INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CT TEMPERATURE-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 CT relay is an induction type relay operating from exploring coils imbedded in or attached to the equipment being protected, and from a line current transformer. The relay is used to protect a-c equipment from overheating resulting from overloads, open phase, or insulation failure when the line current may be insufficient to operate short circuit protective devices. In order for the relay to operate, the temperature of the windings of the apparatus must be above values for which the relay is set, and these two conditions must have existed for a certain period of time because of the inherent time-delay of the induction-type unit. Thus, the danger of disconnecting the apparatus upon transient overloads is eliminated.

This relay is manufactured and set at the factory for each application and cannot be changed after shipment. In order to make the application, the following information is necessary:

1. Frequency of the connected system.
2. Power rating of the apparatus being protected.
3. Full load phase current.
4. Current transformer ratio. This should be chosen so that the full load secondary current is between 3.25 and 5 amperes if possible. This permits use of a 5°C. differential between the balance temperature and the operating temperature. However, by using a differential of 10°C between the balance temperature and the operating temperature, a full load secondary current as low as 2.25 amperes can be permitted in 60 cycle applications.
5. Maximum safe operating temperature at which the relay must trip if full load current or more is present.
6. The metal (usually copper) used in the exploring coil windings and its temperature coefficient of resistance at 25° Centigrade.
7. Resistance of each exploring coil at 25° Centigrade. (Standard relays are available for use with 10 ohm exploring coils only.)
8. Ambient temperature (if appreciably different from 25°C).
9. Resistance of the leads from the exploring coils to the relay terminals. However, if resistance of the leads can not be predetermined, the effect of lead resistance can be balanced out at slight sacrifice of sensitivity by using relays with additional terminals as shown in Fig. 3 and by using three leads to each exploring coil instead of two.

CONSTRUCTION

The type CT relay consists of an operating, element, two fixed resistor legs of the Wheatstone Bridge, and an indicating contactor switch unit.

Operating Unit

This unit is the induction-disc type. The induction disc is mounted on a vertical shaft. A stop riveted to the disc prevents the contact from opening more than approx. 1/4 of an inch. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The electrical connection is made from the moving contact thru the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a

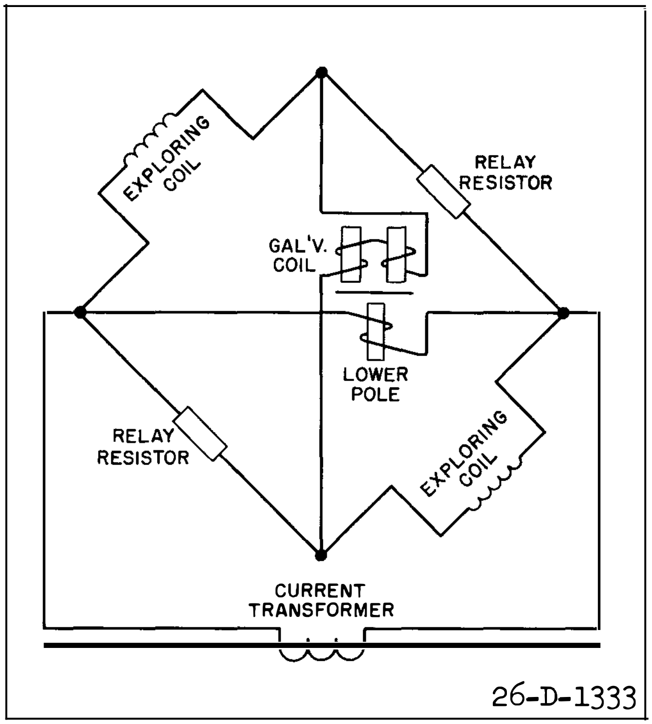

Fig. 1. Schematic Diagram of the Internal and External Connections of the Type CT Relay.

silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow.

The moving disc is rotated by an electro-magnet in the rear and damped by an electro-magnet in the front. The upper pole windings are connected as the galvanometer leg of a Wheatstone Bridge circuit, and the lower pole winding in parallel with the Bridge as shown in Fig. 1. The lower pole winding and the Bridge as shown in Fig. 1. The lower pole winding and the bridge are energized from a current transformer connected to carry the load current of the apparatus being protected. Since the impedance of the bridge is largely resistance, and that of the lower winding almost entirely reactance, there is sufficient phase displacement between the currents in the two relay windings to give a positive rotational torque to the disc.

Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION AND CHARACTERISTICS

The operation of the relay is as follows with reference to Fig. 1. When the resistance of the exploring coils is increased by the rising temperature of the apparatus to equal the resistance of the fixed sides of the bridge, no current will flow thru the upper pole of the relay and there will be no torque. The relay is normally set at the factory so that the bridge circuit is balanced at either 5° or 10° Centigrade below the operating temperature which the customer sets as being the limit which he does not want to exceed. The relay is connected so that when the resistances of the exploring coils are higher than the critical resistance the torque is in the contact closing direction, and when less the torque is in the contact opening direction. Thus the relay will not trip on any load current as long as the temperature of the machine as indicated by the change in resistance of the exploring coil is within the safe limits. If the temperature rises above the safe limit, and the full load current is exceeded, the relay contacts will close.

The closing torque of the Type CT relay is approximately proportional to the product of the current squared and the temperature difference from the balance point. With the rise of these values above the operating limits, the relay contact close with a rapidly increasing force. The limited travel of the disc permits a very short operating time when the operating limits are exceeded considerably.

When the resistance of the leads from the exploring coils to the relay is known at the time the relay is manufactured, each of the two resistors of the bridge circuit is constructed with a resistance equal to that of the exploring coil at the balance temperature plus the resistance of one pair of leads. Since the lead resistance is not affected by the temperature of the exploring coil, the effect of appreciable lead resistance is to reduce the degree of unbalance

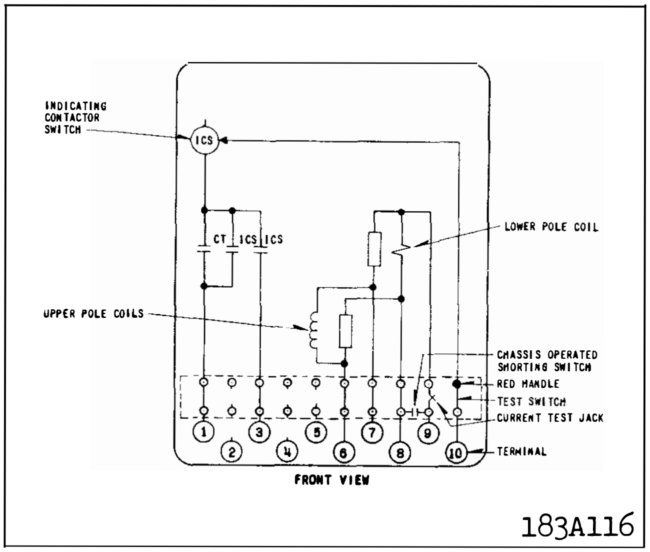

Fig. 2. Internal Schematic of the Type CT Relay in the Type FT21 Case 7-Terminal Relay for use where Exploring Coil Lead Resistance is Known When Relay is Manufactured.

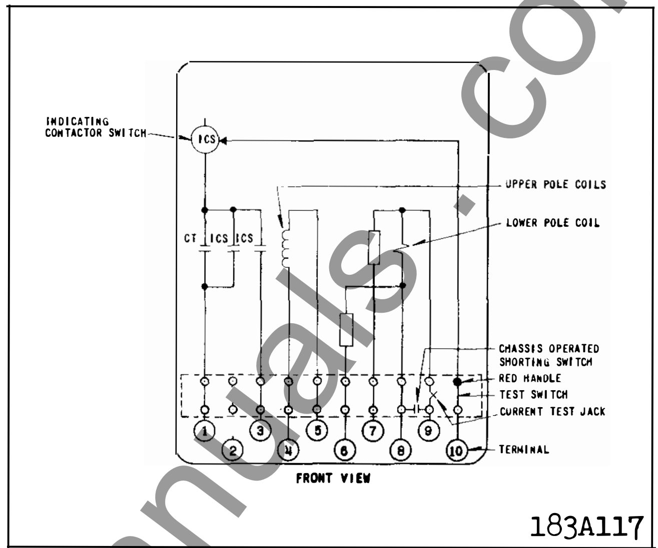

Fig. 3. Internal Schematic of the Type CT Relay in the Type FT21 Case 9-Terminal Relay for use Where Exploring Coil Lead Resistance is Unknown When Relay is Manufactured.

of the bridge at temperatures above or below the balance point. However, lead resistances usually are less than 0.5 ohm per pair, and the reduction in sensitivity would not be serious with lead resistances of 1.0 ohm.

When the resistance of the leads from the exploring coils to the relay can not be determined accurately before the relay is manufactured, the CT relay can be used with internal connections as shown in Fig. 3. The upper pole winding (connected in the galvanometer circuit of the bridge) is connected to independent terminals, and three leads (instead of two) are required between the relay and each exploring coil. With this connection, the resistance of one lead is inserted in each exploring coil leg of the bridge, and the resistance of one lead is inserted in each relay resistor leg. Thus, the balance of the bridge is not affected by the lead resistance. However, the resistance of two leads is inserted in the galvanometer circuit. The relay is rendered somewhat less sensitive by this, but with lead resistance of 0.5 ohm each the operating temperature at full load would be raised less than 2°C above the temperature for zero lead resistance. The necessity of using a total of six leads instead of four may be objectionable in some cases, however.

Trip Circuit

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constant

Indicating Contactor Switch (ICS)

0.2 ampere tap 6.5 ohms d-c resistance
2.0 ampere tap 0.15 ohms d-c resistance

EXPLORING COILS

It is preferable to use exploring coils which are built into the apparatus to be protected at the time of manufacture as they can be placed in the winding slots or otherwise brought into proximity to the windings being protected close to the point of highest temperature rise. The physical design of these coils will vary with the individual apparatus, but exploring coils usually are copper, with a resistance of 10 ohms at 25°C.

If a motor or generator has been built without exploring coils and it is desired to provide temperature-overload protection by means of the type CT relay, a "Rope Coil" may be fastened to the end connections

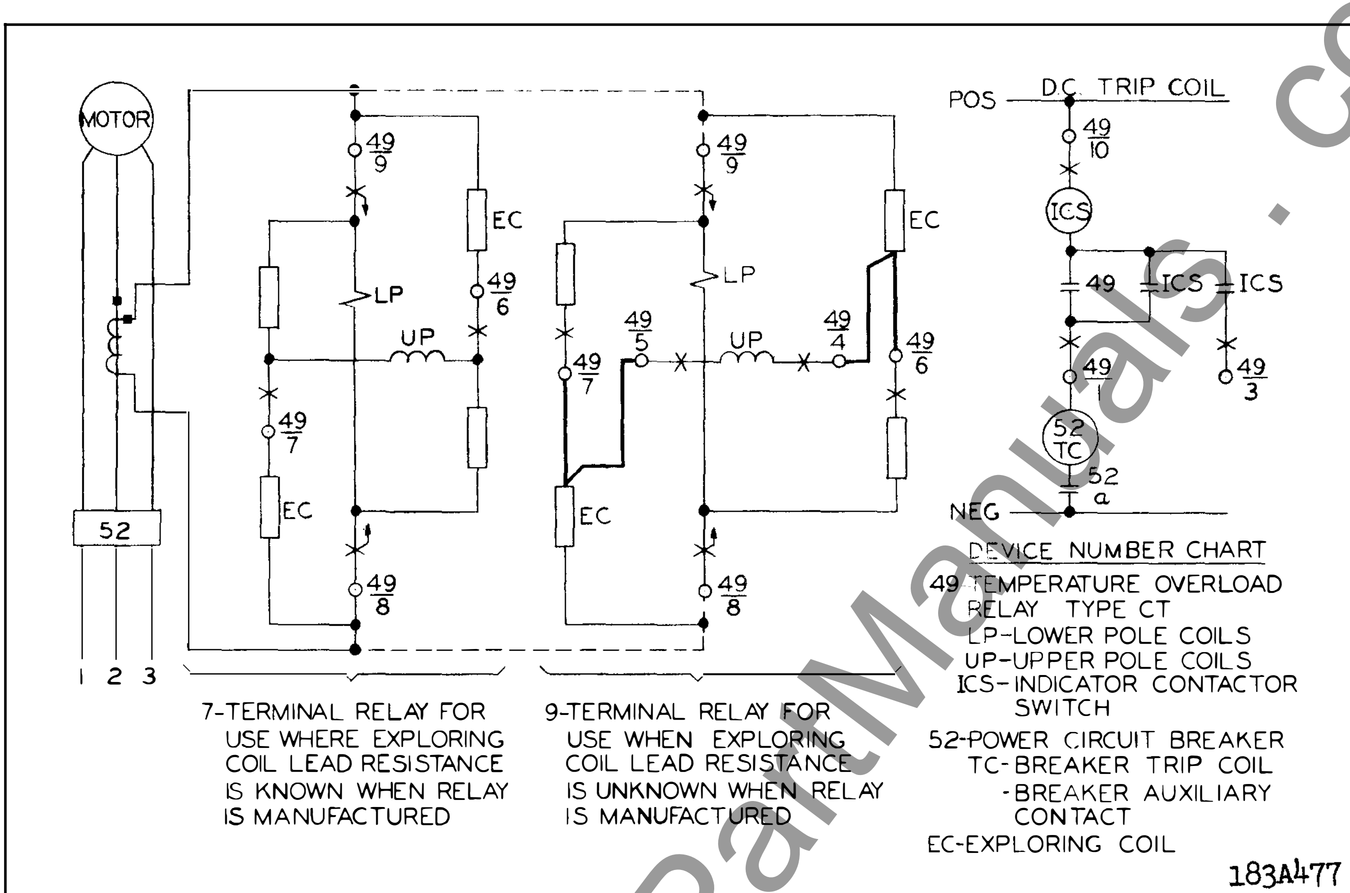

Fig. 4. External Schematic of the Type CT Temperator Overload Relay.

of the windings. Because of its location it can not indicate the winding temperature as accurately as a built-in exploring coil. The "Rope Coil" is a flat loop or skein of wire approximately 10 feet long. Two strands of enameled copper wire are wound in parallel and four leads are brought out, providing the two exploring coil sides of the bridge in the one winding. The coil then is insulated with a tape winding and is varnish dipped and baked. It is sufficiently flexible to permit placing and tying it around the end connections of the winding.

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 four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detailed FT case information refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

All contacts should be periodically cleaned. A contact burnisher S#182A836H01 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.

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.

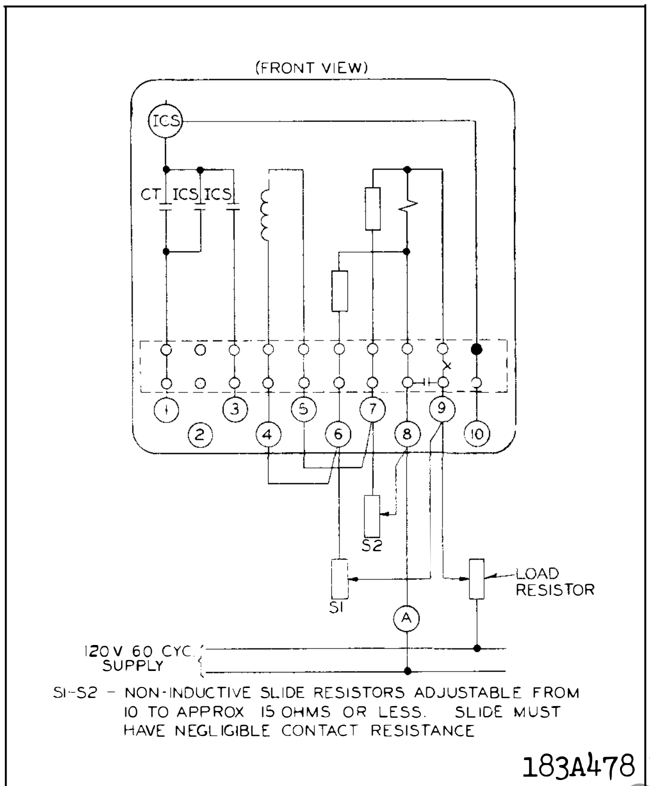

Fig. 5. Diagram of Test Connections for the Type CT Relay in Type FT21 Case.

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, the instructions below should be followed.

Operating Coil

To check the operating coils, connect the relay per Fig. 5. The relay should trip at "A" amperes and "T" degrees C. as marked on its nameplate. The temperature may be represented by increasing the resistance of the exploring coil sides of the bridge by means of slide wire resistances, to the values corresponding as shown in the following table: ▲

Resistance	Temperature	Resistance	Temperature
10.00 ohms	25°C.	12.89	100
10.96	50	13.28	110
11.35	60	13.66	120
11.73	70	14.05	130
12.12	80	14.43	140
12.50	90	14.82	150

▲ NOTE – This table applies only to copper wire coils having 10 ohms resistance at 25°C.

Indicating Contactor Switch (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the particular ICS tap setting being used. The indicator target should drop freely.

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 60 cycle burden of the relay on the current transformer is 15.0 volt-amperes at 5 amperes, 49° lag Power Factor. The continuous rating of the winding is 5 amperes (10 ohms exploring coil), and the one second rating 150 amperes, 60 cycles.

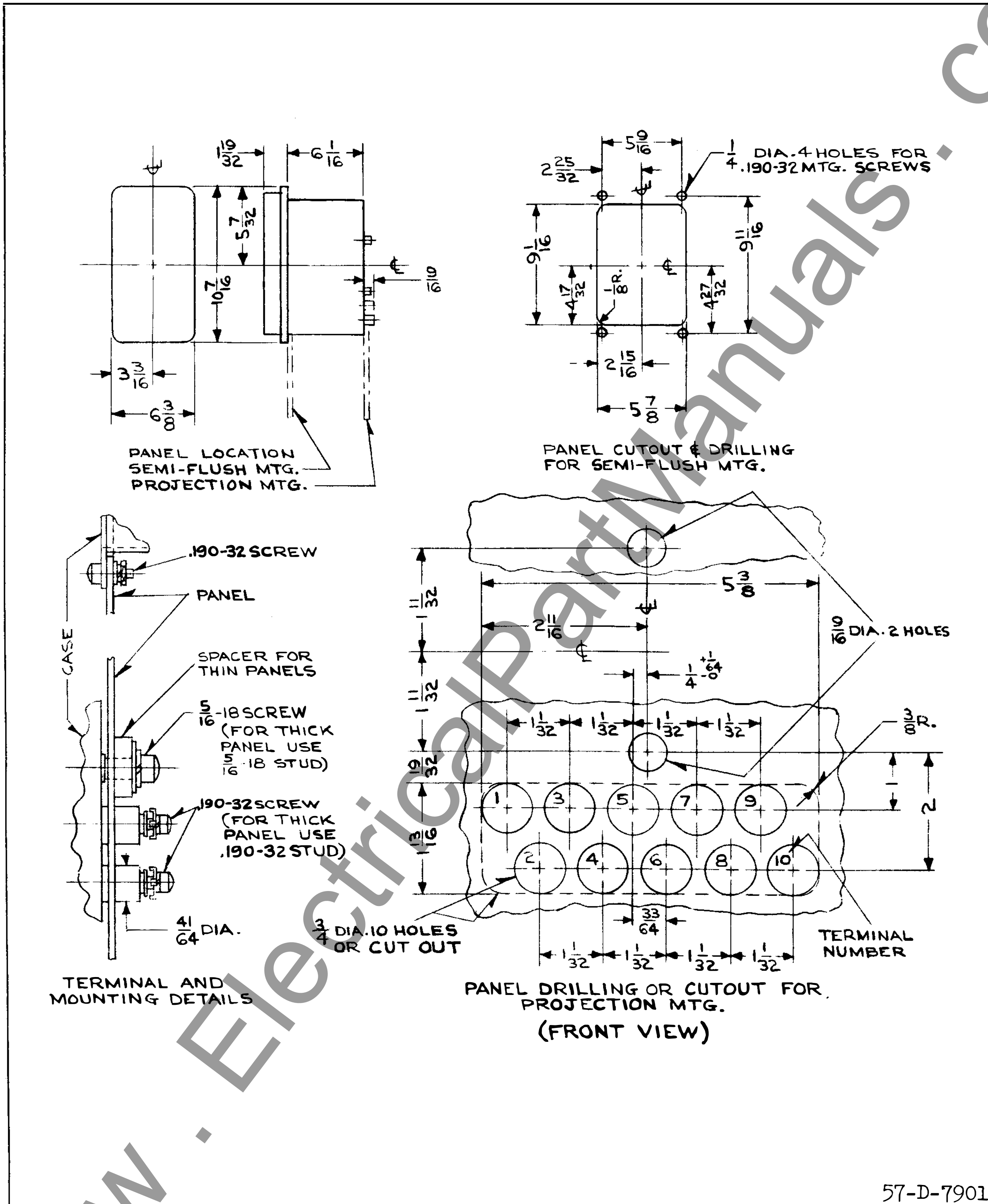

Fig. 6. Outline and Drilling Plan for the Type CT Relay in the Type FT21 Case.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION **NEWARK, N.J.**

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CT TEMPERATURE-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 CT relay is an induction type relay operating from exploring coils imbedded in or attached to the equipment being protected, and from a line current transformer. The relay is used to protect a-c equipment from overheating resulting from overloads, open phase, or insulation failure when the line current may be insufficient to operate short circuit protective devices. In order for the relay to operate, the temperature of the windings of the apparatus must be above values for which the relay is set, and these two conditions must have existed for a certain period of time because of the inherent time-delay of the induction-type unit. Thus, the danger of disconnecting the apparatus upon transient overloads is eliminated.

This relay is manufactured and set at the factory for each application and cannot be changed after shipment. In order to make the application, the following information is necessary:

1. Frequency of the connected system.
2. Power rating of the apparatus being protected.
3. Full load phase current.
4. Current transformer ratio. This should be chosen so that the full load secondary current is between 3.25 and 5 amperes if possible. This permits use of a 5°C. differential between the balance temperature and the operating temperature. However, by using a differential of 10°C between the balance temperature and the operating temperature, a full load secondary current as low as 2.25 amperes can be permitted in 60 cycle applications.
5. Maximum safe operating temperature at which the relay must trip if full load current or more is present.
6. The metal (usually copper) used in the exploring coil windings and its temperature coefficient of resistance at 25° Centigrade.
7. Resistance of each exploring coil at 25° Centigrade. (Standard relays are available for use with 10 ohm exploring coils only.)
8. Ambient temperature (if appreciably different from 25°C).
9. Resistance of the leads from the exploring coils to the relay terminals. However, if resistance of the leads can not be predetermined, the effect of lead resistance can be balanced out at slight sacrifice of sensitivity by using relays with additional terminals as shown in Fig. 3 and by using three leads to each exploring coil instead of two.

CONSTRUCTION

* The type CT relay consists of an operating unit, two fixed resistor, and an indicating contactor switch unit.

Operating Unit

This unit is the induction-disc type. The induction disc is mounted on a vertical shaft. A stop riveted to the disc prevents the contact from opening more than approx. 1/4 of an inch. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The electrical connection is made from the moving contact thru the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a

SUPERSEDES I.L. 41-551.1
*Denotes change from superseded issue.

EFFECTIVE APRIL 1959

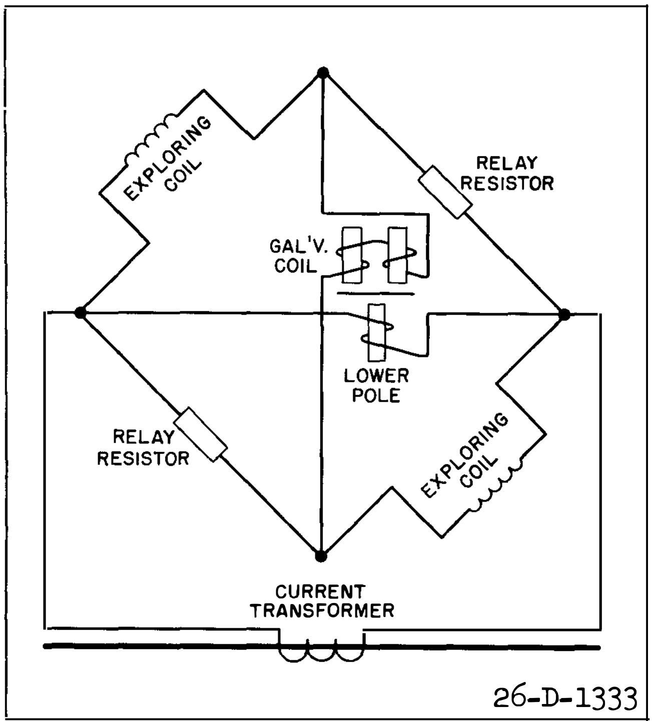


Fig. 1. Schematic Diagram of the Internal and External Connections of the Type CT Relay.

silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow.

Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION AND CHARACTERISTICS

* The relay is connected as a Wheatstone Bridge to the protected apparatus as shown in Fig. 1. Since the impedance of the bridge is resistance, and that of the lower pole winding reactance, there is sufficient phase displacement between the currents in the two windings of the relay to give a positive torque to the disc.

The lower pole winding of the relay is energized by load current of the protected apparatus while the upper pole winding is energized by current flowing as a result of an unbalance in the Wheatstone Bridge. When the temperature of the protected apparatus is lower than the critical temperature, the resistance of the exploring coils is less than the fixed resistors of the relay. This unbalances the Bridge and causes a current to flow in the upper pole winding of the relay. The direction of this current in relationship to the lower pole current is such that a contact opening torque is produced on the disc. When the temperature of the protected apparatus is greater than the critical temperature, the resistance of the exploring coils is greater than the fixed resistors of the relay. The Wheatstone Bridge is unbalanced, and a current flows in the upper pole of the relay. The direction of this current in relationship to the lower pole current is such that a control closing torque is produced on the disc. When the temperature of the protected apparatus is the same as the critical temperature, all resistances of the Wheatstone Bridge are equal. As a result, current will not flow in the upper pole winding and torque will not be produced on the disc. The relay is calibrated at the factory for a specific value of operating temperature and current. The balance temperature is usually set to be 5^{O} to 10^{O}C below the desired tripping temperature.

The closing torque of the Type CT relay is approximately proportional to the product of the current squared and the temperature difference from the balance point. With the rise of these values above the operating limits, the relay contact close with a rapidly increasing force. The limited travel of the disc permits a very short operating time when the operating limits are exceeded considerably.

When the resistance of the leads from the exploring coils to the relay is known at the time the relay is manufactured, each of the two resistors of the bridge circuit is constructed with a resistance equal to that of the exploring coil at the balance temperature plus the resistance of one pair of leads. Since

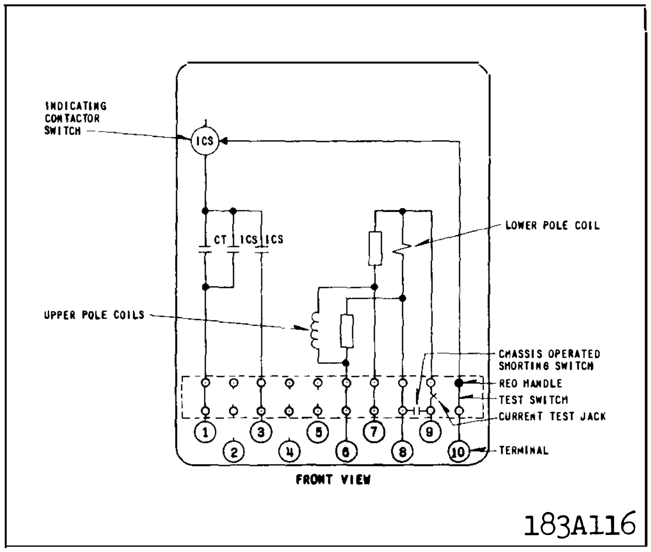


Fig. 2. ***Internal Schematic of the Type CT Relay in the Type FT21 Case 7-Terminal Relay for use where Exploring Coil Lead Resistance is Known When Relay is Manufactured.***

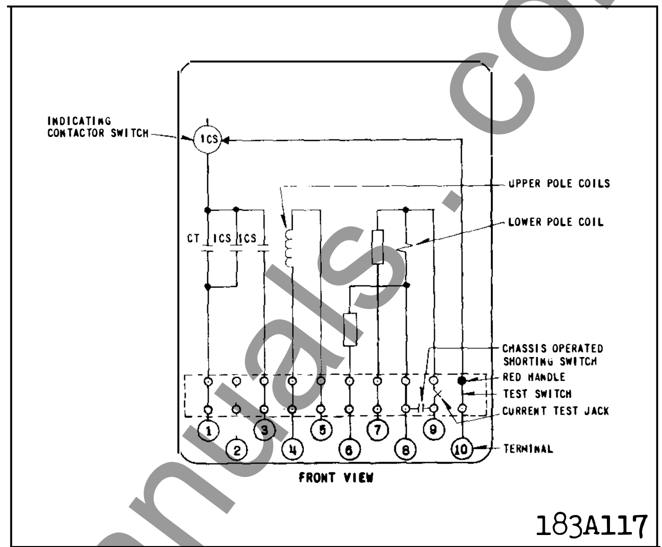


Fig. 3. ***Internal Schematic of the Type CT Relay in the Type FT21 Case 9-Terminal Relay for use Where Exploring Coil Lead Resistance is Unknown When Relay is Manufactured.***

the lead resistance is not affected by the temperature of the exploring coil, the effect of appreciable lead resistance is to reduce the degree of unbalance of the bridge at temperatures above or below the balance point. However, lead resistances usually are less than 0.5 ohm per pair, and the reduction in sensitivity would not be serious with lead resistances of 1.0 ohm.

When the resistance of the leads from the exploring coils to the relay can not be determined accurately before the relay is manufactured, the CT relay can be used with internal connections as shown in Fig. 3. The upper pole winding (connected in the galvanometer circuit of the bridge) is connected to independent terminals, and three leads (instead of two) are required between the relay and each exploring coil. With this connection, the resistance of one lead is inserted in each exploring coil leg of the bridge, and the resistance of one lead is inserted in each relay resistor leg. Thus, the balance of the bridge is not affected by the lead resistance. However, the resistance of two leads is inserted in the galvanometer circuit. The relay is rendered somewhat less sensitive by this, but with lead resistance of 0.5 ohm each the operating temperature at full load would be raised less than 2°C above the temperature for zero lead resistance. The necessity of using a total of six leads instead of four may be objectionable in some cases, however.

Trip Circuit

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constant

Indicating Contactor Switch (ICS)

0.2 ampere tap 6.5 ohms d-c resistance
2.0 ampere tap 0.15 ohms d-c resistance

EXPLORING COILS

It is preferable to use exploring coils which are built into the apparatus to be protected at the time of manufacture as they can be placed in the winding slots or otherwise brought into proximity to the windings being protected close to the point of highest temperature rise. The physical design of these coils will vary with the individual apparatus, but exploring coils usually are copper, with a resistance of 10 ohms at 25°C.

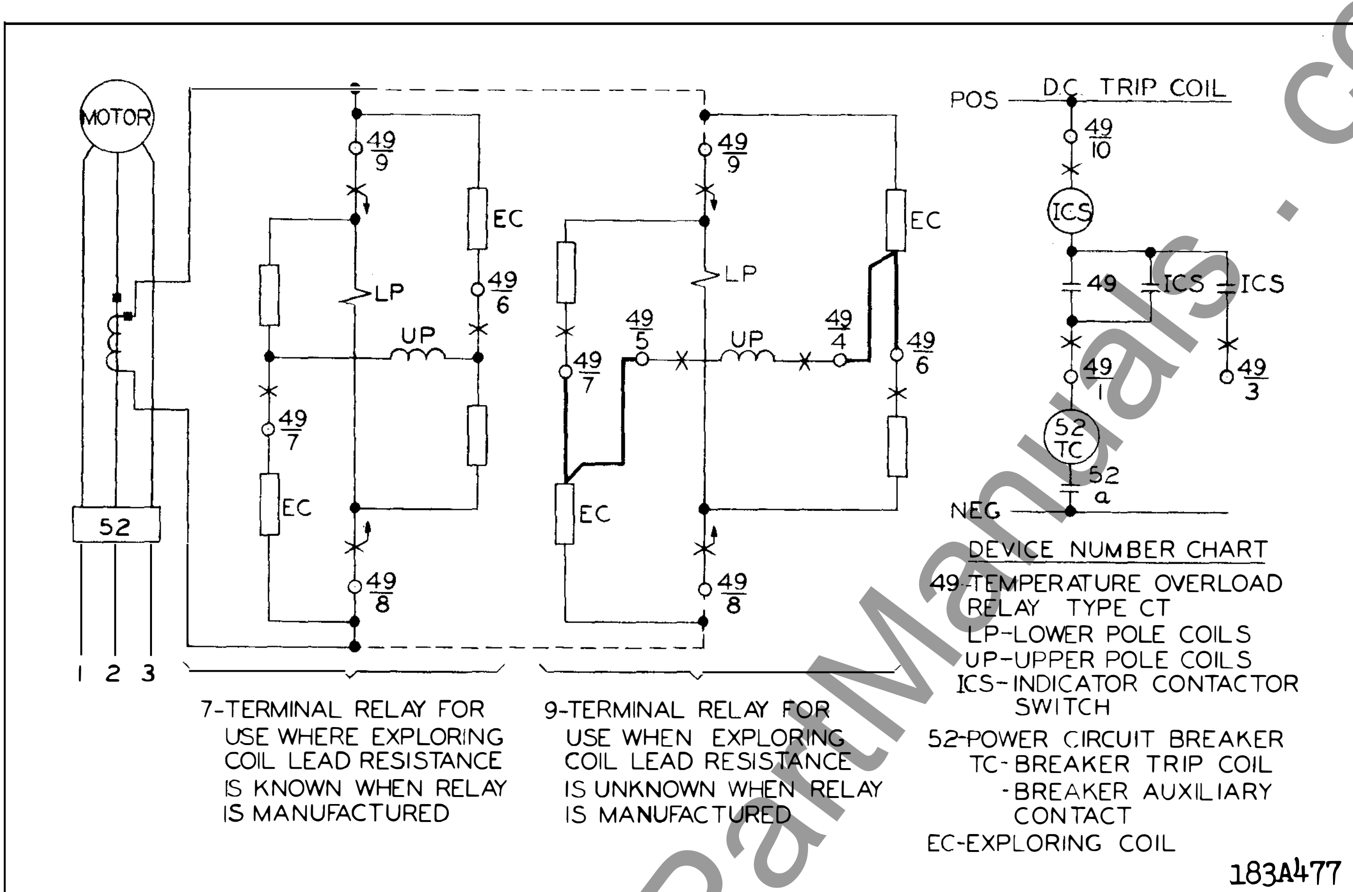


Fig. 4. External Schematic of the Type CT Temperature Overload Relay.

If a motor or generator has been built without exploring coils and it is desired to provide temperature-overload protection by means of the type CT relay, a "Rope Coil" may be fastened to the end connections of the windings. Because of its location it can not indicate the winding temperature as accurately as a built-in exploring coil. The "Rope Coil" is a flat loop or skein of wire approximately 10 feet long. Two strands of enameled copper wire are wound in parallel and four leads are brought out, providing the two exploring coil sides of the bridge in the one winding. The coil then is insulated with a tape winding and is varnish dipped and baked. It is sufficiently flexible to permit placing and tying it around the end connections of the winding.

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 four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detailed FT case information refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

All contacts should be periodically cleaned. A contact burnisher S#182A836H01 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.

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.

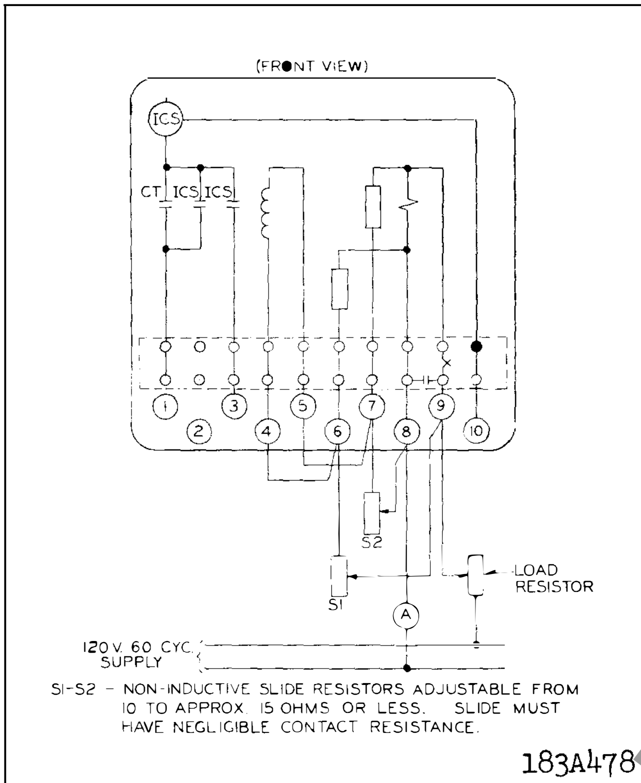


Fig. 5. Diagram of Test Connections for the Type CT Relay in Type FT21 Case.

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, the instructions below should be followed.

Operating Coil

To check the operating coils, connect the relay per Fig. 5. The relay should trip at "A" amperes and "T" degrees C. as marked on its nameplate. The temperature may be represented by increasing the resistance of the exploring coil sides of the bridge by means of slide wire resistances, to the values corresponding as shown in the following table: ▲

Resistance	Temperature	Resistance	Temperature
10.00 ohms	25°C.	12.89◆	100
10.96	50	13.28	110
11.35	60	13.66	120
11.73	70	14.05	130
12.12	80	14.43	140
12.50	90	14.82	150

▲ NOTE – This table applies only to copper wire coils having 10 ohms resistance at 25°C.

Indicating Contactor Switch (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the particular ICS tap setting being used. The indicator target should drop freely.

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 60 cycle burden of the relay on the current transformer is 15.0 volt-amperes at 5 amperes, 49° lag Power Factor. The continuous rating of the winding is 5 amperes (10 ohms exploring coil), and the one second rating 150 amperes, 60 cycles.

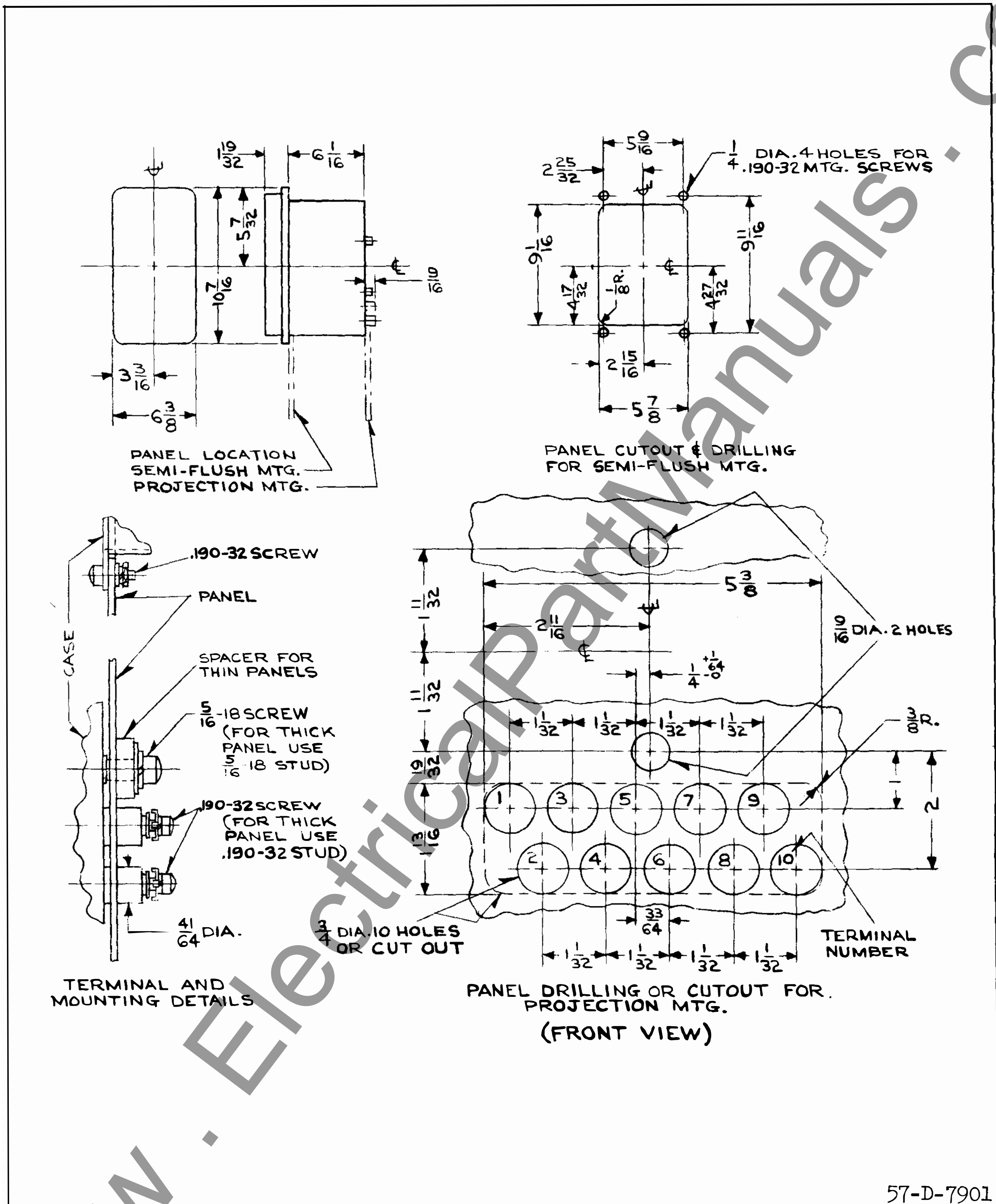
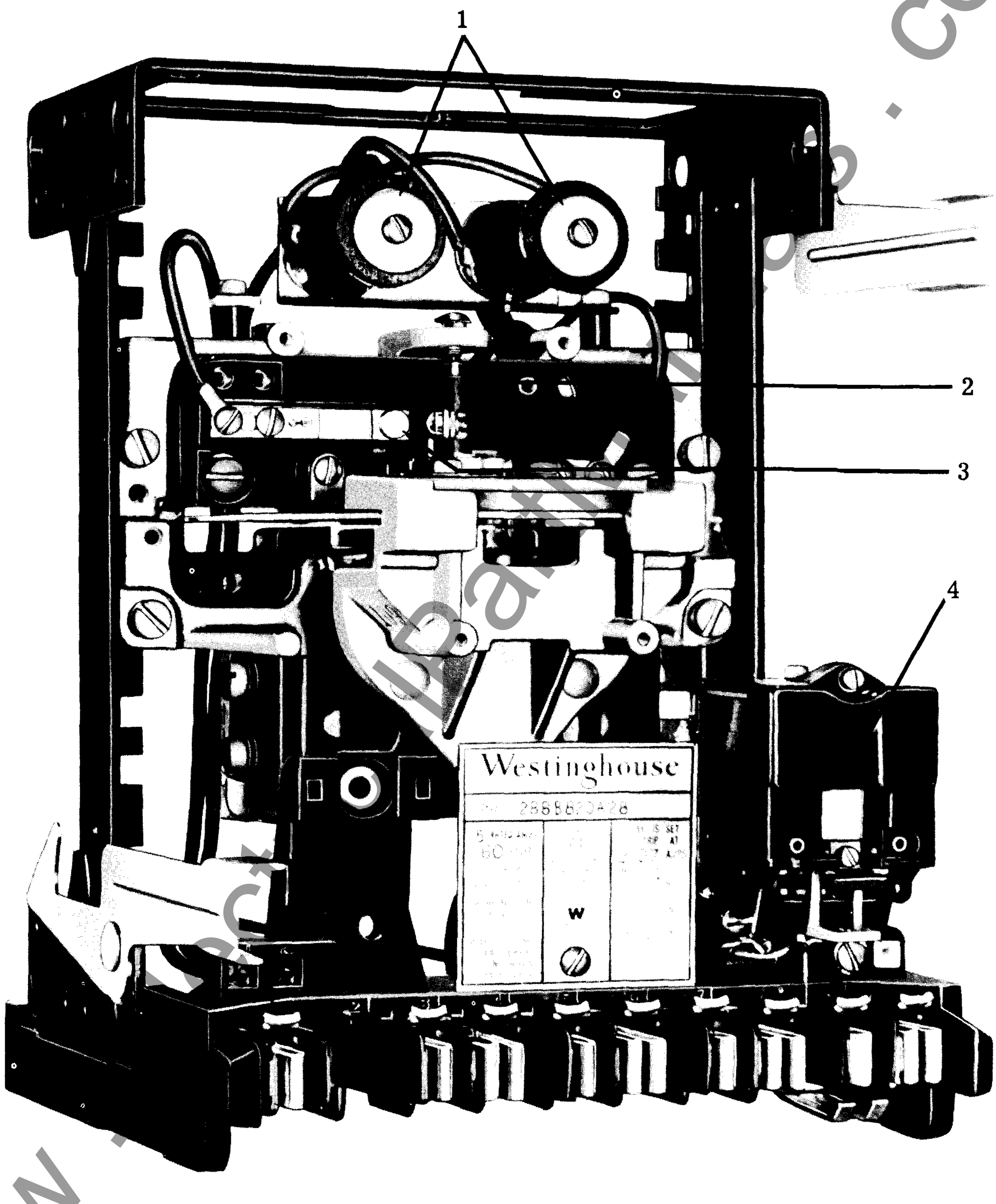


Fig. 6. Outline and Drilling Plan for the Type CT Relay in the Type FT21 Case.



* *Fig. 7. Type CT Relay 1 – Balancing Resistor. 2 – Moving Contact Assembly. 3 – Stationary Contact Assembly. 4 – Indicating Contactor Switch (ICS).*

WESTINGHOUSE ELECTRIC CORPORATION

RELAY DEPARTMENT **NEWARK, N. J.**

Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CT TEMPERATURE-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 CT relay is an induction type relay operating from exploring coils imbedded in or attached to the equipment being protected, and from a line current transformer. The relay is used to protect a-c equipment from overheating resulting from overloads, open phase, or insulation failure when the line current may be insufficient to operate short circuit protective devices. In order for the relay to operate, the temperature of the windings of the apparatus must be above values for which the relay is set, and these two conditions must have existed for a certain period of time because of the inherent time-delay of the induction-type unit. Thus, the danger of disconnecting the apparatus upon transient overloads is eliminated.

This relay is manufactured and set at the factory for each application and cannot be changed after shipment. In order to make the application, the following information is necessary:

1. Frequency of the connected system.
2. Power rating of the apparatus being protected.
3. Full load phase current.
4. Current transformer ratio. This should be chosen so that the full load secondary current is between 3.25 and 5 amperes if possible. This permits use of a 5°C. differential between the balance temperature and the operating temperature. However, by using a differential of 10°C between the balance temperature and the operating temperature, a full load secondary current as low as 2.25 amperes can be permitted in 60 cycle applications.
5. Maximum safe operating temperature at which the relay must trip if full load current or more is present.
6. The metal (usually copper) used in the exploring coil windings and its temperature coefficient of resistance at 25° Centigrade.
7. Resistance of each exploring coil at 25° Centigrade. (Standard relays are available for use with 10 ohm exploring coils only.)
8. Ambient temperature (if appreciably different from 25°C).
9. Resistance of the leads from the exploring coils to the relay terminals. However, if resistance of the leads can not be predetermined, the effect of lead resistance can be balanced out at slight sacrifice of sensitivity by using relays with additional terminals as shown in Fig. 3 and by using three leads to each exploring coil instead of two.

CONSTRUCTION

* The type CT relay consists of an operating unit, two fixed resistor, and an indicating contactor switch unit.

Operating Unit

This unit is the induction-disc type. The induction disc is mounted on a vertical shaft. A stop riveted to the disc prevents the contact from opening more than approx. 1/4 of an inch. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The electrical connection is made from the moving contact thru the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a

SUPERSEDES I.L. 41-551.1
*Denotes change from superseded issue.

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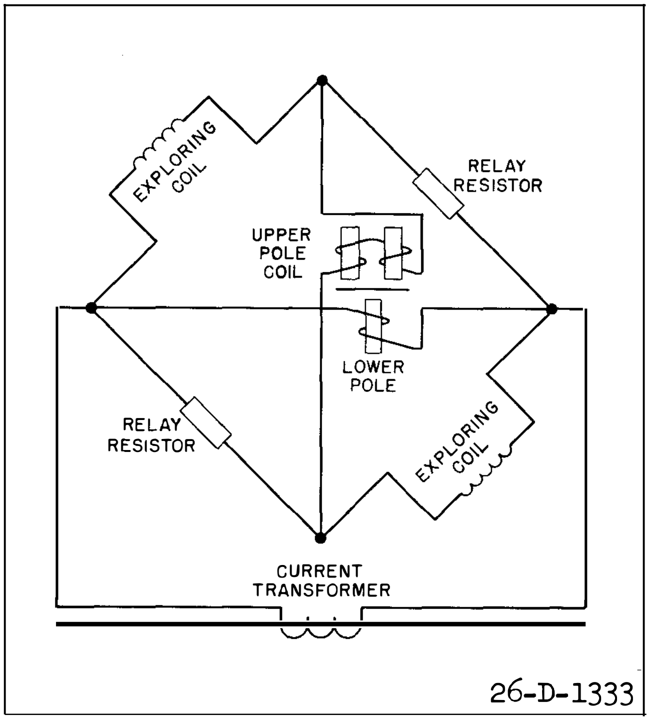


Fig. 1. Schematic Diagram of the Internal and External Connections of the Type CT Relay.

silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow.

Indicating Contactor Switch Unit (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION AND CHARACTERISTICS

* The relay is connected as a Wheatstone Bridge to the protected apparatus as shown in Fig. 1. Since the impedance of the bridge is resistance, and that of the lower pole winding reactance, there is sufficient phase displacement between the currents in the two windings of the relay to give a positive torque to the disc.

The lower pole winding of the relay is energized by load current of the protected apparatus while the upper pole winding is energized by current flowing as a result of an unbalance in the Wheatstone Bridge. When the temperature of the protected apparatus is lower than the critical temperature, the resistance of the exploring coils is less than the fixed resistors of the relay. This unbalances the Bridge and causes a current to flow in the upper pole winding of the relay. The direction of this current in relationship to the lower pole current is such that a contact opening torque is produced on the disc. When the temperature of the protected apparatus is greater than the critical temperature, the resistance of the exploring coils is greater than the fixed resistors of the relay. The Wheatstone Bridge is unbalanced, and a current flows in the upper pole of the relay. The direction of this current in relationship to the lower pole current is such that a control closing torque is produced on the disc. When the temperature of the protected apparatus is the same as the critical temperature, all resistances of the Wheatstone Bridge are equal. As a result, current will not flow in the upper pole winding and torque will not be produced on the disc. The relay is calibrated at the factory for a specific value of operating temperature and current. The balance temperature is usually set to be 5^o to 10^oC below the desired tripping temperature.

The closing torque of the Type CT relay is approximately proportional to the product of the current squared and the temperature difference from the balance point. With the rise of these values above the operating limits, the relay contact close with a rapidly increasing force. The limited travel of the disc permits a very short operating time when the operating limits are exceeded considerably.

When the resistance of the leads from the exploring coils to the relay is known at the time the relay is manufactured, each of the two resistors of the bridge circuit is constructed with a resistance equal to that of the exploring coil at the balance temperature plus the resistance of one pair of leads. Since

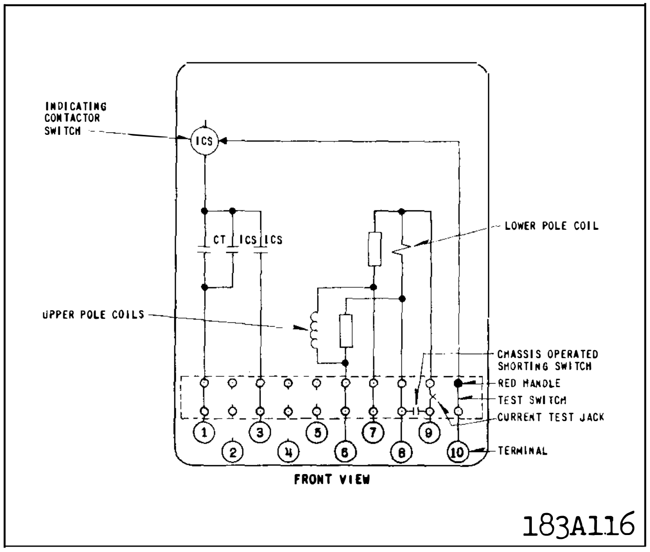


Fig. 2. Internal Schematic of the Type CT Relay in the Type FT21 Case 7-Terminal Relay for use where Exploring Coil Lead Resistance is Known When Relay is Manufactured.

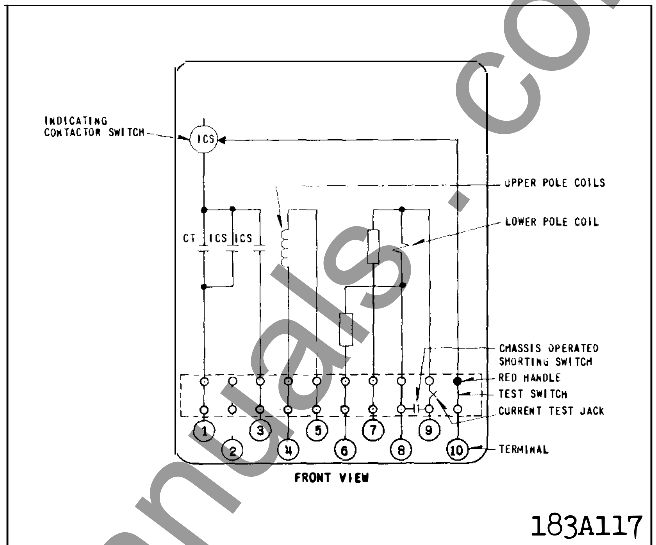


Fig. 3. Internal Schematic of the Type CT Relay in the Type FT21 Case 9-Terminal Relay for use Where Exploring Coil Lead Resistance is Unknown When Relay is Manufactured.

the lead resistance is not affected by the temperature of the exploring coil, the effect of appreciable lead resistance is to reduce the degree of unbalance of the bridge at temperatures above or below the balance point. However, lead resistances usually are less than 0.5 ohm per pair, and the reduction in sensitivity would not be serious with lead resistances of 1.0 ohm.

When the resistance of the leads from the exploring coils to the relay can not be determined accurately before the relay is manufactured, the CT relay can be used with internal connections as shown in Fig. 3. The upper pole winding (connected in the galvanometer circuit of the bridge) is connected to independent terminals, and three leads (instead of two) are required between the relay and each exploring coil. With this connection, the resistance of one lead is inserted in each exploring coil leg of the bridge, and the resistance of one lead is inserted in each relay resistor leg. Thus, the balance of the bridge is not affected by the lead resistance. However, the resistance of two leads is inserted in the galvanometer circuit. The relay is rendered somewhat less sensitive by this, but with lead resistance of 0.5 ohm each the operating temperature at full load would be raised less than 2°C above the temperature for zero lead resistance. The necessity of using a total of six leads instead of four may be objectionable in some cases, however.

Trip Circuit

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constant

Indicating Contactor Switch (ICS)

0.2 ampere tap 6.5 ohms d-c resistance
2.0 ampere tap 0.15 ohms d-c resistance

EXPLORING COILS

It is preferable to use exploring coils which are built into the apparatus to be protected at the time of manufacture as they can be placed in the winding slots or otherwise brought into proximity to the windings being protected close to the point of highest temperature rise. The physical design of these coils will vary with the individual apparatus, but exploring coils usually are copper, with a resistance of 10 ohms at 25°C.

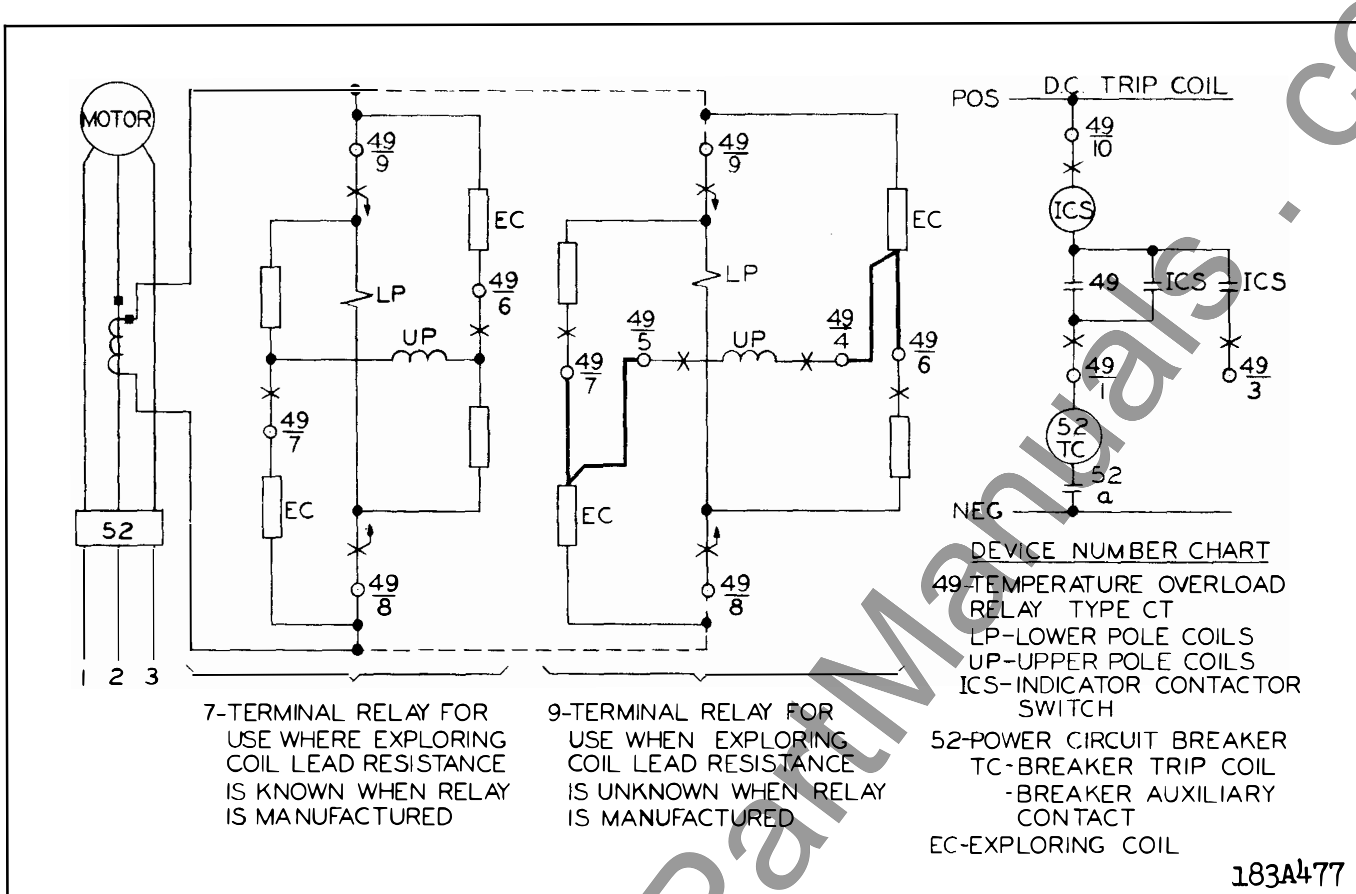


Fig. 4. External Schematic of the Type CT Temperature Overload Relay.

If a motor or generator has been built without exploring coils and it is desired to provide temperature-overload protection by means of the type CT relay, a "Rope Coil" may be fastened to the end connections of the windings. Because of its location it can not indicate the winding temperature as accurately as a built-in exploring coil. The "Rope Coil" is a flat loop or skein of wire approximately 10 feet long. Two strands of enameled copper wire are wound in parallel and four leads are brought out, providing the two exploring coil sides of the bridge in the one winding. The coil then is insulated with a tape winding and is varnish dipped and baked. It is sufficiently flexible to permit placing and tying it around the end connections of the winding.

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 four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detailed FT case information refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

All contacts should be periodically cleaned. A contact burnisher S#182A836H01 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.

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.

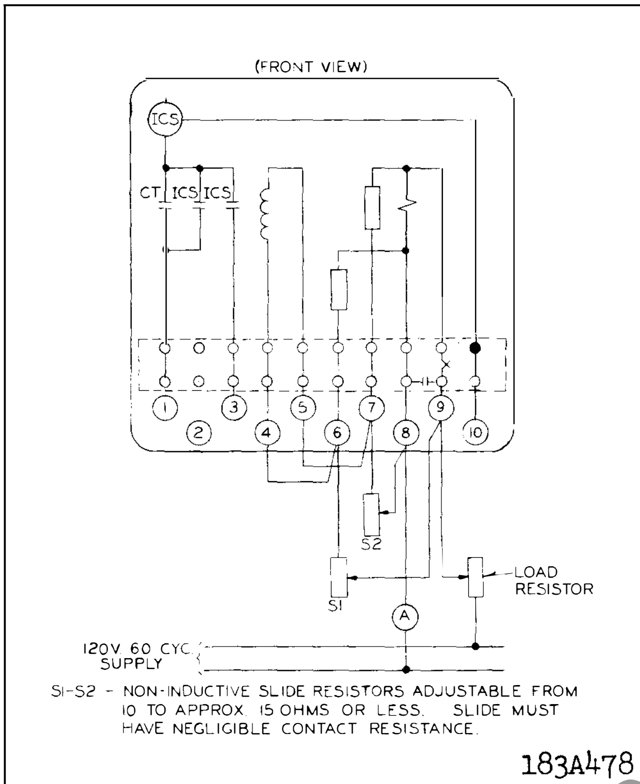


Fig. 5. Diagram of Test Connections for the Type CT Relay in Type FT21 Case.

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, the instructions below should be followed.

Operating Coil

To check the operating coils, connect the relay per Fig. 5. The relay should trip at "A" amperes and "T" degrees C. as marked on its nameplate. The temperature may be represented by increasing the resistance of the exploring coil sides of the bridge by means of slide wire resistances, to the values corresponding as shown in the following table: ▲

Resistance	Temperature	Resistance	Temperature
10.00 ohms	25°C.	12.89	100
10.96	50	13.28	110
11.35	60	13.66	120
11.73	70	14.05	130
12.12	80	14.43	140
12.50	90	14.82	150

▲ NOTE – This table applies only to copper wire coils having 10 ohms resistance at 25°C.

Indicating Contactor Switch (ICS)

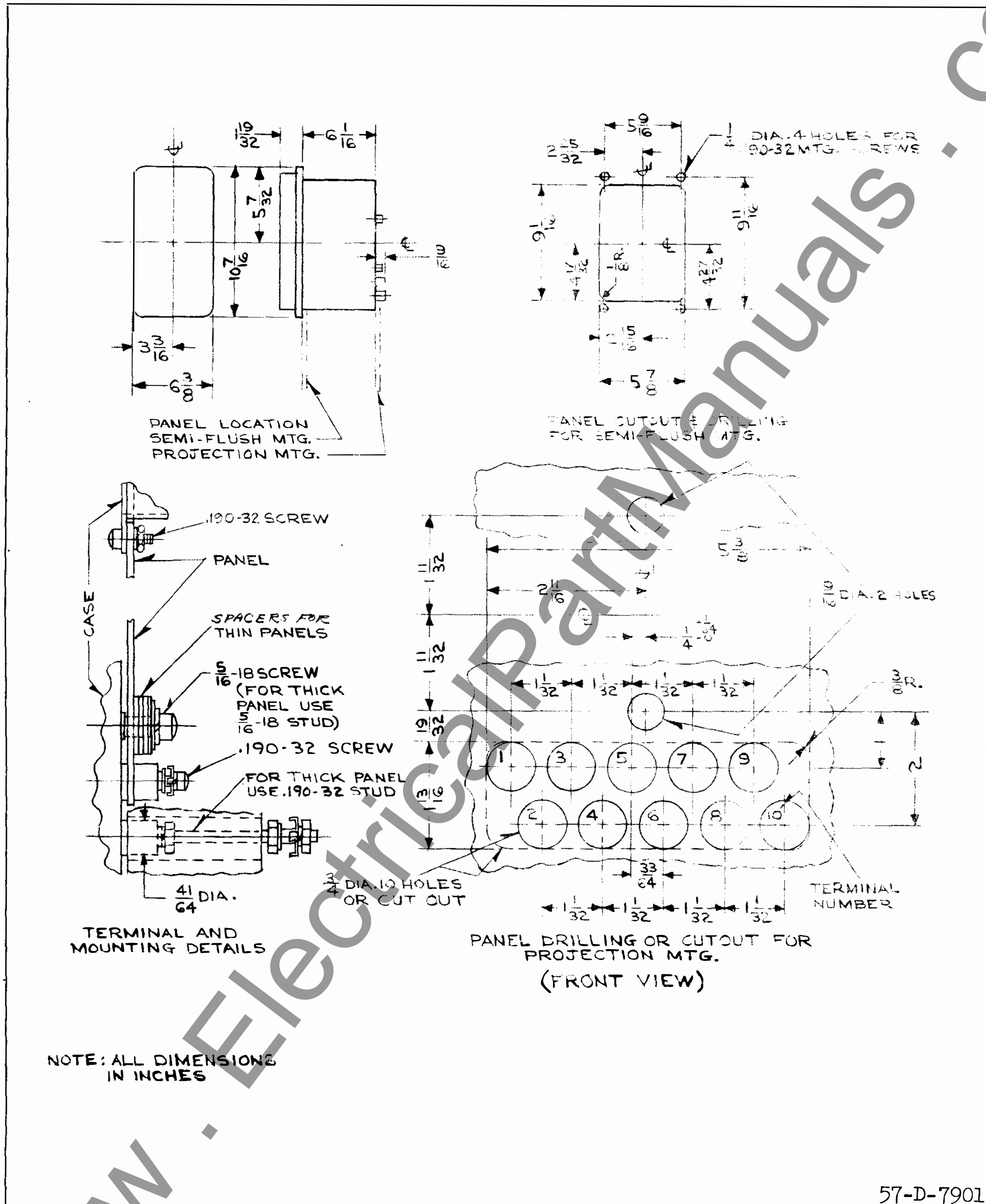
Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the particular ICS tap setting being used. The indicator target should drop freely.

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 60 cycle burden of the relay on the current transformer is 15.0 volt-amperes at 5 amperes, 49° lag Power Factor. The continuous rating of the winding is 5 amperes (10 ohms exploring coil), and the one second rating 150 amperes, 60 cycles.



NOTE: ALL DIMENSIONS IN INCHES

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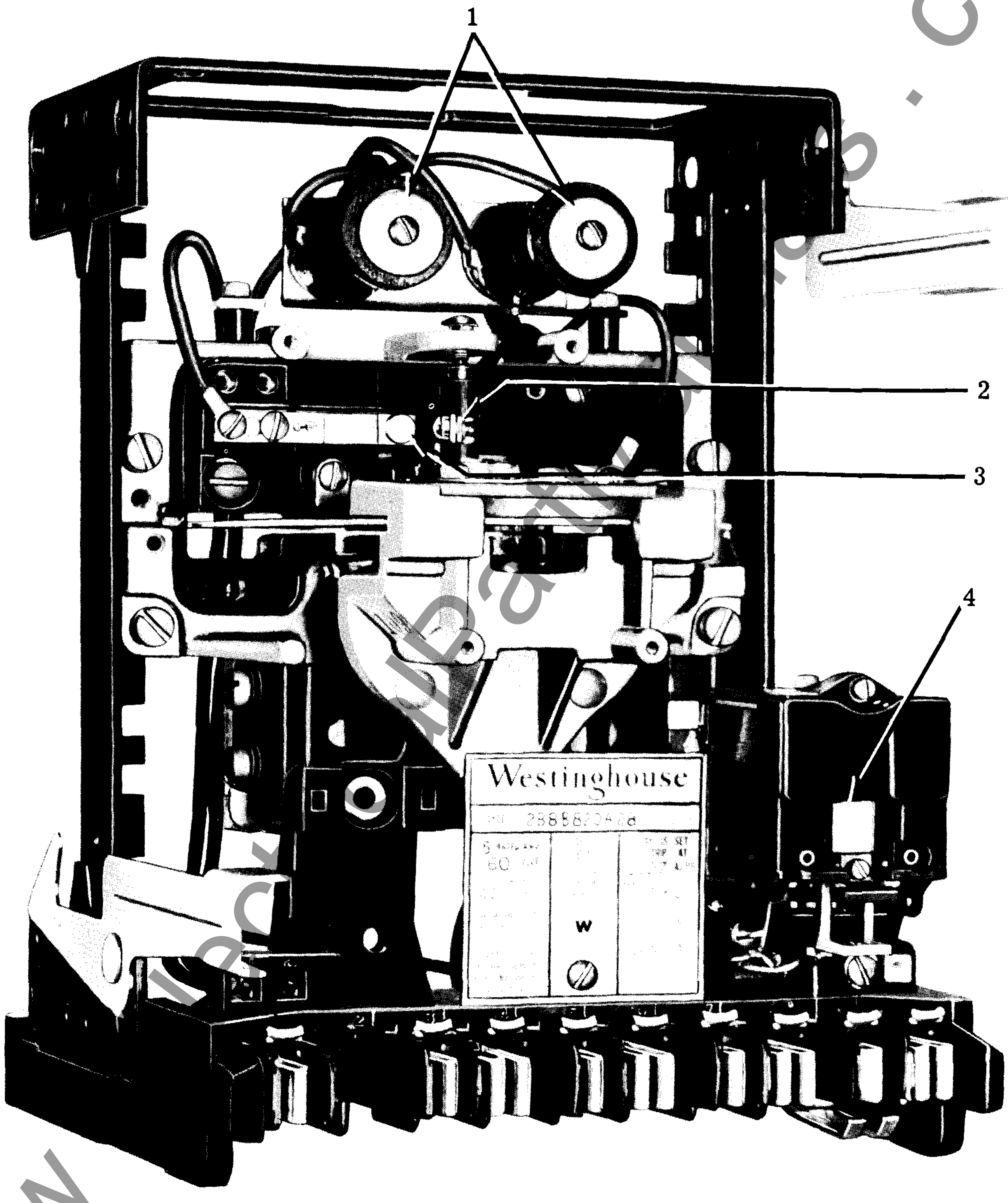
* ***Fig. 6. Outline and Drilling Plan for the Type CT Relay in the Type FT21 Case.***



* *Fig. 7. Type CT Relay 1 – Balancing Resistor. 2 – Moving Contact Assembly. 3 – Stationary Contact Assembly. 4 – Indicating Contactor Switch (ICS).*

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RELAY DEPARTMENT **NEWARK, N. J.**

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