PRIVATE LINE TELEPHONE SERVICE
600/1500-CYCLE SELECTIVE SIGNALING SYSTEM
MAINTENANCE AND TROUBLE LOCATION TESTS
CUSTOMER'S PREMISES

1.00 GENERAL

1.01 This section describes a method of testing the 600- to 1500-cycle selective signaling equipment when installed at the customer's premises, that is, at a subscriber station, key equipment, or PBX. When the 600- to 1500-cycle selective signaling equipment is located at the toll office, it should be maintained by the toll office maintenance forces in accordance with established practices.

1.02 The tests covered are:

A. Operation Test of Local Receiving Circuit by Local Sending Circuit (4.01)

B. Test of Oscillator Control Circuit (4.07)

C. Test of Switching Relays of Oscillator Circuit (4.13)

D. Test of Output Level of Oscillator—Approximate Method (4.21)

E. Test of Output Level of Oscillator—Accurate Method (4.31)

F. Test of Output Voltage of Oscillator (4.40)

G. Test of Output Frequencies of Oscillator (4.48)

H. Test of Sending Circuit (4.55)

I. Current Measurements in Receiving Circuit (4.58)

J. Test of 60-type Selectors in Receiving Circuit (4.69)

K. Test of Signaling Connector Circuit (4.73)

L. Operation Tests (4.78)

M. Test for the Suppression of 600- to 1500-cycle Tones in Loudspeakers Using the 554A and 554B Filters (4.99)

1.03 Test A provides a method for testing the over-all operating features of the 600- to 1500-cycle signaling equipment at the installation under test.

1.04 Tests B through K are for use in analyzing the cause of failures while making test A and in clearing trouble reports.

1.05 Test L provides a method for testing the operating features of private lines having 600- to 1500-cycle signaling. The test provides: a check of incoming calls including the receiving circuit, line pickup keys, line lamps, buzzers, and time-out circuits; a check of outgoing calls including the station dial and the sending circuit; and a check of cutoff features between a station and a PBX on the same 600- to 1500-cycle line.

1.06 Tests D and G require an assistant at the toll test board. The operation tests in L require an assistant at another station.

1.07 In tests D, E, and F, alternate methods of measuring the power output of the oscillator are given. Of these, test D is to be considered as an approximate test, having as its advantage the fact that no meters or other testing equipment are needed at the station. However, where suitable measuring equipment can be had, use either test E or test F, depending on the equipment available.

1.08 In making all tests, periods of light traffic should be chosen when possible, to reduce service interruptions.

1.09 The general maintenance of apparatus, such as handsets, hand telephone sets, dials, and similar items used with 600- to 1500-cycle selective signaling and commonly used at other stations, is given in other sections of the practices.

1.10 Similarly, maintenance information on keys and relays is not included in this section.

1.11 For maintenance information on selectors used with 600- to 1500-cycle selective signaling, refer to the Section entitled, "60-type Selectors, Description, Maintenance, and Supplies" or to the sections which cover the 204-type selectors.

1.12 In most installations, five digits are used to dial the desired station. The first digit is 2, which serves to connect the oscillator to the line. The second digit is 1, which releases any operated 60-type selectors on the line. The remaining three digits cause the called station to be signaled.

1.13 In some installations, however, four digits may be used to dial the desired station. In these cases, the first digit dialed is 1, and the dial is held off normal momentarily by the attendant to provide time to connect the oscillator to the line. The remaining three digits cause the called station to be signaled.

1.14 The following J specification and schematic drawings cover the use of 600- to 1500-cycle selective signaling with private lines terminating in stations, key equipments, and PBXs, and will be required for maintenance purposes.

J53019 —600/1500-cycle Selective Signaling Equipment

SD-69167-01—Line Circuit for 4-wire Private Lines

SD-69168-01—600/1500-cycle Selective Signaling Circuit

SD-64691-01—600/1500-cycle Oscillator Circuit

SD-65655-01—Signaling Connector Circuit

SD-69159-01—102A Key Equipment—Attendant Telephone and Key Circuit

SD-66679-01—Auxiliary Trunk Circuit for PBXs

SD-65651-01—Tie Trunk Circuit for 551A, B, and D, and 600C PBXs—600/1500-cycle Sending — 600/1500-cycle or 20-cycle Receiving

SD-65653-01—Tie Trunk Circuit for 551A, B, and D, and 600C PBXs—20-cycle Sending—600/1500-cycle or 20-cycle Receiving

SD-65652-01—Tie Trunk Circuit for 552A, 552D, 605A, 700C, and 701A PBXs 600/1500-cycle Sending—600/1500-cycle or 20-cycle Receiving

SD-65654-01—Tie Trunk Circuit for 552A, 552D, 605A, 700C, and 701A PBXs—20-cycle Sending—600/1500-cycle or 20-cycle Receiving

2.00 APPARATUS

The apparatus required for each test is shown in Table A.

TABLE A

TEST EQUIPMENT

Apparatus	Test										Remarks
	A	B	C	D	E	F	G	H	I	J	
	Quantity Required										
Test Dial	1	1	1	0	0	0	0	0	1	1	Either No. 5H dial (see 3.01) connected to a D3AL-9 cord (see 3.02) or No. 5H dial connected to an S3B cord equipped with a No. 310 plug (see 3.03)
Transmission Measuring Set	0	0	0	0	1	0	0	0	0	0	No. 13A transmission measuring set, or equivalent
Fixed Pad	0	0	0	0	1	0	0	0	0	0	Fixed pad, 10 db, 600 ohms, required with the 13A TMS to bring the db reading within the range of the TMS
DC Voltmeter	0	0	0	1	1	1	0	0	0	0	DC voltmeter, 1000 ohms per volt, 0 to 150 volts, or equivalent
AC Voltmeter	0	0	0	0	0	1	0	0	0	0	AC voltmeter, 0 to 10 volts such as Weston No. 779 analyzer, or equivalent
DC Milliammeter	0	0	0	0	0	0	0	0	1	0	DC milliammeter, 0 to 15 ma
Test Equipment at Toll Test Board	0	0	0	1	0	0	1	0	0	0	Test equipment at the toll test board, capable of measuring the db level and frequency of the 600- to 1500-cycle signals sent out from the station
Patching Cord	2	1	1	0	0	0	0	0	2	2	P3E cord, 1 foot long, equipped with two No. 310 plugs (3P6A cord)
Testing Cord	0	0	0	0	1	1	0	0	1	0	W2BC cord, 5 feet 6 inches long, equipped with one No. 310 plug (2W27A cord)
Test Receiver with Plug	0	0	1	0	0	0	0	0	0	0	No. 716E or No. 528 receiver attached to an R2CF cord equipped with a No. 310 plug (2W4A cord)
Test Receiver with Picks	0	0	0	0	0	0	0	1	0	0	No. 716E or No. 528 receiver attached to a W2AB cord equipped with No. 360A tools (2W21A cord) and two No. 411A tools
Resistor	0	0	0	0	0	1	0	0	0	0	Resistor per KS-13490, List 1, 620 ohms, or any equivalent 1/2-watt resistor

3.00 PREPARATION

Test A, B, C, I, and J

3.01 These tests require a test dial on a cord about 6 feet long so that relay response to dialing may be checked. The 5H dial is recommended as a test dial, because it has the off-normal contact springs required in tests B and C. The dial contact springs may be protected from mechanical damage by the use of a 30A dial mounting with a 52C adapter, or equivalent. Two methods of providing the test dial are given in 3.02 and 3.03.

3.02 Connect the 5H dial and D3AL-9 cord to the signaling equipment as shown in Fig. 1.

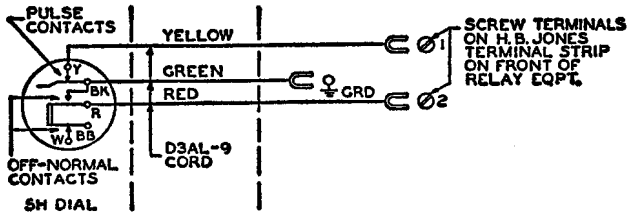

Fig. 1 — 5H Dial with D3AL Cord

3.03 If greater convenience in testing is desired, the cord of the test dial may be terminated in a plug which engages a jack on the equipment. This jack is not regularly furnished and should be installed locally by the telephone company. For this purpose, a 238A jack in a 212A jack mounting may be used. Connect the 5H dial to the S3B cord and No. 310 plug, and connect the 238A jack to the signaling equipment as shown in Fig. 2.

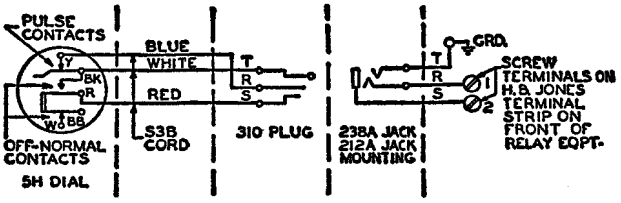

Fig. 2 — 5H Dial, S3B Cord, and 238A Jack

4.00 METHOD

A. Operation Test of Local Receiving Circuit by Local Sending Circuit

4.01 This test provides an over-all operational check of the sending and receiving equipment at the installation under test. It is made by connecting the output of the sending circuit through a test pad into the input of the receiving circuit and observing that test calls can be dialed through properly. (See SD-69168-01.)

4.02 At the relay rack on which the 600- to 1500-cycle equipment is mounted, make the following connections using the two patching cords.

From Jack	To Jack
OSC OUT (Oscillator Ckt)	OSC (Test Pad)
REC (Test Pad)	REC IN (Receiving Ckt)

4.03 Using the test dial (3.01), dial the calling code of one of the local stations whose line lamp and buzzer are operated by the receiving circuit under test. After the last digit is dialed, observe that the line circuit relay which controls the line lamp and buzzer at the called station has operated (SD-69167-0106, Fig. 45, 65, or 70). When the called station answers, request that signals received during the test be disregarded.

4.04 Repeat the test for each additional receiving circuit in which the 600- to 1500-cycle line terminates at the installation under test.

4.05 At the conclusion of the test, remove the patching cords and restore the circuit to normal. Disconnect the test dial unless other tests requiring it are to be made.

4.06 If this test fails and the nature of the trouble is not known, proceed with tests B through K in alphabetical order to localize the trouble. If the general location of the trouble is recognized, however, use only those tests required to locate the trouble.

B. Test of Oscillator Control Circuit

4.07 This test checks that the oscillator control circuit causes the dial to be connected to the oscillator circuit when dialing begins, and to be disconnected from the oscillator circuit after the complete code has been dialed. (See SD-69168-01, Fig. 1.)

4.08 At the relay rack, insert one of the plugs of the patching cord into the OSC OUT jack to serve as a dummy plug, and to prevent the 600-

to 1500-cycle pulses from being sent out on the line. Place the other plug of this cord on an insulated surface. If available, a dummy plug (No. 258A plug or equivalent) may be used in place of the patching cord plug.

4.09 Remove the covers of the 204E selector and the *A*, *B*, and *C* relays in the oscillator control circuit. Remove the cover of the *P* relay in the oscillator circuit. Observe that these relays and the selector are normal.

4.10 Using the test dial (3.01), dial the digit 1 while making the following observations:

- When the dial is moved off normal, observe that relays *A*, *B*, *C*, and *P* operate.
- While the dial is returning to normal, observe that relay *P* releases when the dial pulse contacts break, and reoperates when the dial pulse contacts make.
- When the dial comes to normal, observe that relay *A* releases and that the selector advances one step. Also observe that relays *B*, *C*, and *P* remain operated.

4.11 Dial the digit 1 repeatedly, to complete the number of dial pulls required by the station code (see 1.12 and 1.13) and observe the following:

- Each time the dial is moved off normal, relay *A* operates.
- Each time the dial returns toward normal, relay *P* releases and then reoperates.
- When the dial reaches normal on each dial pull except the last, relay *A* releases and the selector advances one step. Relays *B*, *C*, and *P* remain operated.
- When the dial reaches normal on the last pull, the selector, as well as relays *A*, *B*, *C*, and *P*, return to normal.

4.12 At the conclusion of the test, remove the plug from the OSC OUT jack, replace covers, and restore the circuit to normal. Disconnect the test dial, unless other tests requiring it are to be made.

C. Test of Switching Relays of Oscillator Circuit

4.13 This test checks that the switching relays in the oscillator convert the make and break battery pulses of the dial into 600- and 1500-cycle signaling current. (See SD-64691-01.)

4.14 At the relay rack, using a patching cord, connect the OSC OUT jack to the OSC jack. Connect the plug of the test receiver to the REC jack.

4.15 Using the test dial (3.01), dial the digit 1 while making the following observations:

- When the dial is moved off normal, check that the low-frequency signaling tone (600 cycles) is heard in the test receiver.
- After the dial has returned to normal, check that the high-frequency signaling tone (1500 cycles) is heard in the test receiver.

4.16 Dial the digit 1 a second time and check that the low frequency is again heard after the dial has returned to normal. Dial the digit 1 repeatedly to complete the number of dial pulls required by the station code, and check that a change in tone frequency is obtained after each digit is dialed. (See 1.13 and 1.14.) After the last digit has been dialed, check that a final change of frequency is heard after a short time. (This change of frequency releases any operated 60-type selectors on the line.) If this test is successful, the switching relays of the oscillator circuit may be assumed to be operating satisfactorily. If this test is not successful, make the following detailed test.

4.17 Remove the covers from the *P*, *SR*, *SW*, *PD1*, *PD2*, and *PD3* relays in the oscillator circuit. Observe that all relays are normal. Using the test dial, dial the digit 1 while making the following observations:

- When the dial is moved off normal, observe that relays *P* and *SR* operate. With the dial held off normal, block relay *SR* operated.
- Allow the dial to return to normal very slowly, and when the dial pulse contacts open, observe that relay *P* releases and that relays *PD1* and *SW* operate.

- When the dial pulse contacts make, observe that relay *P* reoperates, operating relay *PD2*.
- When the dial comes to rest, observe that relays *P, PD1, PD2,* and *SW* are operated. Listen in the test receiver and check that the high-frequency signaling tone is heard.

4.18 Dial the digit 1 a second time, while making the following observations:

- When the dial is moved off normal, observe that none of the relays whose covers are off operates or releases.
- Allow the dial to return to normal very slowly, and when the dial pulse contacts open, observe that relays *P, PD1,* and *SW* release and that relay *PD3* operates.
- When the dial pulse contacts make, observe that relay *P* reoperates and that relays *PD2* and *PD3* release.
- When the dial comes to rest, observe that relay *P* is operated. Listen to the test receiver and check that the low-frequency signaling tone is heard.

4.19 Failure of the circuit to operate as described should localize the trouble.

4.20 At the conclusion of the test, remove the patching cord and the test receiver. Replace relay covers, remove the blocking tool from the *SR* relay, and restore the circuit to normal. Disconnect the test dial, unless other tests requiring it are to be made.

D. Test of Output Level of Oscillator — Approximate Method

4.21 This test checks that the output levels of the 600- and 1500-cycle signaling currents produced by the oscillator are within proper limits. (See SD-64691-01.)

4.22 In this test, the db output of the oscillator is measured at the toll test board. No meters are required on the customer's premises. The results obtained are only approximate.

4.23 At one of the stations of the installation under test, operate the line key of the 600- to 1500-cycle line whose oscillator is to be tested, and remove the handset from its support. If the test is to be made from a PBX termination of the 600- to 1500-cycle line, insert a front or rear cord of an idle cord circuit into the TALK jack. Insert the front cord of another idle cord circuit into the DIAL jack. Listen on the line to make certain that it is not in use. If the line is not in use, dial the test code required to signal the 600- to 1500-cycle test equipment at the toll test board. When the attendant at the toll test board answers, request a test of the db output of the oscillator. If no test code is provided, arrange with the attendant at the toll test board to connect the test equipment to the circuit.

4.24 When the toll test board attendant is ready, dial the digit 2 to cause 600-cycle signaling frequency to be sent out on the transmitting pair. Meanwhile the station man should keep the handset receiver to his ear. When the 600-cycle test is finished, the toll test board attendant will talk on the line requesting 1500 cycles. (Under this condition the station can hear but not talk.) At the station, dial the digit 1 which will cause 1500 cycles instead of 600 to be applied to the transmitting pair. The attendant at the toll test board will advise the station as to whether the 600- and 1500-cycle db output levels of the oscillator are within limits.

4.25 If within limits, the oscillator output may be considered satisfactory and the equipment may be restored to normal.

4.26 If the 600-cycle db output is outside the limit, loosen the locknut of the 600-cycle potentiometer of the oscillator, and turn the screwdriver control clockwise to raise the output or counterclockwise to lower it. Recheck with the toll test board. If the limit of the 600-cycle potentiometer is reached without obtaining the desired db output, replace the LF electron tube in the oscillator.

4.27 Similarly, if the 1500-cycle output is outside the limit, turn the screwdriver control of the 1500-cycle potentiometer clockwise to raise the output or counterclockwise to lower it. Recheck

with the toll test board. Also, replace the HF electron tube if the desired output cannot be obtained by means of the potentiometer.

4.28 If the 600- and 1500-cycle output levels are both outside of limits, replace the AMP tube in the oscillator circuit and recheck.

4.29 Should potentiometer adjustment and tube replacement fail to correct the db output, check by means of the dc voltmeter that the plate supply between terminals 4 and 15 of the oscillator is about 130 to 150 volts. If this is correct, check the oscillator circuit in accordance with established practices for amplifier maintenance.

4.30 At the conclusion of the test, restore the circuit to normal.

E. Test of Output Level of Oscillator — Accurate Method

4.31 This test checks that the output levels of the 600- and 1500-cycle signaling currents produced by the oscillator are within proper limits. (See SD-64691-01.)

4.32 In this test, the db output of the oscillator is measured at the location of the equipment under test. The results are accurate, but require the use of a transmission measuring set and other apparatus on the customer's premises.

4.33 Connect the transmission measuring set to a power source of 105 to 125 volts dc (or 25 to 60 cycles ac), and allow 5 minutes for the set to warm up. Turn the dial switch to the 0 setting designated in red.

4.34 Connect the spade tips of the testing cord to the input of the fixed pad (see Table A) and insert the No. 310 plug of this cord into the OSC OUT jack of the oscillator. Using wire, connect the output of the fixed pad to the IN terminals of the transmission measuring set.

4.35 In testing the 600-cycle output level, insulate the No. 2 bottom contact of the *SR* relay, and then block the *P* relay operated. Observe that the 600-cycle level indicated on the transmission measuring set is 2 ±0.2 db. If the reading is outside this limit, loosen the locknut of the 600-cycle potentiometer and turn the screwdriver control until the specified level is obtained. If the limit of the 600-cycle potentiometer is reached without producing this level, replace the LF electron tube in the oscillator and recheck.

4.36 In testing the 1500-cycle output level, the No. 2 bottom contact of the *SR* relay should remain insulated. Block relay *SR* operated, and then remove the blocking tool from relay *P*. Observe that the level indicated on the transmission measuring set is 2 ±0.2 db. If the reading is outside this limit, loosen the locknut of the 1500-cycle potentiometer, and turn the screwdriver control until the specified level is obtained. If potentiometer adjustment cannot produce this level, replace the HF electron tube in the oscillator circuit and recheck.

4.37 If the 600- and 1500-cycle output levels are both outside of limits, replace the AMP tube in the oscillator circuit and recheck.

4.38 Should potentiometer adjustment and tube replacement fail to correct the db output, check by means of the dc voltmeter that the plate supply between terminals 4 and 15 of the oscillator is about 130 volts. If this is correct, check the oscillator circuit in accordance with established practices for amplifier maintenance.

4.39 At the conclusion of the test, remove all cords, remove insulating and blocking tools from the *SR* relay, remove the plug of the testing cord from the OSC OUT jack, and restore the circuit to normal.

F. Test of Output Voltage of Oscillator

4.40 This test checks that the 600- and 1500-cycle output voltages of the oscillator are within proper limits. It is a substitute for test E when a transmission measuring set is not available and an ac voltmeter is available. (See SD-64691-01.)

4.41 In this test, the output voltage of the oscillator is measured at the location of the equipment under test. The results are accurate but require the use of an ac voltmeter on the customer's premises.

4.42 Connect the spade tips of the testing cord to the ac voltmeter. Operate the voltmeter scale key to measure 10 volts. Connect the 620-ohm resistor across the input of the voltmeter. Insert

the No. 310 plug of the testing cord into the OSC OUT jack of the oscillator.

4.43 In testing the 600-cycle output voltage, insulate the No. 2 bottom contact of the *SR* relay, and then block the *P* relay operated. Observe that the meter reads 3.1 ±0.1 volts. If the reading is outside these limits, loosen the locknut of the 600-cycle potentiometer, and turn the screwdriver control until the specified voltage is obtained. If the limit of the 600-cycle potentiometer is reached without producing this voltage, replace the LF electron tube in the oscillator and recheck.

4.44 In testing the 1500-cycle output voltage, the No. 2 bottom contact of the *SR* relay should remain insulated. Block relay *SR* operated, and then remove the blocking tool from relay *P*. Observe that the meter reads 3.1 ±0.1 volts. If the reading is outside these limits, loosen the locknut of the 1500-cycle potentiometer, and turn the screwdriver control until the specified voltage is obtained. If the limit of the 1500-cycle potentiometer is reached without producing this voltage, replace the HF electron tube in the oscillator and recheck.

4.45 If the 600- and 1500-cycle output voltages are both outside of limits, replace the AMP tube in the oscillator circuit and recheck.

4.46 Should potentiometer adjustment and tube replacement fail to correct the voltage output, check by means of the dc voltmeter that the plate supply between terminals 4 and 15 of the oscillator is about 130 volts. If this is correct, check the oscillator circuit in accordance with established practices for amplifier maintenance.

4.47 At the conclusion of the test, remove all cords, remove insulating and blocking tools from the *SR* relay, remove the plug of the testing cord from the OSC OUT jack, and restore the circuit to normal.

G. Test of Output Frequencies of Oscillator

4.48 This test checks that the 600- and 1500-cycle output frequencies of the oscillator are within proper limits.

4.49 In this test, the 600- and the 1500-cycle output frequencies of the oscillator are applied to the line for frequency measurement at the toll test board. (See SD-64691-01 and SD-69168-01.)

4.50 At one of the stations of the installation under test, operate the line key of the 600- to 1500-cycle line whose oscillator is to be tested, and remove the handset from its support. If the test is to be made from a PBX termination of the 600- to 1500-cycle line, insert a front or rear cord of an idle cord circuit into the TALK jack. Insert the front cord of another idle cord circuit into the DIAL jack. Listen on the line to make certain that it is not in use. If the line is not in use, dial the test code required to signal the 600- to 1500-cycle test equipment at the toll test board. When the attendant at the toll test board answers, request a frequency test of the oscillator. If no test code is provided, arrange with the attendant at the toll test board to connect the test equipment to the circuit.

4.51 When the toll test board attendant is ready, dial the digit 2, to cause 600-cycle signaling frequency to be sent out to the toll test board attendant who will determine if it is within the limits of 600 ±8 cycles. Meanwhile the station man should keep the handset receiver to his ear. When the 600-cycle test is finished, the toll test board attendant will talk on the line requesting 1500 cycles. (Under this condition, the station can hear but not talk.) At the station, dial the digit 1, which will cause 1500 cycles instead of 600 cycles to be applied to the transmitting pair. The toll test board attendant will determine if the limit of 1500 ±18 cycles has been met.

4.52 If the 600-cycle frequency is found to be outside the limit, change the strapping of the units of the LF capacitor in the oscillator circuit until the output frequency is 600 ±4 cycles per second, and recheck with the toll test board.

> **Note:** The strapping of additional LF capacitor units into the circuit will decrease the output frequency. The removal of LF capacitor units from the circuit by removing strapping will increase the output frequency. For example, an increase of 0.002 mf in LF capacitor will cause a decrease of about 6 cps in the low-frequency output. The nominal capacities of the 10 units of the LF capacitor (187A capacitor) are as follows:

Capacitor Terminal No.	Nominal Capacity mf
1	0.002
2	0.002
3	0.004
4	0.007
5	0.012
6	0.020
7	0.034
8	0.058
9	0.100
10	0.174

4.53 If the 1500-cycle frequency is found to be outside the limit, change the strapping of the units of the HF capacitor in the oscillator circuit until the output frequency is 1500 ±10 cycles per second, and recheck with the toll test board.

Note: The strapping of additional HF capacitor units into the circuit will decrease the output frequency. The removal of HF capacitor units from the circuit by removing strapping will increase the output frequency. For example, an increase of 0.001 mf in HF capacitor will cause a decrease of about 16 cps in the high-frequency output. The nominal capacities of the ten units in the HF capacitor (187B capacitor) are as follows:

Capacitor Terminal No.	Nominal Capacity mf
1	0.001
2	0.001
3	0.002
4	0.002
5	0.004
6	0.004
7	0.008
8	0.008
9	0.020
10	0.035

4.54 At the conclusion of the test, restore the circuit to normal.

H. Test of Sending Circuit

4.55 This test checks that the 600- and 1500-cycle signaling frequencies are connected to the line during dialing, to signal the distant station. (See SD-69168-01, Fig. 3.)

4.56 Remove the covers from the *P* relay in the oscillator circuit and the *S* relay in the sending circuit. Block the *P* relay operated. Observe that the *S* relay has operated. With the test receiver slightly away from the ear, connect the test picks to No. 2 top and bottom contacts of the *S* relay. Observe that signaling frequency is heard in the receiver.

4.57 At the conclusion of the test, remove the blocking tool from the *P* relay, and restore the circuit and equipment to normal.

I. Current Measurements in Receiving Circuit

4.58 This test checks that incoming 600- and 1500-cycle signaling currents, when amplified and rectified in the receiving circuit, will cause the *A* relay to operate. (See SD-69168-01, Fig. 4.)

4.59 At the relay rack on which the equipment is mounted, make the following connections with the two patching cords:

From Jack	To Jack
OSC OUT (Oscillator Ckt)	OSC (Test Pad)
REC (Test Pad)	REC IN (Receiving Ckt)

4.60 Connect the spade tips of the testing cord to the dc milliammeter. Insert the No. 310 plug of the testing cord into the 1500-cycle jack of the receiving circuit.

4.61 Using the test dial (3.01), dial the digit 1 which will cause rectified 1500-cycle signaling current to flow through a winding of the *A* relay. Observe that the meter reading is between 4.5 ma and 12 ma. If not, loosen the locknut of the AMP potentiometer in the receiving circuit, and turn the screwdriver control until 8 ma is obtained.

Remove the plug from the 1500-cycle jack and insert it in the 600-cycle jack. Observe that the meter reading (1500-cycle leakage current) is less than 20 per cent of the previous reading.

4.62 With the milliammeter still connected to the 600-cycle jack, dial the digit 1 again, to cause rectified 600-cycle signaling current to flow through a winding of the *A* relay. Observe that the meter reading is between 4.5 ma and 12 ma. If not, loosen the locknut of the AMP potentiometer in the receiving circuit and turn the screwdriver control until 8 ma is obtained. Remove the plug from the 600-cycle jack, and insert it into the 1500-cycle jack. Observe that the meter reading (600-cycle leakage current) is less than 20 per cent of the reading just obtained.

4.63 Remove the plug from the 1500-cycle jack and insert it into the BIAS jack. Observe that the bias current reading is between 2.0 and 2.5 ma.

4.64 For proper detection of incoming 600-cycle signals by the *A* relay in the receiving circuit, the 600-cycle rectified current should be maintained at a value which is at least twice the sum of the bias current and the 1500-cycle leakage current.

4.65 Similarly, for proper detection of incoming 1500-cycle signals by the *A* relay, the 1500-cycle rectified current should be maintained at a value which is at least twice the sum of the bias current and the 600-cycle leakage current.

4.66 In the above tests, low values of the rectified signal current of *both* 600 and 1500 cycles, which cannot be corrected by turning the AMP potentiometer, may indicate trouble in the amplifier portion of the receiving circuit. Replace one or both of the No. 310A electron tubes of the receiving circuit. A total absence of both signals indicates an open in the receiver circuit or in the power supply circuit.

4.67 If only one value of rectified current is low, or absent entirely, and the other is normal, the trouble may be located in the 92A filter or the 33D varistor. Replace the varistor and retest. If the trouble is still present, replace the 92A filter.

4.68 At the conclusion of the test, disconnect the milliammeter, remove all patching cords, and restore the circuit to normal. Disconnect the test dial, unless other tests requiring it are to be made.

J. Test of 60-type Selectors in Receiving Circuit

4.69 This test checks the ability of the 60-type selector to respond to its own station call. (See SD-69168-01, Fig. 4 and 7.)

4.70 At the relay rack on which the equipment is mounted, make the following connections using the two patching cords:

From Jack	To Jack
OSC OUT (Oscillator Ckt)	OSC (Test Pad)
REC (Test Pad)	REC IN (Receiving Ckt)

4.71 Using the test dial (3.01), dial the code which will operate the 60-type selector under test. As each of the last three digits of the code is dialed, observe that the selector wheel advances, and that at the end of each digit the holding spring engages reliably with the code pin. If this does not occur, see 1.11.

4.72 At the conclusion of the test, remove the patching connections, and restore the circuit to normal. Disconnect the test dial unless other tests requiring it are to be made.

K. Test of Signaling Connector Circuit

4.73 This test checks the ability of the signaling connector circuit to (a) connect the dial of the calling station to the common oscillator so that 600- to 1500-cycle signal current can be dialed out on the line to signal the distant station, (b) exclude other stations on the same premises from the common oscillator during the brief period that the calling station is using it, and (c) release the common oscillator after the last digit has been dialed, so that it will be available for use on other lines, by other stations on the same premises. (See SD-65655-01 and SD-69168-01.)

4.74 At one of the stations, operate the line key of the line to be tested and remove the handset from its support. (At PBXs, insert a front or rear cord of an idle cord circuit in the TALK jack,

and the front cord of another idle cord circuit in the DIAL jack.) Listen on the line to make sure that it is not in use. Dial the digit 2 and check that a low-frequency signaling tone (600 cycles) is heard after the dial returns to normal, showing that the dial has actuated the signaling connector circuit and the oscillator circuit. Leave the station in this condition, and proceed as in 4.75 if the oscillator is used by more than one station; otherwise proceed directly to 4.76.

4.75 Go to another station which uses the common oscillator. Operate the line key of some other line, lift the handet from its support, and dial the digit 2. After the dial returns to normal, check that signaling tone is not heard—showing that the signaling connector has denied the second station the use of the oscillator. At the second station, replace the handset on its support and restore the line key.

4.76 At the first station, dial the remaining digits of the call. After the last digit has been dialed, observe that signaling frequency is removed from the line, showing that the oscillator has been released for use by other stations.

4.77 At the conclusion of the test, restore the circuit to normal.

L. Operation Tests

4.78 The following is a method of testing the operating features of private lines which employ 600- to 1500-cycle selective signaling.

600- to 1500-cycle Lines Terminating at a Station

4.79 At stations where private lines having 600- to 1500-cycle selective signaling terminate in a station handset, the following operational tests of outgoing and incoming calls may be made to determine if the system is working properly. (See SD-69167-0106, Fig. 7, 65, 66, or others, according to the circuit options used.)

4.80 At the station, operate the line key, if furnished, lift the handset from its support, and listen to the receiver to check that the line is not in use before dialing. Using the station dial, dial the code of some other station on the line, and when the station answers, observe that the transmission is satisfactory. Ask the station to call back. When the call is received, observe that the visual and audible line signals operate. If an automatic time-out circuit is provided, allow the line signals to operate for about 30 seconds, and observe that they are released automatically at the end of this time. Answer the call by operating the line key, if provided, and removing the handset from its mounting. Observe that the line signals (if not previously released by the automatic time-out) are cut off. Restore the circuit to normal, and repeat the test for other lines.

600- to 1500-cycle Lines Terminating in a No. 102A Key Equipment

4.81 Where private lines employing 600- to 1500-cycle selective signaling terminate in a No. 102A key equipment, the following operational tests may be made to determine if the system is working properly. (See SD-69167-0106, Fig. 45, 47, 70, 71, 72, and others, according to the circuit options used; also SD-69159-012, Fig. 18.)

4.82 **2-lamp Signaling:** At a position of the 102A key equipment, operate the line key of the 600- to 1500-cycle line to be tested. Remove the handset from its mounting and listen to the receiver to check that the line is not in use before dialing. Observe that the white LINE & BUSY lamp lights at each 102A key equipment position. Using the position dial, dial the first digit (digit 2) of the code of some other station on the line. Check that a low-frequency signaling tone (600 cycles) is heard after the dial has returned to normal, indicating that the dial transfer circuit and the oscillator circuit have operated. Dial the remaining digits of the code, and when the called station answers, observe that transmission is satisfactory. Ask the station to call back. Replace the handset on its mounting. When the call is received, observe that the white LINE & BUSY lamp flashes and that the buzzer operates. In addition, observe that the red SUPV lamp lights at the position under test. Answer the call by lifting the handset from its support. Observe that the red SUPV lamp goes out, that the buzzer is silenced, and that the white LINE & BUSY lamp now lights steadily at each position. Replace the handset on its support, and restore the line key to normal. Observe that the LINE & BUSY lamp at each position goes out. Repeat this test for other positions and for other lines equipped for 600- to 1500-cycle selective signaling.

4.83 **1-lamp Signaling:** At a position of the 102A key equipment, operate the line key of the 600- to 1500-cycle line to be tested. Remove the handset from its mounting, and listen to the receiver to check that the line is not in use before dialing. Observe that the white LINE & BUSY lamp lights at each 102A key equipment position. Using the position dial, dial the first digit (digit 2) of the code of some other station on the line. Check that a low-frequency signaling tone (600 cycles) is heard after the dial has returned to normal, indicating that the dial transfer circuit and the oscillator circuit have operated. Dial the remaining digits of the code, and when the called station answers, observe that transmission is satisfactory. Ask the station to call back, and replace the handset on its mounting. When the call is received, observe that the white LINE & BUSY lamp flashes at the position under test and lights steadily at all other positions. Also observe that the common buzzer operates. Answer the call by lifting the handset from its support. Observe that the LINE & BUSY lamp at each position now burns steadily, and that the buzzer is silenced. Restore the handset to its support, and restore the line key to normal. Observe that the LINE & BUSY lamp at each position goes out. Repeat this test for other positions and for other lines equipped for 600- to 1500-cycle selective signaling.

600- to 1500-cycle Lines Terminating at a PBX

4.84 Where private lines employing 600- to 1500-cycle selective signaling terminate at a PBX, the following operational tests may be made to learn if the system is functioning as it should.

4.85 The 600- to 1500-cycle selective signaling arrangement has been made available for No. 551A, B, and D; 552A and D; 600C, 605A, 700C, and 701A PBXs; and is shown on SD-65651-01, SD-65652-01, SD-65653-01, SD-65654-01, and SD-66679-01.

4.86 Insert a front or rear cord of an idle cord circuit in the TALK jack. Listen on the line to make sure that it is not in use before testing. On lines having 600- to 1500-cycle sending, insert the front cord of an idle cord circuit in the DIAL jack and dial the first digit (digit 2) of the station at which the assistant is located. Check that a low-frequency signaling tone (600 cycles) is heard after the dial has returned to normal, indicating that the dial transfer circuit and the oscillator circuit have operated. Dial the remaining digits of the code and remove the cord from the DIAL jack. (On lines with 20-cycle sending instead of 600- to 1500-cycle sending, insert a front or rear cord of an idle cord circuit in the TALK jack, listen on line, and if not busy, use the PBX cord circuit ringing key to signal the assistant at his station.) When the assistant at the called station answers, observe that transmission is satisfactory. Ask the assistant to call back. Disconnect from the line by removing the cord from the TALK jack.

4.87 When the assistant calls back, observe that the tie trunk lamp lights and that the audible signal sounds. Insert the rear cord of an idle cord circuit in the associated TALK jack. Observe that the tie trunk lamp is extinguished, that the buzzer is silenced, and that the rear cord supervisory lamp remains extinguished. Observe that transmission is satisfactory. With the rear cord still in the TALK jack, test for a rering by having the assistant call back. Observe that the tie trunk lamp and the audible signal reoperate for a period of 2 to 4 seconds, and then are cut off automatically.

4.88 At the conclusion of the test, disconnect the cord from the TALK jack and restore the circuit to normal.

600- to 1500-cycle Line Terminating at Station and PBX

4.89 Where a private line having 600- to 1500-cycle selective signaling terminates both at a station and at a PBX on the same premises, the following operational tests may be made to check circuit operation. (See SD-69167-0105, Fig. 38, 39, 69, 73, and 74.)

4.90 **No Cutoff Key at Station or PBX:** At the station, lift the handset from its mounting, and if the line is not busy, dial the code of another station on the line. When the station answers, observe that transmission is satisfactory. Ask the station to call back on the private line. When the call is received, observe that the line signals at the station operate. Answer the call by removing the handset from its mounting, and observe that the line signals are cut off. Replace the handset on its mounting.

4.91 At the PBX, insert a front or rear cord of an idle cord circuit in the TALK jack. Listen on the line, and if it is not busy, insert the front cord of an idle cord circuit in the DIAL jack and dial the code of another station. Remove the cord from the DIAL jack. When the station answers, check for satisfactory transmission, and then ask the station to call back on the private line. Remove the cord from the TALK jack. When the call is received at the PBX, observe that the tie trunk lamp lights and that the audible signal sounds. Answer the call by inserting the rear cord of an idle cord circuit in the TALK jack. Observe that the line signals are extinguished and that connection to the station is established. Restore the circuit to normal.

4.92 **Key at PBX to Cut Off the Station:** A locking key is provided at the PBX so that the use of the private line is under control of the PBX attendant. That is, with the key normal, both the station and the PBX may use the line. With the key operated, the station is cut off from the line and incoming calls for the station are routed to the PBX. A lamp designated SCO, at the station, lights whenever the station is cut off from the line. (See SD-69167-0105, Fig. 38, 39, and 69.)

4.93 With the SCO (station cut off) key at the PBX in its normal position, test the operation of the station and the PBX on the private line as described in 4.90 and 4.91.

4.94 At the PBX, operate the SCO key so that the incoming call will signal the PBX but not the station. Arrange for another station on the line to call into the station. Request the PBX attendant beforehand not to answer the call when received, but to wait a short time (about 10 seconds). After this interval, the PBX attendant should restore the SCO key to normal, again wait a few seconds, and then answer on the line. At the station, observe that the SCO lamp is lighted. A short time later, observe that the SCO lamp is extinguished and that the station line lamp and buzzer operate—indicating that the PBX attendant has restored the SCO key to normal as instructed. Answer the call at the station, and observe that the station line lamp and buzzer are cut off. When the PBX attendant comes in on the connection, request that the SCO key be reoperated. Observe that the station telephone is cut off from the talking connection and that the SCO lamp lights. Restore the circuit to normal at the station and at the PBX.

Key at Station to Cut Off the PBX

4.95 A locking key is provided at the station so that the use of the private line is under control of the station. With the key normal, both the station and the PBX may use the line. With the key operated, the PBX is cut off from the line, and incoming calls for the PBX are routed automatically to the station. (See SD-69167-0105, Fig. 73.)

4.96 With the PBX CO (PBX cut off) key at the station in its normal position, test the operation of the station and the PBX on the private line as described in 4.90 and 4.91.

4.97 At the station, operate the PBX CO key to cause the incoming call to signal the station but not the PBX. Arrange for another station on the line to call the PBX. Request the PBX attendant to pick up the private line as soon as the associated trunk lamp lights and the buzzer sounds. At the station, when the call is received, allow the line lamp and buzzer to operate for about 10 seconds. Nonanswer by the PBX indicates that the PBX is cut off and is not being signaled. At the station, restore the PBX CO key to normal, and observe that the PBX attendant answers on the private line soon after, indicating that the PBX has been signaled. Lift the handset from its support, so that the station set is bridged in on the line with the PBX attendant. At the station, operate the PBX CO key and observe that the PBX is cut off from the talking connection.

4.98 At the conclusion of the test, restore the circuit to normal.

M Test for the Suppression of 600- to 1500-cycle Tones in Loudspeaker Using the 554A and 554B Filters

4.99 Methods to determine whether the 600- to 1500-cycle tones have been eliminated in the loudspeaker are shown below.

- Busy Line: On the central office side of the receiving loop filters, monitor the circuit using a 1011B test set with the talk monitor switch in the monitor position. When any station on the circuit is dialing and the dial pulsing tones are heard in the test set but are not audible from the loudspeaker, the circuit is functioning properly.

- Idle Line: Request the toll testman to dial a series of digits on the 4-wire circuit. The testman should use caution when dialing so as not to signal a station on the circuit. The absence of dial pulsing tones in the loudspeaker is an indication that the circuit is functioning properly.