere meter	818 504
Reactor	825 279
Rectox Rectifier	971 301
Tube socket	793 202
Tube clamp	968 212
Resistor, 13000 ohms	943 670
Capacitor (2, 2, 2, .1 MF)	948 995
Capacitor (4, 4 MF)	1014 338
Potentiometer 0.5 MEG	968 591
Potentiometer 400 ohms	--- ---
Potentiometer Dial Knob	869 654
Resistor 500 ohms	943 634
Resistor 25,000 ohms	1038 165
Resistor 0.1 Megohm	860 002
Resistor 0.25 Megohm	846 668
Resistor 0.5 Megohm	846 667
Switch	1014 539
Relay I, II, III	1008 535
Relay 25 cycle (IV)	1009 786
Relay 60 cycle (IV)	1009 785
Grid Clip for Tubes	829 334

SCANNER

Lamp Socket	1014 663
Lens	849 887
Cable with Connector	974 405
Glass Window	849 991
Capacitor 0.01 MF	1014 540
Resistor 5 Megohm	1018 949
Grid Clip	799 907

SELECTOR SWITCH

Carbon Brush	832 403
Spring for Carbon Brush	170 509
Brush holder	374 187

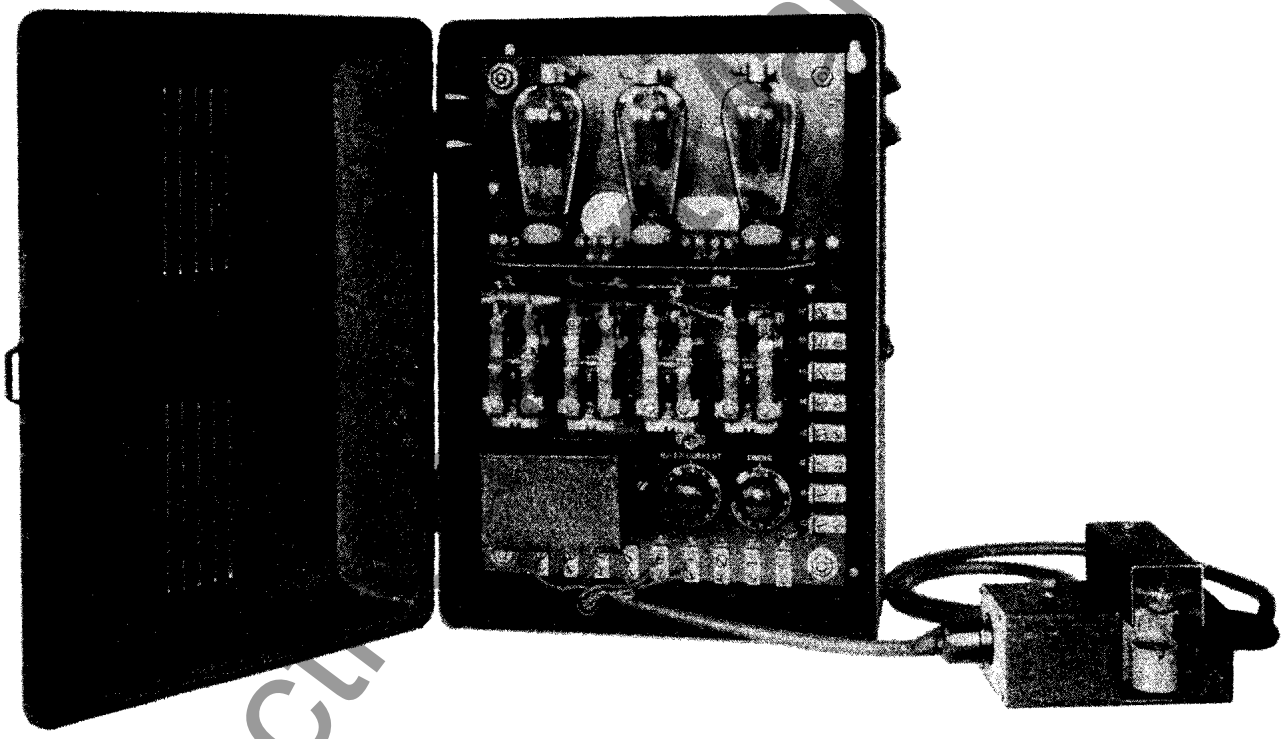


FIG. 1 Photograph showing the type RR-6 register regulator and the scanner for reflected light.

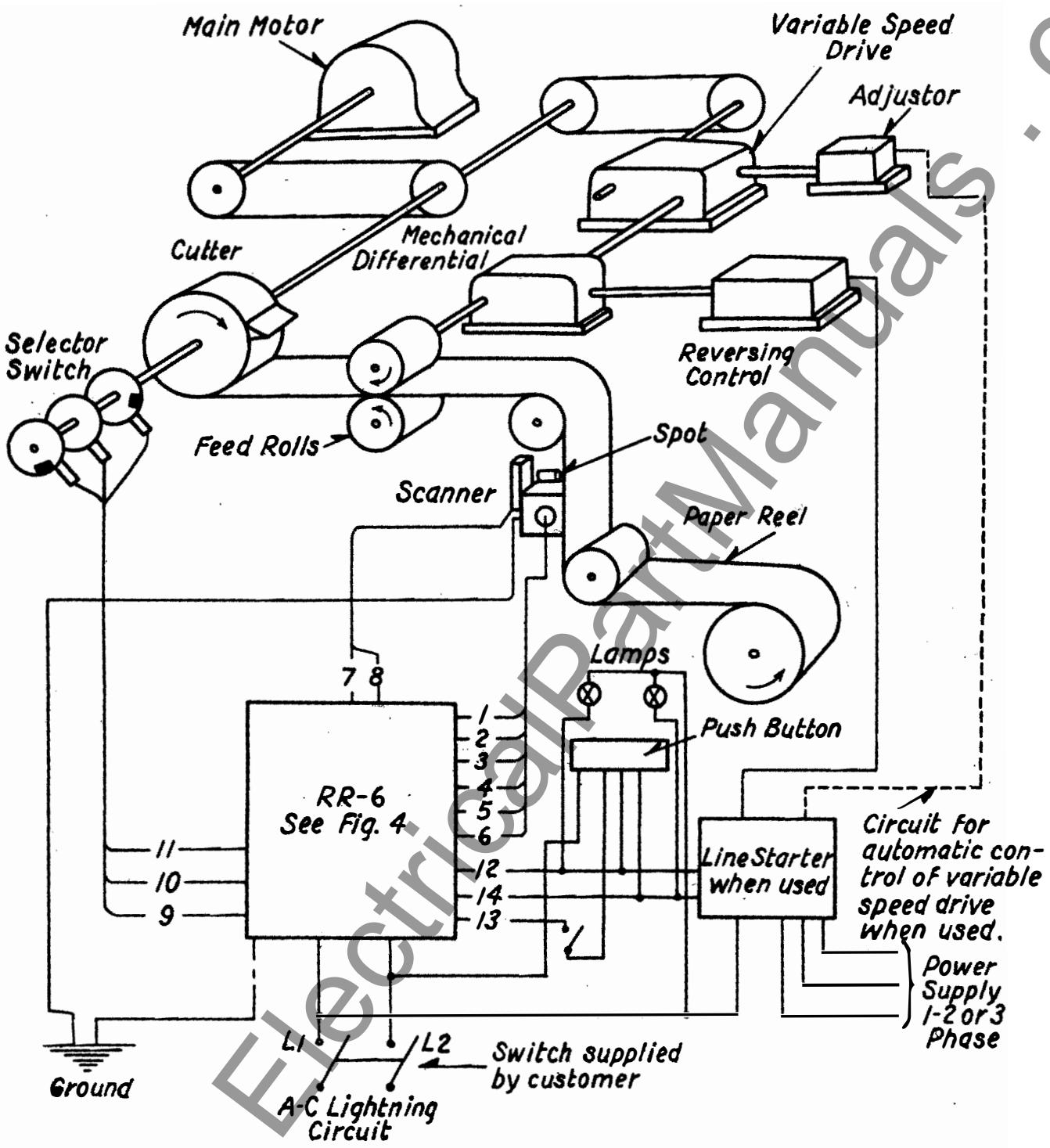


FIG. 2 Schematic arrangement of mechanical and electrical equipment.

APPLICATION

1. A-C. VOLTAGE VARIATIONS: WHEN CONNECTION IS MADE TO TERMINAL 16: 105 TO 119 VOLTS. WHEN CONNECTION IS MADE TO TERMINAL 17: 110 TO 125 VOLTS. (SEE PARAGRAPH 12-A).

2. A-C. FREQUENCY: AS GIVEN ON NAMEPLATE ± 10 PER CENT.

3. TRANSMITTED OR REFLECTED LIGHT: THE SCANNER MAY BE ARRANGED FOR OPERATION FROM EITHER REFLECTED OR TRANSMITTED LIGHT AS OUTLINED IN INSTRUCTION BOOK 5670-31, PARAGRAPH 15.

4. COLOR AND SIZE OF SPOT: SEE I.B. 5670-31, PARAGRAPH 16 AND 17.

5. SENSITIVITY: THE SENSITIVITY IS ± 1/32 INCH OR BETTER, I.E., THE EQUIPMENT WILL OPERATE EITHER OF RELAYS I AND II IF THE PAPER MOVES 1/32 INCH OFF THE NEUTRAL POSITION. SEE I.B. 5670-31, PARAGRAPH 18.

6. PAPER SPEED: MAXIMUM PAPER SPEED IS 500 TO 3000 FEET PER MINUTE, DEPENDING UPON COLOR OF SPOT. SEE I.B. 5670-31, PARAGRAPH 19.

7. TEMPERATURE: RR-6: (WITH KU-627 TUBES, MAXIMUM 110° F, MINIMUM 50° F.)
(WITH KU-636 TUBES, MAXIMUM 150° F, MINIMUM 0° F.)
SCANNER: MAXIMUM 150° F, MINIMUM 0° F.

8. RELAY CONTACT CAPACITY: (AMPERES)

110 VOLTS A-C.	220 VOLTS A-C.	440 VOLTS A-C.	125 VOLTS D-C.	250 VOLTS D-C.
20	12	7	2	0.7

CURRENT CARRYING CAPACITY - 10 AMPERES CONTINUOUS.

(D) SELECTOR SWITCH: USE CABLE P.D.S. 7123 TO CONNECT THE SELECTOR SWITCH TO TERMINALS 9, 10, AND 11. RUN CABLE IN GROUNDED CONDUIT. THE SWITCH SHOULD BE CONNECTED SO THAT THE LEADING SEGMENT, I.E. THE SEGMENT WHICH FIRST ENGAGES A BRUSH WHEN THE SWITCH ROTATES, IS CONNECTED TO TERMINAL 9. THE LAGGING SEGMENT BRUSH SHOULD BE CONNECTED TO 11. THE SOLID CONTACT RING TO 10.

(E) LIMIT SWITCH: CONNECT THE LIMIT SWITCH AS SHOWN SO THAT THE REVERSING SWITCH CONTROL IS DISCONNECTED WHEN THE MACHINE IS STOPPED.

PLACING INTO SERVICE

13. TUBES: WITH A-C. POWER OFF, INSERT THE TUBES AND THE LAMP IN THEIR SOCKETS. THEN APPLY A-C. VOLTAGE.

14. SCANNER ADJUSTMENT:

(A) REFLECTED LIGHT: WITH THE PAPER SLIDING AGAINST THE BOTTOM OF THE SCANNER HOUSING, ADJUST THE POSITION OF THE LAMP TO GIVE A CLEARLY FOCUSED LIGHT SPOT, APPROXIMATELY 1/16" X 5/16".

(B) TRANSMITTED LIGHT: FOCUS THE LAMP AS DESCRIBED IN I.B. 5670-31, PARAGRAPH 28B.

15. RJ-571 TEST: WITH THE SELECTOR SWITCH IN A POSITION SO THAT THE BRUSHES DO NOT ENGAGE THE SEGMENTS, OPERATE THE RJ-571 CURRENT SWITCH TO LEFT AND TURN THE RJ-571 POTENTIOMETER TO POSITION 100. THE RJ-571 CURRENT SHOULD NOW BE 0.7 MA OR MORE. TURN THE POTENTIOMETER TOWARD ZERO UNTIL THE RJ-571 CURRENT IS 0.4 MA. BY TURNING THE POTENTIOMETER 15 DIVISIONS MORE TOWARD ZERO FROM THIS SETTING, THE RJ-571 CURRENT SHOULD DECREASE TO 0.2 MA OR LESS. IF THIS DOES

ADJUST THE ARM SUPPORTING THE BRUSHES IN THE MIDDLE OF POSITION. ARRANGE THE PAPER, SO THAT THE SPOT INTERCEPTS THE BEAM OF LIGHT, AND TURN THE CUTTER SO THAT THE KNIFE TOUCHES THE PAPER. LOOSEN THE COUPLING BETWEEN THE SELECTOR SHAFT AND THE DRIVING SHAFT, AND TURN THE SELECTOR SWITCH SHAFT UNTIL THE BRUSHES ARE IN THE NEUTRAL ZONE BETWEEN THE SEGMENTS. TIGHTEN THE SET SCREWS ON THE SELECTOR SHAFT COUPLING.

20. COLOR OF SPOT: TO TEST WHETHER THE COLOR OF THE SPOT GIVES SUFFICIENT CONTRAST TO OPERATE RELIABLY, ADJUST THE RJ-571 CURRENT TO 0.65 MA AND TURN THE SELECTOR SWITCH SO THAT ONE OF THE OUTSIDE BRUSHES ENGAGES ITS SEGMENT. SLIDE THE PAPER WITH THE PRINTED SPOT BACK AND FORTH IN FRONT OF THE SCANNER. IF THIS CAUSES THE RELAYS TO OPERATE, THE SPOT COLOR IS SATISFACTORY.

21. OPERATION:

(A) START UP THE MACHINE UNDER MANUAL CONTROL AND ADJUST THE VARIABLE SPEED TRANSMISSION SO THAT THE PAPER SPEED IS CORRECT. RUN MACHINE FOR SEVERAL MINUTES TO OBTAIN STABLE OPERATION.

(B) APPLY A-C. VOLTAGE TO THE REGISTER REGULATOR AND AFTER ONE MINUTE ADJUST THE RJ-571 CURRENT TO 0.65 MA, AND ADJUST THE TIMING POTENTIOMETER TO POSITION 40, THEN OPERATE THE "ON" PUSH BUTTON.

(C) ADJUST THE POSITION OF THE SELECTOR BRUSHES UNTIL THE CUT IS MADE IN THE CORRECT POSITION.

(D) ADJUST THE TIMING POTENTIOMETER TO GIVE THE MOST SURE TIMING ADJUSTMENT WHICH WILL DEPEND UPON THE MECHANICAL CHARACTERISTIC OF THE MACHINE, BUT WILL IN MOST APPLICATIONS BE BETWEEN 0.5 AND 1.0 SECOND. ON A PROPERLY ADJUSTED MACHINE, THE REGISTER REGULATOR SHOULD NOT NEED OPERATE MORE FREQUENTLY THAN 8 TO 10 TIMES

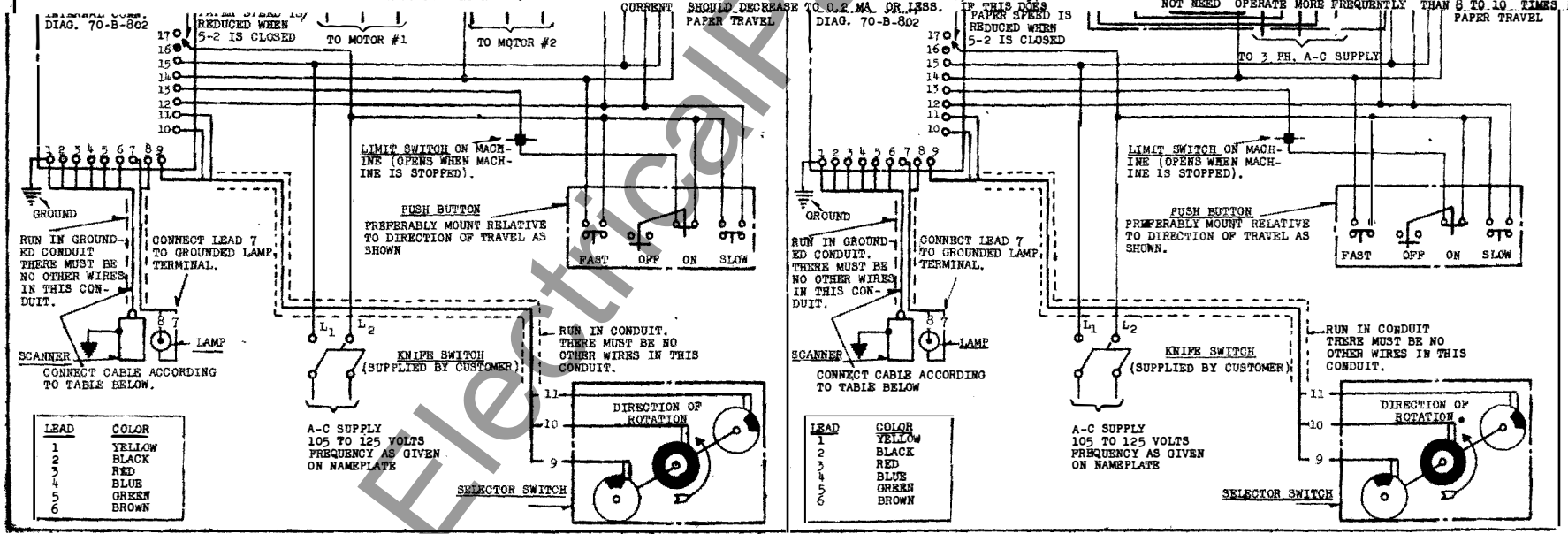


FIG. 3 Diagram of external connections.

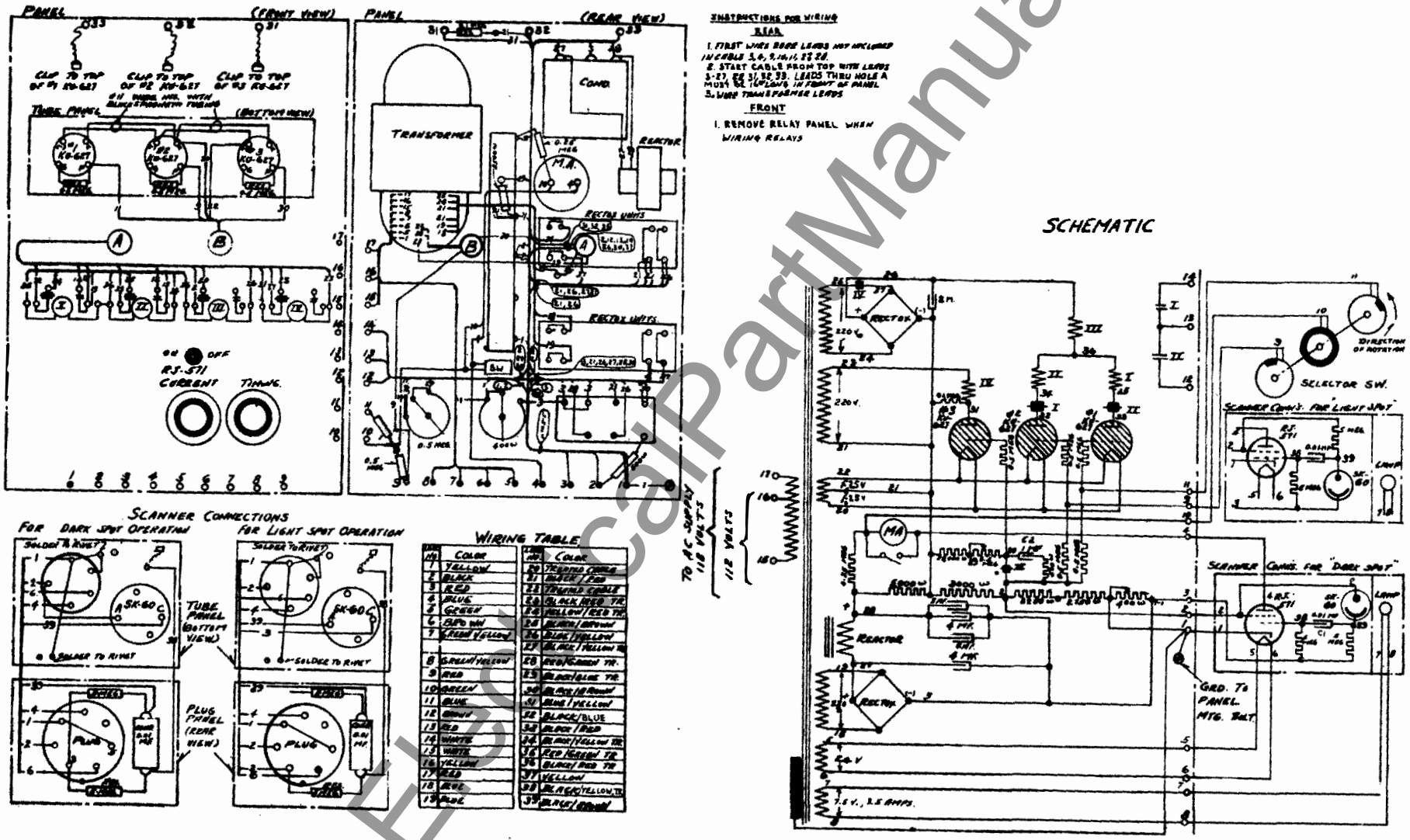


FIG. 4 Diagram of internal connections.

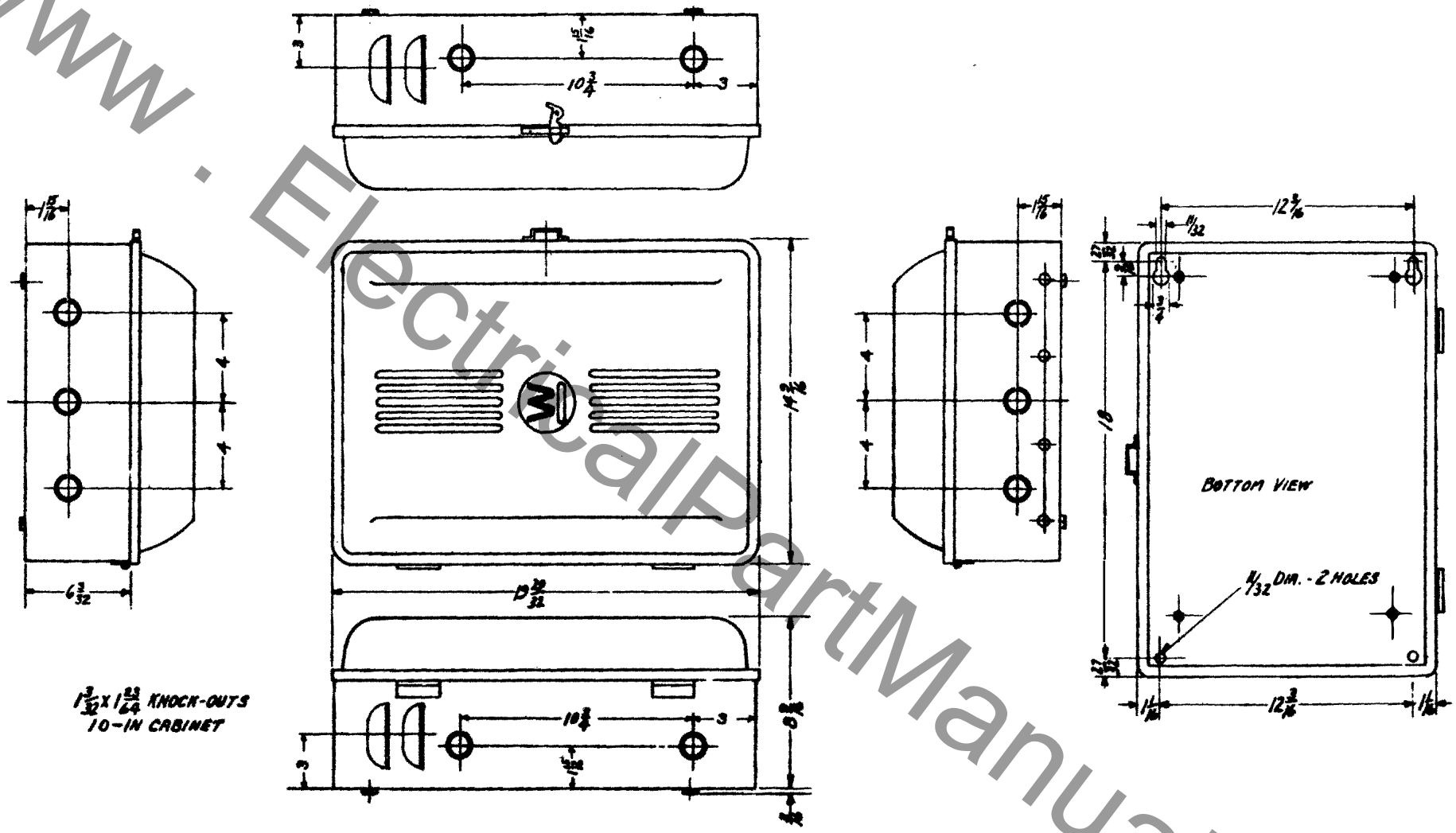


FIG. 5 Outline drawing for type RR-6 register regulator.

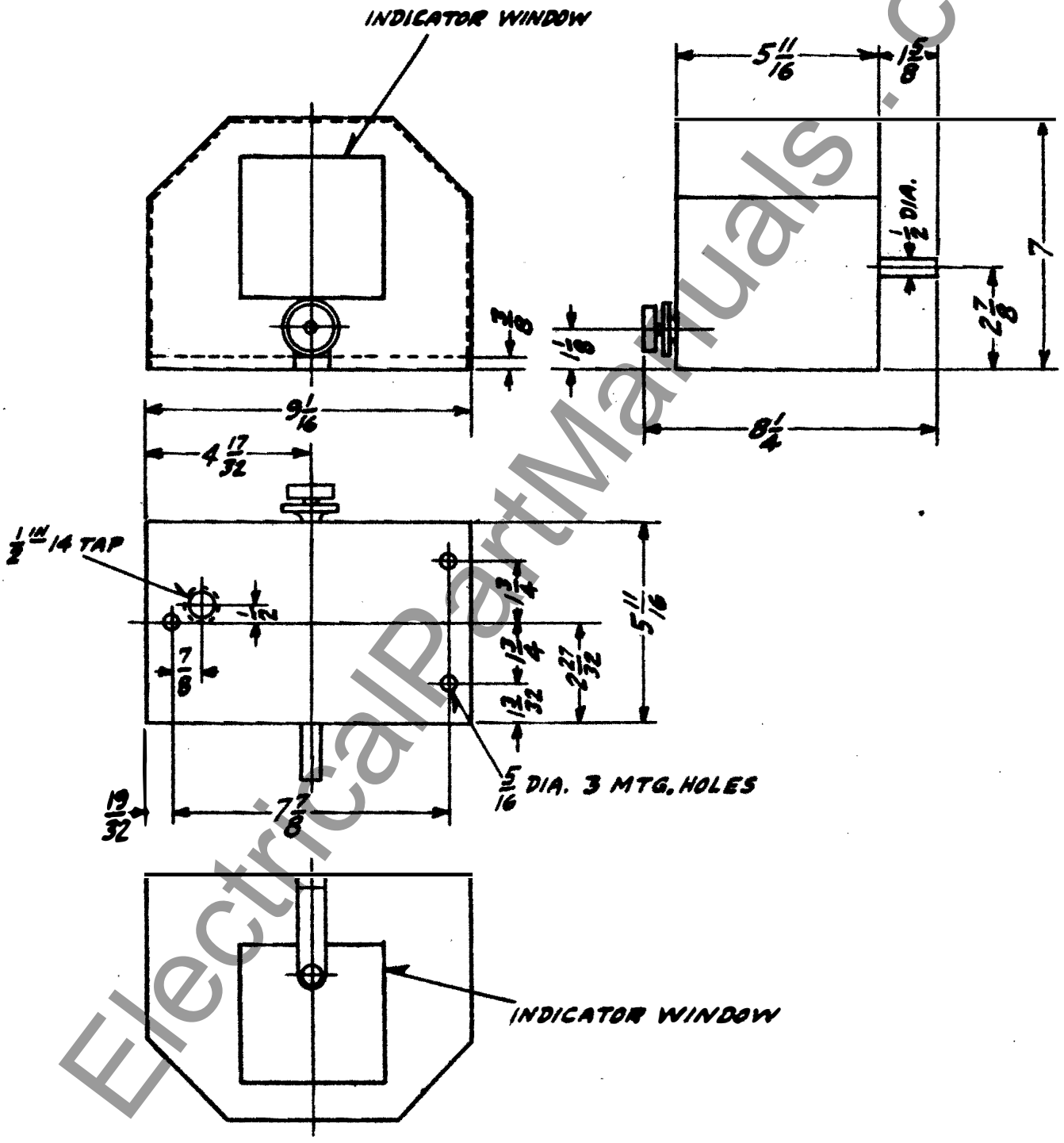


FIG. 6 Outline drawing for selector switch.

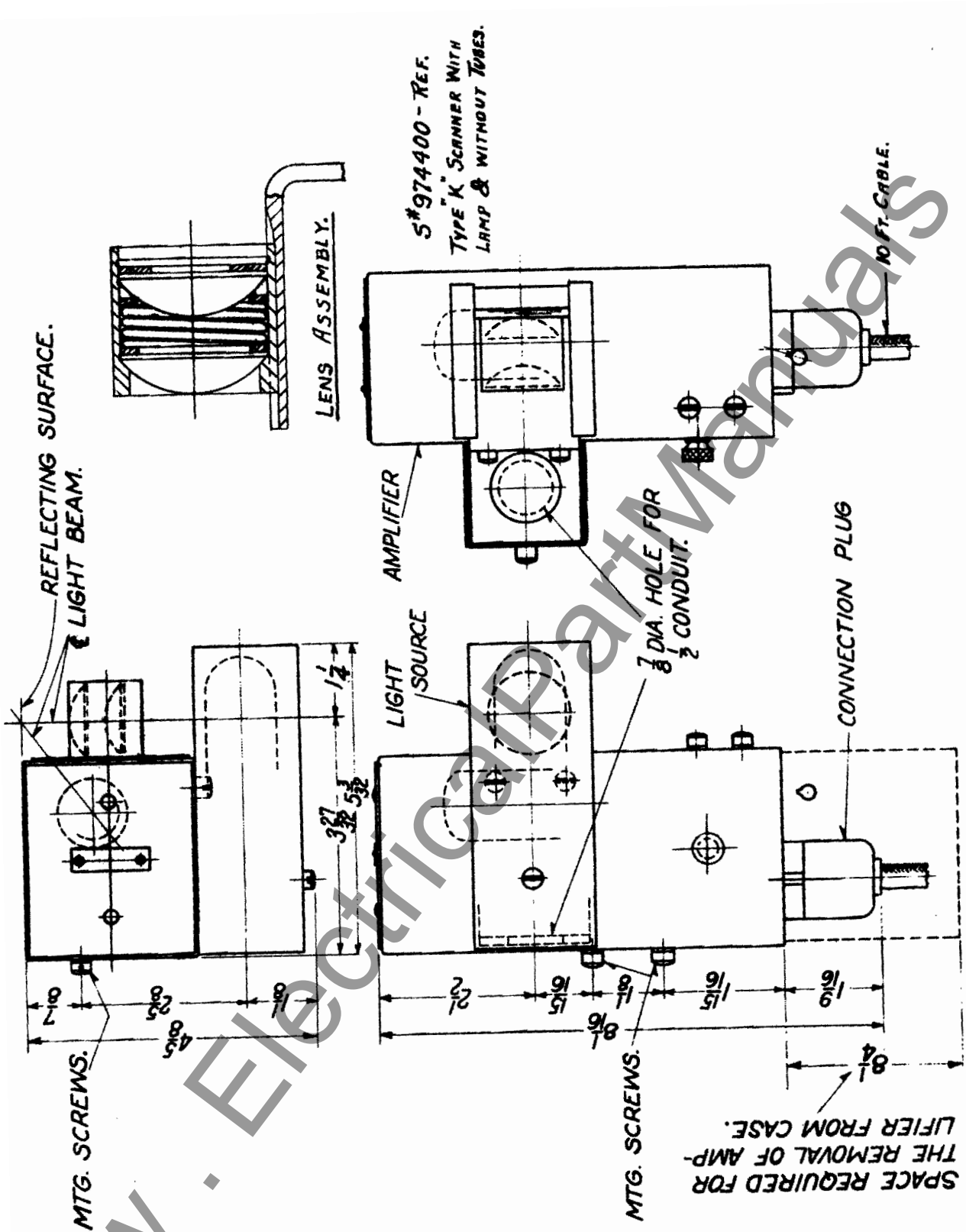


FIG. 7 Outline drawing for scanner for reflected light.

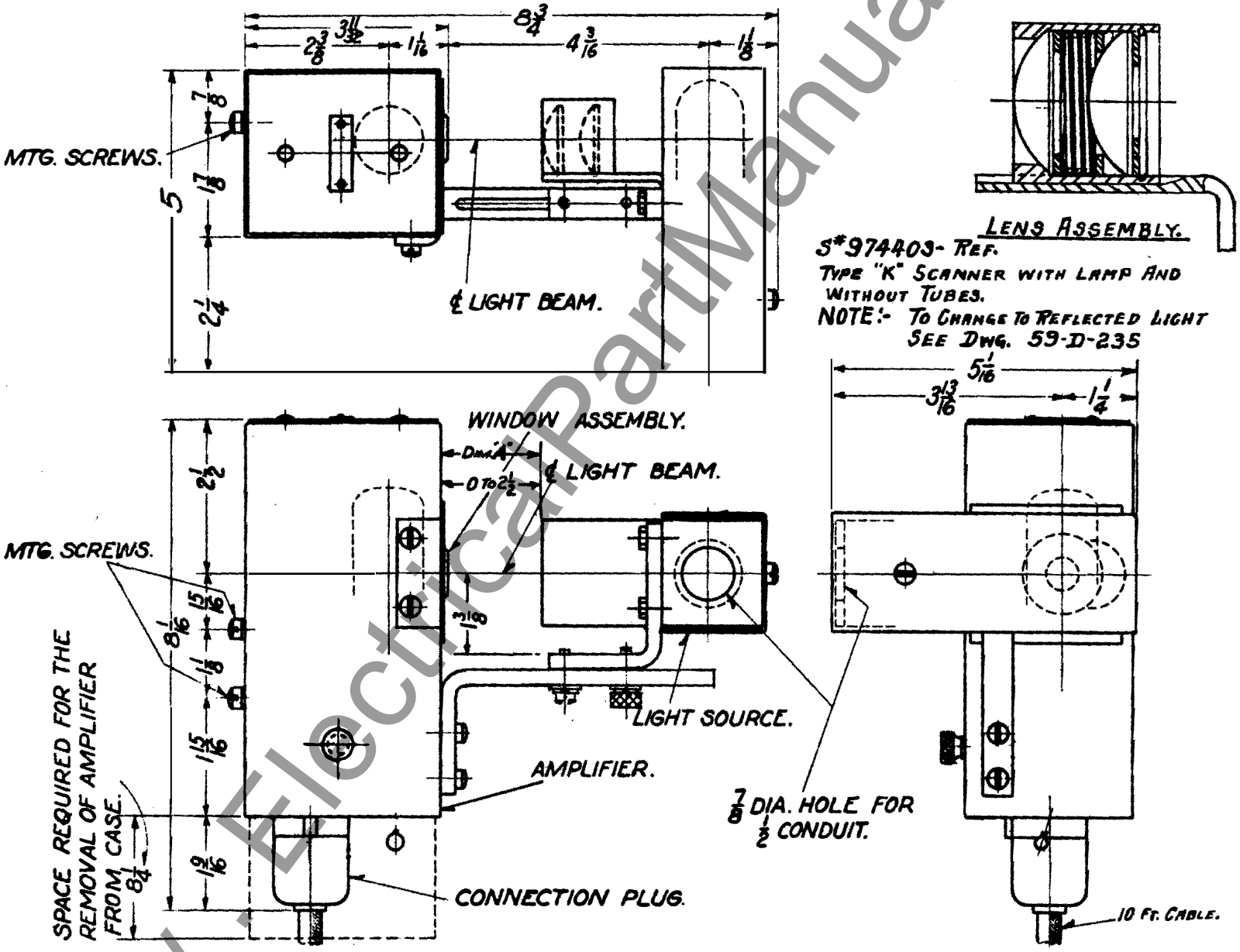
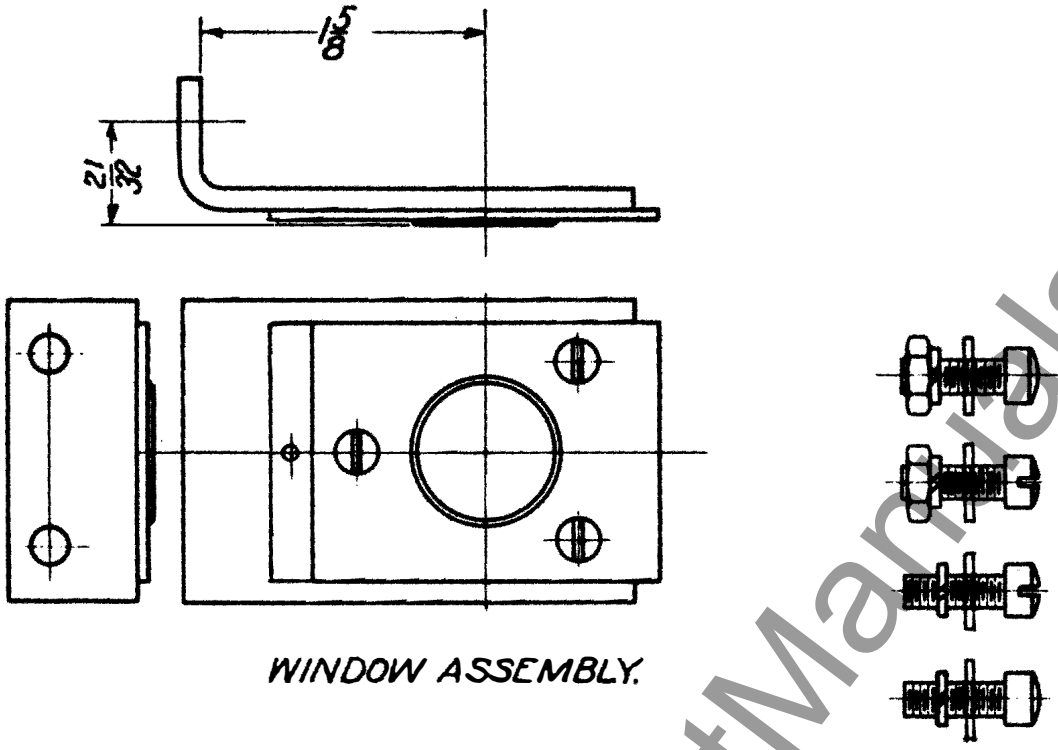


FIG. 8 Outline drawing for scanner for transmitted light.



WINDOW ASSEMBLY.

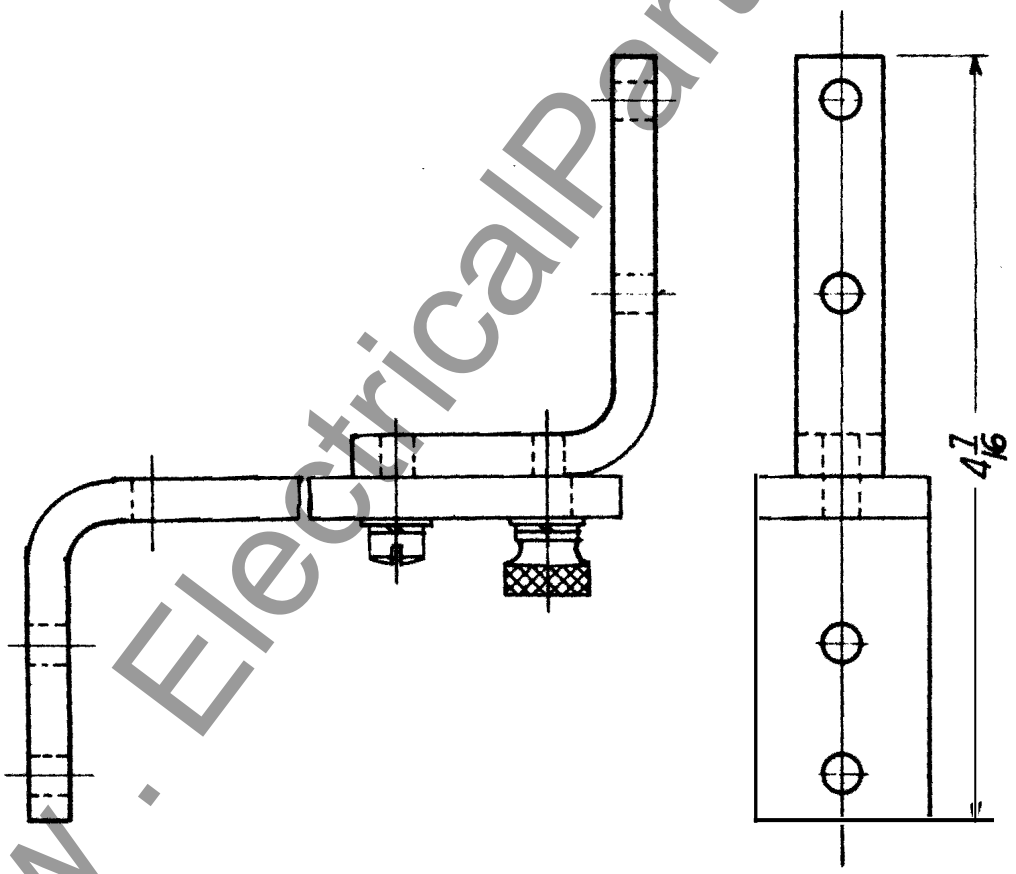
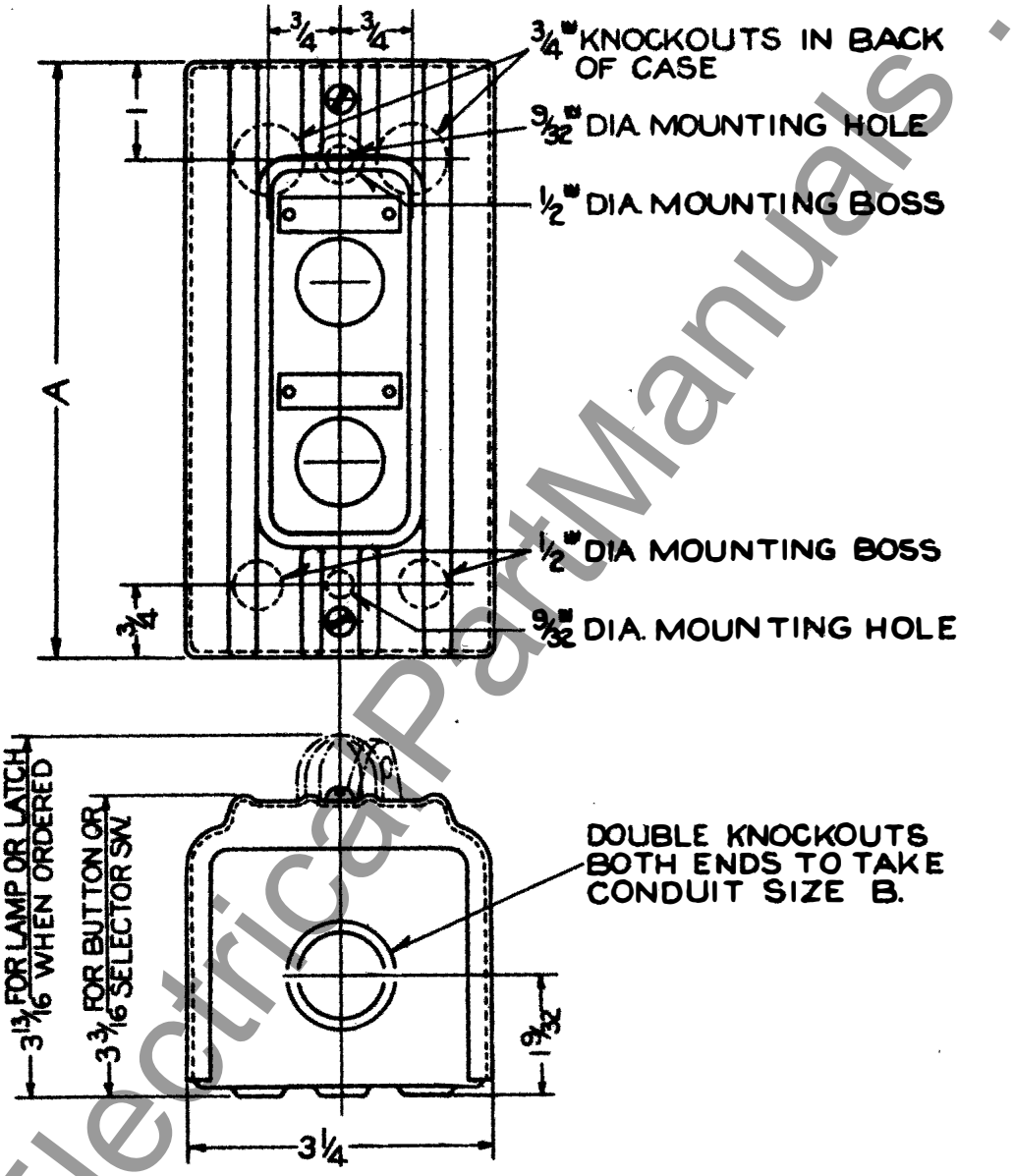


FIG. 9 Additional parts needed to transform a reflected light scanner to a transmitted light scanner.

OUTLINE DIMENSIONS IN INCHES



⊗NUMBER OF UNITS IN CASE	LENGTH A	CONDUIT SIZE B
1	4 3/8	1/2 - 3/4
2	6 1/4	1/2 - 3/4
3	8 1/8	3/4 - 1
4	10	3/4 - 1
5	11 7/8	3/4 - 1
6	13 3/4	3/4 - 1
7	15 5/8	3/4 - 1

⊗ THE UNITS REFERRED TO ARE PUSH BUTTONS, SELECTOR SWITCHES, PILOT-LIGHT UNITS OR ADDITIONAL RESISTOR UNITS FOR USE WITH PILOT-LIGHTS ABOVE 250 VOLTS. THESE UNITS MAY BE ARRANGED IN ANY COMBINATION DESIRED.

FIG. 10 Type C push button stations

Westinghouse Sizes No. 0 and 1 Dn Reversing LINESTARTERS

I. L. 2329-E

SIZE NO. 0: CLASSES 11-210 S0, V0, W0, Y0 and .0
SIZE NO. 1: CLASSES 11-210 S1, T1, V1, W1, Y1 and .1

MAXIMUM HP. RATINGS WHEN PROVIDED WITH SUITABLE OVERLOAD RELAY HEATERS

Volts	MAXIMUM HP.			
	POLYPHASE		SINGLE PHASE	
	Size 0	Size 1	Size 0	Size 1
110	1½	3	1	1½
220	2	5	1½	3
440-600	2	7½	1½	5

General—This **LINESTARTER** will provide protection for overloads (but not against short circuit currents, hence provide fuses or circuit breaker) when wired in accordance with Figs. 1 and 2 and supplied with overload heaters selected according to the **Heater Table** accompanying the starter.

Installation—1. To remove a cross-bar of a Size 0 starter take out the two screws holding it to the magnet armature. In the Size 1 starter remove the armature stop bracket, held to the magnet frame by two screws just above the arc box, and withdraw the armature downward through the arc box.

2. The overload heaters together with their mounting screws are shipped in a separate carton and should be installed as indicated in Fig. 3. Mount the heater with its loop-shaped portion within the cup recess. First check the heater marking against the **Heater Table** to see that the full load current marking of the motor nameplate comes within the current range of the heaters.

3. To provide automatic reset of the overload relay, open the relay contact and remove the reset rod.

4. **To remove a contactor coil,** remove the cross-bar, and remove the magnet by removing the two screws securing it to the back-plate. Then remove the retainer and coil.

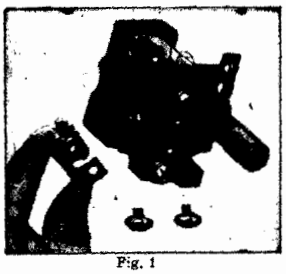


Fig. 1

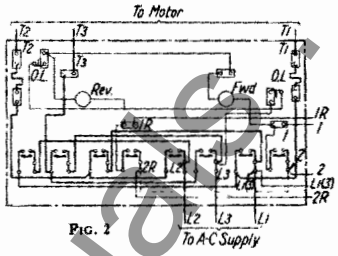


FIG. 2

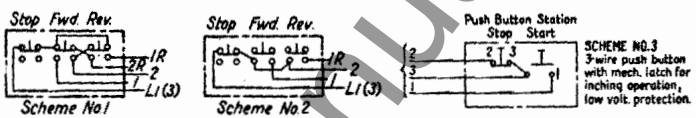


FIG. 3—PUSH BUTTON STATION

Renewal Parts

Coil	(see number marked on coil)	
Moving contact	S#899	837
Moving contact guide	S#899	836
Stationary contact	S#899	826
Contact spring (for size 0)	S#944	780
Contact spring (for size 1)	S#899	835
Armature guide	S#899	842
Overload relay unit	S#972	879

NOTE:—The starter is shipped connected for 3 phase or 2 phase 3 wire operation. For 2 phase 3 wire operation, L3 is the common lead. Connect T4 of the motor to T3 on the control panel. Push button Scheme No. 1, Fig. 2, is preferable. If Scheme No. 2 is to be employed, connect a jumper on the starter panel from 2 to 2R as indicated by the dashed line in Fig. 1.

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FIG. 11 Type DN Reversing Linestarter

Westinghouse Sizes No. 0 and 1 Dn Reversing LINESTARTERS—Single Phase

I. L. 2342-C

SIZE No. 0: CLASSES 11-210 S0, V0, W0, Y0 and .0 SIZE No. 1: CLASSES 11-210 S1, V1, W1, Y1 and .1

MAXIMUM HP. RATINGS WHEN PROVIDED WITH SUITABLE OVERLOAD RELAY HEATERS

Volts	MAXIMUM HP. SINGLE PHASE	
	Size No. 0	Size No. 1
110	1	1½
220	1½	3
440-600	1½	5

General—This **LINESTARTER** will provide protection for overloads (but not against short circuit currents, hence provide fuses or circuit breaker) when wired in accordance with Figs. 2 and 3 and supplied with overload heaters selected according to the **Heater Table** accompanying the starter.

Installation—1. To remove a cross-bar of a Size No. 0 Starter, remove the interlock, held to the bottom of the arc box by a single screw, and take out the two screws holding the cross-bar to the magnet armature. In the Size No. 1 Starter, remove the interlock and the armature stop bracket (the latter held to the magnet frame by two screws just above the top of the arc box) and withdraw the armature downward thru the arc box.

2. A magnet may be easily removed for **replacement** of its coil by withdrawing its mounting screws and armature stop bracket. In enclosed starters removal of the magnet is facilitated by loosening the two top mounting screws of the starter sufficiently to tilt it forward.

3. The **overload heaters** together with their mounting screws are shipped in a separate carton and should be installed as indicated in Fig. 1. Mount the heater with its loop-shaped portion within the cup recess. First check the heater marking against the **Heater Table** to see that the full load current marking of the motor nameplate comes within the current range of the heaters.

4. To provide automatic reset of the overload relay, open the relay contact and remove the reset rod.

Renewal Parts

Coil	(see number marked on coil)	
Moving contact	S#899	837
Moving contact guide	S#899	836
Stationary contact	S#899	826
Contact spring (for Size No. 0)	S#944	780
Contact spring (for Size No. 1)	S#899	835
Armature guide	S#899	842
Overload relay unit	S#972	879
"Make" interlock complete	S#972	892
Interlock moving contact	S#899	850
Interlock stationary contact	S#899	849

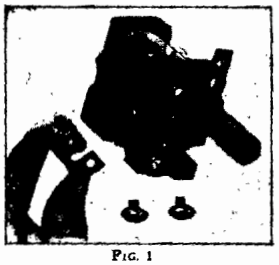

FIG. 1

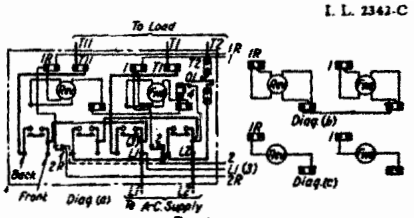

FIG. 2

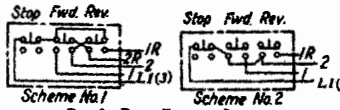

FIG. 3—PUSH BUTTON STATION

NOTE—LINESTARTERS are shipped with dual voltage coils or single voltage coils. The dual voltage coils are shipped connected for high voltage per diag. (a) of Fig. 2. To operate the dual voltage coil on its low voltage, reconnect per diag. (b). Single voltage coils are connected per diag. (c).

If it is desired to operate the coil from a separate control circuit, remove the lead connecting L2 to terminal 4 of the overload relay. Connect the power supply to terminal 4 of the overload relay and terminal 3 of the push button.

Push button Scheme No. 1, Fig. 3, is to be preferred. If Scheme No. 2 is to be employed, connect a jumper on the starter panel from 2 to 2R as indicated by the dashed line in Fig. 2.

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FIG. 12 Type DN Reversing Linestarter

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BINGHAMTON 62, N. Y., Suite 704, Marine Midland Bldg., 86 Court St.
BIRMINGHAM 3, ALA., 1407 Comer Bldg.
BLUEFIELD, W. VA., Appalachian Elec. Power Co. Bldg., Room 620, 704 Bland St., P.O. Box 848
BOSTON 10, MASS., 10 High St.
BRIDGEPORT 8, CONN., 540 Grant St.
BUFFALO 3, N. Y., 814 Ellicott Square Bldg.
BURLINGTON, VT., 208 Flynn Ave.
BUTTE, MONTANA, 52 East Broadway
CANTON 2, OHIO, 901 First National Bank Bldg., 120 W. Tuscarawas
CEDAR RAPIDS, IOWA, 361 21st St., S.E., P.O. Box 1828
CHARLESTON, S. C., 89 G. Smith St., P.O. Box 303
CHARLESTON 23, W. VA., 610 Union Bldg., P.O. Box 911
CHARLOTTE 1, N. C., 210 East Sixth St.
CHATTANOOGA 2, TENN., Volunteer State Life Bldg., Georgia Ave & East Ninth St.
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CINCINNATI 2, OHIO, 207 West Third St.
CLEVELAND 13, OHIO, The Standard Bldg., 1370 Ontario St.
COLUMBUS 16, OHIO, 266 N. 4th St.
CORPUS CHRISTI, TEXAS, 416 N. Chaparral St.
DALLAS 1, TEXAS, 209 Browder St.
DAVENPORT, IOWA, 206 E. Second St., P.O. Box 29
DAYTON 2, OHIO, 30 North Main St.
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JACKSON, MISS., General Delivery
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JOHNSTOWN, PA., 107 Station St.
KANSAS CITY 6, MO., 101 W. Eleventh St.
KNOXVILLE 8, TENN., Gay & Clinch St.
LITTLE ROCK, ARKANSAS, 103 W. Capitol St.
LOS ANGELES 13, CALIF., 420 S. San Pedro St.
LOUISVILLE 2, KY., 332 West Broadway
MADISON 3, WISC., 1022 E. Washington Ave.
MANSFIELD, OHIO, 246 E. Fourth St.
MEMPHIS 3, TENN., 130 Madison Ave.
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MINNEAPOLIS 13, MINN., 2303 Kennedy St., N.E.
MONROE, LA., 1107 N. 2nd St., P.O. Box 1851
NASHVILLE 3, TENN., 219 Second Ave., N.
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NEW ORLEANS 13, LA., 238 South Saratoga St.
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NIAGARA FALLS, N. Y., 253 Second St.
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OKLAHOMA CITY 2, OKLA., 120 N. Robinson St.
OMAHA 2, NEB., 409 South Seventeenth St.
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PHILADELPHIA 4, PA., 3001 Walnut St.
PHOENIX, ARIZONA, 11 West Jefferson St.
PITTSBURGH 30, PA., 306 4th Ave., Box 1017
PORTLAND 4, OREGON, 309 S. W. Sixth Ave.
PROVIDENCE 3, R. I., 16 Elbow St.
RALEIGH 1, N. C., 1, 803 North Person St., P.O. Box 2146
RICHMOND 19, VA., 301 S. Fifth St.
ROCHESTER 7, N. Y., 1048 University Ave.
ROCKFORD, ILL., 130 South Second St.
SACRAMENTO 14, CALIF., 1730 14th St.
ST. LOUIS 1, MO., 411 North Seventh St.
SALT LAKE CITY 1, UTAH, 10 West First S. St.
SAN ANTONIO 5, TEXAS, 115 W. Travis St.
SAN DIEGO 1, CALIF., 861 Sixth Ave.
SAN FRANCISCO 4, CALIF., 1 Montgomery St.
SEATTLE 4, WASH., 3451 East Marginal Way
SIOUX CITY 4, IOWA, P.O. Box 683
SOUTH BEND 4, IND., 216 East Wayne St.
SPOKANE 8, WASH., 1023 W. Riverside Ave.
SPRINGFIELD, ILL., 601 E. Adams St., Box 37
SPRINGFIELD 1, MASS., 395 Liberty St.
SYRACUSE 4, N. Y., 700 W. Genesee St.
TACOMA 2, WASH., 1930 Pacific Ave.
TAMPA 1, FLA., 417 Ellamae Ave., Box 230
TOLEDO 4, OHIO, 245 Summit St.
TRENTON 10, N. J., 1100 S. Broad St.
TULSA 3, OKLA., 303 East Brady St.
UTICA 1, N. Y., 113 N. Genesee St.
WASHINGTON 6, D. C., 1625 K St., N.W.
WICHITA 2, KANSAS, 301 South Market St.
WILKES-BARRE, PA., 267 N. Pennsylvania Ave.
WILLIAMSPORT 1, PA., 348 W. Fourth St.
WORCESTER 8, MASS., 507 Main St.
YORK 2, PA., 11 W. Market St., P. O. Box 1466
YOUNGSTOWN 3, OHIO, 25 E. Boardman St.

MANUFACTURING AND REPAIR DEPARTMENT OFFICES

ATLANTA 2, GA., 1299 Northside Drive, N.W., P.O. Box 4808
AUGUSTA, MAINE, 9 Bowman St
BALTIMORE 24, MD., 4015 Foster Ave.
BATON ROUGE, LA., 555 Choctaw Drive
BOSTON 27, MASS., 235 Old Colony Ave., So. Boston
BRIDGEPORT 8, CONN., 540 Grant St.
BUFFALO 10, N. Y., 1132 Seneca St.
CHARLOTTE 1, N. C., 210 East Sixth St.
CHICAGO 9, ILL., 2211 W. Pershing Road, P.O. Box 1103, Zone 80
CINCINNATI 2, OHIO, 207 West Third St.
CLEVELAND 2, OHIO, 5901 Breakwater Ave., Station A
DENVER 4, COLORADO, 988 Cherokee St.
DETROIT 31, MICH., 5757 Trumbull Ave., P.O. Box 828
EMERYVILLE 8, CALIF., 5915 Hollis St.
FAIRMONT, W. VA., 10th and Beltline, P.O. Box 1147
HOUSTON 2, TEXAS, 2315 Commerce Ave.
HUNTINGTON 1, W. VA., 1029 Seventh Ave., P.O. Box 1150
INDIANAPOLIS 2, IND., 551 West Merrill St., P.O. Box 1535
JOHNSTOWN, PA., 107 Station St.
LOS ANGLES 13, CALIF., 420 S. San Pedro St.
MILWAUKEE 3, WISC., 424 North Fourth St.
MINNEAPOLIS 13, MINN., 2303 Kennedy St., N.E.
NEWARK 1, N. J., Haynes Ave. & Lincoln Hwy.
PHILADELPHIA 4, PA., 3001 Walnut St.
PITTSBURGH 8, PA., 543 N. Lang Ave.
PORTLAND 12, ORE., 626 North Tillamook St.
PROVIDENCE 3, R. I., 16 Elbow St.
ST. LOUIS 2, MO., 717 South Twelfth St.
SALT LAKE CITY 7, UTAH, 346A Pierpont Ave.
SEATTLE 4, WASH., 3451 East Marginal Way
SPRINGFIELD 1, MASS., 395 Liberty St.
SYRACUSE 4, N. Y., 700 W. Genesee St.
UTICA 1, N. Y., 113 N. Genesee St.
WILKES-BARRE, PA., 267 N. Pennsylvania Ave.

DISTRICT ENGINEERING AND SERVICE DEPARTMENT OFFICES

ATLANTA 2, GA., 1299 Northside Drive, N.W., P.O. Box 4808
BALTIMORE 2, MD., 200 W. Baltimore St
BLUEFIELD, W. VA., Appalachian Elec. Power Co. Bldg., Room 620, 704 Bland St., P.O. Box 848
BOSTON 10, MASS., 10 High St.
BRIDGEPORT 8, CONN., 540 Grant St.
BUFFALO 3, N. Y., 814 Ellicott Square Bldg.
CHARLOTTE 1, N. C., 210 East Sixth St.
CHICAGO 6, ILL., 20 N. Wacker Drive, P.O. Box B, Zone 90
CINCINNATI 2, OHIO, 207 West Third St.
CLEVELAND 13, OHIO, The Standard Bldg., 1370 Ontario St.
COLUMBUS 16, OHIO, 266 N. 4th St.
DALLAS 1, TEXAS, 209 Broder St.
DENVER 2, COLORADO, 910 Fifteenth St.
DES MOINES 8, IOWA, 1400 Walnut St.
DETROIT 31, MICH., 5757 Trumbull Ave., P.O. Box 828
DULUTH 2, MINN., 10 East Superior St.
HOUSTON 2, TEXAS, 1314 Texas Ave.
HUNTINGTON 1, W. VA., 1029 Seventh Ave., P.O. Box 1150
INDIANAPOLIS 9, IND., 137 S. Penna. St.
KANSAS CITY 6, MO., 101 W. Eleventh St.
LOS ANGELES 13, CALIF., 420 S. San Pedro St.
LOUISVILLE 2, KY., 332 West Broadway
MILWAUKEE 2, WISC. 538 N. Broadway
MINNEAPOLIS 13, MINN., 2303 Kennedy St., N.E.
NEW ORLEANS 13, LA., 238 South Saratoga St.
NEW YORK 5, N. Y., 40 Wall St.
PHILADELPHIA 4, PA., 3001 Walnut St.
PITTSBURGH 30, PA., 306 4th Ave., Box 1017
PHOENIX, ARIZ., 11 West Jefferson St.
PORTLAND 4, OREGON, 309 S.W. Sixth Ave.
PROVIDENCE 3, R. I., 16 Elbow St.
ST. LOUIS 1, MO., 411 North Seventh St.
SALT LAKE CITY 1, UTAH, 10 West First St.
SAN DIEGO 1, CALIF., 861 Sixth Ave.
SAN FRANCISCO 4, CALIF., 1 Montgomery St.
SEATTLE 4, WASH., 3451 East Marginal Way
SPOKANE 8, WASH. 1023 W. Riverside Ave.
SPRINGFIELD 1, MASS., 395 Liberty St.
TOLEDO 4, OHIO, 245 Summit St.
UTICA 1, N. Y., 113 N Genesee St.
WASHINGTON 6, D. C., 1625 K Street, N.W.
WILKES-BARRE, PA., 267 N. Pennsylvania Ave.
YOUNGSTOWN 3, OHIO, 25 E. Boardman St.