# TESTS AND ADJUSTMENTS
# VOLCAS FOR 22-TYPE REPEATERS USED WITH TOLL CONFERENCE GROUPING CIRCUITS

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## 1. GENERAL

1.01 This section describes the methods of making tests and adjustments on the volcas. Tests and adjustments on the volcas alone and in conjunction with its associated 22-type repeater are included.

### Testing Precautions

1.02 Unless otherwise stated, all the tests in this section are made with the volcas equipped repeater temporarily removed from service or spare.

1.03 The volcas equipped repeater should be monitored before it is patched out in order to choose an opportune moment for completing the patch. The patched layout then should be monitored to assure that it is operating properly.

1.04 The meter circuit TEST key of the echo suppressor test circuit must be thrown to the 2-W ECHO SPR position for all volcas tests involving the use of the plate circuit milliammeter.

1.05 Before changing a tube, the volcas should be turned off by inserting a 258C dummy plug into the FIL jack.

1.06 Sensitivity measurements require the use of a multi-frequency oscillator, since the frequency of maximum sensitivity for the volcas is near 1200 cycles rather than 1000 cycles.

1.07 In all the procedures the test on the E to W or drop side is given first, followed by the test on the W to E or line side.

1.08 Occasionally, on a volcas equipped repeater, the wrong volcas side will operate when a gain measurement is attempted. This may result where a large sensitivity difference exists between the two sides of the volcas and the gain measurement is attempted in the direction involving the lower volcas sensitivity. In such cases, when using a 6A transmission measuring set, the sending power should momentarily be lowered to -10 or -20 db after which the gain measurement may be made in the usual manner. When using a 40B transmission measuring system it usually will be sufficient to send at the lowest power which permits the gain to be measured. Otherwise the opposite volcas side input should be terminated while measuring.

1.09 In order to obtain a visual indication of volcas operation a 165C dummy plug is inserted into the volcas TR jack. Similarly, in order to measure detector plate current a 165C plug is inserted into either the E TST or W TST jack. 165C plugs manufactured during a

certain period have the tip diameter sufficiently reduced to cause unreliable contact operation when used for these purposes. Such plugs (tip diameter of .192 to .200 inch) should not be used where 165C plugs with a greater tip diameter are available.

## 2. MONITORING AND TALKING

2.01 Apparatus:

Two 2P13A Patching Cords and one 3P13A Patching Cord (or equivalent)
Operator's Telephone Set

2.02 Procedure:

(1) Arrange the keys on the telephone set panel for monitoring in both directions.

(2) Plug the operator's telephone set into the jacks on the telephone set panel.

(3) Patch the TEL SET jacks to the MON T and R jacks of the volcas monitoring repeating coil set, using the 3P13A (three-conductor) patching cord. Avoid a tip-ring turnover when making this patch.

(4) Patch the DROP MON and LINE MON jacks of the monitoring repeating coil set to the HO DROP and HO LINE jacks of the volcas, respectively, using the 2P13A (two-conductor) cords.

(5) The circuit then may be monitored or talked over in either or both directions, by using the keys on the telephone set panel in the standard manner.

## 3. PATCHING

3.01 A spare volcas equipped repeater or a non-volcas equipped repeater may be patched into the circuit in place of the regular volcas equipped repeater by following the procedure normally employed when patching a non-volcas equipped 22-type repeater. The monitoring precautions of Paragraph 1.03 should be observed. The regular volcas equipped repeater then may be picked up for testing by patching into its EAST REP LINE and WEST REP LINE jacks and inserting a 600-ohm (217D) plug in the EAST REP NET jacks. (The normal west network is a 600-ohm resistance.) Tests on the volcas alone may be made by patching into the DROP VLC IN and LINE VLC IN jacks.

## 4. RELAY ADJUSTMENTS

4.01 209FA relay adjustments are covered in sections of the central office series of maintenance practices.

## 5. HEATER CURRENT

5.01 The current through the vacuum tube heaters may be measured at the FIL jack on the volcas panel, using a portable meter set, without removing the volcas from service.

5.02 Apparatus - Portable meter set consisting of a Weston Model 1 Ammeter, 0-1.8 ampere range, and either a 2W26A or 2W27A two-conductor testing cord and plug assembly (or equivalent). The 1R tube test set, for example, is a satisfactory substitute apparatus.

5.03 Requirements for Heater Current - Circuit Order and Maintenance Tests - The heater current in regulated battery offices should be between 0.580 and 0.700 ampere.

5.04 The initial adjustment of heater current in a regulated battery office is made with 113A resistances (31.2 ohms ± 1 per cent.) substituted for the 310A vacuum tubes. Adjustments in heater current are made by strapping resistances X, Y and Z, which are in series with the heaters and filament battery and are mounted on the volcas panel. Any deviation of the battery voltage from its mean value, at the time of measurement, is considered when making this adjustment, as outlined in Paragraph 5.05 and on Drawing SD-64366-011, not attached. Thereafter, the effect of tube replacements on heater circuit resistance is not expected to be great enough to move the heater current outside of limits and require restrapping of X, Y and Z.

5.05 Requirements for Heater Current - Initial Tests - When four 113A resistances are substituted for the four 310A vacuum tubes, heater circuit resistances, X, Y, and Z should be strapped to obtain 0.640 + 0.006 ampere, subject to the following corrections:

| Deviation from Mean Voltage of Fil. Batt. | Correction in Amperes |
|---|---|
| 0.1 | .003 |
| 0.2 | .006 |
| 0.3 | .009 |
| 0.4 | .012 |
| 0.5 | .015 |

In this table the correction is added to 0.640 ampere when the filament battery voltage is above the mean value and subtracted from 0.640 ampere when the voltage is below the mean value.

## 6. VACUUM TUBE TESTS

### (A) Cathode Activity

6.01 Cathode activity of the amplifier tubes (1) or (2) may be measured with the 1R tube test set. In order to measure the cathode activity

of the detector tubes ED and WD they must be substituted for the amplifier tubes. An M4T cord equipped with 306A and 307A plugs should be used for connecting the test set to the FIL ACT TST jack on the volcas panel. The cord and plug for connecting the test set to the volcas FIL jack are permanently attached to the test set.

6.02 The Hickok Model 530B tube tester may also be used for making cathode activity tests on the volcas amplifier and detector tubes.

6.03 Requirements for Cathode Activity - Measured in 1R Tube Test Set - The percentage activity should not exceed 15 per cent when the heater current is reduced 0.040 ampere from the existing value. This limit applies to the amplifier tubes, or to the detector tubes when tested as amplifiers in the amplifier tube sockets.

6.04 Requirements for Cathode Activity - Measured on Hickok Model 530B Tube Tester - The percentage activity of the amplifier or detector tubes shall not exceed 25 per cent.

(B) Detector Plate Current - Idle Condition

6.05 Vacuum tubes which have been tested and found suitable for use as amplifiers occasionally may be unsatisfactory as detectors. A test for plate current in the idle (no input) condition furnishes an additional check on the ability of the tube to function satisfactorily as a detector. For this test, the volcas is assumed to be in working condition. The sensitivity setting is inconsequential.

6.06 Apparatus:

(1) Where the meter panel of the standard echo suppressor testing arrangements is not available, the apparatus needed for testing consists of:

165C Dummy Plug
Two 217D (600-ohm) Plugs
Weston Model 280 Portable Milliammeter (0-5, 10 and 50 mil scales) and a 2W10A two-conductor testing cord and plug assembly, or equivalent.

(2) Where the echo suppressor meter panel is available, the apparatus is as follows:

165C Dummy Plug
Two 217D (600-ohm) Plugs

6.07 Procedure - With Portable Milliammeter:

(1) Terminate the volcas inputs by inserting the 600-ohm plugs into the DROP VLC IN and LINE VLC IN jacks.

(2) Transfer the east-to-west detector plate circuit to the PLT C jack by inserting a 165C plug into the E TEST jack.

(3) Connect the testing cord tips to the 0-5 mil scale of the milliammeter and insert the plug into the PLT C jack at the volcas bay.

(4) Read the milliammeter, being careful to observe that any deflection is in the positive direction.

(5) To check the west-to-east detector, move the 165C plug from the E TST to the W TST jack and repeat Item (4).

6.08 Requirements for Detector Plate Current - Idle Condition - The detector plate current shall be less than 0.1 mil.

6.09 Procedure - With Meter Panel Milliammeter:

(1) Terminate the volcas inputs by inserting the 600-ohm plugs into the DROP VLC IN and LINE VLC IN jacks.

(2) Transfer the east-to-west detector plate circuit to the echo suppressor testing set meter panel by inserting a 165C plug into the E TST jack.

(3) On the meter panel, operate the 2-W ECHO SPR key and the 2.5 milliampere key. Note any indication of plate current on the panel milliammeter.

(4) To check the west-to-east detector, move the 165C plug from the E TST to the W TST jack and repeat Item (3).

(5) Remove all plugs.

6.10 Requirements for Detector Plate Current - Idle Condition - The detector plate current shall be less than 0.1 mil.

(C) Maximum Detector Plate Current

6.11 Another check on the ability of a particular 310A tube to function satisfactorily as a detector is obtained by measuring its maximum plate current. This test involves measurements of sensitivity, using one of the methods of Part 7.

6.12 Apparatus - In addition to the apparatus needed for the sensitivity measurements, provide one of the following:

(1) Where the meter panel of the standard echo suppressor testing arrangements is not available:

165C Dummy Plug
217D (600-ohm) Plug
Weston Model 280 Portable Milliammeter (0-5, 10 and 50 mil scales) and a 2W10A two-conductor testing cord and plug assembly, or equivalent.

(2) Where the echo suppressor meter panel is available, the apparatus is as follows:

165C Dummy Plug
217D (600-ohm) Plug

6.13 Procedure - With Portable Milliammeter:

(1) Transfer the east-to-west detector plate circuit to the PLT C jack by inserting a 165C plug into the E TST jack.

(2) Connect the testing cord tips to the 0-50 mil scale of the milliammeter and insert the plug into the PLT C jack at the volcas bay (or at the measuring bay, if available and more convenient).

(3) Terminate the LINE VLC IN jacks with the 217D plug.

(4) With the 602A input transformer E INT on tap 6, measure the sensitivity of the bare volcas, east-to-west. (The feedback condenser EB need not be changed from its working connection.)

(5) Increase the sending power at the volcas input as follows:

(Sending power) = 50 - (Sensitivity),

where the sending power is in db above (+) or below (-) 1 MW and the sensitivity is as measured in Item (4). The sensitivity is regarded as a positive quantity. For example, if the measured sensitivity = 60 db; the sending power = 50 - 60 = -10 db relative to 1 MW (10 db below 1 MW).

(6) Note the detector plate current on the portable milliammeter while sending as described in Item (5).

(7) To measure the maximum detector plate current west-to-east, interchange the volcas input connections and move the 165C plug from the E TST to the W TST jack. Repeat Items (4), (5) and (6), for the west-to-east side.

(8) Remove all patch cords and plugs.

6.14 Requirements for Maximum Detector Plate Current - With the interstage transformer secondary connection on tap 6, the maximum plate current shall not be less than 9 mils and the difference between the E-W and W-E maximum plate currents shall be less than 2 mils.

6.15 Procedure - With Meter Panel Milliammeter:

(1) Transfer the east-to-west detector plate circuit to the echo suppressor testing set meter panel by inserting a 165C plug into the E TST jack.

(2) Operate the 2-W ECHO SPR key.

(3) Terminate the LINE VLC IN jacks with the 217D plug.

(4) Measure the sensitivity of the bare volcas, east-to-west.

(5) Increase the sending power at the volcas input as follows:

(Sending power) = 50 - (Sensitivity),

where the sending power is in db above (+) or below (-) 1 MW, and the sensitivity is as measured in Item (4). The sensitivity is regarded as a positive quantity. For example, if the measured sensitivity = 60 db, the sending power = 50 - 60 = -10 db relative to 1 MW (10 db below 1 MW).

(6) Note the detector plate current on the 25 mil scale of the panel milliammeter, while sending as described in Item (5).

(7) To measure the maximum detector plate current west-to-east, interchange the volcas input connections and move the 165C plug from the E TST to the W TST jack. Repeat Items (4), (5) and (6) for the west-to-east side.

(8) Remove all patch cords and plugs.

6.16 Requirements for Maximum Detector Plate Current - The plate current should meet the requirements of Paragraph 6.14.

## 7. LOCAL SENSITIVITY MEASUREMENTS

7.01 This test is one of the checks on the overall operation of the volcas. Since the relationship between the response of the volcas to single frequencies and its response to voice waves is well understood, single-frequency sensitivity measurements can be used to determine that the volcas will be adequately sensitive to the lowest speech volumes for which operation is desired.

7.02 As discussed in another section of this series, there are two local sensitivities of interest. With the high impedance volcas input connected across a 600-ohm circuit, the sensitivity is determined as the amount of power at the volcas input above or below 1 milliwatt, which will just operate the volcas relays. This amount of power is arbitrarily regarded as a positive sensitivity value, when less than 1 milliwatt. The other local sensitivity of interest, termed the operating sensitivity, is determined as the amount of power from a 600-ohm source, at the input of the volcas-equipped repeater, which will just operate the volcas relays. As in the case of the volcas alone, this just-operate power is referred to 1 milliwatt and is regarded as a positive sensitivity value when less than 1 milliwatt.

7.03 The input power required to produce 1.5 milliamperes of detector plate current is sometimes specified for sensitivity measurements, rather than the just-operate input power. While the difference between these methods is small, the just-operate value is specified in this series since it is of prime interest in so far as the proper operation and maintenance of the overall system is concerned.

7.04 In general, the sensitivity measurements require a multi-frequency oscillator covering the frequency range from 500 to 2000 cycles, a means for attenuating the oscillator output in small steps, from 1 milliwatt to 70 db below 1 milliwatt, and a means for determining the attenuated output. The use of the following three measuring arrangements is discussed here:

(1) 6A transmission measuring set, with 13A or 6010B oscillator.

(2) The multi-frequency measuring arrangements of the 40B transmission measuring system.

(3) 1A attenuator or equivalent and multi-frequency oscillator.

Methods for measuring the operating sensitivity (volcas plus repeater) as well as the bare volcas sensitivity will be given. At echo suppressor offices the various methods involve the use of the standard echo suppressor testing set and instructions are included for its use.

(A) Local Sensitivity Measurements with 6A Transmission Measuring Set

7.05 Apparatus:

2P13A Patching Cords, or equivalent
165C Dummy Plug
217D (600-ohm) Plugs

7.06 Procedure - Bare Volcas:

(1) Patch the 6A set SEND jacks to the 20 db NET IN jacks at the volcas bay, via a measuring trunk if required. Patch the 20 db NET OUT jacks to the DROP VLC IN jacks. Terminate the LINE VLC IN jacks with a 217D plug. The 20 db network is composed of a balanced 600-ohm 20 db pad whose output is effectively terminated in 600 ohms. Noise and crosstalk considerations require that measuring powers on office trunks be kept above about - 50 dt relative to 1 MW. Since volcas sensitivities often exceed 50 db, the additional attenuation over that permitted at the sending circuit is supplied by the 20 db network adjacent to the volcas input.

(2) Insert a 165C dummy plug in the volcas TR jack, thereby operating the transfer relay so that the OPR lamp at the volcas bay or on the echo suppressor testing panel (and at the measuring set bay where required) will light whenever either side of the volcas operates. Where the standard echo suppressor testing panel is involved, operate the TEST TIME, TEST REC MAKE and BAT keys.

(3) Set the oscillator frequency to 1200 cycles.

(4) Place the 6A set GAIN dial 4 on 0, operate the GAIN key and NEG key, send 1 MW and calibrate the 6A set. (While sending, the OPR lamp will be lighted.)

Note: During the sending adjustment, SEND dial 1 should be kept near its maximum output position.

(5) With the MEAS key operated the OPR lamp again will light. Now reduce the sending power by increasing the setting of GAIN dial 4 to the highest step on which the OPR lamp remains lighted. (In many cases the sensitivity of the volcas will be great enough to hold the OPR lamp lighted with the GAIN dial on 40.)

(6) Reduce the sending power still further by means of SEND dial 1, and the oscillator output control if necessary, until the OPR lamp is extinguished. Then increase the sending power slowly, by means of the SEND dial, until the OPR lamp just lights.

(7) Patch the 6A set SEND and REC jacks together, after removing the existing patch from the 6A set SEND jacks.

(8) Without changing the position of the oscillator output control, SEND dial 1, or CAL dial 2; turn GAIN dial 4 back to 0 and measure the sending power on the back scale of MEAS dial 3, (with the -10 key operated, if necessary).

(9) This measurement, when added to 20 db plus the GAIN dial setting of Item (5) is the "just operate" sensitivity of the volcas at 1200 cycles, in db relative to 1 MW in a 600-ohm circuit.

(10) To measure the sensitivity of the W to E or line side, patch the 20 db NET OUT jacks to the LINE VLC IN jacks. Terminate the DROP VLC IN jacks with a 217D plug. Repeat Items (4) to (9) inclusive.

(11) Remove all patch cords and plugs.

7.07 Requirements for 1200-Cycle Local Sensitivity - Initial Tests - Before a volcas is first placed in service and whenever it is desired to make a check test, the 1200-cycle sensitivity of the bare volcas, for the maximum sensitivity adjustment (B condenser connected to ground and INT transformer on tap 6), shall be within limits of 59.0 and 66.5 db. For other sensitivity adjustments, the volcas shall meet the requirements of Table I and Table II.

TABLE I

EFFECT OF CHANGING FEEDBACK ADJUSTMENT FROM MAXIMUM SENSITIVITY SETTING

| Feedback or B Condenser Connection | 602A Input or INT Transformer Connection | Required Sensitivity Change - db |
|---|---|---|
| Between E and F(1) | Fixed - any tap | -2.0 ± 0.8 |
| Between F and G | Fixed - any tap | -4.0 ± 1.0 |
| Between G and H | Fixed - any tap | -6.1 ± 1.2 |
| Off | Fixed - any tap | -10.0 ± 3.0 |

(1) See the E4 section of these Practices for information on resistances E, F, G and H.

TABLE II

EFFECT OF CHANGING INTERSTAGE TRANSFORMER CONNECTION FROM MAXIMUM SENSITIVITY SETTING

| Feedback or B Condenser Connection | 602A Input or INT Transformer Connection | Required Sensitivity Change - db |
|---|---|---|
| Fixed | Tap 5 | -5.7 ± 1.2 |
| Fixed | Tap 4 | -11.7 ± 1.5 |

7.08 Procedure - Operating Sensitivity:

(1) Patch the 6A set SEND jacks to the EAST REP LINE jacks of the volcas equipped repeater. Terminate the WEST REP LINE and the EAST REP NET jacks in 600 ohms, by means of the 217D plugs. Where measuring trunks are required between the 6A set bay and the repeater bay, both repeater lines should be patched to these trunks so that the tester can measure both sides of the volcas without returning to the repeater bay. The idle measuring trunk (connected to the west repeater line, in this case) should be terminated at the measuring bay in 600 ohms, unless it is of the type which remains automatically terminated while idle.

Note: Observe that there are no plugs in the VLC IN jacks.

(2) Insert a 165C dummy plug in the volcas TR jack thereby operating the transfer relay so that the OPR lamp at the volcas bay or on the echo suppressor testing panel (and at the measuring set where required) will light whenever either side of the volcas operates. Where the standard echo suppressor testing panel is involved, operate the TEST TIME, TEST REC MAKE and BAT keys.

(3) Set the oscillator frequency to 1200 cycles.

(4) Place the 6A set GAIN dial on 0, operate the GAIN key and NEG key, send 1 milliwatt and calibrate the set. (While sending, the OPR lamp will light.)

Note: During the sending adjustment, SEND dial 1 preferably should be kept near its maximum output position.

(5) With the MEAS key operated, the OPR lamp again will light. Now reduce the sending power by increasing the setting of GAIN dial 4 to the highest step on which the operate lamp remains lighted. (In many cases the sensitivity of the volcas will be great enough to hold the OPR lamp lighted with the GAIN dial on 40.)

(6) Reduce the sending power still further by means of SEND dial 1, and the oscillator output control if necessary, until the OPR lamp is extinguished. Then increase the sending power slowly, by means of the SEND dial, until the OPR lamp just lights.

(7) At 6A sets, remove patch cord plug from EAST REP LINE jacks (or from measuring trunk connected to these jacks) and insert in 6A set REC jacks, thereby connecting the 6A set SEND and REC jacks directly together.

(8) Without changing the position of the oscillator output control, SEND dial 1, or CAL dial 2; turn GAIN dial 4 back to 0 and measure the sending power on the black scale of MEAS dial 3, (with the -10 key operated, if necessary).

(9) This measurement when added to the GAIN dial setting of Item (5) is the "just-operate" operating sensitivity of the volcas at 1200 cycles, in db relative to 1 MW from a 600-ohm source at the repeater output.

(10) To measure the operating sensitivity of the W to E or line side: In Item (1), move the patch cord from the EAST REP LINE jacks to the WEST REP LINE jacks and the termination from the WEST REP LINE jacks to the EAST REP LINE jacks. Or, where measuring trunks are used, make the corresponding changes at the measuring bay. Repeat Items (4) to (9), inclusive.

(11) Remove all patch cords and plugs.

7.09 Requirements for 1200-Cycle Operating Sensitivity: The operating sensitivity requirements for all tests are as follows:

| Repeater Side | Pad Control Office | Cord Circuit Repeater Office |
|---|---|---|
| EW (drop) | 41.0 ± 2.0 db | 44.0 ± 2.0 db |
| WE (line) | 46.0 ∓ 2.0 | 46.0 ∓ 2.0 |

7.10 The sensitivity requirements of Paragraph 7.09 permit a maximum sensitivity unbalance of 4.0 db between the two sides, after allowing for the difference in specified sensitivities. In rare cases this amount of unbalance may require that the precautions of Paragraph 1.08 be observed while making gain measurements.

(B) Local Sensitivity Measurements with 40B Transmission Measuring System

7.11 Apparatus:

2P13A Patching Cords, or equivalent
165C Dummy Plug
217D (600-ohm) Plugs

7.12 Procedure - Bare Volcas:

(1) Patch the SEND jacks of the multi-frequency measuring circuit to the 20 db NET IN jacks at the volcas bay, via a measuring trunk if required. Patch the 20 db NET OUT jacks to the DROP VLC IN jacks. Terminate the LINE VLC IN jacks with a 217D plug. The 20 db network is composed of a balanced 600-ohm 20 db pad whose output is effectively terminated in 600 ohms. Noise and crosstalk considerations require that measuring powers on office trunks be kept above about -50 db relative to 1 MW. Since volcas sensitivities often exceed 50 db, the additional attenuation over that permitted at the sending circuit is supplied by the 20 db network adjacent to the volcas input.

(2) Insert a 165C dummy plug in the volcas TR jack, thereby operating the transfer relay so that the OPR lamp at the volcas bay or on the echo suppressor testing panel (and at the measuring bay where required) will light whenever either side of the volcas operates. Where a standard echo suppressor testing panel is involved, operate the TEST TIME, TEST REC MAKE and BAT keys.

(3) Set the oscillator frequency to 1200 cycles.

(4) With the measuring circuit sending pads set to zero loss, operate the CAL key and measure the sending power with the oscillator output control on its minimum setting. Then adjust the oscillator output control to obtain a sending power of 1 MW. (While sending 1 MW the OPR lamp will remain lighted.)

(5) If the available range of sending power adjustment below 1 MW, as determined in Item (4), is 5 db or more, proceed as follows: With the sending pads, reduce the sending power in 5 db steps to the lowest step on which the OPR lamp remains lighted. With the oscillator output control, continue reducing the sending power until the OPR lamp is extinguished, then increase it slowly until the OPR lamp just lights. Operate the CAL key and measure the oscillator output in db below 1 MW, on the B scale.

(6) If the available range of sending power adjustment below 1 MW, as determined in Item (4), is less than 5 db, proceed as follows: With the sending pads, reduce the sending power in 5 db steps to the first step on which the OPR lamp is extinguished. With the oscillator output control, increase the sending power slowly until the OPR lamp just lights. Operate the CAL key and measure the oscillator output in db above 1 MW, on the A scale.

(7) When proceeding according to Item (5) the just-operate sensitivity is the sum of the 20 db network loss, the sending pad loss and the oscillator output in db below 1 MW.

(8) When proceeding according to Item (6) the just-operate sensitivity equals the sum of the 20 db network and sending pad losses minus the oscillator output in db above 1 MW.

(9) To measure the sensitivity of the W-E or line side, patch the SEND jacks of the multi-frequency measuring circuit to the 20 db NET IN jacks at the volcas bay via a measuring trunk if required. Patch the 20 db NET OUT jacks to the LINE VLC IN jacks. Terminate the DROP VLC IN jacks with a 217D plug. Repeat Items (4) to (8), inclusive.

(10) Remove all patch cords and plugs.

7.13 Requirements for 1200-Cycle Local Sensitivity - Initial Tests - The sensitivity should meet the requirements of Paragraph 7.07.

7.14 Procedure - Operating Sensitivity:

(1) Patch the SEND jacks of the multi-frequency measuring circuit to the EAST REP LINE. Terminate the WEST REP LINE and EAST REP NET jacks with 217D plugs. Where measuring trunks are required between the multi-frequency bay and the repeater bay, both repeater lines should be patched to these trunks so that the tester can measure both sides of the volcas without returning to the repeater bay. The idle measuring trunk (connected to the west

repeater line in this case) should be terminated at the measuring bay in 600 ohms, unless it is of the type which remains automatically terminated while idle.

Note: Observe that there are no plugs in the VLC IN jacks.

(2) Insert a 165C dummy plug in the volcas TR jack, thereby operating the transfer relay so that the OPR lamp at the volcas bay or on the echo suppressor testing panel (and at the measuring set bay, where required) will light whenever either side of the volcas operates. Where a standard echo suppressor testing circuit is involved, operate the TEST TIME, TEST REC MAKE and BAT keys.

(3) Set the oscillator frequency to 1200 cycles.

(4) With the measuring circuit sending pads set to zero loss, operate the CAL key and measure the sending power with the oscillator output control on its minimum setting. Then adjust the oscillator output control to obtain a sending power of 1 MW. (While sending 1 MW the OPR lamp will remain lighted.)

(5) If the available range of sending power adjustment below 1 MW, as determined in Item (4), is 5 db or more, proceed as follows: With the sending pads, reduce the sending power in 5 db steps to the lowest step on which the OPR lamp remains lighted. With the oscillator output control, continue reducing the sending power until the OPR lamp is extinguished, then increase it slowly until the OPR lamp just lights. Operate the CAL key and measure the oscillator output in db below 1 MW, on the B scale.

Note: With the volcas on or within a few db of its maximum sensitivity setting, it will occasionally be impossible to reduce the sending power sufficiently to release the volcas. In such cases a 600-ohm 10 db pad should be inserted in the measuring path, adjacent to the volcas input. This pad should be considered as an additional sending pad when determining the sensitivity in Item (7).

(6) If the available range of sending power adjustment below 1 MW, as determined in Item (4), is less than 5 db, proceed as follows: With the sending pads, reduce the sending power in 5 db steps to the first step on which the OPR lamp is extinguished. With the oscillator output control, increase the sending power slowly until the OPR lamp just lights. Operate the CAL key and measure the oscillator output in db above 1 MW, on the A scale.

Note: With the volcas on or within a few db of its maximum sensitivity setting, it will occasionally be impossible to reduce the sending power sufficiently to release the volcas. In such cases a 600-ohm 10 or 15 db pad should be inserted in the measuring path, adjacent to the volcas input. This pad should be considered as an additional sending pad when determining the sensitivity in Item (8).

(7) When proceeding according to Item (5) the just-operate operating sensitivity is the sum of the sending pad loss and the oscillator output in db below 1 MW.

(8) When proceeding according to Item (6) the just-operate operating sensitivity equals the sending pad loss minus the oscillator output in db above 1 MW.

(9) To measure the operating sensitivity of the W-E or line side, patch the SEND jacks of the multi-frequency measuring circuit to the WEST REP LINE, via a measuring trunk if required. Terminate the EAST REP NET jacks with a 217D plug. Terminate the EAST REP LINE, or the measuring trunk in which it is patched, in 600 ohms. Repeat Items (4) to (8), inclusive.

(10) Remove all patch cords and plugs.

7.15 Requirements for 1200-Cycle Operating Sensitivity - The sensitivity should meet the requirements of Paragraph 7.09.

(C) Local Sensitivity Measurements with 1A Attenuator

7.16 Where a 600-ohm source of power at 1200 cycles and means for adjusting the output of 1 MW is available, the 1A attenuator; or its equivalent, can be used for measuring local sensitivities. The 20 db network is not required for sensitivity measurements with the 1A attenuator.

7.17 Apparatus

2P13A Patching Cords, or equivalent
2 - 2W15A Testing Cords, or equivalent
217D (600-ohm) Plugs
1A Attenuator, or equivalent

7.18 Procedure - Bare Volcas

(1) Locate the 1A attenuator where the operation of the volcas OPR lamp will be visible to the attendant and as close to the volcas as the above requirement will permit.

(2) Set the oscillator frequency to 1200 cycles and adjust the sending power to 1 MW.

(3) Connect the 2W15A testing cords to the 1A attenuator. With the testing cords patch the attenuator between the 1 MW (1200-cycle) source and a 600-ohm (217D plug) termination across which is connected the drop volcas input. Use available means for connecting the attenuator output the 600-ohm termination and the volcas input together, preferably three-pair strap jacks. Terminate the LINE VLC IN jacks with a 217D plug.

(4) Insert a 165C dummy plug in the volcas TR jack, enabling the OPR lamp to light whenever either side of the volcas operates. At stations where the OPR lamp on the standard echo suppressor testing panel is used for this purpose, operate the TEST TIME, TEST REC MAKE and BAT keys.

(5) With the attenuator on 0 db the OPR lamp will light. Increase the attenuator loss until the OPR lamp extinguishes then decrease the loss slowly, in 0.5 db steps, until the OPR lamp lights.

(6) The final setting of the attenuator obtained in Item (5) is a measure of the just-operate volcas sensitivity, assuming that the sending power has not changed.

(7) In order to measure the sensitivity of the west-to-east or line side, shift the patch cord plug from the DROP VLC IN jacks to the LINE VLC IN jacks. At the same time, move the 217D plugs from the LINE VLC IN jacks to the DROP VLC IN jacks. Repeat Items (5) and (6).

(8) Remove all patch cords and plugs.

7.19 Requirements for 1200-Cycle Local Sensitivity - Initial Tests - The sensitivity should meet the requirements of Paragraph 7.07.

7.20 Procedure - Operating Sensitivity

(1) Locate the 1A attenuator where the operation of the volcas OPR lamp will be visible to the tester and as close to the volcas as the above requirements will permit.

(2) Set the oscillator frequency to 1200 cycles and adjust the sending power to 1 MW.

(3) Connect the 2W15A testing cords to the 1A attenuator. With the testing cords patch the attenuator between the 1 MW (1200-cycle) source and the EAST REP LINE jacks of the volcas repeater, using measuring trunks if required. Terminate the WEST REP LINE and EAST REP NET jacks with 217D plugs.

Note: Observe that there are no plugs in the VLC IN jacks.

(4) Insert a 165C dummy plug in the volcas TR jack, thereby operating the transfer relay and enabling the OPR lamp to light whenever either side of the volcas operates. At stations where the OPR lamp on the standard echo suppressor testing panel is used for this purpose operate the TEST TIME, TEST REC MAKE and BAT keys.

(5) With the attenuator on 0 db the OPR lamp will light. Increase the attenuator loss until the OPR lamp extinguishes, then decrease the loss slowly, in 0.5 db steps, until the OPR lamp lights.

(6) The final setting of the attenuator obtained in Item (5) is a measure of the just-operate operating sensitivity, assuming that the sending power has not changed.

(7) In order to measure the west-to-east or line sensitivity, shift the patch cord plug from the EAST REP LINE to the WEST REP LINE jacks and the 217D plug from the WEST REP LINE to the EAST REP LINE jacks. Repeat Items (5) and (6).

(8) Remove all patch cords and plugs.

7.21 Requirements for 1200-Cycle Operating Sensitivity - The sensitivity should meet the requirements of Paragraph 7.09.

## 8. MEASUREMENT OF SENSITIVITY-FREQUENCY CHARACTERISTICS

8.01 Measurement of the volcas sensitivity at frequencies other than 1200 cycles may conveniently be made following a measurement at 1200 cycles. One of the methods given in Part 7 should be used, substituting the desired frequency for 1200 cycles. Measurements on the bare volcas at 500, 1200 and 2000 cycles ordinarily are considered sufficient for determining the state of this characteristic.

8.02 Requirements for Sensitivity-Frequency Characteristic - All Tests - The requirements at 500 and 2000 cycles, relative to 1200 cycles, are given in Table III, for a bare volcas with the maximum sensitivity adjustment.

TABLE III

SENSITIVITY-FREQUENCY CHARACTERISTICS
BARE VOLCAS WITH MAXIMUM SENSITIVITY ADJUSTMENT

| Frequency in Cycles per Second | Required Sensitivity Limits in db |
|---|---|
| 500 | $-15.0 \pm 4.5$ |
| 1200 | - |
| 2000 | $-9.5 \pm 2.0$ |

## 9. MEASUREMENT OF FREQUENCY OF MAXIMUM SENSITIVITY

9.01 In addition to sensitivity measurements at specified frequencies the tuning of the volcas in the region of 1200 cycles may be explored when the sensitivity measuring arrangements include a heterodyne type oscillator. A milliammeter is connected into the plate circuit of the detector tube and observed for maximum deflection as the oscillator frequency is varied in the region of 1200 cycles.

9.02 Apparatus:

(1) Where the standard echo suppressor testing arrangements are not involved, a portable meter set consisting of a Weston Model 280 milliammeter (0-5, 10 and 50 mil scales) and a 2W10A two-conductor testing cord and plug assembly, or equivalent, is required, in addition to the apparatus for sensitivity measurements.

(2) Where the standard echo suppressor testing arrangements are available, the meter panel milliammeter is used.

9.03 Procedure - No Echo Suppressor Test Set:

(1) Connect the testing cord tips to the 0-10 mil scale of the milliammeter. Insert the plug into the PLT C jack at the volcas bay (or at the measuring set bay, if available and more convenient).

(2) Insert a 165C dummy plug in the E TST jack of the volcas, thereby connecting the PLT C jack into the east-to-west detector plate circuit.

(3) Using one of the local sensitivity measuring methods given in Part 7, arrange the test connections for a measurement of sensitivity in the east-to-west direction (drop side). Adjust the sending power until a detector plate current of 3 mils is obtained. Vary the oscillator frequency between about 1000 and 1400 cycles and observe the milliammeter reading. (Reverse the meter connections, if necessary, to obtain a positive indication.) Note the frequency at which the maximum deflection of the meter occurs.

(4) Shift the 165C dummy plug from the E TST to the W TST jack for measurements on the W-E or line side.

(5) Remove all patch cords and plugs.

9.04 Requirements for Frequency of Maximum Sensitivity - The frequency of maximum sensitivity shall be higher than 1000 cycles and lower than 1400 cycles. No tuning adjustments are provided on the volcas. Any appreciable departure from the above limits probably indicates a trouble condition.

9.05 Procedure - Echo Suppressor Test Set Used:

(1) Operate the 2W ECHO SPR and 25-mil keys on the meter panel.

(2) Insert a 165C dummy plug in the E TST jack of the volcas, thereby connecting the meter panel milliammeter into the detector plate circuit.

(3) Using one of the local sensitivity measuring methods given in Part 7, arrange the test connections for a measurement of sensitivity in the east-to-west direction (drop side). Adjust the sending power until a detector plate current of 3 mils is obtained. Vary the oscillator frequency between about 1000 and 1400 cycles and observe the milliammeter reading. Note the frequency at which the maximum deflection of the meter occurs.

(4) Shift the dummy plug from the E TST to the W TST jack for measurements on the W-E or line side.

(5) Remove all patch cords and plugs.

9.06 Requirements for Frequency of Maximum Sensitivity - The frequency should meet the requirements of Paragraph 9.04.

## 10. MEASUREMENT OF OPERATE AND RELEASE MASTER RELAY CURRENTS

10.01 Measurements of "just-operate" and "just-release" master relay current provide a check on the adjustment of this relay and, to a certain extent, on the condition of the hangover relay as well. The test involves the use of one of the local sensitivity measuring methods of Part 7 together with a milliammeter for measuring the detector plate (master relay operate winding) current. The testing arrangements are therefore the same as those used for measuring the frequency of maximum sensitivity.

Note: Where the 1A attenuator method of measuring sensitivity is used, the operate and release current values can be approximated to about the nearest 0.15 mil.

10.02 Apparatus:

(1) Where the standard echo suppressor testing arrangements are not involved, a portable meter set consisting of a Weston Model 280 milliammeter (0-5, 10 and 50-mil scales) and a 2W10A two-conductor testing cord and plug assembly, or equivalent, is required, in addition to the apparatus for sensitivity measurements.

(2) Where the standard echo suppressor testing arrangements are available, the meter panel milliammeter is used.

10.03 Procedure - No Echo Suppressor Test Set:

(1) Connect the testing cord tips to the 0-10 mil scale of the milliammeter. Insert the plug into the PLT C jack of the volcas bay (or at the measuring set bay, if available and more convenient).

(2) Insert a 165C dummy plug in the E TST jack of the volcas, thereby connecting the PLT C jack into the detector plate circuit.

(3) Measure the E-W, or drop side, sensitivity at 1200 cycles, using one of the methods given in Part 7. Observe the detector plate current corresponding to the just-operate and just-release values of sending power, as determined from the OPR lamp signals. In other words, first increase the sending power slowly from below the operate value. The detector plate current reading at the moment the OPR lamp lights is the master relay operate current. Then reduce the sending power slowly until the OPR lamp extinguishes. The detector plate current at this point is the master relay release current.

(4) Shift the 165C dummy plug from the E TST to the W TST jack for measurements on the W-E or line side.

(5) Remove all patch cords and plugs.

10.04 Requirements for Master Relay Operate Current - The master relay shall operate on currents between 1.2 and 1.8 milliamperes. If the master relay fails to meet these limits, it requires adjustment or is defective.

10.05 Requirements for Master Relay Release Current - The master relay shall release on not less than 0.6 milliampere. Otherwise, the relay requires adjustment.

10.06 Procedure - Echo Suppressor Test Set Used:

(1) Operate the 2W ECHO SPR key of the meter panel.

(2) Insert a 165C dummy plug in the E TST jack of the volcas, thereby connecting the meter panel milliammeter into the detector plate circuit.

(3) Measure the E-W, or drop side, sensitivity at 1200 cycles, using one of the methods given in Part 7. Operate and hold the 2.5 mil key of the meter panel. Observe the detector plate currents corresponding to the just-operate and just-release values of sending power, as determined from the OPR lamp signals. In other words, first increase the sending power slowly from below the operate value. The detector plate current reading at the moment the OPR lamp lights is the master relay operate current. Then reduce the sending power slowly until the OPR lamp extinguishes. The detector plate current at this point is the master relay release current.

(4) Shift the 165C dummy plug from the E TST to the W TST jack for measurements on the W-E or line side.

(5) Remove all patch cords and plugs.

10.07 Requirements for Master Relay Operate and Release Currents - The currents shall meet the requirements of Paragraphs 10.04 and 10.05.

## 11. TIME CHARACTERISTICS OF VOLCAS

11.01 At non-echo suppressor points, the release time can be approximately determined as a function of the capacity of the slow-release (hangover) circuit condensers, assuming the relays are in satisfactory adjustment. As a working rule, each microfarad which is added to the slow-release circuit condenser capacity increases the release time approximately 15.3 milliseconds. For example, assume that the E and G condensers are being used. Since these condensers have average capacities of 4.32 and 1.12 mf. respectively, the release time will be approximately 15.3 (4.32 + 1.12) = 83 milliseconds. If, for any reason, a trouble condition is suspected in the hangover circuit, the N resistance may be measured on a Wheatstone bridge or with an ohmmeter and the capacity of the E, F and G condensers measured on a testboard bridge or capacity meter.

11.02 There are no convenient means, other than the echo suppressor time measuring set, available for determining operate time. With the volcas relays in good condition, however, the operate time will rarely, if ever, be a factor in faulty operation.

### Time Measurements

11.03 Measurements of operate time and release time may be made on the volcas, using the time measuring arrangements of the standard echo suppressor test set.

11.04 Apparatus:

165C Dummy Plugs
2P13A Patching Cords, or equivalent

11.05 Procedure

(1) The calibration of the test circuit should be checked.

(2) To check the time characteristics of the E-W or drop side, patch the DROP VLC IN jacks to the TEST E-W jacks of the testing circuit, and the LINE VLC IN jacks to the TEST W-E jacks.

(3) Insert 165C dummy plugs into the TR and E TST jacks of the volcas thereby transferring the short-circuiting contacts of the hangover relay to the time measuring circuit and the detector plate circuit to the meter panel.

(4) 1000 or 1200 cycles should be supplied to the testing circuit from a permanently connected oscillator or from an oscillator or 1000-cycle 1-MW sending circuit patched to the OSC jacks.

Note: In some cases the high sensitivity of the volcas requires that an attenuator or pad be inserted between the oscillator output and the OSC jacks of the testing circuit. Depending upon the volcas sensitivity, this pad, or the attenuator setting, may be 10, 20 or 30 db.

(5) Operate the meter panel 2W ECHO SPR key.

(6) Operate the TEST TIME, TEST SEND MAKE, TEST REC MAKE, TEST SPR EW and BAT keys on the echo suppressor test panel.

(7) Operate the 25-mil key of the meter panel and adjust the B potentiometer on the test panel (and if necessary, the pad or attenuator between the oscillator output and the test circuit OSC jacks) until the milliammeter indicates 5 mils.

(8) Operate and restore the TEST TIME key repeatedly, allowing a slight interval in each position, adjusting the three time-measuring dials until a zero deflection is obtained on the test set galvonometer. The OPR lamp should light each time the TEST TIME key is operated.

(9) The reading of the time measuring dials indicates the time required for the E-W or drop side relays to operate.

(10) Operate the TEST SEND BREAK and the TEST REC BREAK keys on the test panel.

(11) Operate and restore the TEST TIME key repeatedly, allowing a slight interval in each position, adjusting the three time-measuring dials until a zero deflection is obtained on the test set galvonometer. The OPR lamp should light each time the TEST TIME key is operated.

(12) The reading of the time measuring dials indicates the time required for the E-W or drop side slow-release relay to release.

(13) To check the time characteristics of the W-E or line side of the volcas, remove the dummy plug from the E TST jack and insert it into the W TST jack.

(14) Operate the TEST TIME, TEST SEND MAKE, TEST REC MAKE, TST SPR WE and BAT keys on the test panel.

(15) Repeat Items (7) through (12) to obtain the operate and release times for the west-to-east relay chain.

(16) Remove all patch cords and plugs.

11.06 Requirements for Volcas Operate Time - The volcas relays shall operate in less than 11 milliseconds. If the relays fail to meet this limit they probably need adjustment or are defective. This requirement applies only to installations where a time measuring set is available.

11.07 Requirements for Volcas Release Time - The release time should be 150 milliseconds $\pm$ 0.030 second. This requirement applies only to installations where a time measuring set is available.

## 12. BRIDGING AND SWITCHING LOSSES

12.01 The repeater gain is reduced by a small amount, termed the bridging loss, when the volcas input is connected to the repeater. In the idle condition, the east-to-west volcas introduces a loss in the east-to-west transmission path (and the west-to-east volcas a similar loss in the west-to-east transmission path) which is termed the transmitting switched loss (TSL). In the operated condition, the west-to-east volcas introduces loss in the east-to-west transmission path (and the east-to-west volcas a similar loss in the west-to-east transmission path) which is termed the receiving switched loss (RSL).

12.02 Bridging and switching losses may be measured by comparing repeater gains with and without the various losses included, as described in the following procedure. A transmission measuring set with multi-frequency oscillator and a separate 1000-cycle oscillator are required for the complete series of measurements. Where the bridging loss is desired at 1000 cycles only, the multi-frequency oscillator may be replaced by a 1000-cycle oscillator.

12.03 Apparatus:

Four (600-Ohm) 127D Plugs, or equivalent
Sufficient two-conductor 2P13A Patching Cords, or equivalent

12.04 Procedure

(1) Patch the repeater to the transmission measuring set. Terminate the EAST REP NET jacks in 600 ohms, using a 217D plug.

(2) For measurements in the E-W direction: Patch the DROP VLC IN jacks to a separate 1000-cycle oscillator, sending sufficient power to operate the volcas. Terminate the LINE VLC IN jacks in 600 ohms, using a 217D plug.

(3) Measure the E-W repeater gain at 1000 cycles - and at 250 and 2750 cycles if the bridging loss is desired at these frequencies.

(4) Remove the patch cord plug from the DROP VLC IN jacks.

(5) Measure the E-W repeater gain at 1000 cycles - and at 250 and 2750 cycles if the bridging loss is desired at these frequencies. (Omit this step if switching losses only are being measured.)

(6) Terminate the DROP VLC IN jacks in 600 ohms, using a 217D plug. (Both volcas inputs now are terminated in 600 ohms.)

(7) Measure the E-W repeater gain at 1000 cycles.

(8) Remove the testing tone, then remove the 217D plug terminations from both the DROP VLC IN and LINE VLC IN jacks. Patch the LINE VLC IN jacks to a separate 1000-cycle oscillator, sending sufficient power to operate the volcas.

(9) Measure the E-W repeater gain at 1000 cycles.

(10) To measure the bridging, transmitting switched and receiving switched losses in the W-E direction: Perform Items (1) to (9) of this paragraph, substituting references to LINE VLC IN jacks for references to DROP VLC IN jacks and vice versa, make the gain measurements in the W-E direction.

(11) Restore all connections to normal.

12.05 Bridging Loss - The bridging loss, for a given repeater side and measuring frequency, is obtained by subtracting the gain measured in Item (5) of Paragraph 12.04 from that measured in Item (3) of Paragraph 12.04.

Requirements: The bridging loss shall measure within limits of 0.3 db and 1.1 db for any frequency between 250 and 2750 cycles per second.

12.06 Transmitting Switched Loss - In a given direction of transmission, the transmitting switched loss at 1000 cycles is obtained by subtracting the gain in that direction as measured in Item (7) of Paragraph 12.04 from that measured in Item (3) of Paragraph 12.04.

Requirements: The transmitting switched loss limits, for all settings of the S resistance, are given in Table IV.

TABLE IV

| Nominal Value of S Resistance in Ohms | Transmitting Switched Loss in db |
|---|---|
| 0 | 5.9 to 9.7 |
| 10 | 4.0 to 7.0 |
| 20 | 3.2 to 5.4 |
| 40 | 2.1 to 3.9 |
| Open | Zero |

12.07 Receiving Switched Loss - The receiving switched loss at 1000 cycles for a given direction of echo transmission is obtained by subtracting the gain in that direction as measured in Item (9) of Paragraph 12.04 from that measured in Item (7) of Paragraph 12.04. In many cases the gain measured in Item (9) will be negative (a loss) and should, therefore, be regarded as a negative quantity when subtracted from Item (7).

Requirements: The receiving switched loss limits are given in Table V.

TABLE V

| A + B Resistance in Ohms | Receiving Switched Loss in db |
|---|---|
| 62.5 | 10.1 to 12.1 |

12.08 Effective Receiving Switched Loss - The results of Paragraph 12.07 are a measure

of the loss to echo transmission produced by the shunt which is placed across the echo transmission path when the volcas operates. In normal operation, however, the bridging loss is automatically removed when the receiving switched loss is applied, so that the effective loss to echo transmission is less than the loss determined in Paragraph 12.07 by the amount of the 1000-cycle bridging loss (i.e., about 0.5 db less).

12.09 Example - Assume that gain measurements were made on the E-W or drop side of a volcas equipped repeater, as outlined in Paragraph 12.04, with results as follows:

| Par. 12.04 Item | Gain Meas. db |
|---|---|
| (3) | 9.0 |
| (5) | 8.5 |
| (7) | 6.0 |
| (9) | -5.0 |

The desired losses may then be obtained by performing the operations of Paragraphs 12.05 through 12.07:

| Par. | Quantity | Operation | Loss - db |
|---|---|---|---|
| 12.05 | Bridging Loss | Item (3) - Item (5) | 0.5 |
| 12.06 | Trans. Sw. Loss | Item (3) - Item (7) | 3.0 |
| 12.07 | Rec. Sw. Loss | Item (7) - Item (9) | 11.0 |
| 12.08 | Effective RSL | 11.0 - 0.5 | 10.5 |