223-TYPE COAXIAL SWITCHES

REQUIREMENTS

1. GENERAL

1.01 This section covers the method of making transmission and dc operational tests on the 223A, 223B, and 223C coaxial switches when these switches are used to switch signal circuits at frequencies up to 80 megahertz. It also includes the test requirements for the 223D and 223E switches. A method of cleaning the 223A, 223B, and 223C switches is also included.

1.02 This section is reissued to include the 223D and 223E switches. Since this is a general revision, arrows ordinarily used to denote changes have been omitted.

1.03 The 223-type switch (Fig. 1, 2, 3, and 4) is a high-speed, electro-magnetically operated, coaxial-type transfer switch used for switching 75-ohm lines at high frequencies. The 223A, 223B, and 223C switches are reed-type mercury switches while the 223D and 223E switches are the dry-reed sealed contact type. The D and E switches are similar although the D switch is designed to operate at 60 V dc and the E switch at 24 V dc.

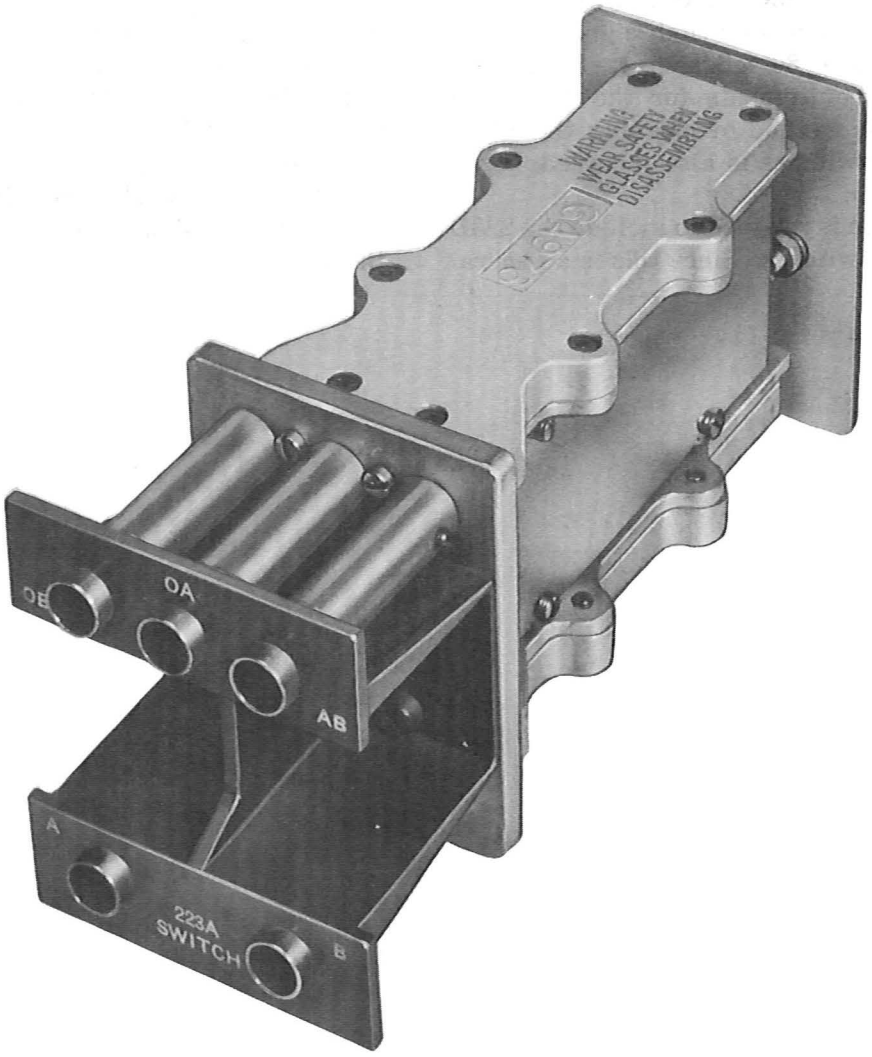


Fig. 1 — 223A Coaxial Switch, Assembled

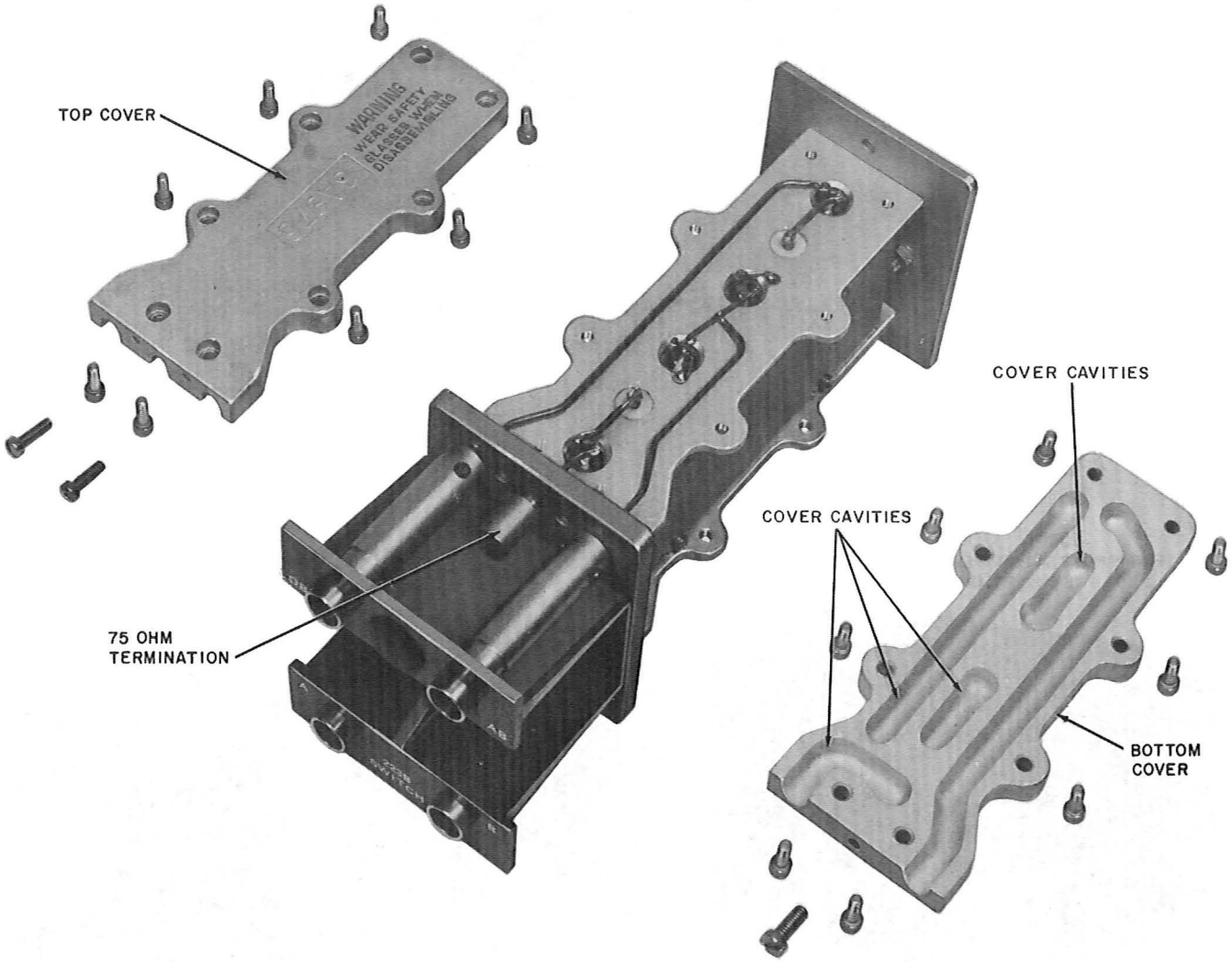


Fig. 2 — 223B Coaxial Switch, Disassembled, Top View

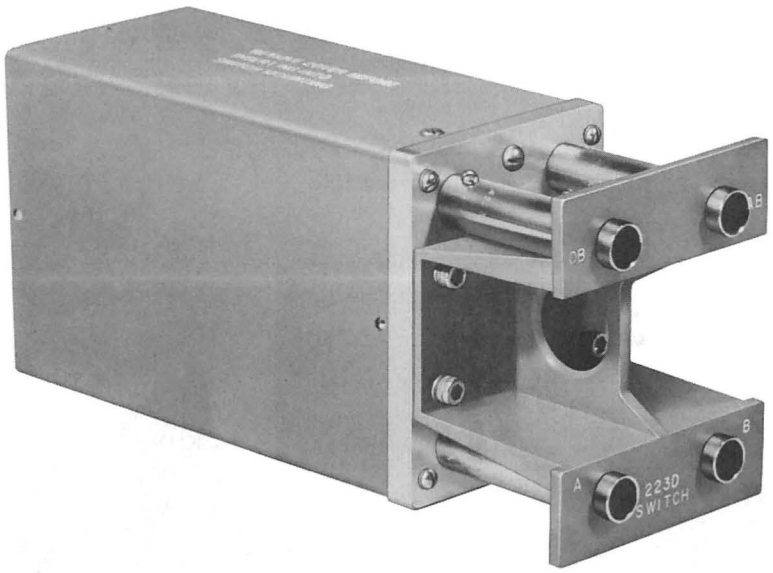


Fig. 3 — 223D Coaxial Switch, Assembled

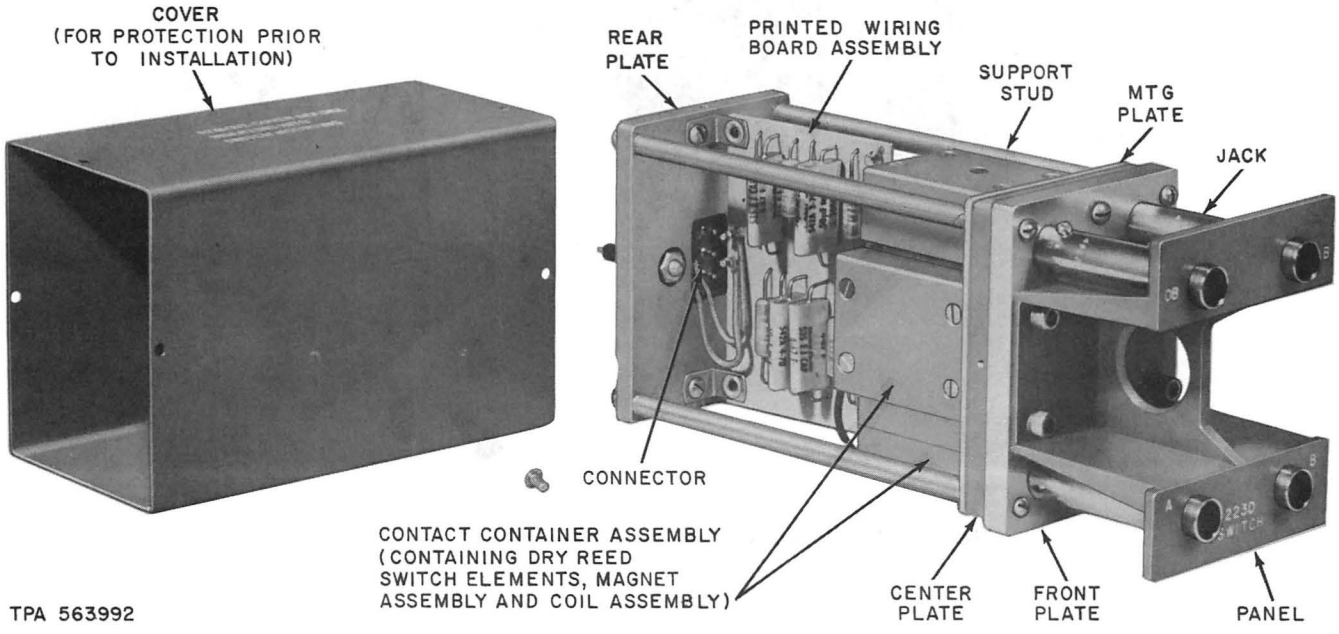


Fig. 4 — 223D Coaxial Switch, Cover Removed

1.04 There are two separate transmission paths through the switches. In all switches, with the switch normal, the paths are: Path A to AB and Path B to OB. With the switches operated, the paths for the 223A, 223B, and 223C switches are: Path A to OA and Path B to AB. See Fig. 5. For the 223D and 223E switches, these paths are: Path A to OB and Path B to AB. See Fig. 6.

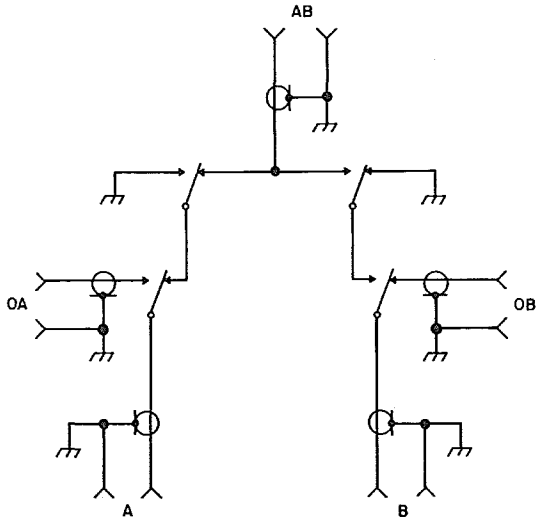


Fig. 5 — 223A Coaxial Switch Schematic Shown in Normal (Released Condition)

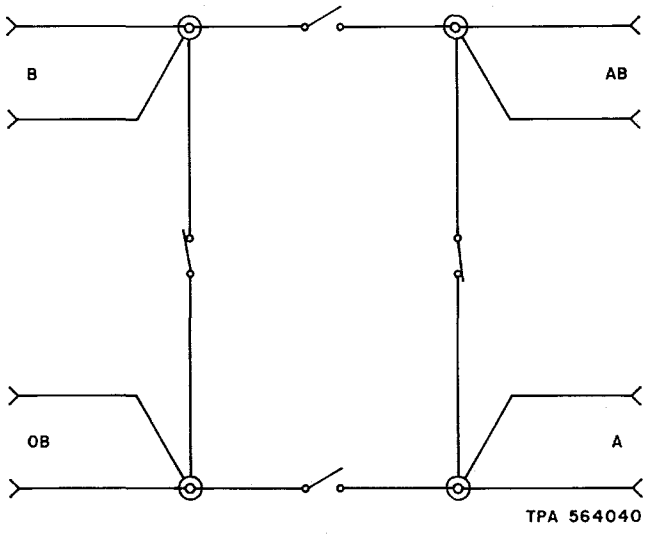


Fig. 6 — 223E Coaxial Switch Schematic Shown in Normal (Released Condition)

1.05 In the 223A, 223B, and 223C switches, jack OB is provided so in normal (nonoperated or released) condition, the input B can be terminated by a 75-ohm circuit or termination.

1.06 In the 223A and 223C switches, jack OA is provided so in the operated condition, input A can be terminated.

1.07 In the 223B switch, Jack OA is replaced with a built-in 75-ohm resistive termination, internal to the switch.

2. PRECAUTIONS

2.01 These precautions apply only to the 223A, 223B, and 223C switches.

2.02 Safety glasses must be worn while disassembling, cleaning, and reassembling the switch. The four glass-sealed mercury switching elements of the 223A, 223B, and 223C coaxial switches contain hydrogen at a pressure of 100 pounds per square inch.

2.03 ***Exercise extreme caution. Do not place a strain on any of the conductors which may result in a bent lead, broken glass capsule, or broken solder joint. The dress of the leads is important at high frequencies and should not be disturbed.***

2.04 When reassembling, make certain no foreign matter has been allowed to enter the cavity areas and cover junction surfaces are clean and dry.

3. CLEANING OF THE SWITCH

3.01 These cleaning procedures apply only to the 223A, 223B, and 223C switches.

3.02 Failure of the switch to meet any of the test requirements hereinafter specified may be due to the formation of metallic whiskers on the die-cast surfaces adjacent to the copper-inner conductors. Switches found to be malfunctioning as indicated by the tests might be restored to an operative condition by resorting to a cleaning procedure that would remove whiskers which may be present.

3.03 Metallic whiskers can be removed as follows:

(1) Remove the top cover plate.

(2) Either of the following two methods may be used to remove whiskers:

(a) Direct a blast of pressurized air (from air line or aerosol can) to cover cavities and mating main body areas for a few seconds. This method is preferred because it is fast and the most efficient.

(b) Using a clean soft bristle brush such as the KS-2993 brush, clean the cover cavities and the mating main body areas.

(3) Replace the top cover and repeat the procedure on the bottom of the switch.

3.04 Switches that cannot be cleaned using this method may be considered defective and returned in accordance with local instructions to the Western Electric Company.

3.05 A tag shall be attached to any returned switch with a brief statement regarding trouble experienced and whether or not there was any evidence of mercury present on the exterior of the switch at the time of removal from service. This, if present, is in the form of a black discoloration.

4. TESTS OF 223A, 223B, and 223C SWITCHES

4.01 These tests include operate and release current values, transmission, crosstalk, return loss, and switching time tests.

4.02 These tests are on an out-of-service basis.

4.03 If any requirements in the following tests cannot be met, the switch should be returned to the Western Electric Company on an Engineering Complaint form E-5141 in accordance with local instructions.

4.04 The following apparatus is required for these tests:

1 — 35-Type Relay Test Set

1 — J68340A or J68345A Test Bay

1 — J68333 Test Bench

1 — Spare TD-2 IF Main Amplifier

1 — KS-16669 Timing Test Set

1 — KS-14510 L5 Volt-Ohm-Milliammeter

1 — P2CF Cord

Misc. P2BJ Patch Cords

3 — 368A Plugs

1 — 358A Shorted Plug

1 — Power Cord per Fig. 7.

4.05 ***Operate and Release Current Test:***

(a) Establish test circuit of Fig. 8.

(b) For the 223A or B switch, set the 35-type test set as follows:

(1) Set resistance switches associated with key number 4 to 100,000 ohms. (3 right-hand toggle switches in top row.)

(2) Close key 4 and adjust rheostat 4 for a current of 1.0 ma through the switch.

(3) Close key 3 and adjust rheostat 3 for a current of 5.5 ma.

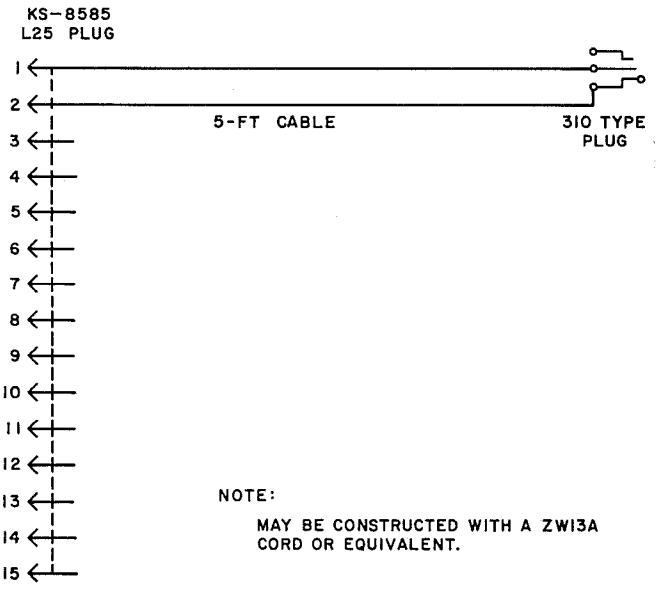
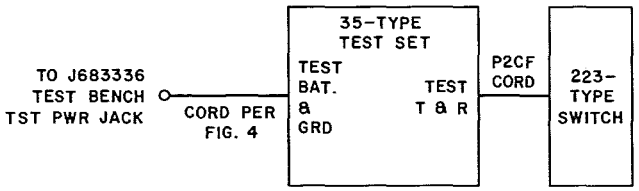


Fig. 7 — Power Cable to Connect 35-Type Test Set to J68333 Test Bench



35-TYPE TEST SET
PREPARATION FOR TEST

1. SET ALL RHEOSTAT SLIDERS FOR MAXIMUM RESISTANCE (EXTREME RIGHT).
2. OPEN ALL KEY SWITCHES.
3. G SWITCH TO OPEN. BAT. & GRD CO LEVER SWITCH NORMAL. REV LEVER SWITCH NORMAL. VM SWITCH NORMAL (TO READ CURRENT). ALL RESISTANCE SWITCHES TO 0.
4. ESTABLISH TEST CIRCUIT.

Fig. 8—Test Arrangement to Operate 223-Type Switch

This establishes the release and operate current values for the 223A and B switches. With key 4 closed for the remainder of the tests, closing or opening key 3 will operate or release the 223 switch.

(c) For the 223C switch, set the 35-type test set as follows:

(1) Close key 4 and adjust rheostat 4 for 5 ma.

(2) Close key 3 and adjust rheostat 3 for 20 ma.

This establishes the release and operate current values for the 223C switch. With key 4 closed for the remainder of the tests, closing or opening key 3 will operate or release the 223C switch.

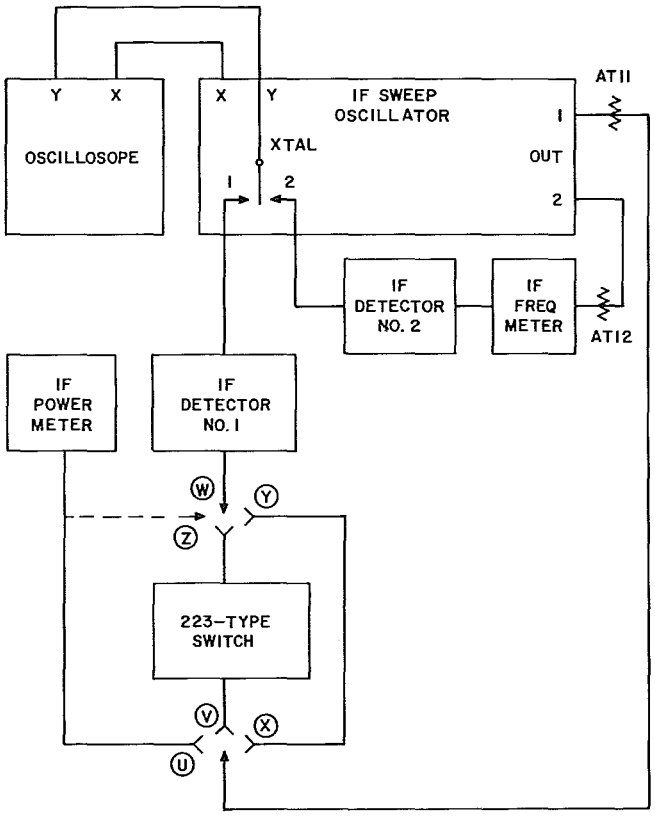
(d) Establish the test circuit of Fig. 9 (40A bay) or Fig. 10 (45A bay) and prepare for test.

(e) Connect the test circuit to the 223-switch as shown by options V (jack A) and Z (jack AB). With the 223-switch released, the IF power meter should read approximately 0 dB.

(f) Operate the switch by closing key 3 on the 35-type test set. The IF power meter reading should drop. Release and operate the switch several times to ensure that the contacts do not bridge permanently.

(g) Change option V to jack B and Z to jack AB. With the 223 switch released the IF power meter should show no reading.

(h) Operate the switch. The IF power meter should read 0 db. Operate and release the switch several times to ensure that the contacts do not bridge permanently.

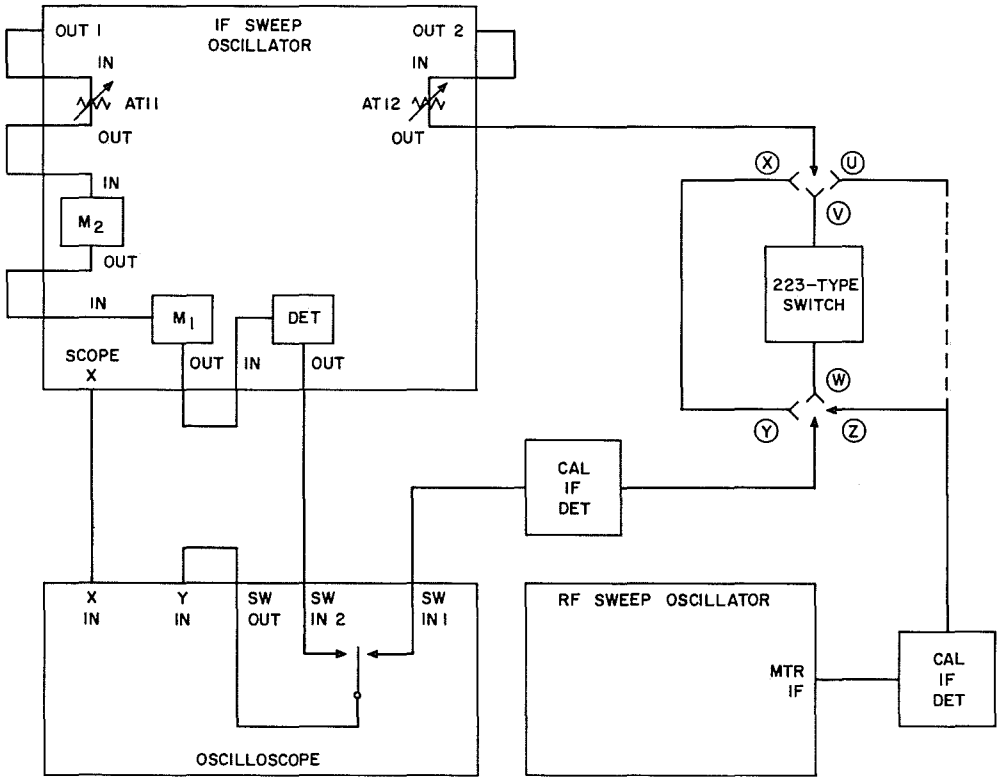


40 A TEST BAY
PREPARATION FOR TEST

1. OPERATE SWEEP AND SLOPE CONTROLS TO OFF.
2. SET OSCILLATOR TO 70 MC.
3. CONNECT CIRCUIT PER OPTION U.
4. ADJUST AT11 TO GIVE A READING OF 0 DBM ON THE IF POWER METER.
5. SET AT12 TO THE SAME VALUE AS AT11.

NOTE:
IF DETECTOR NO. 1 SHOULD BE THE PORTABLE ONE.

Fig. 9 — Arrangement for Transmission Test of 223-Type Switches Using 40A Test Bay



45A TEST BAY
PREPARATION FOR TEST

1. OPERATE SWEEP AND SLOPE CONTROLS TO OFF
2. CONNECT CIRCUIT PER OPTION U.
3. ADJUST AT12 TO GIVE A READING OF 0 DB ON THE IF POWER METER.
4. SET AT11 TO THE SAME VALUE AS AT12.

Fig. 10 — Arrangement for Transmission Test of 223-Type Switches Using 45A Test Bay

4.06 ***Transmission Tests:***

(a) Change the test circuit of Fig. 9 or Fig. 10 to option X and Y.

(b) Adjust the following IF frequency meters:

40A TEST BAY (Fig. 9)	45A TEST BAY (Fig. 10)
Meter on IF oscillator to 80 mc. Meter on IF detector #2 to 60 mc.	M1 to 80 mc M2 to 60 mc

40A TEST BAY (Fig. 9)	45A TEST BAY (Fig. 10)
(c) Turn on sweep and adjust horizontal gain of scope to a scale of 10 mc per inch by making the two frequency meter pips 2 inches apart.	Adjust the sweep to maximum and adjust horizontal gain of scope to a scale of 10 mc per main division by making the two IF frequency meter pips 2 main divisions apart.

(d) Adjust the following control to make the test and reference traces coincide at 70 mc:

40A TEST BAY (Fig. 9)	45A TEST BAY (Fig. 10)
ADJ XTAL 1	ADJUST INPUT 1

Note: If necessary, reverse SW IN 1 and SW IN 2 cords due to slight difference in their lengths. See (h).

(e) Increase the setting of the following attenuator by 1 db:

40A TEST BAY (Fig. 9)	45A TEST BAY (Fig. 10)
AT11	AT12

Adjust the vertical gain of the scope to a scale of 1 db per inch by making the separation of the traces equal to 1 inch.

(f) Decrease the attenuator setting in step (e) 1 db to its previous value. The traces should coincide at 70 mc within ±0.05 inch. If not, repeat steps (d), (e), and (f).

(g) Because of the close limits which must be met by the gain-frequency characteristics, the test trace must match the reference trace as exactly as possible before the amplifier is connected into the circuit.

Requirement: When the highest point of the test trace coincides with the reference trace, no point on the test trace should be below the reference trace by more than 0.05 db between 60 and 80 mc.

(h) If this requirement is not met, the test and reference circuits should be examined and made as nearly alike as posible. For example, lengths of patch cord should be changed and the effect of the slope of the traces noted. Minor rearrangements are ordinarily adequate to meet the requirement.

(i) Change the circuit of Fig. 9 (40A Bay) or Fig. 10 (45A Bay) to Option V (jack A) and W (jack AB). Terminate all unused jacks on the 223 switch.

Requirement: With the 223 switch released, no point on the test trace should be more than 0.2 db below the reference trace.

(j) Change option V to jack B and W to jack OB.

Requirement: With the 223 switch released, no point on the test trace should be more than 0.15 db below the reference trace.

(k) Change option W to jack AB and operate the 223 switch.

Requirement: No point on the test trace should be more than 0.2 db below the reference trace.

(l) For the 223A or C switch, change option V to jack A and W to jack OA. Operate the switch.

Requirement: No point on the test trace should be more than 0.15 db below the reference trace.

(m) For the 223B switch, set the KS-14510 volt-ohm-milliameter to read ohms. Connect the meter to the center conductor and shell of jack A. Operate the switch.

Requirement: 70 to 80 ohms.

4.07 *IF Return Loss Tests:*

(a) Prepare the test equipment and the test bench for tests as shown in Fig. 11 and Fig. 12.

40A TEST BAY (Fig. 11)	45A TEST BAY (Fig. 12)
(b) Adjust AT11 to read +3.0 dbm on IF power meter.	Adjust AT13 to read +3.0 dbm on MTR IF.
(c) Adjust AT12 to same value as AT11.	Adjust AT11 to same value as AT13.
(d) Change from (X) to (Y) option.	

(e) Adjust the following IF frequency meters:

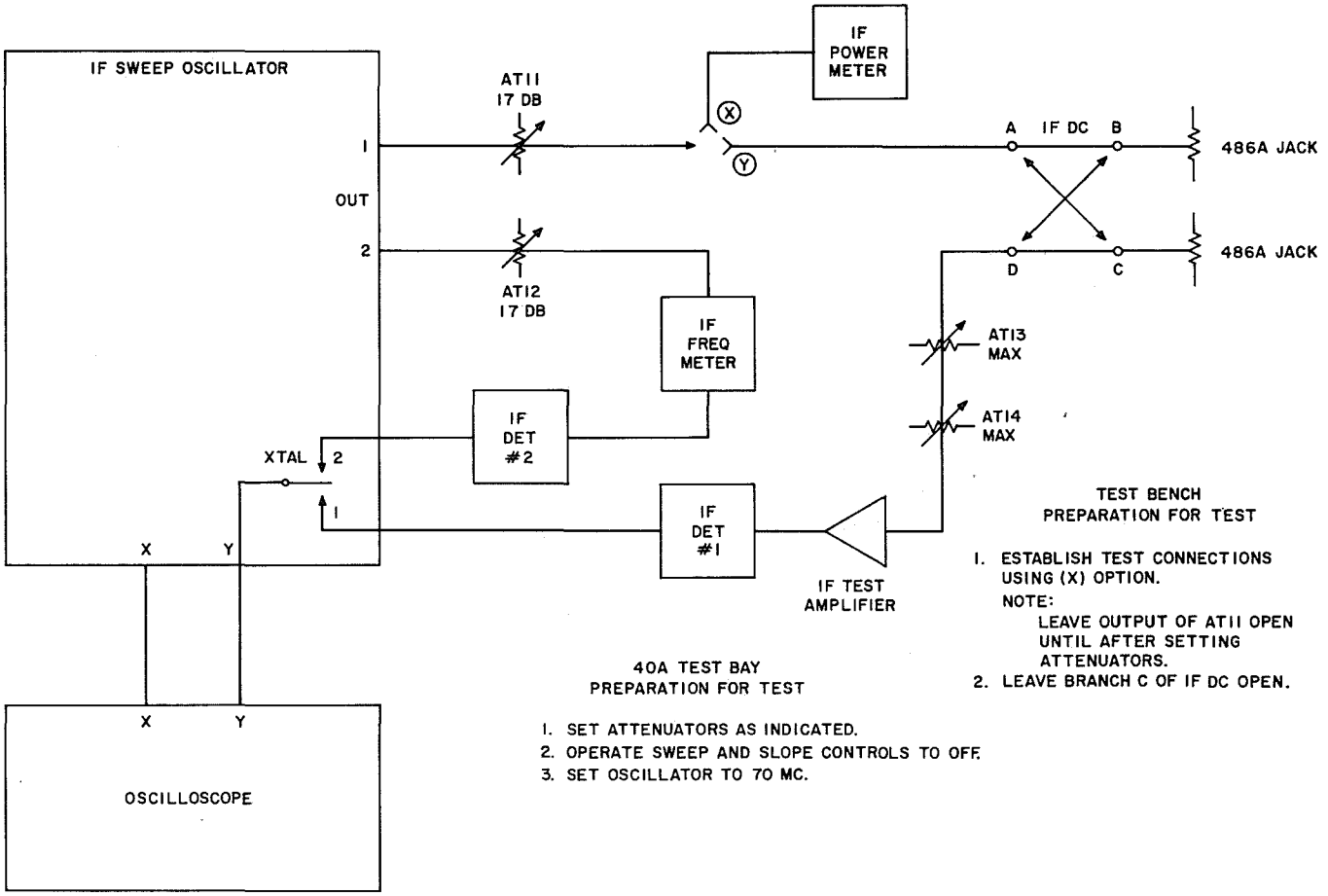


Fig. 11 — Test Arrangement for Return Loss Measurement of the 223-Type Switch Using 40A Test Bay

40A TEST BAY (Fig. 11)	45A TEST BAY (Fig. 12)
Meter on IF oscillator to 80 mc. Meter on IF detector #2 to 60 mc.	M1 to 80 mc M2 to 60 mc
(f) Turn on sweep and adjust horizontal gain of scope to a scale of 10 mc per inch by making the two frequency meter pips 2 inches apart.	Adjust the sweep to maximum and adjust horizontal gain of scope to a scale of 10 mc per main division by making the two IF frequency meter pips 2 main divisions apart.

(g) Set the following attenuators for a loss totaling 38 db:

40A TEST BAY (Fig. 11)	45A TEST BAY (Fig. 12)
AT13 and AT14	AT12 and AT14

(h) Turn on the SLOPE.

(i) Adjust the gain of the amplifier and controls, indicated below, for coincidence of test and reference traces, producing a scope picture similar to Fig. 13B:

40A TEST BAY (Fig. 11)	45A TEST BAY (Fig. 12)
ADJ SLOPE ADJ XTAL 1	SLOPE ADJUST INPUT 1

This condition, including the attenuation of 38db, obtained in (g), constitutes a calibration for reference in adjusting impedance. Reflection from the open end of branch C of IF DC should be practically complete.

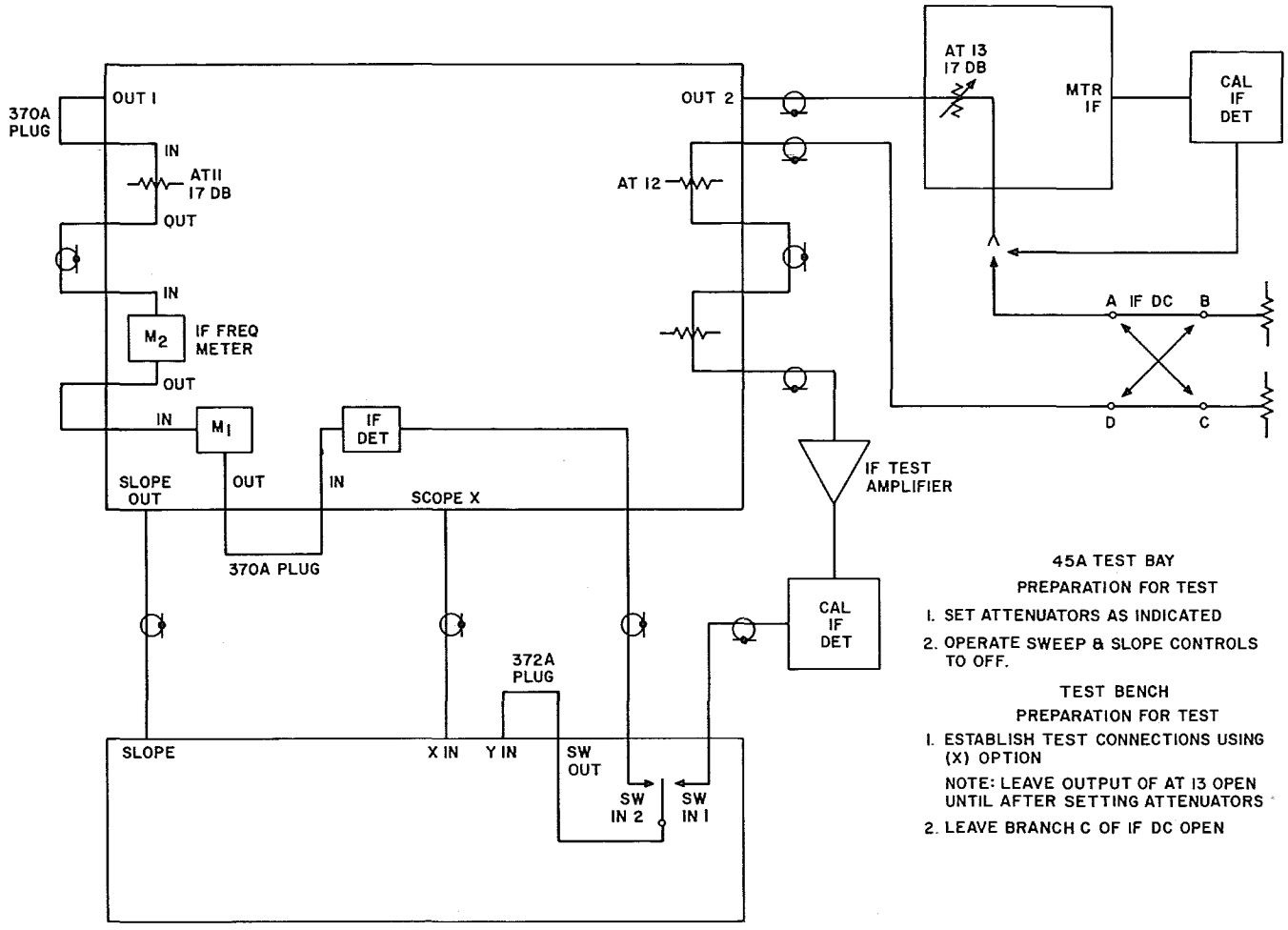


Fig. 12 — Test Arrangement for Return Loss Measurement of the 223-Type Switch Using 45A Test Bay

(j) Adjust the vertical gain of the scope to 1 db per inch by noting the change in position of the test trace when the following attenuator is decreased by 1 db and increased again 1 db:

40A TEST BAY (Fig. 11)	45A TEST BAY (Fig. 12)
AT11	AT12

(k) Terminate branch C of IF DC with a 486A jack. Reduce the attenuators in (g) to zero.

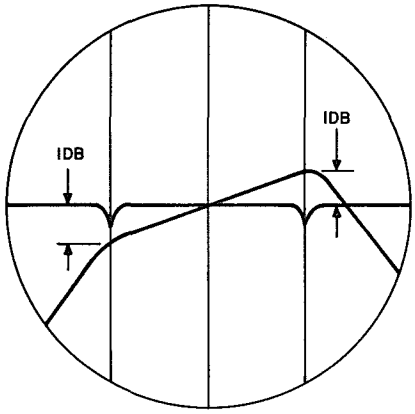
Requirement: The test trace should remain below the reference trace between 60 and 80 mc.

If this requirement is not met, either IF DC or one of the 486A jacks is defective. This condition must be cleared before proceeding with the test.

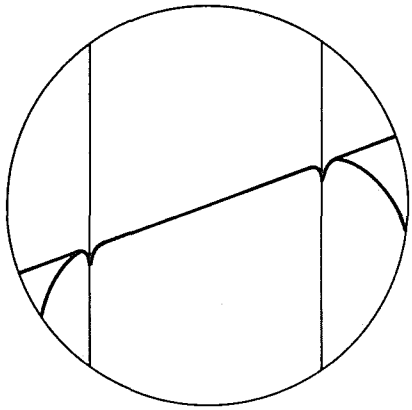
(l) Remove the 486A jack from branch C of IF DC.

(m) Connect branch C to jack A of 223-type switch. With all unused jacks of the 223 switch terminated with 368A plugs, the test trace should remain below the reference trace for both operated and released condition of switch. (>38 db return loss.)

(n) Repeat (m) with branch C connected to jack B.



A. NO TERMINATION
SLOPE CKT OFF



B. NO TERMINATION SLOPE CKT
ON REF TRACE ADJUSTED
TO MATCH TEST TRACE

Fig. 13 — Oscilloscope Trace Appearance for Return Loss Setup

4.08 *Crosstalk Tests:*

(a) Establish the circuit of Fig. 14 or 15 option U.

(b) Adjust the following attenuators for a reading of 0 dbm on the IF power meter:

40A TEST BAY (Fig. 14)	45A TEST BAY (Fig. 15)
AT11	AT12

(c) Change to options V, Z, and X.

(d) Set AT13 and AT14 to a total of 100 db.

(e) Adjust IF-gain and MAN-gain controls on test bench for a reading of 0 db on the IF power meter.

(f) Reduce AT14 3 db. The IF power meter reading should increase 3 db. If it does not, test the IF amplifiers per Section 410-724-500 before continuing the crosstalk test.

(g) With the 223 switch released, connect the test circuit per options y, w, and x. Jack connections for options y and w are shown in Table A. Reduce AT13 and AT14 to obtain a reading of 0 db on the IF power meter. Determine the crosstalk loss as 100-(AT13 + AT14).

Requirements per Table A:

TABLE A

SWITCH IN RELEASED CONDTION

OPTION (See Note 1)	JACK				
W / Y	A	B	AB	OA (See Note 2)	OB
JACK A	—	90 db MIN	—	30 db MIN (See Note 2)	—
JACK B	90 db MIN	—	—	90 db MIN (See Note 2)	—

Note 1: Option W reads horizontally.
Option Y reads vertically.

Note 2: 223 A&C only.

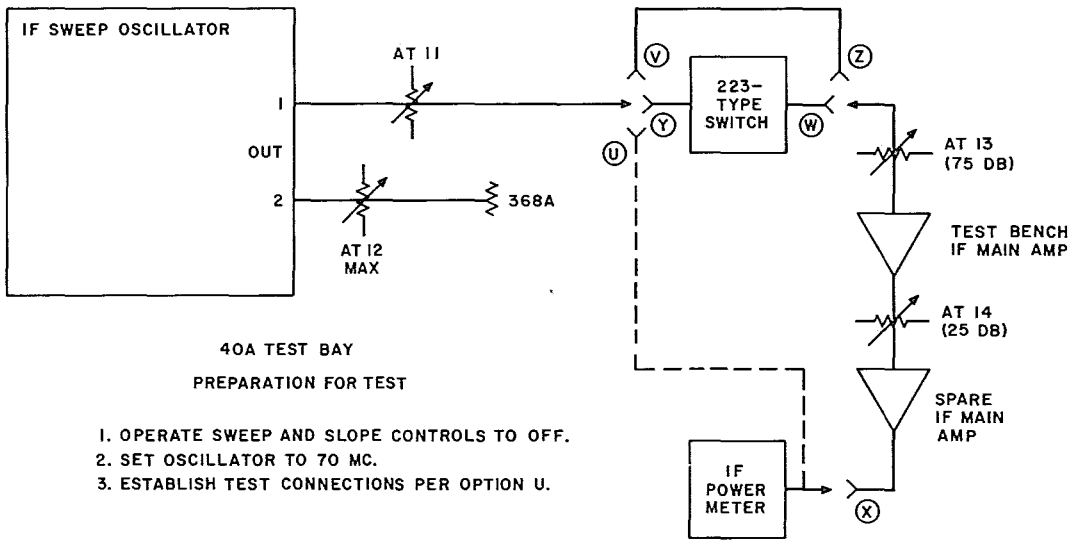


Fig. 14 — Arrangement for Crosstalk Test Using 40A Test Bay

TABLE B

SWITCH IN OPERATED CONDITION

OPTION (See Note) / JACK	A	B	AB	OA	OB
JACK A	—	90 db MIN	—	—	90 db MIN
JACK B	90 db MIN	—	—	—	30 db MIN

Note: Option W reads horizontally, Y vertically.

(h) Repeat (g) for the switch operated using Table B.

4.09 ***Operating Time Tests:***

Note: These tests apply only to 223A and B switches.

(a) Break Contact Test

(1) Set up the test circuit as shown in Fig. 16A.

(2) Set the controls of the KS-16669 L1 timing test set as follows:

CONTROL	POSITION
AUTO-TIME	Full Clockwise
SLOPE	—
LEVEL	Midway between + and —

(3) Operate the AUTO-OP switch of the KS-16669 timing test set. The test set will register directly in tenths of milliseconds the time required for the 223 switch to operate.

(4) Repeat step (3) ten times allowing at least 10 seconds to elapse between operations.

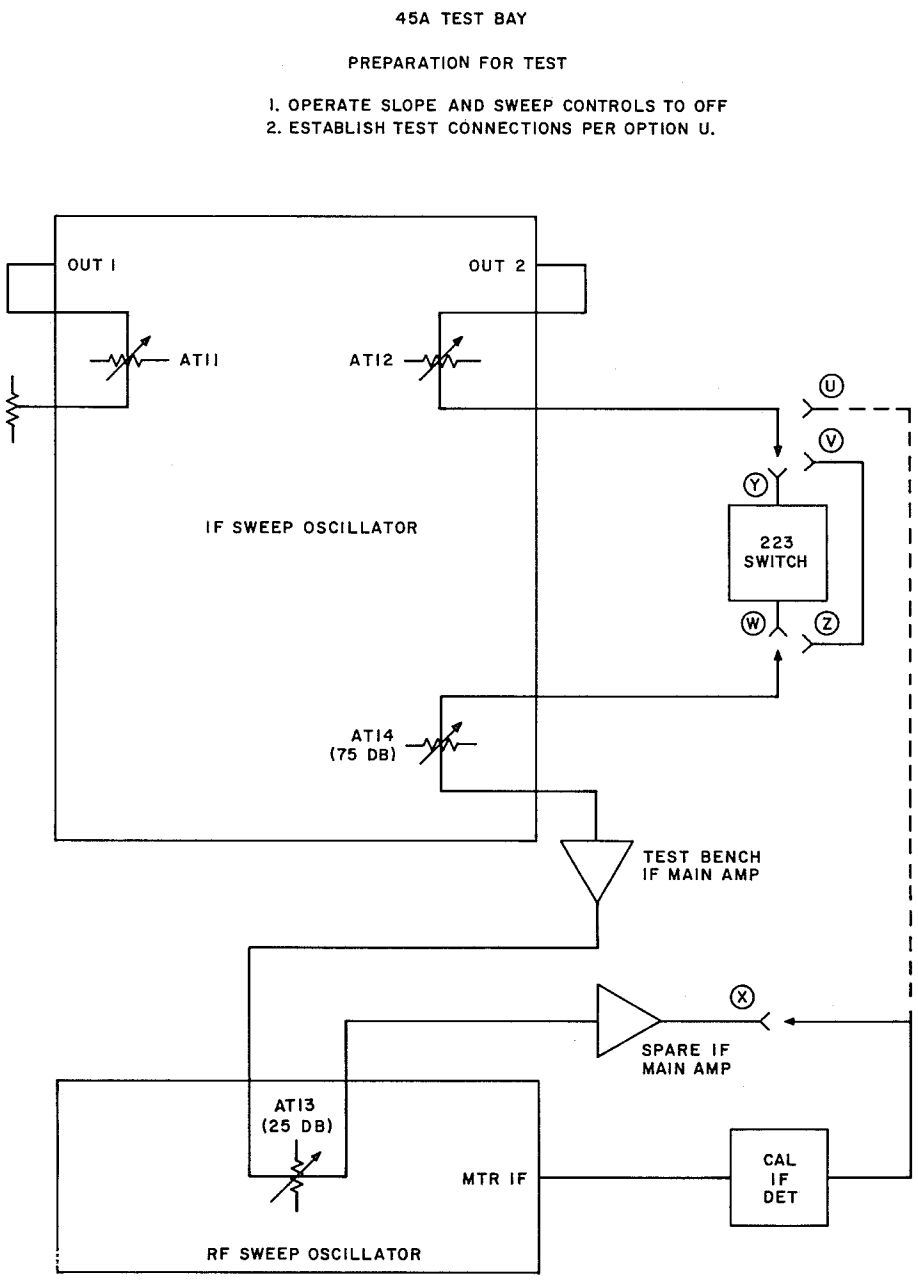


Fig. 15 — Arrangement for Crosstalk Test Using 45A Test Bay

(5) Divide the time registered on the test set by 10 and record.

(6) Operate the RESET button on the test set.

Requirement: The operate time shall not be more than 2 milliseconds.

(b) Make Contact Test

(1) Set up the test circuit as shown in Fig. 16B.

(2) Set the controls of the KS-16669 L1 timing test set as follows:

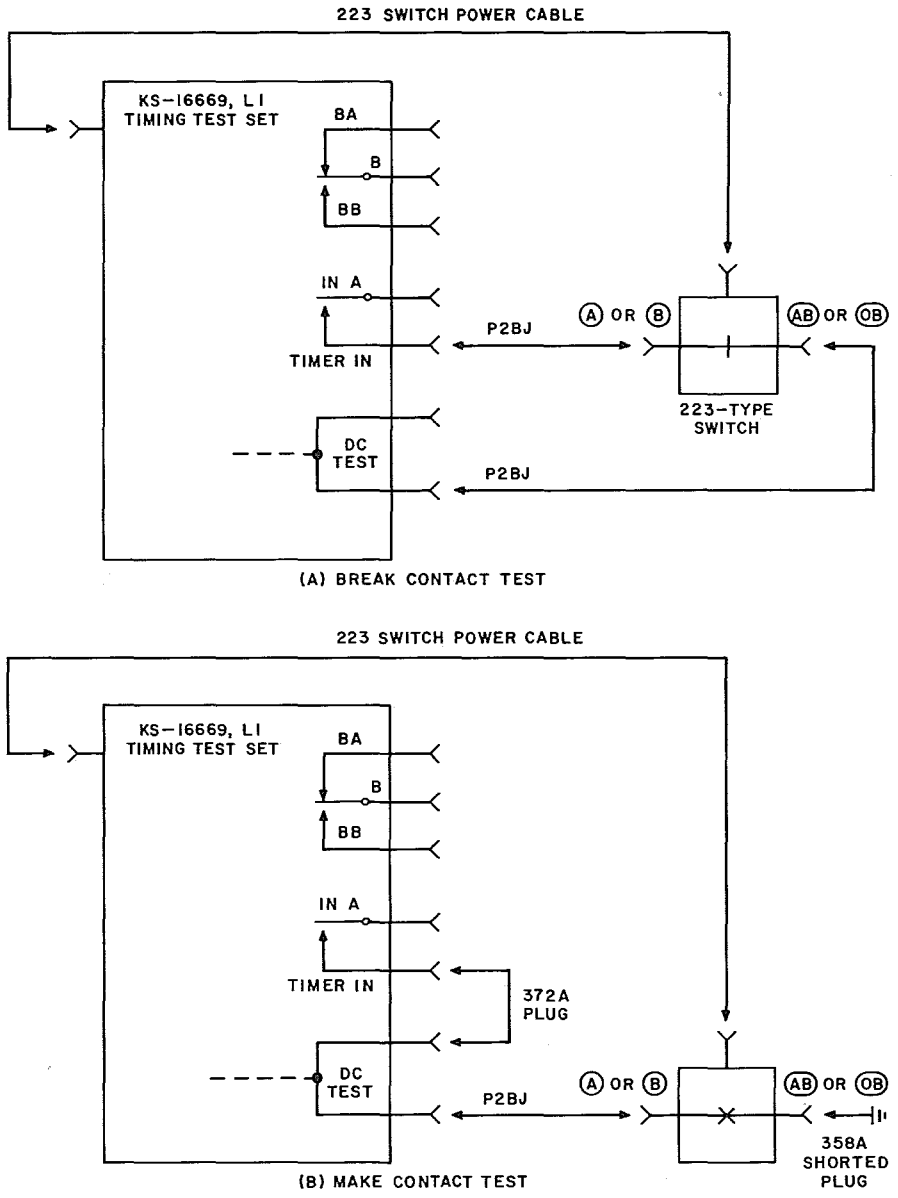


Fig. 16 — Test Arrangement for 223-Type Switch Timing Tests

CONTROL	POSITION
AUTO-TIME	Full Clockwise
SLOPE	—
LEVEL	Midway between + and —

(3) Operate the AUTO-OP switch of the KS-16669 timing test set. The test set will register directly in tenths of milliseconds the time required for the 223 switch to operate.

(4) Repeat step (3) ten times allowing at least 10 seconds to elapse between operations.

(5) Divide the time registered on the test set by 10 and record.

(6) Operate the RESET button on the test set.

Requirement: The operate time shall not be more than 2 milliseconds.

5. TEST REQUIREMENTS FOR 223D AND 223E SWITCHES

5.01 *Adjustment of Block Magnets*

(a) After assembly, blocks P-44N102 or P-44N103 shall be magnetized to saturation. The S pole (Fig. 17) shall attract the north seeking pole of a magnetic compass.

(b) Using the indicating current (Fig. 18), or its equivalent, each block, P-44N102 or P-44N103, shall be demagnetized until both switch elements (combined) open at 8.0 ±0.5 ma. The first switch should open at 6 ma or greater.

(c) Using the indicating current (Fig. 18), verify that each block, P-44N100 or 101 switch elements close between 5 and 7 ma and opens at 2.4 ±0.5 ma.

5.02 Insertion loss is the loss when a path is completed. Isolation loss is the loss across the path when the contact is open. The following table can be used to determine these losses:

FREQUENCY 8 MHz COIL CURRENT	PATH	PATH LOSS	SWITCH
<1ma	A-AB, B-OB	≤0.2db	223 D&E
<1ma	A-OB, B-AB	≥90db	223 D&E
>9.5ma	A-AB, B-OB	≥90db	223 D
>9.5ma	A-OB, B-AB	≥0.2db	223 D
>20ma	A-AB, B-OB	≥90db	223 E
>20ma	A-OB, B-AB	≥0.2db	223 E

5.03 Return loss tests are used to determine that the impedance of unit is within specified range at jack under test. The following table may be used to determine this loss:

FREQUENCY 8 MHz COIL CURRENT	MEASURED AT JACK	TERMINATED AT JACK	RETURN LOSS	SWITCH
<1ma	A	AB	≥35db	223 D&E
<1ma	B	OB	≥35db	223 D&E
>9.5ma	A	OB	≥35db	223 D
>9.5ma	B	AB	≥35db	223 D
>20ma	A	OB	≥35db	223 E
>20ma	B	AB	≥35db	223 E

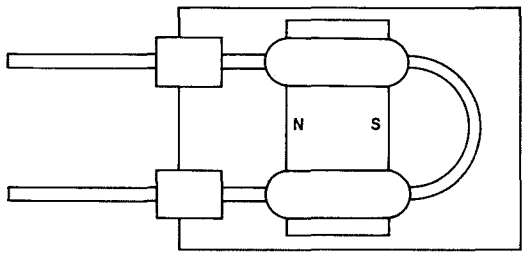


Fig. 17 — Block Magnets

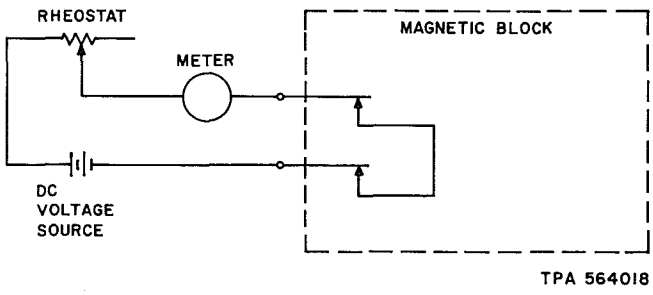


Fig. 18 — Indicating Current

5.04 Bridging time checks are used to determine that the switch is a make-before-break operation. The bridging time can be determined as follows (see Fig. 19):

(a) t1 and t2 shall be less than 4.5 ma.

(b) Contact bounce time (b) shall be less than 75% of the associated t1 (increasing current) or t2 (decreasing current) time.

6. OPERATIONAL CHECKS

6.01 The operational checks in the following table are used to verify that both reed switches in each path are operating correctly.

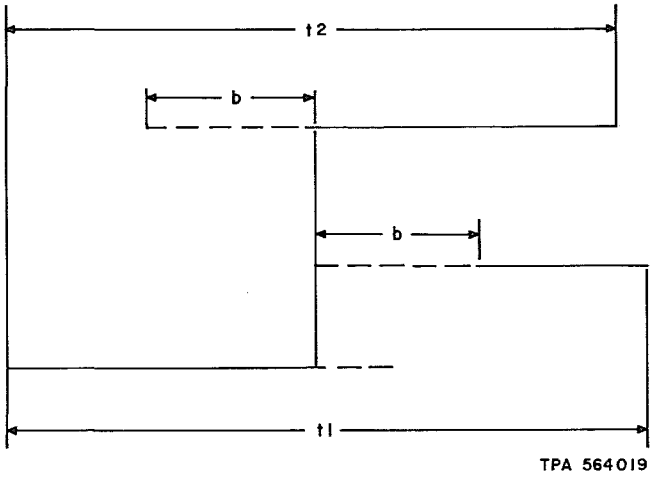


Fig. 19 — Timing Chart

OPERATIONAL CHECKS

APPLIED VOLTAGE	PATH	PATH LOSS	223D SWITCH COIL CURRENT	223E SWITCH COIL CURRENT
Increasing	A-AB, B-OB	0db	0 to ≈ 7.5ma	0 to ≈ 13ma
Increasing	A-AB, B-OB	−70 to ≧−90db	7.5 to 8.5ma	13 to 17ma
Increasing	A-AB, B-OB	≧−90db	>8.5ma	>17ma
Decreasing	A-AB, B-OB	≧−90 to −70db	2.9 to 2.5ma	8 to 5ma
Decreasing	A-AB, B-OB	0db	<2.5ma	<5ma
Increasing	A-OB, B-OB	≧−90db	0 to 5ma	0 to 11ma
Increasing	A-OB, B-OB	≧−90 to −70db	5 to 6ma	11 to 13ma
Increasing	A-OB, B-OB	0db	>6ma	>13ma
Decreasing	A-OB, B-OB	−70 to ≧−90db	6 to 5ma	6 to 5ma
Decreasing	A-OB, B-OB	≧−90db	<5ma	<5ma