INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE HVS-SINGLE-PHASE-TO-GROUND FAULT-DETECTOR 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 HVS relay is intended for use as a supervising relay operating in conjunction with the ground relay in a differential protection scheme. In the application of sensitive ground differential relays to systems grounded through a relatively large impedance, the problem of false tripping sometimes arises. This is due to the erroneous response of the current transformers on heavy external phase-to-phase or two-phase-to-ground faults, particularly when there is a d-c transient. The type HVS relay will prevent this false tripping by blocking out the ground relay on every type of fault except single-phase-to-ground.

The relay is applicable on those systems where the zero-sequence impedance of the system up to the bus where the relay is applied exceeds the negative-sequence impedance by a reasonable margin. The characteristics of the relay are such that a ratio of zero-sequence impedance to negative-sequence impedance equal to or greater than 2/1 will permit satisfactory operation.

CONSTRUCTION

The type HVS relay consists of a negative-sequence filter, a zero-sequence filter, two Rectox rectifying units with series resistors, a sensitive permanent magnet type polar element, a contactor switch, and an operation indicator. These elements are connected as shown in Figure 1.

The negative-sequence and zero-sequence filter inputs are connected in parallel. The output of the negative-sequence filter is rectified by means of a full-wave Rectox rectifier, which has a current limiting resistor connected in series with it. The rectified output is applied to the restraining coil of the polar element. The output of the zero-sequence filter is rectified by means of a full-wave Rectox rectifier, which has a variable, current-limiting resistor connected in series with it. The rectified output of the zero-sequence filter is applied to the operating coil of the polar element.

The d-c. contactor switch in the relay 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. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

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

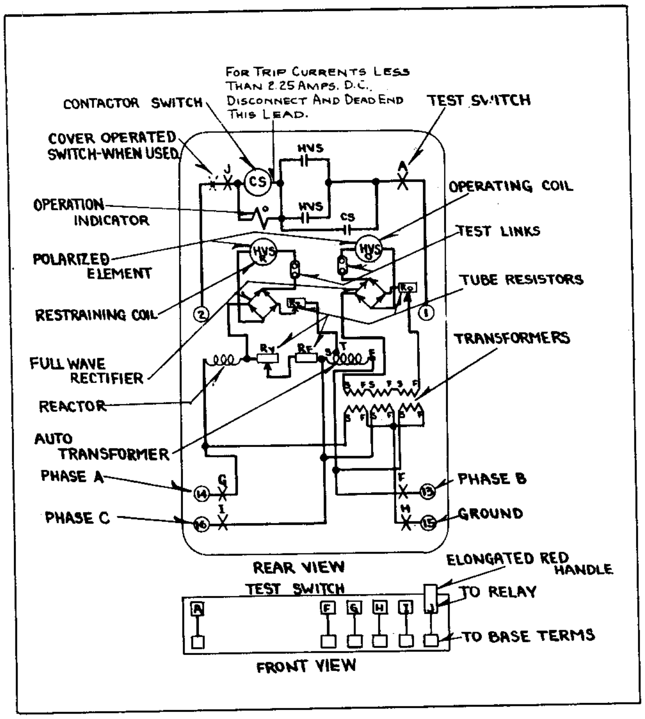

Fig. 1—Internal Schematic of The Type HVS Relay in The Type FT Case.

The negative-sequence filter consists of a reactor, resistors, and an auto transformer connected as shown in Figure 1.

The zero-sequence filter consists of three 2/1 transformers connected as shown in Fig. 1.

OPERATION

The type HVS relay operates in accordance with the magnitude of the negative-sequence voltage and the zero-sequence voltage at the bus. The contact-closing force in the relay is developed in proportion to the zero-sequence voltage, while the restraining force opposing contact closing is proportional to the negative-sequence voltage. In the event of a two-phase-to-ground fault, the relay will receive equal negative and zero-sequence voltages from potential transformers connected to the bus. In this case, the characteristics of the restraining and operating circuits will keep the relay from operating and the contacts will remain open.

During a single-phase-to-ground fault, the ratio of operating voltage to restraining voltage will be equal to the ratio of zero-sequence impedance, Z_0, to negative-sequence impedance, Z_2, of the source. If this ratio, Z_0/Z_2, is equal to or greater than 2/1 the operating force will overcome the restraining force and the relay contacts will close.

CHARACTERISTICS

Figure 2 shows a typical operating curve for the relay as it is calibrated at the factory. For operation with this calibration, the ratio Z_0/Z_2, of the system should be well above 2/1. In cases where the ratio of Z_0 to Z_2 is quite close to 2, relay operation will be more satisfactory if an adjustment of the shunts on the permanent magnet polar element is made so that the minimum trip point will occur at approximately 10% operating voltage instead of 20%. This adjustment will be discussed later.

RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover, and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that houses the relay elements and supports the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades.

Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches first before opening any of the black handle switches or the cam action

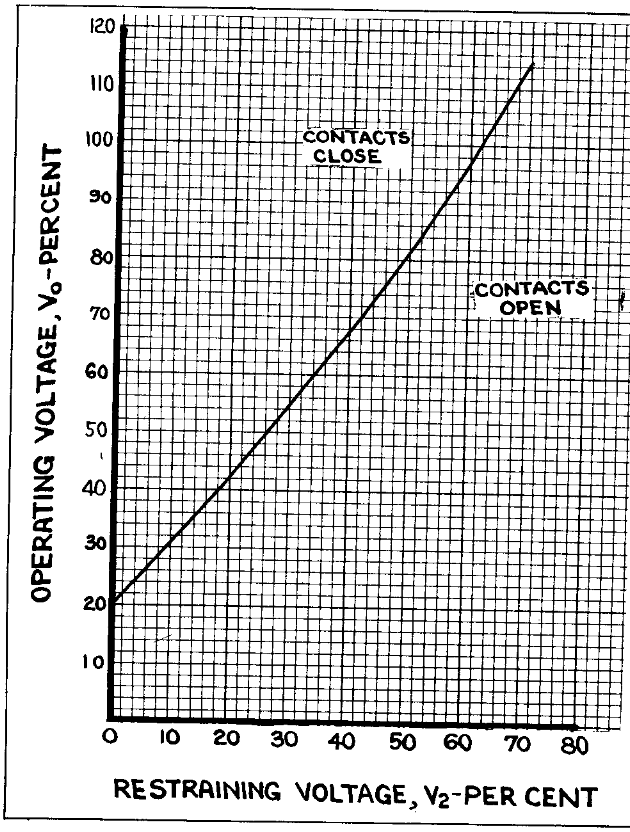

Fig. 2—Typical Operating Curve of The Type HVS Relay.

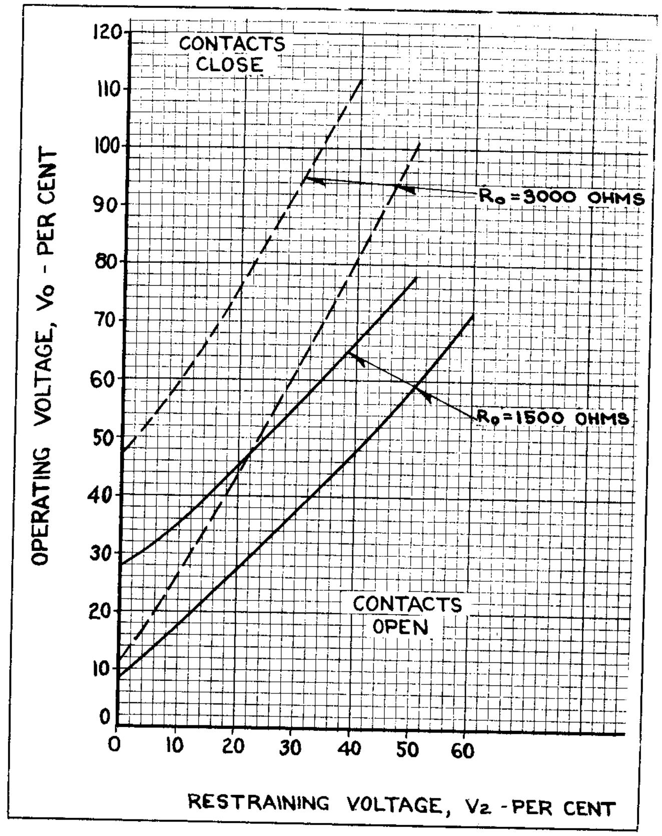

Fig. 3—Typical Range of Adjustment of The Type HVS Relay.

latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position for test as well as on its back or sides for easy inspection and maintenance.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis.

When the chassis is to be put back in the case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

Testing

The relays can be tested in service, in the case but with the external circuits isolated or out of the case as follows:

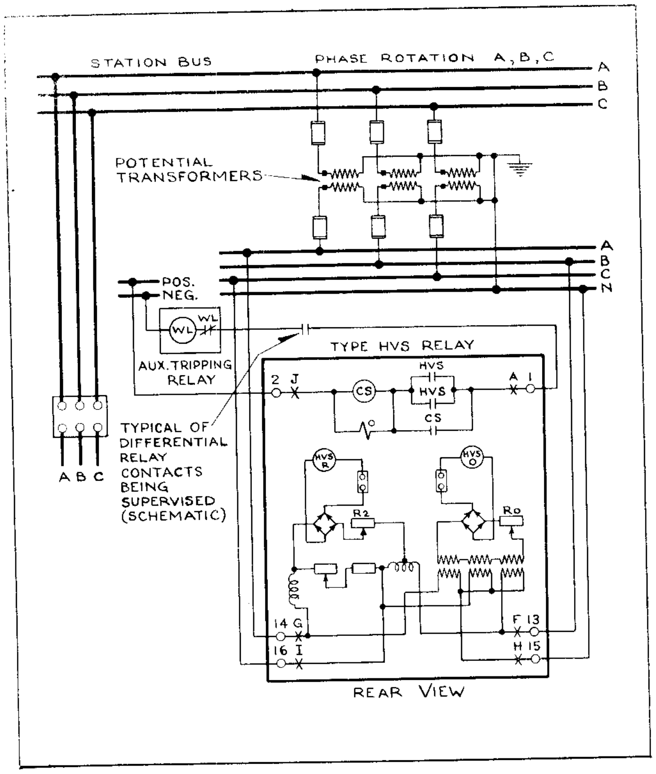

Fig. 4—External Connection of The Type HVS Relay.

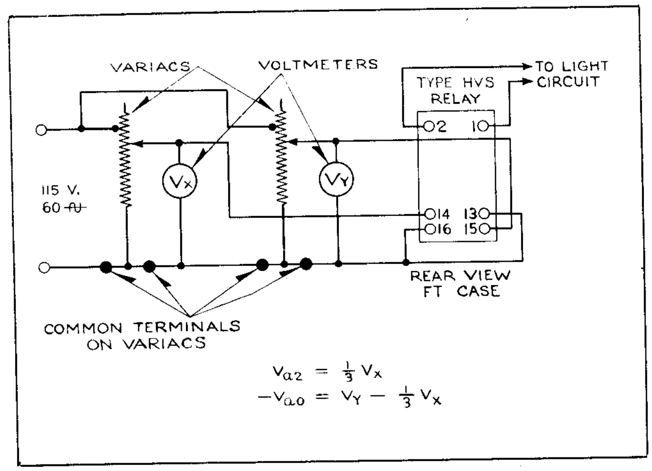

Fig. 5—Test Diagram of The Type HVS Relay.

Testing in Service

Voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

Testing in Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug.

Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values by a small percentage.

It is recommended that the relay be checked in position as a final check on the calibration.

INSTALLATION

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

The complete external connections are shown in Figure 4. The contacts of the differential relay are shown schematically. The details for the differential relay wiring are not shown, as these will depend upon the type of differential relay used.

The relay is shipped with the operation indicator and the contactor switch connected in parallel. This circuit has a resistance of approximately 0.25 ohm and is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil, remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead ended) under the small filister-head screw located on the Micarta base of the contactor switch. The operation indicator will operate for trip currents above 0.2 ampere d-c. The resistance of its coil is approximately 2.8 ohms.

When using the contactor switch, it is necessary that the auxiliary tripping relay have a suitable contact to interrupt the relay trip circuit.

INSTALLATION TESTS

After the relay has been connected as shown in Figure 4, a check should be made to assure proper wiring and phase rotation. Measure the a-c voltage across each Rectox unit and its series-connected resistor with a high resistance voltmeter. The voltage across the Rectox and resistor which are connected to the zero-sequence filter must be 2 volts or less. The voltage across the Rectox and resistor which are connected to the negative-sequence filter must be 2.5 volts or less (see instructions on adjustments). If either of these two voltages is materially greater than the specified values, the external wiring is incorrect, the supply voltages are not balanced, or the phase rotation is not A, B, C.

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

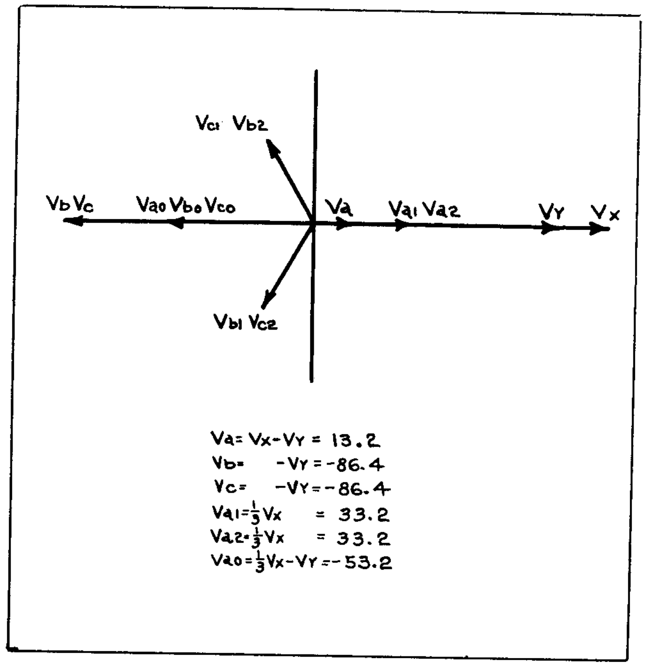

Fig. 6—Vector Diagram of The Voltages Applied to The Type HVS Relay Connected As Shown in Figure 5, With V_x = 99.6 and V_y = 86.4 Volts. (V_{a2} = 50%, V_{a0} = 80%).

The diagram of test connections is given in Figure 5. This test circuit does not represent any particular fault on the system, but is a very convenient method of getting values of V_{a0} and V_{a2} for calibration of the relay. (Vector diagram, Figure 6.)

Polar Element

The sensitivity of the polar element is adjusted by means of two magnetic shunts at the rear of the assembly. Looking at the relay front view, drawing out the right-hand shunt increases the amount of current required to close the relay contacts. Conversely, drawing out the left-hand shunt decreases the amount of current required to trip the relay. It will usually be possible to set the relay to the desired tripping value by leaving the left hand shunt at the extreme "in" position and making all the adjustments with the right-hand shunt. For any adjustments, a final reading should not be taken until the locking screws which hold the shunts securely in position are tightened.

When making a minimum trip adjustment, the relay should first be polarized with 100% zero-sequence voltage (V_x=0, Vy=66.4) for a few seconds to make sure that the contacts will reset when the voltage is reduced to zero.

CAUTION: Do not apply 100% zero-sequence voltage or 100% negative-sequence voltage to the relay for an extended period of time.

When the relay is de-energized, the armature rivet should rest against the right-hand pole face. When the relay is operated electrically, the contacts should have a deflection equivalent to one-half turn of the stationary contact screw. This is obtained by allowing the armature rivet to strike the left-hand pole face, then bringing up the stationary contact screws until the contact circuit just makes, then giving the stationary contact screws an additional one-half turn before locking them in place with the lock nut provided.

Negative Sequence Filter

The filter is adjusted for balance at the factory and no further adjustment or maintenance should be required. The normal voltage output on positive-sequence should not be more than 2.5 volts. This slight unbalance is caused by harmonics which may be present because of the iron core in the reactor. If the filter output voltage should be more than this value, with positive-sequence input, the filter may be balanced by adjusting the R_V resistor (see Figure 1). Open the polar element restraining coil circuit at the test link and insert a d-c milliammeter in the circuit. Energize the relay with rated three-phase positive-sequence voltage and adjust R_V until the milliammeter reads a minimum. At this adjustment, the filter output voltage should not be more than 2.5 volts.

Zero Sequence Filter

The following is a check on the polarity of the transformer connections:

Connect A, B and C phase terminals of the relay (terminals 14, 13 and 16 on the FT case)

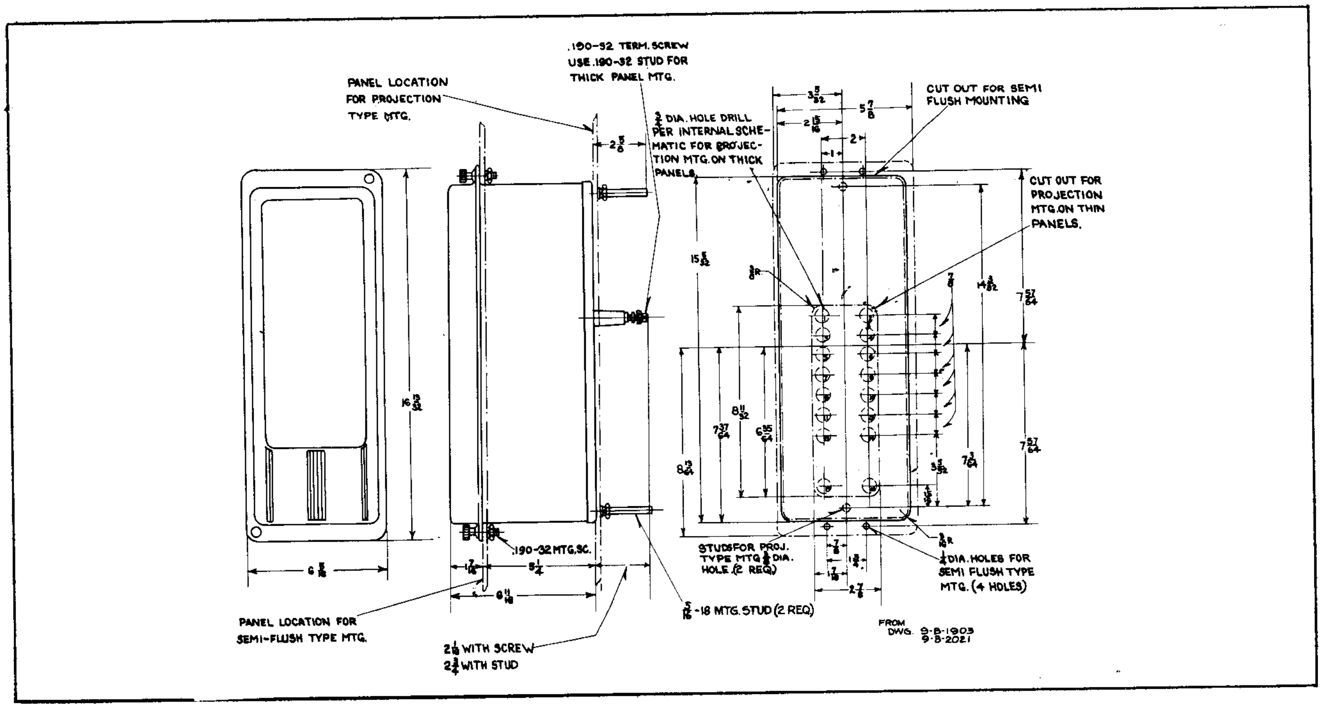

Fig. 7—Outline and Drilling Plan for The M10 Semi-Flush or Projection Type FT Flexitest Case. See The Internal Schematics for The Terminals Supplied. For Reference Only.

together and apply 66.4 volts 60 cycles between this common connection and the neutral terminal (terminal 15 on the FT case). Measure the secondary voltage of each of the three transformers with a high resistance voltmeter. The voltage, in each case, should be in the order of 31 volts. Measure the total voltage across all three secondary windings in series. This voltage should be equal to the sum of the three individual voltages.

Calibration

The relay is calibrated by adjusting the magnetic shunts to a desired minimum trip point, and by adjusting the R_0 resistor to a desired operating point. In the final factory calibration, the relay is set for an operating point of 50% restraining voltage and 80% operating voltage, with a minimum trip point at 20% operating voltage. If some other operating point is desired, the relay calibration may be changed by adjusting the magnetic shunts to obtain a new minimum trip voltage, and changing the R_0 resistor to the new operating point.

A typical range of adjustment for the type HVS relay is shown in Figure 3. There are two operating curves with R_0 set at 3000 ohms, which is its maximum value, and two operating curves with R_0 set at 1500 ohms, which is the limiting value of resistance. The resistor must not be set lower than 1500 ohms as this would result in an excessive voltage across the Rectox unit. In each pair of curves the lower curve is the operating characteristic with the shunts set for minimum trip. The upper curve, in each case, is the operating characteristic with the shunts set for maximum voltage required to operate the relay.

The R_2 resistor, Figure 1, is made adjustable for factory calibration only. This resistor is adjusted at approximately 900 ohms when R_0 is set at 1500 ohms by measurement, to get the V_2=50% V_0=59% point on the lower curve of Figure 3. In some relays, the R_2 resistor is a fixed resistor.

Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core of 1/64" when the switch is picked up. This can be done by turning the relay up-side-down or by disconnecting the switch and turning it up-side-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 where 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 3/32" by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes have been passed through the coil.

Operation Indicator

Adjust the indicator to operate at 0.2 ampere d.c. gradually applied. Test for sticking after 5 amperes d.c. are passed thru the coil. Adjustments may be made by loosening the two screws on the under side of the assembly and moving the bracket forward or backward. If the two helical springs, which reset the armature, are replaced with new springs, they should be weakened slightly by stretching just beyond their elastic limit.

RENEWAL PARTS

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

ENERGY REQUIREMENTS

The following table gives the burden at 60 cycles, positive sequence voltage, with the relay connected to three star-connected potential transformers (66.4 volts to neutral).

Potential Transf. Across Phase	Volts	Watts	Volt-Amps	Power Factor Angle
A-N	66.4	.12	6.7	89° Lag
B-N	66.4	.46	.65	45° Lag
C-N	66.4	5.85	6.9	32° Lag

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APPLICATION

The type HVS relay is intended for use as a supervising relay operating in conjunction with the ground relay in a differential protection scheme. In the application of sensitive ground differential relays to systems grounded through a relatively large impedance, the problem of false tripping sometimes arises. This is due to the erroneous response of the current transformers on heavy external phase-to-phase or two-phase-to-ground faults, particularly when there is a d-c transient * or during external phase faults due to errors caused by linear coupler manufacturing tolerances. The type HVS relay will prevent this false tripping by blocking out the ground relay on every type of fault except single-phase-to-ground.

The relay is applicable on those systems where the zero-sequence impedance of the system up to the bus where the relay is applied exceeds the negative-sequence impedance by a reasonable margin. The characteristics of the relay are such that a ratio of zero-sequence impedance to negative-sequence impedance equal to or greater than 2/1 will permit satisfactory operation.

CONSTRUCTION

The type HVS relay consists of a negative-sequence filter, a zero-sequence filter, two Rectox rectifying units with series resistors, a sensitive permanent magnet type polar element, a contactor switch, and an operation indicator. These elements are connected as shown in Figure 1.

The negative-sequence and zero-sequence filter inputs are connected in parallel. The output of the negative-sequence filter is rectified by means of a full-wave Rectox rectifier, which has a current limiting resistor connected in series with it. The rectified output is applied to the restraining coil of the polar element. The output of the zero-sequence filter is rectified by means of a full-wave Rectox rectifier, which has a variable, current-limiting resistor connected in series with it. The rectified output of the zero-sequence filter is applied to the operating coil of the polar element.

The d-c. contactor switch in the relay 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. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

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

SUPERSEDES I.L. 41-435A
*Denotes change from superseded issue.

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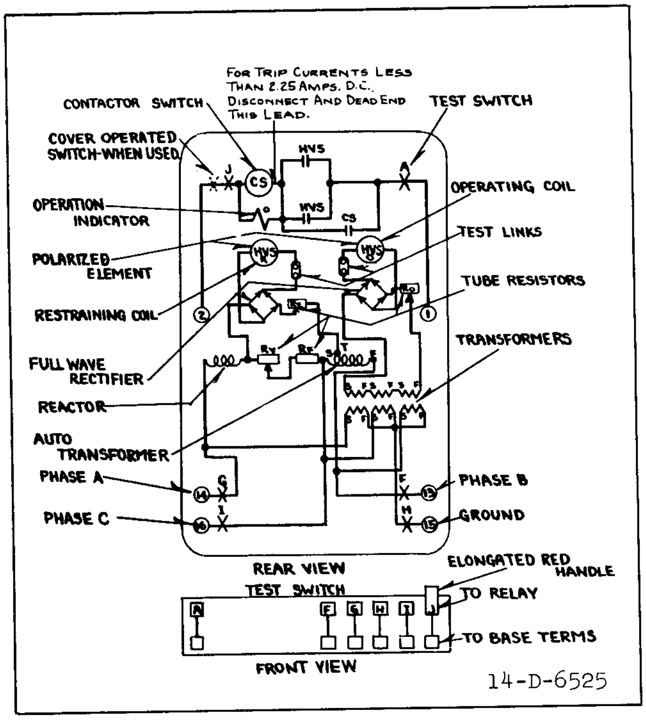

Fig. 1—Internal Schematic of The Type HVS Relay in The Type FT Case.

The negative-sequence filter consists of a reactor, resistors, and an auto transformer connected as shown in Figure 1.

The zero-sequence filter consists of three 2/1 transformers connected as shown in Fig. 1.

OPERATION

The type HVS relay operates in accordance with the magnitude of the negative-sequence voltage and the zero-sequence voltage at the bus. The contact-closing force in the relay is developed in proportion to the zero-sequence voltage, while the restraining force opposing contact closing is proportional to the negative-sequence voltage. In the event of a two-phase-to-ground fault, the relay will receive equal negative and zero-sequence voltages from potential transformers connected to the bus. In this case, the characteristics of the restraining and operating circuits will keep the relay from operating and the contacts will remain open.

During a single-phase-to-ground fault, the ratio of operating voltage to restraining voltage will be equal to the ratio of zero-sequence impedance, Z_0, to negative-sequence Z_2, of the source. If this ratio, Z_0/Z_2, is equal to or greater than 2/1 the operating force will overcome the restraining force and the relay contacts will close.

CHARACTERISTICS

Figure 2 shows a typical operating curve for the relay as it is calibrated at the factory. For operation with this calibration, the ratio Z_0/Z_2, of the system should be well above 2/1. In cases where the ratio of Z_0 to Z_2 is quite close to 2, relay operation will be more satisfactory if an adjustment of the shunts on the permanent magnet polar element is made so that the minimum trip point will occur at approximately 10% operating voltage instead of 20%. This adjustment will be discussed later.

INSTALLATION

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

The complete external connections are shown in Figure 4. The contacts of the differential relay are shown schematically. The details for the differential relay wiring are not shown, as these will depend upon the type of differential relay used.

The relay is shipped with the operation indicator and the contactor switch connected in parallel. This circuit has a resistance of approximately 0.25 ohm and is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there

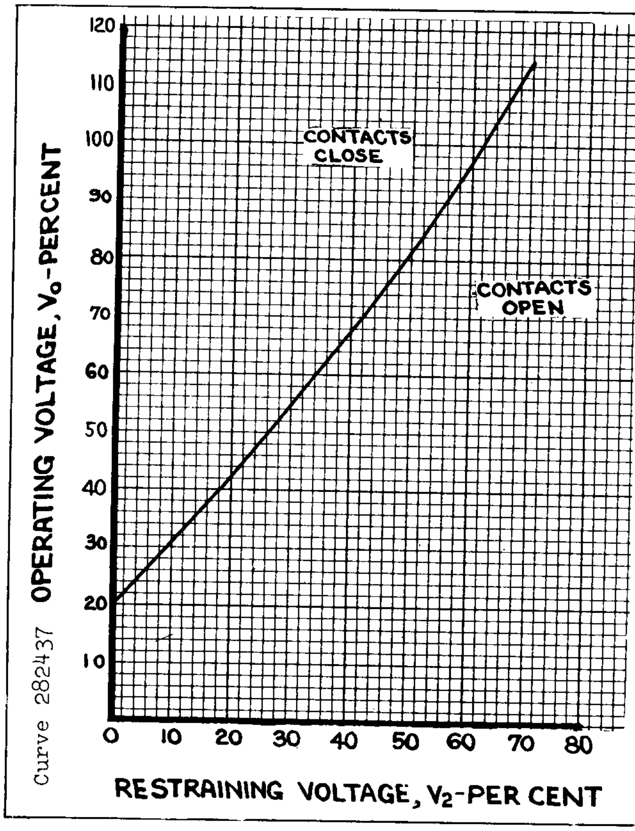

Fig. 2—Typical Operating Curve of The Type HVS Relay.

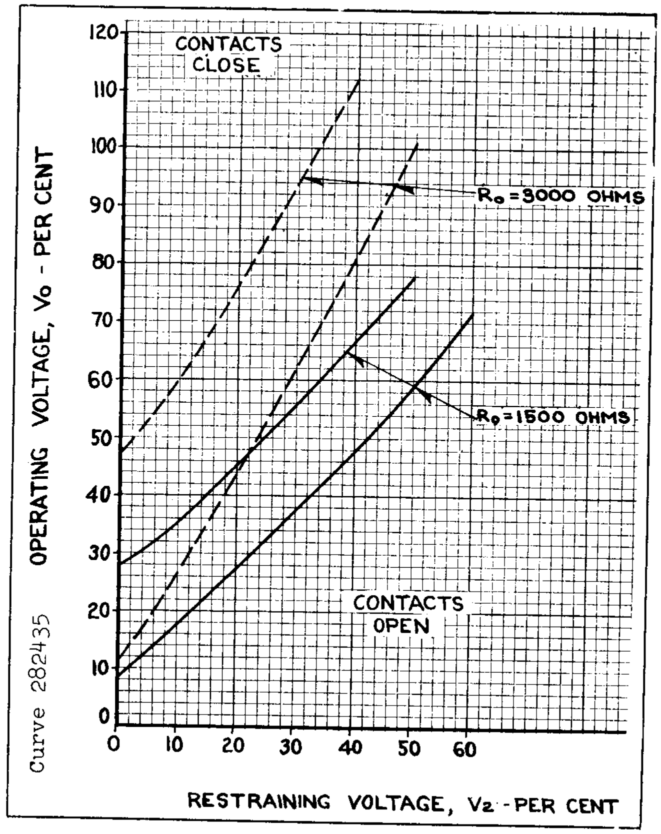

Fig. 3—Typical Range of Adjustment of The Type HVS Relay.

is no need for the contactor switch and it should be disconnected. To disconnect the coil, remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead ended) under the small filister-head screw located on the Micarta base of the contactor switch. The operation indicator will operate for trip currents above 0.2 ampere d-c. The resistance of its coil is approximately 2.8 ohms.

When using the contactor switch, it is neccessary that the auxiliary tripping relay have a suitable contact to interrupt the relay trip circuit.

INSTALLATION TESTS

After the relay has been connected as shown in Figure 4, a check should be made to assure proper wiring and phase rotation. Measure the a-c voltage across each Rectox unit and its series-connected resistor with a high resistance voltmeter. The voltage across the Rectox and resistor which are connected to the zero-sequence filter must be 2 volts or less. The voltage across the Rectox and resistor which are connected to the negative-sequence filter must be 2.5 volts or less (see instructions on adjustments). If either of these two voltages is materially greater than the specified values, the external wiring is incorrect, the supply voltages are not balanced, or the phase rotation is not A, B, C.

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, be-

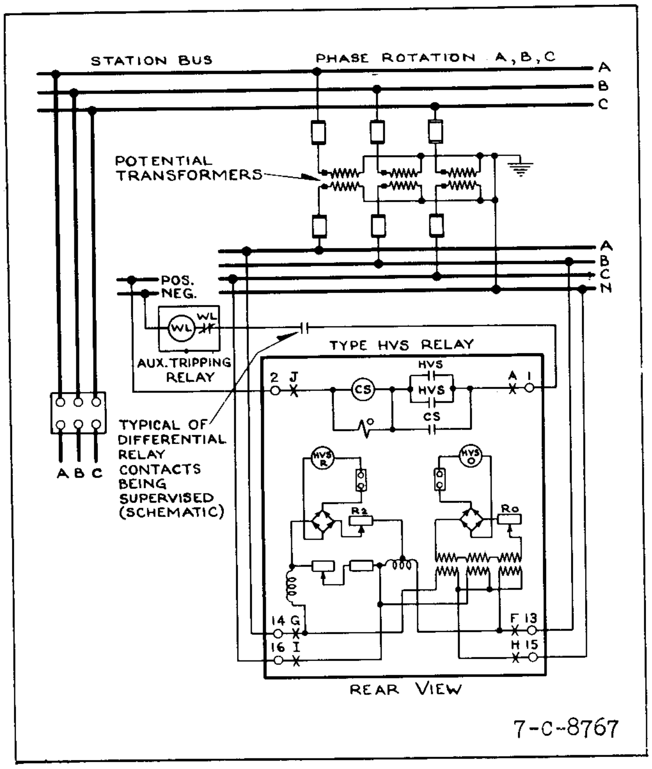

Fig. 4—External Connection of The Type HVS Relay.

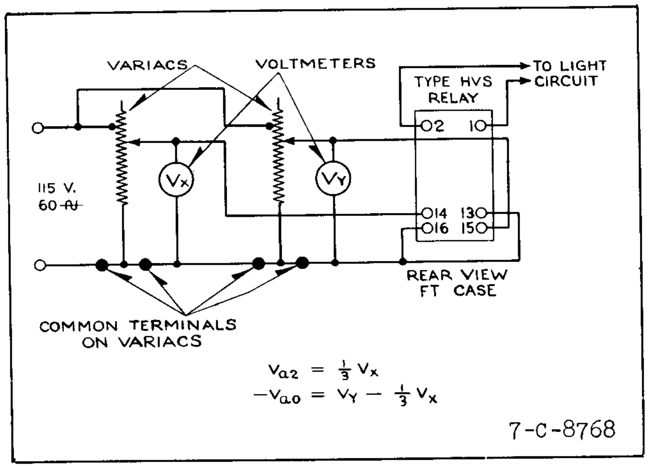

Fig. 5—Test Diagram of The Type HVS Relay.

cause of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The diagram of test connections is given in Figure 5. This test circuit does not represent any particular fault on the system, but is a very convenient method of getting values of V_{ao} and V_{a2} for calibration of the relay. (Vector diagram, Figure 6.)

Polar Element

The sensitivity of the polar element is adjusted by means of two magnetic shunts at the rear of the assembly. Looking at the relay front view, drawing out the right-hand shunt increases the amount of current required to close the relay contacts. Conversely, drawing out the left-hand shunt decreases the amount of current required to trip the relay. It will usually be possible to set the relay to the desired tripping value by leaving the left hand shunt at the extreme "in" position and making all the adjustments with the right-hand shunt. For any adjustments, a final reading should not be taken until the locking screws which hold the shunts securely in position are tightened.

When making a minimum trip adjustment, the relay should first be polarized with 100% zero-sequence voltage ($V_x = 0$, $V_y = 66.4$) for a few seconds to make sure that the contacts will reset when the voltage is reduced to zero.

CAUTION: Do not apply 100% zero-sequence voltage or 100% negative-sequence voltage to the relay for an extended period of time.

When the relay is de-energized, the armature rivet should rest against the right-hand pole face. When the relay is operated electrically, the contacts should have a deflection equivalent to one-half turn of the stationary contact screw. This is obtained by allowing the armature rivet to strike the left-hand pole face, then bringing up the stationary contact screws until the contact circuit just makes, then giving the stationary contact screws an additional one-half turn before locking them in place with the lock nut provided.

Negative Sequence Filter

The filter is adjusted for balance at the factory and no further adjustment or maintenance should be required. The normal voltage output on positive-sequence should not be more than 2.5 volts. This slight unbalance is caused by harmonics which may be present because of the iron core in the reactor. If the filter output voltage should be more than this value, with positive-sequence input, the filter may be balanced by adjusting the R_V resistor (see Figure 1). Open the polar element restraining coil circuit at the test link and insert a d-c milliammeter in the circuit. Energize the relay with rated three-phase positive-sequence voltage and adjust R_V until the milliammeter reads a minimum. At this adjustment, the filter output voltage should not be more than 2.5 volts.

Zero Sequence Filter

The following is a check on the polarity of the transformer connections:

Connect A, B and C phase terminals of the relay (terminals 14, 13 and 16 on the FT case) together and apply 66.4 volts 60 cycles between this common connection and the neutral terminal (terminal 15 on the FT case). Measure the secondary voltage of each of the three transformers with a high resistance voltmeter. The voltage, in each case, should be in the order of 31 volts. Measure the total voltage across all three secondary windings in series. This voltage should be equal to the sum of the three individual voltages.

Calibration

The relay is calibrated by adjusting the magnetic shunts to a desired minimum trip point, and by adjusting the R_O resistor to a desired operating point. In the final factory calibration, the relay is set for an operating point of 50% restraining voltage and 80% operating voltage, with a minimum trip point at 20% operating voltage. If some other operating point is desired, the relay calibration may be changed by adjusting the magnetic shunts to obtain a new minimum trip voltage, and changing the R_O resistor to the new operating point.

A typical range of adjustment for the type HVS relay is shown in Figure 3. There are two operating curves with R_O set at 3000 ohms, which is its maximum value, and two operating curves with R_O set at 1500 ohms, which is the limiting value of resistance. The resistor must not be set lower than 1500 ohms as this would result in an excessive voltage across the Rectox unit. In each pair of curves the lower curve is the operating characteristic with the shunts set for minimum trip. The upper curve, in each case, is the operating characteristic with the shunts set for maximum voltage required to operate the relay.

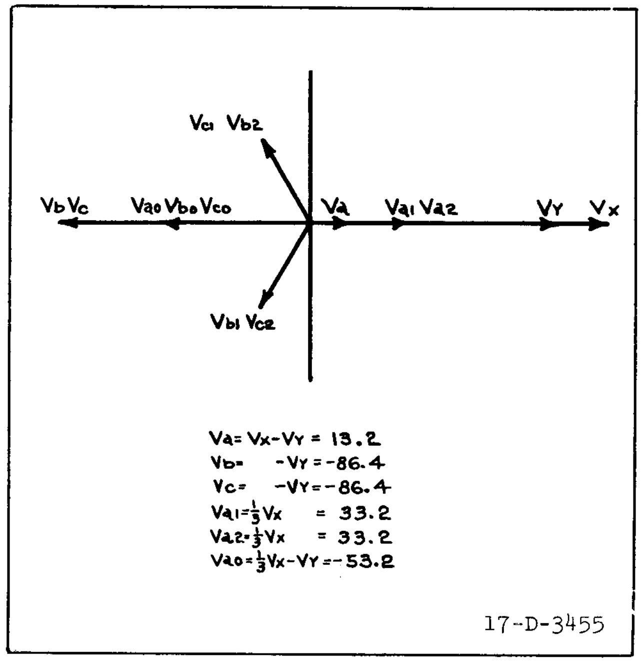

Fig. 6—Vector Diagram of The Voltages Applied to The Type HVS Relay Connected As Shown in Figure 5, With V_x = 99.6 and V_y = 86.4 Volts. (V_{a2} = 50%, V_{a0} = 80%).

The R_2 resistor, Figure 1, is made adjustable for factory calibration only. This resistor is adjusted at approximately 900 ohms when R_O is set at 1500 ohms by measurement, to get the V_2=50% V_O=59% point on the lower curve of Figure 3. In some relays, the R2 resistor is a fixed resistor.

Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core of 1/64" when the switch is picked up. This can be done by turning the relay up-side-down or by disconnecting the switch and turning it up-side-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 where 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 3/32" by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes have been passed through the coil.

Operation Indicator

Adjust the indicator to operate at 0.2 ampere d.c. gradually applied. Test for sticking after 5 amperes d.c. are passed thru the coil. Adjustments may be made by loosening the two screws on the under side of the assembly and moving the bracket forward or backward. If the two helical springs, which reset the armature, are replaced with new springs, they should be weakened slightly by stretching just beyond their elastic limit.

RENEWAL PARTS

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

ENERGY REQUIREMENTS

The following table gives the burden at 60 cycles, positive sequence voltage, with the relay connected to three star-connected potential transformers (66.4 volts to neutral).

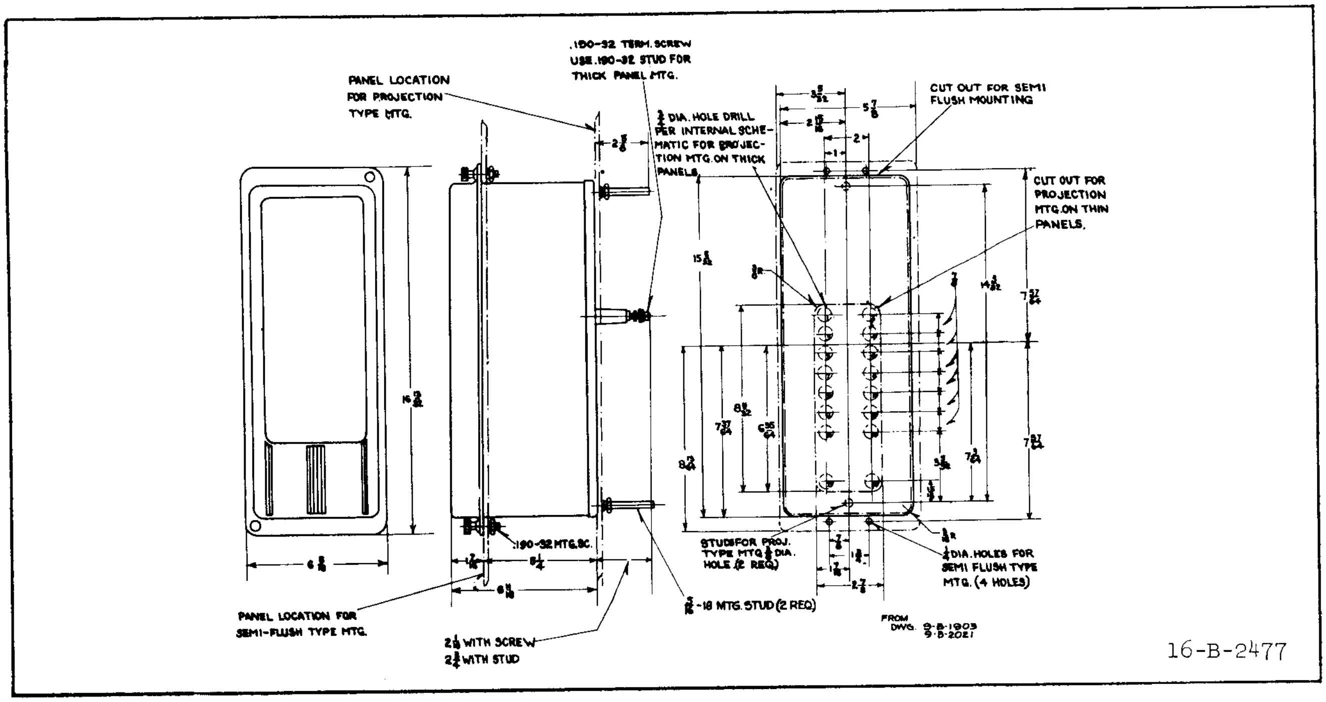

Fig. 7—Outline and Drilling Plan for The M10 Semi-Flush or Projection Type FT Flexitest Case. See The Internal Schematics for The Terminals Supplied. For Reference Only.

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