I. L. 41-554

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE BL THERMAL OVERLOAD RELAY

CAUTION Before putting relays into service remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

The Type BL Relay is used for thermal overload and instantaneous overcurrent protection of transformers, a-c or d-c motors and generators. The Thermal element is the "replica" type and has a time-current characteristic closely approximating the average heating curves of electrical apparatus. Its characteristics prevent the protected equipment from being subjected to overloads of such magnitude or duration as to cause them to reach dangerous temperature, but at the same time permit the utilization of the inherent thermal capacity of the apparatus in carrying intermittent overloads which will not cause the windings to become overheated. As its operation depends upon the rate of heat generation in a heater winding within the relay, it may be used for either a-c or d-c application. It is ordinarily connected in the secondary circuit of a suitable current transformer in a-c application.

Since the voltage drop across the relay must be within a range of about 2 to 5 volts at full load on the protected machine, customary shunts rated in millivolts are unsuited for d-c applications. However, the drop across a portion of the protected circuit, such as the interpole field winding of a machine, sometimes can be utilized as a source of energy for the relay.

CONSTRUCTION AND OPERATION

The single element Type BL Relay consists of a heater element, an instantaneous overcurrent element, and two operation indicators when mounted in the standard or Type FT Cases. The operation indicators are omitted when the relay is in the small case of Figure 14.

The double element Type BL Relay contains two heater elements, two instantaneous elements, and three operation indicators. These are mounted in the standard and Type FT cases.

Heater Element

Two heater coils and a bi-metallic coil spring are enclosed in a polished metal shell. The outer end of the spring is stationary and the inner end is fastened to a shaft which projects thru one end of the metal housing. An arm connected to the outer end of the shaft carries the moving contacts.

The stationary make contacts are mounted on a Micarta block which in turn is fastened to a segment of a slotted circular disc on the end of the housing. This disc and the contacts may be moved by loosening the locking screw and turned to various contact spacing or settings as indicated by the scale on the end of the metal housing. Bridging type silver contacts are used with the bridge as the moving contacts.

Where a break contact is required another bridging contact is added to the moving arm and a second set of stationary contacts are mounted on another slotted disc segment. Both front and back contacts are adjustable independently but are held in position by the same locking screw.

SUPERSEDES I. L. 41-296G
*Denotes change from superseded issue.

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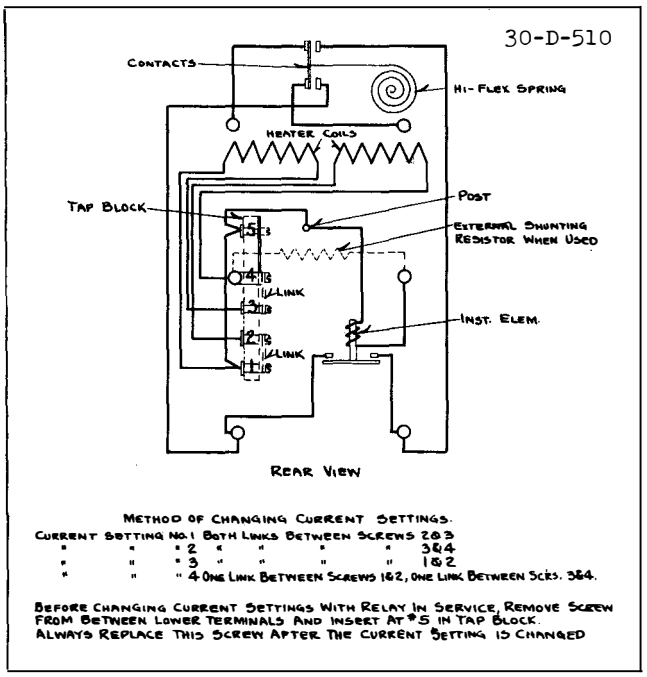


Fig. 1—Internal Wiring Diagram of the Single Element Type BL Relay with Front and Back Contacts in the Small Glass Case of Figure 14. The Relay with Front Contacts only has the top two Terminals omitted.

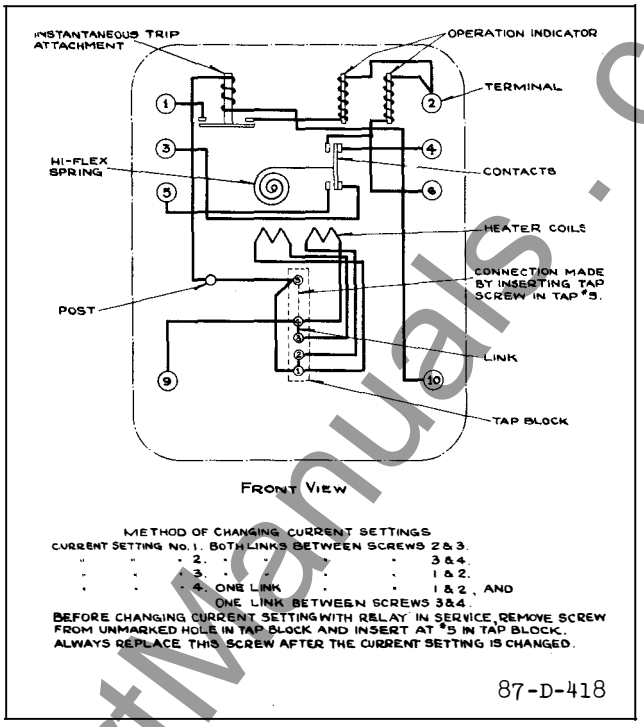


Fig. 2—Internal Wiring Diagram Of The Single Element Type BL Relay With Front And Back Contacts In The Standard Case. The Relay With Front Contacts Only Has Terminals 3 And 4 Omitted.

The heat generated by the current in the heater coils causes the bi-metallic spring to rotate the shaft with temperature variation. There is a time lag between the generation of the heat in the heater element and its transfer to the spring and the time required to move the contacts over a fixed arc is dependent upon the magnitude and duration of the overload current in the machine terminals.

The four leads of the two heater coils are brought out to a tap block with links so that either coil may be used alone or in parallel or series as required.

Instantaneous Element

This is a small solenoid type element. A cylindrical plunger moves up and down on a vertical guide rod in the center of the solenoid coil. This guide rod is fastened to the stationary core which in turn screws into the element frame. A silver disc is fastened to the moving plunger thru a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical shaped stationary contacts. After the contacts close the plunger moves slightly farther before seating against the stationary core. This assures positive contact pressure.

A Micarta disc on a threaded bushing is assembled on the lower portion of the guide rod and is locked in place by a nut. Its position determines the de-energized postion of the plunger and therefore the pickup current of the element, as indicated by the graduated scale beside the disc.

Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to indicate the completion of the trip circuit. The indicator is reset from outside the case by a push rod in the cover or cover studs.

CHARACTERISTICS

The two heater coils are brought out to four link screws numbered 1,2,3, and 4. One coil is between 1 and 3 and the other between 2 and 4. Link screw 1 is connected to one relay terminal, and link screw 4 to a second terminal through the instantaneous element coil.

The arrangement of the two links for various operating conditions is as follows:

Current Setting No.	Operating Conditions	*Current Tap Value In Amperes	Link Position
1	Coils in series	2.5	Both Between 2 & 3
2	One Coil	3.2	Both Between 3 & 4
3	Second Coil	3.9	Both Between 1 & 2
4	Coils in Parallel	5.0	One Between 1 & 2 One Between 3 & 4

*The current required to deflect the contacts to the No. 10 scale position with the moving contacts at 0, and an ambient temperature of 25°C. These values are the current tap value referred to on the curves.

Tap 5 is connected to both link screws 1 and 4 so that the heater element may be short-circuited while changing links with the relay in service to prevent open-circuiting the current transformers. A tap screw in a spare hole is available for the purpose. Inserting this tap screw in tap 5 does not make the instantaneous element inoperative.

The circular stationary contact setting scale of the heater element has main divisions numbered from 0 to 10 inclusive. Between the main divisions are five sub-divisions corresponding to 0.2 main division.

When both make and break contacts are supplied, the maximum spacing between the two sets is 8 main divisions.

The instantaneous element has a vertical scale graduated from 6 to 50 amperes. The values indicate the pick-up current when the Micarta disc is opposite the scale divisior and when the element is in correct adjustment

The contact rating of the elements are as follows:

Element	Control Voltage	Control Capacity In Amperes Will Break	Will Close
Heater	125 V.d-c	0.5	3.0
Heater	125 V.a-c	2.0	3.0
Instantaneous	125 V.d-c	1.5	5.0
Instantaneous	125 V.a-c	5.0	5.0

The make contacts of the two elements are connected in parallel between the relay terminals for the relays in the small case of figure 1. The trip circuit arrangements of the relays in the standard and Type FT Cases are shown in figure 6.

The operation indicator normally supplied in the standard and Type FT Case relays will pick-up at 1.0 amperes d-c.

The time-current characteristics of the type BL Relay starting from the cold condition are shown in figure 7. The current necessary to deflect the moving contacts to various scale positions for the different taps are shown in figure 8. Figures 10 to 12 show the time current characteristics of the relay when an overload is applied after it has been carrying a continuous normal load long enough for the temperature to become constant. Figure 9 shows the time required for the contacts to open after they have been closed on the No. 10 scale positions by overload, and for the contacts to reset from that position. All of these curves apply for an ambient temperature of 25°C.

The relay curves show the time-current characteristics up to 500% of the current setting. Current setting No. 1, 2, and 4 will stand this overload for the time necessary for the moving contacts to deflect to No. 10 scale position without being injured, but it is not advisable to subject the relay to more than 400% of the current setting on setting No. 3 for the time required to deflect the contacts to the No. 10 position. This setting employs the inner section of the winding alone, and the watts per unit length of winding are greater than for any other condition. It should be remembered, however, that 400% of the current setting will usually represent 600% or 700% of the full load current of the protected apparatus, and 500% of the current setting represents 700% to 900% of the full

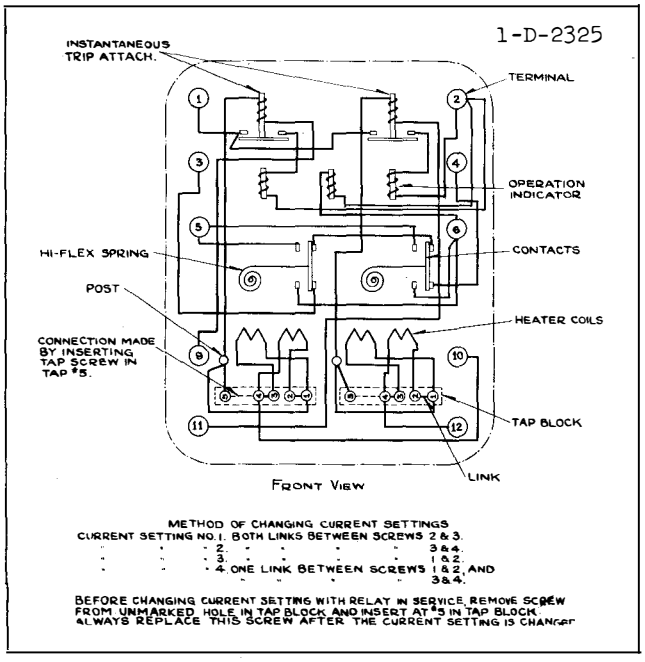


Fig. 3—Internal Wiring Diagrams Of The Double Element Relay With Front And Back Contacts In The Standard Case. The Relay With Front Contacts Only Has Terminals 3 And 4 And Associated Circuits Omitted.

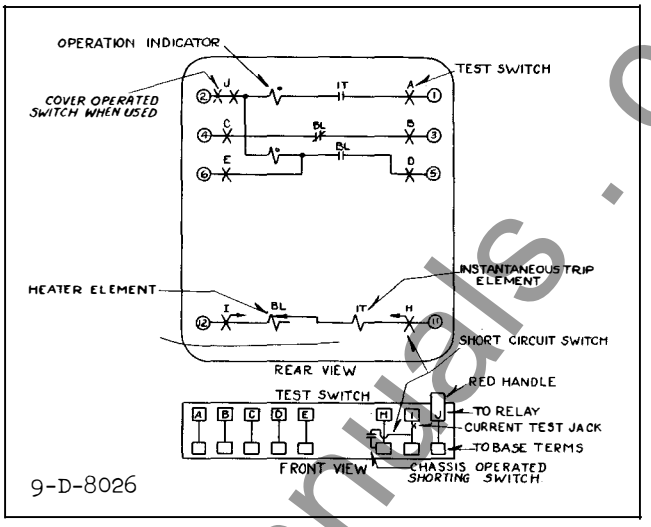


Fig. 4—Internal Schematic of the Single Element Relay With Front And Back Contacts In The Type FT Case. The Relay With Front Contacts Only Has Terminals 3 And 4 And Associated Circuits Omitted.

load current.

* INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs for the standard cases and the Type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connection may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

SETTINGS

There are two settings to be made on the relay. They are as follows:

1. Instantaneous element - Set the element for a pick-up current slightly above the maximum current which the apparatus may receive in normal service, as for example, the starting current of motor or the magnetizing inrush current of a transformer. This setting is made by moving the Micarta disc to a point opposite the desired pick-up current value indicated on graduated scale. After the setting is made lock the disc in place by means of the locknuts.

2. Heater Element - The setting of the heater element requires a time-current heating curve of the equipment to be protected. With this curve the procedure is to select a relay heating curve from the figures which most closely approaches the equipment curve but which will permit the relay to operate just before the equipment reaches the temperature indicated by the heating curve. The relay curve approximates the typical apparatus heating curves most closely at the moderate overloads which usually occur, and in order to obtain a sufficiently long delay at these moderate overloads it may be necessary to use a setting which gives fairly slow operation at high overloads. If the instantaneous element cannot be used at the higher currents (as in the case of motors which take a very high starting current), then the use of a long-

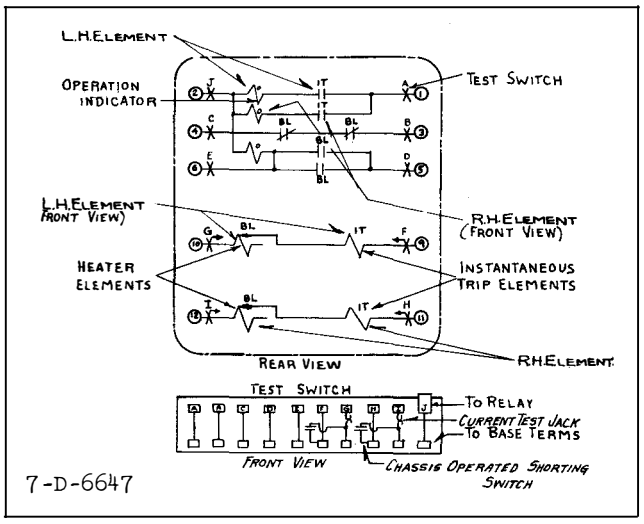


Fig. 5—Internal Schematic Of The Double Element Relay With Front And Back Contacts.

time-delay type CO relay in conjunction with the Type BL Relay is recommended. The type CO Relay should be set to pick up at about 250% to 300% of full load.

CASE I - Intermittent Load

The setting of the heater element is best explained by the use of examples. There are two cases to be considered, one with the electrical apparatus carrying an intermittent load and the second, with a continuous load.

To set the relay to protect a machine carrying an intermittent load, Figure 7 should be used. Assume that the secondary current for 100% load on the machine is 2.6 amperes, and that it will stand 175% load for 30 minutes. Let the No. 2 current tap be used. The current equivalent to 175% load is 4.55 amperes, which is 142% of the No. 2 current tap rating. Reference to Figure 7 and interpolation between the curves for contact settings No. 8 and No. 10 shows that the stationary contacts should be set at the 9.4 position. It should be noted that it would also be possible to use the No. 3 current setting with a stationary contact setting No. 6.5. However, it is preferable to use a stationary contact setting of 7.0 or more, since this reduces the error which might be caused by differences between the ambient temperatures of the machine and the relay.

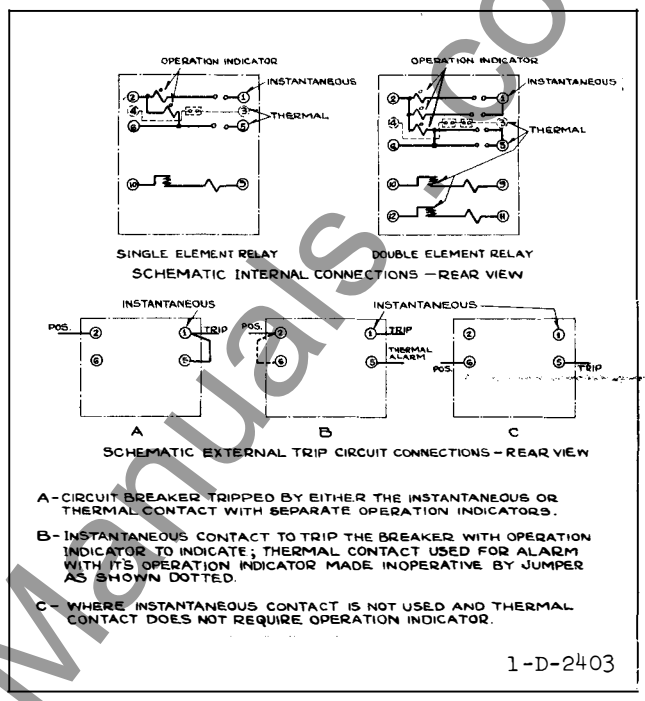


Fig. 6—Schematic Trip Circuit Connections For Various Applications Of Single And Double Element Type BL Relays In The Standard Cases.

CASE II - Continuous Load

To illustrate a case where the machine is carrying a continuous normal load but is occasionally subjected to overloads, assume that 100% load current is 2.6 amperes as before, but that the machine carries only 80% of its normal load continuously. This represents a current of 2.08 amperes. It will be assumed that the No. 1 current tap can be used. Reference to Figure 8 shows that the moving contacts will stand at the 7.1 position with continuous current of this value. Let it be assumed that the machine will carry 150% of its rating for 30 minutes if the overload occurs after the machine has been running continuously. This overload is equivalent to 3.9 secondary amperes, or 156% of the current tap value. Reference to Figure 12 will show that a time-delay of 30 minutes cannot be obtained for this condition, so the No. 2 current tap will be tried. Figure 8 shows that the moving contacts will stand at about the 4.8 scale position for the continuous normal load. The 150% overload represents 122% of the No. 2 current tap rating, and examination of Figures 10 and 12 (since the contacts are standing be-

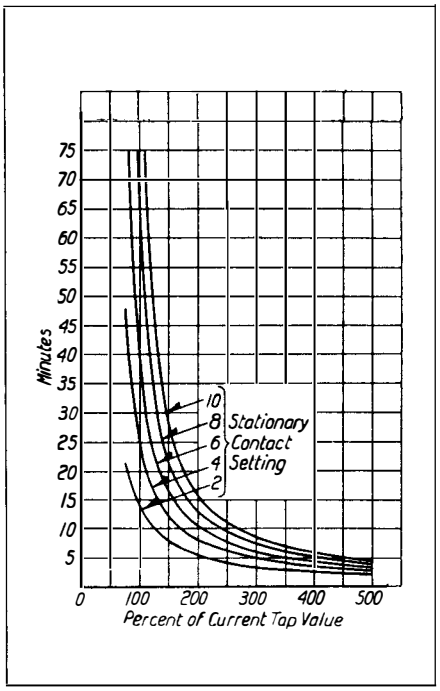


Fig. 7—Typical Time-Current Curves Of The Type BL Relay With No Initial Load.

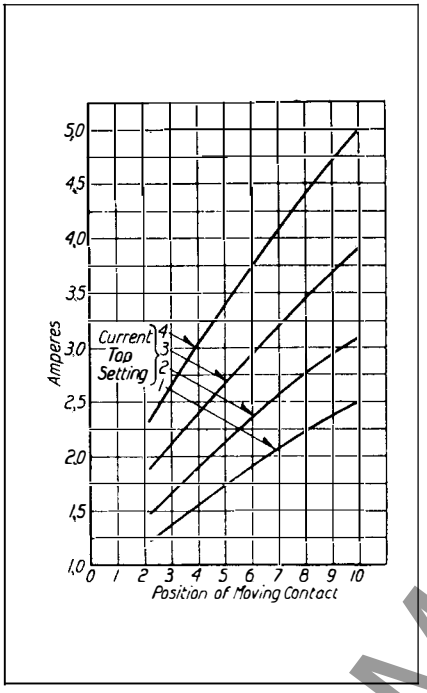


Fig. 8—Typical Current-Deflection Curves Of The Type BL Relay For Steady-State Conditions.

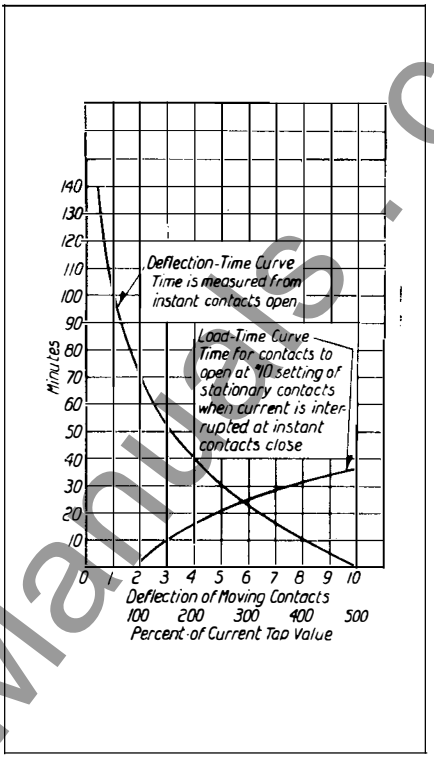


Fig. 9—Typical Time-Current Curves Of The Type BL Relay On Resetting From No. 10 Scale Position After Overload.

tween the No. 4 and the No. 6 positions) show that the stationary contacts should be set at about the No. 9.6 position.

CASE III - General

When setting the relay, the position of the 0 line on the graduated scale plate should be noted. This line should be in a vertical position directly over the lower screw which holds the plate. With the plate in this position the center line of the moving contact arm should lie directly over the 0 mark with no current in the relay and with an ambient temperature of 25°C. With a different ambient temperature, the contact arm should stand one scale subdivision ahead or behind the 0 mark for every 2.5°C. that the ambient temperature is above or below 25°C. In case it is necessary to change the position of the contact arm, the set screw which holds it in place on the shaft should be tightened very securely after making the change.

In setting the stationary contacts. the short radial edge of the plate to which the contact block is mounted is located directly over the desired scale division. When the moving contact is touching the stationary contacts the center of the Micarta arm which carries the moving contact will be directly over this same scale division.

While the relay characteristic curves shown are average curves and apply to any of the four current settings, curves taken on any particular relay and at any particular current setting will usually check the curves shown within 10%. Greater uniformity is obtained with currents of 175% and above than with currents slightly above 100%, of course, since any friction in the relay has less effect. Any particular relay will repeat its characteristic curves very consistently, so that if the best accuracy is desired the relay should be adjusted by trial for a given time-delay at some important current value. However, the thermal characteristics of the apparatus to be protected are seldom known with any great accuracy, and a sufficient factor of safety should be allowed to provide for reasonable

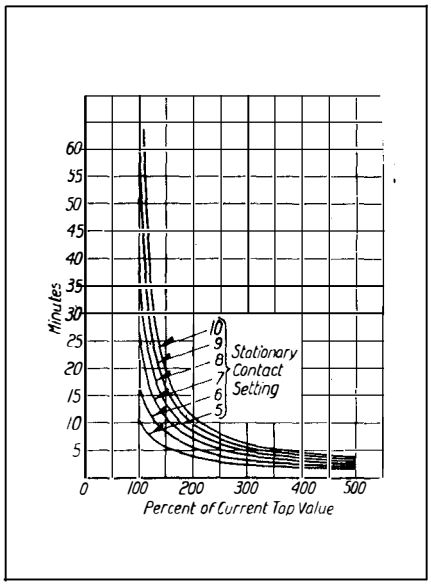


Fig. 10—Typical Time-Current Curves Of The Type BL Relay With The Contacts Maintained At The No. 4 Scale Position By Continuous Current Before Overload Is Applied.

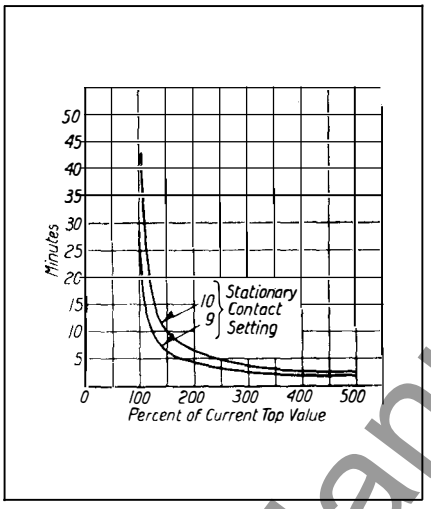


Fig. 11—Typical Time-Current Curves Of The Type BL Relay With The Contact Maintained At The No. 8 Scale Position By Continuous Current Before Overload Is Applied.

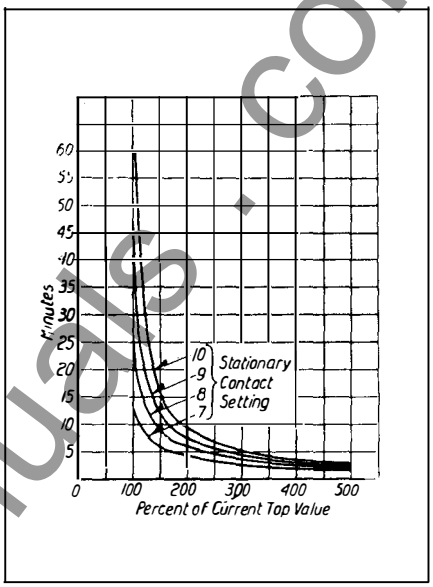


Fig. 12—Typical Time-Current Curves Of The Type BL Relay With The Contacts Maintained At The No. 6 Scale Position By Continuous Current Before Overload Is Applied.

variations in the relay timing also.

The Type BL relay should be located so that it is subjected as nearly as possible to the same temperature conditions as the equipment which it protects. The relay should not be mounted where it will be subjected to a draft of air from a fan or blower, or where it will be affected by heat from resistors or other sources. Typical external connections are shown in figure 13.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, instructions below should be followed.

All contacts should be periodically cleaned with a fine file. S#1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Heater Element

The relay should be allowed to stand in the test room two or three hours before making any of the following tests in order to be sure that it is at room temperature internally. Measure the resistance between the current terminals with both links connected between taps 3 and 4. This should be 1.52 to 1.64 ohms. The resistance measured with both links between taps 1 and 2 should be 0.92 to 0.99 ohm. With both links removed from the relay the resistance measurement should indicate an open circuit.

Rotate the moving contact to the #10 position by hand and observe whether the arm moves freely without binding of the shaft. Connect the contact terminals to an indicating circuit. The contacts should not open more than 0.25 ampere at 110 volts d-c when testing. Connect the heater circuit across 115 volts, 60 cycles, with suitable resistance

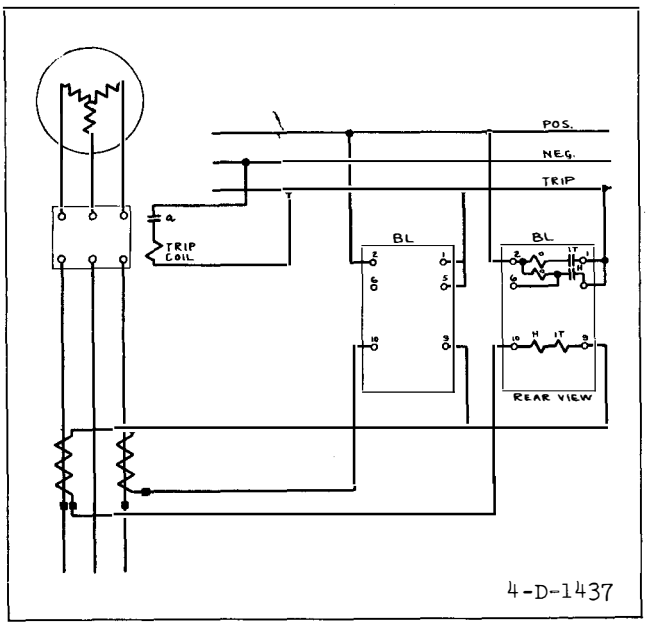


Fig. 13—Typical Diagram Of External Connections For The Type BL Relay Used To Protect A Machine Against Excessive Temperatures When Running Three Phase Or Single Phase.

to adjust the current for the tests that follow. The moving contact at room temperature should rest in a vertical position with the center of the Micarta arm directly above the 0 mark of the graduated scale. The stationary contact should be at the #10 scale position in the front contact relay, and at the #8 position in the front and back contact relay, in order that the moving contacts can start from the 0 position. Connect both links between taps 3 and 4 and adjust the resistance so that 6.4 amperes flow thru the relay. The time for the moving contact to reach the various scale positions should be approximately as follows:

Scale Divisions	Time (minutes)
#2	5.5
#4	8.0
#6	10.25
#8	12.75
#10	15.25

Allow the relay to cool to room temperature and repeat the timing run as above with both links between taps 1 and 2 and with 7.8 amperes thru the relay. The timing should be within the limits given above. For either test, the front and back contact relay can only be timed to the #8 scale positions.

After completing the above tests, the moving contact should be located on the shaft so that when the relay is at a temperature of 25°C, the center line of the Micarta arm will be directly over the 0 mark. For every five degrees C above 25 degrees C, the contacts should be moved two small scale divisions above the 0 mark. Conversely, for every five degrees below 25 degrees C, the contacts should be moved two small scale divisions back of the 0 mark. After adjusting the position of the moving contacts described, tighten the set screw as tightly as possible. This is important as otherwise the contact arm may slip on the shaft, when the contacts are closed by a heavy overload.

If the heater element is tested under very heavy overloads caution should be employed to open the current circuit as soon as the contacts close, since the winding of the thermal element might be injured if subjected to overload for a somewhat longer period. Some smoke may also be noticed coming from the thermal element at 400% or 500% of the current tap setting and any moisture which happens to be inside the relay will condense on the inside of the cover. These conditions do not indicate any defect. The thermal element is insulated with asbestos and mica and is designed to operate without injury even with the winding red-hot. However, traces of the binder which is used in the insulation may remain even after the thermal element is thoroughly baked during manufacture, and this may produce noticeable smoke on long heavy overloads.

It may occur, also, that if the contacts have been deflected to the #10 position several times on overloads of 400% or 500% the bi-metallic spring will show a slight set. This will be indicated by the moving contact arm standing slightly back of the 0 point at 25°C. This will not be sufficient to affect the timing seriously, but it can be corrected by loosening the set screw in the moving contact arm and readjusting its position on the shaft.

Instantaneous Element

Remove the tap screw from the spare hole and insert in the No. 5 tap. Next remove the plunger core and see that the top of the plunger is clean. Reassemble the plunger, and adjust the position of the core screw so that when the contacts are closed the plunger butts against the stop with the spring half compressed. With a 1/32 inch contact separation, the contacts should pick-up at 6 amperes, 60 cycles. If the plunger does not pick-up and seal in at this current, adjust the core screw so that it will and yet have sufficient compression of the spring to prevent sticking. Test for sticking after 50 amperes has been passed thru the coil. After all adjustments have been made, return the tap screw from the No. 5 position to the spare hole.

Operation Indicator

Adjust the indicator to operate at 1.0 ampere d-c. gradually applied by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. If the two helical springs which reset the armature are replaced by new springs, they should be weakened slightly by stretching to obtain the 1 ampere calibration. The coil resistance is approximately 0.16 ohm.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ENERGY REQUIREMENTS

The burdens of one heater element and one instantaneous element in series at 5 amperes 60 cycles is as follows:

Tap	Continuous Rating Amp.	Watt	Volt-Amperes	Power Factor
2.5	2.5	64.0	64.0	0°
5.0	5.0	16.0	16.0	0°

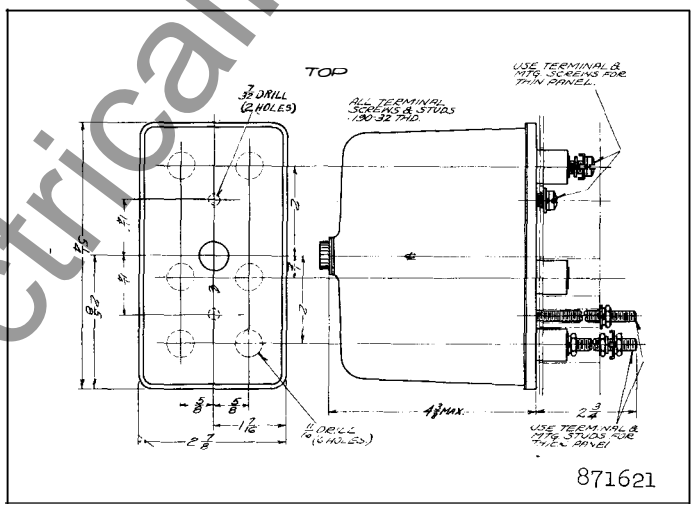


Fig. 14—Outline and Drilling Plan for the Small Glass Case (Wiring per Fig. 1). For the Relay with Front Contacts only. Omit the top two 11/16" Holes. For Reference only.

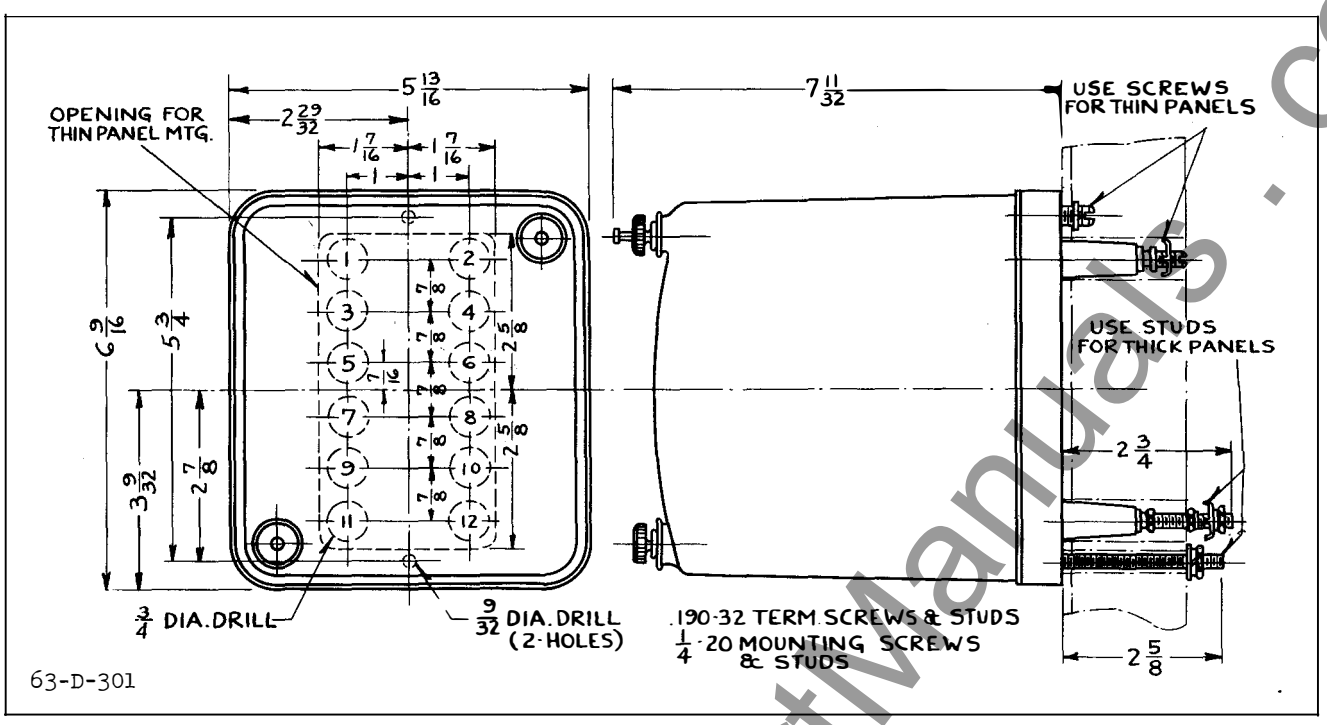
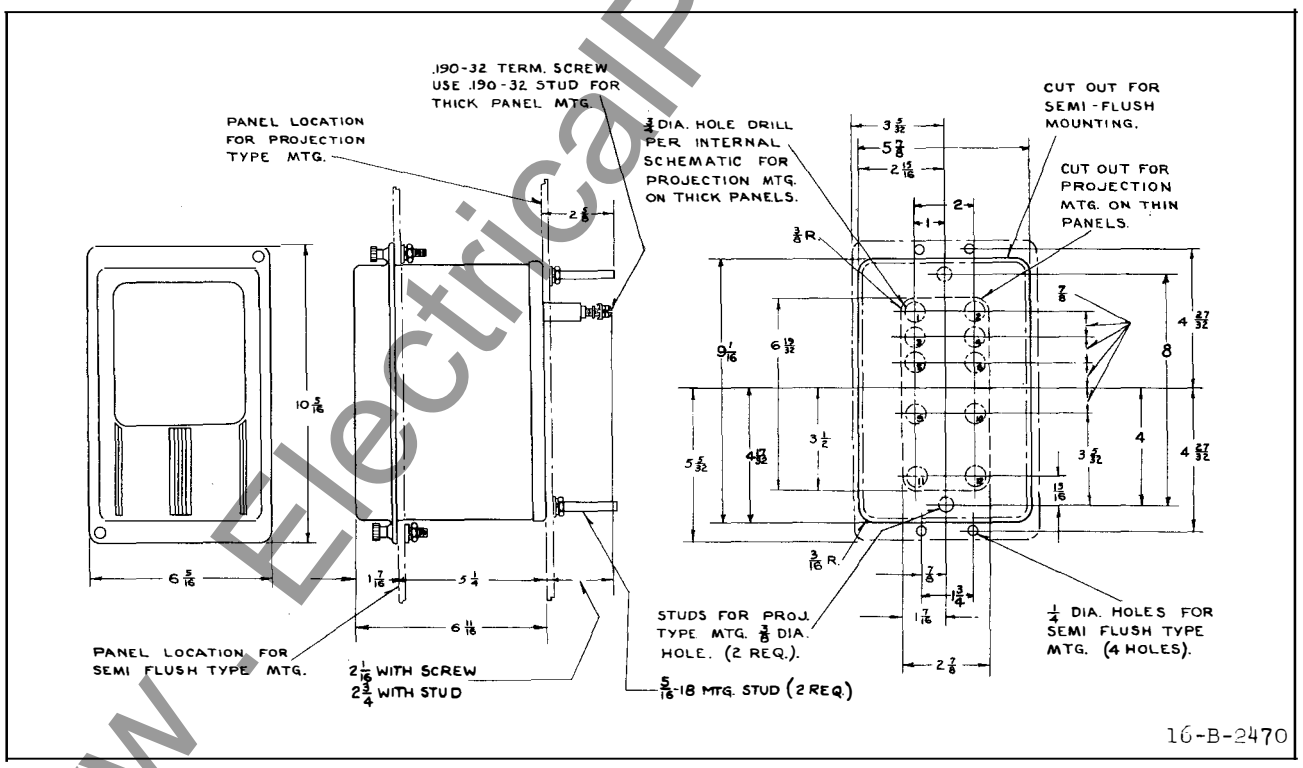


Fig. 15—Outline and Drilling Plan For The Standard Projection Type Case. (See The Internal Diagrams For The Terminals Supplied.) For Reference Only.



*** Fig. 16—Outline and Drilling Plan for the S-10 Projection or Semi-Flush Type FT Case. See the Internal Schematic for the Terminals Supplied. For reference only.**

WESTINGHOUSE ELECTRIC CORPORATION
METER DIVISION **NEWARK, N.J.**

Printed in U. S. A.