INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE D-3 DIRECT CURRENT 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 D-3 relay is suitable for applications where overload, underload, or reverse-current protection is required on direct current circuits. One particular application is in the protection of rotary converters which require sensitive reverse-current relays to prevent sensitive reverse-current relays to prevent running inverted.

In the usual application of the D-3 relay the moving coil is connected to a shunt in the circuit being protected. By suitable selection of relay calibration and of shunt rating, the relay can be made to respond to particular magnitudes or directions of current flow through the shunt as required.

In applications where the D-3 relay is used for the purpose of regulating a load, closing of the overload contacts will initiate action to reduce the amount of the load. Since the relay is very sensitive, a slight reduction in load will cause the overload contacts to open. If the reduction of load is interrupted, the relay will close contacts again on a small load increase. Thus small load (fluctuations might cause excessive operation of the relay and the device controlled by it. The connections of Fig. 5 show the use of an external auxiliary relay (type SG) to keep the controlled device energized until the load had dropped by an amount determined by the setting of the left-hand contact of the D-3 relay.

CONSTRUCTION

The type D-3 relay is a d'Arsonvol type d.c. contact making voltmeter consisting of a moving coil permanent magnet, and contacts. The magnetic circuit is shown schematically in Fig. 1.

Permanent Magnet

The permanent magnet is a cylindrical core, consisting of an Alnico permanent magnet, two iron pole pieces and two brass spacer blocks. This magnet is mounted concentrically in the bore of a mallable iron frame.

A magnetic field is produced by the permanent magnet in the air gap between the magnet and the iron frame. The path of magnetic flux is from the Alnico magnet through the iron pole piece across the air gap to the iron frame. The return path of the flux is through the frame across the second air gap to the second pole piece. The pole pieces and the bore of the frame are shaped such that a uniform flux distribution is obtained in the air gaps.

Moving Coil

The moving coil rotates in the air gap between the core and the iron frame. Electrical connections are made to the coil through two springs located at the top of the element. One end of each spring is connected through a lever arm to a head of the coil. The other end of each spring is fastened to posts mounted in a circular insulation plate. This plate can be rotated to permit adjustment of the zero position of the moving element.

A third spiral spring located at the bottom of the element provides a current path to the moving contact.

Contractor Switch (When used)

The contactor switch is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts.

OPERATION

The D-3 relay operates on the principle of a cur-

SUPERSEDES I.L. 41-151.1
COMPLETE REVISION

EFFECTIVE AUGUST 1961

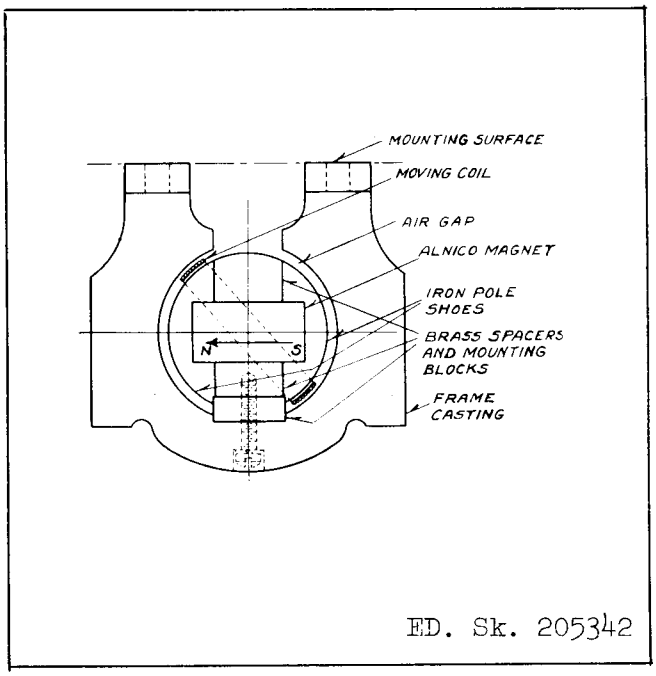


Fig. 1. Schematic Drawing of Magnetic Circuit of Type D-3 Relay (Top View). Moving Coil Bearing Supports, Springs and Contacts Omitted.

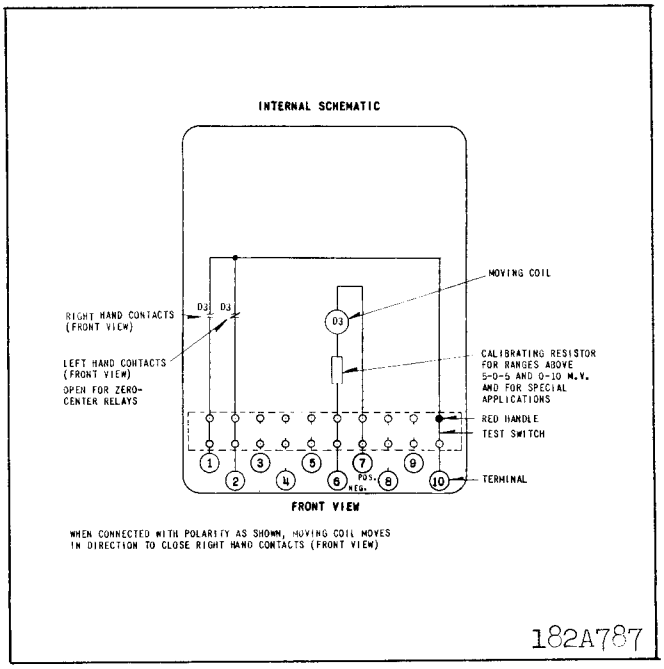


Fig. 2. Internal Schematic of the Type D-3 Relay in the Type FT21 Case.

rent carrying conductor (moving coil) located in a magnetic field (permanent magnet). When a current is applied to the coil of the relay, a torque is produced that rotates the moving coil until the electrical torque is equal to the torque of the restraining spring. The moving contact will assume a position in its travel that is proportional to the current applied to the moving coil.

The direction of movement of the moving coil is determined by the polarity of the current applied to the coil. In the "left zero" and "suppressed zero" D-3 relays, the contacts will move to the right when a current of the proper magnitude and polarity is applied to the relay. On the other hand, the contact of the "center zero" relay will move either left or right depending on the polarity and magnitude of the applied current.

CHARACTERISTICS

The type D-3 relay is supplied in the standard ranges listed in the table below. The numbers on the scale indicate in millivolts the potential required at the relay base terminals to operate the moving element to the indicated scale position.

MOVING COIL CIRCUIT

Ranges in Millivolts, d-c	Average Resistance in Ohms at 25°C
0-10	0.3
5-0-5	0.3
40-80	1.2
100-0-100	6.0
0-200	6.0

As shown in the above Table, the D-3 relay is available with a "left zero," "suppressed zero" and "center zero" scale. In the "left zero" and the "suppressed zero" relays the moving contact is located in the extreme left hand position of the scale when the relays are deenergized. The "suppressed zero" relay is held in this position with considerable more force than the "left zero" relay. When the relays are energized with voltages of the proper magnitude and polarity, the moving contact moves to the right.

In the "center zero" relay, the moving contact is located in the center of the scale when the relay is deenergized. When the relay is energized, the contact will move either to the right or left depending upon the polarity of the applied voltage.

A modification of the D-3 relay, in which a rectifier is mounted internally, makes it suitable for a.c.

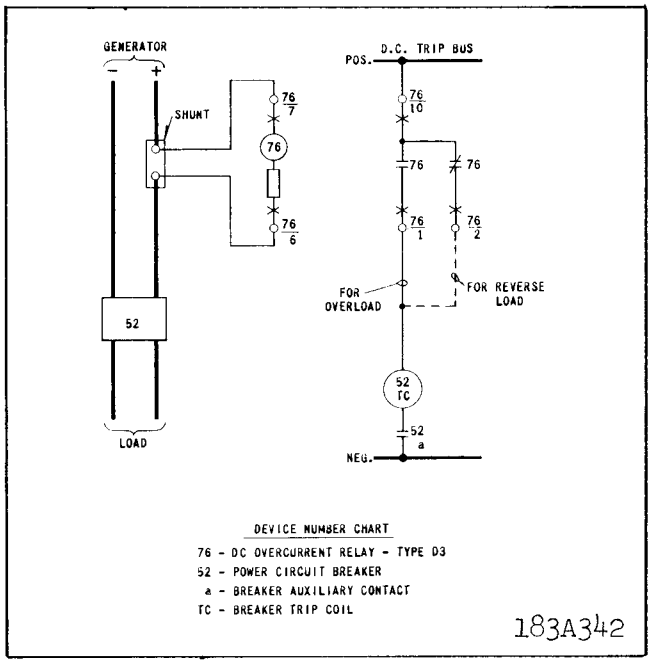


Fig. 3. External Schematic Diagram for Overload or Reverse Current Protection, using the Type D-3 Relay.

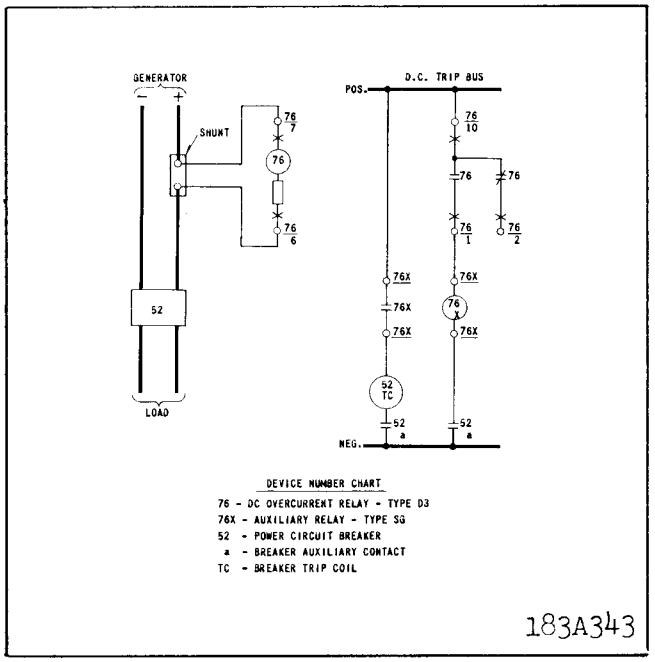


Fig. 4. External Schematic Diagram for Overload Protection where Trip Currents in Excess of One Ampere Rating Require Use of an Auxiliary Relay.

operation. Full scale deflection can be obtained with 6 milliamperes a.c.

The relay has a slight time-delay, with inverse characteristics. In the usual application the moving coil terminals are connected across a shunt, and this results in longer delay for both operating and reset times. When a shunt is used the operating time for full scale travel at 125% of the minimum operating current is about 4 seconds, while at 1000% it is about .25 second. In applications where no shunt is used, the operating times for the same conditions are about 1.25 and .15 second respectively. When the relay is de-energized, the time required for it to reset from the full scale position to the 10% position is approximately 5 seconds when a shunt is used, and 2 seconds when there is no shunt.

TRIP CIRCUIT

contacts	d-c control voltage	amperes contacts will: (non-inductive load) open	close	carry continuously
D-3 relay	125 v	0.04♦	1.0	....
	250 v	0.02♦	1.0	....
contractor switch (when supplied)	125 v	3.5	30	5.0
	250 v	1.0	30	5.0

♦ infrequent operation

SETTINGS

For reverse-current protection a sensitivity of 2 per cent is obtained when using a standard 50 millivolt shunt and setting the relay at 1 millivolt. A 10 per cent sensitivity is obtained by setting the relay at 5 millivolts. These values of sensitivity can be doubled by using a 100 millivolt shunt.

For overload protection the relay is set at the index setting which, with respect to the millivolt drop of the shunt, will operate at desired per cent of overload.

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

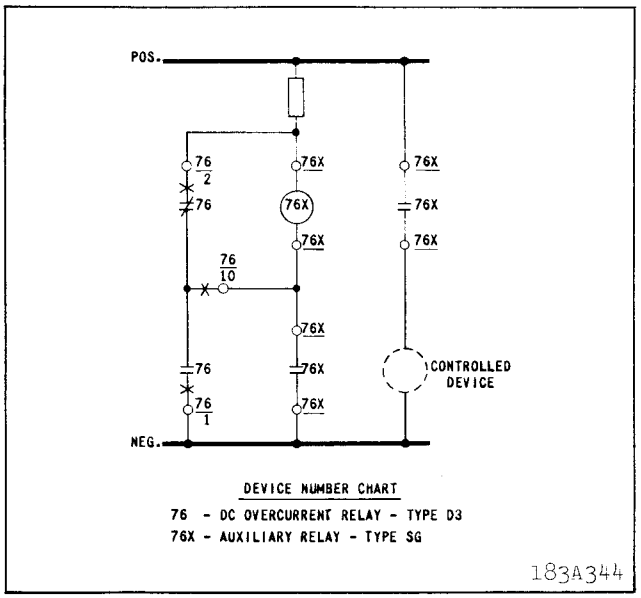


Fig. 5. External Schematic Diagram for Use of External Auxiliary Relay to Prevent Pumping of the Type D-3 Relay when used for Overload Protection.

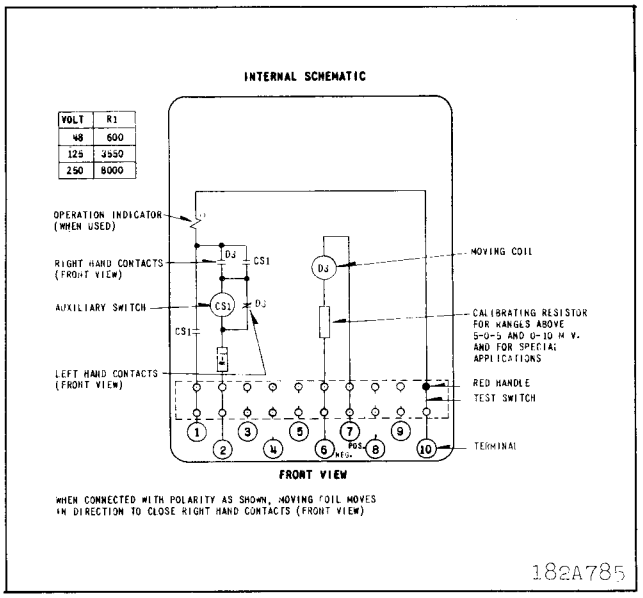


Fig. 6. Internal Schematic of the Type D-3 Relay in the Type FT21 Case with Self-Contained Auxiliary Relay used to Prevent Pumping on Overload Protection.

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.

Standard D-3 relays are calibrated in millivolts measured at the relay terminals. Hence, the resistance of the leads between the relay and the ammeter shunt must be sufficiently low to avoid introducing an excessive error in the relay indication. With the 0-10 or 5-0-5 millivolt relays, leads 8 feet long of #10 B&S gauge copper wire will reduce the relay indication by approximately 5%. If the lead length is less or the conductor size is larger, the error will be correspondingly reduced. Relays with higher millivolt ranges have proportionally greater internal resistances, and consequently error due to lead resistance is reduced. For example, a 0-100 millivolt relay with leads as described above would have an error of 0.5% due to lead resistance.

The use of standard ammeter shunts may be avoided by connecting the moving element leads over an equivalent length of bus-bar or cable. On a basis of 1000 amp. per square inch, at 20°C., 6 feet of copper bus-bar will give 50 millivolts drop.

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Check

Check the scale markings by setting either of the two adjustable contacts at a value marked on the scale. Then alternately apply this voltage plus and minus 3%. The contacts should make and break.

Remove the adjustable contact from the setting and set the second adjustable contact at the same point on the scale. Alternately apply this voltage plus and minus 3%. The contacts should make and break.

Routine Maintenance

All contacts should be cleaned periodically. 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.

If the moving element should be removed, the bearing end-play should be checked when replacing it.

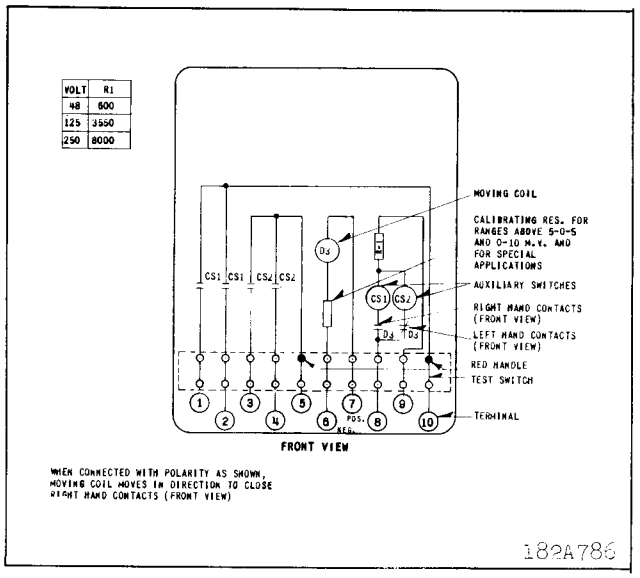


Fig. 7. Internal Schematic of the Type D-3 in the Type FT21 Case with Two Self-Contained Auxiliary Relays used to Increase Contact Capacity.

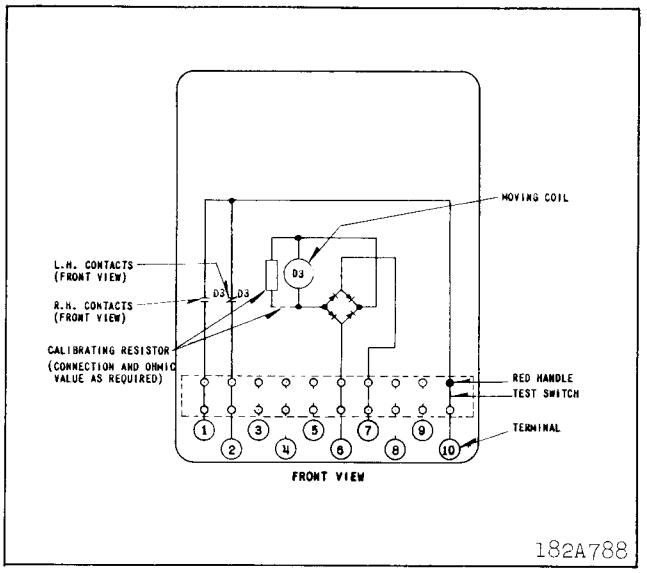


Fig. 8. Internal Schematic of the Type D-3 Relay in the Type FT21 Case, Modified for A-C Operation.

This should be from .020 inch to .025 inch, and can be measured by inserting a feeler gauge between the upper bearing screw and the shoulder on the moving element shaft.

The core and moving coil assembly should not be removed from the frame casting of the D-3 relay unless a keeper having the same radius on the core is placed on the core in such manner as to bridge the iron pole pieces as the core is withdrawn from the bore of the casting. It is necessary also to insert spacers in the air gap so that the core will remain approximately centered when the mounting screws are removed, to prevent damaging the coil winding when sliding the assembly out of the casting.

REPAIRS AND 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.

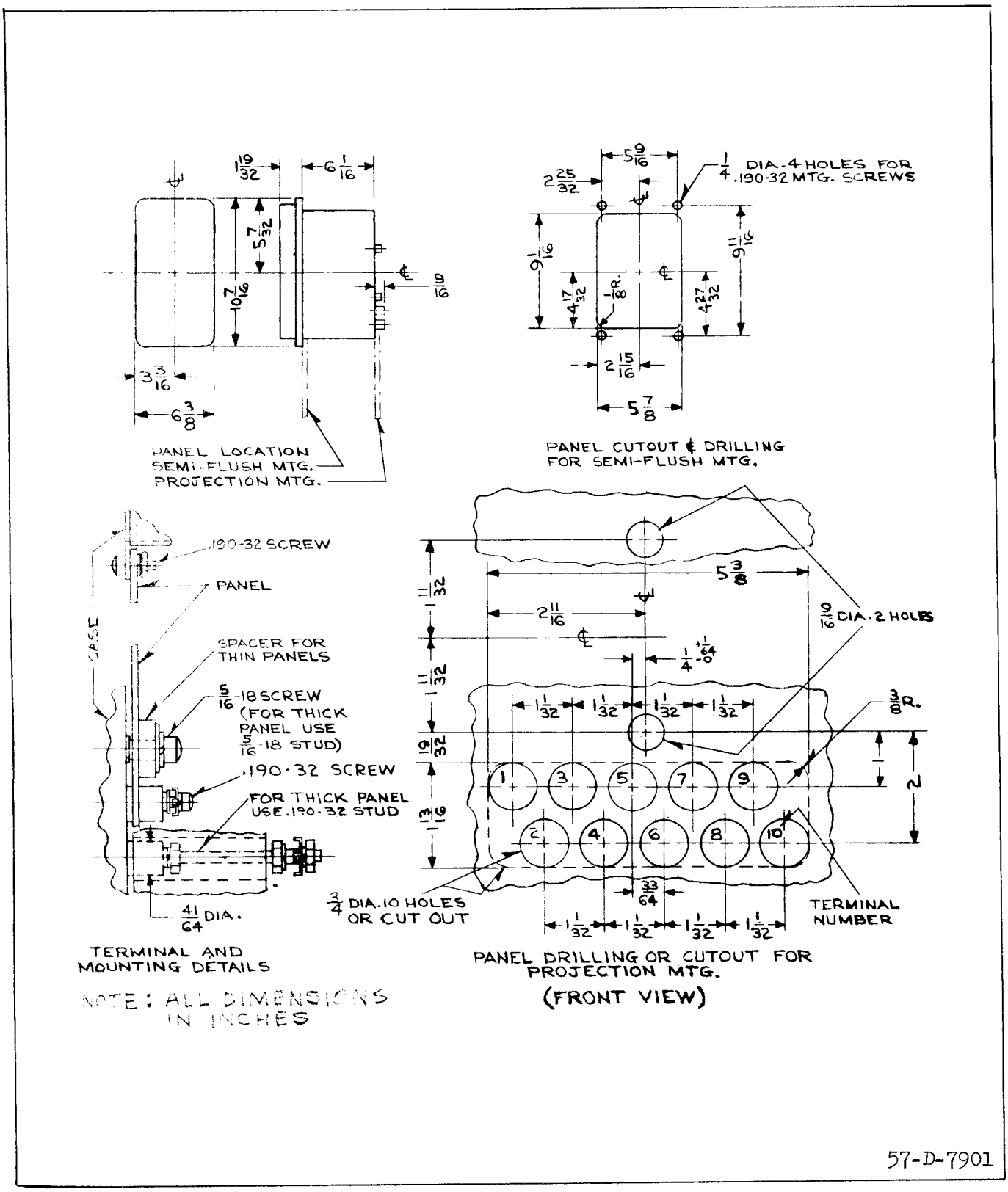
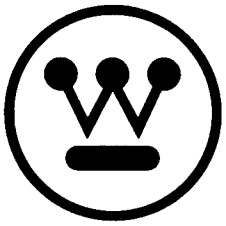


Fig. 9. Outline and Drilling Plan for the Type D-3 Relay in the Type FT21 Case.



WESTINGHOUSE ELECTRIC CORPORATION
RELAY DEPARTMENT
NEWARK, N. J.
Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE D-3 DIRECT CURRENT 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 D-3 relay is suitable for applications where overload, underload, or reverse-current protection is required on direct current circuits. One particular application is in the protection of rotary converters which require sensitive reverse-current relays to pre-
* vent running inverted.

In the usual application of the D-3 relay the moving coil is connected to a shunt in the circuit being protected. By suitable selection of relay calibration and of shunt rating, the relay can be made to respond to particular magnitudes or directions of current flow through the shunt as required.

In applications where the D-3 relay is used for the purpose of regulating a load, closing of the overload contacts will initiate action to reduce the amount of the load. Since the relay is very sensitive, a slight reduction in load will cause the overload contacts to open. If the reduction of load is interrupted, the relay will close contacts again on a small load increase. Thus small load fluctuations might cause excessive operation of the relay and the device controlled by it. The connections of Fig. 5 show the use of an external auxiliary relay (type SG) to keep the controlled device energized until the load had dropped by an amount determined by the setting of the left-hand contact of the D-3 relay.

CONSTRUCTION

The type D-3 relay is a d'Arsonvol type d.c. contact making voltmeter consisting of a moving coil, permanent magnet, and contacts. The magnetic circuit is shown schematically in Fig. 1.

Permanent Magnet

The permanent magnet is a cylindrical core, consisting of an Alnico permanent magnet, two iron pole pieces and two brass spacer blocks. This magnet is mounted concentrically in the bore of a mallable iron frame.

A magnetic field is produced by the permanent magnet in the air gap between the magnet and the iron frame. The path of magnetic flux is from the Alnico magnet through the iron pole piece across the air gap to the iron frame. The return path of the flux is through the frame across the second air gap to the second pole piece. The pole pieces and the bore of the frame are shaped such that a uniform flux distribution is obtained in the air gaps.

Moving Coil

The moving coil rotates in the air gap between the core and the iron frame. Electrical connections are made to the coil through two springs located at the top of the element. One end of each spring is connected through a lever arm to a lead of the coil. The other end of each spring is fastened to posts mounted in a circular insulation plate. This plate can be rotated to permit adjustment of the zero position of the moving element.

A third spiral spring located at the bottom of the element provides a current path to the moving contact.

Contactor Switch (When used)

The contactor switch is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts.

OPERATION

The D-3 relay operates on the principle of a cur-

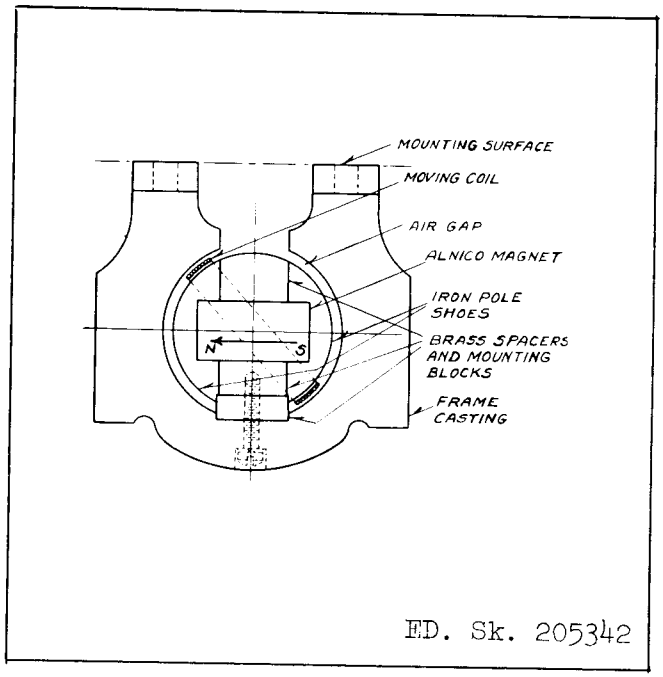


Fig. 1. Schematic Drawing of Magnetic Circuit of Type D-3 Relay (Top View). Moving Coil Bearing Supports, Springs and Contacts Omitted.

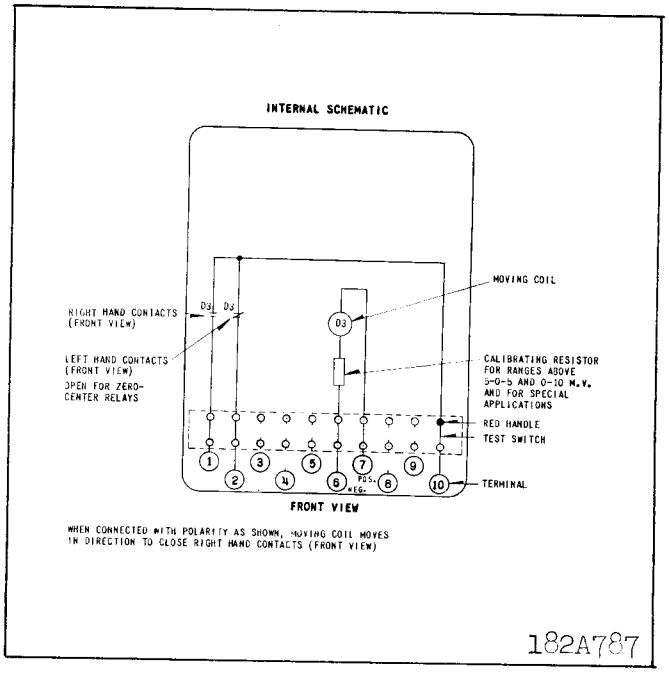


Fig. 2. Internal Schematic of the Type D-3 Relay in the Type FT21 Case.

rent carrying conductor (moving coil) located in a magnetic field (permanent magnet). When a current is applied to the coil of the relay, a torque is produced that rotates the moving coil until the electrical torque is equal to the torque of the restraining spring. The moving contact will assume a position in its travel that is proportional to the current applied to the moving coil.

The direction of movement of the moving coil is determined by the polarity of the current applied to the coil. In the "left zero" and "suppressed zero" D-3 relays, the contacts will move to the right when a current of the proper magnitude and polarity is applied to the relay. On the other hand, the contact of the "center zero" relay will move either left or right depending on the polarity and magnitude of the applied current.

CHARACTERISTICS

The type D-3 relay is supplied in the standard ranges listed in the table below. The numbers on the scale indicate in millivolts the potential required at the relay base terminals to operate the moving element to the indicated scale position.

MOVING COIL CIRCUIT

Ranges in Millivolts, d-c	Average Resistance in Ohms at 25°C
0-10	0.3
5-0-5	0.3
40-80	1.2
100-0-100	6.0
0-200	6.0

As shown in the above Table, the D-3 relay is available with a "left zero," "suppressed zero" and "center zero" scale. In the "left zero" and the "suppressed zero" relays the moving contact is located in the extreme left hand position of the scale when the relays are deenergized. The "suppressed zero" relay is held in this position with considerable more force than the "left zero" relay. When the relays are energized with voltages of the proper magnitude and polarity, the moving contact moves to the right.

In the "center zero" relay, the moving contact is located in the center of the scale when the relay is deenergized. When the relay is energized, the contact will move either to the right or left depending upon the polarity of the applied voltage.

A modification of the D-3 relay, in which a rectifier is mounted internally, makes it suitable for a.c.

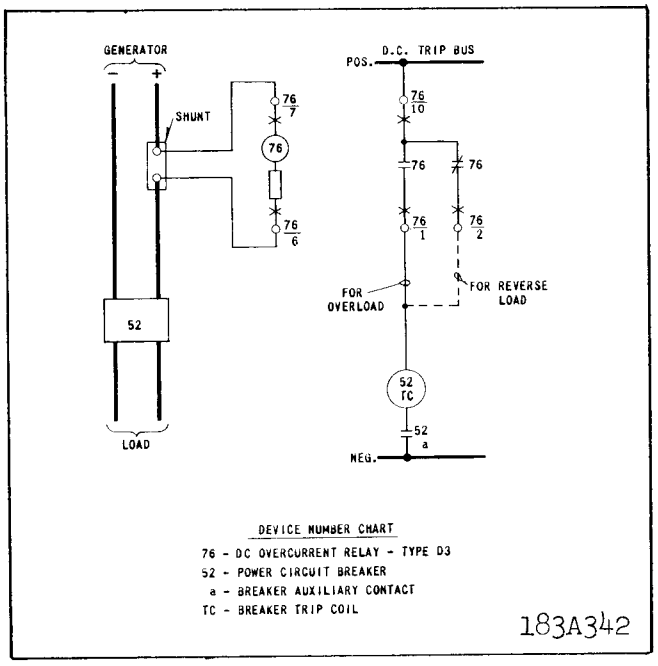


Fig. 3. External Schematic Diagram for Overload or Reverse Current Protection, using the Type D-3 Relay.

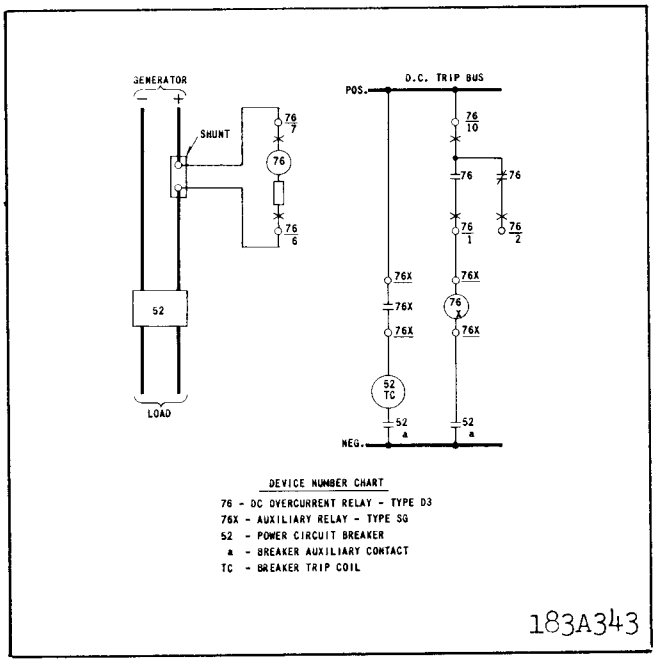


Fig. 4. External Schematic Diagram for Overload Protection where Trip Currents in Excess of One Ampere Rating Require Use of an Auxiliary Relay.

operation. Full scale deflection can be obtained with 6 milliamperes a.c.

The relay has a slight time-delay, with inverse characteristics. In the usual application the moving coil terminals are connected across a shunt, and this results in longer delay for both operating and reset times. When a shunt is used the operating time for full scale travel at 125% of the minimum operating current is about 4 seconds, while at 1000% it is about .25 second. In applications where no shunt is used, the operating times for the same conditions are about 1.25 and .15 second respectively. When the relay is de-energized, the time required for it to reset from the full scale position to the 10% position is approximately 5 seconds when a shunt is used, and 2 seconds when there is no shunt.

TRIP CIRCUIT

contacts	d-c control voltage	amperes contacts will: (non-inductive load) open	close	carry continuously
D-3 relay	125 v	0.04♦	1.0	....
	250 v	0.02♦	1.0	....
contactor switch (when supplied)	125 v	3.5	30	5.0
	250 v	1.0	30	5.0

♦ infrequent operation

SETTINGS

For reverse-current protection a sensitivity of 2 per cent is obtained when using a standard 50 millivolt shunt and setting the relay at 1 millivolt. A 10 per cent sensitivity is obtained by setting the relay at 5 millivolts. These values of sensitivity can be doubled by using a 100 millivolt shunt.

For overload protection the relay is set at the index setting which, with respect to the millivolt drop of the shunt, will operate at desired per cent of overload.

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

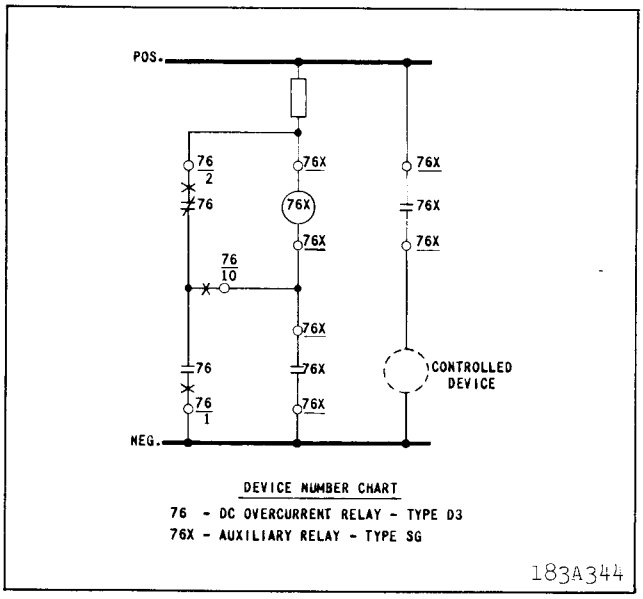


Fig. 5. External Schematic Diagram for Use of External Auxiliary Relay to Prevent Pumping of the Type D-3 Relay when used for Overload Protection.

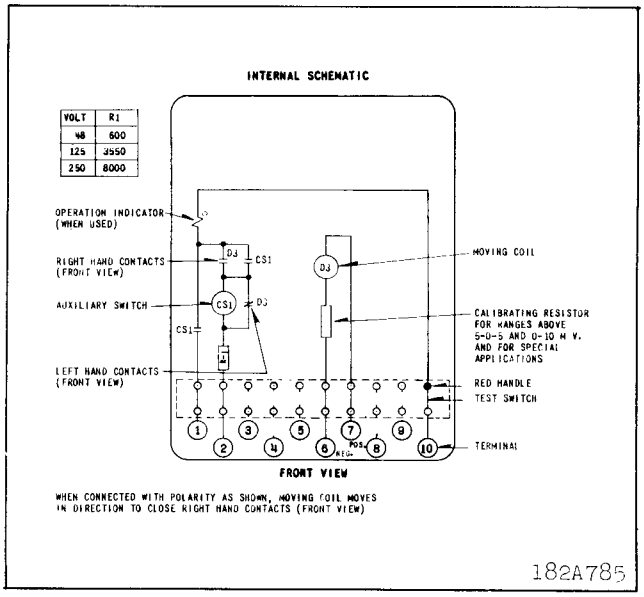


Fig. 6. Internal Schematic of the Type D-3 Relay in the Type FT21 Case with Self-Contained Auxiliary Relay used to Prevent Pumping on Overload Protection.

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.

Standard D-3 relays are calibrated in millivolts measured at the relay terminals. Hence, the resistance of the leads between the relay and the ammeter shunt must be sufficiently low to avoid introducing an excessive error in the relay indication. With the 0-10 or 5-0-5 millivolt relays, leads 8 feet long of #10 B&S gauge copper wire will reduce the relay indication by approximately 5%. If the lead length is less or the conductor size is larger, the error will be correspondingly reduced. Relays with higher millivolt ranges have proportionally greater internal resistances, and consequently error due to lead resistance is reduced. For example, a 0-100 millivolt relay with leads as described above would have an error of 0.5% due to lead resistance.

The use of standard ammeter shunts may be avoided by connecting the moving element leads over an equivalent length of bus-bar or cable. On a basis of 1000 amp. per square inch, at 20°C., 6 feet of copper bus-bar will give 50 millivolts drop.

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Check

Check the scale markings by setting either of the two adjustable contacts at a value marked on the scale. Then alternately apply this voltage plus and minus 3%. The contacts should make and break.

Remove the adjustable contact from the setting and set the second adjustable contact at the same point on the scale. Alternately apply this voltage plus and minus 3%. The contacts should make and break.

Routine Maintenance

All contacts should be cleaned periodically. 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.

If the moving element should be removed, the bearing end-play should be checked when replacing it.

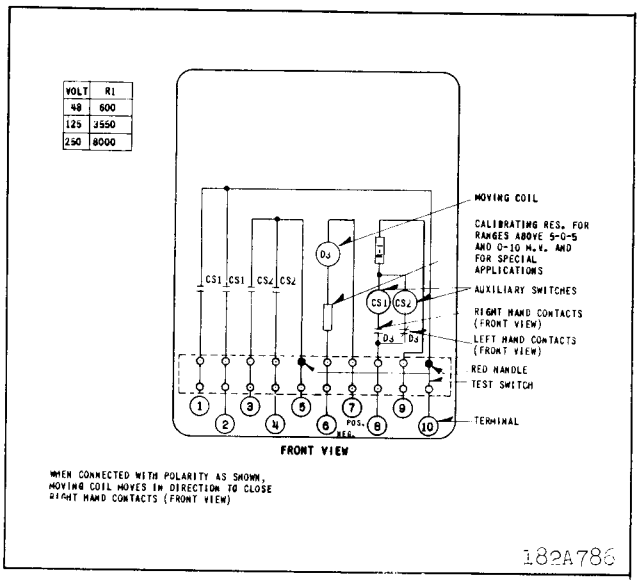


Fig. 7. Internal Schematic of the Type D-3 in the Type FT21 Case with Two Self-Contained Auxiliary Relays used to Increase Contact Capacity.

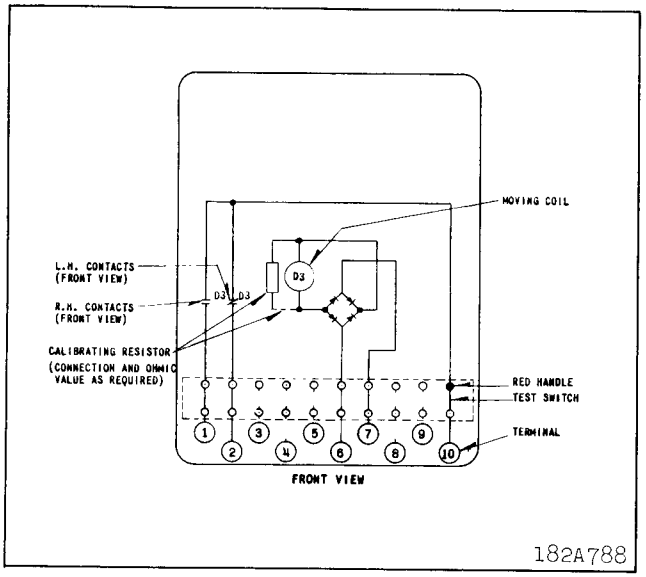


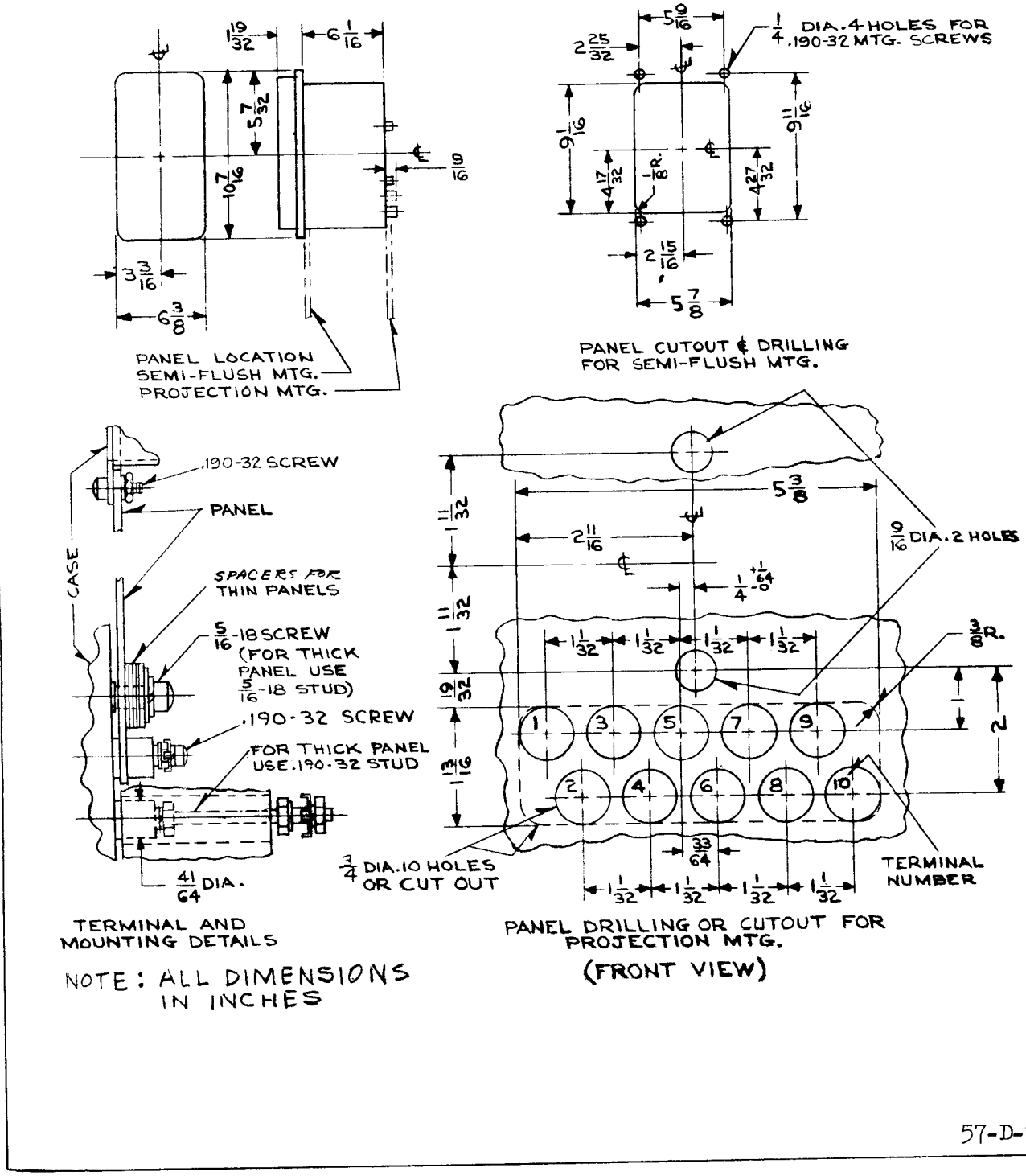
Fig. 8. Internal Schematic of the Type D-3 Relay in the Type FT21 Case, Modified for A-C Operation.

This should be from .020 inch to .025 inch, and can be measured by inserting a feeler gauge between the upper bearing screw and the shoulder on the moving element shaft.

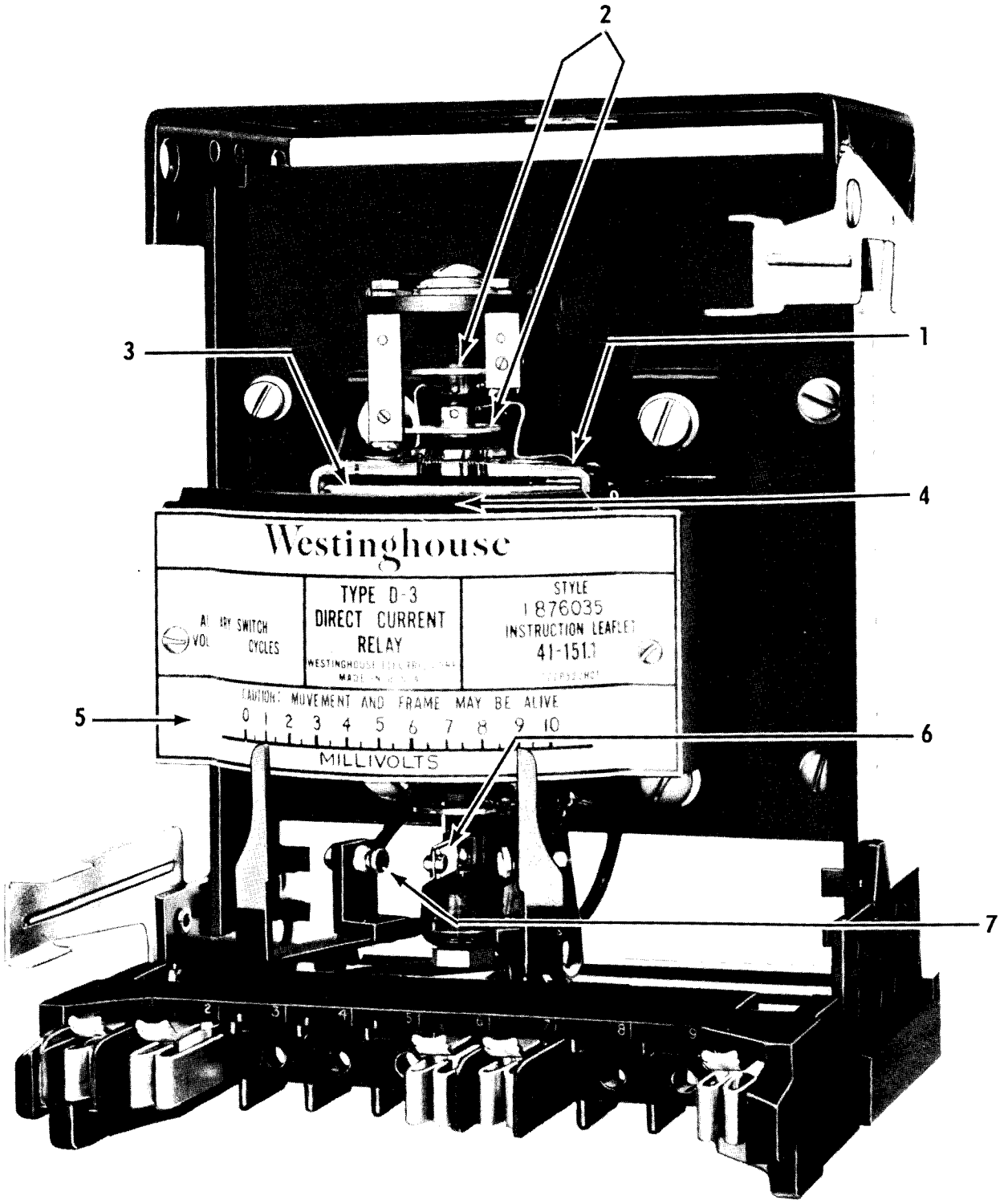
The core and moving coil assembly should not be removed from the frame casting of the D-3 relay unless a keeper having the same radius on the core is placed on the core in such manner as to bridge the iron pole pieces as the core is withdrawn from the bore of the casting. It is necessary also to insert spacers in the air gap so that the core will remain approximately centered when the mounting screws are removed, to prevent damaging the coil winding when sliding the assembly out of the casting.

REPAIRS AND RENEWAL PARTS

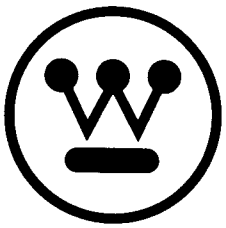
Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.



* *Fig. 9. Outline and Drilling Plan for the Type D-3 Relay in the Type FT21 Case.*



** Fig. 10. Type D-3 Relay without Case. 1-Moving Coil. 2-Current-carrying restraining springs. 3-Permanent Magnet. 4-Iron-Frame. 5-Scale. 6-Moving Contact. 7-Stationary Contacts.*



WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE D-3 DIRECT CURRENT 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 D-3 relay is suitable for applications where overload, underload, or reverse-current protection is required on direct current circuits. One particular application is in the protection of rotary converters which require sensitive reverse-current relays to prevent running inverted.

In the usual application of the D-3 relay the moving coil is connected to a shunt in the circuit being protected. By suitable selection of relay calibration and of shunt rating, the relay can be made to respond to particular magnitudes or directions of current flow through the shunt as required.

In applications where the D-3 relay is used for the purpose of regulating a load, closing of the overload contacts will initiate action to reduce the amount of the load. Since the relay is very sensitive, a slight reduction in load will cause the overload contacts to open. If the reduction of load is interrupted, the relay will close contacts again on a small load increase. Thus small load fluctuations might cause excessive operation of the relay and the device controlled by it. The connections of Fig. 5 show the use of an external auxiliary relay (type SG) to keep the controlled device energized until the load had dropped by an amount determined by the setting of the left-hand contact of the D-3 relay.

CONSTRUCTION

The type D-3 relay is a d'Arsonvol type d.c. contact making voltmeter consisting of a moving coil, permanent magnet, and contacts. The magnetic circuit is shown schematically in Fig. 1.

Permanent Magnet

The permanent magnet is a cylindrical core, consisting of an Alnico permanent magnet, two iron pole pieces and two brass spacer blocks. This magnet is mounted concentrically in the bore of a mallable iron frame.

A magnetic field is produced by the permanent magnet in the air gap between the magnet and the iron frame. The path of magnetic flux is from the Alnico magnet through the iron pole piece across the air gap to the iron frame. The return path of the flux is through the frame across the second air gap to the second pole piece. The pole pieces and the bore of the frame are shaped such that a uniform flux distribution is obtained in the air gaps.

Moving Coil

The moving coil rotates in the air gap between the core and the iron frame. Electrical connections are made to the coil through two springs located at the top of the element. One end of each spring is connected through a lever arm to a lead of the coil. The other end of each spring is fastened to posts mounted in a circular insulation plate. This plate can be rotated to permit adjustment of the zero position of the moving element.

A third spiral spring located at the bottom of the element provides a current path to the moving contact.

*** Auxiliary Switch (When used)**

The auxiliary switch is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts.

OPERATION

The D-3 relay operates on the principle of a cur-

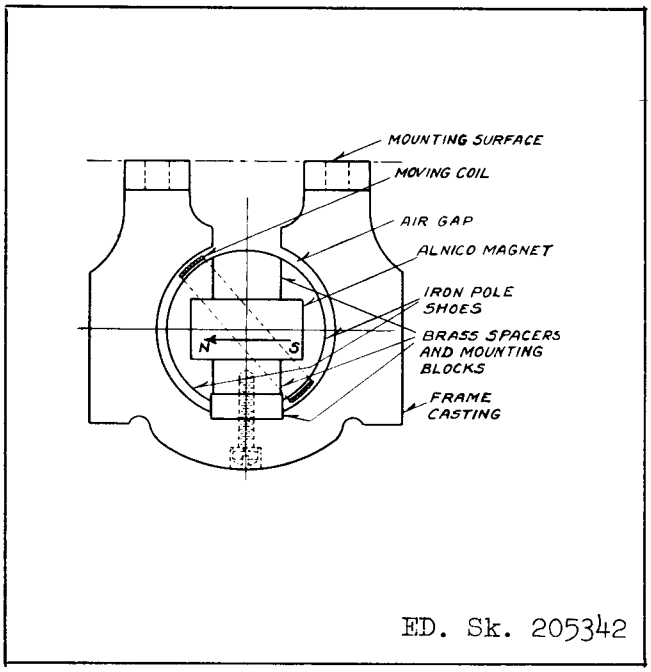


Fig. 1. Schematic Drawing of Magnetic Circuit of Type D-3 Relay (Top View). Moving Coil Bearing Supports, Springs and Contacts Omitted.

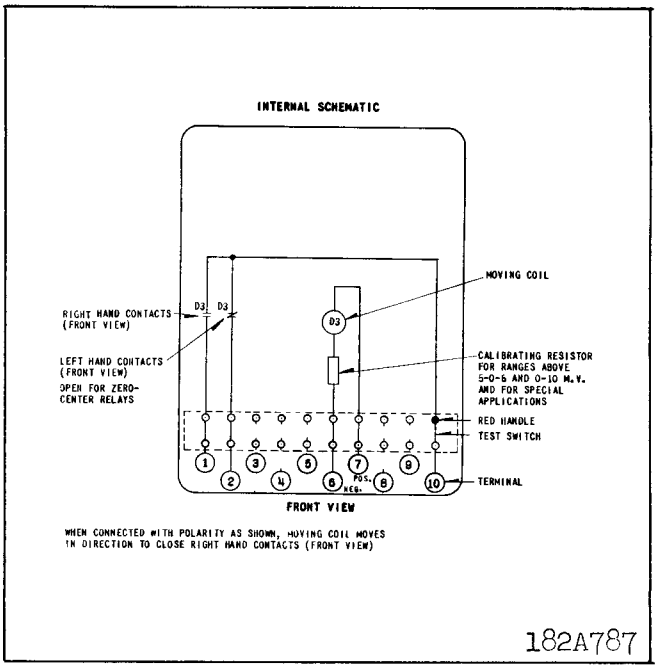


Fig. 2. Internal Schematic of the Type D-3 Relay in the Type FT21 Case.

rent carrying conductor (moving coil) located in a magnetic field (permanent magnet). When a current is applied to the coil of the relay, a torque is produced that rotates the moving coil until the electrical torque is equal to the torque of the restraining spring. The moving contact will assume a position in its travel that is proportional to the current applied to the moving coil.

The direction of movement of the moving coil is determined by the polarity of the current applied to the coil. In the "left zero" and "suppressed zero" D-3 relays, the contacts will move to the right when a current of the proper magnitude and polarity is applied to the relay. On the other hand, the contact of the "center zero" relay will move either left or right depending on the polarity and magnitude of the applied current.

CHARACTERISTICS

The type D-3 relay is supplied in the standard ranges listed in the table below. The numbers on the scale indicate in millivolts the potential required at the relay base terminals to operate the moving element to the indicated scale position.

MOVING COIL CIRCUIT

Ranges in Millivolts, d-c	Average Resistance in Ohms at 25°C
0-10	0.3
5-0-5	0.3
40-80	1.2
100-0-100	6.0
0-200	6.0

As shown in the above Table, the D-3 relay is available with a "left zero," "suppressed zero" and "center zero" scale. In the "left zero" and the "suppressed zero" relays the moving contact is located in the extreme left hand position of the scale when the relays are deenergized. The "suppressed zero" relay is held in this position with considerable more force than the "left zero" relay. When the relays are energized with voltages of the proper magnitude and polarity, the moving contact moves to the right.

In the "center zero" relay, the moving contact is located in the center of the scale when the relay is deenergized. When the relay is energized, the contact will move either to the right or left depending upon the polarity of the applied voltage.

A modification of the D-3 relay, in which a rectifier is mounted internally, makes it suitable for a.c.

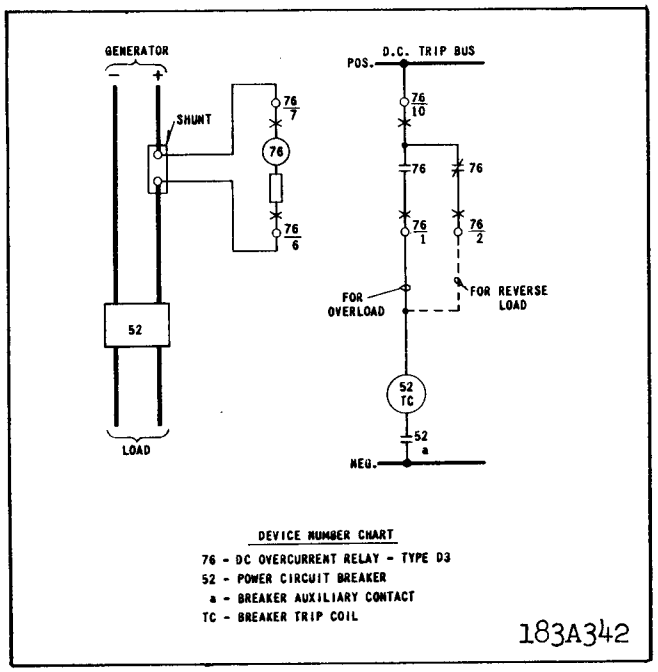


Fig. 3. External Schematic Diagram for Overload or Reverse Current Protection, using the Type D-3 Relay.

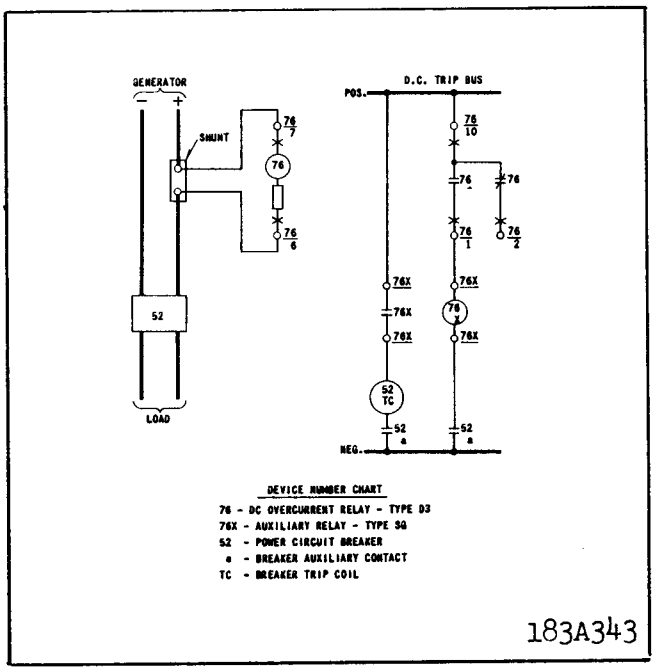


Fig. 4. External Schematic Diagram for Overload Protection where Trip Currents in Excess of One Ampere Rating Require Use of an Auxiliary Relay.

operation. Full scale deflection can be obtained with 6 milliamperes a.c.

The relay has a slight time-delay, with inverse characteristics. In the usual application the moving coil terminals are connected across a shunt, and this results in longer delay for both operating and reset times. When a shunt is used the operating time for full scale travel at 125% of the minimum operating current is about 4 seconds, while at 1000% it is about .25 second. In applications where no shunt is used, the operating times for the same conditions are about 1.25 and .15 second respectively. When the relay is de-energized, the time required for it to reset from the full scale position to the 10% position is approximately 5 seconds when a shunt is used, and 2 seconds when there is no shunt.

TRIP CIRCUIT

contacts	d-c control voltage	amperes contacts will: (non-inductive load) open	close	carry continuously
D-3 relay	125 v	0.04♦	1.0	....
	250 v	0.02♦	1.0	....
contactor switch (when supplied)	125 v	3.5	30	5.0
	250 v	1.0	30	5.0

♦ infrequent operation

SETTINGS

For reverse-current protection a sensitivity of 2 per cent is obtained when using a standard 50 millivolt shunt and setting the relay at 1 millivolt. A 10 per cent sensitivity is obtained by setting the relay at 5 millivolts. These values of sensitivity can be doubled by using a 100 millivolt shunt.

For overload protection the relay is set at the index setting which, with respect to the millivolt drop of the shunt, will operate at desired per cent of overload.

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

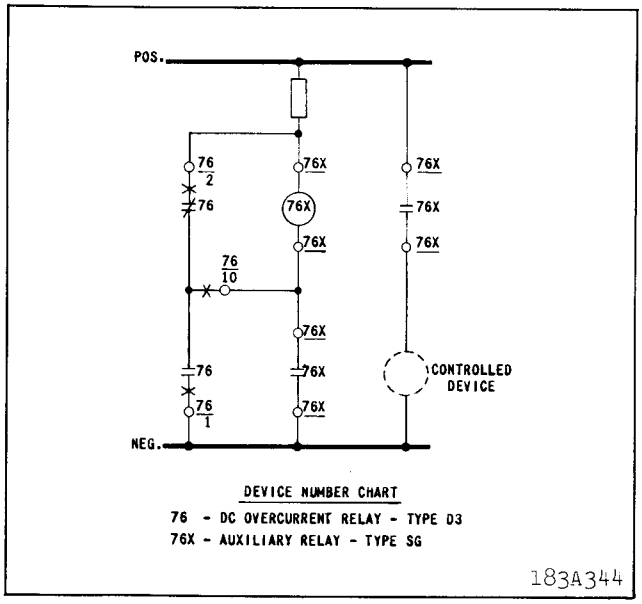


Fig. 5. External Schematic Diagram for Use of External Auxiliary Relay to Prevent Pumping of the Type D-3 Relay when used for Overload Protection.

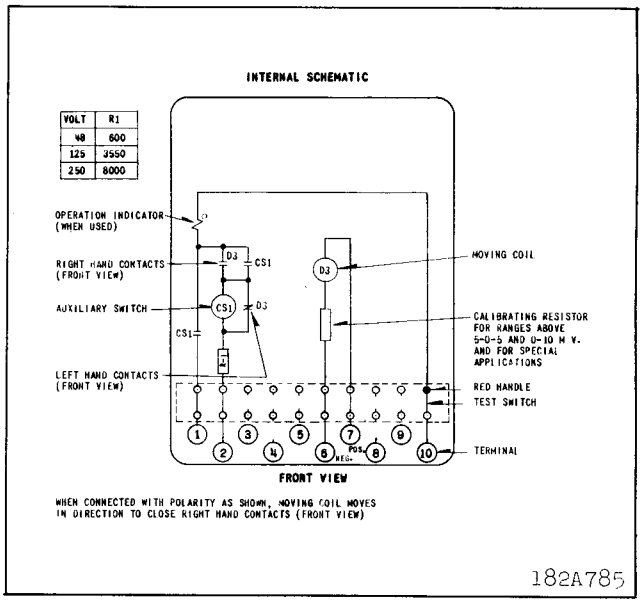


Fig. 6. Internal Schematic of the Type D-3 Relay in the Type FT21 Case with Self-Contained Auxiliary Relay used to Prevent Pumping on Overload Protection.

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.

Standard D-3 relays are calibrated in millivolts measured at the relay terminals. Hence, the resistance of the leads between the relay and the ammeter shunt must be sufficiently low to avoid introducing an excessive error in the relay indication. With the 0-10 or 5-0-5 millivolt relays, leads 8 feet long of #10 B&S gauge copper wire will reduce the relay indication by approximately 5%. If the lead length is less or the conductor size is larger, the error will be correspondingly reduced. Relays with higher millivolt ranges have proportionally greater internal resistances, and consequently error due to lead resistance is reduced. For example, a 0-100 millivolt relay with leads as described above would have an error of 0.5% due to lead resistance.

The use of standard ammeter shunts may be avoided by connecting the moving element leads over an equivalent length of bus-bar or cable. On a basis of 1000 amp. per square inch, at 20°C., 6 feet of copper bus-bar will give 50 millivolts drop.

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Check

Check the scale markings by setting either of the two adjustable contacts at a value marked on the scale. Then alternately apply this voltage plus and minus 3%. The contacts should make and break.

Remove the adjustable contact from the setting and set the second adjustable contact at the same point on the scale. Alternately apply this voltage plus and minus 3%. The contacts should make and break.

Routine Maintenance

All contacts should be cleaned periodically. 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.

If the moving element should be removed, the bearing end-play should be checked when replacing it.

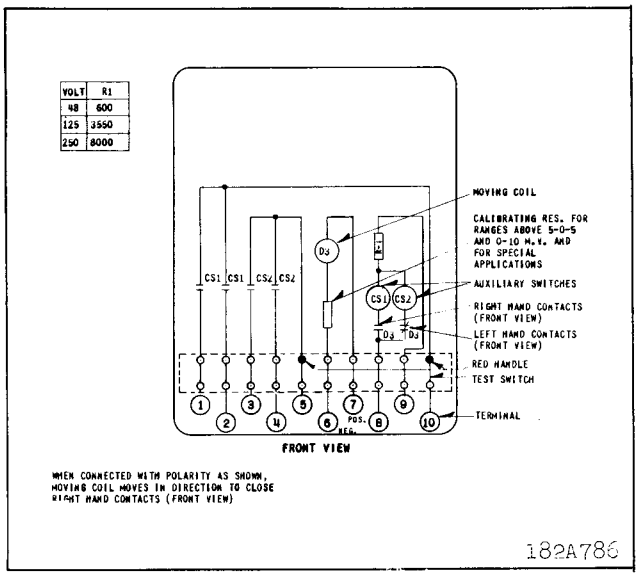


Fig. 7. Internal Schematic of the Type D-3 in the Type FT21 Case with Two Self-Contained Auxiliary Relays used to Increase Contact Capacity.

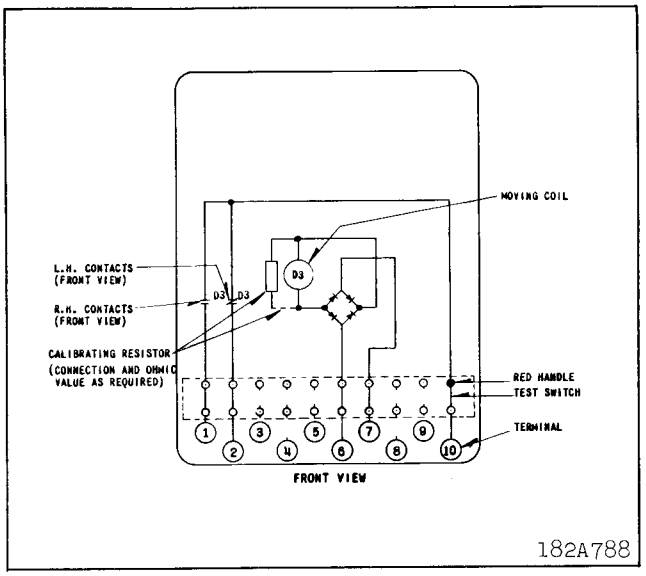


Fig. 8. Internal Schematic of the Type D-3 Relay in the Type FT21 Case, Modified for A-C Operation.

This should be from .020 inch to .025 inch, and can be measured by inserting a feeler gauge between the upper bearing screw and the shoulder on the moving element shaft.

The core and moving coil assembly should not be removed from the frame casting of the D-3 relay unless a keeper having the same radius on the core is placed on the core in such manner as to bridge the iron pole pieces as the core is withdrawn from the bore of the casting. It is necessary also to insert spacers in the air gap so that the core will remain approximately centered when the mounting screws are removed, to prevent damaging the coil winding when sliding the assembly out of the casting.

*** Auxiliary Switch (CS-1)**

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be done by turning the relay upside-down. Then screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/64" by means of the two small nuts on either side of the Micarta disc.

* Block main contacts closed and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make.

REPAIRS AND 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.

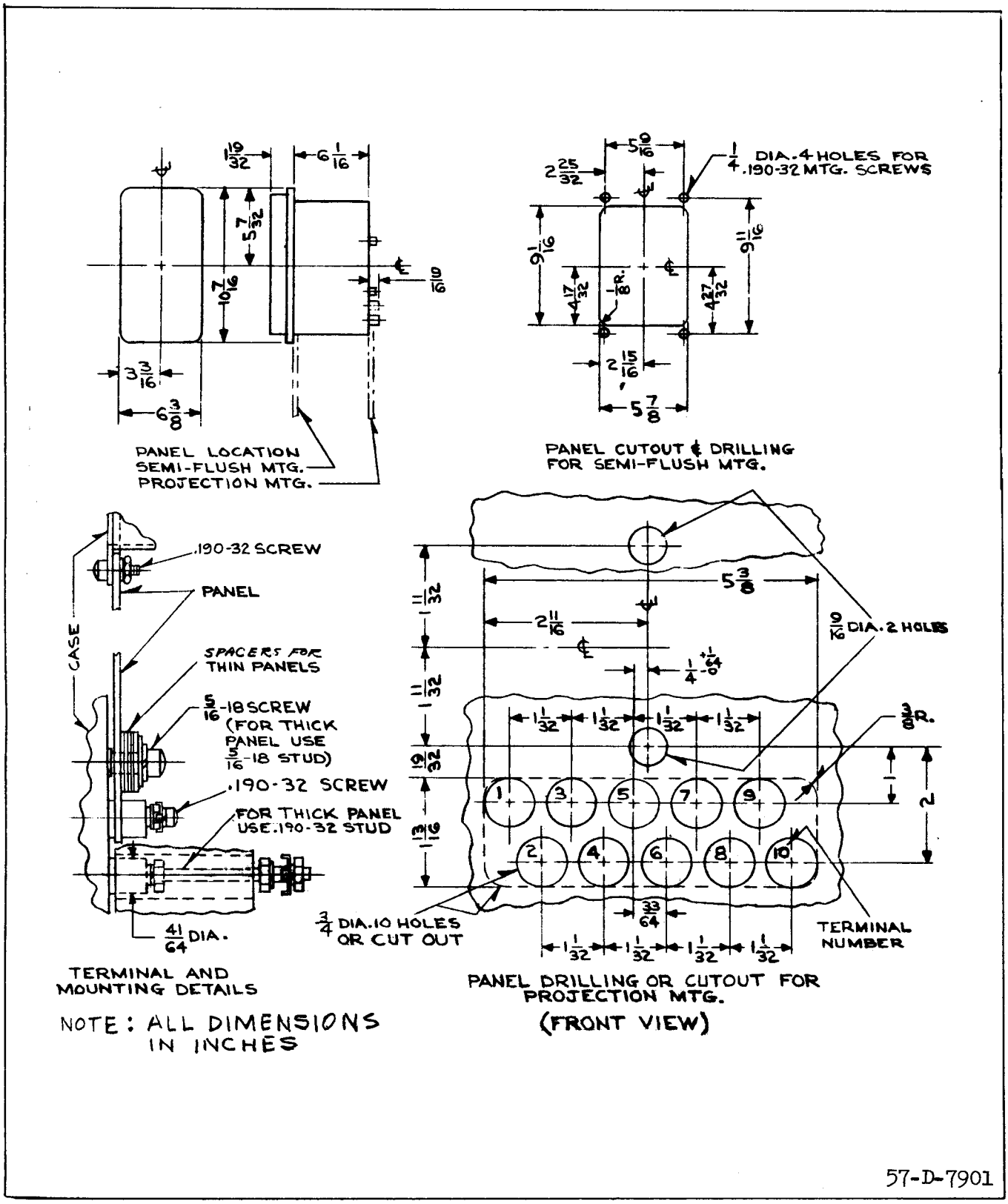


Fig. 9. Outline and Drilling Plan for the Type D-3 Relay in the Type FT21 Case.

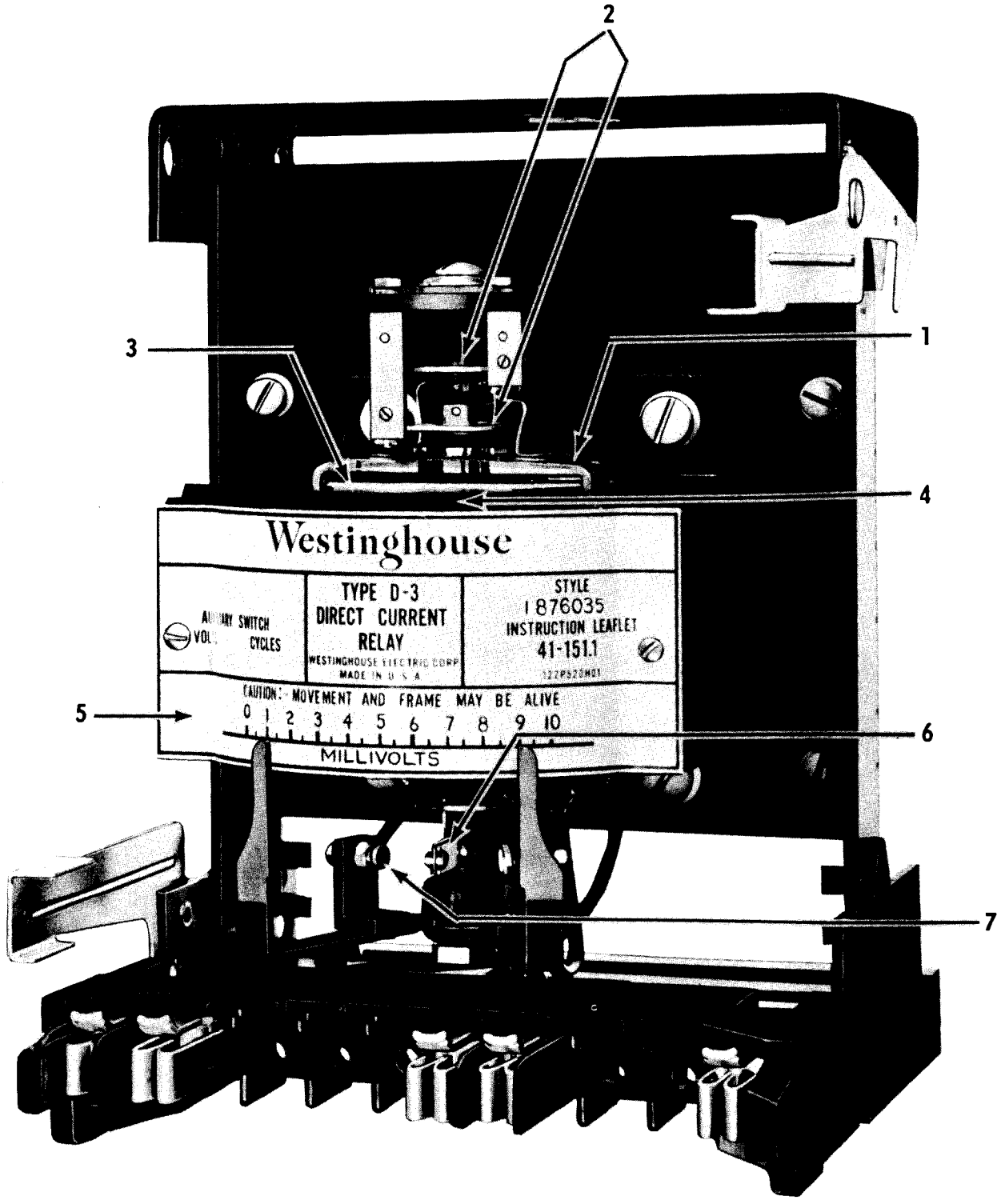
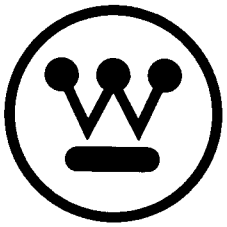


Fig. 10. Type D-3 Relay without Case. 1-Moving Coil. 2-Current-carrying restraining springs. 3-Permanent Magnet. 4-Iron-Frame. 5-Scale. 6-Moving Contact. 7-Stationary Contacts.



WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE D-3 DIRECT CURRENT 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 D-3 relay is suitable for applications where overload, underload, or reverse-current protection is required on direct current circuits. One particular application is in the protection of rotary converters which require sensitive reverse-current relays to prevent running inverted.

In the usual application of the D-3 relay the moving coil is connected to a shunt in the circuit being protected. By suitable selection of relay calibration and of shunt rating, the relay can be made to respond to particular magnitudes or directions of current flow through the shunt as required.

In applications where the D-3 relay is used for the purpose of regulating a load, closing of the overload contacts will initiate action to reduce the amount of the load. Since the relay is very sensitive, a slight reduction in load will cause the overload contacts to open. If the reduction of load is interrupted, the relay will close contacts again on a small load increase. Thus small load fluctuations might cause excessive operation of the relay and the device controlled by it. The connections of Fig. 5 show the use of an external auxiliary relay (type SG) to keep the controlled device energized until the load had dropped by an amount determined by the setting of the left-hand contact of the D-3 relay.

CONSTRUCTION

The type D-3 relay is a d'Arsonvol type d.c. contact making voltmeter consisting of a moving coil, permanent magnet, and contacts. The magnetic circuit is shown schematically in Fig. 1.

Permanent Magnet

The permanent magnet is a cylindrical core, consisting of an Alnico permanent magnet, two iron pole pieces and two brass spacer blocks. This magnet is mounted concentrically in the bore of a mallable iron frame.

A magnetic field is produced by the permanent magnet in the air gap between the magnet and the iron frame. The path of magnetic flux is from the Alnico magnet through the iron pole piece across the air gap to the iron frame. The return path of the flux is through the frame across the second air gap to the second pole piece. The pole pieces and the bore of the frame are shaped such that a uniform flux distribution is obtained in the air gaps.

Moving Coil

The moving coil rotates in the air gap between the core and the iron frame. Electrical connections are made to the coil through two springs located at the top of the element. One end of each spring is connected through a lever arm to a lead of the coil. The other end of each spring is fastened to posts mounted in a circular insulation plate. This plate can be rotated to permit adjustment of the zero position of the moving element.

A third spiral spring located at the bottom of the element provides a current path to the moving contact.

Auxiliary Switch (When used)

The auxiliary switch is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts.

OPERATION

The D-3 relay operates on the principle of a cur-

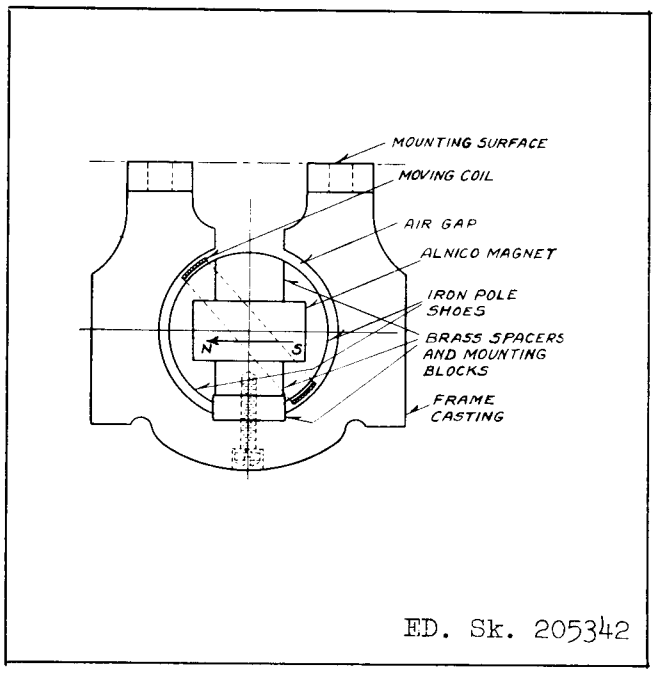


Fig. 1. Schematic Drawing of Magnetic Circuit of Type D-3 Relay (Top View). Moving Coil Bearing Supports, Springs and Contacts Omitted.

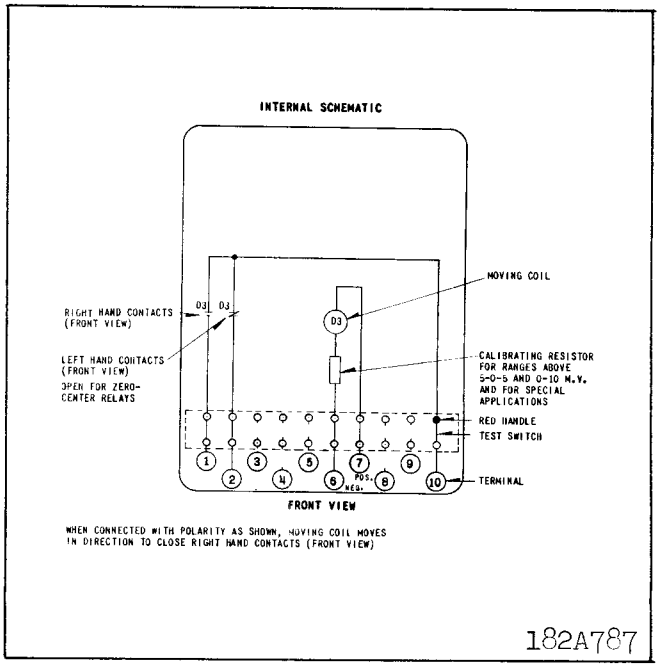


Fig. 2. Internal Schematic of the Type D-3 Relay in the Type FT21 Case.

rent carrying conductor (moving coil) located in a magnetic field (permanent magnet). When a current is applied to the coil of the relay, a torque is produced that rotates the moving coil until the electrical torque is equal to the torque of the restraining spring. The moving contact will assume a position in its travel that is proportional to the current applied to the moving coil.

The direction of movement of the moving coil is determined by the polarity of the current applied to the coil. In the "left zero" and "suppressed zero" D-3 relays, the contacts will move to the right when a current of the proper magnitude and polarity is applied to the relay. On the other hand, the contact of the "center zero" relay will move either left or right depending on the polarity and magnitude of the applied current.

CHARACTERISTICS

The type D-3 relay is supplied in the standard ranges listed in the table below. The numbers on the scale indicate in millivolts the potential required at the relay base terminals to operate the moving element to the indicated scale position.

MOVING COIL CIRCUIT

Ranges in Millivolts, d-c	Average Resistance in Ohms at 25°C
0-10	0.3
5-0-5	0.3
40-80	1.2
100-0-100	6.0
0-200	6.0

As shown in the above Table, the D-3 relay is available with a "left zero," "suppressed zero" and "center zero" scale. In the "left zero" and the "suppressed zero" relays the moving contact is located in the extreme left hand position of the scale when the relays are deenergized. The "suppressed zero" relay is held in this position with considerable more force than the "left zero" relay. When the relays are energized with voltages of the proper magnitude and polarity, the moving contact moves to the right.

In the "center zero" relay, the moving contact is located in the center of the scale when the relay is deenergized. When the relay is energized, the contact will move either to the right or left depending upon the polarity of the applied voltage.

A modification of the D-3 relay, in which a rectifier is mounted internally, makes it suitable for a.c.

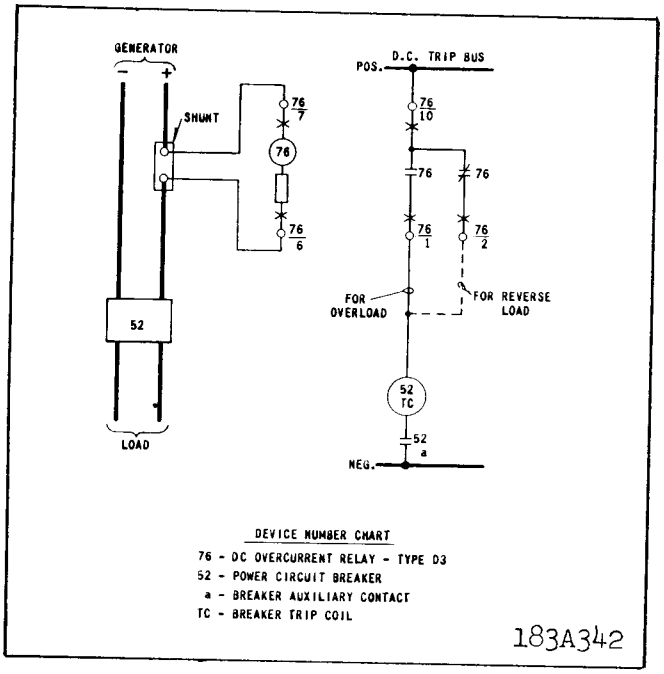


Fig. 3. External Schematic Diagram for Overload or Reverse Current Protection, using the Type D-3 Relay.

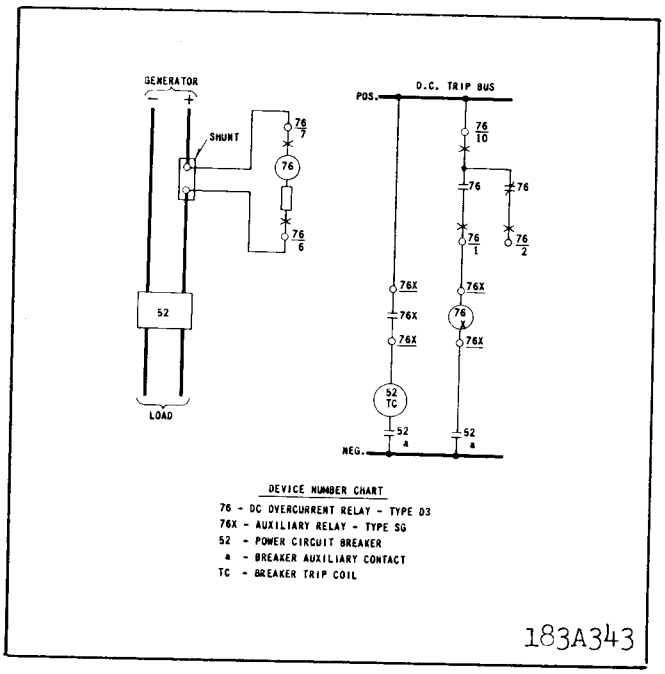


Fig. 4. External Schematic Diagram for Overload Protection where Trip Currents in Excess of One Ampere Rating Require Use of an Auxiliary Relay.

operation. Full scale deflection can be obtained with 6 milliamperes a.c.

The relay has a slight time-delay, with inverse characteristics. In the usual application the moving coil terminals are connected across a shunt, and this results in longer delay for both operating and reset times. When a shunt is used the operating time for full scale travel at 125% of the minimum operating current is about 4 seconds, while at 1000% it is about .25 second. In applications where no shunt is used, the operating times for the same conditions are about 1.25 and .15 second respectively. When the relay is de-energized, the time required for it to reset from the full scale position to the 10% position is approximately 5 seconds when a shunt is used, and 2 seconds when there is no shunt.

* Continuous maximum overload is approximately 1500% of full scale.

SETTINGS

For reverse-current protection a sensitivity of 2 per cent is obtained when using a standard 50 millivolt shunt and setting the relay at 1 millivolt. A 10 per cent sensitivity is obtained by setting the relay at 5 millivolts. These values of sensitivity can be doubled by using a 100 millivolt shunt.

For overload protection the relay is set at the index setting which, with respect to the millivolt drop of the shunt, will operate at desired per cent of overload.

TRIP CIRCUIT

		amperes contacts will: (non-inductive load)		
contacts	d-c control voltage	open	close	carry continuously
D-3 relay	125 v	0.04♦	1.0	. . . .
	250 v	0.02♦	1.0	. . . .
contactor switch (when supplied)	125 v	3.5	30	5.0
	250 v	1.0	30	5.0

♦ infrequent operation

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

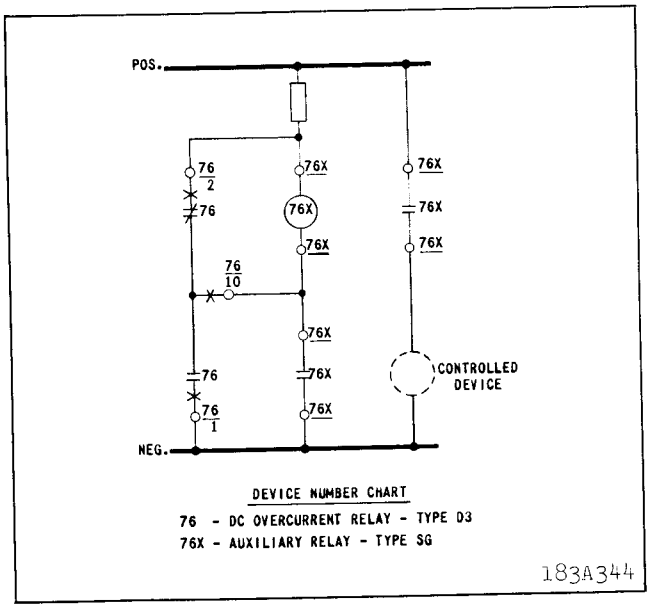


Fig. 5. External Schematic Diagram for Use of External Auxiliary Relay to Prevent Pumping of the Type D-3 Relay when used for Overload Protection.

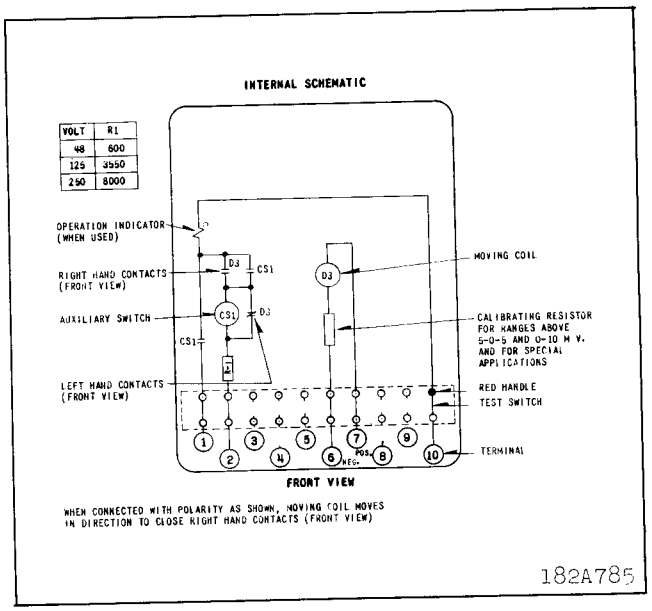


Fig. 6. Internal Schematic of the Type D-3 Relay in the Type FT21 Case with Self-Contained Auxiliary Relay used to Prevent Pumping on Overload Protection.

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.

Standard D-3 relays are calibrated in millivolts measured at the relay terminals. Hence, the resistance of the leads between the relay and the ammeter shunt must be sufficiently low to avoid introducing an excessive error in the relay indication. With the 0-10 or 5-0-5 millivolt relays, leads 8 feet long of #10 B&S gauge copper wire will reduce the relay indication by approximately 5%. If the lead length is less or the conductor size is larger, the error will be correspondingly reduced. Relays with higher millivolt ranges have proportionally greater internal resistances, and consequently error due to lead resistance is reduced. For example, a 0-100 millivolt relay with leads as described above would have an error of 0.5% due to lead resistance.

The use of standard ammeter shunts may be avoided by connecting the moving element leads over an equivalent length of bus-bar or cable. On a basis of 1000 amp. per square inch, at 20°C., 6 feet of copper bus-bar will give 50 millivolts drop.

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Check

Check the scale markings by setting either of the two adjustable contacts at a value marked on the scale. Then alternately apply this voltage plus and minus 3%. The contacts should make and break.

Remove the adjustable contact from the setting and set the second adjustable contact at the same point on the scale. Alternately apply this voltage plus and minus 3%. The contacts should make and break.

Routine Maintenance

All contacts should be cleaned periodically. 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.

If the moving element should be removed, the bearing end-play should be checked when replacing it.

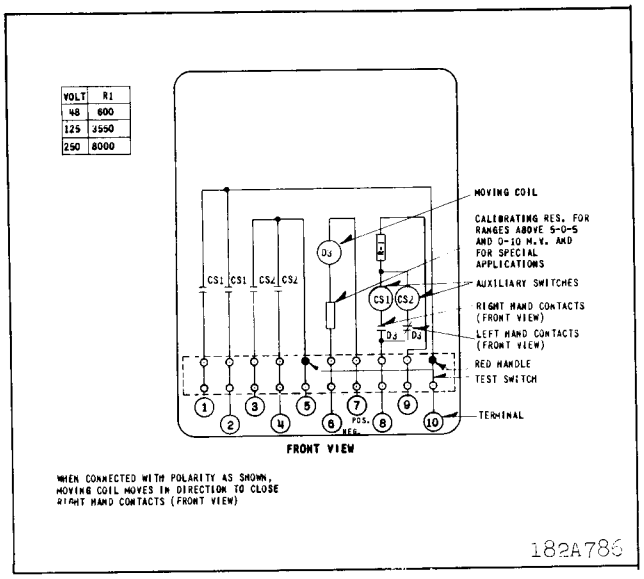


Fig. 7. Internal Schematic of the Type D-3 in the Type FT21 Case with Two Self-Contained Auxiliary Relays used to Increase Contact Capacity.

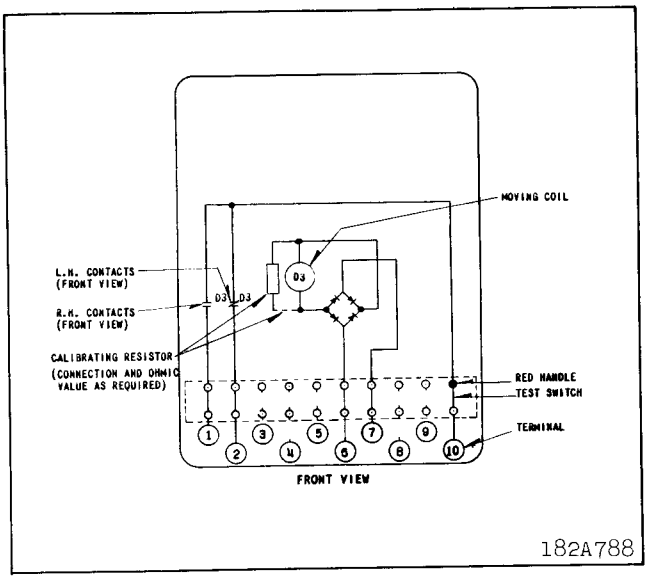


Fig. 8. Internal Schematic of the Type D-3 Relay in the Type FT21 Case, Modified for A-C Operation.

This should be from .020 inch to .025 inch, and can be measured by inserting a feeler gauge between the upper bearing screw and the shoulder on the moving element shaft.

The core and moving coil assembly should not be removed from the frame casting of the D-3 relay unless a keeper having the same radius on the core is placed on the core in such manner as to bridge the iron pole pieces as the core is withdrawn from the bore of the casting. It is necessary also to insert spacers in the air gap so that the core will remain approximately centered when the mounting screws are removed, to prevent damaging the coil winding when sliding the assembly out of the casting.

Auxiliary Switch (CS-1)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be done by turning the relay upside-down. Then screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/64" by means of the two small nuts on either side of the Micarta disc.

Block main contacts closed and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make.

REPAIRS AND 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.

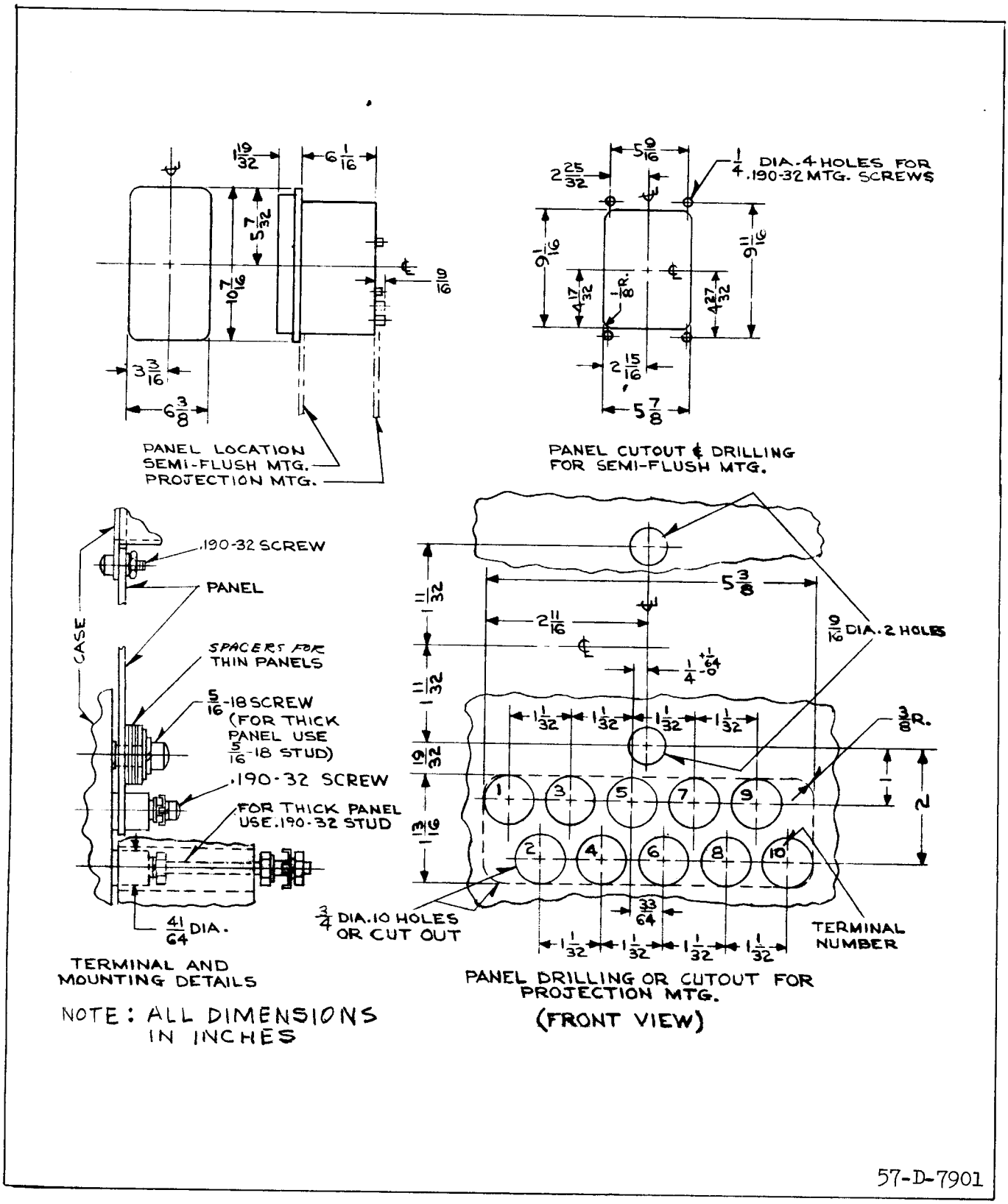


Fig. 9. Outline and Drilling Plan for the Type D-3 Relay in the Type FT21 Case.

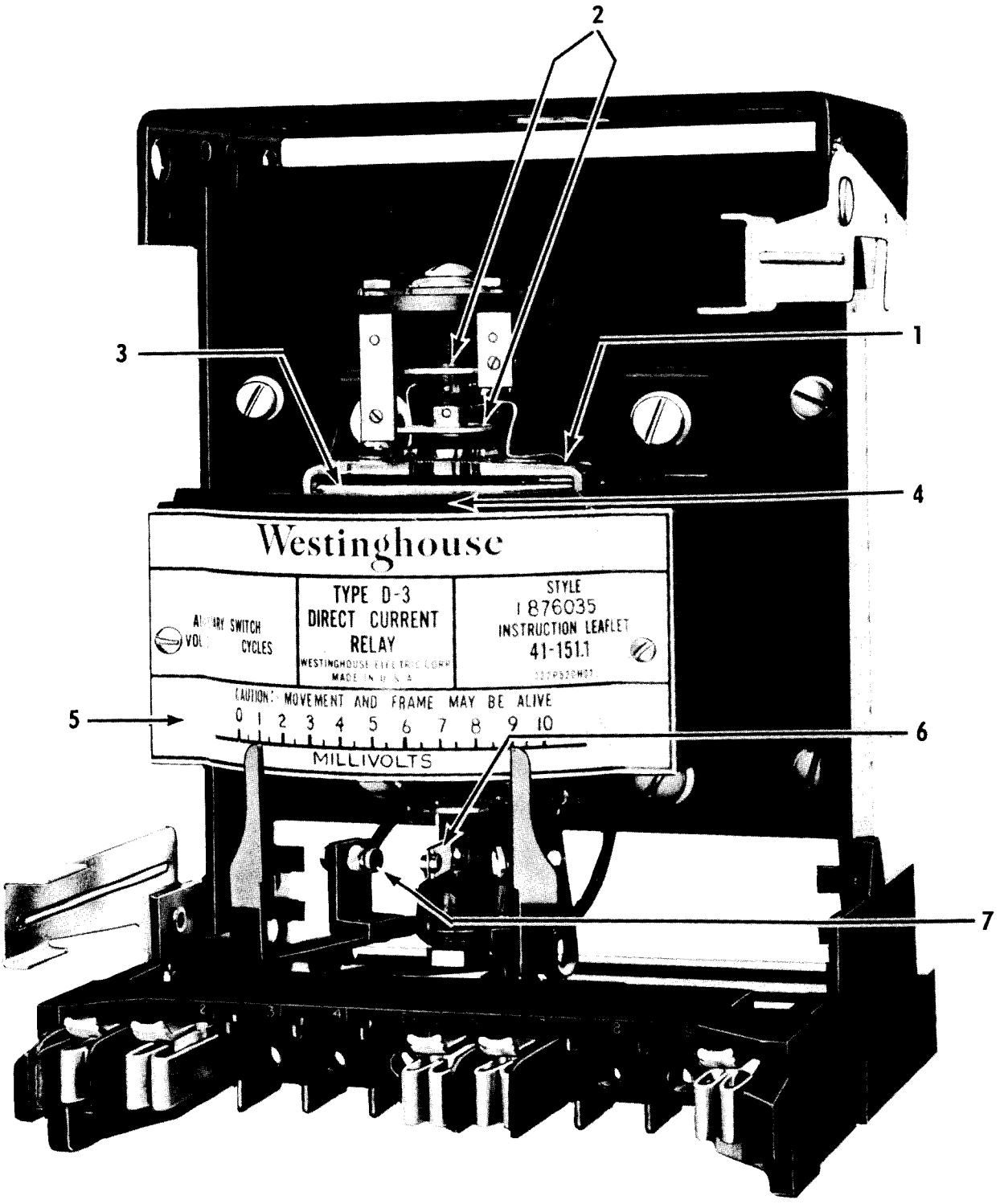
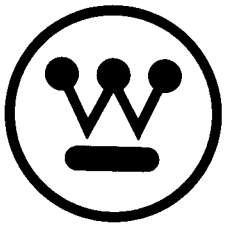


Fig. 10. Type D-3 Relay without Case. 1-Moving Coil. 2-Current-carrying restraining springs. 3-Permanent Magnet. 4-Iron-Frame. 5-Scale. 6-Moving Contact. 7-Stationary Contacts.



WESTINGHOUSE ELECTRIC CORPORATION
RELAY-INSTRUMENT DIVISION
NEWARK, N. J.
Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE D-3 DIRECT CURRENT 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 D-3 relay is suitable for applications where overload, underload, or reverse-current protection is required on direct current circuits. One particular application is in the protection of rotary converters which require sensitive reverse-current relays to prevent running inverted.

In the usual application of the D-3 relay the moving coil is connected to a shunt in the circuit being protected. By suitable selection of relay calibration and of shunt rating, the relay can be made to respond to particular magnitudes or directions of current flow through the shunt as required.

In applications where the D-3 relay is used for the purpose of regulating a load, closing of the overload contacts will initiate action to reduce the amount of the load. Since the relay is very sensitive, a slight reduction in load will cause the overload contacts to open. If the reduction of load is interrupted, the relay will close contacts again on a small load increase. Thus small load fluctuations might cause excessive operation of the relay and the device controlled by it. The connections of Fig. 5 show the use of an external auxiliary relay (type SG) to keep the controlled device energized until the load had dropped by an amount determined by the setting of the left-hand contact of the D-3 relay.

CONSTRUCTION

The type D-3 relay is a d'Arsonvol type d.c. contact making voltmeter consisting of a moving coil, permanent magnet, and contacts. The magnetic circuit is shown schematically in Fig. 1.

Permanent Magnet

The permanent magnet is a cylindrical core, consisting of an Alnico permanent magnet, two iron pole pieces and two brass spacer blocks. This magnet is mounted concentrically in the bore of a mallable iron frame.

A magnetic field is produced by the permanent magnet in the air gap between the magnet and the iron frame. The path of magnetic flux is from the Alnico magnet through the iron pole piece across the air gap to the iron frame. The return path of the flux is through the frame across the second air gap to the second pole piece. The pole pieces and the bore of the frame are shaped such that a uniform flux distribution is obtained in the air gaps.

Moving Coil

The moving coil rotates in the air gap between the core and the iron frame. Electrical connections are made to the coil through two springs located at the top of the element. One end of each spring is connected through a lever arm to a lead of the coil. The other end of each spring is fastened to posts mounted in a circular insulation plate. This plate can be rotated to permit adjustment of the zero position of the moving element.

A third spiral spring located at the bottom of the element provides a current path to the moving contact.

Auxiliary Switch (When used)

The auxiliary switch is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts.

OPERATION

The D-3 relay operates on the principle of a cur-

SUPERSEDES I.L. 41-151.1D
*Denotes change from superseded issue.

EFFECTIVE NOVEMBER 1967

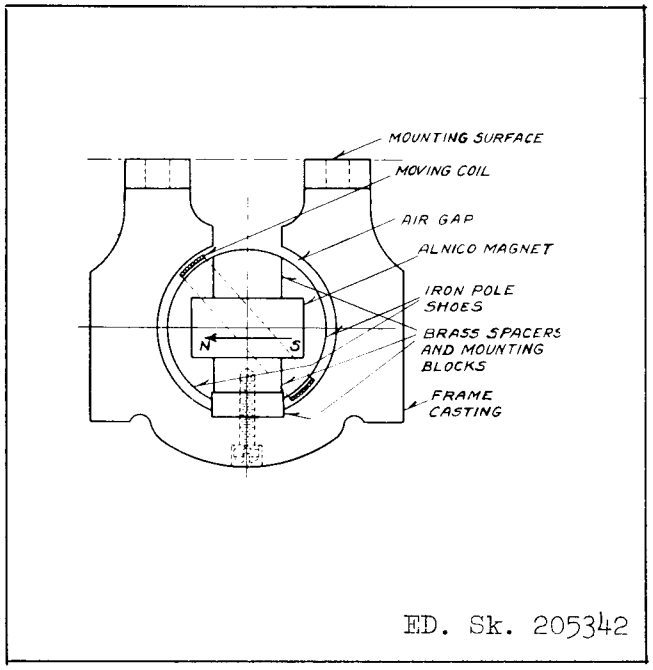


Fig. 1. Schematic Drawing of Magnetic Circuit of Type D-3 Relay (Top View). Moving Coil Bearing Supports, Springs and Contacts Omitted.

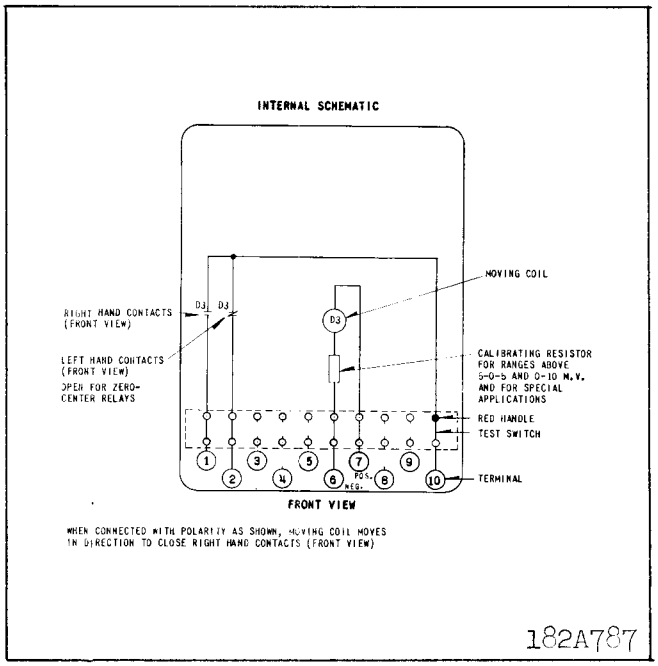


Fig. 2. Internal Schematic of the Type D-3 Relay in the Type FT21 Case.

rent carrying conductor (moving coil) located in a magnetic field (permanent magnet). When a current is applied to the coil of the relay, a torque is produced that rotates the moving coil until the electrical torque is equal to the torque of the restraining spring. The moving contact will assume a position in its travel that is proportional to the current applied to the moving coil.

The direction of movement of the moving coil is determined by the polarity of the current applied to the coil. In the "left zero" and "suppressed zero" D-3 relays, the contacts will move to the right when a current of the proper magnitude and polarity is applied to the relay. On the other hand, the contact of the "center zero" relay will move either left or right depending on the polarity and magnitude of the applied current.

CHARACTERISTICS

The type D-3 relay is supplied in the standard ranges listed in the table below. The numbers on the scale indicate in millivolts the potential required at the relay base terminals to operate the moving element to the indicated scale position.

MOVING COIL CIRCUIT

Ranges in Millivolts, d-c	Average Resistance in Ohms at 25°C
0-10	0.3
5-0-5	0.3
40-80	1.2
100-0-100	6.0
0-200	6.0

As shown in the above Table, the D-3 relay is available with a "left zero," "suppressed zero" and "center zero" scale. In the "left zero" and the "suppressed zero" relays the moving contact is located in the extreme left hand position of the scale when the relays are deenergized. The "suppressed zero" relay is held in this position with considerable more force than the "left zero" relay. When the relays are energized with voltages of the proper magnitude and polarity, the moving contact moves to the right.

In the "center zero" relay, the moving contact is located in the center of the scale when the relay is deenergized. When the relay is energized, the contact will move either to the right or left depending upon the polarity of the applied voltage.

A modification of the D-3 relay, in which a rectifier is mounted internally, makes it suitable for a.c.

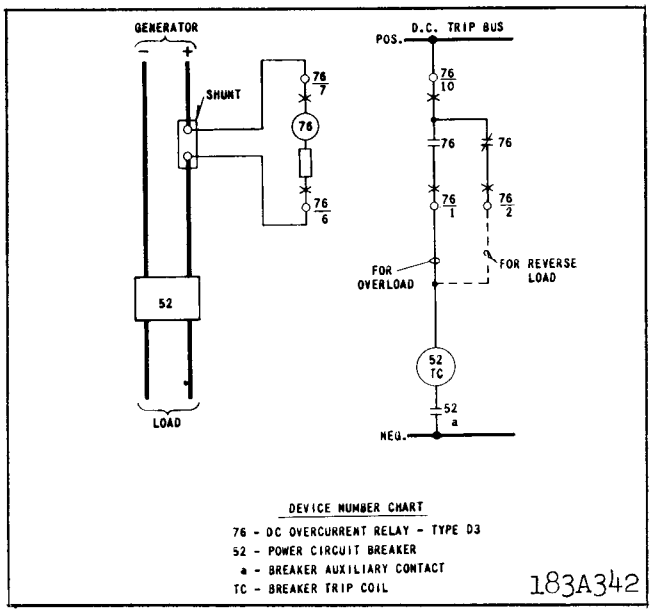


Fig. 3. External Schematic Diagram for Overload or Reverse Current Protection, using the Type D-3 Relay.

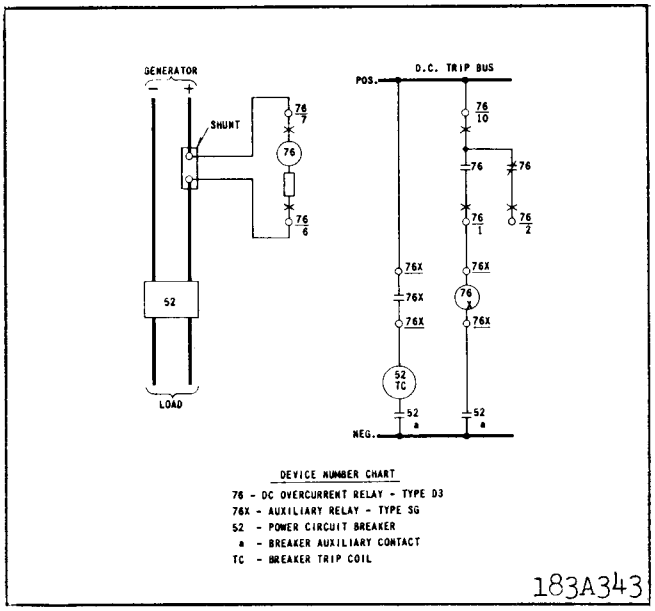


Fig. 4. External Schematic Diagram for Overload Protection where Trip Currents in Excess of One Ampere Rating Require Use of an Auxiliary Relay.

operation. Full scale deflection can be obtained with 6 milliamperes a.c.

The relay has a slight time-delay, with inverse characteristics. In the usual application the moving coil terminals are connected across a shunt, and this results in longer delay for both operating and reset times. When a shunt is used the operating time for full scale travel at 125% of the minimum operating current is about 4 seconds, while at 1000% it is about .25 second. In applications where no shunt is used, the operating times for the same conditions are about 1.25 and .15 second respectively. When the relay is de-energized, the time required for it to reset from the full scale position to the 10% position is approximately 5 seconds when a shunt is used, and 2 seconds when there is no shunt.

Continuous maximum overload is approximately 1500% of full scale.

* The minimum setting which D-3 Relay can accommodate is 5% of the full scale.

SETTINGS

For reverse-current protection a sensitivity of 2 per cent is obtained when using a standard 50 millivolt shunt and setting the relay at 1 millivolt. A 10 per cent sensitivity is obtained by setting the relay at 5 millivolts. These values of sensitivity can be doubled by using a 100 millivolt shunt.

For overload protection the relay is set at the index setting which, with respect to the millivolt drop of the shunt, will operate at desired per cent of overload.

TRIP CIRCUIT

contacts	d-c control voltage	amperes contacts will: (non-inductive load) open	close	carry continuously
D-3 relay	125 v	0.04♦	1.0	. . . .
	250 v	0.02♦	1.0	. . . .
contactor switch (when supplied)	125 v	3.5	30	5.0
	250 v	1.0	30	5.0

♦ infrequent operation

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

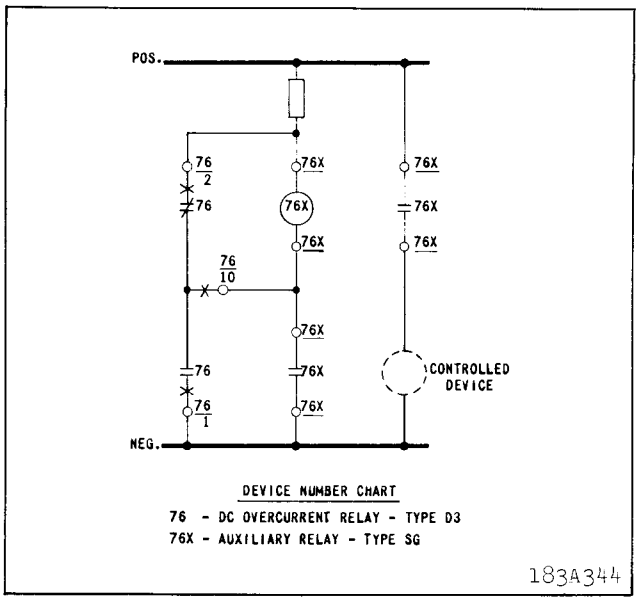


Fig. 5. External Schematic Diagram for Use of External Auxiliary Relay to Prevent Pumping of the Type D-3 Relay when used for Overload Protection.

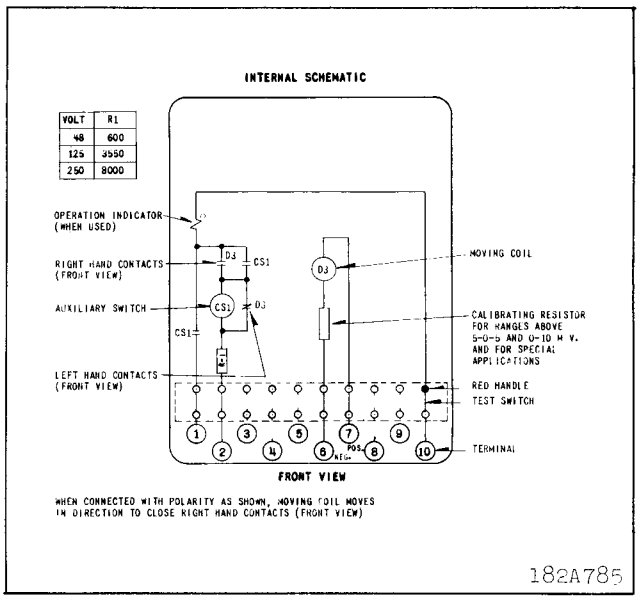


Fig. 6. Internal Schematic of the Type D-3 Relay in the Type FT21 Case with Self-Contained Auxiliary Relay used to Prevent Pumping on Overload Protection.

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.

Standard D-3 relays are calibrated in millivolts measured at the relay terminals. Hence, the resistance of the leads between the relay and the ammeter shunt must be sufficiently low to avoid introducing an excessive error in the relay indication. With the 0-10 or 5-0-5 millivolt relays, leads 8 feet long of #10 B&S gauge copper wire will reduce the relay indication by approximately 5%. If the lead length is less or the conductor size is larger, the error will be correspondingly reduced. Relays with higher millivolt ranges have proportionally greater internal resistances, and consequently error due to lead resistance is reduced. For example, a 0-100 millivolt relay with leads as described above would have an error of 0.5% due to lead resistance.

The use of standard ammeter shunts may be avoided by connecting the moving element leads over an equivalent length of bus-bar or cable. On a basis of 1000 amp. per square inch, at 20°C., 6 feet of copper bus-bar will give 50 millivolts drop.

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Check

Check the scale markings by setting either of the two adjustable contacts at a value marked on the scale. Then alternately apply this voltage plus and minus 3%. The contacts should make and break.

Remove the adjustable contact from the setting and set the second adjustable contact at the same point on the scale. Alternately apply this voltage plus and minus 3%. The contacts should make and break.

Routine Maintenance

All contacts should be cleaned periodically. 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.

If the moving element should be removed, the bearing end-play should be checked when replacing it.

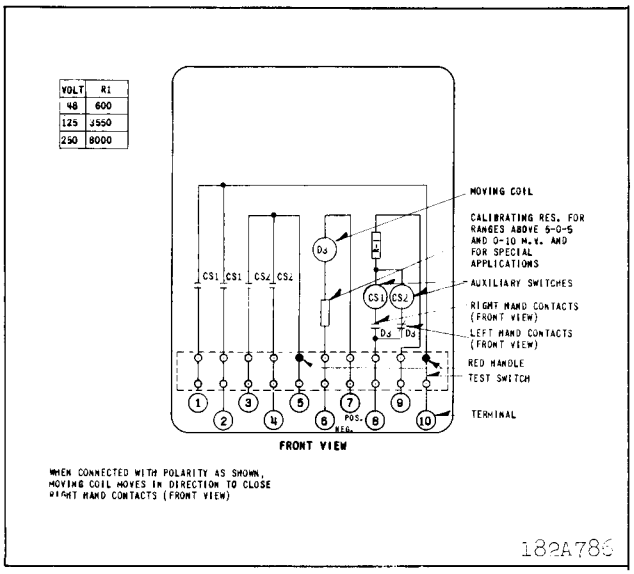


Fig. 7. Internal Schematic of the Type D-3 in the Type FT21 Case with Two Self-Contained Auxiliary Relays used to Increase Contact Capacity.

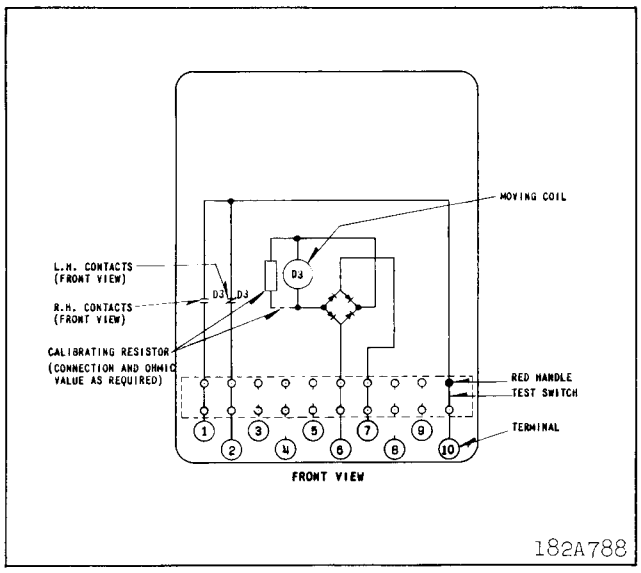


Fig. 8. Internal Schematic of the Type D-3 Relay in the Type FT21 Case, Modified for A-C Operation.

This should be from .020 inch to .025 inch, and can be measured by inserting a feeler gauge between the upper bearing screw and the shoulder on the moving element shaft.

The core and moving coil assembly should not be removed from the frame casting of the D-3 relay unless a keeper having the same radius on the core is placed on the core in such manner as to bridge the iron pole pieces as the core is withdrawn from the bore of the casting. It is necessary also to insert spacers in the air gap so that the core will remain approximately centered when the mounting screws are removed, to prevent damaging the coil winding when sliding the assembly out of the casting.

Auxiliary Switch (CS-1)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be done by turning the relay upside-down. Then screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/64" by means of the two small nuts on either side of the Micarta disc.

Block main contacts closed and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make.

REPAIRS AND 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.

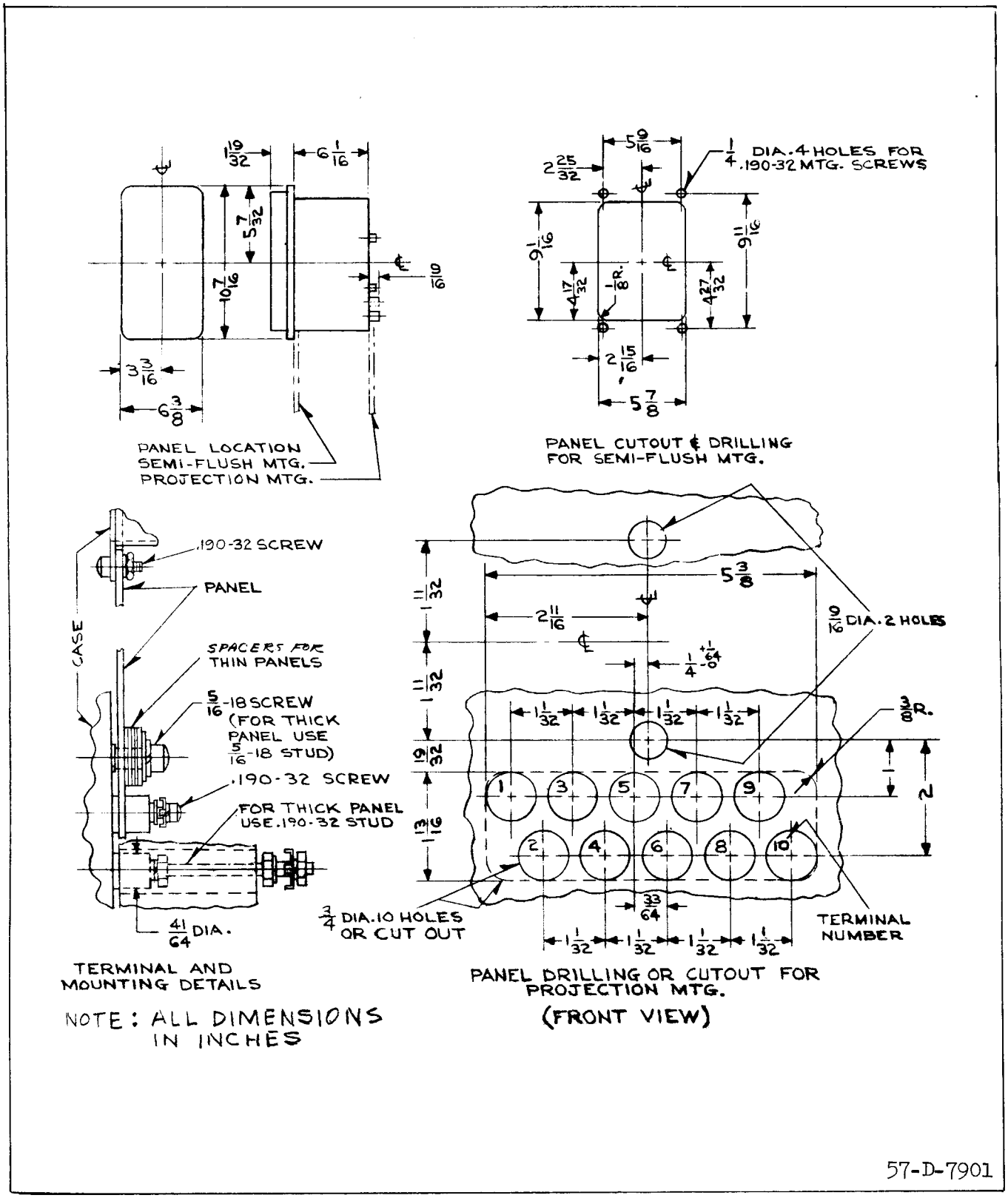


Fig. 9. Outline and Drilling Plan for the Type D-3 Relay in the Type FT21 Case.

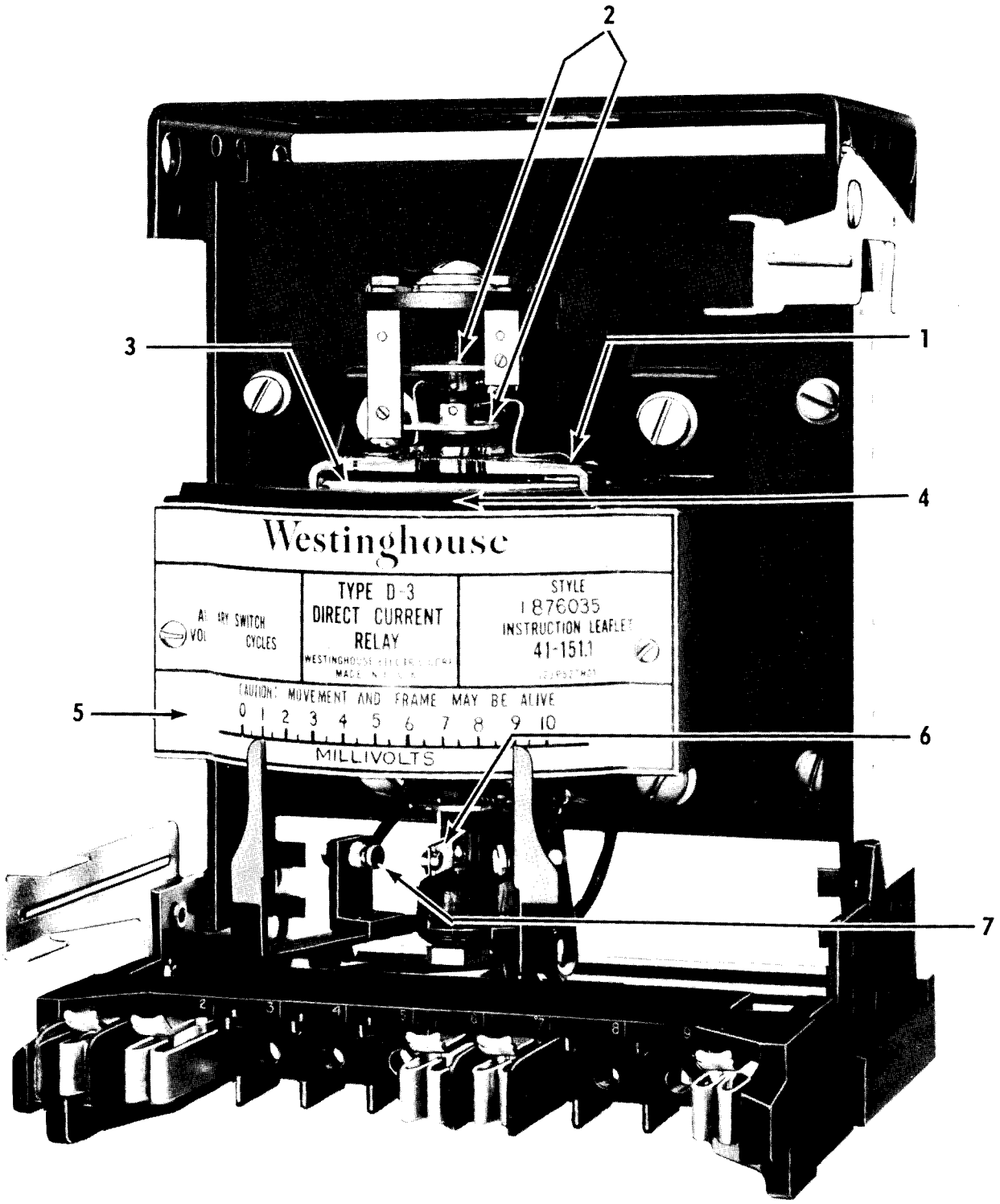
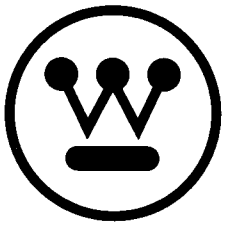


Fig. 10. Type D-3 Relay without Case. 1-Moving Coil. 2-Current-carrying restraining springs. 3-Permanent Magnet. 4-Iron-Frame. 5-Scale. 6-Moving Contact. 7-Stationary Contacts.



WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE D-3 DIRECT CURRENT 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 D-3 relay is suitable for applications where overload, underload, or reverse-current protection is required on direct current circuits. One particular application is in the protection of rotary converters which require sensitive reverse-current relays to prevent running inverted.

In the usual application of the D-3 relay the moving coil is connected to a shunt in the circuit being protected. By suitable selection of relay calibration and of shunt rating, the relay can be made to respond to particular magnitudes or directions of current flow through the shunt as required.

In applications where the D-3 relay is used for the purpose of regulating a load, closing of the overload contacts will initiate action to reduce the amount of the load. Since the relay is very sensitive, a slight reduction in load will cause the overload contacts to open. If the reduction of load is interrupted, the relay will close contacts again on a small load increase. Thus small load fluctuations might cause excessive operation of the relay and the device controlled by it. The connections of Fig. 5 show the use of an external auxiliary relay (type SG) to keep the controlled device energized until the load had dropped by an amount determined by the setting of the left-hand contact of the D-3 relay.

CONSTRUCTION

The type D-3 relay is a d'Arsonvol type d.c. contact making voltmeter consisting of a moving coil, permanent magnet, and contacts. The magnetic circuit is shown schematically in Fig. 1.

Permanent Magnet

The permanent magnet is a cylindrical core, consisting of an Alnico permanent magnet, two iron pole pieces and two brass spacer blocks. This magnet is mounted concentrically in the bore of a mallable iron frame.

A magnetic field is produced by the permanent magnet in the air gap between the magnet and the iron frame. The path of magnetic flux is from the Alnico magnet through the iron pole piece across the air gap to the iron frame. The return path of the flux is through the frame across the second air gap to the second pole piece. The pole pieces and the bore of the frame are shaped such that a uniform flux distribution is obtained in the air gaps.

Moving Coil

The moving coil rotates in the air gap between the core and the iron frame. Electrical connections are made to the coil through two springs located at the top of the element. One end of each spring is connected through a lever arm to a lead of the coil. The other end of each spring is fastened to posts mounted in a circular insulation plate. This plate can be rotated to permit adjustment of the zero position of the moving element.

A third spiral spring located at the bottom of the element provides a current path to the moving contact.

Auxiliary Switch (When used)

The auxiliary switch is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts.

OPERATION

The D-3 relay operates on the principle of a cur-

SUPERSEDES I.L. 41-151.1E
*Denotes change from superseded issue.

EFFECTIVE JUNE 1969

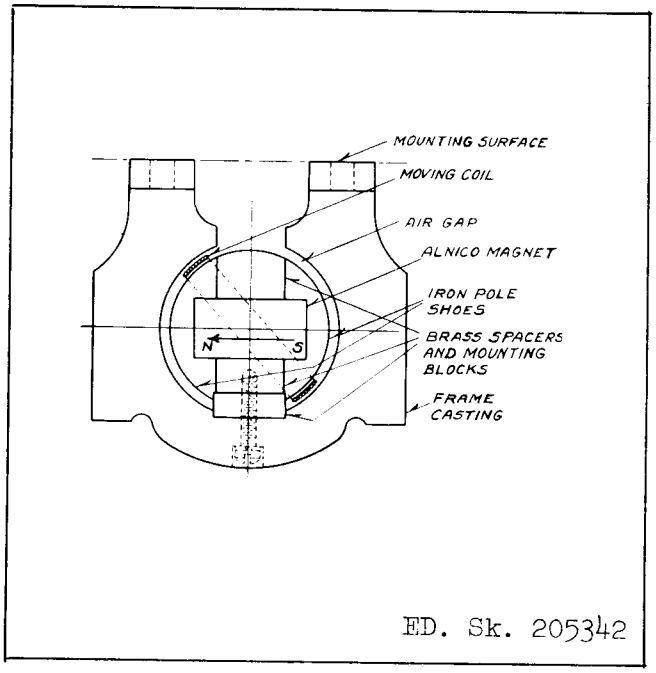


Fig. 1. Schematic Drawing of Magnetic Circuit of Type D-3 Relay (Top View). Moving Coil Bearing Supports, Springs and Contacts Omitted.

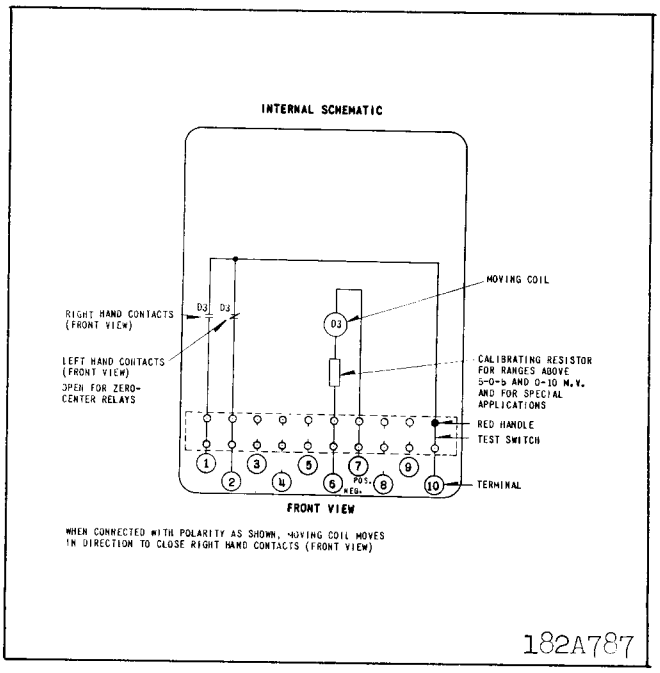


Fig. 2. Internal Schematic of the Type D-3 Relay in the Type FT21 Case.

rent carrying conductor (moving coil) located in a magnetic field (permanent magnet). When a current is applied to the coil of the relay, a torque is produced that rotates the moving coil until the electrical torque is equal to the torque of the restraining spring. The moving contact will assume a position in its travel that is proportional to the current applied to the moving coil.

The direction of movement of the moving coil is determined by the polarity of the current applied to the coil. In the "left zero" and "suppressed zero" D-3 relays, the contacts will move to the right when a current of the proper magnitude and polarity is applied to the relay. On the other hand, the contact of the "center zero" relay will move either left or right depending on the polarity and magnitude of the applied current.

CHARACTERISTICS

The type D-3 relay is supplied in the standard ranges listed in the table below. The numbers on the scale indicate in millivolts the potential required at the relay base terminals to operate the moving element to the indicated scale position.

MOVING COIL CIRCUIT

Ranges in Millivolts, d-c	Average Resistance in Ohms at 25°C
0-10	0.3
5-0-5	0.3
40-80	1.2
100-0-100	6.0
0-200	6.0

As shown in the above Table, the D-3 relay is available with a "left zero," "suppressed zero" and "center zero" scale. In the "left zero" and the "suppressed zero" relays the moving contact is located in the extreme left hand position of the scale when the relays are deenergized. The "suppressed zero" relay is held in this position with considerable more force than the "left zero" relay. When the relays are energized with voltages of the proper magnitude and polarity, the moving contact moves to the right.

In the "center zero" relay, the moving contact is located in the center of the scale when the relay is deenergized. When the relay is energized, the contact will move either to the right or left depending upon the polarity of the applied voltage.

A modification of the D-3 relay, in which a rectifier is mounted internally, makes it suitable for a.c.

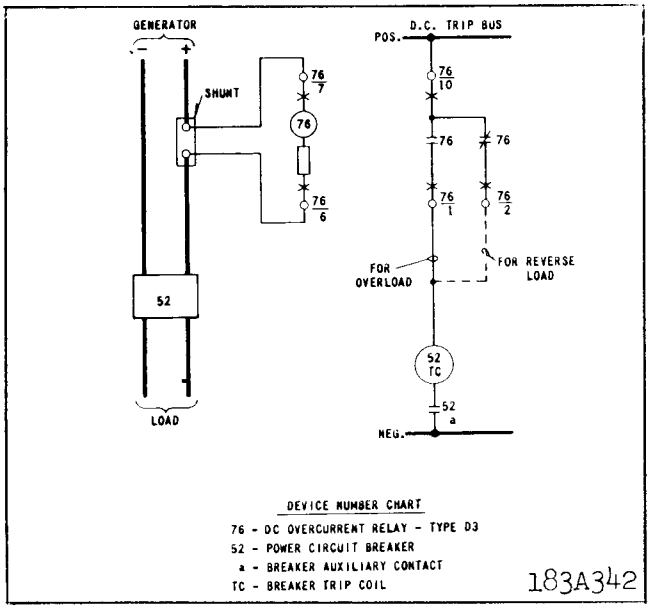


Fig. 3. External Schematic Diagram for Overload or Reverse Current Protection, using the Type D-3 Relay.

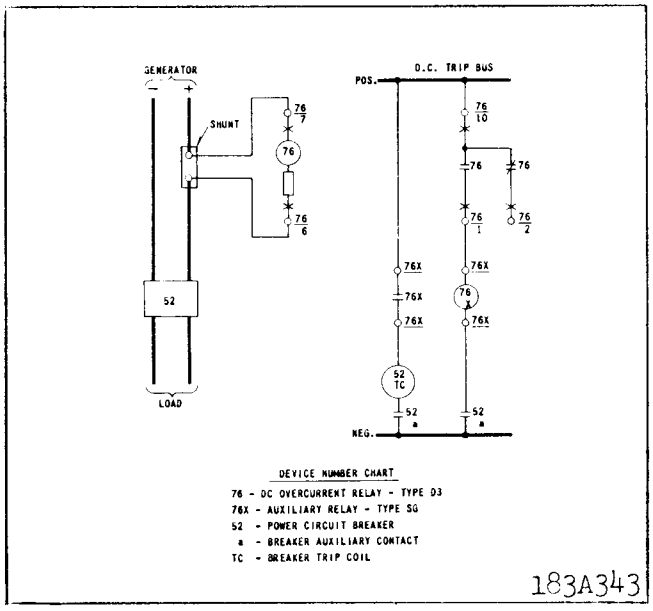


Fig. 4. External Schematic Diagram for Overload Protection where Trip Currents in Excess of One Ampere Rating Require Use of an Auxiliary Relay.

operation. Full scale deflection can be obtained with 6 milliamperes a.c.

The relay has a slight time-delay, with inverse characteristics. In the usual application the moving coil terminals are connected across a shunt, and this results in longer delay for both operating and reset times. When a shunt is used the operating time for full * scale travel at 125% of the full scale operating current is about 4 seconds, while at 1000% it is about .25 second. In applications where no shunt is used, the operating times for the same conditions are about 1.25 and .15 second respectively. When the relay is de-energized, the time required for it to reset from the full scale position to the 10% position is approximately 5 seconds when a shunt is used, and 2 seconds when there is no shunt.

Continuous maximum overload is approximately 1500% of full scale.

The minimum setting which D-3 Relay can accommodate is 5% of the full scale.

SETTINGS

For reverse-current protection a sensitivity of 2 per cent is obtained when using a standard 50 millivolt shunt and setting the relay at 1 millivolt. A 10 per cent sensitivity is obtained by setting the relay at 5 millivolts. These values of sensitivity can be doubled by using a 100 millivolt shunt.

For overload protection the relay is set at the index setting which, with respect to the millivolt drop of the shunt, will operate at desired per cent of overload.

TRIP CIRCUIT

		amperes contacts will: (non-inductive load)		
contacts	d-c control voltage	open	close	carry continuously
D-3 relay	125 v	0.04♦	1.0	....
	250 v	0.02♦	1.0	....
contactor switch (when supplied)	125 v	3.5	30	5.0
	250 v	1.0	30	5.0

♦ infrequent operation

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

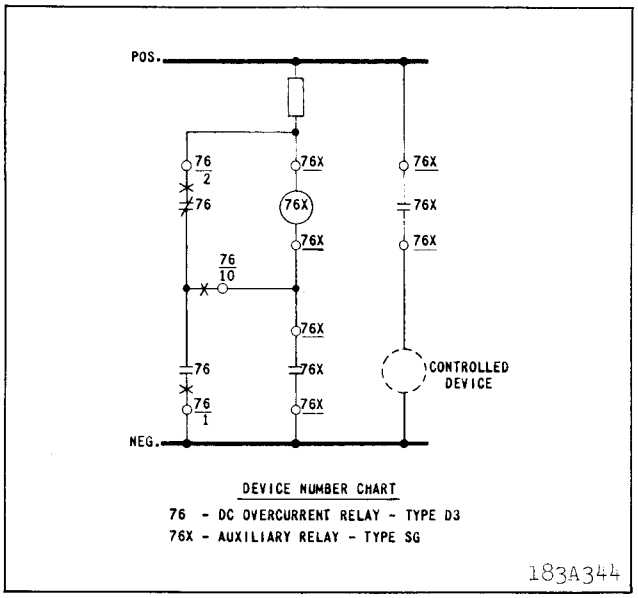


Fig. 5. External Schematic Diagram for Use of External Auxiliary Relay to Prevent Pumping of the Type D-3 Relay when used for Overload Protection.

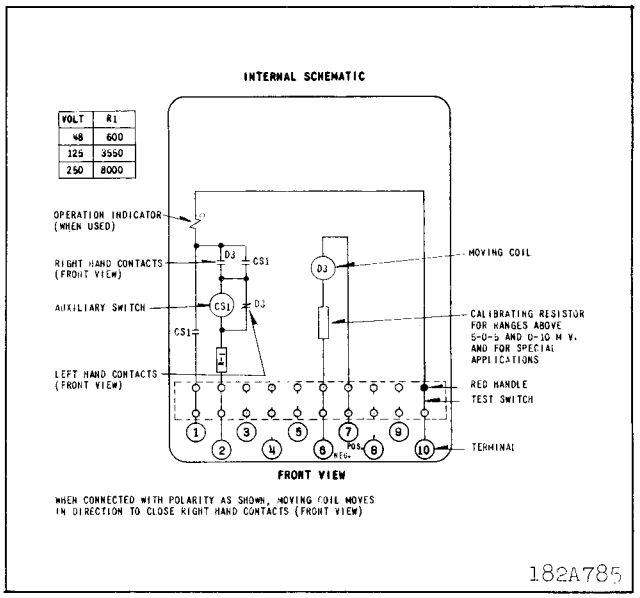


Fig. 6. Internal Schematic of the Type D-3 Relay in the Type FT21 Case with Self-Contained Auxiliary Relay used to Prevent Pumping on Overload Protection.

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.

Standard D-3 relays are calibrated in millivolts measured at the relay terminals. Hence, the resistance of the leads between the relay and the ammeter shunt must be sufficiently low to avoid introducing an excessive error in the relay indication. With the 0-10 or 5-0-5 millivolt relays, leads 8 feet long of #10 B&S gauge copper wire will reduce the relay indication by approximately 5%. If the lead length is less or the conductor size is larger, the error will be correspondingly reduced. Relays with higher millivolt ranges have proportionally greater internal resistances, and consequently error due to lead resistance is reduced. For example, a 0-100 millivolt relay with leads as described above would have an error of 0.5% due to lead resistance.

The use of standard ammeter shunts may be avoided by connecting the moving element leads over an equivalent length of bus-bar or cable. On a basis of 1000 amp. per square inch, at 20°C., 6 feet of copper bus-bar will give 50 millivolts drop.

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Check

Check the scale markings by setting either of the two adjustable contacts at a value marked on the scale. Then alternately apply this voltage plus and minus 3%. The contacts should make and break.

Remove the adjustable contact from the setting and set the second adjustable contact at the same point on the scale. Alternately apply this voltage plus and minus 3%. The contacts should make and break.

Routine Maintenance

All contacts should be cleaned periodically. 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.

If the moving element should be removed, the bearing end-play should be checked when replacing it.

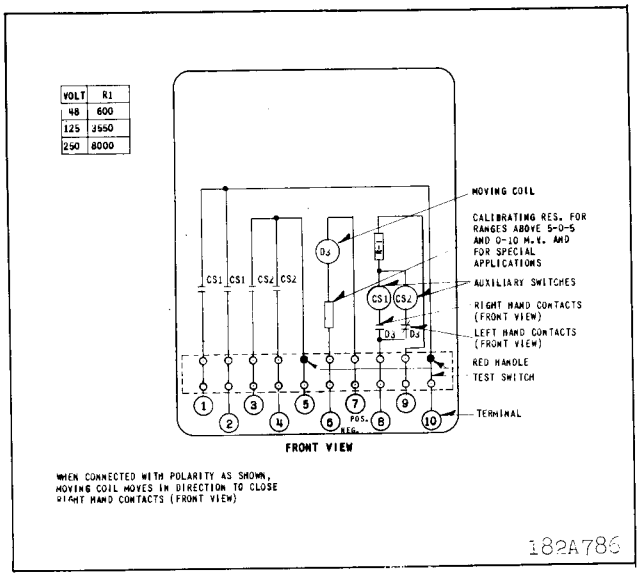


Fig. 7. Internal Schematic of the Type D-3 in the Type FT21 Case with Two Self-Contained Auxiliary Relays used to Increase Contact Capacity.

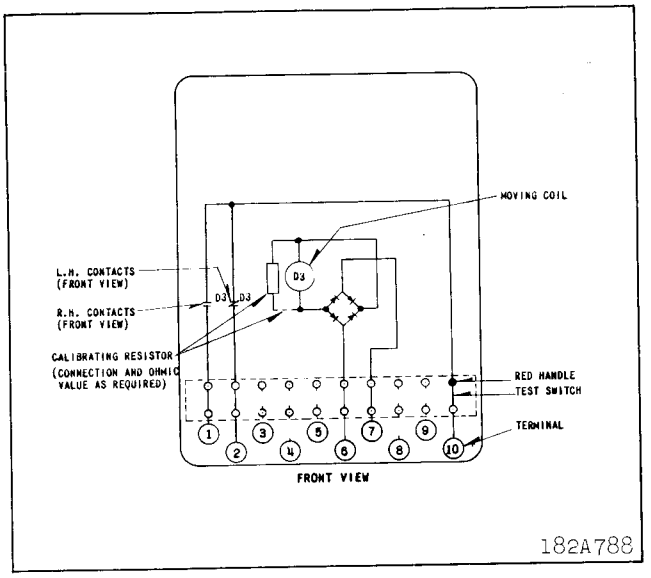


Fig. 8. Internal Schematic of the Type D-3 Relay in the Type FT21 Case, Modified for A-C Operation.

This should be from .020 inch to .025 inch, and can be measured by inserting a feeler gauge between the upper bearing screw and the shoulder on the moving element shaft.

The core and moving coil assembly should not be removed from the frame casting of the D-3 relay unless a keeper having the same radius on the core is placed on the core in such manner as to bridge the iron pole pieces as the core is withdrawn from the bore of the casting. It is necessary also to insert spacers in the air gap so that the core will remain approximately centered when the mounting screws are removed, to prevent damaging the coil winding when sliding the assembly out of the casting.

Auxiliary Switch (CS-1)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be done by turning the relay upside-down. Then screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/64" by means of the two small nuts on either side of the Micarta disc.

Block main contacts closed and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make.

REPAIRS AND 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.

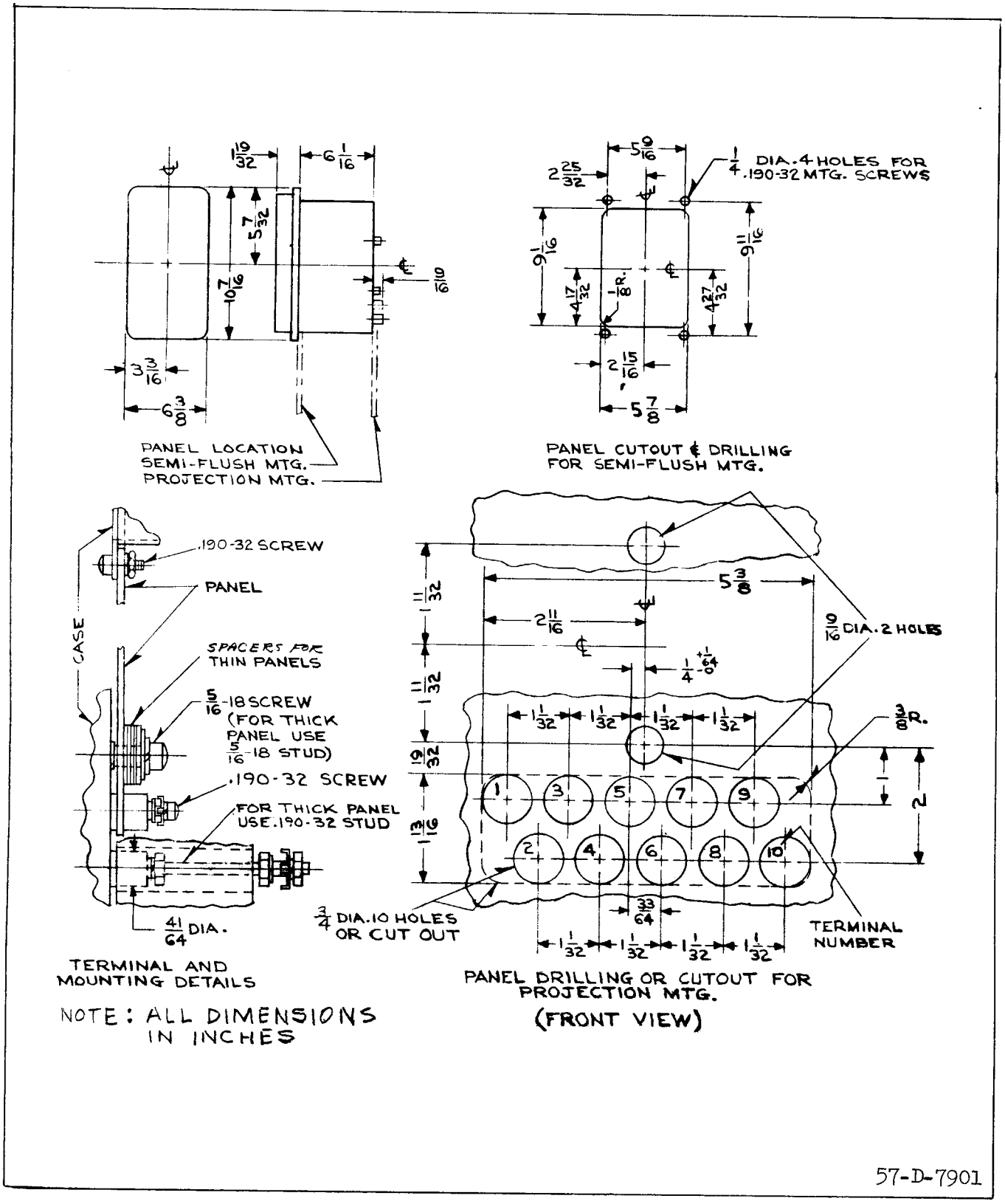


Fig. 9. Outline and Drilling Plan for the Type D-3 Relay in the Type FT21 Case.

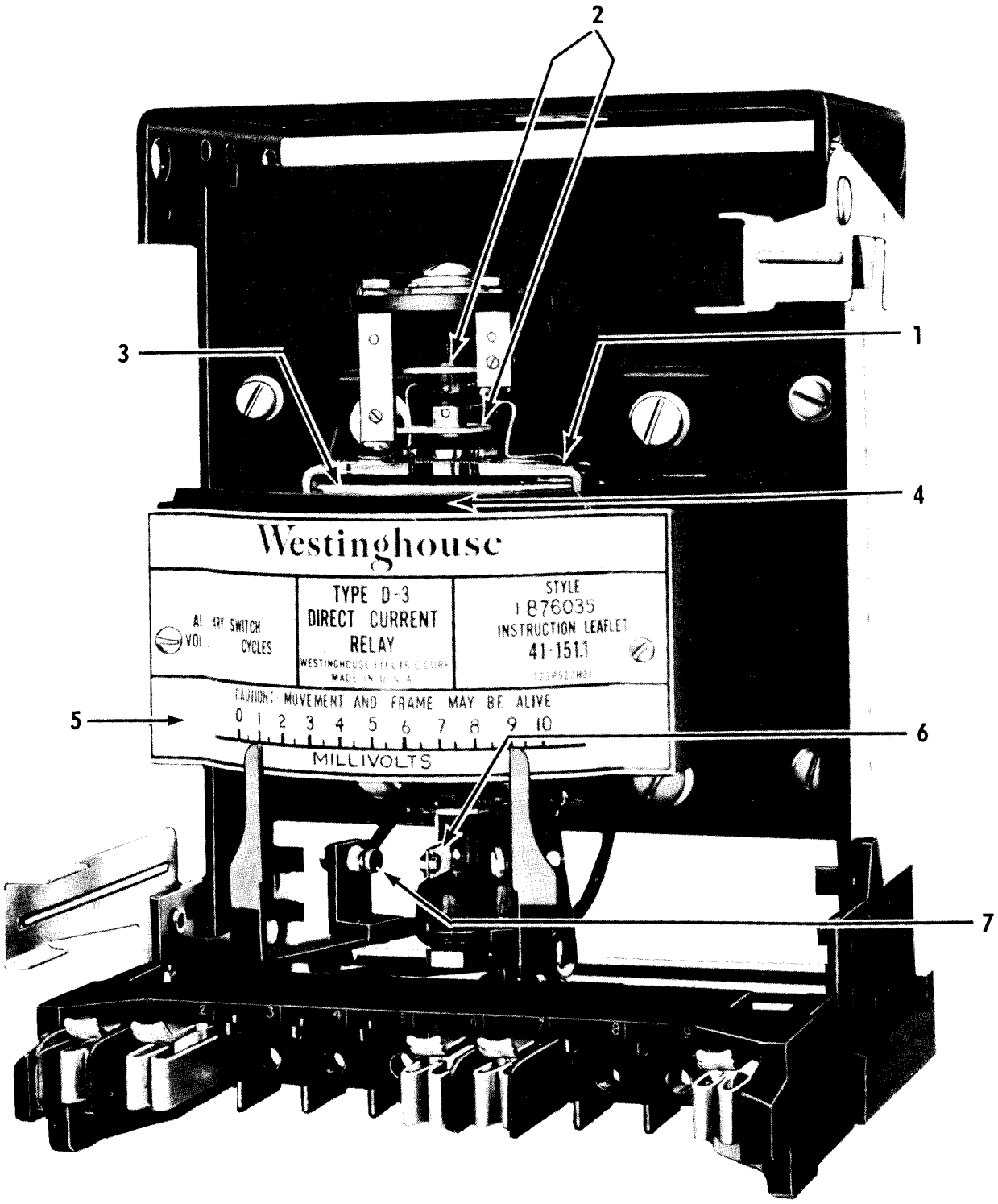
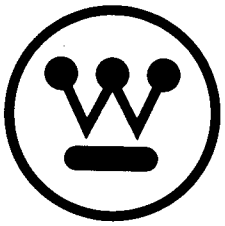


Fig. 10. Type D-3 Relay without Case. 1-Moving Coil. 2-Current-carrying restraining springs. 3-Permanent Magnet. 4-Iron-Frame. 5-Scale. 6-Moving Contact. 7-Stationary Contacts.



WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE D-3 DIRECT CURRENT 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 D-3 relay is suitable for applications where overload, underload, or reverse-current protection is required on direct current circuits. One particular application is in the protection of rotary converters which require sensitive reverse-current relays to prevent running inverted.

In the usual application of the D-3 relay the moving coil is connected to a shunt in the circuit being protected. By suitable selection of relay calibration and of shunt rating, the relay can be made to respond to particular magnitudes or directions of current flow through the shunt as required.

In applications where the D-3 relay is used for the purpose of regulating a load, closing of the overload contacts will initiate action to reduce the amount of the load. Since the relay is very sensitive, a slight reduction in load will cause the overload contacts to open. If the reduction of load is interrupted, the relay will close contacts again on a small load increase. Thus small load fluctuations might cause excessive operation of the relay and the device controlled by it. The connections of Fig. 5 show the use of an external auxiliary relay (type SG) to keep the controlled device energized until the load had dropped by an amount determined by the setting of the left-hand contact of the D-3 relay. Fig. 6 shows how this feature has been added to some styles.

CONSTRUCTION

The type D-3 relay is a d'Arsonvol type d.c. contact making voltmeter consisting of a moving coil, permanent magnet, and contacts. The magnetic circuit is shown schematically in Fig. 1.

Permanent Magnet

The permanent magnet is a cylindrical core, consisting of an Alnico permanent magnet, two iron pole pieces and two brass spacer blocks. This magnet is mounted concentrically in the bore of a mallable iron frame.

A magnetic field is produced by the permanent magnet in the air gap between the magnet and the iron frame. The path of magnetic flux is from the Alnico magnet through the iron pole piece across the air gap to the iron frame. The return path of the flux is through the frame across the second air gap to the second pole piece. The pole pieces and the bore of the frame are shaped such that a uniform flux distribution is obtained in the air gaps.

Moving Coil

The moving coil rotates in the air gap between the core and the iron frame. Electrical connections are made to the coil through two springs located at the top of the element. One end of each spring is connected through a lever arm to a head of the coil. The other end of each spring is fastened to posts mounted in a circular insulation plate. This plate can be rotated to permit adjustment of the zero position of the moving element.

A third spiral spring located at the bottom of the element provides a current path to the moving contact.

Auxiliary Switch (When used)

The auxiliary switch is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts.

OPERATION

The D-3 relay operates on the principle of a cur-

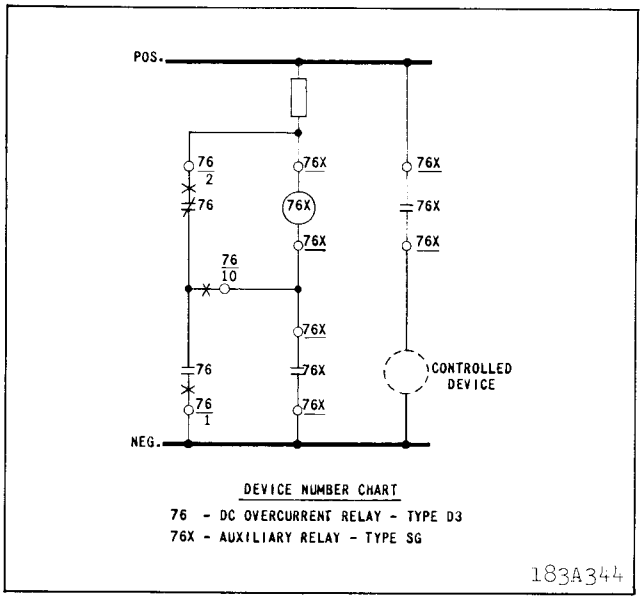


Fig. 5. External Schematic Diagram for Use of External Auxiliary Relay to Prevent Pumping of the Type D-3 Relay when used for Overload Protection.

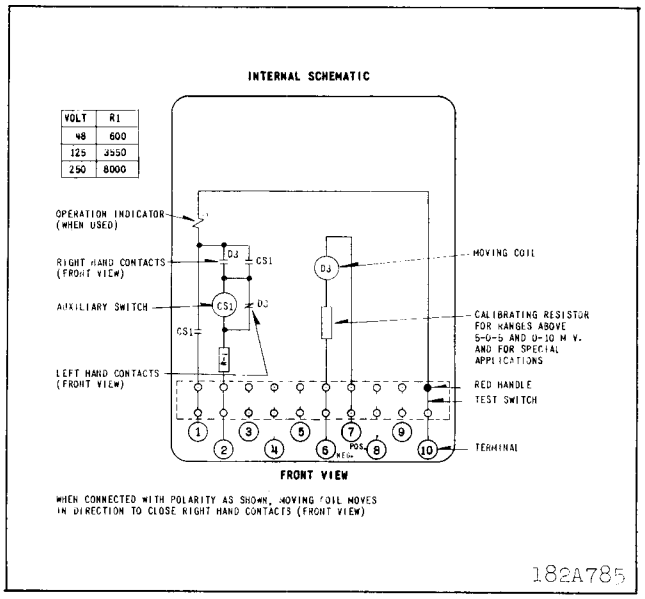


Fig. 6. Internal Schematic of the Type D-3 Relay in the Type FT21 Case with Self-Contained Auxiliary Relay used to Prevent Pumping on Overload Protection.

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.

Standard D-3 relays are calibrated in millivolts measured at the relay terminals. Hence, the resistance of the leads between the relay and the ammeter shunt must be sufficiently low to avoid introducing an excessive error in the relay indication. With the 0-10 or 5-0-5 millivolt relays, leads 8 feet long of #10 B&S gauge copper wire will reduce the relay indication by approximately 5%. If the lead length is less or the conductor size is larger, the error will be correspondingly reduced. Relays with higher millivolt ranges have proportionally greater internal resistances, and consequently error due to lead resistance is reduced. For example, a 0-100 millivolt relay with leads as described above would have an error of 0.5% due to lead resistance.

The use of standard ammeter shunts may be avoided by connecting the moving element leads over an equivalent length of bus-bar or cable. On a basis of 1000 amp. per square inch, at 20°C., 6 feet of copper bus-bar will give 50 millivolts drop.

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Check

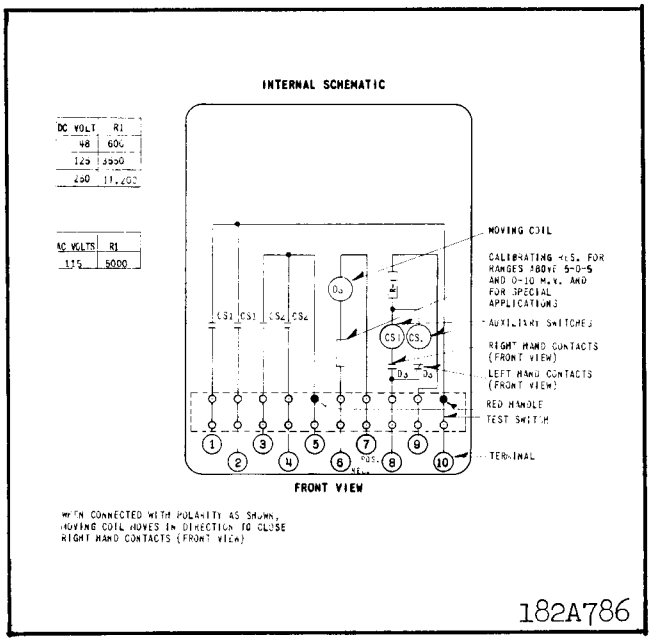
Check the scale markings by setting either of the two adjustable contacts at a value marked on the scale. Then alternately apply this voltage plus and minus 3%. The contacts should make and break.

Remove the adjustable contact from the setting and set the second adjustable contact at the same point on the scale. Alternately apply this voltage plus and minus 3%. The contacts should make and break.

Routine Maintenance

All contacts should be cleaned periodically. 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.

If the moving element should be removed, the bearing end-play should be checked when replacing it.



* *Fig. 7. Internal Schematic of the Type D-3 in the Type FT21 Case with Two Self-Contained Auxiliary Relays used to Increase Contact Capacity.*

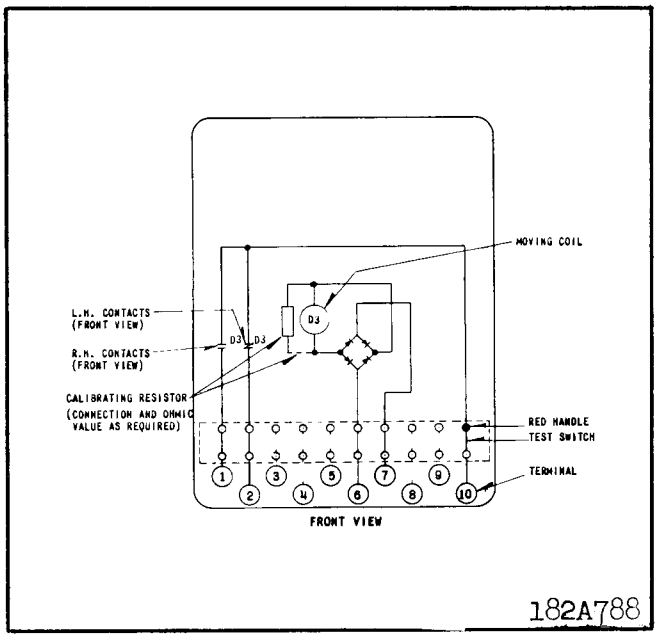


Fig. 8. Internal Schematic of the Type D-3 Relay in the Type FT21 Case, Modified for A-C Operation.

This should be from .020 inch to .025 inch, and can be measured by inserting a feeler gauge between the upper bearing screw and the shoulder on the moving element shaft.

The core and moving coil assembly should not be removed from the frame casting of the D-3 relay unless a keeper having the same radius on the core is placed on the core in such manner as to bridge the iron pole pieces as the core is withdrawn from the bore of the casting. It is necessary also to insert spacers in the air gap so that the core will remain approximately centered when the mounting screws are removed, to prevent damaging the coil winding when sliding the assembly out of the casting.

Auxiliary Switch (CS-1)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be done by turning the relay upside-down. Then screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/64" by means of the two small nuts on either side of the Micarta disc.

Block main contacts closed and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make.

Operation Indicator

The operation indicator (when used) consists of a small solenoid coil mounted in a steel frame, a spring restrained armature and a white flag. The indicator is reset by a push rod in the cover. Block the CS-1 auxiliary relay contacts closed and pass 0.2 amperes AC or DC through the indicator. The white target should fall into view.

The coil has a resistance of approximately 2.8 ohms and a continuous current carrying capacity of 0.6 amperes.

REPAIRS AND 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.

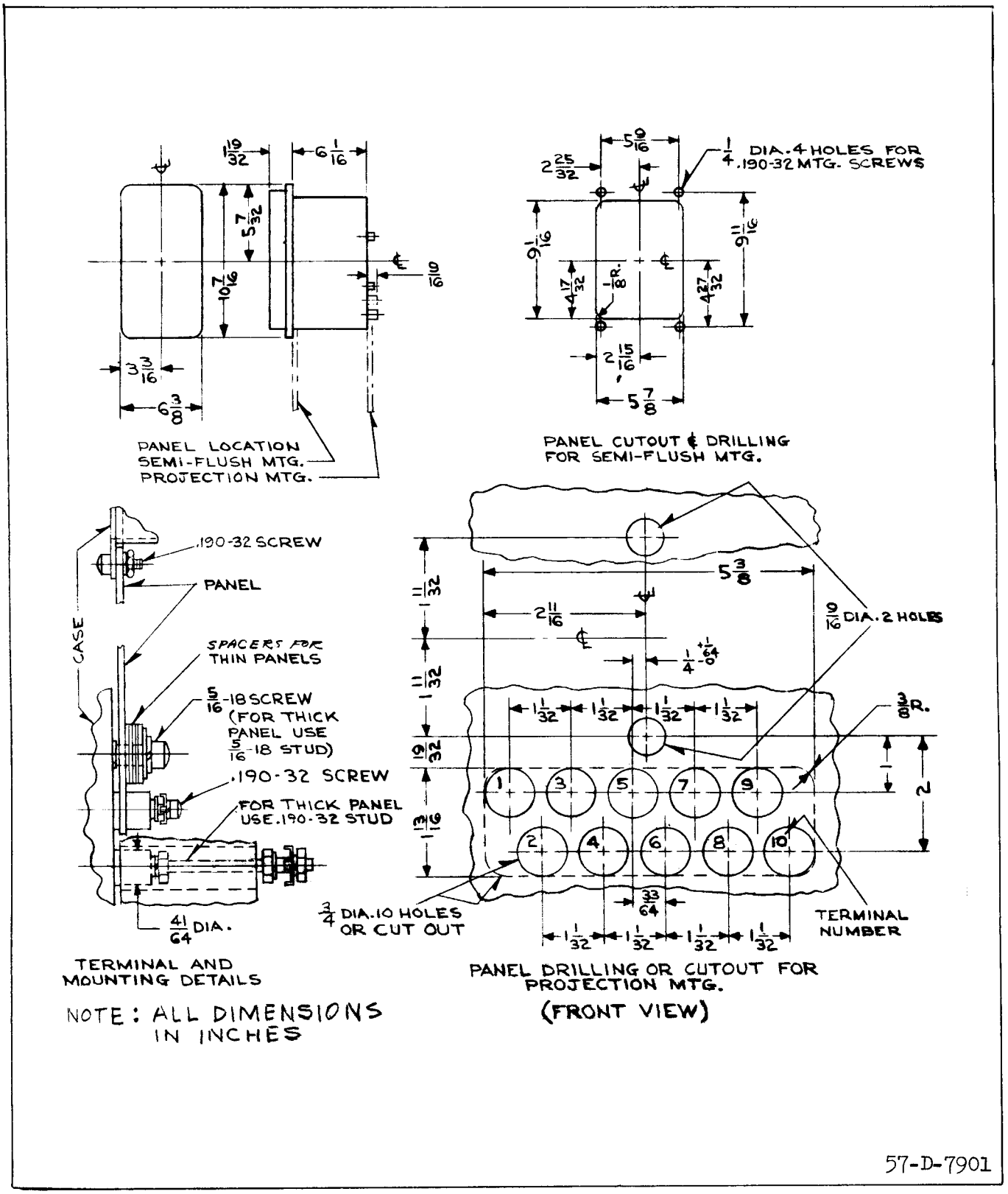


Fig. 9. Outline and Drilling Plan for the Type D-3 Relay in the Type FT21 Case.

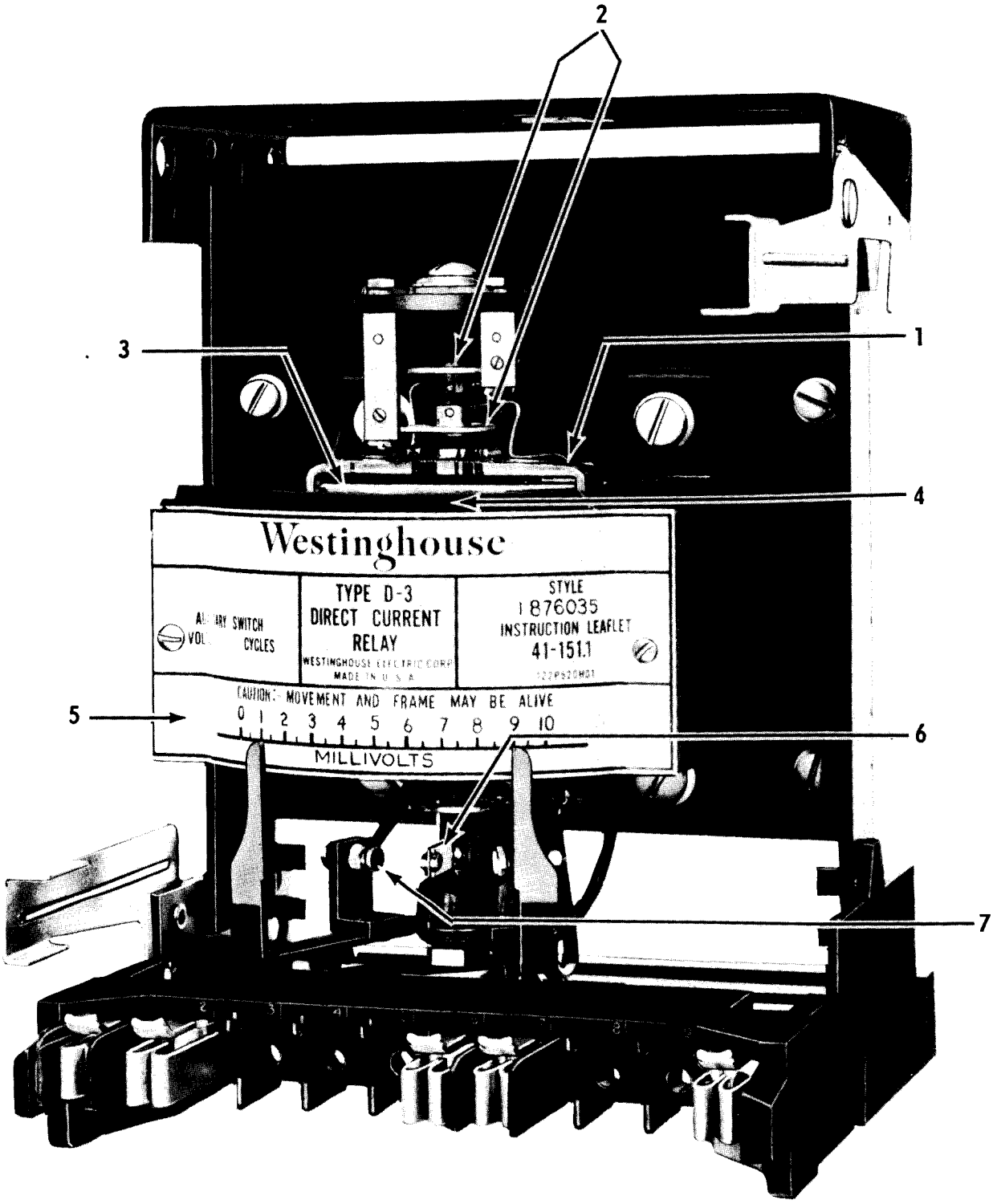


Fig. 10. Type D-3 Relay without Case. 1-Moving Coil. 2-Current-carrying restraining springs. 3-Permanent Magnet. 4-Iron-Frame. 5-Scale. 6-Moving Contact. 7-Stationary Contacts.

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TYPE D-3 DIRECT CURRENT RELAY

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APPLICATION

The type D-3 relay is suitable for applications where overload, underload, or reverse-current protection is required on direct current circuits. One particular application is in the protection of rotary converters which require sensitive reverse-current relays to prevent running inverted.

In the usual application of the D-3 relay the moving coil is connected to a shunt in the circuit being protected. By suitable selection of relay calibration and of shunt rating, the relay can be made to respond to particular magnitudes or directions of current flow through the shunt as required.

In applications where the D-3 relay is used for the purpose of regulating a load, closing of the overload contacts will initiate action to reduce the amount of the load. Since the relay is very sensitive, a slight reduction in load will cause the overload contacts to open. If the reduction of load is interrupted, the relay will close contacts again on a small load increase. Thus small load fluctuations might cause excessive operation of the relay and the device controlled by it. The connections of Fig. 5 show the use of an external auxiliary relay (type SG) to keep the controlled device energized until the load has dropped by an amount determined by the setting of the left-hand contact of the D-3 relay. Fig. 6 shows how this feature has been added to some styles.

CONSTRUCTION

The type D-3 relay is a d'Arsonvol type d.c. contact making voltmeter consisting of a moving coil, permanent magnet, and contacts. The magnetic circuit is shown schematically in Fig. 1.

Permanent Magnet

The permanent magnet is a cylindrical core, consisting of an Alnico permanent magnet, two iron pole pieces and two brass spacer blocks. This magnet is mounted concentrically in the bore of a mallable iron frame.

A magnetic field is produced by the permanent magnet in the air gap between the magnet and the iron frame. The path of magnetic flux is from the Alnico magnet through the iron pole piece across the air gap to the iron frame. The return path of the flux is through the frame across the second air gap to the second pole piece. The pole pieces and the bore of the frame are shaped such that a uniform flux distribution is obtained in the air gaps.

Moving Coil

The moving coil rotates in the air gap between the core and the iron frame. Electrical connections are made to the coil through two springs located at the top of the element. One end of each spring is connected through a lever arm to a head of the coil. The other end of each spring is fastened to posts mounted in a circular insulation plate. This plate can be rotated to permit adjustment of the zero position of the moving element.

A third spiral spring located at the bottom of the element provides a current path to the moving contact.

Auxiliary Switch (CS-1) (When Used)

The auxiliary switch is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts.

* Operation Indicator (When Used)

The operation indicator consists of a small solenoid coil mounted in a steel frame, a spring restrained armature and a white flag. The indicator is reset by a push rod in the cover.

OPERATION

The D-3 relay operates on the principle of a cur-

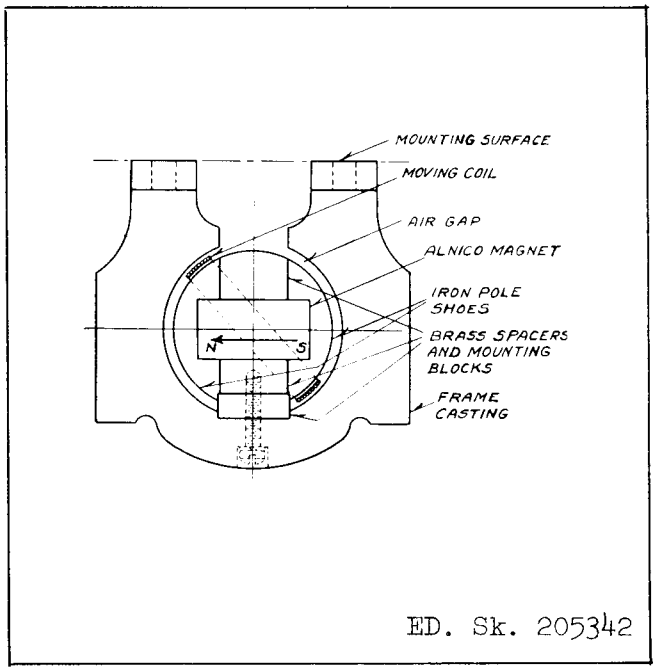
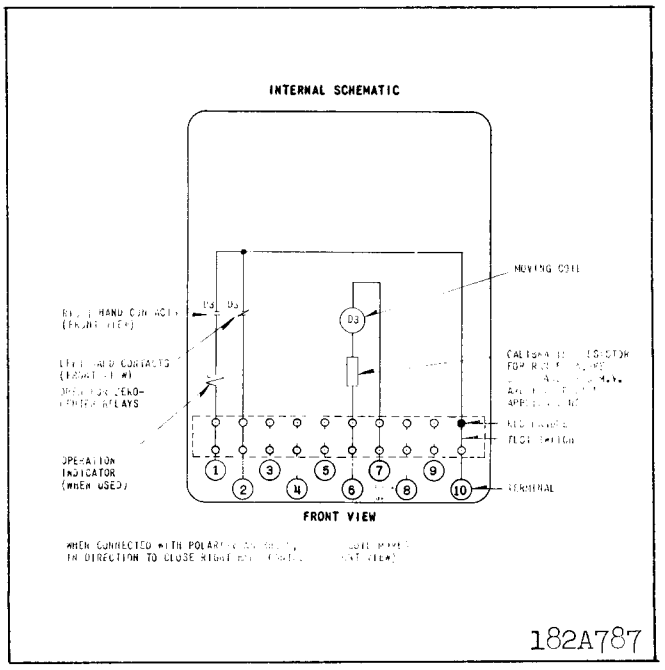


Fig. 1. Schematic Drawing of Magnetic Circuit of Type D-3 Relay (Top View). Moving Coil Bearing Supports, Springs and Contacts Omitted.



* *Fig. 2. Internal Schematic of the Type D-3 Relay in the Type FT21 Case.*

rent carrying conductor (moving coil) located in a magnetic field (permanent magnet). When a current is applied to the coil of the relay, a torque is produced that rotates the moving coil until the electrical torque is equal to the torque of the restraining spring. The moving contact will assume a position in its travel that is proportional to the current applied to the moving coil.

The direction of movement of the moving coil is determined by the polarity of the current applied to the coil. In the "left zero" and "suppressed zero" D-3 relays, the contacts will move to the right when a current of the proper magnitude and polarity is applied to the relay. On the other hand, the contact of the "center zero" relay will move either left or right depending on the polarity and magnitude of the applied current.

CHARACTERISTICS

The type D-3 relay is supplied in the standard ranges listed in the table below. The numbers on the scale indicate in millivolts the potential required at the relay base terminals to operate the moving element to the indicated scale position.

MOVING COIL CIRCUIT

Ranges in Millivolts, d-c	Average Resistance in Ohms at 25°C
0-10	0.3
5-0-5	0.3
40-80	1.2
100-0-100	6.0
0-200	6.0

* Other ranges can also be supplied.

As shown in the above Table, the D-3 relay is available with a "left zero," "suppressed zero" and "center zero" scale. In the "left zero" and the "suppressed zero" relays the moving contact is located in the extreme left hand position of the scale when the relays are deenergized. The "suppressed zero" relay is held in this position with considerable more force than the "left zero" relay. When the relays are energized with voltages of the proper magnitude and polarity, the moving contact moves to the right.

In the "center zero" relay, the moving contact is located in the center of the scale when the relay is deenergized. When the relay is energized, the contact will move either to the right or left depending upon the polarity of the applied voltage.

A modification of the D-3 relay, in which a rectifier is mounted internally, makes it suitable for a.c.

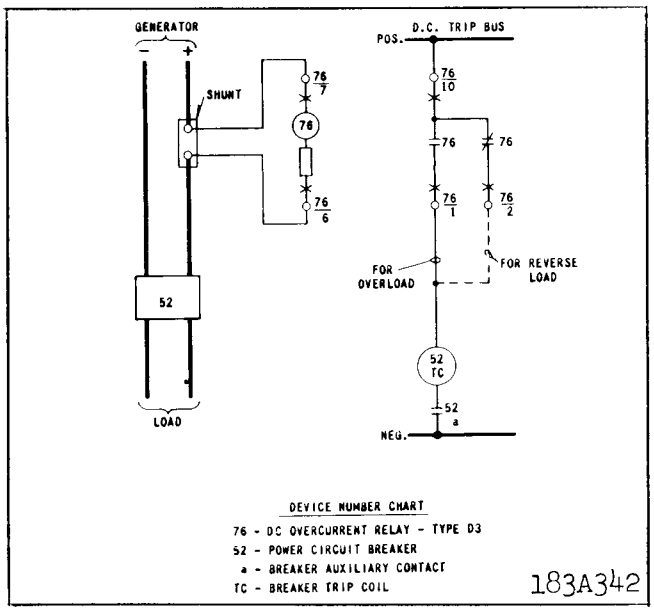


Fig. 3. External Schematic Diagram for Overload or Reverse Current Protection, using the Type D-3 Relay.

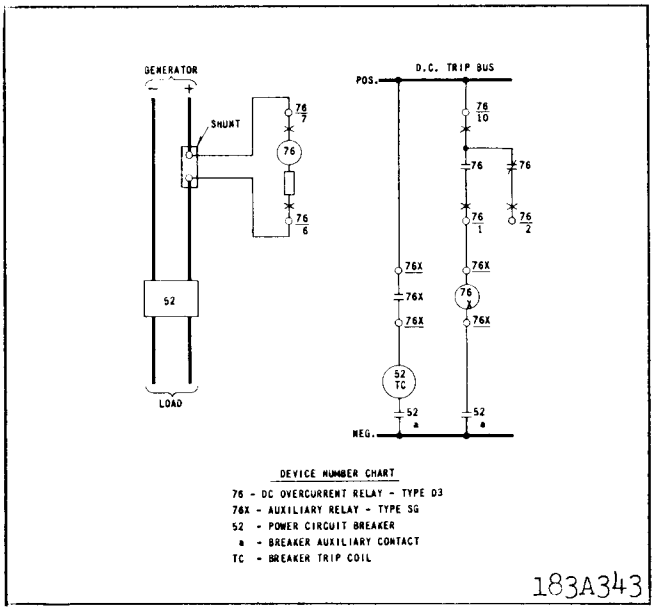


Fig. 4. External Schematic Diagram for Overload Protection where Trip Currents in Excess of One Ampere Rating Require Use of an Auxiliary Relay.

operation. Full scale deflection can be obtained with * 6 milliamperes a.c. Relays modified for AC volts can also be supplied.

The relay has a slight time-delay, with inverse characteristics. In the usual application the moving coil terminals are connected across a shunt, and this results in longer delay for both operating and reset times. When a shunt is used the operating time for full scale travel at 125% of the full scale operating current is about 4 seconds, while at 1000% it is about .25 second. In applications where no shunt is used, the operating times for the same conditions are about 1.25 and .15 second respectively. When the relay is de-energized, the time required for it to reset from the full scale position to the 10% position is approximately 5 seconds when a shunt is used, and 2 seconds when there is no shunt.

Continuous maximum overload is approximately 1500% of full scale.

The minimum setting which D-3 Relay can accommodate is 5% of the full scale.

SETTINGS

For reverse-current protection a sensitivity of 2 per cent is obtained when using a standard 50 millivolt shunt and setting the relay at 1 millivolt. A 10 per cent sensitivity is obtained by setting the relay at 5 millivolts. These values of sensitivity can be doubled by using a 100 millivolt shunt.

For overload protection the relay is set at the index setting which, with respect to the millivolt drop of the shunt, will operate at desired per cent of overload.

TRIP CIRCUIT

		amperes contacts will: (non-inductive load)		
contacts	d-c control voltage	open	close	carry continuously
D-3 relay	125 v	0.04♦	1.0	....
	250 v	0.02♦	1.0	....
contactor switch (when supplied)	125 v	3.5	30	5.0
	250 v	1.0	30	5.0

♦ infrequent operation

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

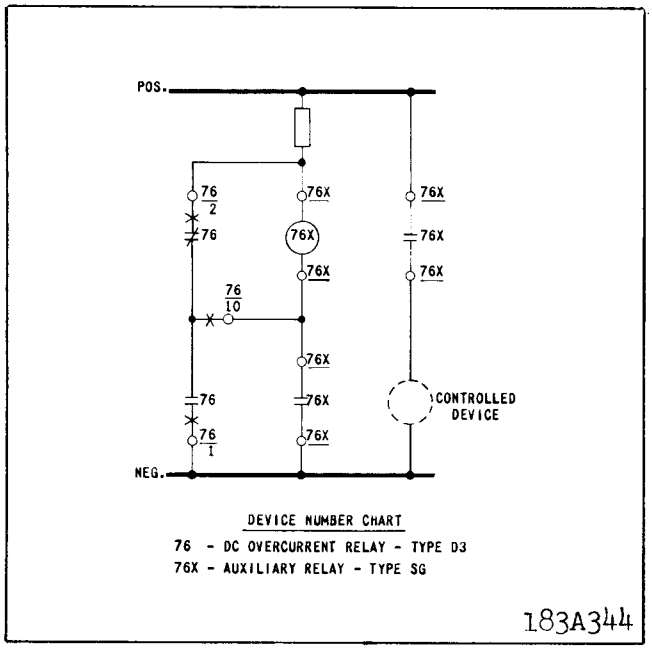
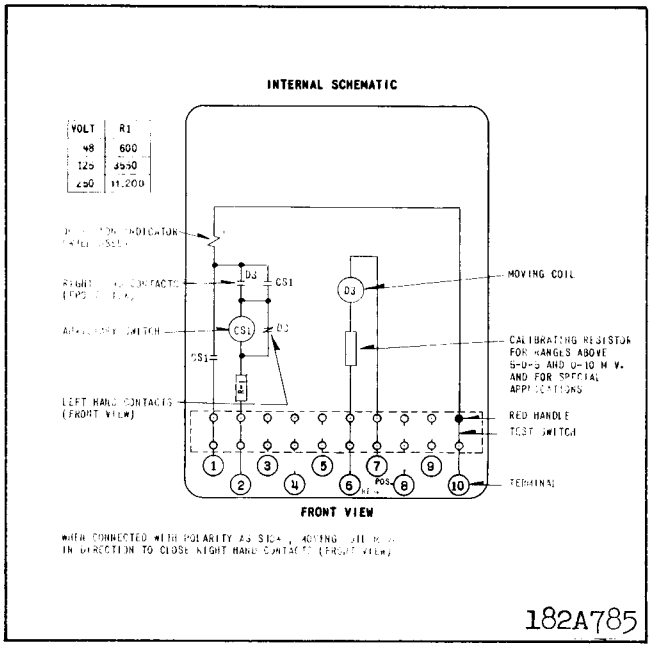


Fig. 5. External Schematic Diagram for Use of External Auxiliary Relay to Prevent Pumping of the Type D-3 Relay when used for Overload Protection.



* *Fig. 6. Internal Schematic of the Type D-3 Relay in the Type FT21 Case with Self-Contained Auxiliary Relay used to Prevent Pumping on Overload Protection.*

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.

Standard D-3 relays are calibrated in millivolts measured at the relay terminals. Hence, the resistance of the leads between the relay and the ammeter shunt must be sufficiently low to avoid introducing an excessive error in the relay indication. With the 0-10 or 5-0-5 millivolt relays, leads 8 feet long of #10 B&S gauge copper wire will reduce the relay indication by approximately 5%. If the lead length is less or the conductor size is larger, the error will be correspondingly reduced. Relays with higher millivolt ranges have proportionally greater internal resistances, and consequently error due to lead resistance is reduced. For example, a 0-100 millivolt relay with leads as described above would have an error of 0.5% due to lead resistance.

The use of standard ammeter shunts may be avoided by connecting the moving element leads over an equivalent length of bus-bar or cable. On a basis of 1000 amp. per square inch, at 20°C., 6 feet of copper bus-bar will give 50 millivolts drop.

ADJUSTMENTS AND MAINTENANCE

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

Acceptance Check

Check the scale markings by setting either of the two adjustable contacts at a value marked on the scale. Then alternately apply this voltage plus and minus 3%. The contacts should make and break.

Remove the adjustable contact from the setting and set the second adjustable contact at the same point on the scale. Alternately apply this voltage plus and minus 3%. The contacts should make and break.

Routine Maintenance

All contacts should be cleaned periodically. 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.

If the moving element should be removed, the bearing end-play should be checked when replacing it.

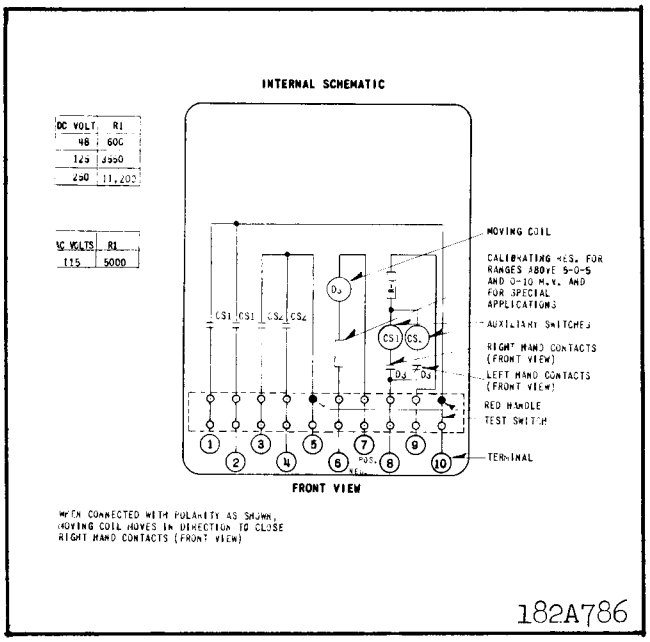


Fig. 7. Internal Schematic of the Type D-3 in the Type FT21 Case with Two Self-Contained Auxiliary Relays used to Increase Contact Capacity.

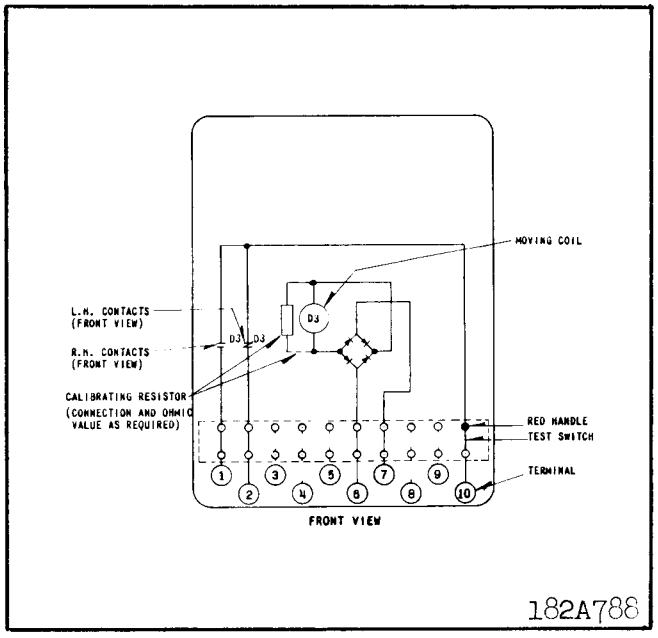


Fig. 8. Internal Schematic of the Type D-3 Relay in the Type FT21 Case, Modified for A-C Operation.

This should be from .020 inch to .025 inch, and can be measured by inserting a feeler gauge between the upper bearing screw and the shoulder on the moving element shaft.

The core and moving coil assembly should not be removed from the frame casting of the D-3 relay unless a keeper having the same radius on the core is placed on the core in such manner as to bridge the iron pole pieces as the core is withdrawn from the bore of the casting. It is necessary also to insert spacers in the air gap so that the core will remain approximately centered when the mounting screws are removed, to prevent damaging the coil winding when sliding the assembly out of the casting.

Auxiliary Switch (CS-1)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be done by turning the relay upside-down. Then screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/64" by means of the two small nuts on either side of the Micarta disc.

Block main contacts closed and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make.

Operation Indicator

The operation indicator (when used) consists of a small solenoid coil mounted in a steel frame, a spring restrained armature and a white flag. The indicator is reset by a push rod in the cover. Block the CS-1 auxiliary relay contacts closed and pass 0.2 amperes AC or DC through the indicator. The white target should fall into view.

The coil has a dc resistance of approximately 2.8 * ohms and a continuous current carrying capacity of 0.6 amperes.

REPAIRS AND 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.

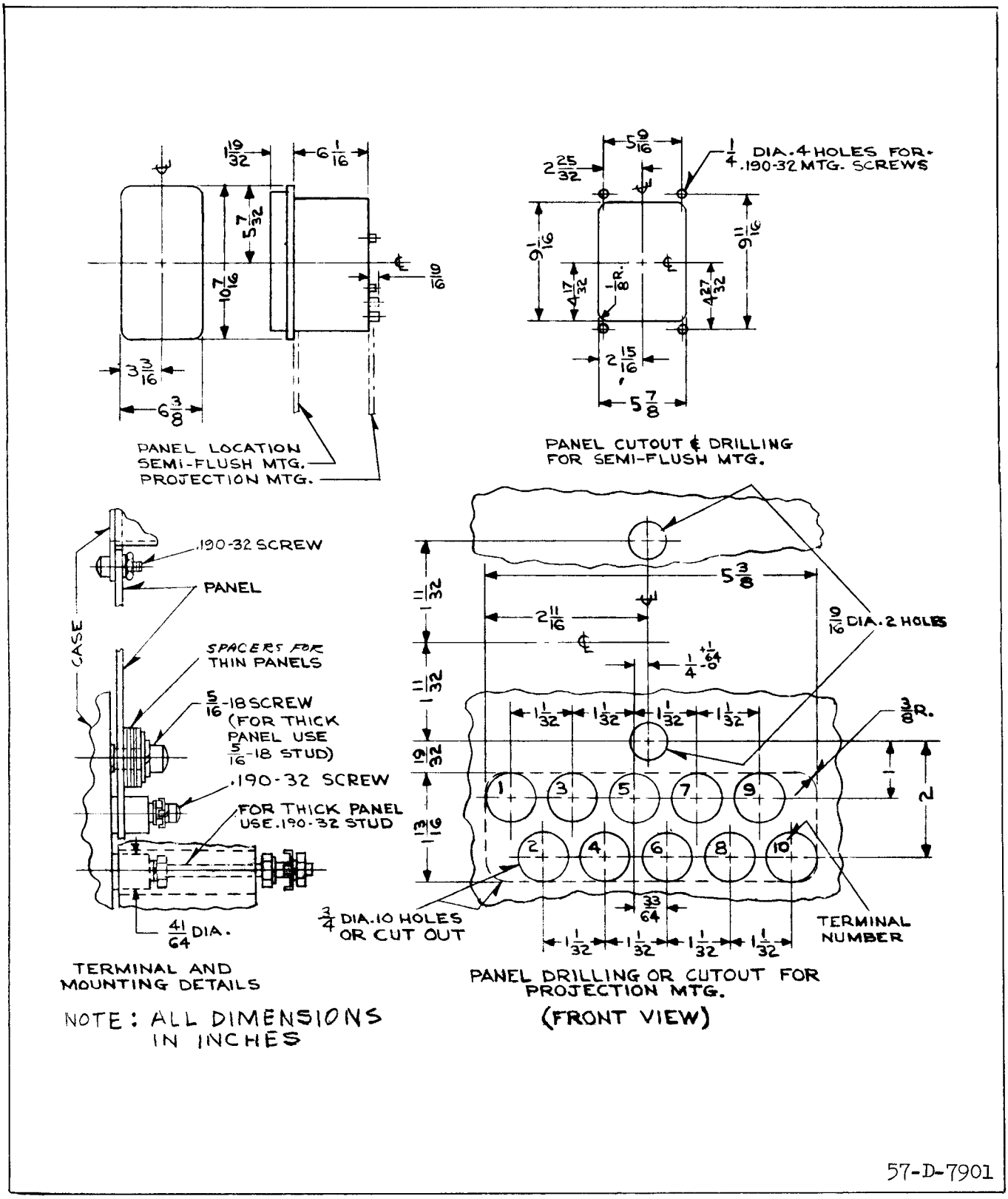


Fig. 9. Outline and Drilling Plan for the Type D-3 Relay in the Type FT21 Case.

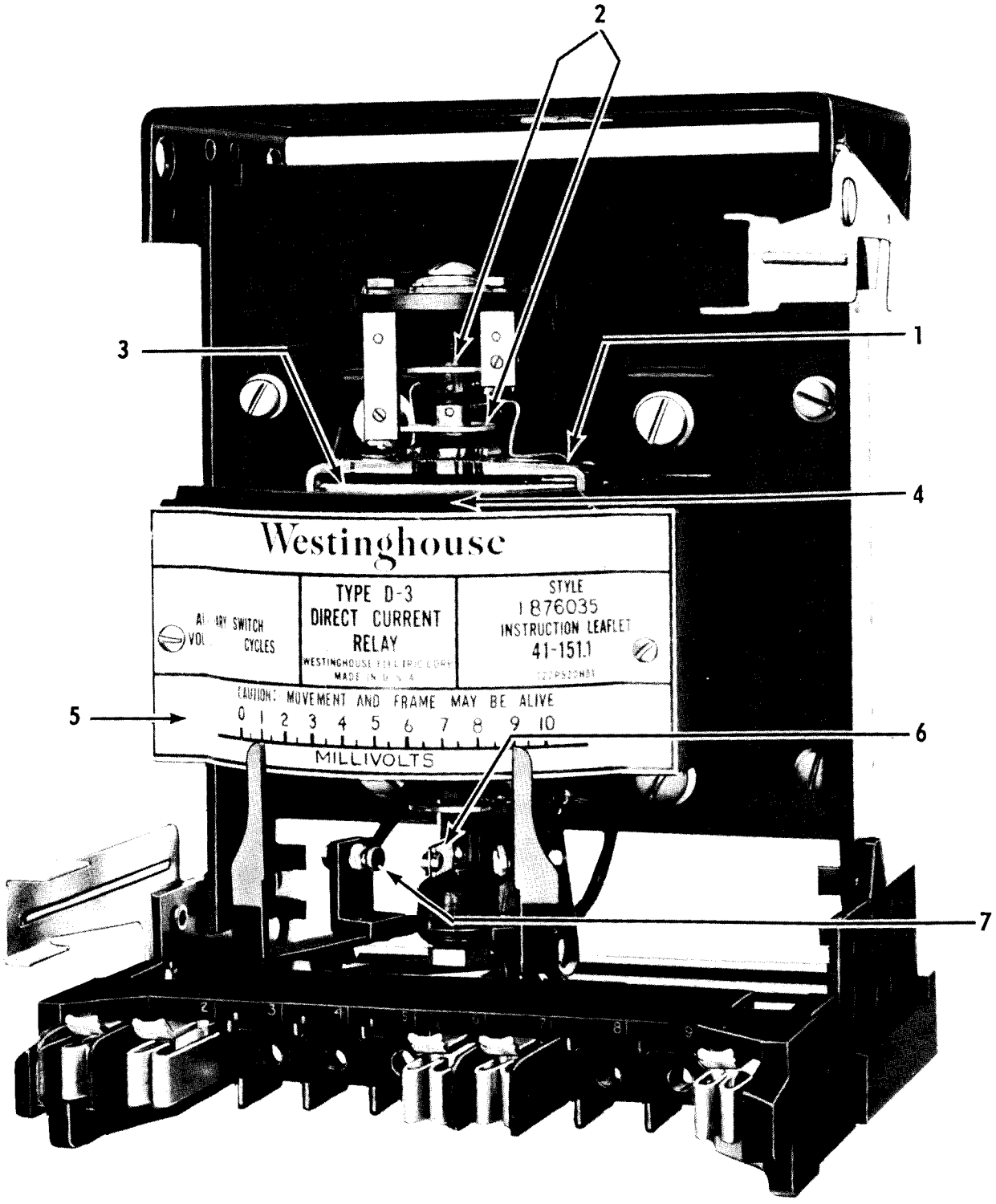


Fig. 10. Type D-3 Relay without Case. 1-Moving Coil. 2-Current-carrying restraining springs. 3-Permanent Magnet. 4-Iron-Frame. 5-Scale. 6-Moving Contact. 7-Stationary Contacts.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE D-3 DIRECT CURRENT 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 D-3 relay is suitable for applications where overload, underload, or reverse-current protection is required on direct current circuits. One particular application is in the protection of rotary converters which require sensitive reverse-current relays to prevent running inverted.

The type D-3 relay has a permanent magnet field and consequently it is free from the variations in operating point that would result from fluctuations in the voltage source if an electromagnet field were used.

CONSTRUCTION AND OPERATION

The type D-3 relay is a d'Arsonval type d-c contact making milliammeter. The magnetic circuit is shown schematically in Fig. 1. A cylindrical core, consisting of an Alnico permanent magnet, two iron pole pieces and two brass spacer blocks, is mounted concentrically in the bore of a malleable iron frame casting. The moving coil rotates in the air gap between the core and the frame casting. A Moldarta bracket mounted on the rear of the core carries bearings for the frame on which the moving coil is wound, and also provides connection points for the spiral springs through which electrical connection is made to the moving contact and the moving coil. The two

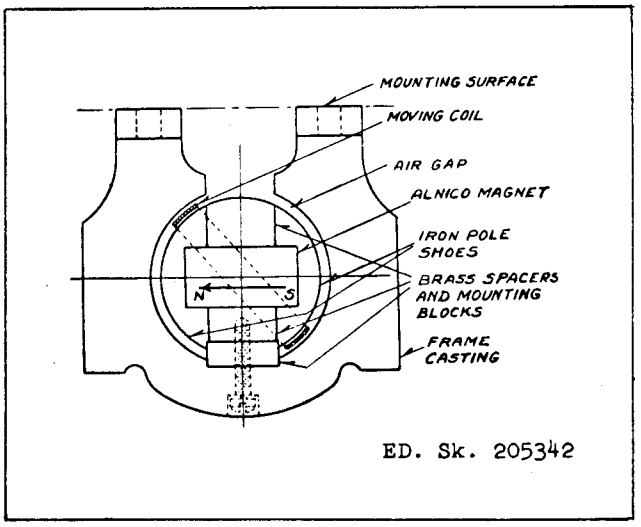


Fig. 1. Schematic Drawing of Magnetic Circuit of Type D-3 Relay (Top View). Moving Coil Bearing Supports, Springs and Contacts Omitted.

springs which are connected to the moving coil are located at the top of the element. The outer ends of these springs are fastened to posts mounted in a circular insulating plate. This plate is mounted on the Moldarta bracket by means of the upper bearing screw and a spring washer, so that it is held in position securely, but yet can be rotated to permit adjustment of the zero position of the moving element.

The moving contact is mounted on the outer end of a counterbalanced arm fastened to the bottom of the moving coil shaft. Current is introduced into this contact by the third spiral spring. On either side, a stationary contact arm is fastened to the frame. Each of these stationary contacts is adjustable in a small arc and an upright guide arm indicates its position relative to a calibrated scale on the lower part of the nameplate. Relays for certain special applications are provided with a pointer, which is fastened to the contact

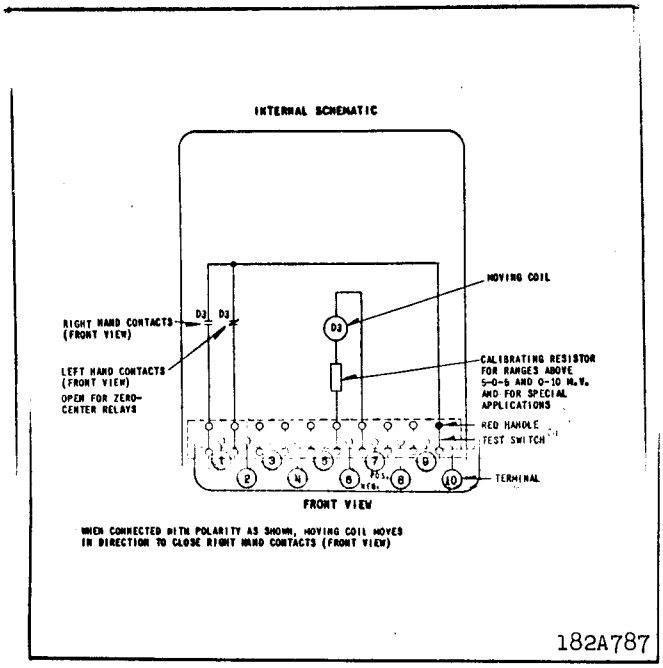


Fig. 2. Internal Schematic of the Type D-3 Relay in the Type FT21 Case.

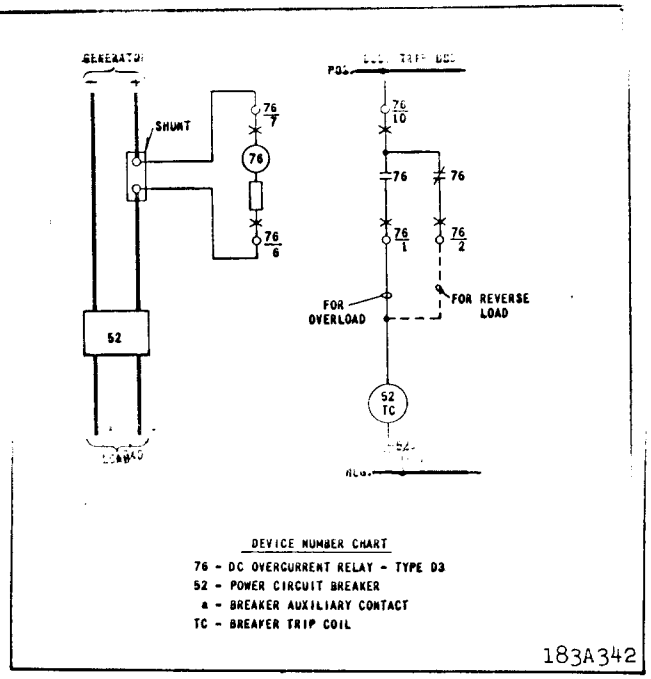


Fig. 3. External Schematic Diagram for Overload or Reverse Current Protection, using the Type D-3 Relay.

arm and moves in front of the calibrated scale.

A screw containing a sapphire thrust bearing and a ring guide bearing is mounted in the lower bearing support of the moving element. The inverted position of this bearing screw prevents dirt particles from falling into it. A guide bearing only is provided at the top of the moving element, but the bearing pin is the lower of the two bearing members here also.

Type D-3 Relay

In the usual application of the D-3 relay the moving coil is connected to a shunt in the circuit being protected. Thus, by suitable selection of relay calibration and of shunt rating, the relay can be made to respond to particular magnitudes or directions of current flow through the shunt as required.

When the relay is calibrated to have a zero center the stationary adjustable contacts may be set to permit the moving contacts to move either right or left depending on the polarity. In all other standard relays the moving contact and one stationary contact are normally making at zero current. With proper polarity the contacts close to the opposite side.

The relay contacts will close a circuit carrying one ampere, but they should not be used to open an appreciable current. Fig. 3 shows a typical external schematic diagram for overload or reverse current protection using the type D-3 relay. These diagrams are for applications in which the trip coil current is within the capacity of the relay contacts. For larger tripping currents an auxiliary relay should be interposed, as shown in Fig. 4. In all cases an auxiliary contact on the circuit breaker must be provided to open the tripping circuit when the breaker opens.

In applications where the D-3 relay is used for the purpose of regulating a load rather than for circuit interruption upon the occurrence of predetermined overload, closing of the overload contacts will initiate action to reduce the amount of the load. Since a very slight reduction in the load will cause the overload contacts to open, if this interrupted the reduction of load the relay would close contacts again on a small load increase.

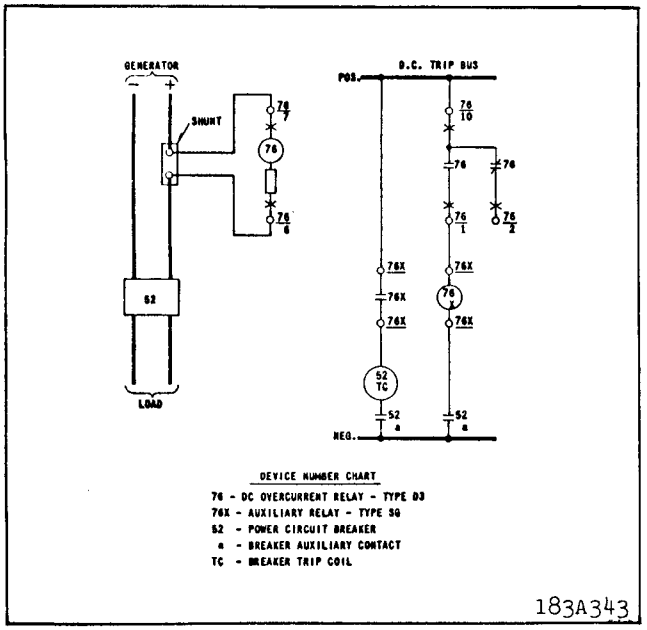


Fig. 4. External Schematic Diagram for Overload Protection where Trip Currents in Excess of One Ampere Rating Require Use of an Auxiliary Relay.

Thus small load fluctuations might cause excessively frequent operation of the relay and the device controlled by it. The connections of Fig. 5 show the use of an external auxiliary relay (type SG) to keep the controlled device energized until the load had dropped by an amount determined by the setting of the left-hand contact of the D-3 relay.

An auxiliary relay, consisting of a standard d.c. contactor switch except with voltage coil, can be mounted inside the D-3 relay case for such an application if the smaller contact capacity is suitable. Fig. 6 shows the internal connections of type D-3 relay so equipped.

In applications where it is desired to handle currents above the capacity of the D-3 contacts but within the capacity of the contactor switch, two of these switches can be mounted inside the relay case, as indicated by Fig. 7. An internal resistor is required in series with the contactor switch coils for most control voltages, since the winding space is not sufficient for the winding of a self-contained coil for voltages higher than about 40 volts.

A modification of the D-3 relay, in which a small Rectox rectifier is mounted internally, makes it suitable for certain A-C applications. Full scale deflection can be obtained at a relay current of 5 milliamperes or less. By using a suitable external series resistor, the relay scale can be calibrated in volts. The internal connections of this relay are shown in Fig. 8.

CHARACTERISTICS AND SETTINGS

The type D-3 relay is supplied in the standard ranges listed in the table below. The numbers on the scale indicate in millivolts the potential required at the relay base terminals to operate the moving element to the indicated scale position.

MOVING COIL CIRCUIT

Ranges in Millivolts, d-c	Average Resistance in Ohms at 25°C
0-10	0.3
5-0-5	0.3
40-80	1.2
100-0-100	6.0
0-200	6.0

Relays calibrated for other millivolt ranges may be supplied on special order, and for a particular rating of shunt it is possible to calibrate the scale in amperes. It is possible also to connect the moving coil across a potential source in series with a suitable external resistor, and the scale may be calibrated in volts for such an application.

For reverse-current protection a sensitivity of 2 per cent is obtained when using a standard 50 millivolt shunt and setting the relay at 1 millivolt. A 10 per cent sensitivity is obtained by setting the relay at 5 millivolts. These values of sensitivity can be doubled by using a 100 millivolt shunt.

For overload protection the relay is set at the index setting which, with respect to the millivolt drop of the shunt, will operate at desired per cent of overload.

The relay has a slight time-delay, with inverse characteristics. In the usual application the moving coil terminals are connected

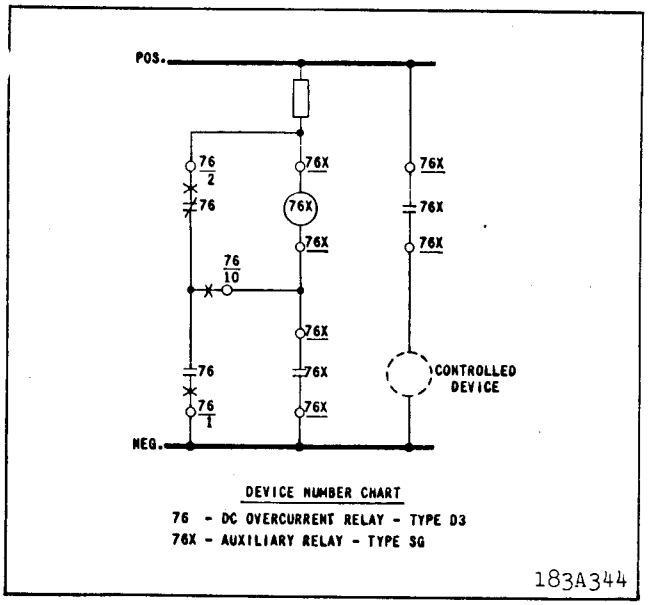


Fig. 5. External Schematic Diagram for Use of External Auxiliary Relay to Prevent Pumping of the Type D-3 Relay when used for Overload Protection.

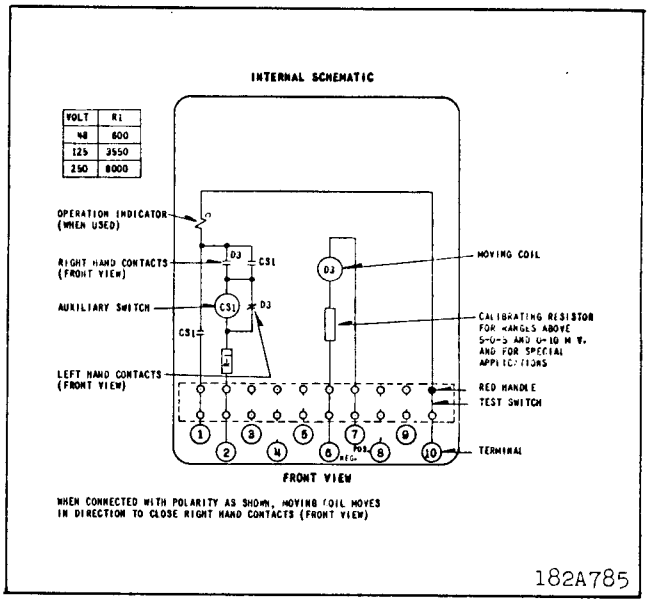


Fig. 6. Internal Schematic of the Type D-3 Relay in the Type FT21 Case with Self-Contained Auxiliary Relay used to Prevent Pumping on Overload Protection.

across a shunt, and this results in longer delay for both operating and reset times. When a shunt is used the operating time for full scale travel at 125% of the minimum operating current is about 4 seconds, while at 1000% it is about .25 second. In applications where no shunt is used, the operating times for the same conditions are about 1.25 and .15 second respectively. When the relay is de-energized, the time required for it to reset from the full scale position to the 10% position is approximately 5 seconds when a shunt is used, and 2 seconds when there is no shunt.

INSTALLATION

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

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

Standard D-3 relays are calibrated in millivolts measured at the relay terminals. For relays with low millivolt scales, such as 0.10 or 5-0-5- millivolts, the resistance of the leads between the relay and the ammeter shunt must be sufficiently low to avoid introducing an excessive error in the relay indication. With the 0-10 or 5-0-5 millivolt relays, leads 8 feet long of #10 B&S gauge copper wire will reduce the relay indication by approximately 5%. If the lead length is less or the conductor size is larger, the error will be correspondingly reduced. However, relays with higher millivolt ranges have proportionally greater internal resistances, and consequently error due to lead resistance is reduced. For example, a 0-100 millivolt relay with leads as described above would have an error of only 0.5% due to lead resistance.

The D-3 relay may be used as a sensitive reverse-current relay, and in such an application it may be subjected to considerable continuous overload with current in the normal

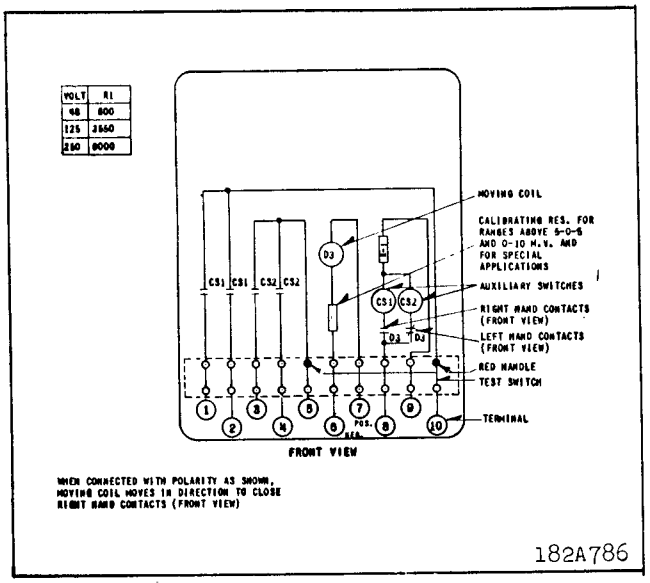


Fig. 7. Internal Schematic of the Type D-3 in the Type FT21 Case with Two Self-Contained Auxiliary Relays used to Increase Contact Capacity.

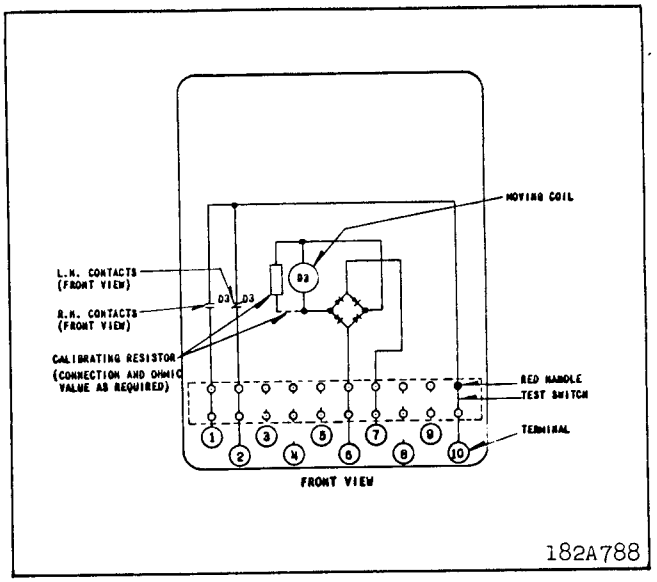


Fig. 8. Internal Schematic of the Type D-3 Relay in the Type FT21 Case, Modified for A-C Operation.

direction. The 0-10 and 5-0-5-millivolt relays may be connected to a shunt which will produce a drop as high as 150 millivolts at full load. In the higher millivolt ranges, the capacity of the internal resistor will limit the percent overload capacity to a lower value.

The use of standard ammeter shunts may be avoided by connecting the moving element leads over an equivalent length of bus-bar or cable. On a basis of 1000 amp. per square inch, at 20°C., 6 feet of copper bus-bar will give 50 millivolts drop.

ADJUSTMENTS AND MAINTENANCE

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

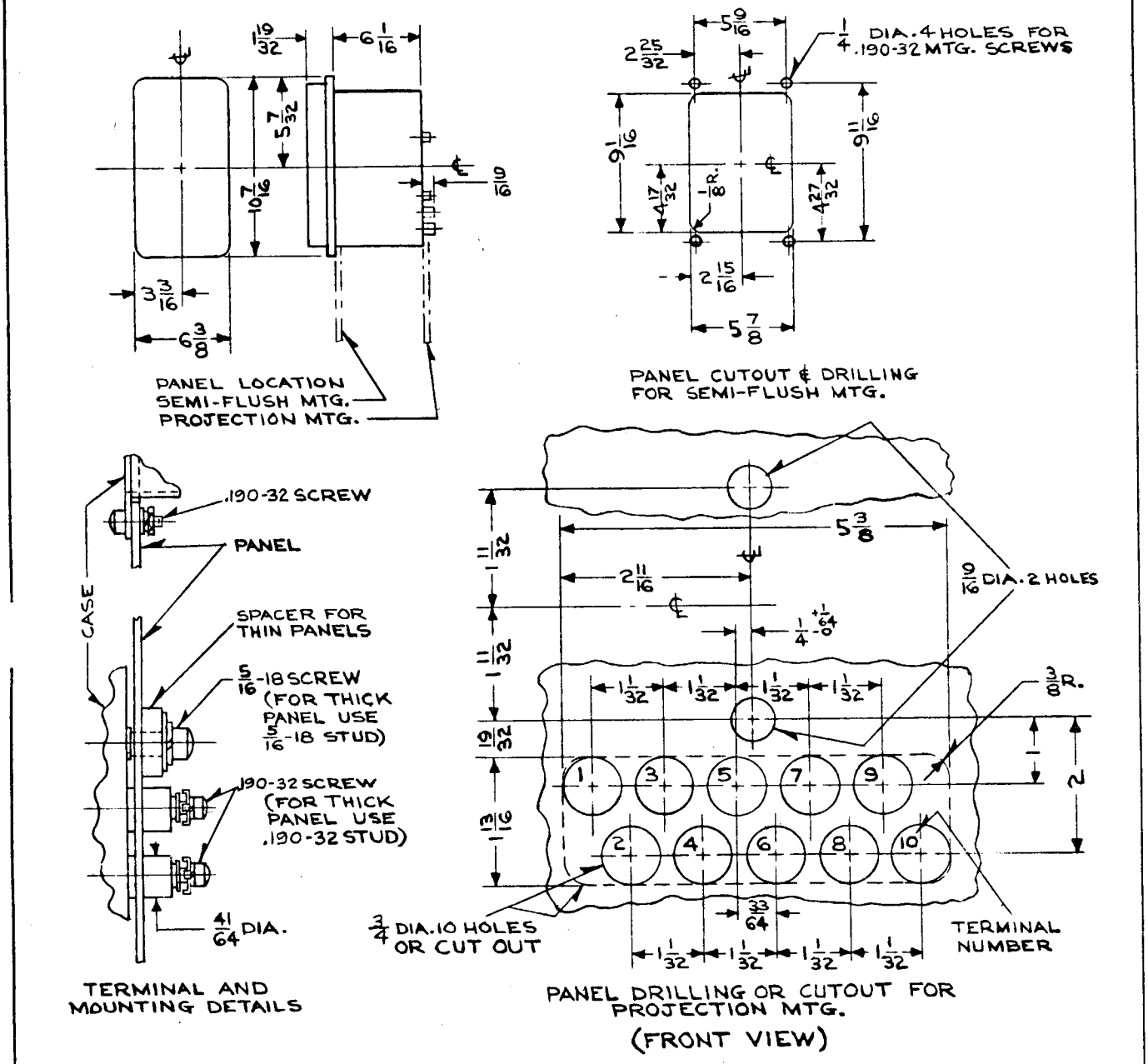
All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

If the moving element should be removed, the bearing end-play should be checked when replacing it. This should be from .020 inch to .025 inch, and can be measured by inserting a feller guage between the upper bearing screw and the shoulder on the moving element shaft.

The core and moving coil assembly should not be removed from the frame casting of the D-3 relay unless a keeper having the same radius on the core is placed on the core in such manner as to bridge the iron pole pieces as the core is withdrawn from the bore of the casting. It is necessary also to insert spacers in the air gap so that the core will remain approximately centered when the mounting screws are removed, to prevent damaging the coil winding when sliding the assembly out of the casting. The factory assembly is made before the magnet has been magnetized, and the complete assembly is placed between the poles of a magnetizer which produces a field sufficiently strong to saturate both the magnet and the frame casting. This avoids the necessity of using magnet keepers and simplifies the assembly.

REPAIRS AND 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.



NOTE: ALL DIMENSIONS
IN INCHES

57-D-7901

Fig. 9. Outline and Drilling Plan for the Type D-3 Relay in the Type FT21 Case.