INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CA-5 PERCENTAGE DIFFERENTIAL RELAY

FOR TRANSFORMER AND GENERATOR PROTECTION

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

Type CA-5 relays are used for differential protection of either a generator or a two-winding power transformer. The transformer and generator relays differ only in the control spring. The generator uses a weaker spring for greater sensitivity. The following paragraphs describe the application requirements.

Transformer Relay

Restraint coil current should not exceed 100 symetrical r.m.s. amperes during external faults. The combined a-c saturation error of the main and auxiliary ratio-matching current transformers on either side of the bank should not exceed 10% for the maximum external fault.

Generator Relay

Current transformer burden in ohms should not exceed $(N_P V_{CL})/133$; further the burden factor, BF, should not differ by more than a 2 to 1 ratio between the two sets of CT's. The above terms are defined as:

N_P = proportion of total number of CT turns in use

V_{CL} = current transformer 10L accuracy class voltage

$$BF = \frac{1000\ R_B}{N_P V_{CL}}$$

R_B = resistance of the burden, excluding CT winding resistance.

For example, if the 400/5 tap of a 600/5 multi-ratio CT is used, $N_P = 400/600 = 0.67$. If this CT has a 10L200 rating, $V_{CL} = 200$, and the burden should not exceed:

$$\frac{N_P V_{CL}}{133} = \frac{0.67 \times 200}{133} = 1.0 \text{ ohm}$$

Assuming a resistance burden of $R_B = 0.5$ ohms, the burden factor, BF, is:

$$BF = \frac{1000\ R_B}{N_P V_{CL}} = \frac{1000 \times 0.5}{0.67 \times 200} = 3.8$$

The other set of CT's may then have a burden factor as high as $2 \times 3.8 = 7.6$, or as low as $1/2 \times 3.8 = 1.9$. If the other set of CT's also has a burden of 0.5 ohms, a 10L100, 10L200, or 10L400 rating would be satisfactory, since the burden factors are 7.6, 3.8 and 1.9, respectively.

In calculating the burden, use the one way lead burden.

CONSTRUCTION

The type CA-5 relay consists of a percentage differential unit, an indicating contactor switch unit, and an optional indicating instantaneous trip unit. The construction and operation of these units are as follows:

Percentage Differential Unit

This unit has one restraining element, with two windings, and one operating element which is energized through an external auxiliary current transformer in accordance with the current flowing in the differential connection of the main current transformers. Taps controlling the sensitivity of the relay are incorporated in the external transformer.

The unit operates on the induction-disc principle, with both electromagnets operating on the same disc. The front electromagnet is the restraining, and the rear electromagnet is the operating element. These are connected as shown in Figs. 1 and 2.

The disc is mounted on a vertical shaft. The lower bearing for the shaft is a steel ball riding between concave sapphire jewel surfaces. A pin bearing is used on the upper end of the shaft.

The moving contact assembly is attached to a Micarta bushing on the disc shaft. When the moving contact strikes the stationary contact, the moving contact spring deflects to provide a wiping action. The

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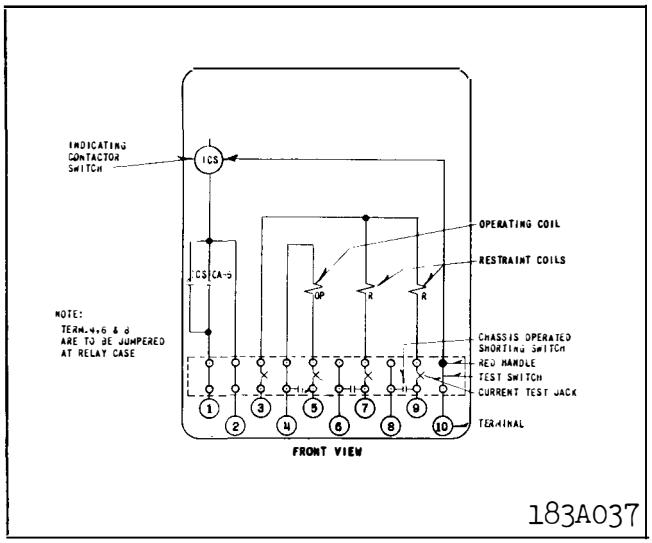

Fig. 1. Internal Schematic of the Type CA-5 Relay in the Type FT21 case.

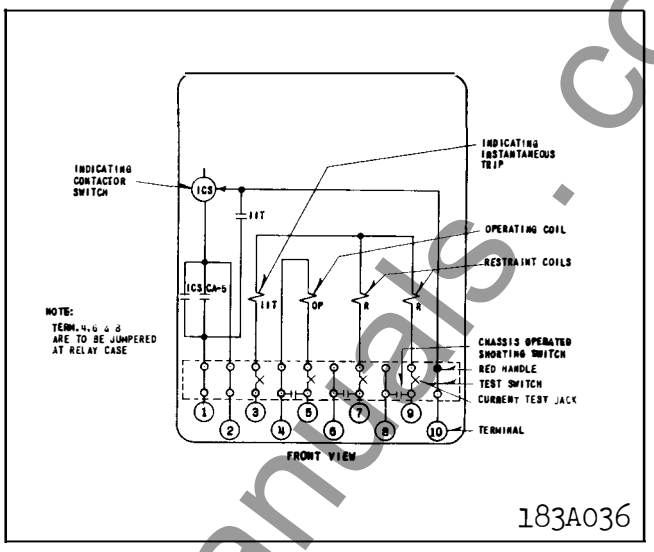

Fig. 2. Internal Schematic of the Type CA-5 Relay with Indicating Instantaneous Trip in the Type FT21 case.

electrical connection from the moving contact is made through the spiral spring to the spring adjuster.

The stationary contact is mounted on a right angle bracket fastened to the element frame through a Micarta insulating block. A contact screw projects through the outer end of the bracket and provides adjustable contact separation.

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.

Indicating Instantaneous Trip Unit (IIT) (When Supplied)

The instantaneous trip unit is a small a-c operated 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.

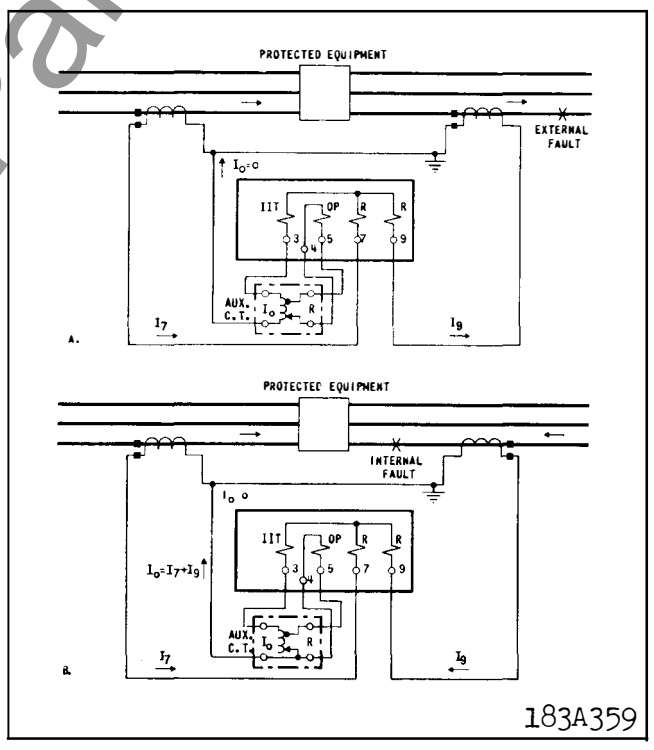

Fig. 3. Schematic Diagrams of the Type CA-5 Relay. (A) Shows the Fault Current Distribution for an External Fault; (B) The Distribution for an Internal Fault.

When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also during the 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.

A core screw accessible from the top of the switch provides the adjustable pickup range. The minimum and maximum pickup points are indicated on the scale, which is located to the rear of the core screw.

OPERATION

Fig. 3 shows the current through the relay for external and internal fault conditions. With the relay connected as in Fig. 3A, a through fault causes currents to flow through the two restraining windings in the same direction. If the main current transformers operate properly, these restraining currents are equal, and no current flows in the auxiliary current transformer and operating coil winding. In this case, there will be only contact opening torque produced.

In the case of a heavy internal fault, when an external source feeds current into the fault, the restraining currents are in opposite directions, and restraining torque tends to cancel out as in Fig. 3B. When the currents fed from the two sides are equal, the restraint is totally cancelled. When unequal currents flow in from the two sides, the restraint is equivalent to the difference in the two currents. In this case, the currents in the restraining windings will add together and go through the operating winding, producing a contact closing torque. The operating curves for the relay are shown in Figs. 4 and 5.

This relay has variable percentage characteristics which means that the operating coil current required to close the relay contact, expressed in percent of the total restraint current, varies with the magnitude of the restraint current. The relay sensitivity is high, corresponding to a low percentage ratio, at light currents, and its sensitivity is low, corresponding to high percentage unbalance, at high currents. The relay is made sensitive at low currents in order that it will detect light internal faults. At the same time, however, its reduced sensitivity at the higher currents allows the various current transformers involved to depart from their true ratio to a large extent without causing false tripping of the relay for external faults.

CHARACTERISTICS

The type CA-5 percentage differential relay is available in two designs: a relay with a minimum trip current of 0.14 amp. for generator protection and a relay with a range of adjustment of minimum trip current from 0.50 amp. to 2.0 amp. for transformer protection.

The time of operation of the generator relay is shown in Fig. 7, and the time of operation of the transformer relay is shown in Fig. 6. The percentage slope characteristics are shown in Fig. 5 (Generator relay) and Fig. 4 (Transformer relay).

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 instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a 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

ENERGY REQUIREMENTS

Restraint Coil Circuit

Continuous Rating	10 amperes
1 Second Rating	250 amperes
Volt Amperes @ 5 amperes	.75
Power Factor	0.7 lag

Operating Coil Circuit

Continuous Rating	5 amperes
1 Second Rating	150 amperes
Volt Amperes	Variable, see Fig.5

SETTING CALCULATIONS

No calculations are required to set the CA-5 relay.

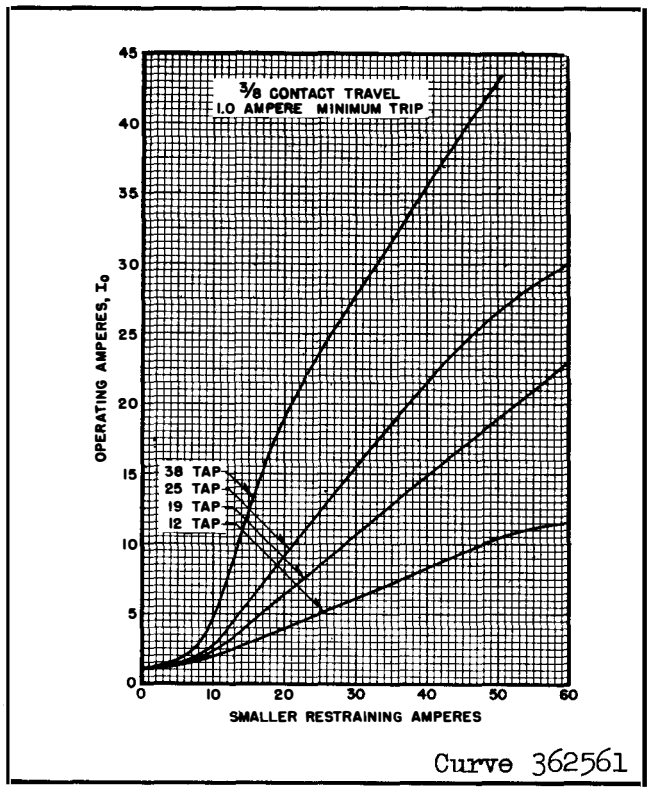

Fig. 4. Typical Operating Characteristics for the Type CA-5 Relay for Transformer Protection.

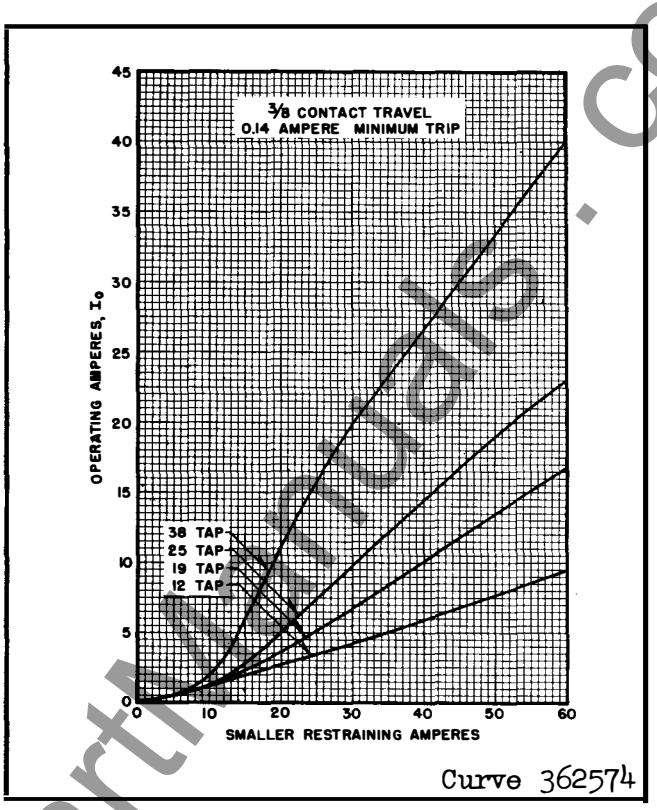

Fig. 5. Typical Operating Characteristics for the Type CA-5 Relay for Generator Protection.

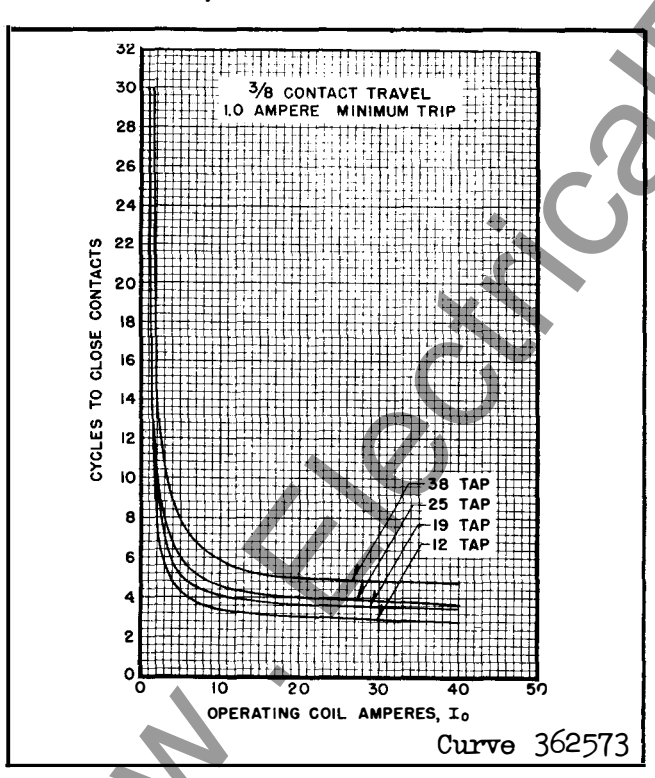

Fig. 6. Typical Time Curves of the Type CA-5 Relay for Transformer Protection.

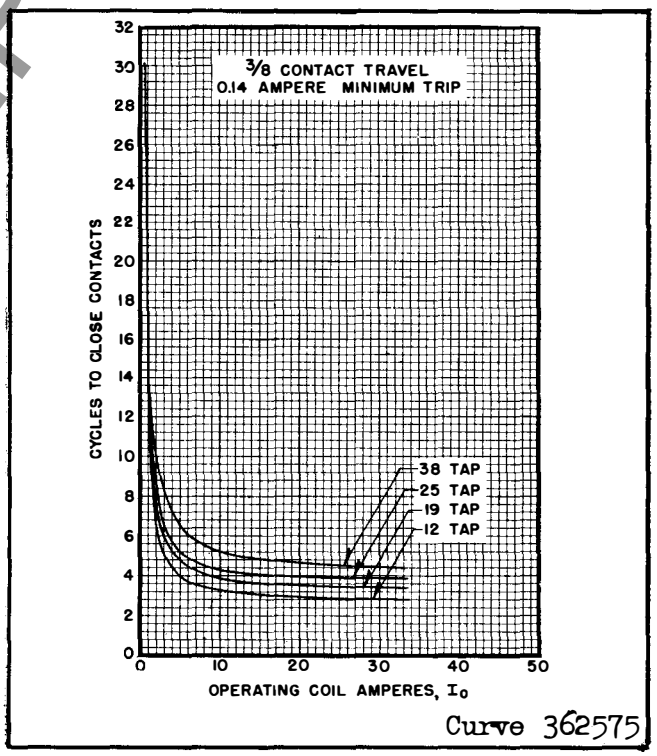

Fig. 7. Typical Time Curves of the Type CA-5 Relay for Generator Protection.

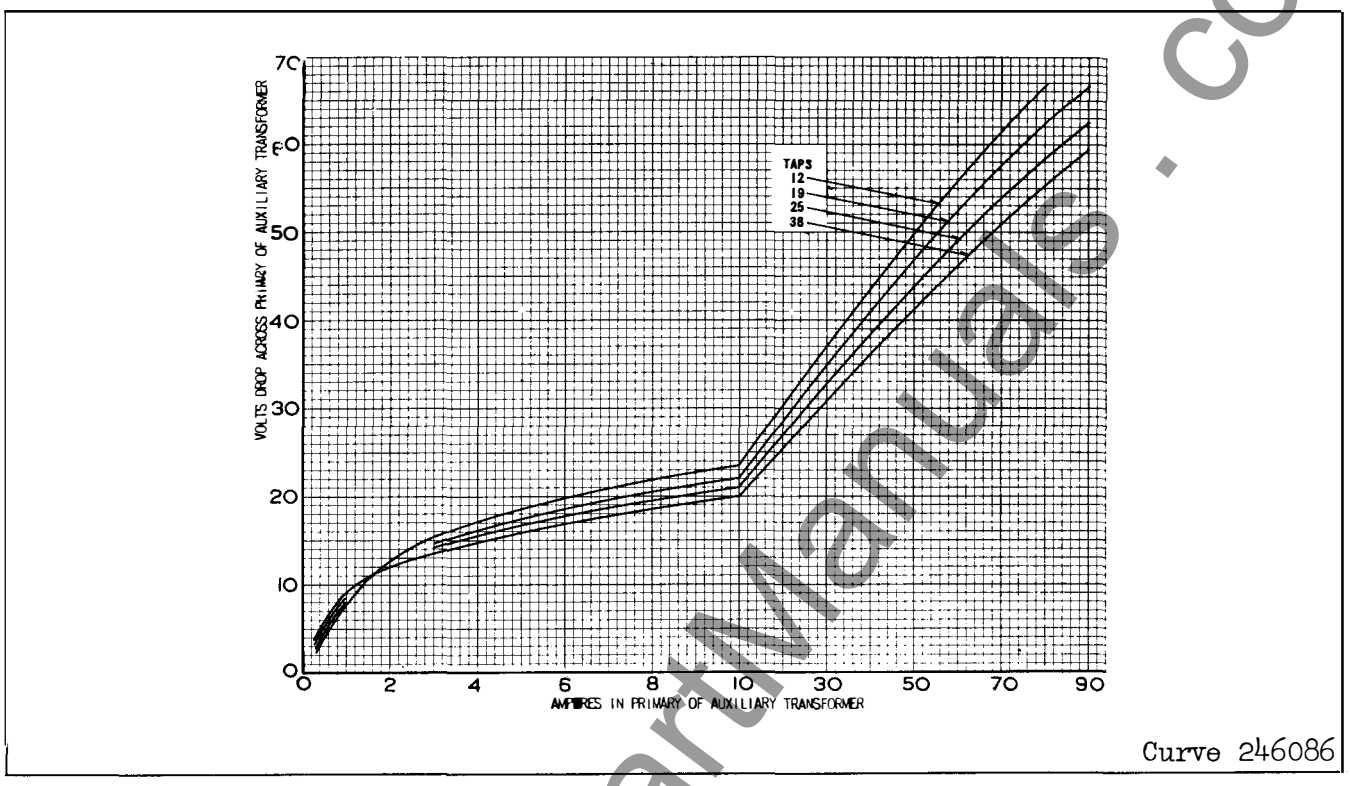

Fig. 8. Typical Burden Curves of the Operating Coil Circuit of the Type CA-5 Relay.

SETTING THE RELAY

Generator Differential Relay

The external current transformer taps are the only setting required. The No. 19 tap is recommended.

Transformer Differential Relay

Set the external current transformer tap. The following settings are recommended for various mismatch percentages.

Percent Mismatch †	Minimum Pickup Setting	Minimum Tap
0-5	.75 Amp.	19
5-10	1.00 Amp.	38
10-15	1.25 Amp.	38

† Includes error due to power transformer tap changing

The pickup of the relay is varied by means of the spring adjuster.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except the selection of the 0.2 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.

Indicating Instantaneous Trip (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, the core screw must be adjusted to the value of pick-up desired. It is recommended that a pickup of 100 amperes be used.

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

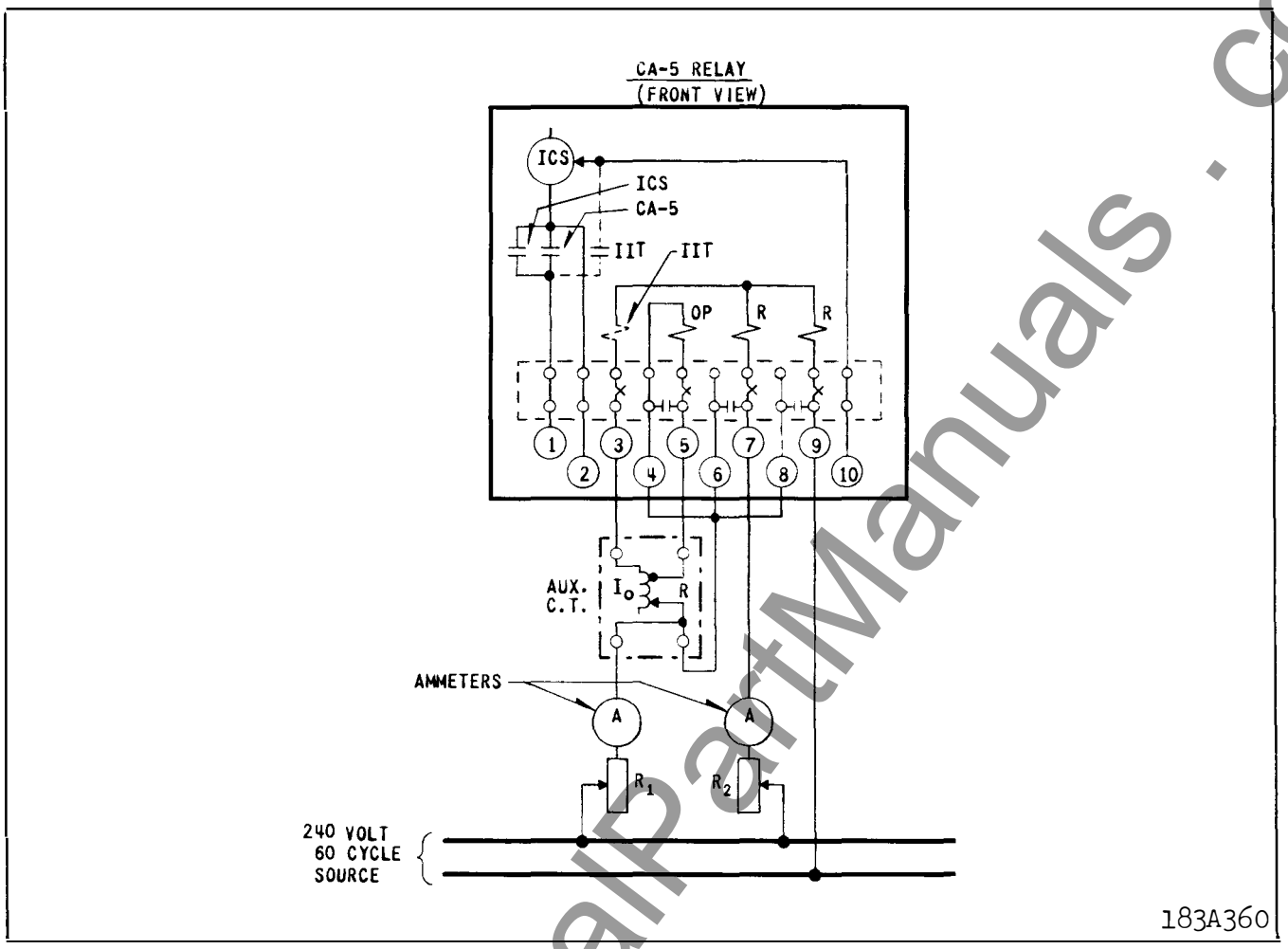

Fig. 9. Diagram of Test Connections for the Type CA-5 Relay in the Type FT21 case.

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.

The total resistance of the leads, connecting relay terminals 4 and 5 to the R terminals of the auxiliary current transformer, must not exceed .05 ohms.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no adjustments, other than those covered under "Settings," should be required.

Receiving Acceptance

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

A. Differential Unit

Connect the relay per the test circuit of Fig. 9. Relays and transformers of matching serial numbers should be connected together. Use tight screw connections between the transformer and the relay. Do not use clip leads.

The total resistance of the leads, connecting relay terminals 4 and 5 to the R terminals of the auxiliary current transformer, must not exceed .05 ohms.

1. Minimum Pickup Pass current through one restraint winding and the primary of the external transformer. The relay should operate on the 19 tap with following current.
   a) Transformer Relay 1.0 ± 5% amp.
   b) Generator Relay 0.145 ± 5% amp.

2. Percentage Slope Characteristic With relay set on 19 tap and 30 amperes smaller re-

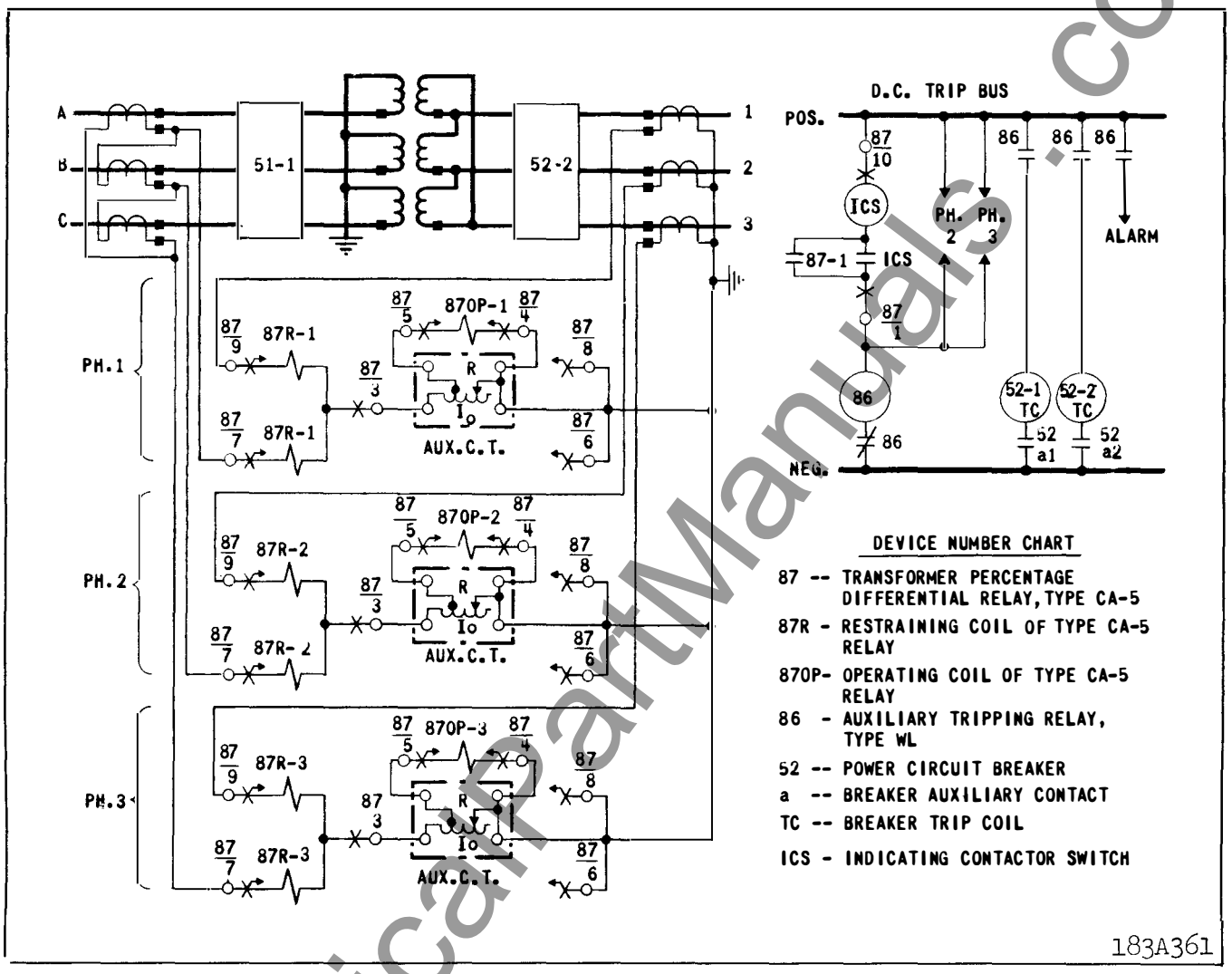

Fig. 10. External Schematic Diagram of the Type CA-5 Relay in the Type FT21 Case for Protection of a Wye-Delta Transformer Bank.

straint current, the relay should operate with following operating current.

a) Transformer Relay	10.5 ± 7% amperes
b) Generator Relay	6.7 ± 7% amperes

B. 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 inch between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

C. Indicating Instantaneous Trip Unit (ITT) (When Supplied)

The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%. Pickup current should be measured with the I_o terminals of the external transformer shorted.

Routine Maintenance

All relays should be checked at least once every year or at such other time intervals as may be dic-

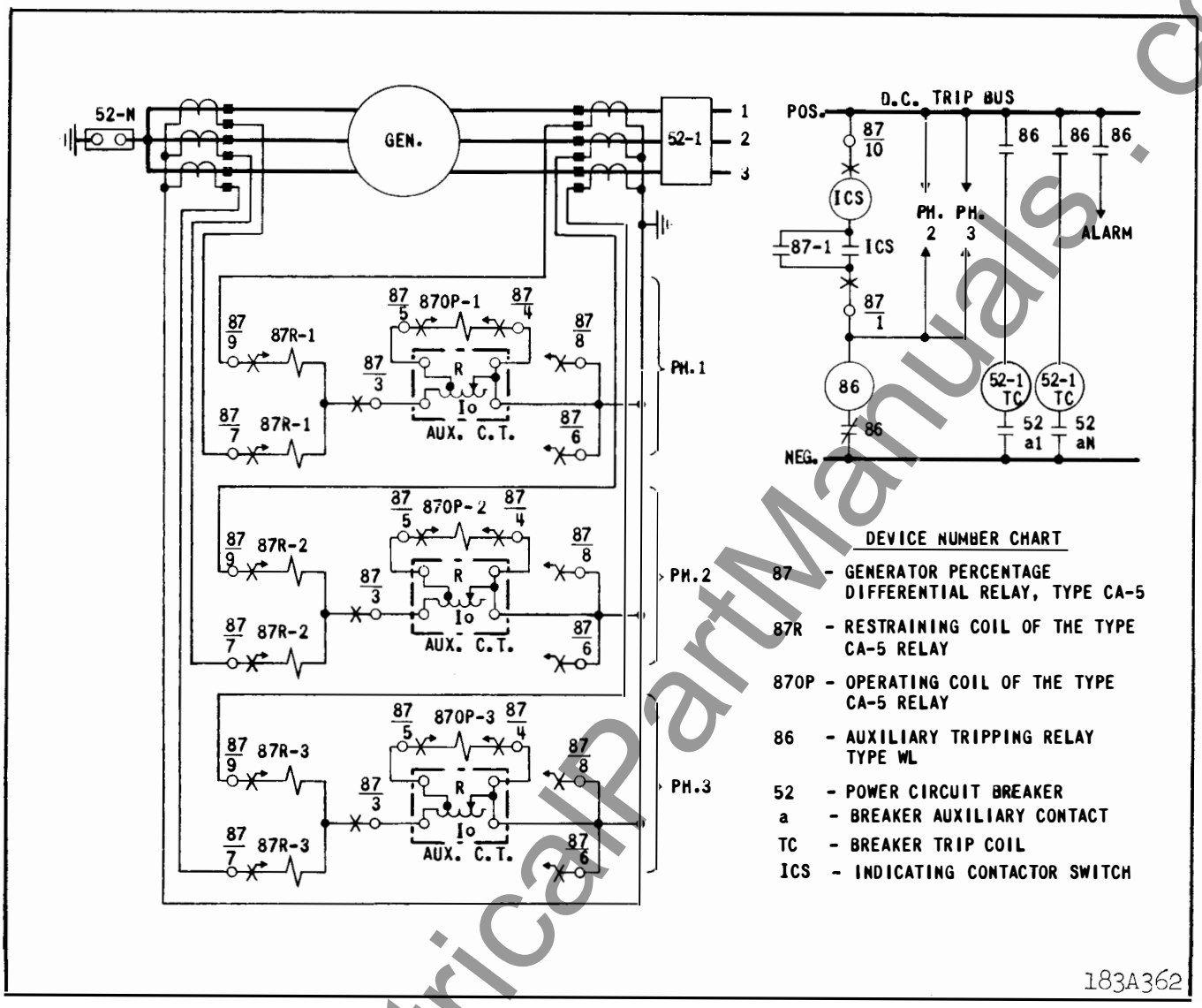

Fig. 11. External Schematic Diagram of the Type CA-5 Relay in the Type FT21 case for Differential Protection of a Generator.

tated by experience to be suitable to the particular application.

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.

Repair 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. Clearance - Adjust the top bearing screw to have .002 to .006 inch clearance between it and the shaft.

2. Contacts - Adjust the stationary contact so that 3/8 inch contact separation is obtained when the moving contact is held in the maximum open position.

3. Minimum Pickup - Adjust the spiral spring such that the relay will just operate with the following currents flowing in one restraint winding and the primary of the operating transformer set on tap 19.

a) Transformer Relay	1.0 amp.
b) Generator Relay	0.145 amp.

4. Percentage Slope Characteristic - Points on the percentage slope curve can be checked by means of the test circuit of Fig. 9. The operating current required to operate the relay should be ± 7% of the curve values. Care should be taken not to overheat the relay during these tests.

5. 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.

6. Indicating Instantaneous Trip Unit (ITT) (Where Used)

The core screw must be adjusted to the value of pick up current desired. It is recommended that the ITT be set for one hundred amperes. This setting should be made with the current flowing into either terminals 7 or 9 and out of terminal 3. In other words, the external transformer should be excluded from the test circuit when making this adjustment.

RENEWAL PARTS

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

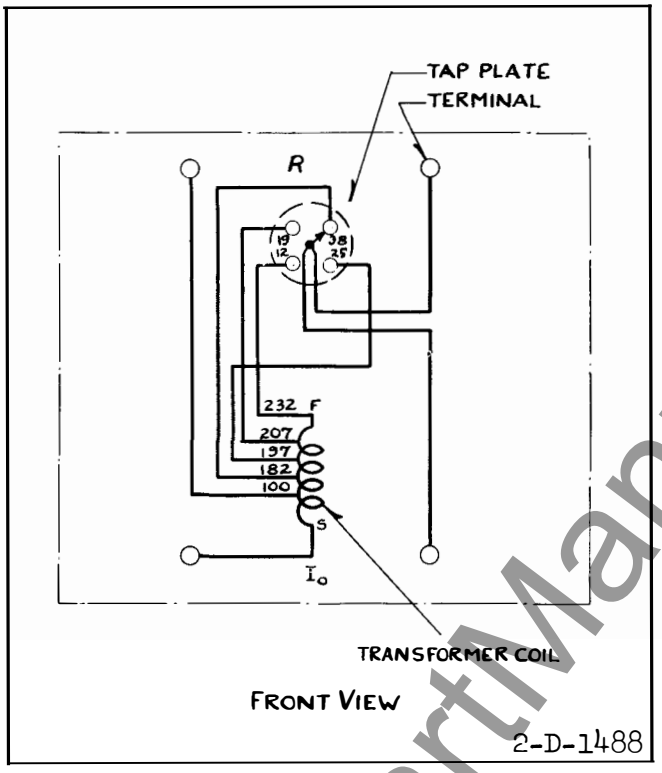

Fig. 12. Internal Schematic for the Auxiliary Current Transformer.

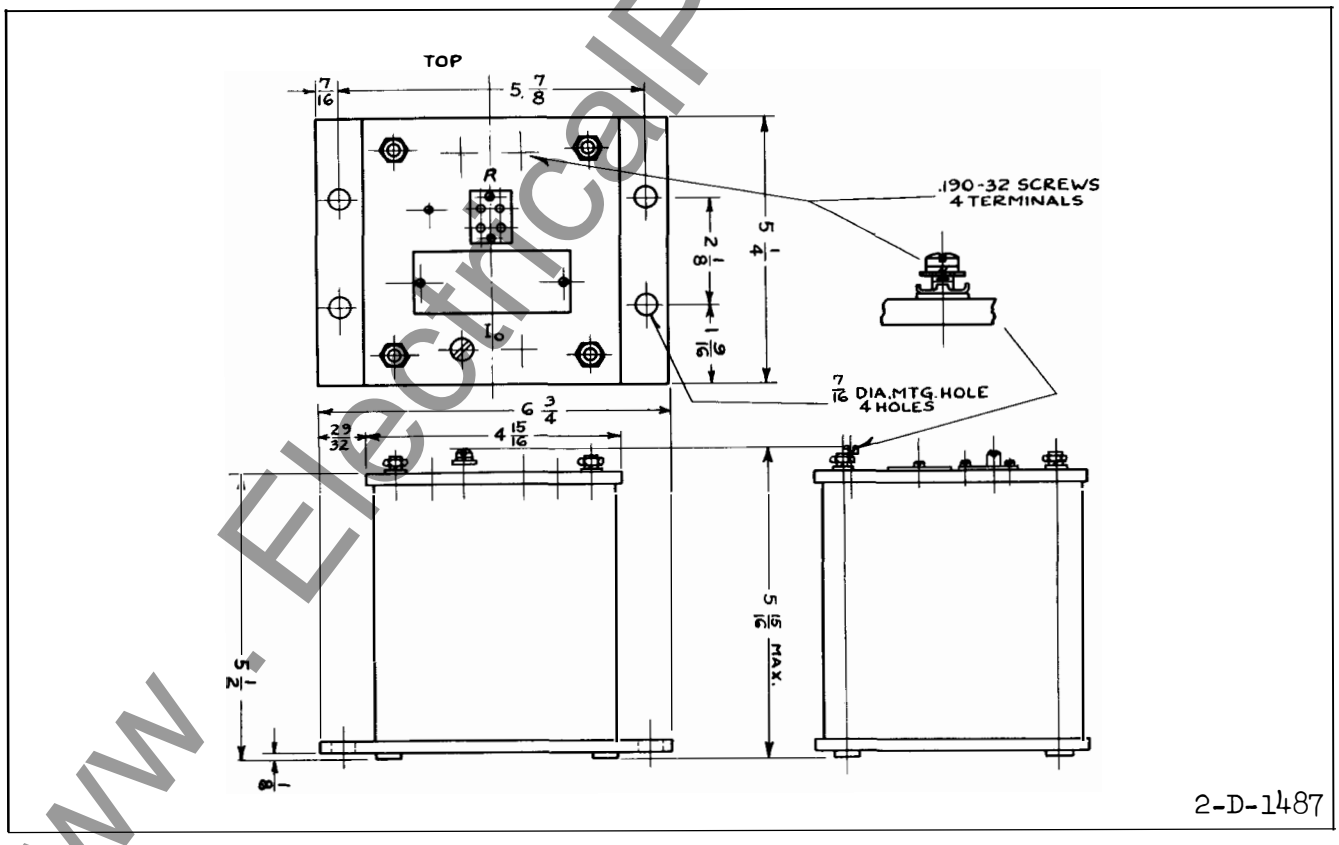

Fig. 13. Outline and Drilling Plan for the Auxiliary Current Transformer.

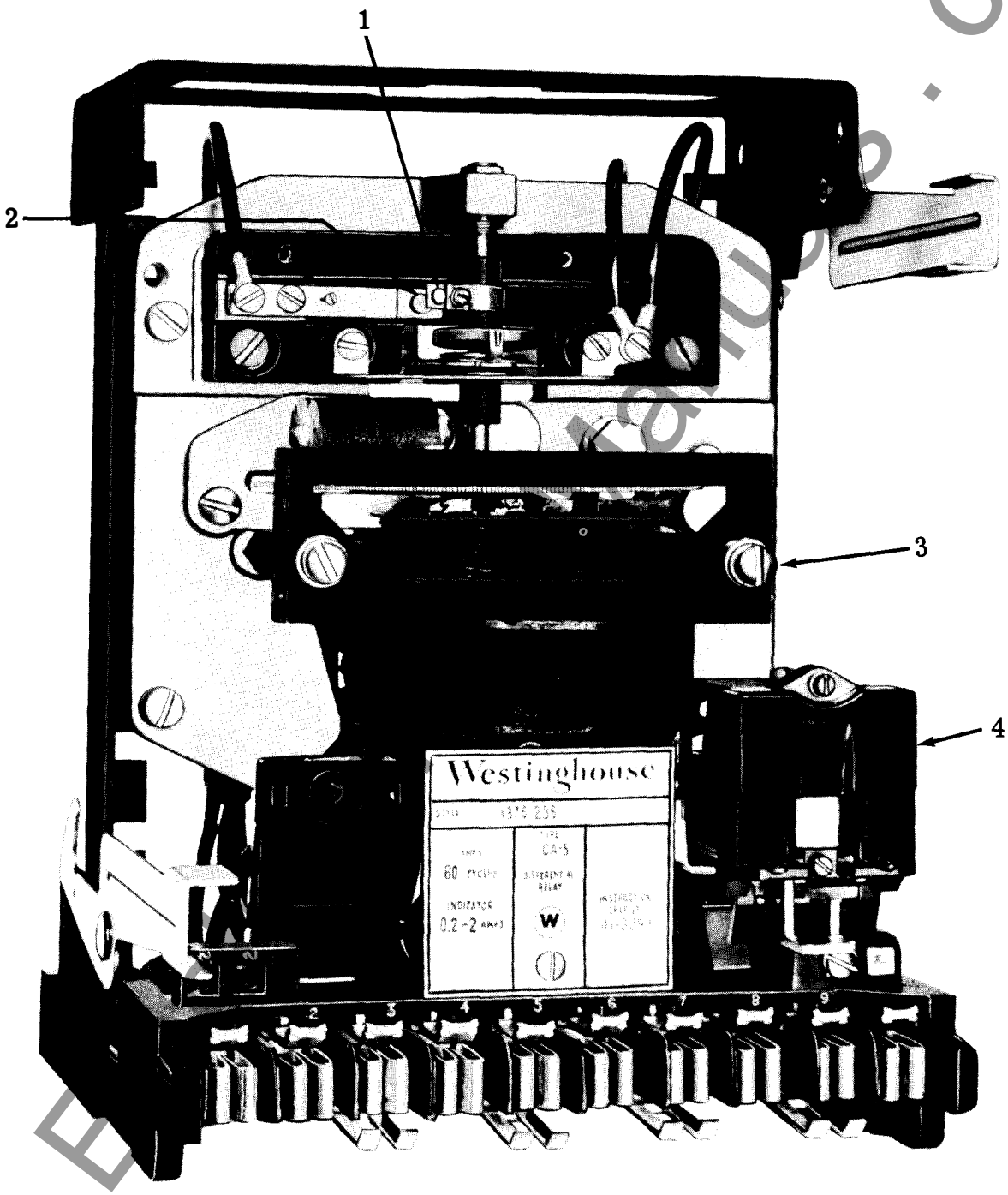

Fig. 14. Types CA-5 Relay Without Case (Front View). 1 – Moving Contact. 2 – Stationary Contact. 3 – Two Electromagnets (front restraint electromagnet with two windings; rear operating electromagnets with single winding). 4 – Indicating Contactor Switch (ICS).

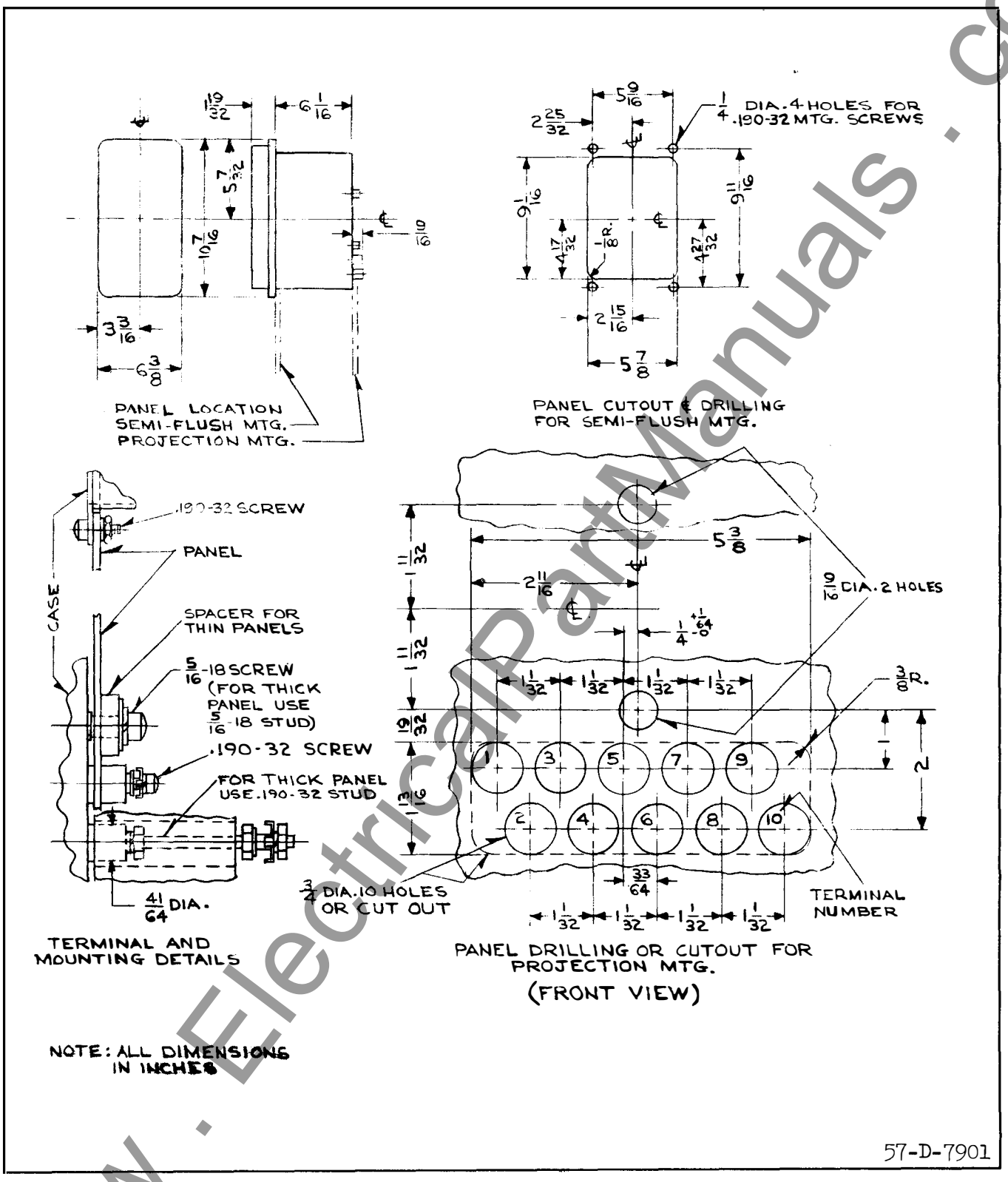

Fig. 15. Outline and Drilling Plan for the Type CA-5 Relay in the Type FT21 case.

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Transformer Relay

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Generator Relay

Current transformer burden in ohms should not exceed $(N_P V_{CL})/133$; further the burden factor, BF, should not differ by more than a 2 to 1 ratio between the two sets of CT's. The above terms are defined as:

N_P = proportion of total number of CT turns in use

V_{CL} = current transformer 10L accuracy class voltage

$$BF = \frac{1000\ R_B}{N_P V_{CL}}$$

R_B = resistance of the burden, excluding CT winding resistance.

For example, if the 400/5 tap of a 600/5 multi-ratio CT is used, $N_P = 400/600 = 0.67$. If this CT has a 10L200 rating, $V_{CL} = 200$, and the burden should not exceed:

$$\frac{N_P V_{CL}}{133} = \frac{0.67 \times 200}{133} = 1.0 \text{ ohm}$$

Assuming a resistance burden of $R_B = 0.5$ ohms, the burden factor, BF, is:

$$BF = \frac{1000\ R_B}{N_P V_{CL}} = \frac{1000 \times 0.5}{0.67 \times 200} = 3.8$$

The other set of CT's may then have a burden factor as high as $2 \times 3.8 = 7.6$, or as low as $1/2 \times 3.8 = 1.9$. If the other set of CT's also has a burden of 0.5 ohms, a 10L100, 10L200, or 10L400 rating would be satisfactory, since the burden factors are 7.6, 3.8 and 1.9, respectively.

In calculating the burden, use the one way lead burden.

CONSTRUCTION

The type CA-5 relay consists of a percentage differential unit, an indicating contactor switch unit, and an optional indicating instantaneous trip unit. The construction and operation of these units are as follows:

Percentage Differential Unit

This unit has one restraining element, with two windings, and one operating element which is energized through an external auxiliary current transformer in accordance with the current flowing in the differential connection of the main current transformers. Taps controlling the sensitivity of the relay are incorporated in the external transformer.

The unit operates on the induction-disc principle, with both electromagnets operating on the same disc. The front electromagnet is the restraining, and the rear electromagnet is the operating element. These are connected as shown in Figs. 1 and 2.

The disc is mounted on a vertical shaft. The lower bearing for the shaft is a steel ball riding between concave sapphire jewel surfaces. A pin bearing is used on the upper end of the shaft.

The moving contact assembly is attached to a Micarta bushing on the disc shaft. When the moving contact strikes the stationary contact, the moving contact spring deflects to provide a wiping action. The

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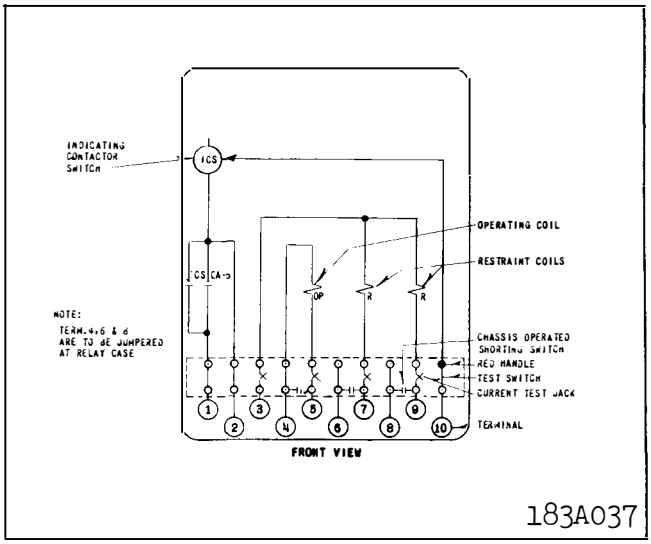


Fig. 1. Internal Schematic of the Type CA-5 Relay in the Type FT21 case.

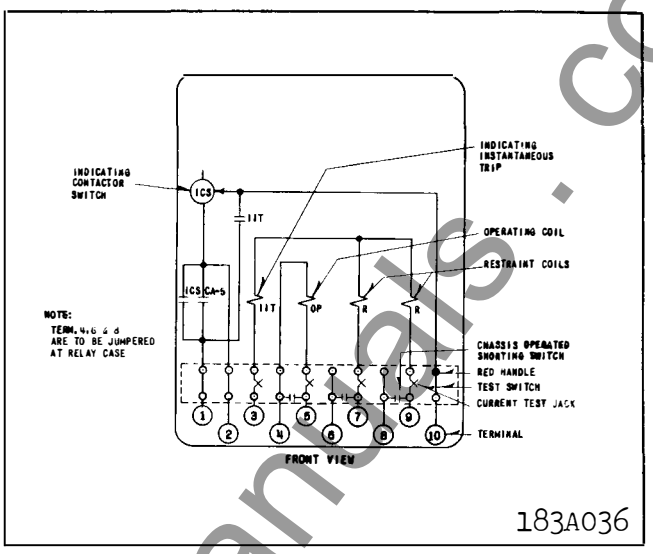


Fig. 2. Internal Schematic of the Type CA-5 Relay with Indicating Instantaneous Trip in the Type FT21 case.

electrical connection from the moving contact is made through the spiral spring to the spring adjuster.

The stationary contact is mounted on a right angle bracket fastened to the element frame through a Micarta insulating block. A contact screw projects through the outer end of the bracket and provides adjustable contact separation.

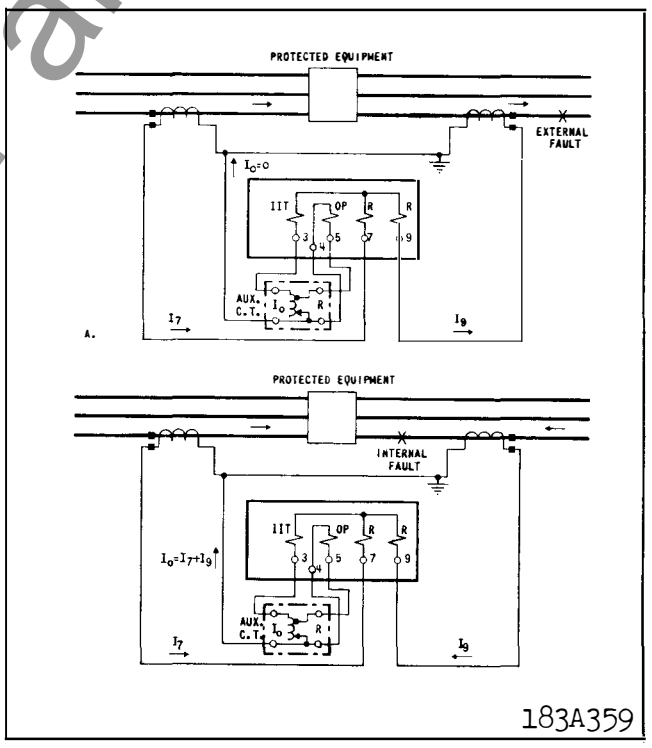
Indicating Contactor Switch Unit (ICS)

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.

Indicating Instantaneous Trip Unit (IIT) (When Supplied)

The instantaneous trip unit is a small a-c operated 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.



* *Fig. 3. Schematic Diagrams of the Type CA-5 Relay. (A) Shows the Fault Current Distribution for an External Fault; (B) The Distribution for an Internal Fault.*

When the switch closes, the moving contacts bridge two stationary contacts completing the trip circuit. Also during the 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.

A core screw accessible from the top of the switch provides the adjustable pickup range. The minimum and maximum pickup points are indicated on the scale, which is located to the rear of the core screw.

OPERATION

Fig. 3 shows the current through the relay for external and internal fault conditions. With the relay connected as in Fig. 3A, a through fault causes currents to flow through the two restraining windings in the same direction. If the main current transformers operate properly, these restraining currents are equal, and no current flows in the auxiliary current transformer and operating coil winding. In this case, there will be only contact opening torque produced.

In the case of a heavy internal fault, when an external source feeds current into the fault, the restraining currents are in opposite directions, and restraining torque tends to cancel out as in Fig. 3B. When the currents fed from the two sides are equal, the restraint is totally cancelled. When unequal currents flow in from the two sides, the restraint is equivalent to the difference in the two currents. In this case, the currents in the restraining windings will add together and go through the operating winding, producing a contact closing torque. The operating curves for the relay are shown in Figs. 4 and 5.

This relay has variable percentage characteristics which means that the operating coil current required to close the relay contact, expressed in percent of the total restraint current, varies with the magnitude of the restraint current. The relay sensitivity is high, corresponding to a low percentage ratio, at light currents, and its sensitivity is low, corresponding to high percentage unbalance, at high currents. The relay is made sensitive at low currents in order that it will detect light internal faults. At the same time, however, its reduced sensitivity at the higher currents allows the various current transformers involved to depart from their true ratio to a large extent without causing false tripping of the relay for external faults.

CHARACTERISTICS

The type CA-5 percentage differential relay is available in two designs: a relay with a minimum trip current of 0.14 amp. for generator protection and a relay with a range of adjustment of minimum trip current from 0.50 amp. to 2.0 amp. for transformer protection.

The time of operation of the generator relay is shown in Fig. 7, and the time of operation of the transformer relay is shown in Fig. 6. The percentage slope characteristics are shown in Fig. 5 (Generator relay) and Fig. 4 (Transformer relay).

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 instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a 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

ENERGY REQUIREMENTS

Restraint Coil Circuit

Continuous Rating	10 amperes
1 Second Rating	250 amperes
Volt Amperes @ 5 amperes	.75
Power Factor	0.7 lag

Operating Coil Circuit

Continuous Rating	5 amperes
1 Second Rating	150 amperes
Volt Amperes	Variable, see Fig. 8

SETTING CALCULATIONS

No calculations are required to set the CA-5 relay.

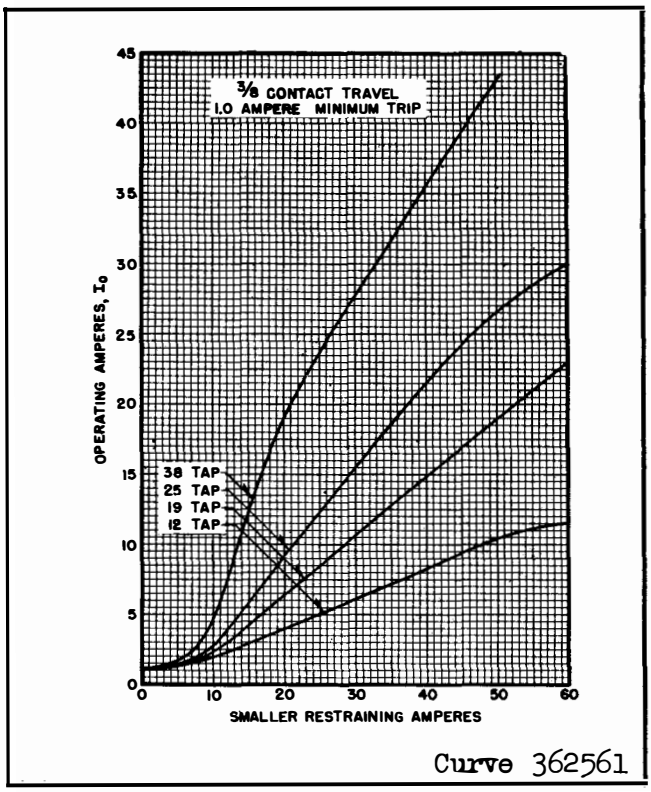


Fig. 4. Typical Operating Characteristics for the Type CA-5 Relay for Transformer Protection.

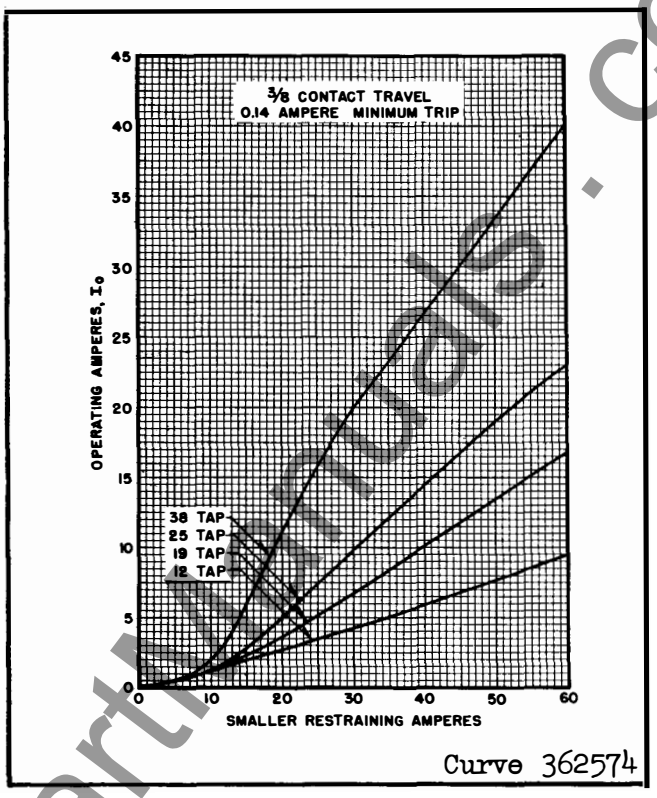


Fig. 5. Typical Operating Characteristics for the Type CA-5 Relay for Generator Protection.

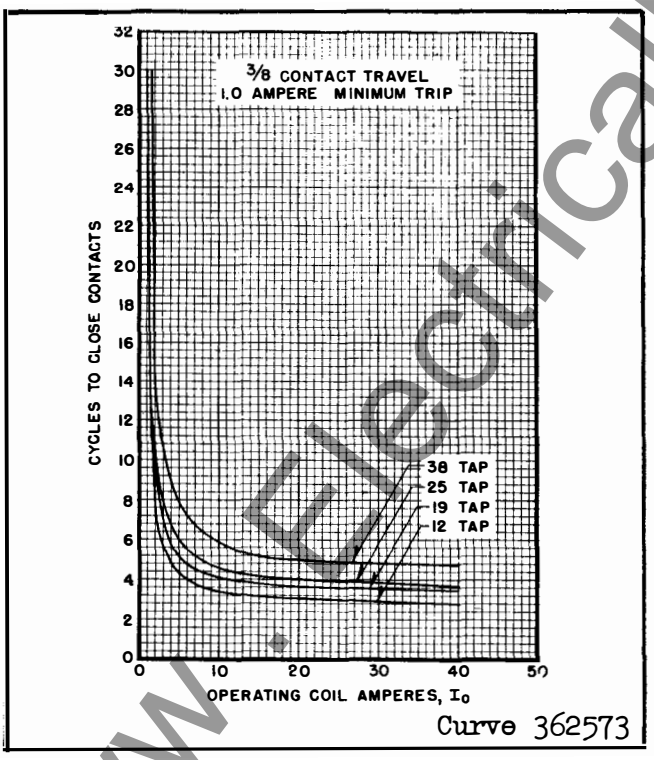


Fig. 6. Typical Time Curves of the Type CA-5 Relay for Transformer Protection.

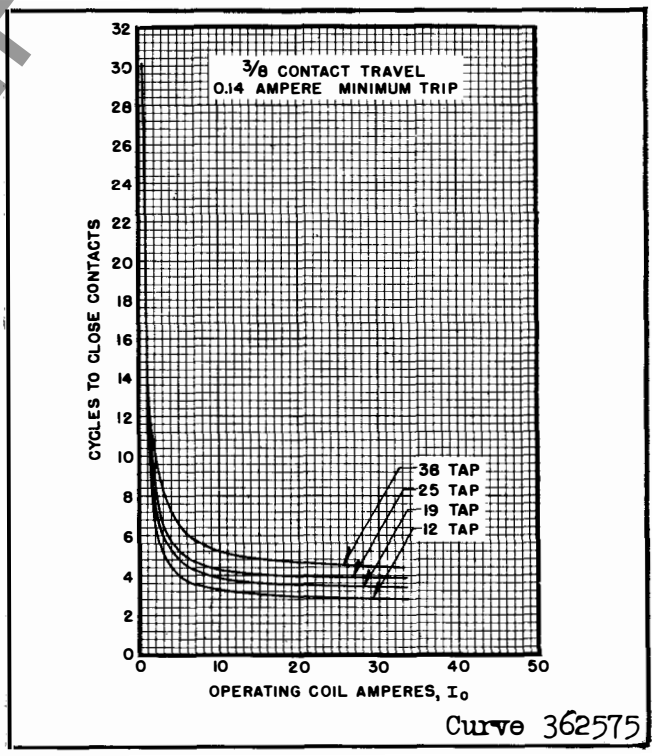


Fig. 7. Typical Time Curves of the Type CA-5 Relay for Generator Protection.

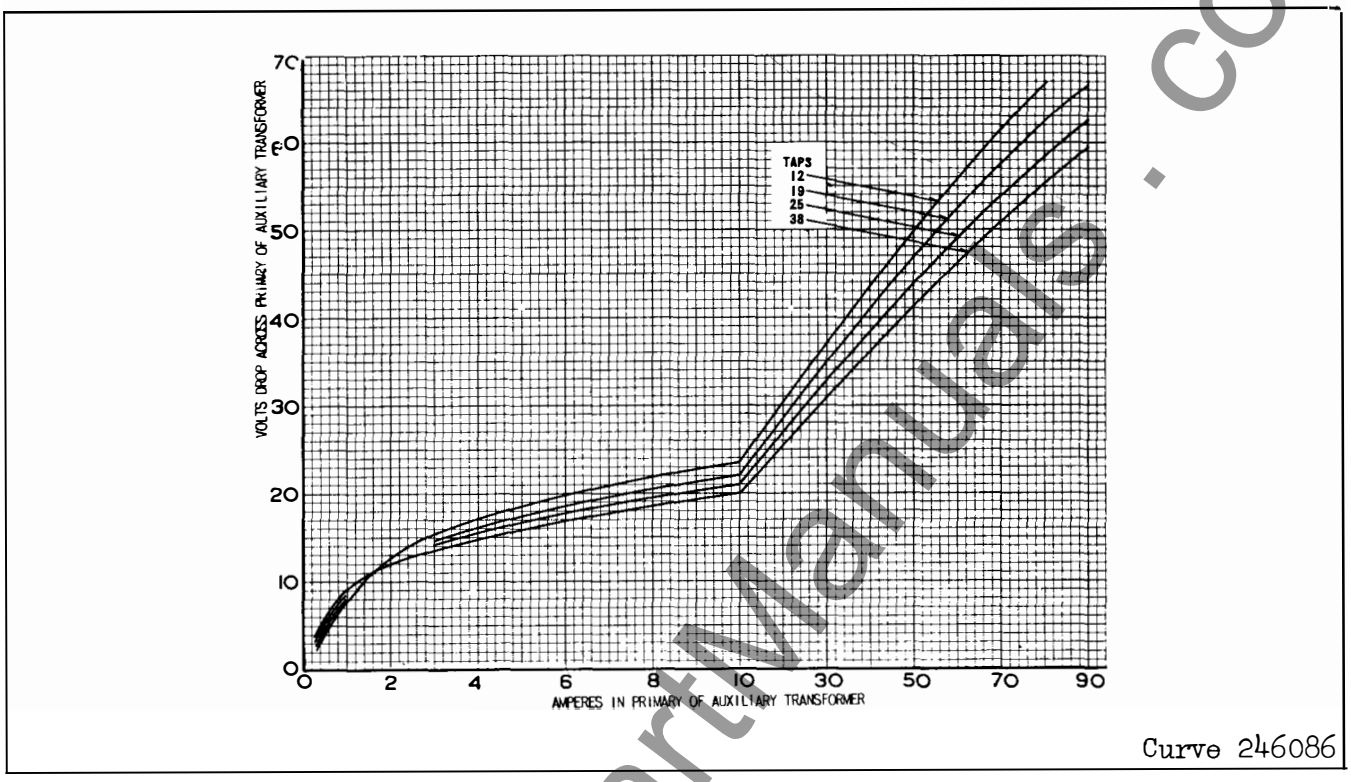


Fig. 8. Typical Burden Curves of the Operating Coil Circuit of the Type CA-5 Relay.

SETTING THE RELAY

Generator Differential Relay

The external current transformer taps are the only setting required. The No. 19 tap is recommended.

Transformer Differential Relay

Set the external current transformer tap. The following settings are recommended for various mismatch percentages.

Percent Mismatch †	Minimum Pickup Setting	Minimum Tap
0-5	.75 Amp.	19
5-10	1.00 Amp.	38
10-15	1.25 Amp.	38

† Includes error due to power transformer tap changing

The pickup of the relay is varied by means of the spring adjuster.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except the selection of the 0.2 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.

Indicating Instantaneous Trip (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, the core screw must be adjusted to the value of pick-up desired. It is recommended that a pickup of 100 amperes be used.

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

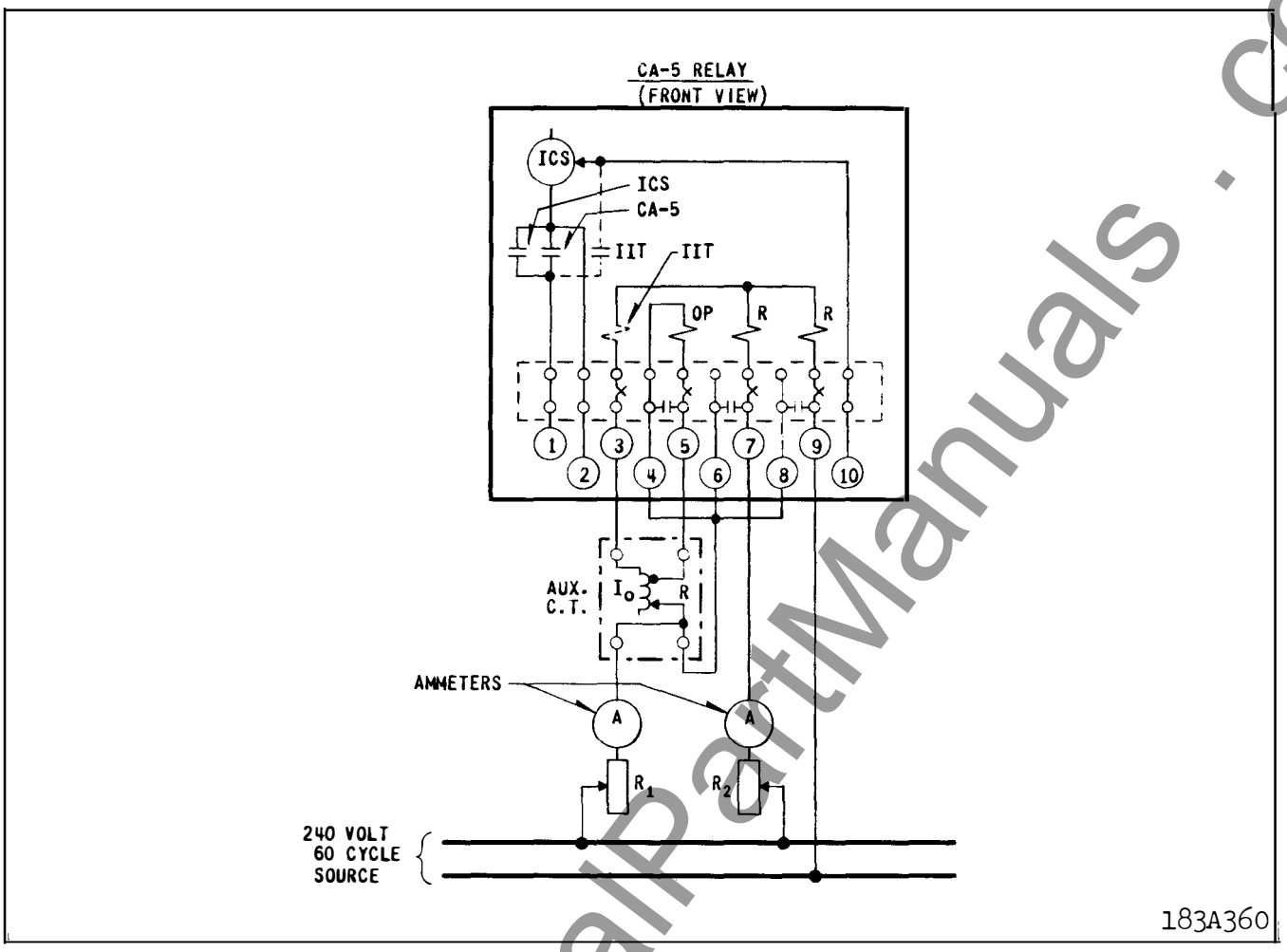


Fig. 9. Diagram of Test Connections for the Type CA-5 Relay in the Type FT21 case.

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.

The total resistance of the leads, connecting relay terminals 4 and 5 to the R terminals of the auxiliary current transformer, must not exceed .05 ohms.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no adjustments, other than those covered under "Settings," should be required.

Receiving Acceptance

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

A. Differential Unit

Connect the relay per the test circuit of Fig. 9. Relays and transformers of matching serial numbers should be connected together. Use tight screw connections between the transformer and the relay. Do not use clip leads.

The total resistance of the leads, connecting relay terminals 4 and 5 to the R terminals of the auxiliary current transformer, must not exceed .05 ohms.

1. Minimum Pickup Pass current through one restraint winding and the primary of the external transformer. The relay should operate on the 19 tap with following current.
   a) Transformer Relay 1.0 ± 5% amp.
   b) Generator Relay 0.145 ± 5% amp.

2. Percentage Slope Characteristic With relay set on 19 tap and 30 amperes smaller re-

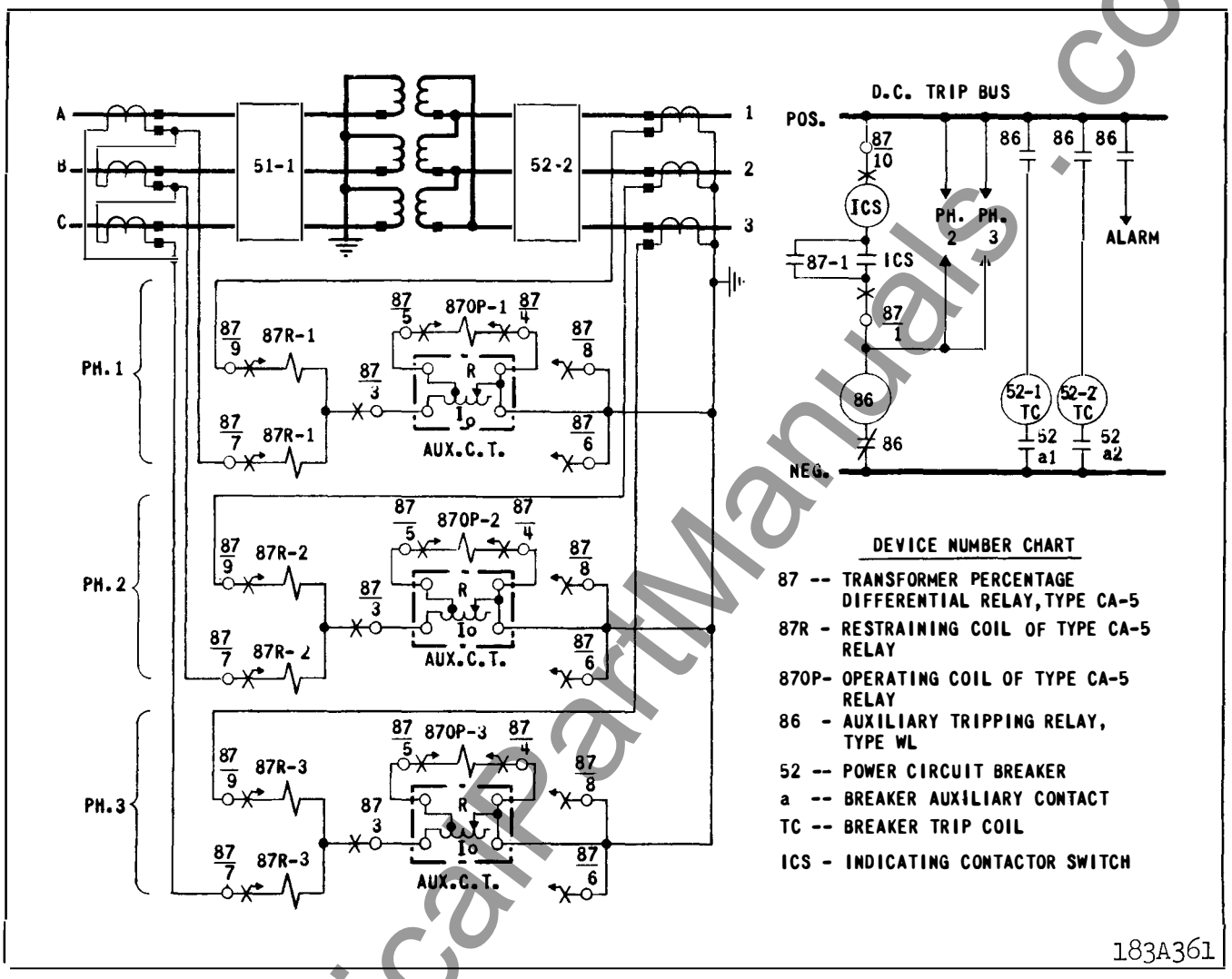


Fig. 10. External Schematic Diagram of the Type CA-5 Relay in the Type FT21 Case for Protection of a Wye-Delta Transformer Bank.

straint current, the relay should operate with following operating current.

a) Transformer Relay 10.5 ± 7% amperes
b) Generator Relay 6.7 ± 7% amperes

B. 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 inch between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

C. Indicating Instantaneous Trip Unit (ITT) (When Supplied)

The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%. Pickup current should be measured with the I_O terminals of the external transformer shorted.

Routine Maintenance

All relays should be checked at least once every year or at such other time intervals as may be dic-

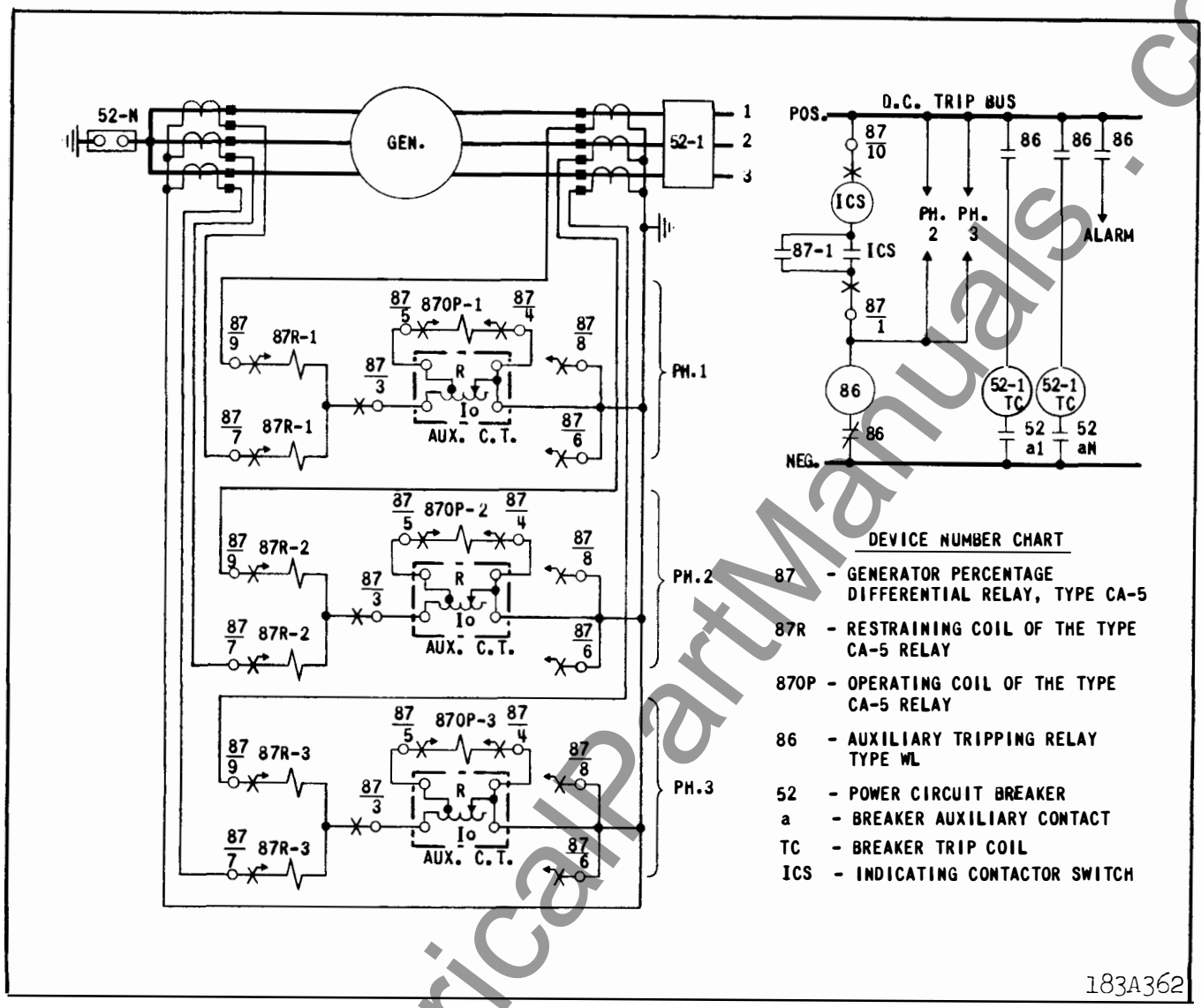


Fig. 11. External Schematic Diagram of the Type CA-5 Relay in the Type FT21 case for Differential Protection of a Generator.

tated by experience to be suitable to the particular application.

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.

Repair 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. Clearance - Adjust the top bearing screw to have .002 to .006 inch clearance between it and the shaft.

2. Contacts - Adjust the stationary contact so that 3/8 inch contact separation is obtained when the moving contact is held in the maximum open position.

3. Minimum Pickup - Adjust the spiral spring such that the relay will just operate with the following currents flowing in one restraint winding and the primary of the operating transformer set on tap 19.

a) Transformer Relay	1.0 amp.
b) Generator Relay	0.145 amp.

4. Percentage Slope Characteristic - Points on the percentage slope curve can be checked by means of the test circuit of Fig. 9. The operating current required to operate the relay should be ± 7% of the curve values. Care should be taken not to overheat the relay during these tests.

5. 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.

6. Indicating Instantaneous Trip Unit (ITT) (Where Used)

The core screw must be adjusted to the value of pick up current desired. It is recommended that the ITT be set for one hundred amperes. This setting should be made with the current flowing into either terminals 7 or 9 and out of terminal 3. In other words, the external transformer should be excluded from the test circuit when making this adjustment.

RENEWAL PARTS

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

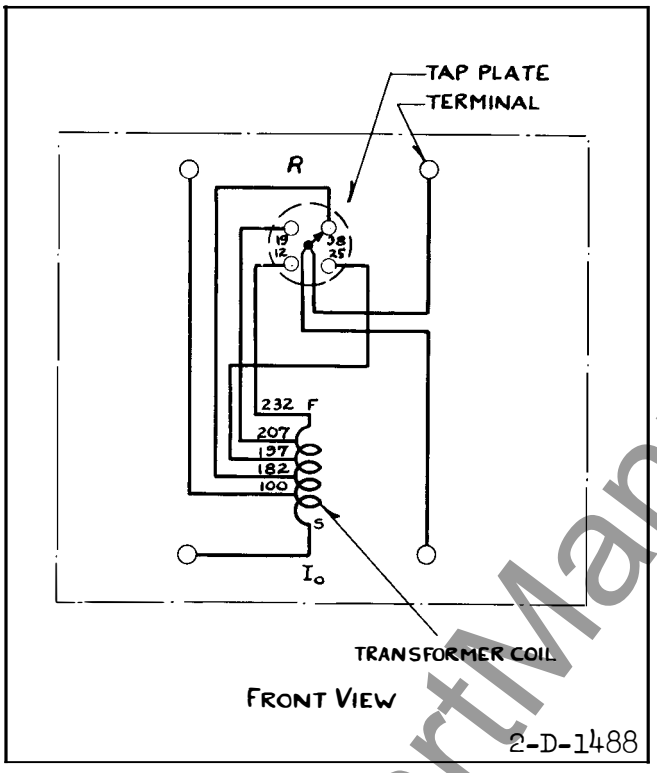


Fig. 12. Internal Schematic for the Auxiliary Current Transformer.

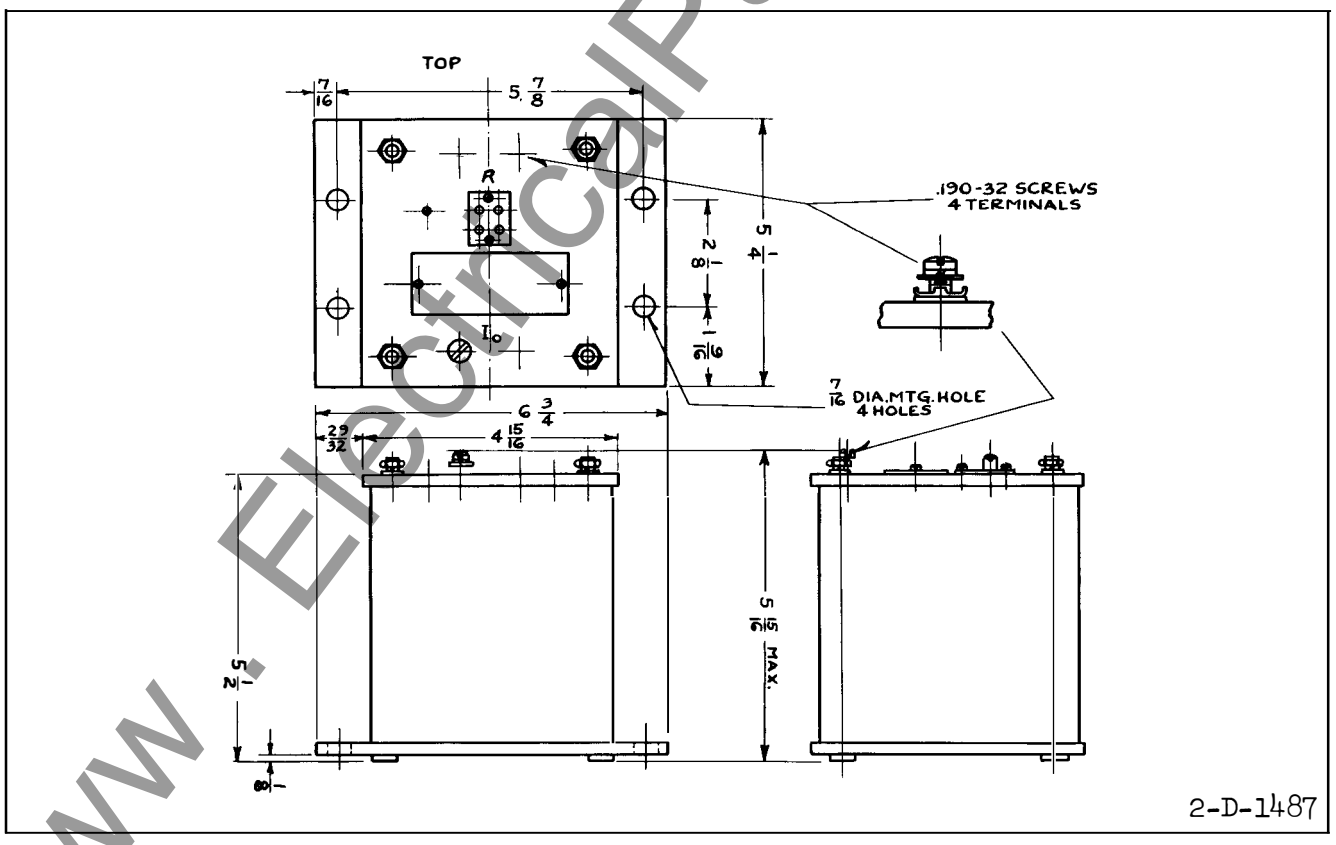


Fig. 13. Outline and Drilling Plan for the Auxiliary Current Transformer.

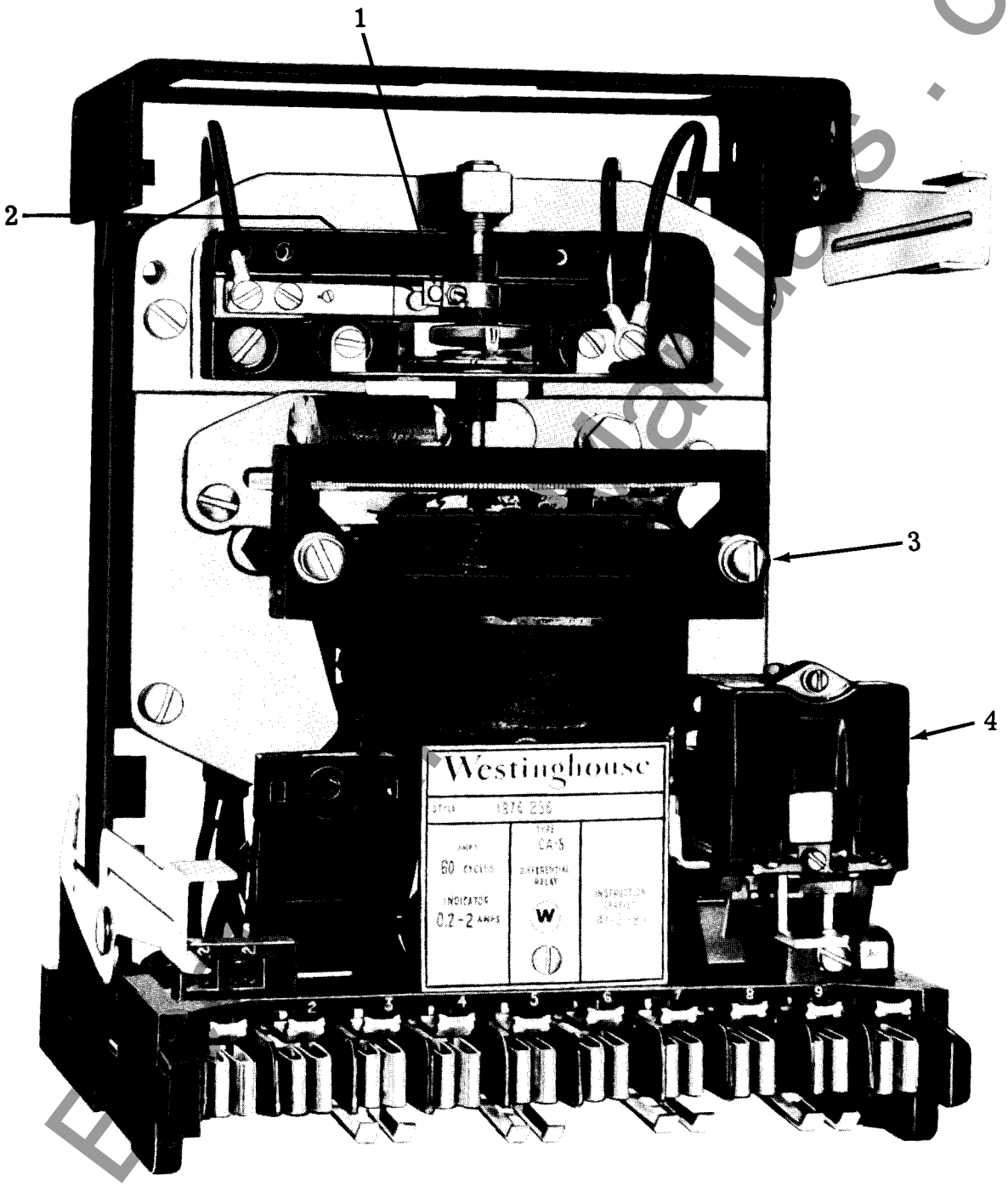


Fig. 14. Types CA-5 Relay Without Case (Front View). 1 – Moving Contact. 2 – Stationary Contact. 3 – Two Electromagnets (front restraint electromagnet with two windings; rear operating electromagnets with single winding). 4 – Indicating Contactor Switch (ICS).

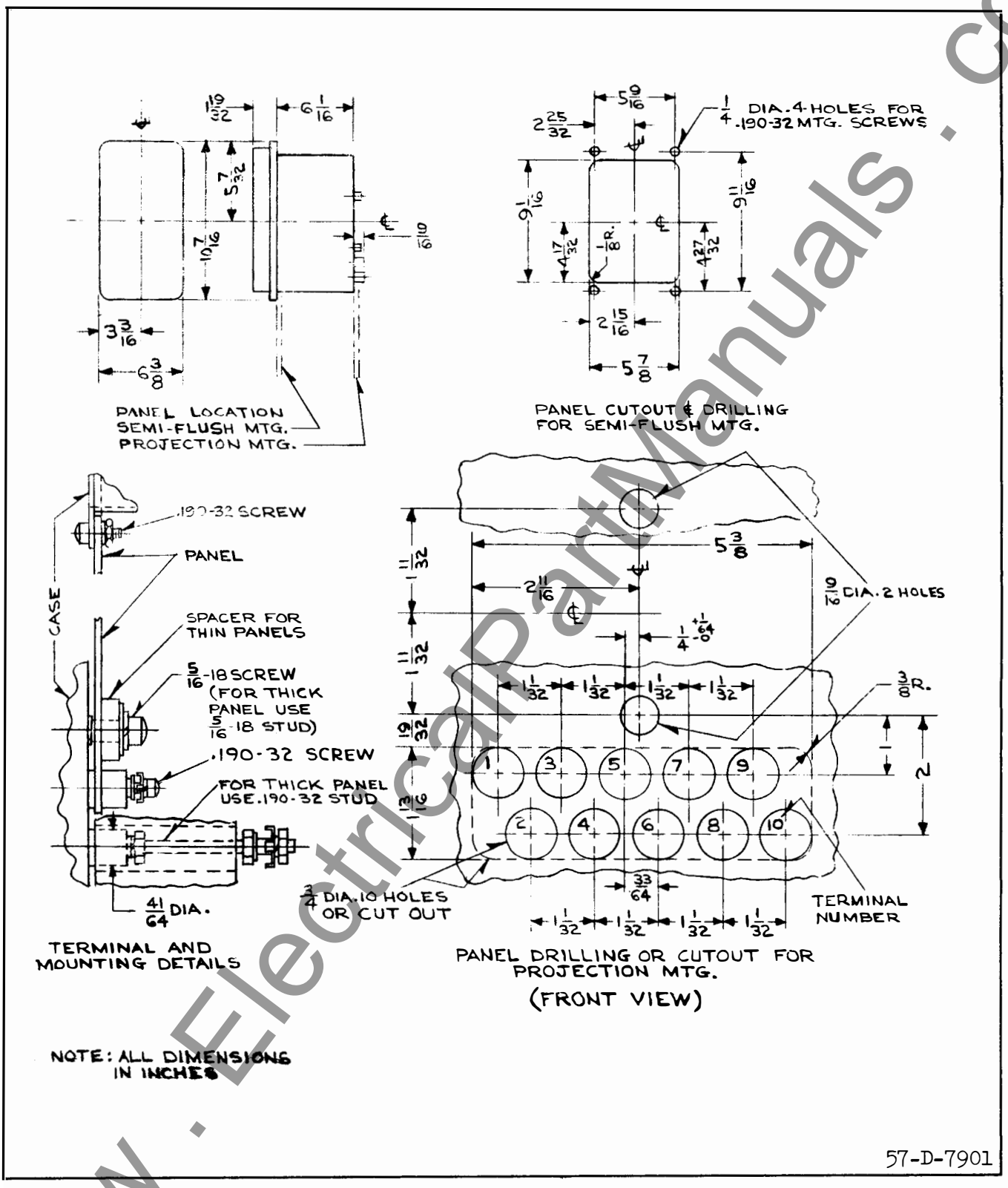


Fig. 15. Outline and Drilling Plan for the Type CA-5 Relay in the Type FT21 case.