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. Full load phase current.
3. 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.
4. Maximum safe operating temperature at which the relay must trip if full load current or more is present.
5. The metal (usually copper) used in the exploring coil windings and its temperature coefficient of resistance at 25° Centigrade.
6. Resistance of each exploring coil at 25° Centigrade. (Standard relays are available for use with 10 ohm exploring coils only.)
7. 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 resistors, 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. ¼ 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 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.

SUPERSEDES I.L. 41-551.2
Complete Revision

EFFECTIVE NOVEMBER 1965

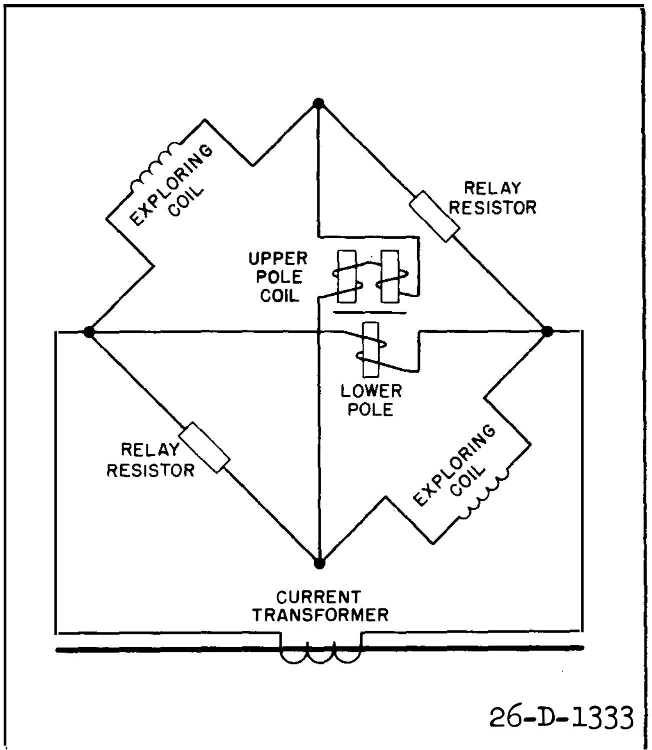


Fig. 1. Schematic Diagram of the Internal and External Connections of the Type CT Relay.

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 at 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° to 10°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.

For lower values of current the temperature at which the contacts will close can be approximated by the relationship $I^2\Delta t = K$. For example if relay rating is 4 amps trip current for a 10 °C differential we can solve for K ($K = I^2\Delta t = (4)^2 \times 10 = 160$). If the current decreases to 3 amps the differential temperature for trip now becomes approximately $\frac{160}{3^2} = 18$ °C.

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 brdige circuit is constructed with a resistance equal to that of the exploring coil at the balance tempera-

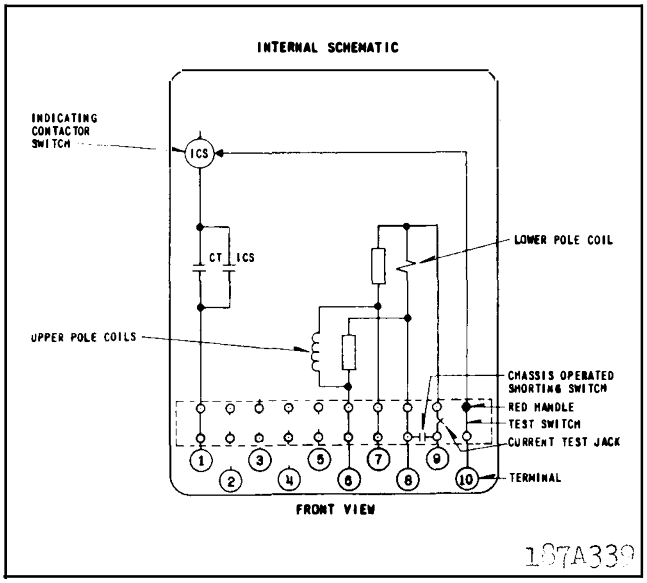


Fig. 2. Internal Schematic of the Type CT Relay in the Type FT21 Case 7-Terminal Relay for use where Exploring Coil Lead Resistance is Known When Relay is Manufactured.

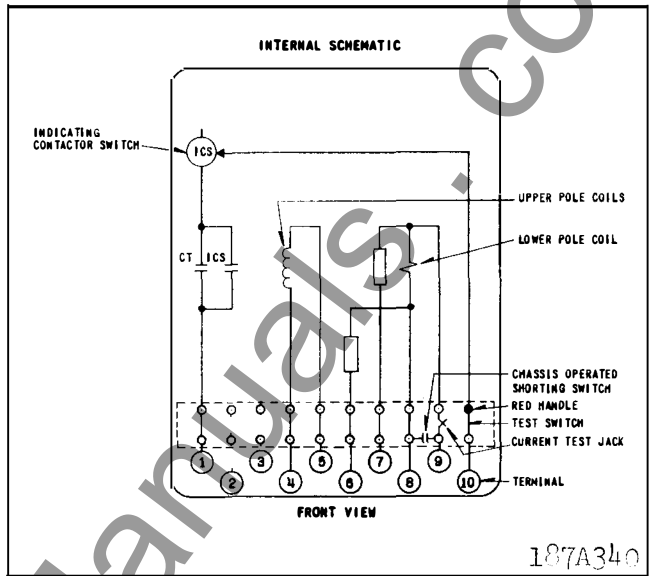


Fig. 3. Internal Schematic of the Type CT Relay in the Type FT21 Case 9-Terminal Relay for use Where Exploring Coil Lead Resistance is Unknown When Relay is Manufactured.

ture 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 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.

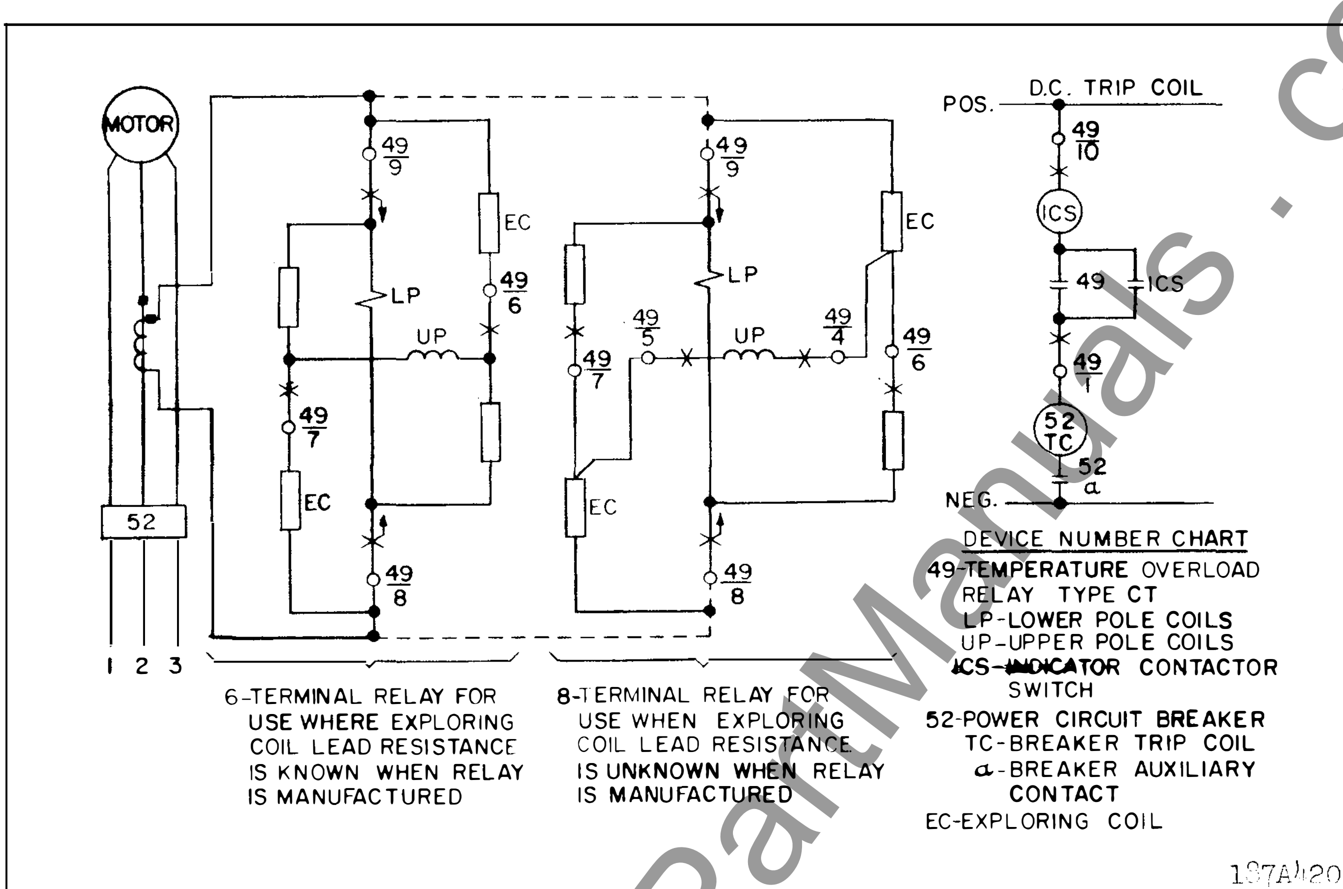


Fig. 4. External Schematic of the Type CT Temperature Overload Relay.

If a motor or generator has been built without exploringcoils 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.

SETTINGS

One setting is required for the operating unit; that is, the setting of the time dial. This setting should be on the number 1 position.

Each style relay is designed for a specific application and hence once the correct relay is chosen for a given application, no adjustment is necessary. If necessary, the spring tension controlling minimum operating current may be altered slightly.

Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is the selection of the 0.2 ampere or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125 or 250 volt d-c type WL relay switch or equivalent, use the 0.2 ampere tap; for 48 volt d-c applications set relay in 2 tap and use WL relay coil S#304C209G01 or equivalent.

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 projec-

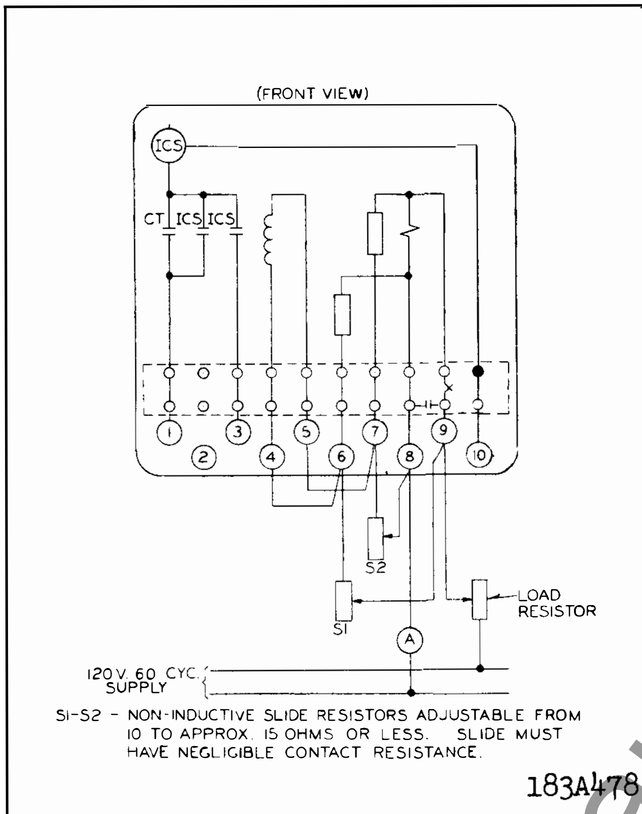


Fig. 5. Diagram of Test Connections for the Type CT Relay in Type FT21 Case.

tion 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

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.

Acceptance Tests

The following check is recommended to insure that the relay is in proper working order.

1. **Contact**

The index mark on the movement frame will coincide with the "0" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "0" mark by approximately .020 inch.

2. **Minimum Trip**

Connect the relay as per test circuit of Fig. 5. The relay should trip at the amperes and temperature specified on the nameplate. The equivalent value of temperature for different values of resistance is shown in Table I. This curve applies to copper wire coils with 10 ohms resistance at 25 °C.

3. **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.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

Routine Maintenance

All relays should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher Style #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.

Calibration

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order (See "Acceptance Check").

1. **Contact**

The index mark on the movement frame will coincide with the "0" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "0" mark by approximately .020".

2. **Minimum Trip**

The balance temperature of the relay is determined by the value of the internal resistors in the relay. Hence, the balance temperature of the relay cannot be changed.

The current value at which the relay operates can be changed by connecting the relay per the test circuit of Fig. 7, setting resistors to value that correspond to the trip temperature and applying the desired current. Adjust the reset spring until contacts just close.

3. **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 be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

TABLE I ▲

Resistance	Temperature	Resistance	Temperature
10.00 ohms	25 °C.	12.89	100
10.96	50	13.29	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.

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.

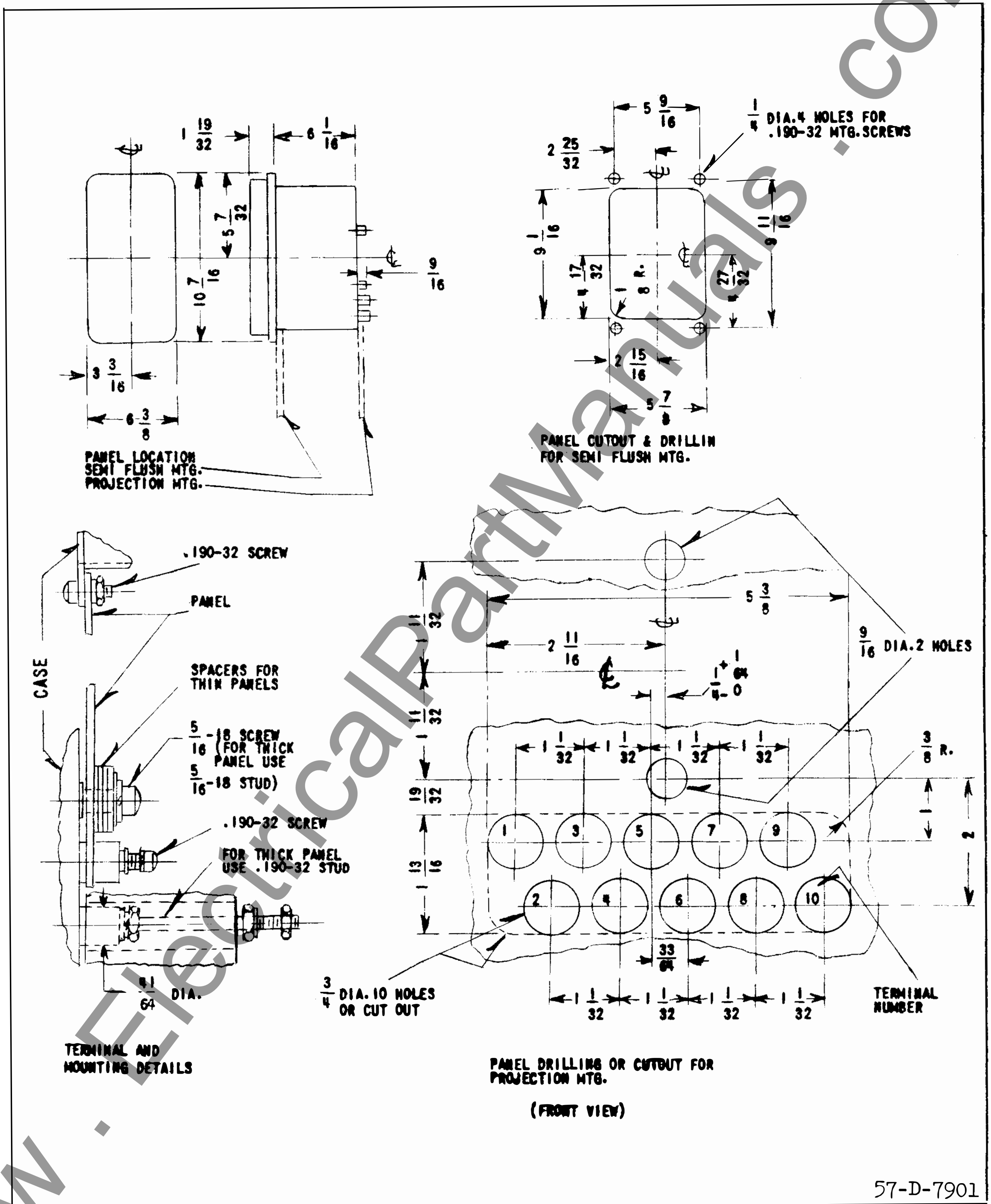


Fig. 6. Outline and Drilling Plan for the Type CT Relay in the Type FT21 Case.

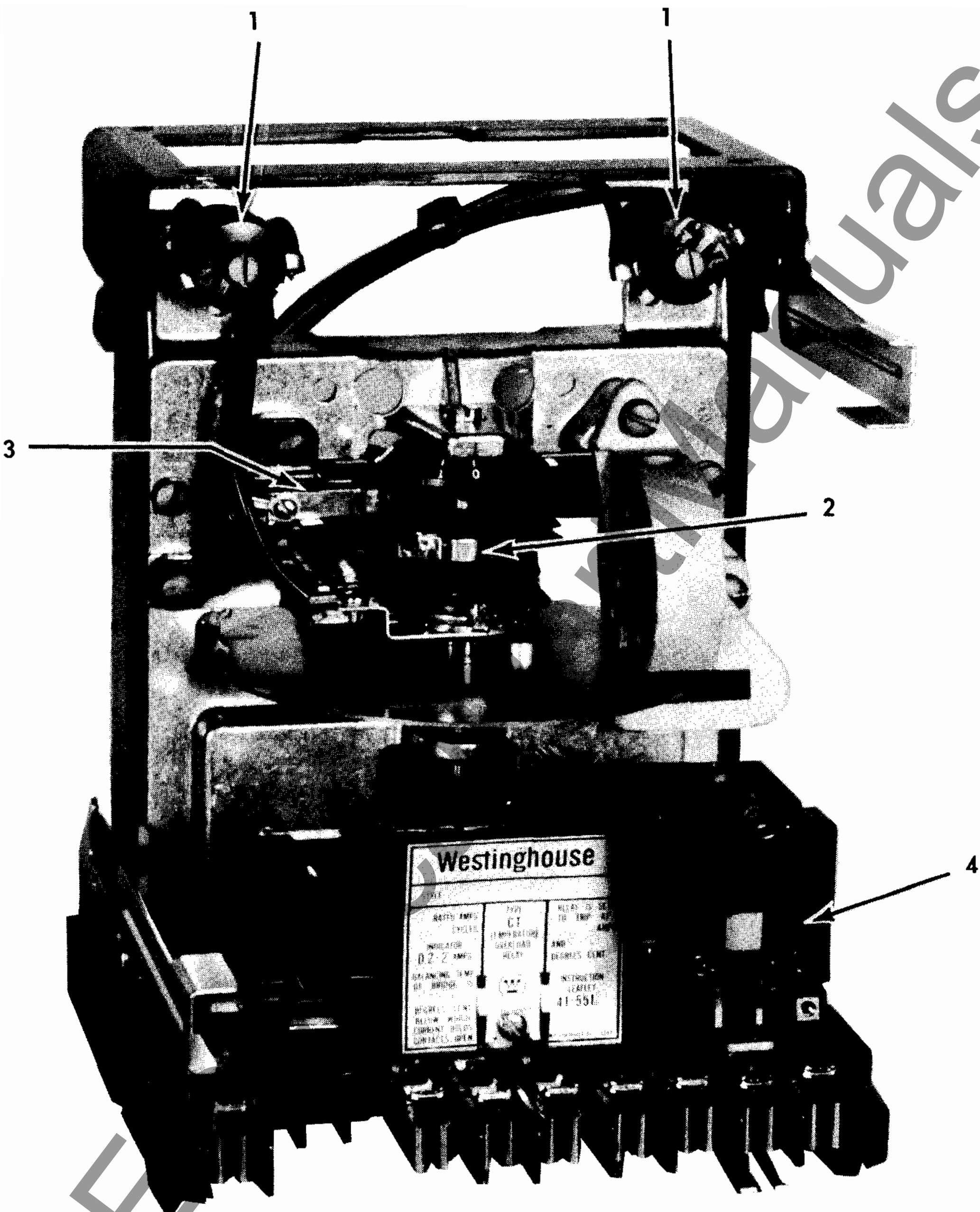


Fig. 7. Type CT Relay 1 – Balancing Resistor. 2 – Moving Contact Assembly. 3 – Stationary Contact Assembly. 4 – Indicating Contactor Switch (ICS).

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. Full load phase current.
3. 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.
4. Maximum safe operating temperature at which the relay must trip if full load current or more is present.
5. The metal (usually copper) used in the exploring coil windings and its temperature coefficient of resistance at 25° Centigrade.
6. Resistance of each exploring coil at 25° Centigrade. (Standard relays are available for use with 10 ohm exploring coils only.)
7. 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 resistors, 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. ¼ 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 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.

SUPERSEDES I.L. 41-551.2A
*Denotes change from superseded issue.

EFFECTIVE OCTOBER 1968

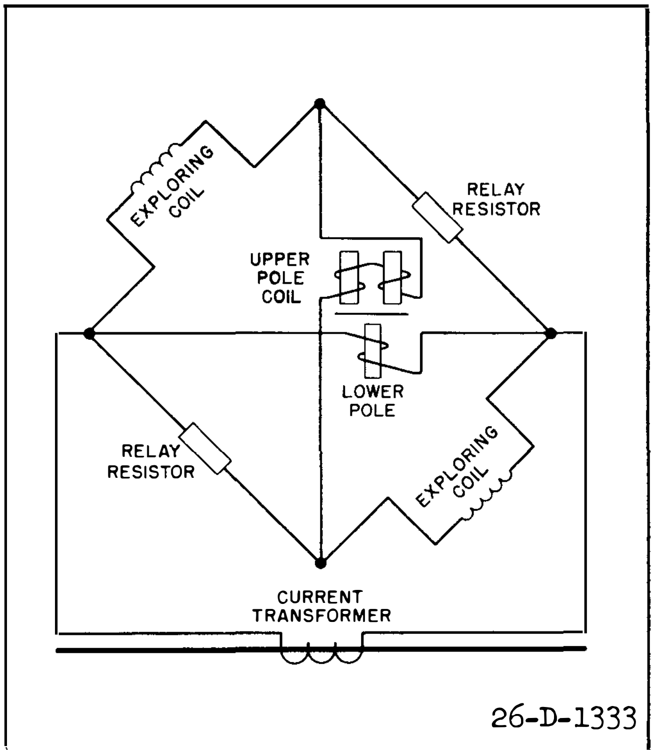


Fig. 1. Schematic Diagram of the Internal and External Connections of the Type CT Relay.

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

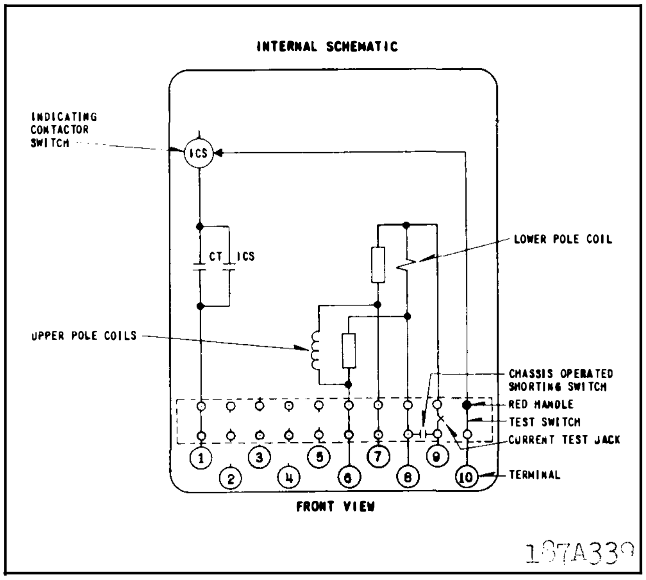
The relay is connected at a Wheatstone Bridge to the protected apparatus as shown in Fig. 1. Since the impedance of the bridge is resistance, and that of the lower pole winding reactance, there is sufficient phase displacement between the currents in the two windings of the relay to give a positive torque 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° to 10°C below the desired tripping temperature.

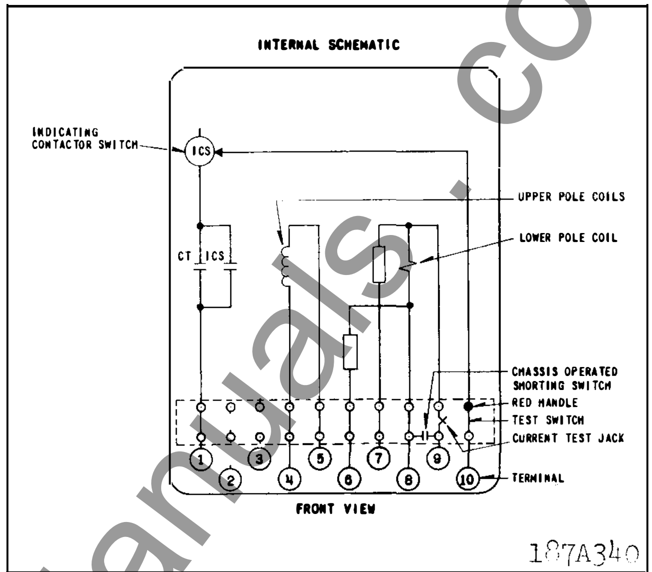
The closing torque of the Type CT relay is approximately proportional to the product of the current squared and the temperature difference from the balance point. With the rise of these values above the operating limits, the relay contact close with a rapidly increasing force. The limited travel of the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

* For lower values of current the temperature at which the contacts will close can be approximated by the relationship $I^2 \Delta t = K$. For example if relay rating is 4 amps trip current for a 5°C differential we can solve for K ($K = I^2 \Delta t = (4)^2 \times 5 = 80$). If the current decreases to 3 amps the differential temperature for trip now becomes approximately $\frac{80}{3^2} = 9°C$. The trip temperature therefore would increase by (9° − 5°) 4°C.

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 brdige circuit is constructed with a resistance equal to that of the exploring coil at the balance tempera-



* *Fig. 2. Internal Schematic of the Type CT Relay in the Type FT21 Case 6-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 8-Terminal Relay for use Where Exploring Coil Lead Resistance is Unknown When Relay is Manufactured.*

ture 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 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.

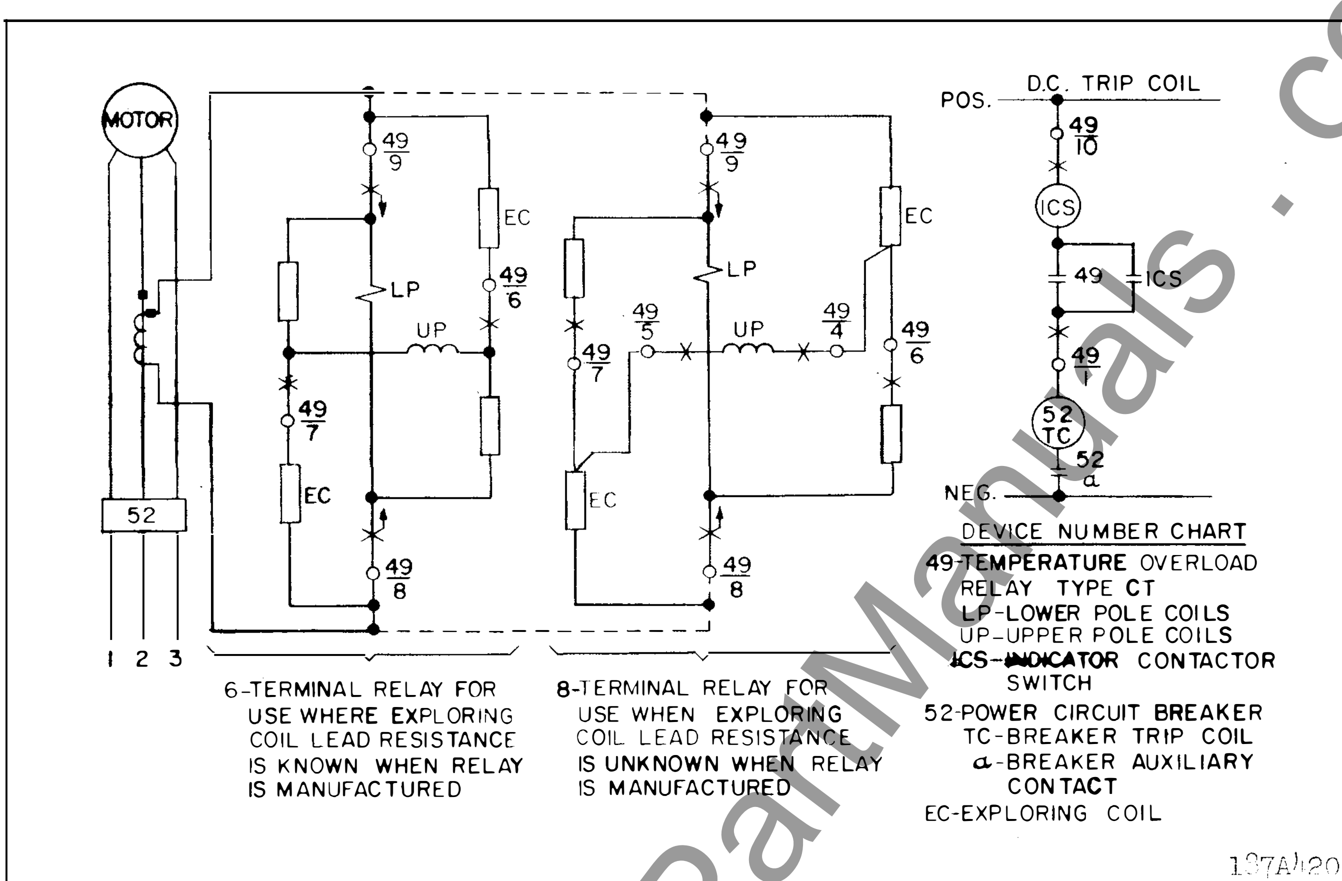


Fig. 4. External Schematic of the Type CT Temperature Overload Relay.

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.

SETTINGS

One setting is required for the operating unit; that is, the setting of the time dial. This setting should be on the number 1 position.

Each style relay is designed for a specific application and hence once the correct relay is chosen for a given application, no adjustment is necessary. If necessary, the spring tension controlling minimum operating current may be altered slightly.

Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is the selection of the 0.2 ampere or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125 or 250 volt d-c type WL relay switch or equivalent, use the 0.2 ampere tap; for 48 volt d-c applications set relay in 2 tap and use WL relay coil S#304C209G01 or equivalent.

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 projec-

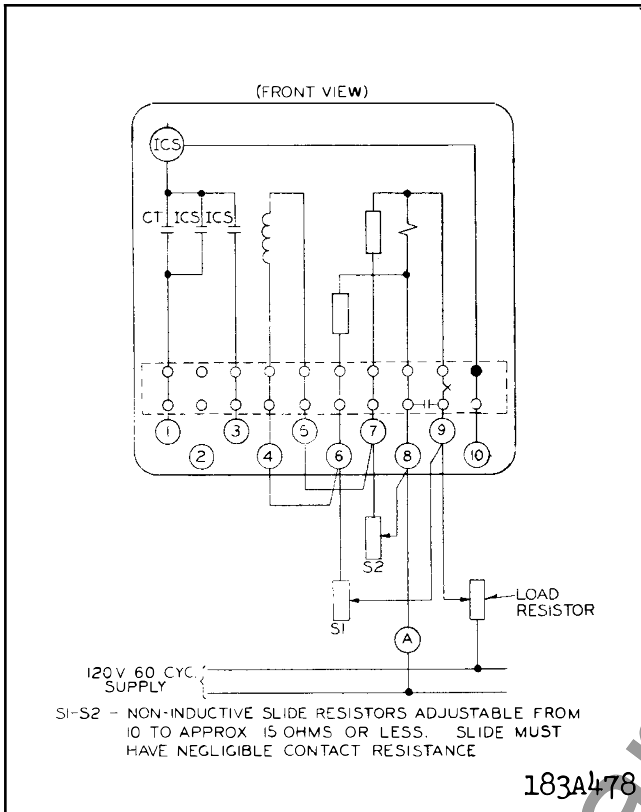


Fig. 5. Diagram of Test Connections for the Type CT Relay in Type FT21 Case.

tion 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

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.

Acceptance Tests

The following check is recommended to insure that the relay is in proper working order.

1. Contact

The index mark on the movement frame will coincide with the "0" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "0" mark by approximately .020 inch.

2. Minimum Trip

Connect the relay as per test circuit of Fig. 5. The relay should trip at the amperes and temperature specified on the nameplate. The equivalent value of temperature for different values of resistance is shown in Table I. This curve applies to copper wire coils with 10 ohms resistance at 25 °C.

3. 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.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

Routine Maintenance

All relays should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher Style #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.

Calibration

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order (See "Acceptance Check").

1. Contact

The index mark on the movement frame will coincide with the "0" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "0" mark by approximately .020".

2. **Minimum Trip**

The balance temperature of the relay is determined by the value of the internal resistors in the relay. Hence, the balance temperature of the relay cannot be changed.

The current value at which the relay operates can be changed by connecting the relay per the test circuit of Fig. 7, setting resistors to value that correspond to the trip temperature and applying the desired current. Adjust the reset spring until contacts just close.

3. **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 be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

TABLE I ▲

Resistance	Temperature	Resistance	Temperature
10.00 ohms	25 °C.	12.89	100
10.96	50	13.29	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.

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.

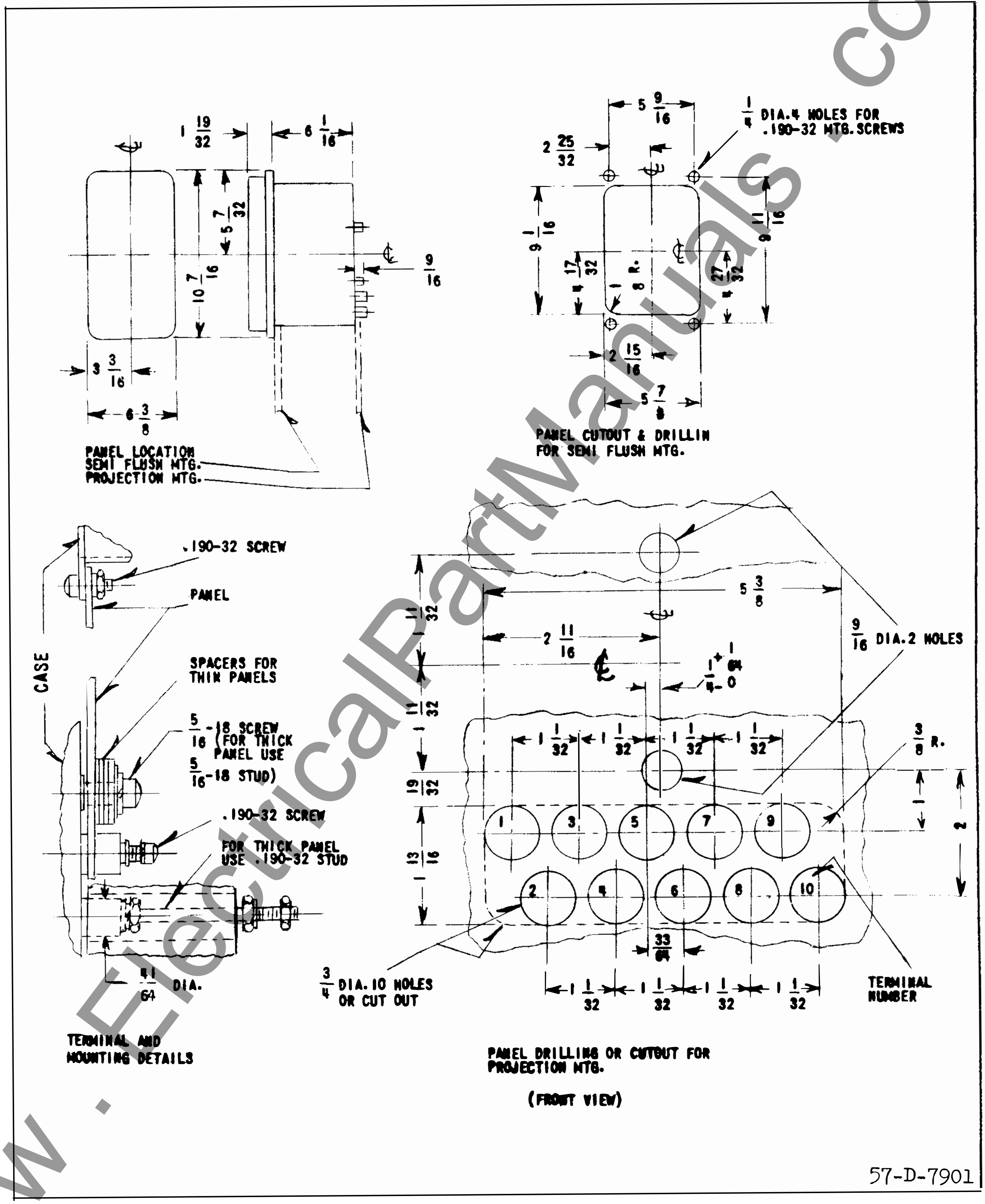


Fig. 6. Outline and Drilling Plan for the Type CT Relay in the Type FT21 Case.

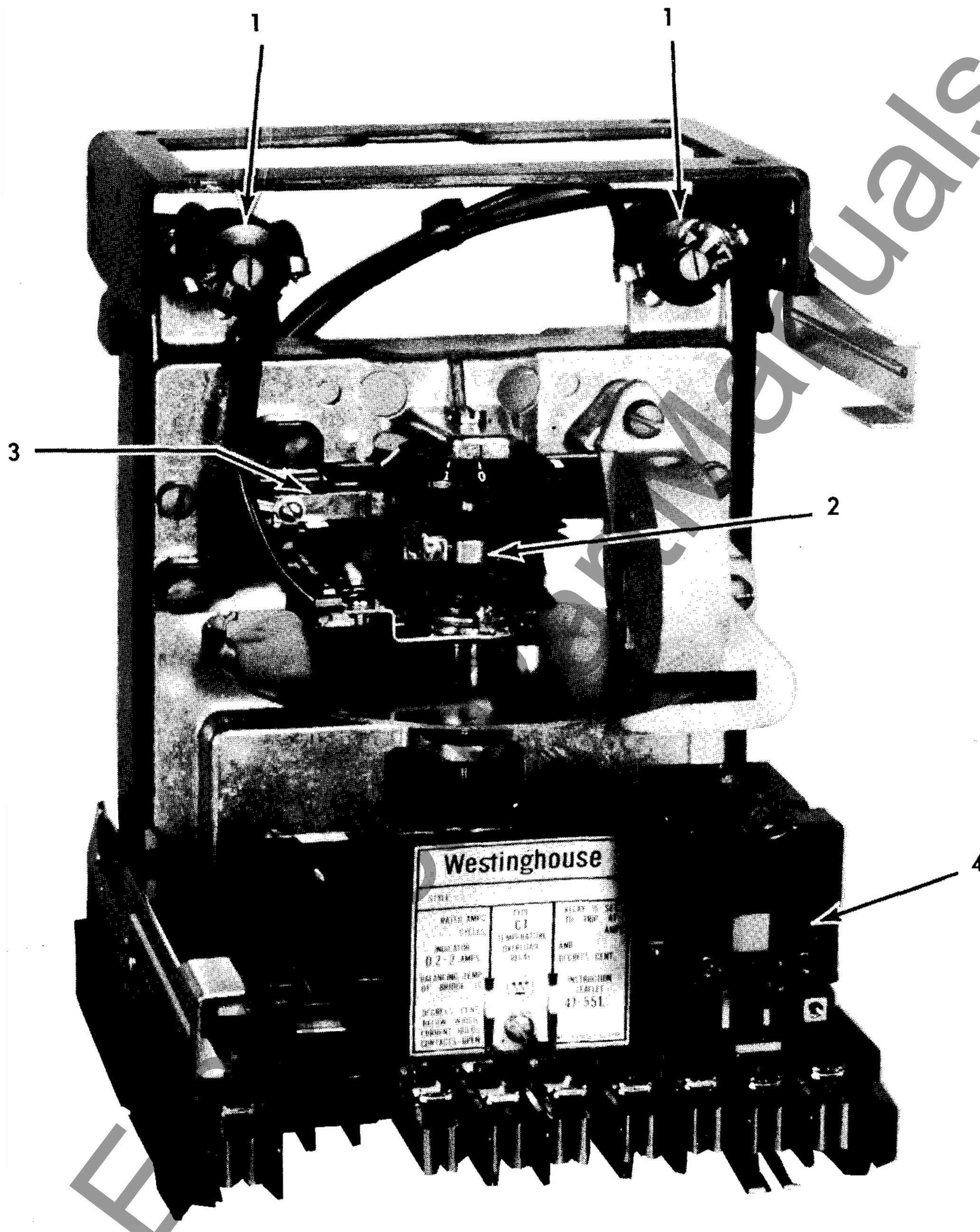


Fig. 7. Type CT Relay 1 – Balancing Resistor. 2 – Moving Contact Assembly. 3 – Stationary Contact Assembly. 4 – Indicating Contactor Switch (ICS).

WESTINGHOUSE ELECTRIC CORPORATION
RELAY-INSTRUMENT DIVISION **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 ac 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 as well as the current flowing through the relay 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.

✪ The relay is applicable for use with 10 ohm copper at 25°C exploring coils (RTD). For 120 ohm 0°C Nickel and 100 ohm 0°C Platinum RTD's use the type DT-3 relay (I.L. 41-552.1).

✪ The amount of current that circulates through the RTD depends on the current transformer secondary current, the resistance of the bridge balancing resistors and the resistance of the RTD at any particular temperature. The RTD should be capable of carrying 0.3 Amperes or more without causing appreciable self-heating error.

✪ From 5 to 10% of the relay input current will flow through the RTD.

This relay is manufactured and set at the factory for each application and cannot easily be changed after shipment. (See Minimum Trip section). In order to make the application, the following information is necessary:

1. Frequency of the connected system.

2. ✪ Trip Current at the trip temperature.

3. 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 hertz applications.

4. ✪ Maximum safe operating temperature at which the relay must trip if trip current or more is present.

5. 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

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-551.2C, DATED MARCH 1969
✪ DENOTES CHANGE FROM SUPERSEDED ISSUE. **EFFECTIVE SEPTEMBER 1978**

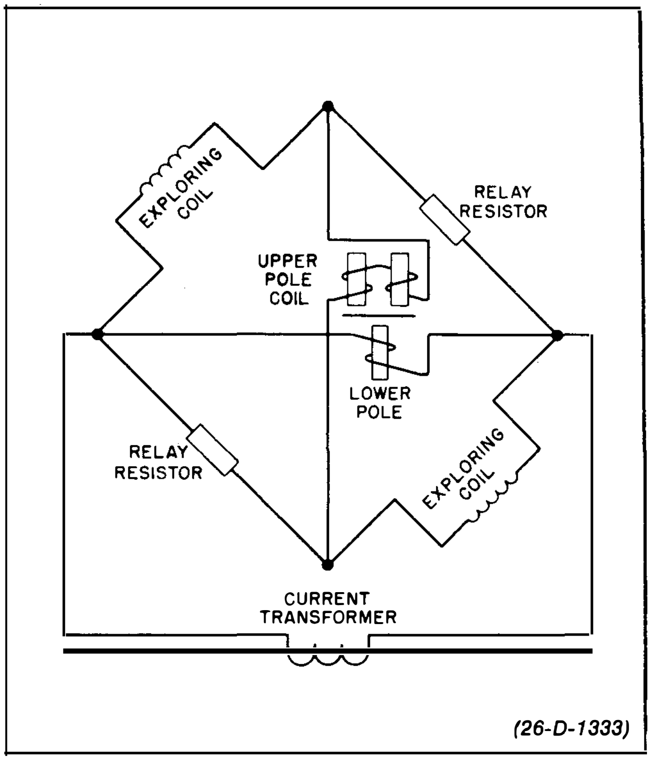


Fig. 1. Schematic Diagram of the Internal and External Connections of the Type CT Relay.

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 resistors, and an indicating contactor switch unit. (ICS or ACS).

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. ¼ 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 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 dc 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.

Indicating Contactor Switch Unit (ACS)

This unit is similar to the ICS unit except the core piece which has a lag loop and a core screw which permits operation on ac current.

OPERATION AND CHARACTERISTICS

The relay is connected at 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

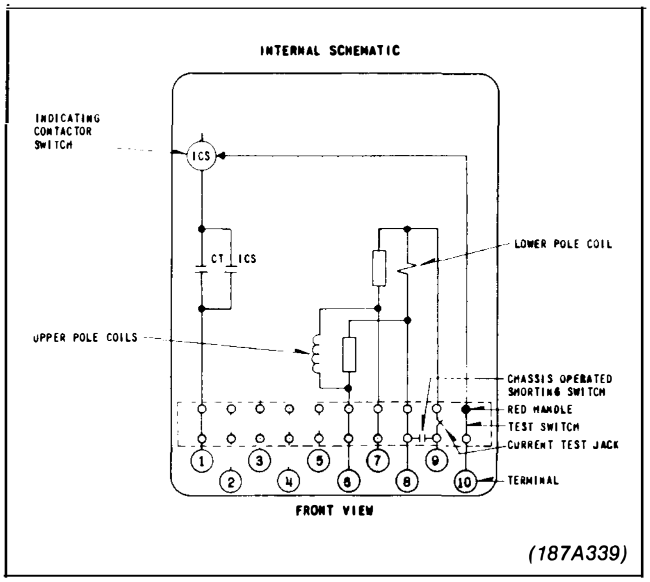


Fig. 2. Internal Schematic of the Type CT Relay in the Type FT21 Case 6-Terminal Relay for use where Exploring Coil Lead Resistance is Known When Relay is Manufactured.

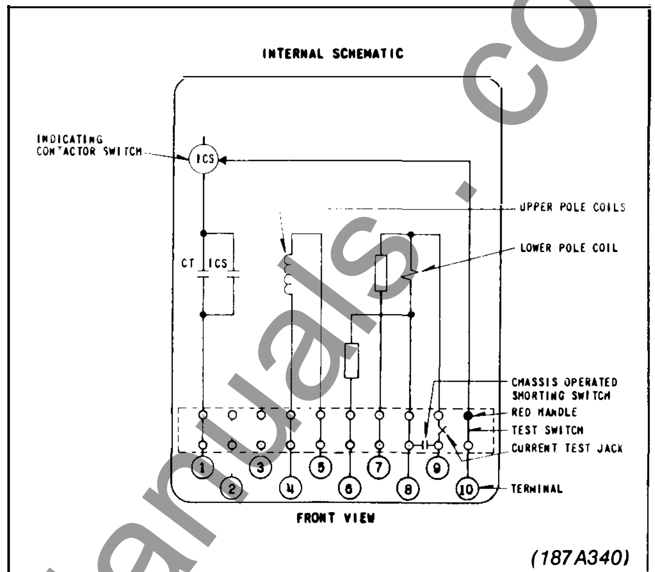
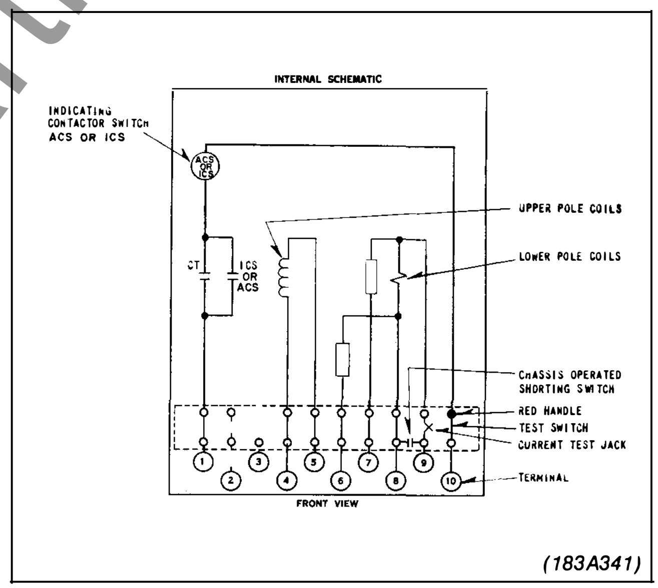


Fig. 3. Internal Schematic of the Type CT Relay in the Type FT21 Case 8-Terminal Relay for use Where Exploring Coil Lead Resistance is Unknown When Relay is Manufactured.

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° to 10°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



✪ *Fig. 3a. "Internal Schematic of the type CT Relay in Type FT21 Case with non-tapped ICS or ACS unit."*

travel of the disc permits a very short operating time when the operating limits are exceeded considerably.

For lower values of current the temperature at which the contacts will close can be approximated by the relationship $I^2 \triangle t = K$. For example if relay rating is 4 amps trip current for a 5°C differential we can solve for K ($K = I^2 \triangle t = (4)^2 \times 5 = 80$). If the current decreases to 3 amps the

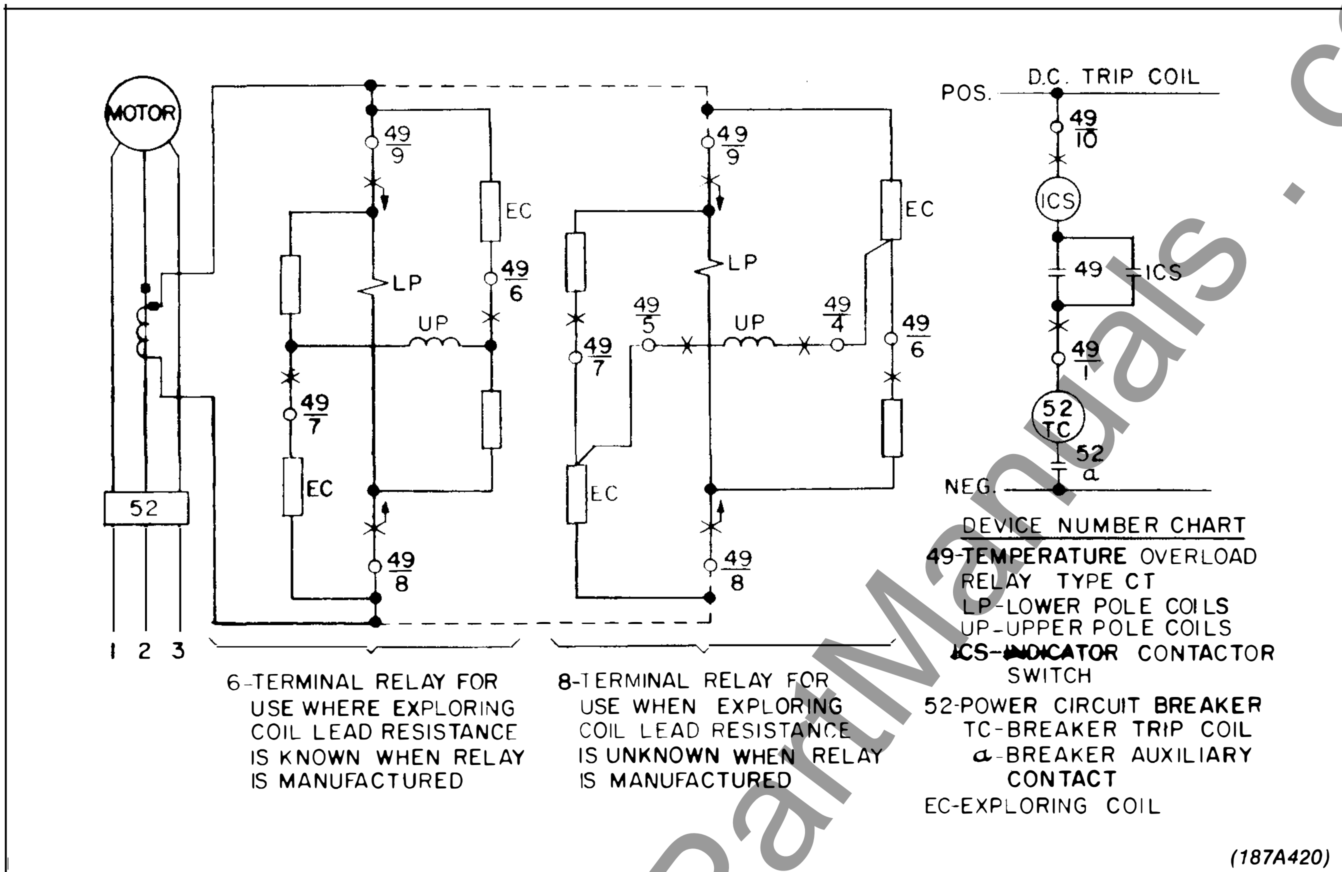


Fig. 4. External Schematic of the Type CT Temperature Overload Relay.

differential temperature for trip now becomes approximately $\frac{80}{32} = 9°C$. The trip temperature therefore would increase by (9°−5°) 4°C.

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 exloring 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 of the bridge at temperatures above the balance point. However, lead resistances usually are less than 0.5 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 of 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 colse 30 amperes

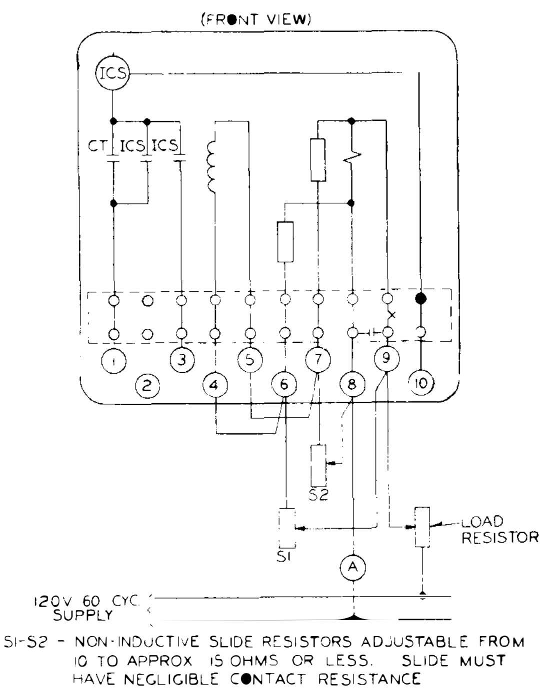


Fig. 5. Diagram of Test Connections for the Type CT Relay in Type FT21 Case.

at 250 volts dc 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 dc resistance
2.0 ampere tap 0.15 ohms dc resistance
1.0 ampere ICS coil has 0.1 ohm resistance
1.0 ampere ACS coil has 4.5 ohm impedance

EXPLORING COILS

It is perferable 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 should be copper, with a resistance of 10 ohms at 25°C.

SETTINGS

One setting is required for the operating unit; that is, the setting of the time dial. The setting should be on the number 1 position.

Each style relay is designed for a specific application and hence once the correct relay is chosen for a given application, no adjustment is necessary. If necessary, the minimum operating current may be adjusted by altering slightly the spring tension.

Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is the selection of the 0.2 ampere or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125 or 250 volt dc type WL relay switch or equivalent, use the 0.2 ampere tap; for 48 volt dc applications set relay in 2 tap and use WL relay coil S#304C209G01 or equivalent.

The non-tapped ICS and ACS unit have a single rated pickup.

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.

Consideration should be given to using shielded cable where the relay is located a long distance (over 50 ft.) from the RTD or where the leads might be subject to electromagnetic or electrostatic coupling. The cable leads should be twisted and the shield grounded at both ends. The shield should not be used as one of the conductors.

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

ADJUSTMENTS

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.

Acceptance Tests

The following check is recommended to insure that the relay is in proper working order.

1. **Contact**
The index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020 inch.

2. **Minimum Trip**
Connect the relay as per test circuit of Fig. 5. The relay should trip at the amperes and temperature specified on the nameplate. The equivalent value of temperature for different values of resistance is shown in Table I. This curve applies to copper wire coils with 10 ohms resistance at 25°C.

3. **Indicating Contactor Switch (ICS)**
Close the main relay contacts and pass sufficient dc 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.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

For the ACS unit check to see that the core screw is all the way in. Apply rated ac current and see that contacts close.

Routine Maintenance
All relays should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher Style #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.

Calibration
Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order (See "Acceptance Check").

1. **Contact**
The index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020".

2. **Minimum Trip**
The balance temperature of the relay is determined by the value of the internal resistors in the relay. Hence, the balance temperature of the relay cannot be changed.

The current value at which the relay operates can be changed by connecting the relay per the test circuit of Fig. 5, setting resistors to value that correspond to the trip temperature and applying the desired current. Adjust the reset spring until contacts just close. With trip current between 3.25 and 5.0 amperes the differential temperature between the balance temperature and trip temperature should be 5°C. For trip currents between 3.25 and 2.25 amperes the differential temperature should be 10°C.

3. Indicating Contactor Switch (ICS)
Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. For the ACS unit the contact gap should be approximately .094".

The bridging moving contact should touch both stationary contacts simultaneously.

TABLE I ▲

Resistance	Temperature	Resistance	Temperature
10.00 ohms	25°C.	12.89	100
10.96	50	13.29	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.

RENEWAL PARTS

Repair work can be done most satisfacorily 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 relay is 5 amperes, and the one second rating 150 amperes, 60 cycles.

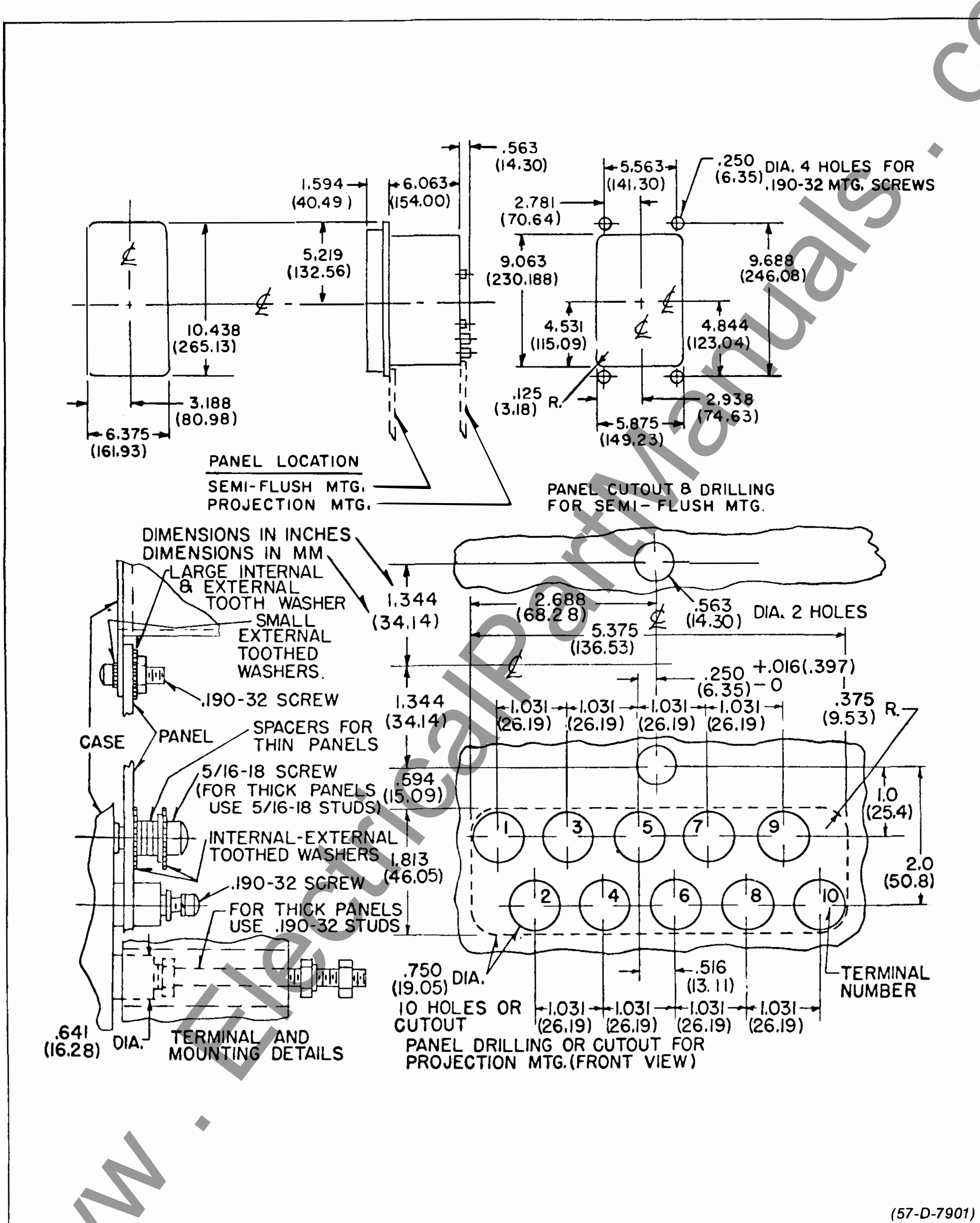


Fig. 6. Outline and Drilling Plan for the Type CT Relay in the Type FT21 Case.

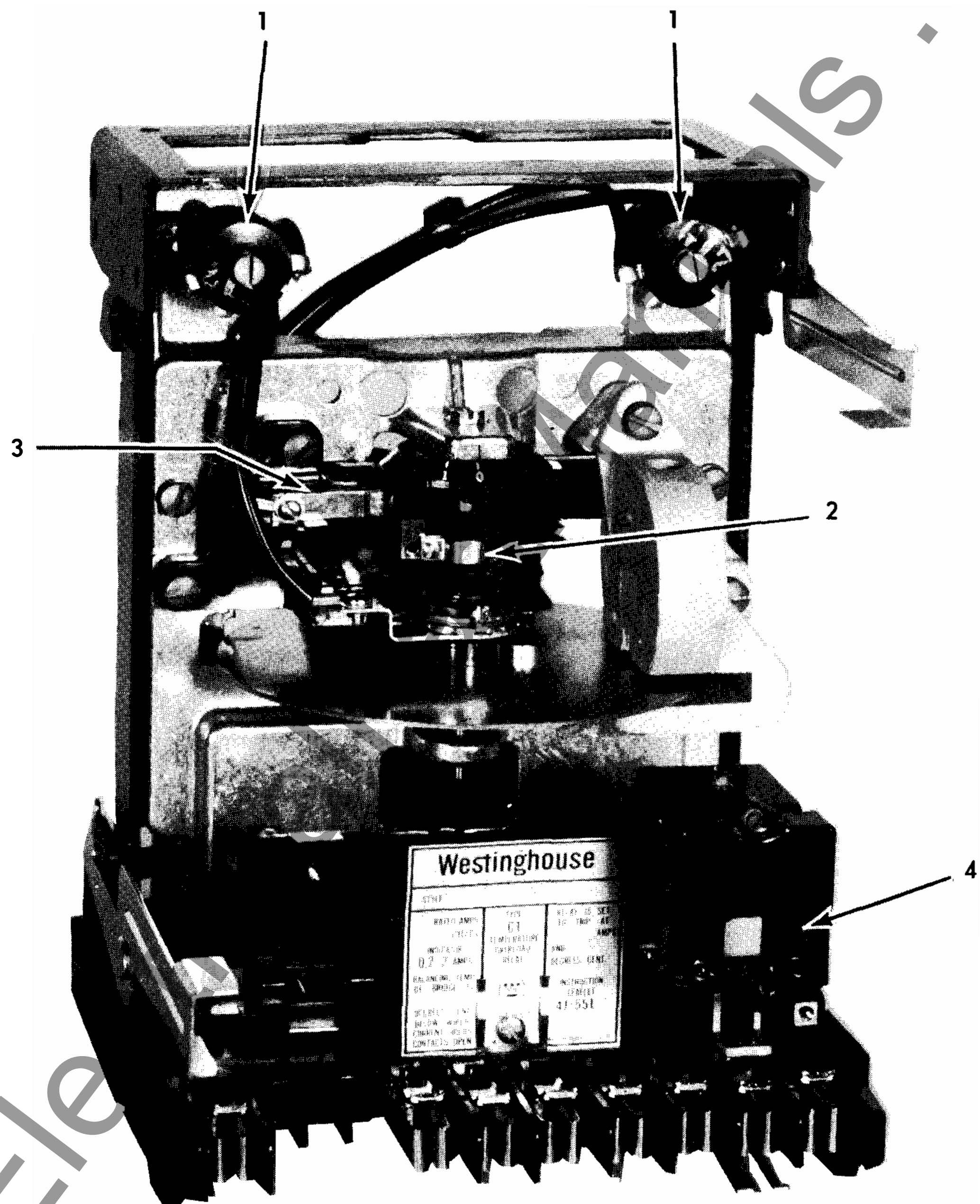


Fig. 7. Type CT Relay 1 – Balancing Resistor. 2 – Moving Contact Assembly. 3 – Stationary Contact Assembly. 4 – Indicating Contactor Switch (ICS).

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

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 ac 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 as well as the current flowing through the relay 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.

The relay is applicable for use with 10 ohm copper at 25°C exploring coils (RTD). For 120 ohm 0°C Nickel and 100 ohm 0°C Platinum RTD's use the type DT-3 relay (I.L. 41-552.1).

The amount of current that circulates through the RTD depends on the current transformer secondary current, the resistance of the bridge balancing resistors and the resistance of the RTD at any particular temperature. The RTD should be ✪ capable of carrying 0.3 Amperes without causing appreciable self-heating error.

From 5 to 10% of the relay input current will flow through the RTD.

This relay is manufactured and set at the factory for each application and cannot easily be changed after shipment. (See Minimum Trip section). In order to make the application, the following information is necessary:

1. Frequency of the connected system.

2. Trip Current at the trip temperature.

3. 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 hertz applications.

4. Maximum safe operating temperature at which the relay must trip if trip current or more is present.

5. 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

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-551.2D, DATED SEPT 1978
✪ DENOTES CHANGE FROM SUPERSEDED ISSUE. EFFECTIVE SEPTEMBER 1979

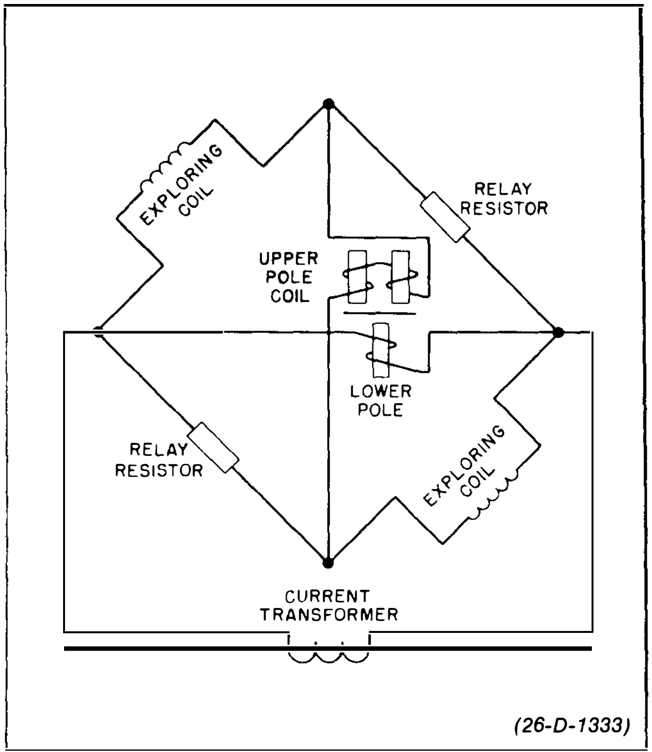


Fig. 1. Schematic Diagram of the Internal and External Connections of the Type CT Relay.

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 resistors, and an indicating contactor switch unit. (ICS or ACS).

Operating Unit

This unit is the induction-disc type. The induction disc is mounted on a vertical shaft. An adjustable contact backstop is used to set the contact gap. 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 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 dc 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.

Indicating Contactor Switch Unit (ACS)

This unit is similar to the ICS unit except the core piece which has a lag loop and a core screw which permits operation on ac current.

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

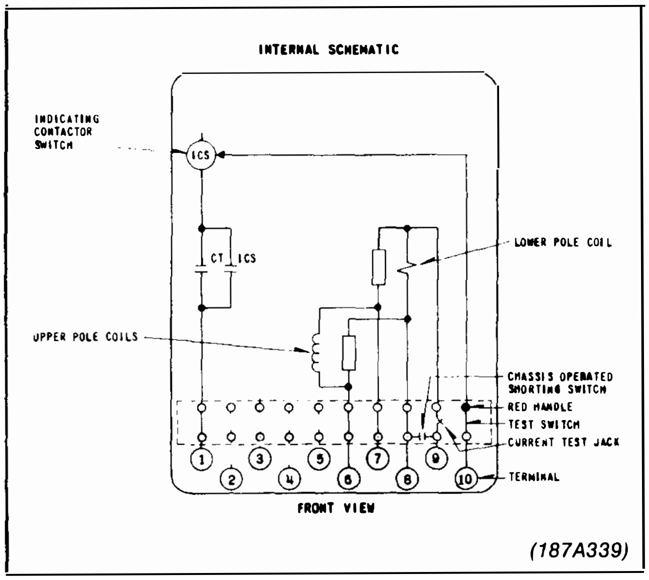


Fig. 2. Internal Schematic of the Type CT Relay in the Type FT21 Case 6-Terminal Relay for use where Exploring Coil Lead Resistance is Known When Relay is Manufactured.

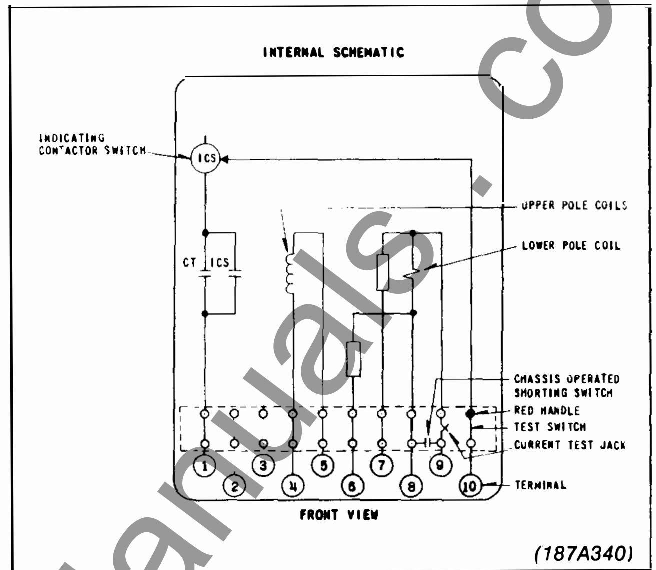


Fig. 3. Internal Schematic of the Type CT Relay in the Type FT21 Case 8-Terminal Relay for use Where Exploring Coil Lead Resistance is Unknown When Relay is Manufactured.

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° to 10°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

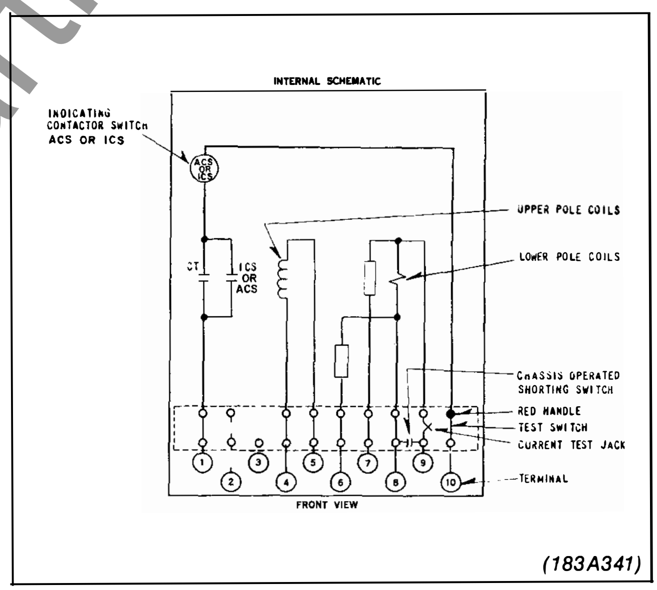


Fig. 3a. "Internal Schematic of the type CT Relay in Type FT21 Case with non-tapped ICS or ACS unit."

travel of the disc permits a very short operating time when the operating limits are exceeded considerably.

For lower values of current the temperature at which the contacts will close can be approximated by the relationship $I^2 \triangle t = K$. For example if relay rating is 4 amps trip current for a 5°C differential we can solve for K ($K = I^2 \triangle t = (4)^2 X 5 = 80$). If the current decreases to 3 amps the

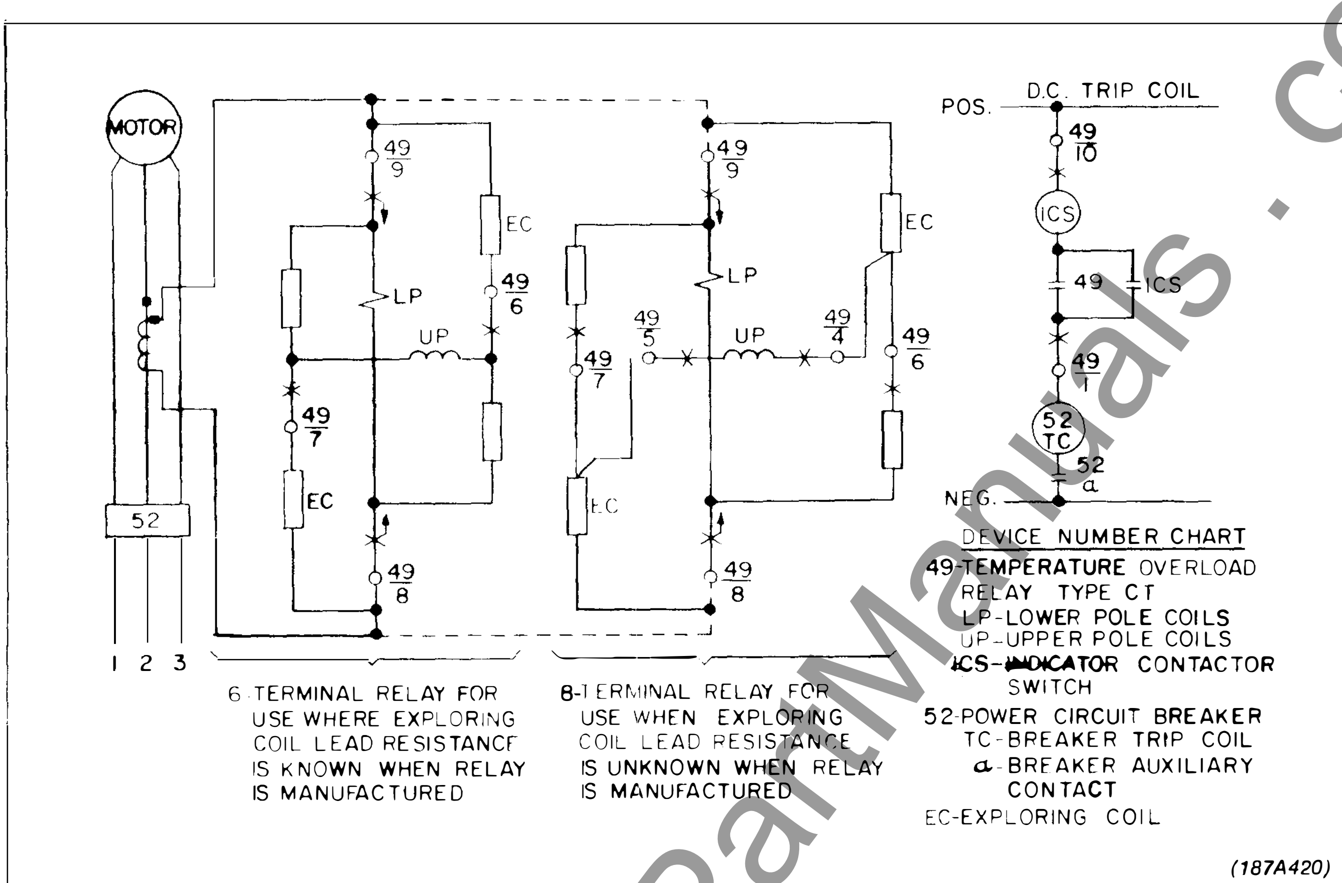


Fig. 4. External Schematic of the Type CT Temperature Overload Relay.

differential temperature for trip now becomes approximately $\frac{80}{32} = 9°C$. The trip temperature therefore would increase by (9°−5°) 4°C.

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 exloring 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 of the bridge at temperatures above the balance point. However, lead resistances usually are less than 0.5 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 colse 30 amperes

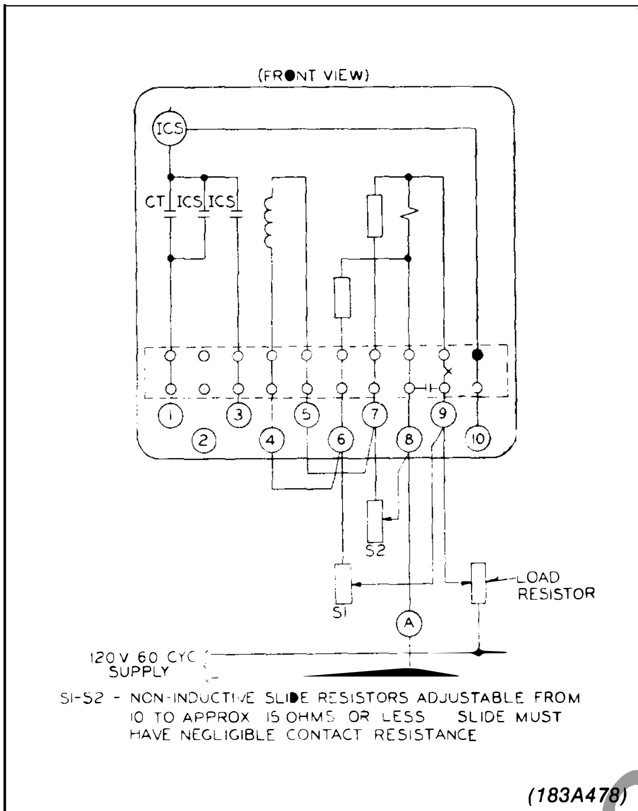


Fig. 5. Diagram of Test Connections for the Type CT Relay in Type FT21 Case.

at 250 volts dc 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 dc resistance
2.0 ampere tap 0.15 ohms dc resistance
1.0 ampere ICS coil has 0.1 ohm resistance
1.0 ampere ACS coil has 4.5 ohm impedance

EXPLORING COILS

It is perferable 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 should be copper, with a resistance of 10 ohms at 25°C.

SETTINGS

One setting is required for the operating unit; that is, the setting of the time dial. The setting should be on the number 1 position.

Each style relay is designed for a specific application and hence once the correct relay is chosen for a given application, no adjustment is necessary. If necessary, the minimum operating current may be adjusted by altering slightly the spring tension.

Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is the selection of the 0.2 ampere or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw. When the relay energizes a 125 or 250 volt dc type WL relay switch or equivalent, use the 0.2 ampere tap; for 48 volt dc applications set relay in 2 tap and use WL relay coil S#304C209G01 or equivalent.

The non-tapped ICS and ACS unit have a single rated pickup.

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.

Consideration should be given to using shielded cable where the relay is located a long distance (over 50 ft.) from the RTD or where the leads might be subject to electromagnetic or electrostatic coupling. The cable leads should be twisted and the shield grounded at both ends. The shield should not be used as one of the conductors.

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

ADJUSTMENTS

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.

Acceptance Tests

The following check is recommended to insure that the relay is in proper working order.

1. **Contact**
   The index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately 020 inch. The relay should be set with the #1 time dial at the index.

2. **Minimum Trip**
   Connect the relay as per test circuit of Fig. 5. The relay should trip at the amperes and temperature specified on the nameplate. The equivalent value of temperature for different values of resistance is shown in Table I. This curve applies to copper wire coils with 10 ohms resistance at 25°C.

3. **Indicating Contactor Switch (ICS)**
   Close the main relay contacts and pass sufficient dc 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.

   The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

   For the ACS unit check to see that the core screw is all the way in. Apply rated ac current and see that contacts close.

Routine Maintenance
All relays should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. A contact burnisher Style #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.

Calibration
Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order (See "Acceptance Check").

1. **Contact**
   The index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020".

2. **Minimum Trip**
   The balance temperature of the relay is determined by the value of the internal resistors in the relay. Hence, the balance temperature of the relay cannot be changed.

   The current value at which the relay operates can be changed by connecting the relay per the test circuit of Fig. 5, setting resistors to value that correspond to the trip temperature and applying the desired current. Adjust the reset spring until contacts just close. With trip current between 3.25 and 5.0 amperes the differential temperature between the balance temperature and trip temperature should be 5°C. For trip currents between 3.25 and 2.25 amperes the differential temperature should be 10°C.

3. **Indicating Contactor Switch (ICS)**
Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. For the ACS unit the contact gap should be approximately .094".

The bridging moving contact should touch both stationary contacts simultaneously.

TABLE I ▲

Resistance	Temperature	Resistance	Temperature
10.00 ohms	25°C.	12.89	100
10.96	50	13.29 ◆	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.

RENEWAL PARTS

Repair work can be done most satisfacorily 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 55 volt-amperes at 5 amperes, 49° lag Power Factor. The continuous rating of the relay is 5 amperes, and the one second rating 150 amperes, 60 cycles.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

Printed in U.S.A.

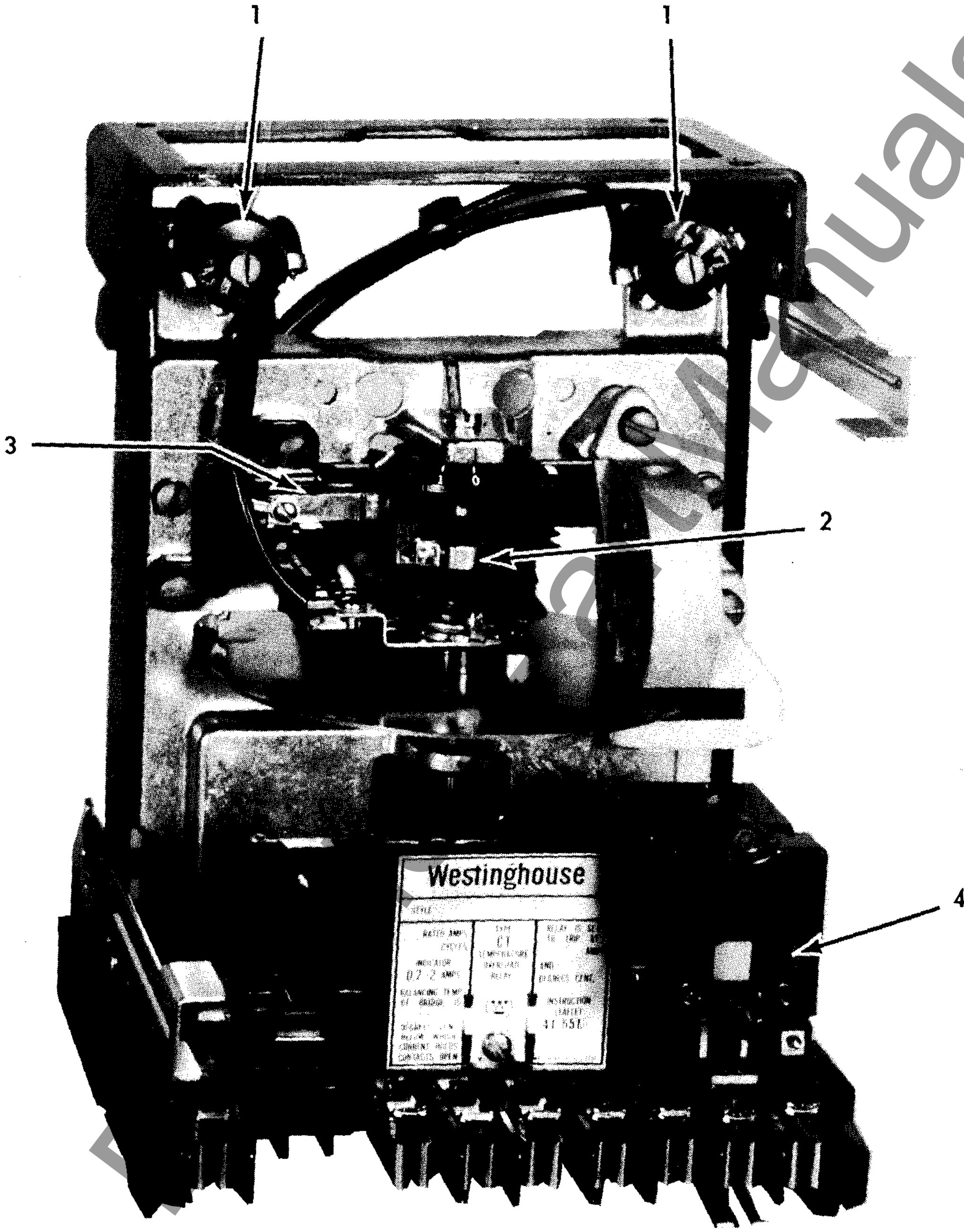


Fig. 7. Type CT Relay 1 – Balancing Resistor. 2 – Moving Contact Assembly. 3 – Stationary Contact Assembly. 4 – Indicating Contactor Switch (ICS).

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. Full load phase current.
3. 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.
4. Maximum safe operating temperature at which the relay must trip if full load current or more is present.
5. The metal (usually copper) used in the exploring coil windings and its temperature coefficient of resistance at 25° Centigrade.
6. Resistance of each exploring coil at 25° Centigrade. (Standard relays are available for use with 10 ohm exploring coils only.)
7. 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 resistors, 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. ¼ 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 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.

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