INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

SOLID STATE PERMISSIVE OVERREACHING TRANSFER TRIP RELAY SYSTEM (Type A2C1A, A2C2A, A2C1B, A2C2B, A2C1C)

INTRODUCTION

This instruction leaflet describes the solid state permissive overreaching transfer trip relay system. The relay system is a permissive overreaching system which requires a trip signal to be received to clear a fault. The communications needed for this system is provided by frequency shift audio tones. Detailed descriptions for individual relays of the system are presented in their respective instruction leaflets.

CAUTION: Before placing equipment in service:

1. Secure the cabinets or panels to the floor before working with the system to prevent tripping of the cabinet or panel.
2. Be sure all printed circuit cards and multi-pin connectors are well seated in their receptacles.
3. Adjust equipment and perform tests outlined under "Installation".
4. It is recommended that before proceeding to adjust the system one becomes familiar with the information in this instruction book and the information in the individual relay instruction books.

APPLICATION

Basic System

High speed relaying is required for modern transmission lines in order to improve transient stability, permit instantaneous reclosing, and minimize conductor damage. By extending the basic principle of differential protection to line relaying, pilot relay systems provide high speed clearing for all internal faults and restraint for all external faults. The pilot channel provides the communication link which enables comparison of current or power flow at all line terminals.

The transfer trip system is a directional comparison system using high speed frequency shift audio tones with a 340 Hz bandwidth. This system is an overreaching permissive scheme which is applicable to long or short lines. The transmission of a constant guard signal enables the system to detect a channel failure at the time it occurs, and block any relay system operation.

* The distance relays need not have overcurrent supervision to prevent false tripping during loss of potential since they are supervised by the tone channel. However, if line side potential sources are used with this system, it is recommended that when the breaker is tripped from any source other than the pilot system, reclosing should be blocked. This is to prevent false reclose initiation when the line is de-energized.

The relay system has also been designed to provide for field conversion of the system to a three terminal application.

System Options

There are several options which may be added to the basic pilot relay system:

1. A common timer may be added to use the phase and ground pilot trip relays for zone two time delay trip. This will provide backup for the carrier channel.
2. A second set of distance relays may be added to provide a first zone of protection.
3. When zone one or zone two have been added to the system, overcurrent relays should be added to supervise zone one and zone two time trip. Also available in the same overcurrent relay are high set overcurrent units for high speed direct trip on close-in faults.
4. A choice of distance or directional overcurrent relays is available for ground fault protection.

SUPERSEDES I.L. 40-205
*Denotes change from superseded issue.

EFFECTIVE SEPTEMBER 1969

5. For out-of-step relaying options the SKSU will provide out-of-step blocking with delayed zone one trip on out-of-step, and the SDBU-2, OS-2 scheme provides out-of-step blocking, controlled angle out-of-step tripping, and out-of-step blocking of reclosing. These options are explained in detail in I.L. 40-211.

6. An audio tone channel of less than 340 Hz bandwidth may be used providing the STU-12 relay transient block time is calibrated for 25 ms.

The audio tone transmission channel should have the following characteristics:

1. Minimum received signal level of -20 dbm.
2. All carbon blocks grounded through 377H drainage reactors.
3. Maximum frequency translation of ± 2% of the frequency shift.
4. Maximum propagation delay of 3 milliseconds.
5. Characteristic impedance of 600 ± 100 ohms.
6. Distortion should not exceed 1%.

EQUIPMENT COMPLEMENT

The layout of components for the basic transfer trip system is shown in Figure 9.

The components for the basic system listed from the top are as follows:

Tone Equipment

Type TA-3 Tone Chassis with the following modules:

1 - Voltage Regulator, HB-25210

1 - DC to DC Converter,
24 V DC - HB-25180
48 V DC - HB-25190
125 V DC -HB-25200

1 - FS Oscillator and Keyer, HB-25110

1 - Transmitter Amplifier, HB-25220

1 - FS Receive Filter, HB-63100

1 - Receiver Limiter and Signal Supervisory, HB-25160-1

1 - FS Discriminator and DC Amplifier, HB-25170

1 - Noise Filter, HB-55187

1 - Line Level and Noise Supervisory, HB-25150

Carrier Auxiliary Relay

Device 85 - Type STU-12 Relay

Trip Output and Indication Relay

Device 95 - Type SRU Relay

System Test Facilities

Type FTU - Functional Test Panel

Fault Detecting Relays

Device 21P - Type SKDU Relay

Device 21NP - Type SDGU-2 Relay or

Device 67N - Type SRGU Relay

Cabinet or Panel

Type SU Swing Rack Cabinet or

Type VU Panel

The items listed below are options which may be added to the basic transfer trip system. See Figure 10.

Fault Detecting Relays

Device 21-1 - Type SKDU

Device 21N-1 - Type SDGU-2

Device 2 - Zone two timer mounted in the SRU, Used with 21NP and 21P.

Device 50 - Type SIU Relay - The SIU must be added to the system when zone one or two options are applied. The overcurrent units needed are I_A, I_C, & I_O.

Device 50 - Type SIU Relay - High set overcurrent units I_{BH}, I_{CH}; and I_{OH}.

Device 68 - Type SKSU or

Device 21B - Type SDBU-1 or

Device 21B1/21B0 - Type SDBU-2 for out-of-step relaying.

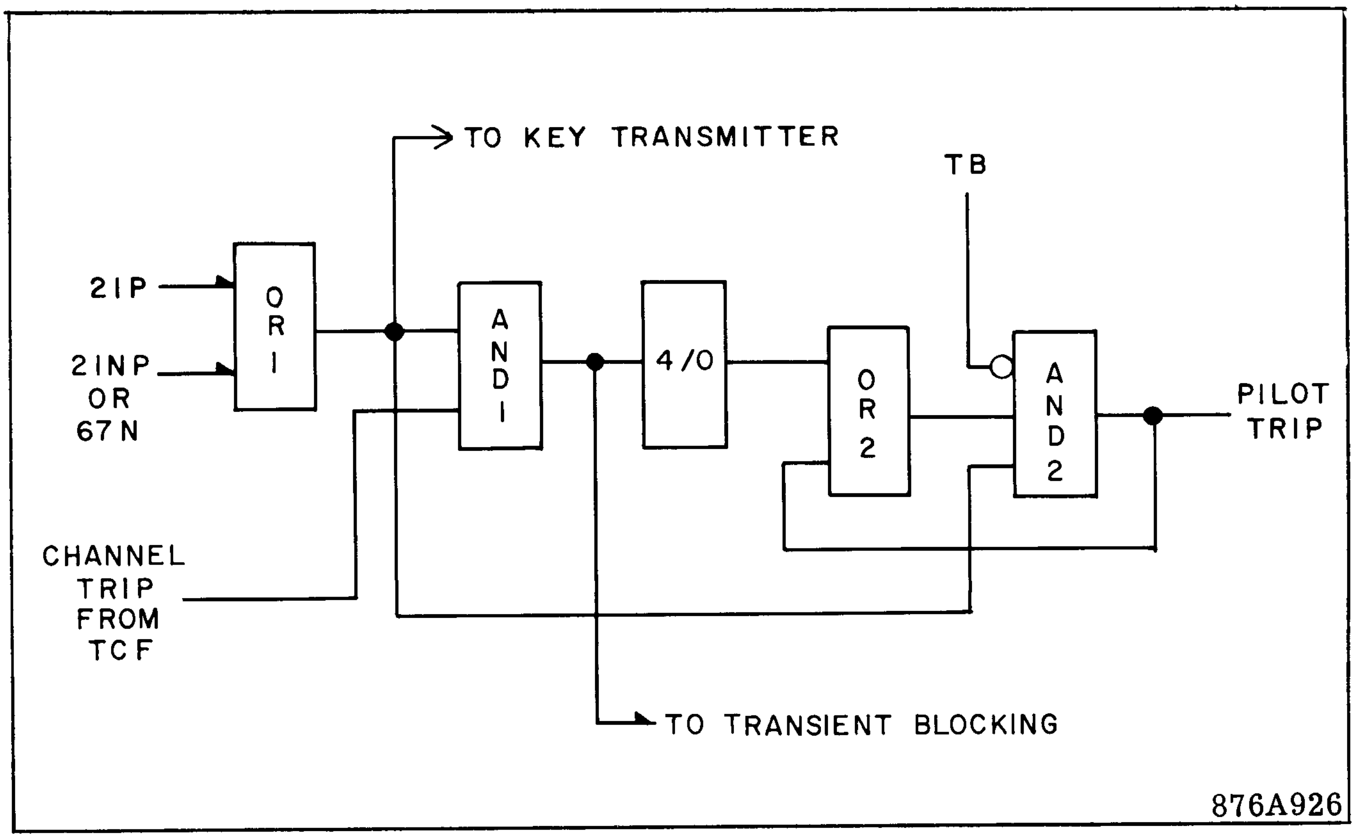

Fig. 1. Transfer Trip System Trip Logic

If the transfer trip system is to be applied to a three terminal line, a printed circuit card must be added to the STU-12 relay and a second TA-3 receiver must be added to the system.

The type SRU relay contains the tripping thyristors to trip two breakers, reclose initiate logic with two contacts for the output, reclose block logic with two contacts for the output, breaker failure initiate output with either two contacts or two transistor outputs, OS-2 Out-of-Step relaying logic when used, zone two timer when used, all system indication, and all system alarms.

A choice of either a 90" swing rack cabinet or a 90" panel is offered. The 90" swing rack cabinet is a type SU with a total mounting space of 46 rack units. One rack unit equals 1 and ¾ inches. Refer to Figure 11 for the cabinet outline. The 90" panel (VU) has a total mounting space of 49 rack units, and Figure 12 shows its outline dimensions.

OPERATION

The transfer trip relay system is an overreaching permissive type relaying system, and Figure 1 shows a simplified block diagram. An output from either the phase distance or ground relay (distance or directional overcurrent) will cause an output from OR1. This in turn keys the local transmitter to the trip frequency and goes to one input of AND 1. If the relay system at the remote terminal has sent a trip signal, there will be a second input to AND 1. Since both the local relays have operated and a trip signal has been received, AND 1 will start the 4/0 timer. If this condition persists for 4 milliseconds, a pilot trip signal will appear at the output of AND 2, providing the transient blocking circuit has not operated. Once a pilot trip output is obtained, AND 2 is sealed in through OR 2. That is, the pilot trip may not reset until the fault detecting relays, 21P or 21NP, have reset.

The channel interface logic of the STU-12 is shown in Figure 2. The "1" and "0" marks at the inputs of each logic block show the normal logic state when a guard frequency is being received by the tone receiver. There are two channel inputs shown in Figure 2. The channel two input is used only when relaying a three terminal line. When the system is applied to a two terminal line, the STU-12 provides an interlock to fulfill channel two trip logic.

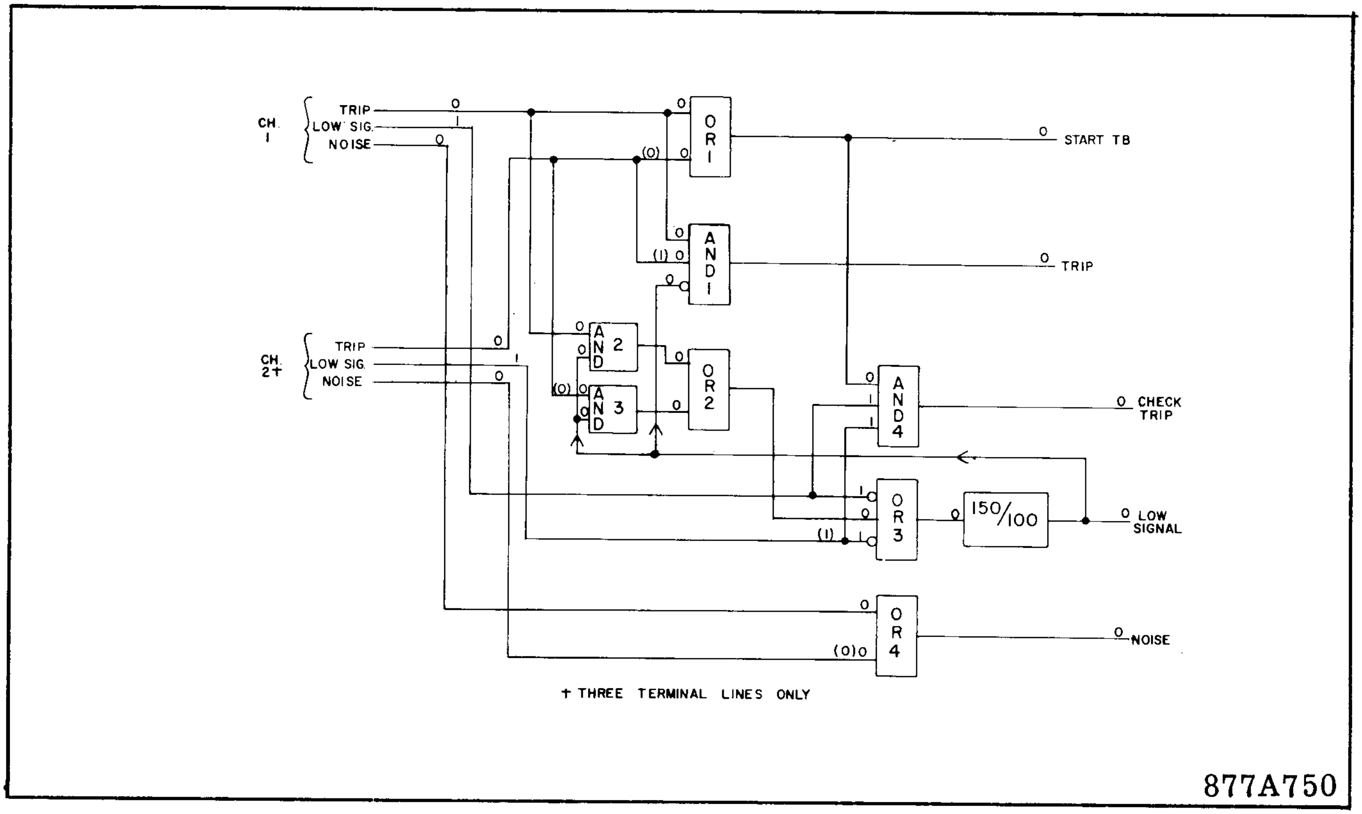

Fig. 2. Channel Logic for Transfer Trip

For purposes of this discussion only two terminal line applications will be considered. The logic inputs shown in parenthesis on OR 1, AND 1, AND 3, OR 3, and OR 4 are those provided by the STU-12 interlock for two terminal line applications.

There are four conditions at the channel one input which are of interest. These are trip received, low signal, noise, and trip received after low signal.

1. Trip Received (normal condition when internal fault occurs).

   When a trip frequency is received on channel 1 the trip input to the channel logic changes to the 1 state. This will start transient blocking through OR 1 and provide a trip output from AND 1 since the other two input conditions to AND 1 are met. That is, the middle input is at a 1 state due to the interlock, and the negated input is 0 indicating a good channel was present before the trip was received.

2. Low Signal Condition

   When the received tone level drops by a predetermined amount (6 db for TA-3), the low signal input to the channel logic will switch to a 0. This is fed to the tap negated input of OR 3. The logic 0 at that input of OR 3 will cause a 1 at its output which starts the 150/100 timer. After 150 milliseconds, a 1 condition appears at the low signal output of the channel logic and block tripping. The low signal output of the 150/100 timer is fed back to AND 1 to block a trip output from the receiver, and to AND 2 which is to insure a guard return. This will be explained later.

3. Noise Circuit Operates

   When the noise monitoring circuits of the tone system operate, a logic 1 is fed to OR 4. The output of OR 4 is used to block tripping.

4. Trip Received after Low Signal

   If a low signal condition has existed for 150 milliseconds, the channel logic is in the state described in part 2 above. The bottom input of AND 2 is in a 1 state. If the channel level returns to normal and a trip frequency received at the same time, both input conditions to AND 2 are present. This causes an output of OR 2, which will maintain an output from OR 3. The 150/100 timer is now sealed in, and the only way to return the relay system to normal after a low signal condition has occured is to return the received frequency to guard for 100 ms.

The output of AND 4 goes to the checkback circuit. This output is present if a trip is received and the low signal input indicates a good channel. Note that the "check trip" output does not depend on guard return after a low signal condition as the "trip" output does.

There are several logic circuits in the type STU-12 relay which function during special system conditions. This logic will be described by dividing it into small logical functions. The logic diagrams in Figure 3, 4, 5, 6, and 7 are for illustration only, and may not correspond to the detailed logic of the system.

Loss of Potential

This logic is shown in Figure 3. Its purpose is to protect against a false trip occurring when an ac potential fuse blows. The AND gate can only provide an output if the distance relays operate and no carrier trip request is received. If the above condition exists for 500 milliseconds it is defined as a loss of ac potential and tripping is blocked and the alarm relay is picked up in the SRU relay.

Transient Blocking

Transient blocking is applied to the pilot systems to prevent false tripping due to a power reversal in the protected line when a parallel line is clearing or reclosing into a fault. Figure 4 shows a portion of the power system to illustrate the problem. Assuming line A-B is the protected line and a fault occurs on a parallel line, the initial fault power flow I_{F2} will be into the line at breaker B. With these conditions the 21 relay at terminal B may operate and transmit a trip signal to terminal A. A trip will not occur since the requirements to trip at A and B are not satisfied. If breaker C on the parallel line opens before breaker D, there will be a power reversal in the protected line A-B. When this happens the 21 relay at breaker A may operate. If its operate time is 4 milliseconds (trip time in the STU-12) less than the reset time of 21 at B plus channel reset time a false trip will occur at breaker A. A power reversal will also occur if breakers C and D are reclosed at different times and the fault on line C-D still exists.

Figure 5 shows the basic logic used for transient blocking. All inputs to all logic blocks in Figure 5 are in the zero state during normal conditions. If 21 operates or a trip is received at OR 1, the 0/1000 timer is picked up. Since a pilot trip has not occurred or the 18/0 unblock timer has not picked up, there will be an output from AND 3. The output of AND 3 will start the 18/0 block timer. If a pilot trip does not occur in 18 milliseconds, tripping is locked out. Assuming an external fault did occur, breakers C and D will clear the fault (see Figure 4). The local 21 or received trip will now reset. However, the 0/1000 timer maintains the blocking of trip, so that a power reversal, when breakers C and D reclose, does not cause a false trip.

If an internal fault occurs after transient blocking has been initiated, the input to AND 2 (from the trip logic) is energized. Since blocking had been set up, AND 2 will start the 18/0 unblock timer. If this condition persists for 18 milliseconds the system will trip breakers A and B. Therefore, if an internal fault occurs after an external fault, tripping is only delayed by 18 ms.

The fast reset circuit on the 0/1000 timer is to keep transient blocking from being initiated during the open cycle of the protected line circuit breakers. This will insure that a high speed trip can occur on reclosing into a permanent fault.

The 18 ms transient block time will provide system coordination for external faults with two cycle breakers applied on adjacent line sections. The 340 Hz bandwidth TA-3 will provide the channel speed needed in order to avoid transient block operation during an internal fault. If two cycle breakers are not used on adjacent power circuits, the 18 ms transient block time is not needed. Therefore, a STU-12 relay with the transient block time increased to 25 ms may be used, and TA-3 tones of lesser bandwidth may be applied to conserve frequency spectrum.

52b and Channel Control of Transient Blocking

The transfer trip system allows the 52b contact of the circuit breaker to key the transmitters to a trip frequency. This is to allow pilot relay tripping when one end of the line is open. The circuit shown in Figure 6 blocks the operation of transient blocking during 52b keying so that a high speed trip will be obtained when a fault occurs.

The 52b input to the AND gate blocks the channel trip from starting transient blocking during the re-

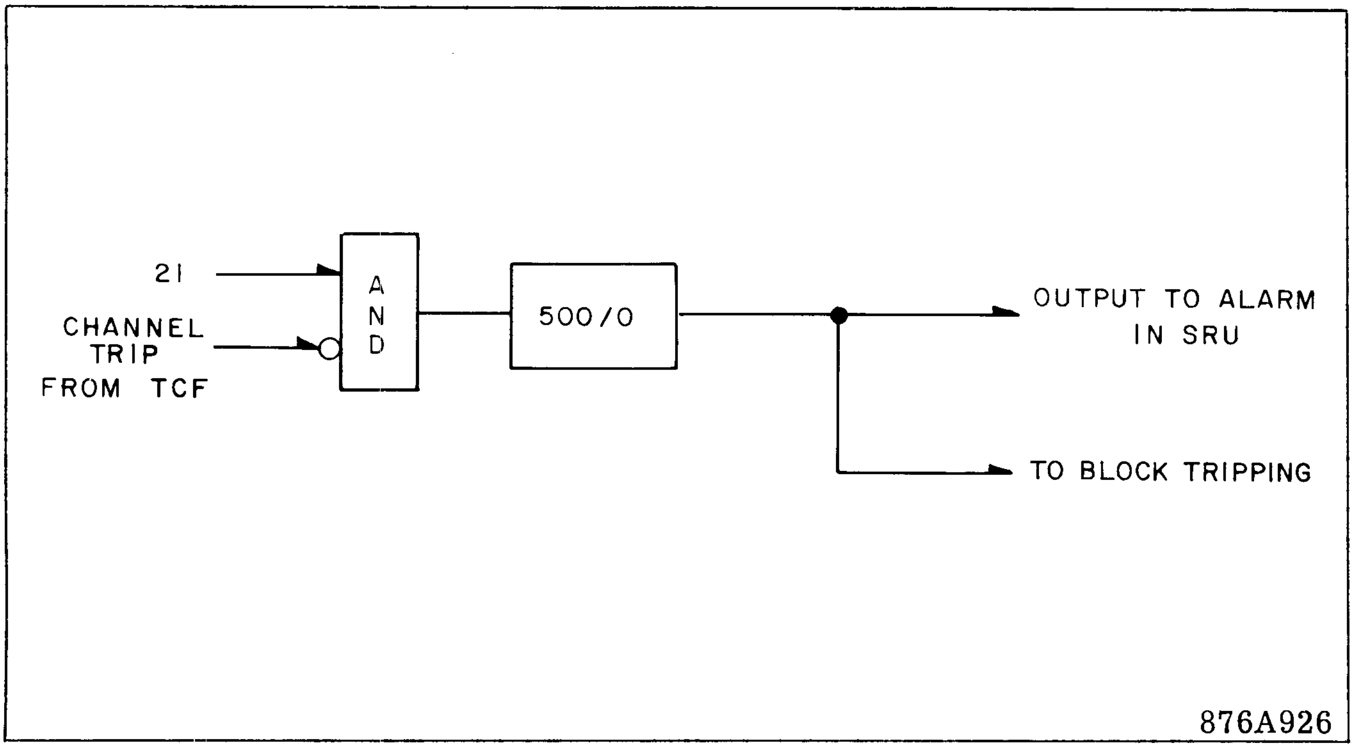

Fig. 3. Loss of AC Potential Logic

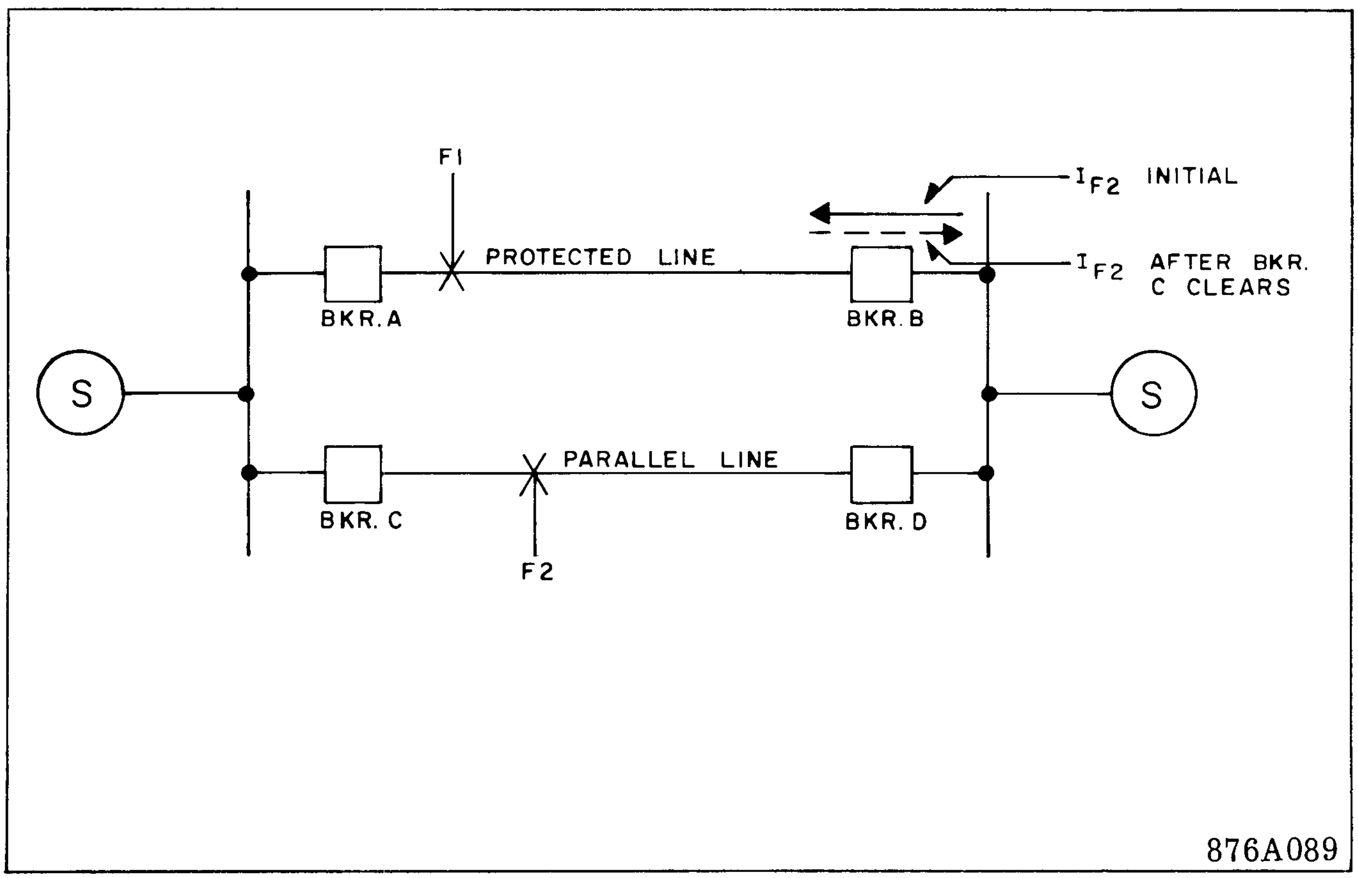

Fig. 4. One Line of Simplified Power System

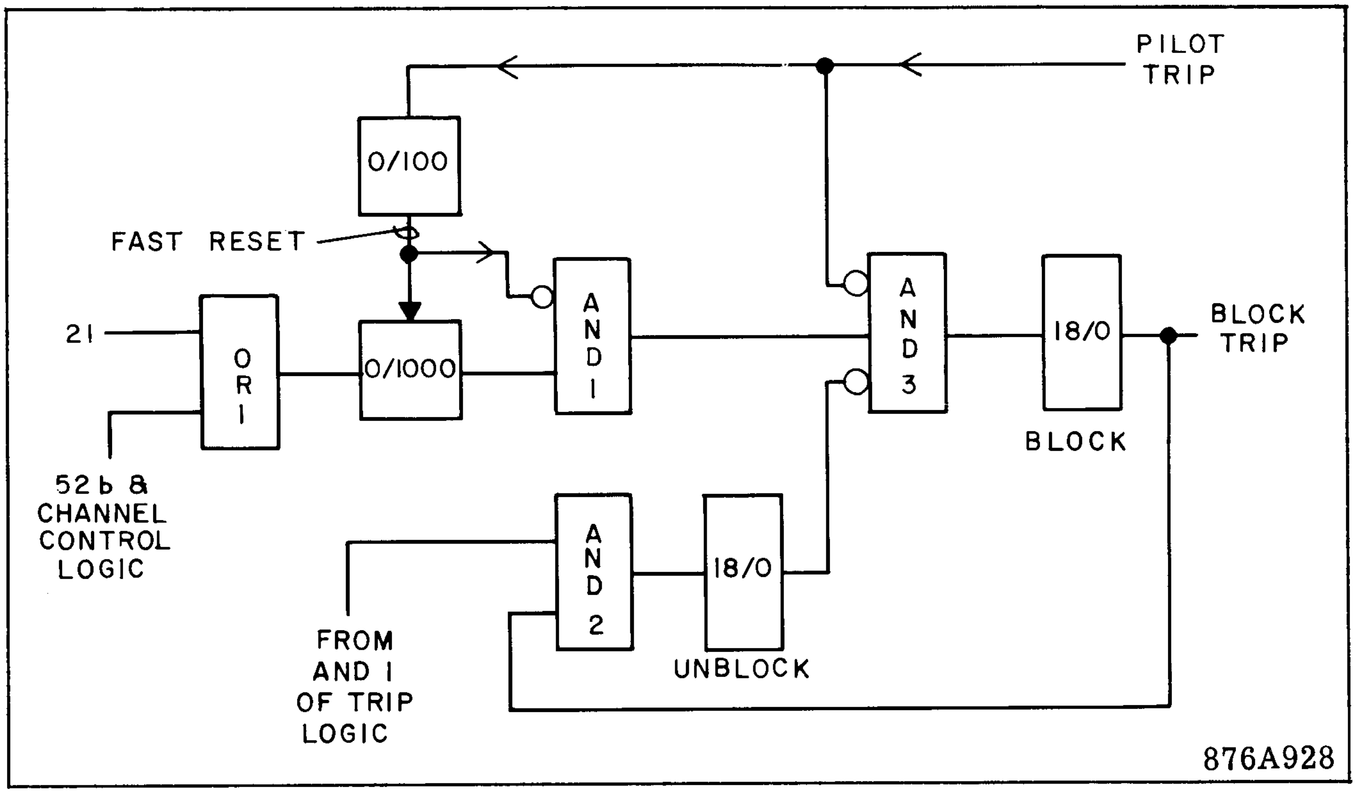

Fig. 5. Transient Block Logic

close cycle after tripping for an internal fault. Therefor, a second high speed trip will occur if the breakers close into a permanent fault. The 2500/0 timer input to the AND gate causes transient blocking to be reset if the channel requests trip for 2.5 seconds. This indicates that the remote breaker is open and transient blocking need not be in service.

Checkback Logic

The unblock system has logic to check the channel in both directions with personnel at one end only. The logic shown in Figure 7 is controlled by the receiver at the remote terminal. If the receiver at the remote terminal detects a low signal for 2.5 seconds and a check trip is then detected, the checkback logic will then key the remote transmitter to trip for 2.5 seconds. Figure 2 shows two trip outputs from the channel logic. The output used for relaying cannot occur if trip is received after a low signal condition; thus, the remote terminal relaying remains locked out during test. The check trip output from the channel logic does not depend on " guard" return.

The checkback test is performed in conjunction with the functional testing which will be described later.

* If it is desired to follow through the detail system logic, Figure 8 may be used.

INSTALLATION

Acceptance Testing

It is desirable to acceptance test relay system components to assure that no component damage or calibration change has occurred during shipment.

The acceptance test procedure of the individual relays should be followed. These procedures may be found in each relay instruction leaflet. The tests may be performed with the relays in place by applying the ac quantities to the Flexitest switches provided on the system test panel and the individual relay test points. Currents in excess of the continuous rating of the device should not be applied for more than a few seconds.

An acceptance test procedure for the relay system may be performed by following those procedures outlined under Functional Testing.

Settings

The setting of the transfer trip system requires adjusting the fault detecting relays for the proper pick up, and adjusting the tone transmitter and receiver levels.

The fault detecting relays which must be set are 21P, 21NP or 67N, and 21-1, 21N-1, 50 when they are used. For the procedure to follow refer to these relay instruction leaflets.

Pilot Relays

The 21P and 21NP relays should be set to overreach the remote line terminal. The usual setting is 150% of the line impedance. If the pilot relays are used to operate a zone 2 timer the 21P and 21NP must underreach any adjacent line zone 1 relay.

Zone 1 Relays

If zone 1 relays are applied as an option they must be set to underreach the remote bus. The SKDU phase relay may be set to reach 90% of the line impedance, and the SDGU-2 may be set to reach 85% of the line. However, the reach of the SDGU-2 should be reduced to 75% where the PCA-5 or equivalent potential device is used.

Overcurrent Fault Detectors for Zone 1 and 2

I_A and I_C in the SIU must be set below the minimum phase fault current but above maximum load current to supervise zone 1 and 2 trip. The I_O in the SIU must be set below the minimum ground fault current but above the normal unbalance current flow.

High Set Overcurrent Relays

The instantaneous overcurrent units I_{BH}, I_{CH} and I_{OH} must be set high enough to avoid operating on faults beyond the next terminal and for faults immediately "behind" the protected line terminal. Also they must not be allowed to operate on out-of-step conditions.

Where the system fault and out-of-step indicates the fulfillment of these requirements to be impractical, the option should be elected to insert the phase only for 50 milliseconds following breaker closure. This is accomplished with additional logic in the SIU, device 50.

SDBU-2 Relay

The blinder units should be set so the inner blinder easily accommodates the maximum fault arc resistance and the outer unit is adequately spaced from the inner blinder to accommodate the maximum rate of ohmic swing during out-of-step conditions within the allowable OS-2 logic lime of 50 milliseconds.

Out-of-Step Overcurrent Supervision

$I_{A\text{-}OS}$ must be set to restrict the reach of the blinder system to the desired extent and to block any possibility of false tripping during long pick-up.

If a zone 2 timer has been applied to the system, its pick up time will have to be adjusted. This can be done by referring to the SRU instruction leaflet.

TA-3 Tone Adjustment

The output level of the TA-3 tone transmitter must be adjusted. This output can be varied from -40 dbm to +8 or +10 dbm depending on the tone transmitter used. It is recommended that the tone transmitter be adjusted to the maximum level allowed by the channel being used to transmit the tone.

At the receive terminal the frequency shift receiver and noise clamp sensitivity must be adjusted. The optimum receive level is -20 dbm; however, it is adjustable from -28 dbm to+10 dbm. The noise receiver is adjusted based on the incoming audio tone level.

The procedure for making the above adjustments may be found in the TA-3 instruction leaflet.

Routine Maintenance

The relay system functional test should be performed periodically, at such time intervals as may be dictated by experience, to insure that the relay system is operating properly.

FUNCTIONAL TESTING

* The directional comparison transfer trip system is equipped with a functional test panel. The purpose of this panel is to provide a simple procedure to check the complete relaying system to insure its proper operation, and provide a test that does not require any special equipment.

Figure 8 shows two types of functional test panels. The solid connections of Figure 8 show a panel re-

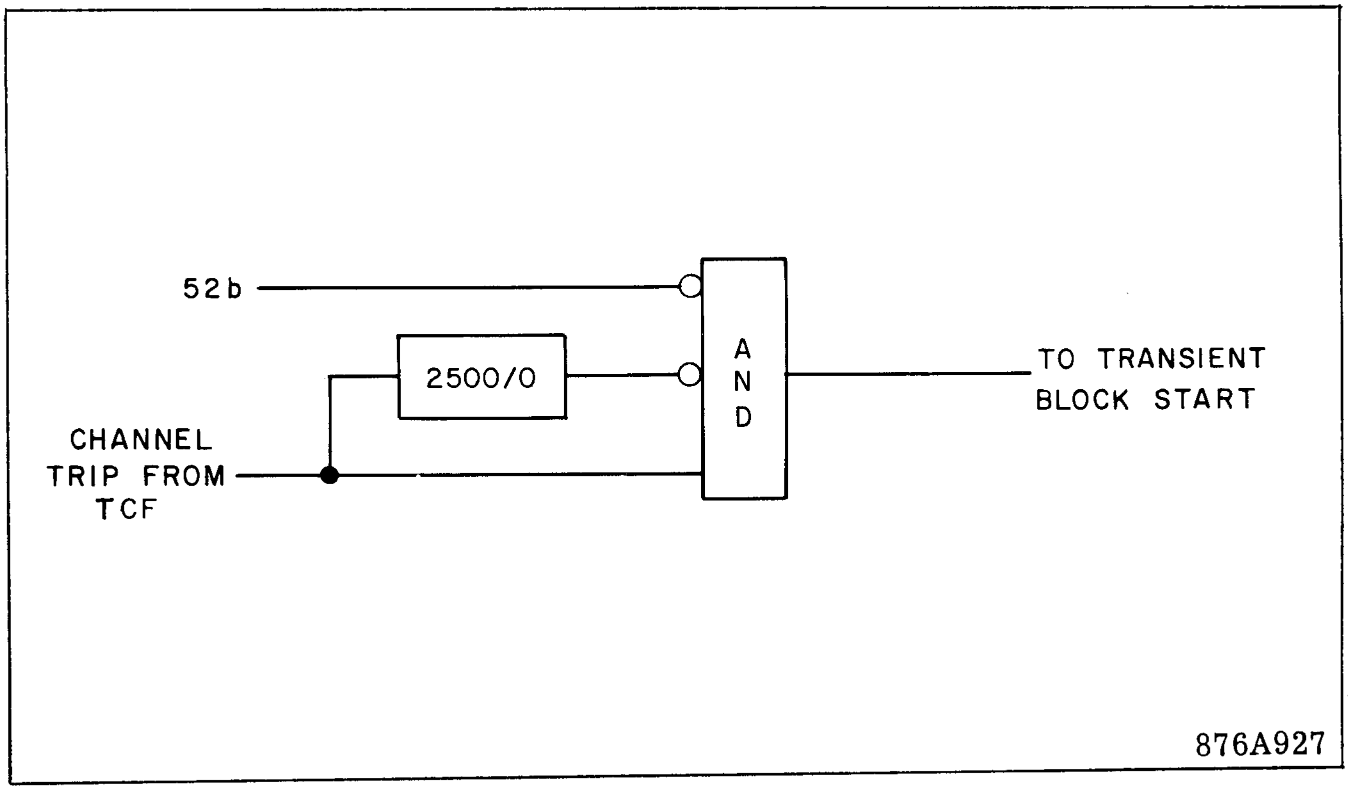

Fig. 6. 52b and Channel Control of Transient Blocking

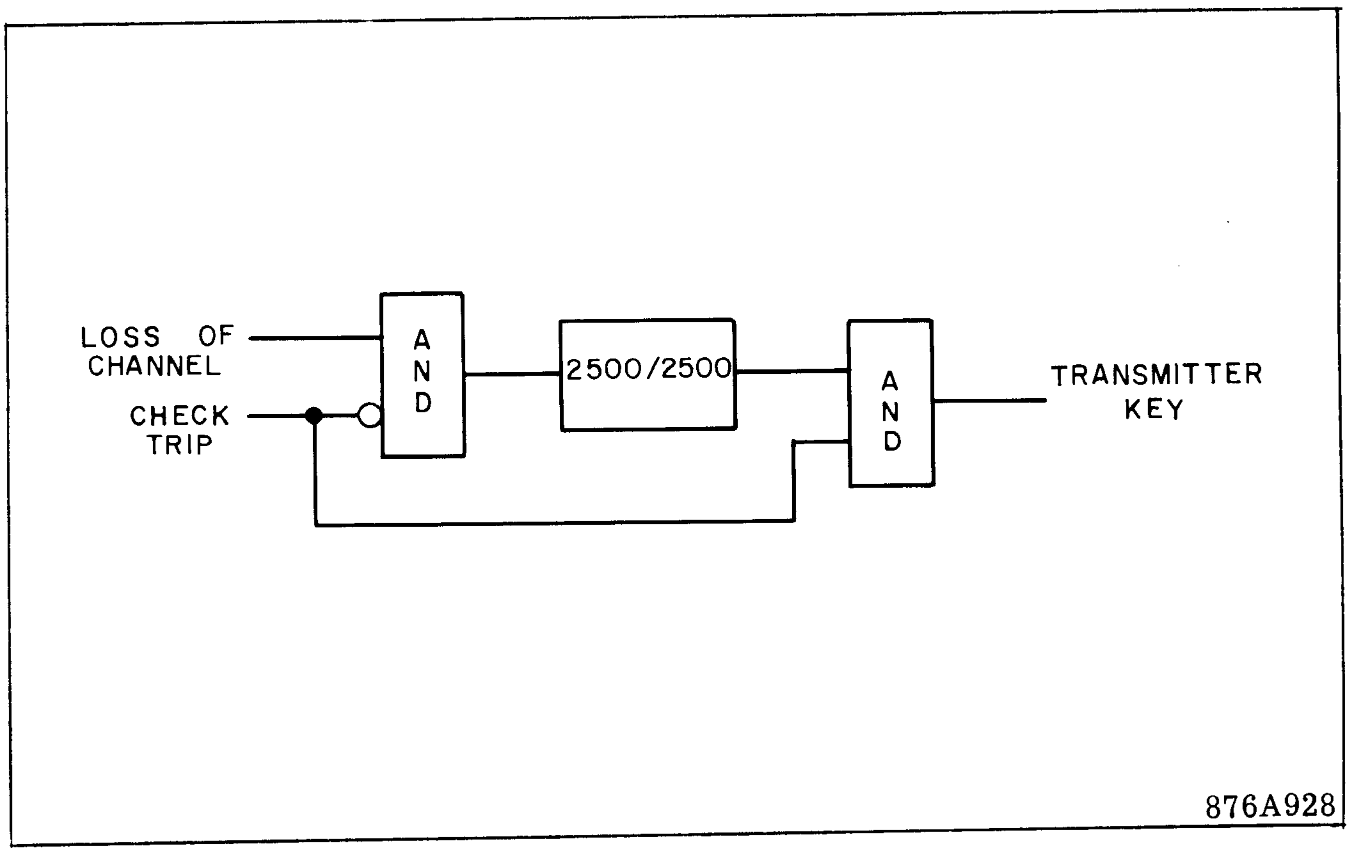

Fig. 7. Tone Checkback Logic

quiring any single phase 60 Hz source. This panel will provide only a test simulating a fault in the forward direction. If the dotted connections of Figure 8 are used, the potential supply is the three phase relay potential and the current source must be from V_A and V_C. However, this test panel is able to provide both a forward and reverse fault simulation.

The procedure for preparing the system for functional test is as follows:

1. Remove the cover from Flexitest switch TS2 and open all red handles.
2. Remove the cover from Flexitest switch TS1 and open black handles D, E, F, G, and H.
3. Place an insulating barrier in the current test jaw marked E on TS-1.
4. If a rotary switch TCO is supplied in place of TS2, step one will be performed when TCO is placed in the test position.
5. If a rotary switch TCO is supplied, the functions of steps 2 and 3 will be performed by the "relay system test" switch.

When a single phase type FTU has been supplied the procedure for using the test panel is listed below.

Single Station Test

1. Prepare the system for testing.
2. Place the channel simulate switch (CSS) in the block position.
3. Place the relay system test (RST) switch in the test position.
4. (a) If a basic pilot system has been supplied, there should be no indication on the SRU or test panel.

   (b) If zone 1, zone 2 time, and high set have been supplied, the light indication should be:

   SRU: Zone 1, Zone 2 Time, High-set overcurrent (depending on 50H setting), and breaker trip.

   FTU: Breaker trip, reclose initiate, and reclose block if zone 2 time operates.
5. Return RST to normal, and then push the test reset pushbutton on the SRU and FTU. All lights should reset.
6. Repeat steps 2, 3, and 5 except with CSS in the unblock position.
7. The light indication should be:

   SRU: Bkr. trip, pilot phase, and pilot ground. If supplied, Zone 1, Zone 2 time, and inst. overcurrent.

   FTU: Brk. trip, reclose initiate, and reclose block if Zone 2 time operates.
8. Return RST and CSS to normal.
9. Reset all lights on the SRU and FTU.
10. If all lights remain off the system may be returned to normal.

Two Station Test

1. Prepare both line terminals for functional test.
2. Place RST in test at one end only. A block signal will be received from the other terminal.
3. The indication at the terminal where RST is in test will be the same as 4a and 4b under single station test. The other terminal should have no indication.
4. Return RST to normal and reset all lights.
5. Repeat steps 1 through 4 except reverse the RST switch position at those terminals.
6. If the above tests have been successful, place the RST switch at both terminals in the test position.
7. The indication at both terminals should be the same as shown in step 6 of the single station test.
8. Return both RST switches to normal, and reset all lights.
9. If all lights at both terminals remain off the system may be returned to normal.

When a three-phase type FTU is supplied, the procedure for using the test panel is listed below.

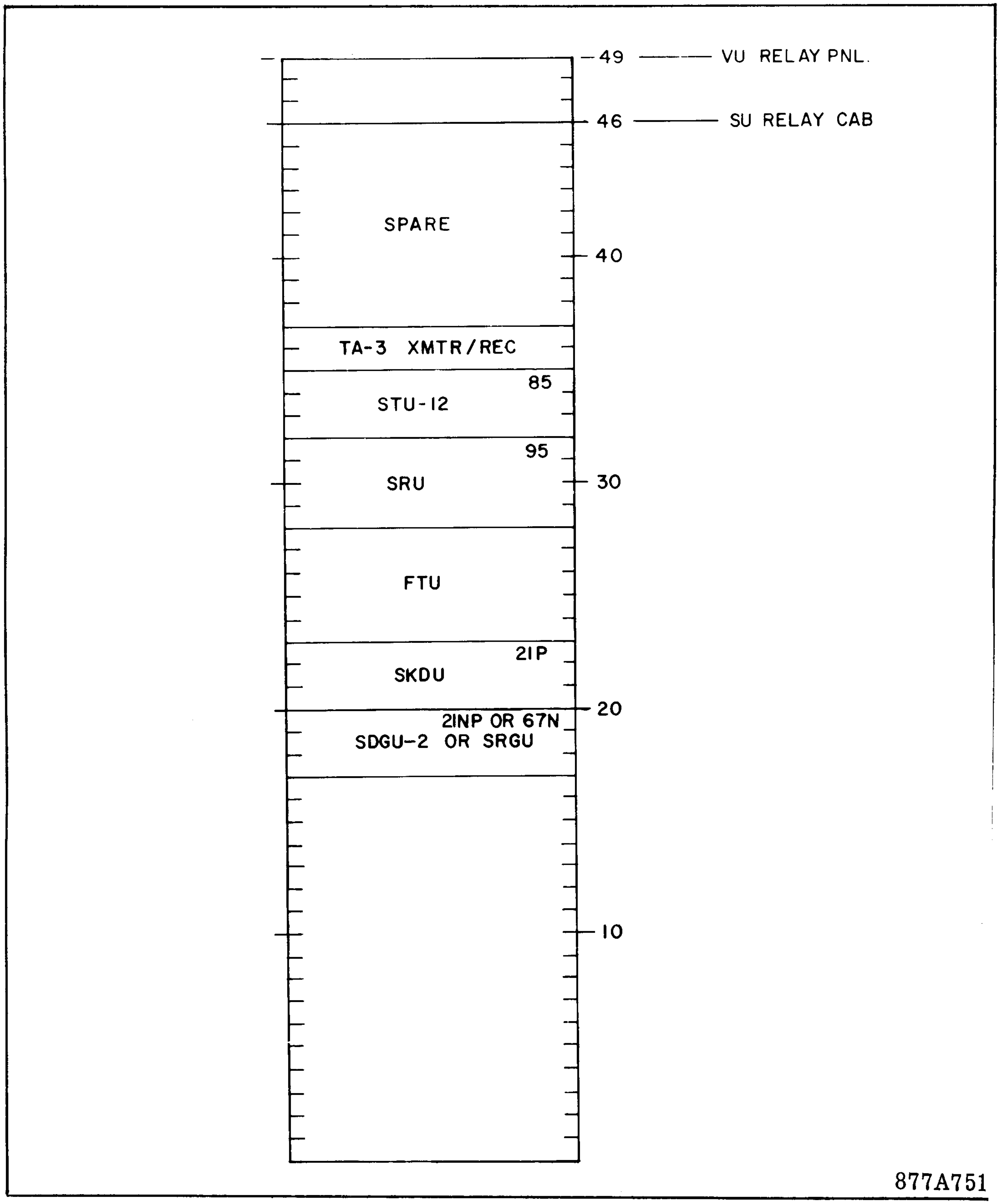

Fig. 9. Basic Transfer Trip System Rack Arrangement

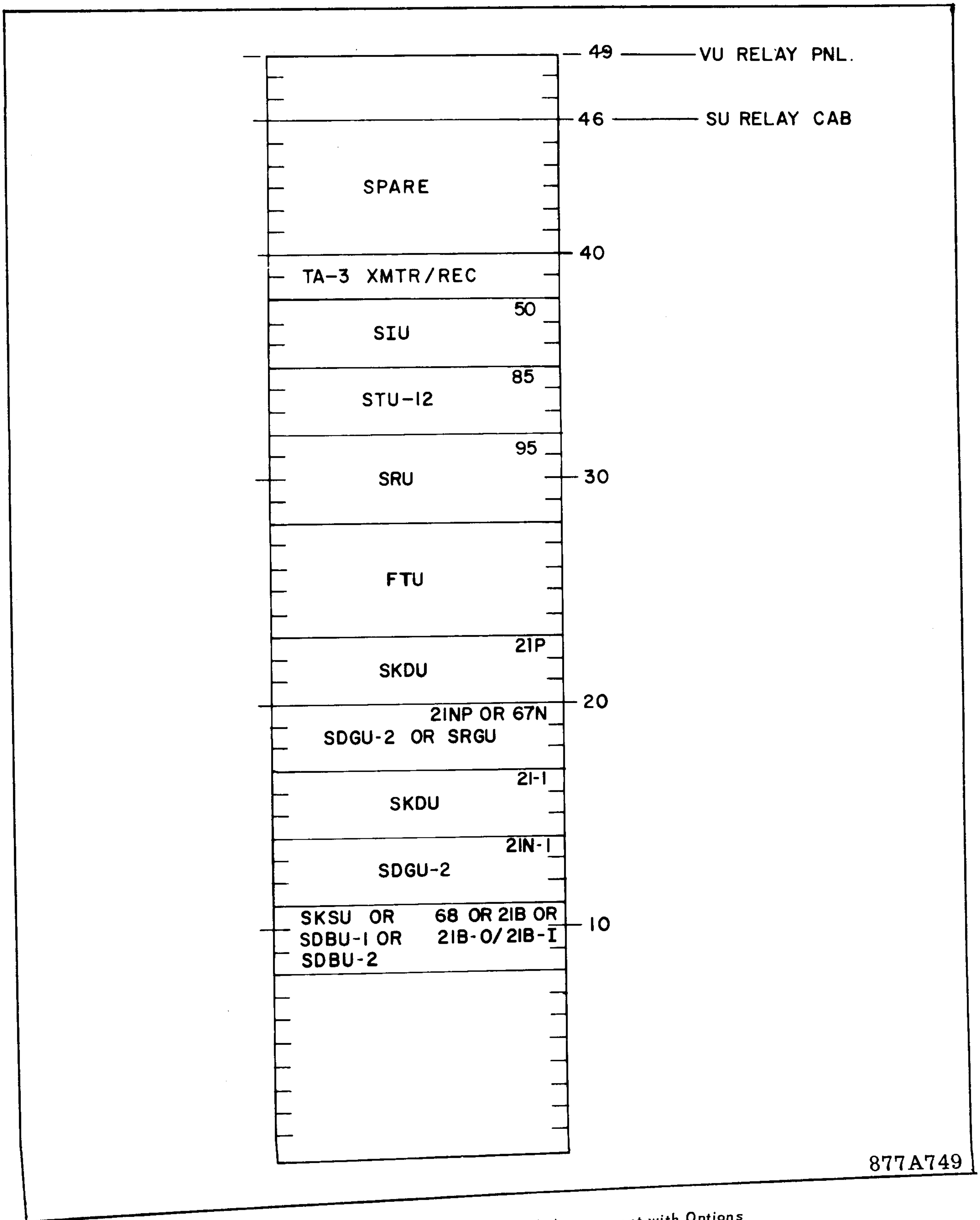

Fig. 10. Transfer Trip System Rack Arrangement with Options

Single Station Test

1. Prepare the system for test.
2. Place the channel simulate switch (CSS) in the guard position.
3. Pull the RST switch to the "out" position and then turn it to the reverse position.
4. No light indication should appear.
5. Repeat step 3 with the CSS in the trip position. Again no light indication should appear.
6. Now place the CSS switch in the block position.
7. Pull the RST switch to the "out" position and then turn it to the forward position.
8. (a) If a basic pilot system has been supplied, there should be no indication on the SRU or FTU.

   (b) If Zone 1, Zone 2 time, or high-set overcurrent has been supplied, the light indication should be:

   SRU: Zone 1, Zone 2 Time, High-set overcurrent (depending on 50H setting), and breaker trip.

   FTU: Brk. trip, reclose initiate, reclose block if Zone 2 time operates.
9. Return the RST switch to the "Normal In" position, and reset all lights.
10. Place the CSS switch in the trip position.
11. Pull the RST switch to the "out" position and then turn it to the forward position.
12. The following indication should appear.

    SRU: Bkr. trip, pilot phase, pilot ground. If supplied, Zone 1, Zone 2 time, and high-set overcurrent.

    FTU: Bkr. trip, reclose initiate, andreclose if Zone 2 time operates
13. Return the RST switch and CSS switch to normal, and reset all lights.
14. If all lights remain off, the system may be returned to normal.

Two Station Test

1. Prepare the system for test as described before.
2. Place the RST switch at one line terminal in the forward position, and place the RST switch at the other line terminal in the reverse position.
3. The indication at the terminal where RST is forward should be the same as described in step 8a and 8b of the single station test.
4. There should be no indication at the terminal where RST is in the reverse position.
5. Return both RST switches to normal, and reset all lights.
6. Repeat steps 2 through 5 except reverse the switch positions at each terminal.
7. Place the RST switch at both line terminals in the forward position.
8. The indication at both terminals should be the same as step 12 of the single station test.
9. Return both RST switches to normal.
10. Reset all lights.
11. If all lights remain off, return the system to normal.

If the system has been supplied with the SDBU-2 and OS-2 out-of-step logic, the following procedure may be used to test these circuits.

1. Prepare the system for testing.
2. Place the RST switch in test (single phase system) or forward (three phase system).
3. Press the OS-PB switch and hold.
4. The out-of-step trip light on the SRU should light, and the reclose block light on the FTU should light.
5. Release the OS-PB pushbutton.
6. Return the RST switch to normal.
7. If the OS trip switch on the SRU is in the ON position, the brk. trip lights on the SRU and FTU will now light.

8. Reset all lights.
9. If all lights remain off, the system may be returned to normal.

As an alternative to the above two station tests, a complete check of a terminal may be made by performing a single station test and a tone checkback test. The single station test will test the local relays, and the checkback test will prove the carrier can be keyed to trip in both directions. The carrier checkback test procedure is listed below.

1. Prepare the system for testing.
2. Turn the channel test switch (CST) to the OFF position.
3. Leave CTS in the off position for at least 3 sec. This will lockout the remote terminal.
4. Turn the CTS switch to the test position. This will cause a trip signal to be transmitted.
5. If the remote tone set is operating properly the received trip will cause the remote transmitter to be keyed for 2.5 sec.
6. The indication at the local terminal should be:

   SRU: Pilot phase, Pilot ground, and bkr. trips.

   FTU: Bkr. trips and reclose initiate.
7. Return the CTS to the normal position.
8. Reset all lights.
9. If all lights remain off, the system may be returned to normal.

If the tests listed above are performed and the system responds as indicated it is operating properly. However, if the system does not respond as it should, refer to the trouble shooting section of this I.L.

TROUBLE SHOOTING

If there is an indication that the system is not working properly, the following procedure will help locate the trouble.

An output from any relay is +20 VDC with respect to negative when operated.

1. Check the white light on the function test panel to be sure dc is applied to the system.
2. Check all SRU indication lamps by operating the lamp reset on the SRU.
3. Check the 20 volt dc logic supply voltage of each relay.
4. If all voltages are present place a scope or voltmeter at the pilot trip output of the STU-12 relay (TP1). Operate the functional test to an internal fault condition. If an output appears, the trouble is in the SRU relay logic. If there is no output from the STU relay, proceed to step 5.
5. Place a voltmeter at the 21P input to the STU-12 relay, and perform an internal functional test. Do this for 21NP or 67N when used, and the trip output of the TA-3 receiver.

   (a) If all of the above three outputs are present the STU-12 relay should be checked for trouble.

   (b) If one of the above fault detector inputs does not operate, the relay involved should be checked.

   (c) If the TA-3 receiver does not give a trip output, check to be sure a good channel is present. This may be done by placing a voltmeter on the low signal input of the STU-12 relay. For a good channel the meter should read + 18 VDC.

   If a good channel indication exists check the noise input to the STU-12. This input should be at 0 VDC. If it is at + 18 VDC, either excessive noise is present or the TA-3 noise receiver is not operating properly. If a good channel does not exist, the audio input voltage should be measured with an ACVTVM to be sure a signal of the proper level is being received from the remote terminal.

   If a signal is being received the TA-3 receiver is at fault.

When it is determined which relay is not operating properly, refer to that relay's instruction leaflet for trouble shooting procedure for the relay.

RECOMMENDED TEST EQUIPMENT

1. Oscilloscope
2. Frequency Counter
3. AC Vacuum Tube Voltmeter
4. TCT Test Meter Unit
5. Carrier Frequency Signal Generator
6. Carrier Frequency Tuned Voltmeter
7. Plus the standard equipment in Section 12 of the "Applied Protective Relaying" book published by Westinghouse Electric Corporation.

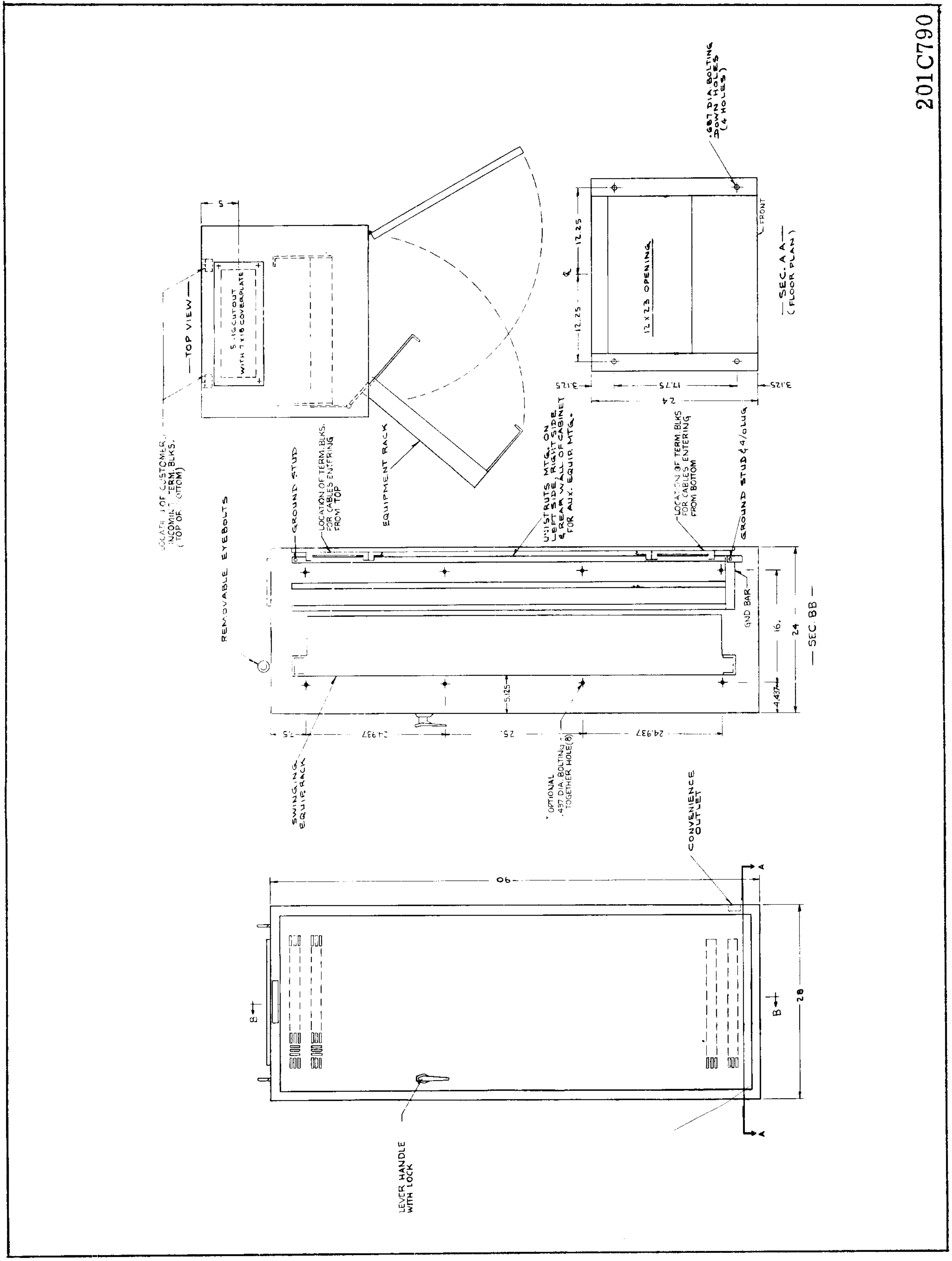

Fig. 11. Type SU Cabinet Outline

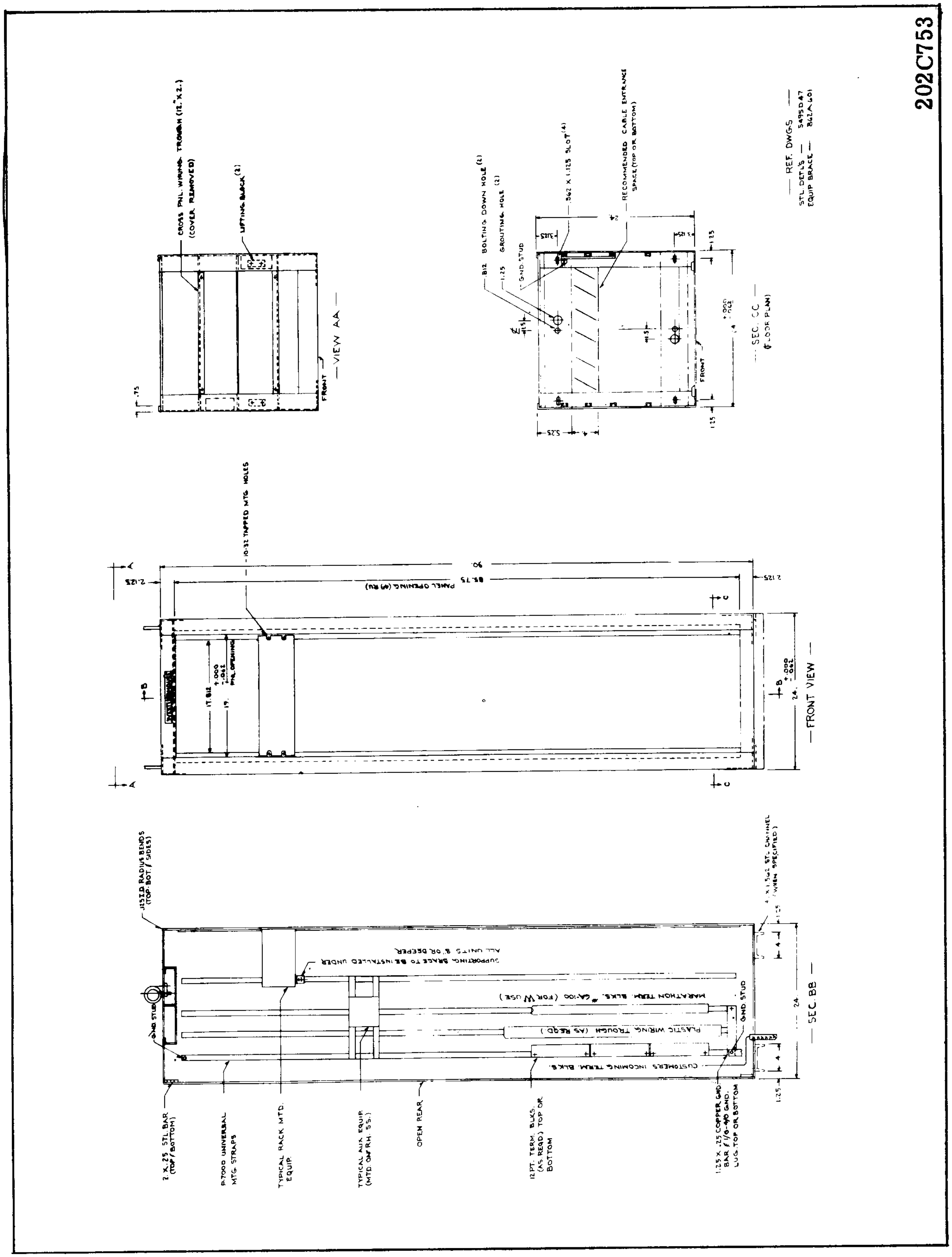

Fig. 12. Type VU Panel Outline

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RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**
Printed in U.S.A.