

ROUTINE FOR MAINTAINING SPECIAL SERVICE REPEATERS

1. GENERAL

1.01 This section provides a routine outlining the acceptance, service order, and maintenance tests, adjustments, and procedures together with the time intervals for the various maintenance tests and the allowable limits which should be applied for special service repeaters. The routine is divided into seven parts as follows:

Part 1. GENERAL, which describes the purpose and arrangement of the routine.

Part 2. ACCEPTANCE TESTS, which covers the tests which should be made and the limits which should be met to insure that this equipment is in a satisfactory condition when installed in an office.

Part 3. SERVICE ORDER TESTS, which covers the tests and adjustments which should be made and the limits which should be met when placing repeaters in service on new or on rearranged circuits to insure that the service requirements are met.

Part 4. MAINTENANCE TESTS, which covers the tests, adjustments, and procedures which should be followed, the time intervals at which the tests should be applied, and the limits which should be met to insure that the equipment remains in a satisfactory condition after it has been placed in service.

Part 5. SUGGESTIONS FOR LOCATING TRANSMISSION TROUBLES, which covers a number of tests, procedures, and investigations which will be of assistance in the prompt clearing of transmission trouble on lines using these repeaters when

either transmission complaints or routine tests indicate the existence of such trouble.

Part 6. DESIGNATION OF REPEATER GAINS, which covers the procedures to be used in designating the potentiometer settings giving the specified gains, and the form to be used for recording temporary changes in gains.

Part 7. DESCRIPTION OF RECORD FORMS, which describes the forms provided for recording the results of tests.

1.02 The time intervals specified for the maintenance tests are based on the minimum amount of testing which should insure satisfactory service. In cases where the number of troubles affecting service is larger than is reasonable, it may be desirable to decrease the intervals between some of the tests until the causes of trouble are removed. If such action is necessary the matter first should be reported to the proper supervisory people.

1.03 In order to facilitate the application of this routine, a list is attached itemizing all of the tests, adjustments, and procedures specified. The list includes references to paragraphs covering the tests and states the frequency at which each should be performed.

1.04 The number in parenthesis following the paragraph covering each test indicates the form on which the results should be recorded.

1.05 For general information regarding the circuits and equipment of special service repeaters, reference should be made to the description of the repeater in Section K24.91. References to the operating features of the testing apparatus will be found in Division K3 of these practices. The methods to be used in making the tests are covered in

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Sections K22.91 and K24.91.

2. ACCEPTANCE TESTS

- 2.01 Acceptance tests should be made on all newly installed special service repeaters. Whenever any of the following tests are performed by the Western Electric Company and satisfactory reports are received by the Telephone Company, it will not be necessary for the Telephone Company testers to repeat the tests.
- 2.02 As some of the coils used in this equipment may become permanently magnetized and rendered useless by direct current through their windings, the ordinary installer's buzzer set should not be used in making continuity tests. All test equipment should meet standard requirements and be used under standard conditions. Acceptance tests should be performed in the order listed.
- 2.03 Unless otherwise specified, all troubles encountered should be cleared as found. A check test should be made on circuits with troubles to insure that the troubles have been corrected. Tests also should be made on adjacent circuits, where these are involved, to insure that no troubles have been introduced.
- 2.04 The results of all acceptance tests should be recorded for future reference, and should be marked "Results of Acceptance Tests."

(a) CURRENT FLOW TESTS

- 2.05 The current flow from the line relay of each repeater through an external 400-ohm resistance in series with a milliammeter should be read. This measurement may be obtained by patching the meter and resistance into the repeater line west jacks. The current flow should be  $.041 \pm .003$  amperes.

(b) ALARM CIRCUIT EQUIPMENT

- 2.06 The plate and filament fuse alarm circuits should be checked to insure that they will operate in case a fuse is blown.
- 2.07 The operation of the high and low voltage alarm circuit used with the plate battery should be checked.

(c) TELEPHONE SET - OPERATION TESTS

- 2.08 Operating tests should be made on each 511-E telephone set panel for the following features:
- (1) Talking on line
  - (2) Monitoring - With both potentiometers adjusted for an infinite loss and 1000-cycle tone applied to the east side of a repeater, tone should be heard in the receiver of the operator's head set when the monitoring key of the 511-E panel is operated to "Monitor East" and "Monitor Both Ways," but no tone or only a very weak tone should be heard when the key is operated to "Monitor West." With tone applied to the west side of the repeater, tone should be heard in the receiver when the monitoring key is operated to "Monitor West" and "Monitor Both Ways," but no tone or only a very weak tone should be heard with the key operated to "Monitor East."

(d) TUBE TESTS

- 2.09 A filament activity test of each tube should be made as follows: Place the tube in the filament activity test set and read the plate current at the maximum and minimum working limits of the filament current, as given in paragraph 2.11. If the variation in plate current is greater than 0.7 milliamperes, the tube should be rejected.
- 2.10 Inspect each tube while in the filament activity test set and if any part of the filament burns considerably brighter than the other parts so as to approach a condition of white heat, or if there is a blue haze around the elements, the tube should be rejected.

(e) FILAMENT CURRENT

- 2.11 Adjust the filament current of the repeater to fall within the limits shown in the following table. In case the battery which supplies the filament current is operated on a charge and discharge basis, account should be taken of the battery voltage in adjusting the filament current. That is, if the battery has just been taken off charge the current should approach the upper limit, while if the battery is shortly to be placed on charge, the

current should approach the lower limit.

Type of Tube	Filament Current		
	Minimum	Normal	Maximum
101-F	.470 amp.	.485 amp.	.500 amp.

(f) GRID VOLTAGES

- 2.12 With the filament current adjusted to the proper value, the voltage at each tube should be measured between the negative filament lug of the tube socket and lug 5 of the input transformer associated with that tube. The reading should be  $8.0 \pm .6$  volts. The potential on lug 5 of the input transformer should be negative with respect to the negative lug of the tube socket.

(g) PLATE VOLTAGES

- 2.13 With the filaments burning, the plate voltage should be read between the plate lug of each vacuum tube socket of the repeater and relay rack ground. The reading should be  $128 \pm 7$  volts. The potential on the plate lug of the tube socket should be positive with respect to ground. In addition to this measurement, whenever dry cells are used as a source of plate current the voltage of each 45-volt block should be measured separately while the filaments are burning. The voltage of each block should be 44 volts or more.

(h) 1000-CYCLE GAIN MEASUREMENTS

- 2.14 The gain of each repeater should be measured in each direction at 1000 cycles with the 36 type resistances connected and the slide wire of the 23-A potentiometer set for maximum gain, minimum gain, and step zero (infinite loss).
- 2.15 The gain at maximum slide wire setting plus the db value of the 36 type resistance should be 17.5 db or more in each direction.
- 2.16 The gain at minimum slide wiring setting should be  $6 \pm .5$  db less than the gain measured at maximum slide wire setting.
- 2.17 At step zero the repeater should cause an infinite loss.

NOTE: 101-F tubes require a few minutes to reach a state of equilibrium after the filament current is turned on. Gain tests should not be made until

five minutes after the filaments are lighted or a cold tube is placed in the socket.

- 2.18 Tests should be made of the wiring of the monitoring circuit on both the west and the east sides of each repeater. With the potentiometer on the side of the repeater under test set for maximum gain, and the other potentiometer set for infinite loss, the gain at 1000 cycles should be measured from the input of the repeater to the output of the monitoring winding of the side under test at the monitoring jacks. The output side of the repeater and the network jacks of both sides of the repeater should be terminated by 600 ohms  $\pm 1\%$ . The measured gain should be  $G - 8.2 \pm 1$  db, G being the gain of the repeater obtained in paragraph 2.15 with the same tube.

- 2.19 Loss Caused by Telephone Set. This test should be made on each 511-E telephone set panel installed in the office. The telephone set should be connected to the monitoring windings of a repeater that has been tested in accordance with paragraphs 2.14 and 2.18. The operator's head set should be plugged into the jack of the telephone set. The potentiometer of one side of the repeater should be set for maximum gain and the other potentiometer for infinite loss. The network jacks of both sides of the repeater should be terminated by 600 ohms  $\pm 1\%$ . Gain measurements should be made on the repeater at 1000 cycles.

(1) With the talking key normal and the monitoring key thrown alternately to Normal, Monitor East, and Monitor West, the values of gain should differ by only a negligible amount (less than 0.1 db) from the value of gain obtained in paragraph 2.15 with the same tube.

(2) With the monitoring key normal and the talking key thrown to TALK on REPEATER, the value of gain should not be more than 4.0 db lower than the value of gain obtained in paragraph 2.15 with the same tube.

(j) INTERNAL BALANCE TEST

- 2.20 Internal balance tests should be made on each side of each repeater. The line and network jacks of one

side of the repeater under test should be opened and short circuited and opened, respectively. The line and network jacks on the other side of the repeater should be terminated by 600 ohms + 1 ohm. The singing point of the west side of the repeater should be at least 35 db. In testing the east side of the repeater, singing should not occur with both potentiometers set for maximum gain. While making this test the 36 type resistances in the poten-

tiometers must be disconnected from the circuit.

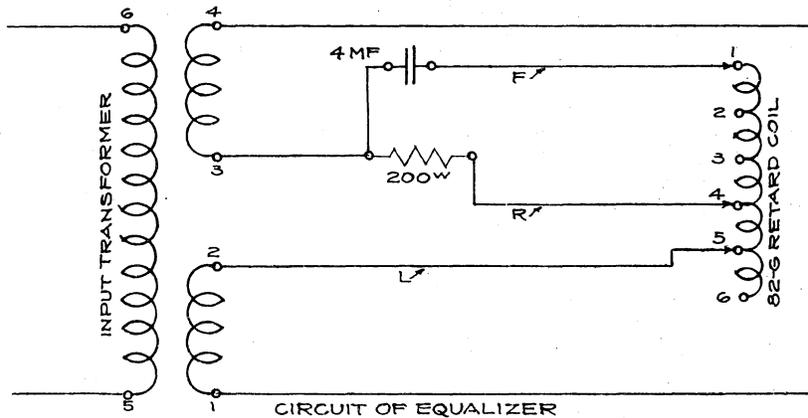
(k) GAIN FREQUENCY MEASUREMENTS

2.21 Gain Frequency tests should be made on each special service repeater in each direction of transmission with the potentiometer set for maximum gain. The gain should be measured at each frequency included in Table I, and the results should be within the limits established in this table for the type of filter in use. Minus signs indicates gains less than the 1000-cycle gain.

TABLE I  
DEVIATIONS FROM 1000-CYCLE GAIN

Fre- quency Cycles	13-B Filter			13-C Filter			No Filter		
	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.
200	-1.5	0	-3.0	-1.5	0	-3.0	-1.5	0	-3.0
300	- .4	+ .2	-1.0	- .4	+ .2	-1.0	- .4	+ .2	-1.0
1000	0	0	0	0	0	0	0	0	0
1600	+ .5	+1.0	0	+ .5	+1.0	0	+ .7	+1.0	0
2000	+ .5	+1.5	- .5	+ .5	+1.5	- .5	+1.2	+2.0	-1.0
2600	-4.0	-2.0	-9.0	-	-	-	-	-	-
2800	-	-	-	-6.0	-4.0	-11.0	+1.2	+3.0	-3.0

Normal equalizer connections (L to 5  
(F to 1  
(R to 4



2.22 If these limits are not met the gain at frequencies above 1000 cycles may be varied by changing the connections of the 82-G retard coil. Table

II shows the db change in gain at various frequencies which may be obtained by various changes from the normal equalizer connections as given in Table I.

TABLE II

Lead F remains on Tap 1 of 82-G retard for all conditions.

Lead L to Tap	5	1	3	6	5	5	5	5
Lead R to Tap	<u>4</u>	<u>4</u>	<u>4</u>	<u>4</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>6</u>
1000 Cycles	0	0	0	0	0	0	0	0
1600 Cycles	0	-.5	-.2	+.1	+.4	+.2	+.1	-.1
2000 Cycles	0	-.8	-.3	+.2	+.7	+.5	+.2	-.3
2600 Cycles	0	-1.0	-.3	+.3	+2.1	+1.4	+.7	-.5
2800 Cycles	0	-1.0	-.3	0	+2.8	+1.9	+1.0	-.5

2.23 No means are provided for adjusting the gain frequency characteristic at frequencies below 1000 cycles. If the limits at these frequencies are not met, the repeater should be considered in trouble.

(1) ASSOCIATED APPARATUS

2.24 Care should be exercised to see that all testing and measuring apparatus associated with the repeaters is in a satisfactory condition. The performance requirements for 6-A Transmission Measuring Sets are given in Specification X-65543 and for 6-C Oscillators in Specification X-65544. These specifications require the Western Electric installer to make certain tests on this apparatus, and specify that records of the stipulated tests be turned over to the Telephone Company with the apparatus. These records should be scrutinized by the technical man making acceptance tests on the associated repeaters to see that the results are within the prescribed limits. The records then should be filed with records of the acceptance tests on the repeaters.

3. SERVICE ORDER TESTS

3.01 All of the tests outlined in this part of the routine should be made when repeaters are cut into service. When any changes are created in the makeup of a repeatered circuit, such tests and adjustments should be made as are necessary to insure that the repeater is satisfactory for the new assignment. To avoid annoyance to the customer it may be desirable

in some instances to have a repairman call at the customer's premises to cooperate with the technical man during the balancing and final operation tests.

3.02 The service order tests should be performed in the order in which they are listed.

3.03 When a service order requires the use of other special equipment (such as terminal ringers) in addition to the repeater, the designation card of the repeater should be marked with the word "Special" in red. The circuit order tests then should be supplemented by any special tests or procedures which may apply to this additional apparatus.

(a) TUBE TESTS

3.04 Make a test of the filament activity of each tube as follows: Place the tube in the filament activity test set and read the plate current at the maximum and minimum working limits of the filament current as given in paragraph 3.06. If the variation in plate current is greater than 1.0 milliamperes the tube should be discarded. In making this test the technical man should mark each tube as he removes it from the repeater so as to insure its return to the socket from which it was removed. (Form P-939).

3.05 Inspect each tube while in the filament activity test set, and if any part of the filament burns considerably brighter than the other parts so as to approach a condition of white heat, or if there is a blue haze around the

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elements, the tube should be discarded. (Form P-938.)

(b) FILAMENT CURRENTS

- 3.06 Read and if necessary adjust the filament current of the repeater to fall within the limits shown in the following table. In case the battery which supplies the filament current is operated on a charge and discharge basis, account should be taken of the battery voltage in adjusting the filament current. This is, if the battery has just been taken off charge the current should approach the upper limit, while if the battery is shortly to be placed on charge the current should approach the lower limit. (Form P-939.)

Type of Tube	Filament Current		
	Minimum	Normal	Maximum
101-F	.470 amp.	.485 amp.	.500 amp.

(c) GRID VOLTAGES

- 3.07 With the filament current adjusted to the proper value, measure the voltage at each tube between the negative filament lug of the tube socket and lug 5 of the input transformer associated with that tube. The reading should be 8.0 + .6 volts. The potential on lug 5 of the input transformer should be negative with respect to negative lug of the tube socket. (Form P-939.)
- 3.08 If the repeater previously has been in service and recent maintenance tests indicate that it is in a satisfactory condition, the grid voltage test may be omitted.

(d) PLATE VOLTAGES

- 3.09 With the filaments burning, the plate voltage should be read between the plate lug of each vacuum tube socket of the repeater and relay rack ground. The reading should be 128 + 7 volts. The potential on the plate lug of the tube socket should be positive with respect to ground. In addition to this measurement, whenever dry cells are used as the source of plate current, the voltage of each 45 volt block should be measured separately while the filaments are burning. If the dry battery is common to a number of repeaters, any 45 volt block

should be replaced if its voltage is below 40 volts under load conditions. However, if the battery is individual to one repeater, as in the case of portable repeaters, it is not necessary to replace a 45 volt block until its voltage on load falls to 37 volts. (Form P-939.)

(e) 1000 CYCLE GAIN MEASUREMENTS

- 3.10 Repeaters Equipped with Yaxley Potentiometers. The gain at 1000 cycles should be measured with the potentiometer on top step. The gain in each direction should be 17.5 db or more. (Form P-939.)
- 3.11 If this limit is not met, before considering the repeater in trouble, the gain should be measured using another vacuum tube which gives normal gain in a repeater known to be in good condition.
- 3.12 Repeaters Equipped with 23-A Potentiometers. The gain in each direction at 1000 cycles should be measured with the slide wire set for maximum gain, minimum gain, and zero step (infinite loss) with the proper 36 type resistance connected. The value of the 36 type resistance should be chosen so that the working gain is obtained as near the center of the slide wire as possible. (Form P-939.)
- 3.13 The gain in db at maximum slide wire setting plus the db value of the 36 type resistance used should be 17.5 db or more in each direction.
- 3.14 The gain at minimum slide wire setting should be 6 + .5 db less than the gain measured at maximum slide wire setting.
- 3.15 At step zero the repeater should cause an infinite loss.
- 3.16 If these 1000 cycle gain limits are not met, before considering the repeater in trouble the gain should be measured with another vacuum tube which gives normal gain in a repeater known to be in good condition.

NOTE: 101-F tubes require a few minutes to reach a state of equilibrium after the filament current is turned on. Gain

tests should not be made until five minutes after the filaments are lighted or a cold tube is placed in the socket.

(f) BALANCING NETWORKS

3.17 Variable networks should be patched to the repeater and adjusted to the best obtainable balance under talking conditions.

3.18 When suitable networks are found the repeater should be adjusted to give a gain in each direction which is one db greater than the gain specified on the copy of Form P-851 attached to the circuit order. The repeater should not sing when a call is placed from the customer's station to each of the following:

- (a) To dial tone
- (b) To busy tone
- (c) To the central office operator
- (d) To a telephone instrument in the originating central office
- (e) To telephones in at least two distant central offices
- (f) In addition when the repeater is used on a P.B.X. trunk, station line, or tie line
  - (1) To the P.B.X. operator
  - (2) To a P.B.X. on-premises station
  - (3) To a P.B.X. off-premises station
  - (4) To a P.B.X. tie line (if one exists)
  - (5) On dial P.B.X.'s the above connections should be established first by dialing directly and then by routing the call through the P.B.X. operator who will complete the connection manually.

3.19 If the repeater sings during the time any of these connections are being established, it will be

necessary to readjust either or both of the variable networks, and to repeat the tests.

NOTE: It is permissible for the repeater to sing while the dial is in the off-normal position. However, no singing should occur between digits, or at any time when the dial is in the normal position.

3.20 As soon as the connection to each of the telephones or operators mentioned in paragraph 3.18 is established and the circuit is ready for talking, the repeater gain in each direction should be increased until singing commences, both potentiometers being advanced together.

3.21 The repeater should not sing during the talking condition before the gain in each direction is 5 db greater than the gains specified for the repeater on the copy of Form P-851 which accompanies the service order.

3.22 After noting the singing gain both potentiometers should be adjusted to the setting specified in paragraph 3.18 before the connection is released.

3.23 If the 5 db margin specified in paragraph 3.21 cannot be obtained it is an indication either:

- (1) Of trouble in the terminal equipment, in the line, in the balancing networks, or in the repeater. Suggestions for locating such trouble will be found in Part 5 of this section.
- (2) Or that it may be desirable to modify the circuit layout using different types or locations of equipment and different cable facilities. It will be necessary to refer this matter to the person responsible for the original circuit layout.
- (3) Or that it may be desirable to remove the "L" lead of each equalizer from its normal connection to terminal 5 of the 82-G retard coil and connect it to terminal 1 along with the "F" lead (see

paragraph 4.14). It is expected that this change will be particularly effective in improving the singing points when loaded cable pairs are involved. However, this change will reduce the gain of the repeater approximately 1 db in each direction at frequencies above 2000 cycles, and therefore should be made only when absolutely necessary.

- (4) Or that it may be desirable to utilize two cable pairs between the repeater and one or both terminals of the repeated circuit. These two pairs in a given direction either may be connected as a four-wire circuit or may be used as line and balancing network. In the latter case, obviously, the pair used as balancing network must be connected to a dummy subset or other appropriate termination at the end of the circuit away from the repeater. The matter of using two cable pairs should be referred to the person responsible for the original circuit layout.
- (5) Or that it may be necessary to establish the service using reduced gains in order to maintain the necessary margin. In such an event the usual tolerances should not be exceeded. It will be necessary to obtain a ruling from the person responsible for the original circuit layout to determine whether such a practice is permissible for the circuit in question.

3.24 After the values of the balancing networks have been finally determined, the permanent networks should be adjusted and connected to the repeater.

(g) 21-CIRCUIT BALANCE TESTS

- 3.25 Using the permanent balancing networks, a 21-circuit balance test should be made on each repeated circuit in each direction. The methods to be used in making 21-circuit balance tests are covered in Section K24.91. (Form P-939.)
- 3.26 When making 21-circuit balance tests the terminations of the repeated line should be those

which resulted in the lowest potentiometer settings obtained in accordance with paragraph 3.20. The terminations which are used in making this test should be noted along with the results so that future tests can employ the same terminations. (Form P-939.)

NOTE: In case the 36 type resistances in the potentiometers of the repeater assigned to the circuit are of such values that the singing point cannot be ascertained, another repeater equipped with other values of these resistances and with the same equalizer connection (see paragraph 3.23) should be patched into the circuit to obtain the singing points in the two directions. When this is necessary, an internal balance test should be made on the repeater which is used. The internal balance test should be made in the manner prescribed in paragraph 2.20 of this section, and the results should be within the limits specified in that paragraph.

3.27 Since the accuracy of 21-circuit balance tests depends directly on the accuracy of the repeater gain calibration, the gain should be measured in each direction while the potentiometers are on the final settings obtained in determining the singing points. In case a portable repeater is being employed and no gain set or transmission measuring set is available, the gain calibration chart accompanying the portable repeater may be used in deriving the singing point.

3.28 The average of the singing points in the two directions as specified in paragraph 3.25 should be at least 5 db greater than the average of the gains in the two directions called for on Form P-851.

3.29 If the 5 db margin specified in paragraph 3.28 cannot be met, the same conditions govern as were covered in paragraph 3.23.

(h) FINAL TESTS

3.30 When the preceding tests indicate that the networks are satisfactory, the potentiometers should be adjusted to give the operating or working gains.

- 3.31 At the customer's telephone a call should be originated to a telephone near the repeater bay, and talking tests should be made. However, if a more accurate check of the transmission performance of the repeatered line is desired by the technical man, this test may be replaced by the "1-way 2-way" tests described in paragraph 5.10. (Form P-938.)
- 3.32 At the customer's telephone a call to the wire chief's telephone or to the test number in the most distant office of the exchange should be originated as a check on the dialing range of the repeatered line. (Form P-939.)
- 3.33 Originate a call to the repeatered line (if a part of a P.B.X. system both via the P.B.X. operator and via a night connection) to check the ringing range of the repeatered line. If satisfactory, this completes the testing work. (Form P-939.)
- 3.34 The repeater designation card should be prepared in accordance with paragraph 6.02 and should be mounted on the repeater.
- 3.35 The circuit layout card should be prepared in accordance with paragraph 7.02 and should be filed.
- 3.36 The operating gains which the repeater was adjusted to deliver should be recorded on Form P-939.
4. MAINTENANCE TESTS
- 4.01 In making routine tests on repeatered circuits care should be taken to avoid any interference with service over the circuit to which the repeater is assigned. Those maintenance tests which interfere with the normal operation of the circuit should be performed during periods of light traffic, and only after notifying the customer of the duration of the test. In case it becomes necessary to make tests on the repeater at a time when the customer cannot release the circuit, the regular repeater may be removed from service for test by patching into the circuit a spare repeater adjusted to the same operating gains. The regular networks should be used with the spare repeater.
- 4.02 Before making any tests or measurements on repeaters the measuring and testing apparatus should be carefully checked. Sections E40.213 and E40.313 of Bell System Practices, Toll Test Room Operation, provide maintenance information on the 6-A Transmission Measuring Set and 6-C Oscillator, respectively. Bulletin 218 provides similar information on the 2-D Gain Set.
- 4.03 Any repeater which is used in connection with other special equipment or is assigned to other than regular exchange service should have a designation card bearing the word "Special" in red. For such a repeater the following maintenance instructions should be supplemented by any special instructions which may apply to this special service.
- (a) TUBE TESTS
- 4.04 The filament activity of each tube should be tested annually. In making this test it is necessary to remove the tube from the repeater. Each tube should be marked as it is removed to insure its return to the socket from which it was taken. The test is performed by placing a tube in the filament activity test set and reading the plate current at the maximum and minimum working limits of the filament current as given in paragraph 4.08. If the variation in plate current is greater than 1.0 milliamperes the tube should be discarded. (Form P-939.)
- 4.05 An inspection of all tubes should be made quarterly for bright spots and blue haze. If any part of the filament burns considerably brighter than the other parts so as to approach a condition of white heat, or if there is a pronounced blue haze adjacent to the elements, the tube should be replaced. Whenever tubes are replaced it will be necessary to perform all of the tests covered in paragraphs 4.08, 4.10, 4.12 and 4.20 before the repeater is returned to service. (Form P-938.)
- (b) INSPECTION AND CLEANING OF CONTACTS
- 4.06 An inspection should be made annually of all relay, jack, vacuum tube socket, and potentiometer

contacts. The inspection should cover dirty contacts, weak spring tension, insufficient contact follow, etc. All dirty relay, vacuum tube socket, or jack contacts and all potentiometer contacts should be cleaned at the time of the inspection. (Form P-939.)

## (c) MECHANICAL INSPECTION

- 4.07 A mechanical inspection of all repeaters and testing equipment used in their maintenance should be made annually. The following items should be included in this inspection. (Form P-939.)

Inspection of all wiring, cabling, terminal blocks, jacks, and relays for loose connections, defective wiring, and other possible sources of trouble.

Inspection of all apparatus for proper mounting and mechanical condition.

## (d) FILAMENT CURRENTS

- 4.08 The filament currents of all repeaters should be read annually and whenever tubes are changed, and if necessary, should be adjusted to fall within the limits shown in the following table. In case the battery which supplies the filament current is operated on a charge and discharge basis, account should be taken of the battery voltage in adjusting the filament current. That is, if the battery has just been taken off charge the current should approach the upper limit, while if the battery is shortly to be placed on charge the current should approach the lower limit. (Form P-939.)

Type of Tube	Filament Current		
	Minimum	Normal	Maximum
No.101-F	.470 amp.	.485 amp.	.500 amp.

## (e) PLATE VOLTAGES

- 4.09 With the filaments burning, the plate voltage should be read between the plate lug of each vacuum tube socket of the repeater and relay rack ground. Where a rectifier or storage battery is provided for plate supply, this measurement should be made annually and the voltage should be  $128 \pm 7$  volts. The potential of the plate lug should be positive with respect to

ground. Wherever dry cells are used either as the regular or emergency source of plate current, their voltage should be checked monthly. If the dry battery is used for a number of repeaters, each 45-volt block should be measured separately and should be replaced when its voltage under load conditions falls below 40 volts. In portable repeaters equipped with individual dry batteries the voltage of each 45-volt block should be measured separately and any block should be replaced when its voltage on load falls below 37 volts. (Form P-939.)

## (f) GRID VOLTAGES

- 4.10 With the filament current adjusted to the proper value, the grid voltage of each tube should be measured between the negative filament lug of the tube socket and lug 5 of the input transformer associated with that tube. The reading should be  $8.0 \pm .6$  volts. The potential on lug 5 of the input transformer should be negative with respect to the negative filament lug of the tube socket. This test should be performed annually and whenever tubes are changed. (Form P-939.)
- 4.11 Before making any of the following maintenance tests it should be noted that the current, voltage, and tube tests given above have been performed and their requirements satisfied.

## (g) GAIN TESTS

- 4.12 Gain tests should be made at 1000 cycles in each direction of transmission with the potentiometers on their normal working steps. These measurements should be made annually and whenever tubes are replaced. The measured gains for repeaters equipped with either "Yaxley" or 23-A potentiometers should be within .5 db of the specified values. (Form P-939.)

NOTE: 101-F tubes require a few minutes to reach a state of equilibrium after the filament current is turned on. Gain tests should not be made until five minutes after the filaments are lighted or a cold tube is placed in the socket.

- 4.13 If the gains are not within .5 db of the specified values under a

condition of normal filament current and plate voltage, the gains should be adjusted as closely as possible to the specified values. However, if a vacuum tube is suspected of giving low gain, the 1000 cycle maximum gain should be measured in accordance with paragraphs 3.10 and 3.12, and the specified requirements should be met.

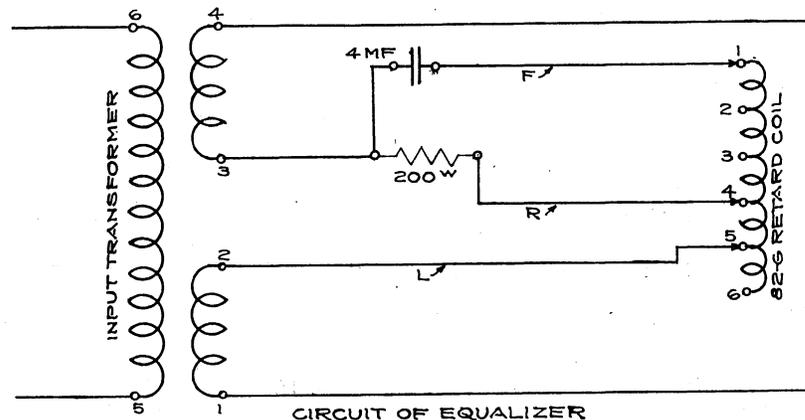
4.14 Periodic gain-frequency tests need not be made on special service

repeaters. In case it seems advisable, however, a gain-frequency test may be specified for some particular office. In making this test the potentiometer of each repeater being measured should be set on its highest step and the gain measured in each direction at each frequency included in Table I. All measured gains should fall within the limits shown in the table for the type of filter in use. Minus signs indicate gains less than the 1000 cycle gain (Form E-466).

TABLE I  
DEVIATIONS FROM 1000 CYCLE GAIN

Frequency Cycles	13-B Filter			13-B Filter			No Filter		
	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.
300	-1.5	0	-3.0	-1.5	0	-3.0	-1.5	0	-3.0
300	-.4	+.2	-1.0	-.4	+.2	-1.0	-.4	+.2	-1.0
1000	0	0	0	0	0	0	0	0	0
1600	+.5	+1.0	0	+.5	+1.0	0	+.7	+1.0	0
2000	+.5	+1.5	-.5	+.5	+1.5	-.5	+1.2	+2.0	-1.0
2600	-4.0	-2.0	-9.0	-	-	-	-	-	-
2800	-	-	-	-6.0	-4.0	-11.0	+1.2	+3.0	-3.0

Normal equalizer connections (L to 5  
(F to 1  
(R to 4



4.15 If these limits are not met the gain at frequencies above 1000 cycles may be varied by changing the connections of the 82-G retard coil. Table II shows the db

change in gain at various frequencies which may be obtained by various changes from the normal equalizer connections as given in Table I.

TABLE II

Lead F remains on Tap 1 of 82-G retard for all conditions

Lead L to Tap	5	1	3	6	5	5	5	5
Lead R to Tap	<u>4</u>	<u>4</u>	<u>4</u>	<u>4</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>6</u>
1000 Cycles	0	0	0	0	0	0	0	0
1600 Cycles	0	-.5	-.2	+.1	+.4	+.2	+.1	-.1
2000 Cycles	0	-.8	-.3	+.2	+.7	+.5	+.2	-.3
2600 Cycles	0	-1.0	-.3	+.3	+2.1	+1.4	+.7	-.5
2800 Cycles	0	-1.0	-.3	0	+2.8	+1.9	+1.0	-.5

- 4.16 No means are provided for adjusting the gain frequency characteristic at frequencies below 1000 cycles. If the limits at these frequencies are not met the repeater should be considered in trouble.

(h) 21-CIRCUIT BALANCE TESTS

- 4.17 21-Circuit balance tests between line and network should be made on all repeatered circuits in each direction annually, and in addition whenever circuit rearrangements or changes in operating gain are required. When making these the line termination in the direction under test should be the same as was employed in obtaining the 21-circuit balance measurement when the repeater was installed on the existing circuit makeup. This is covered in paragraph 3.26. (Form P-939.)

- 4.18 Since the accuracy of 21-circuit balance tests depends directly on the accuracy of the repeater gain calibration, the gain should be measured in each direction while the potentiometers are on the final settings obtained in determining the singing point. The singing point in either direction as given by these measured gains should not be less than the singing point obtained at the time the repeater was connected to the existing circuit makeup by more than 1 db.

- 4.19 If the measured singing point in either direction is lower than this required minimum value it is an indication of trouble in the line, in the line equipment, in the station equipment, in the balancing network, or in the tele-

phone repeater used in making the test. Suggestions for locating the trouble will be found in Part 5 of this section of the practices. Changes in the makeup of the outside plant facilities of a line, which are made after its installation due to cable transfers, etc., and on which the prescribed report has not been received, probably will be a considerable source of low singing point troubles. Such changes, of course, usually will necessitate rebalancing the line.

NOTE: In case the 36 type resistances in the potentiometers of the repeater assigned to a circuit are of such values that the singing point cannot be ascertained, another repeater equipped with other values of these resistances and having the same equalizer connections (see paragraph 4.14) should be patched into the circuit to obtain the singing points in the two directions. When this is necessary, an internal balance test should be made on the repeater used. The internal balance test should be made in the manner prescribed in paragraph 2.20 of this section of these practices, and the results should be within the limits specified in that paragraph.

(j) LISTENING TESTS

- 4.20 Listening tests should be made quarterly, whenever it is necessary to change operating gain, after tubes are changed, and in addition, after a repeatered line has been rebalanced. These tests should be performed by monitoring on the repeater during the setting

up of a connection and the subsequent conversation. Listening tests will assist in disclosing excessive noise and crosstalk, poor balance between either line and its balancing network, poor internal balance in the repeater, and distortion. The various symptoms of these conditions will be found in Section K24.91, "Methods of Making Tests on Special Service Repeaters." Any indications of trouble should be reported at once by telephone to the proper supervisory people. (Form P-938.)

(k) FUSE ALARM TESTS

- 4.21 A test should be made annually of the operation of plate and filament fuse alarm circuit. (Form P-939.)

(l) RINGING AND DIALING TESTS

- 4.22 A call to the wire chief's telephone or to the test number in the most distant central office of the exchange should be originated at the customer's telephone to test the dialing range of the repeatered line. This test should be made annually. (Form P-939.)
- 4.23 Calls to the repeatered line should be originated (if the line is part of a P.B.X. system both via the P.B.X. operator and via a night connection) to check the ringing range of the repeatered line. This test should be made annually. (Form P-939.)

(m) CURRENT FLOW TESTS

- 4.24 A measurement of the current flow from the line relay of each repeater through an external 400 ohm resistance in series with a milliammeter should be made annually. This measurement may be obtained by patching the meter and resistance into the repeater line test jacks. The current flow should be  $.041 \pm .003$  amperes. (Form P-939.)

(n) REPORT OF TROUBLE

- 4.25 Quarterly Report. A quarterly report should be prepared for each central office showing the number of class A and class B troubles experienced on lines using vacuum tube repeaters in the office. Class A troubles are those which are reported as a result of interference with or interruption to service. Class B troubles are those found on

routine tests or inspections. Only troubles which have required work at the repeater (rebalancing, etc.) should be reported. That is, such troubles as broken mouth pieces, worn out receiver cords, etc., should not be included in the report. (Form P-940.)

- 4.26 Semi-annual Summary. A semi-annual report should be prepared for the Los Angeles Division and for each district in the Southern Division summarizing the results of the two preceding, quarterly reports of all the central offices involved. (Form P-940.)

5. SUGGESTIONS FOR LOCATING TRANSMISSION TROUBLES

- 5.01 It is not feasible to set up a definite procedure for locating the source of transmission troubles on repeatered foreign exchange and P.B.X. circuits since the methods to be followed differ under varying conditions and depend, to a considerable extent, upon the type of circuit and nature of trouble experienced. Suggestions are given below, however, which will be of assistance in clearing the lines of such troubles. No attempt has been made to arrange them in the order of their importance, and the procedure to be followed must be decided upon for each case. Unless it is fairly evident that the trouble is due to some other cause, probably a check of the repeater and balancing equipment in the first test to be made. In some cases the results of such tests may indicate trouble in the measuring equipment, and its accuracy should be checked. The bulletin describing the particular type of testing equipment in question may give suggestions for making such a check.

(a) CHECK OF CIRCUIT FACILITIES

- 5.02 When there is an indication of trouble in the line outside the central office where the repeater is located, the actual circuit layout as to equipment and outside plant facilities should be checked against the circuit layout card which shows the makeup which each network is arranged to balance. Much of this check probably can be made by having an attendant at the M.D.F. check the cross connections at each central office through

which the circuit passes.

- 5.03 Facility cuts, plant extensions, cable transfers, or emergency routings, which may have been made and on which the specified report has not been received may have changed this makeup. Also a change in the length of multiple taps on the cable may have been made due to outside plant rearrangements. Any of these changes may necessitate rebalancing the circuit.

(b) COMPARISON WITH SIMILAR CIRCUIT

- 5.04 In the event that a number of circuits have the same layout, as for example a number of foreign exchange trunks to a P.B.X., or a number of foreign exchange lines terminated in the same vicinity and utilizing approximately the same amounts of the same type of outside plant facilities, it is possible to compare the performance of the line in trouble with that of one of the others and to obtain some indication as to the nature of the trouble. Furthermore, by a check of this kind one may discover trouble which is common to the group of circuits, and thus forestall a number of complaints.

(c) UTILIZE SPARE EQUIPMENT

- 5.05 In order to determine whether or not the trouble is due to apparatus, such as long line equipment, the different units of equipment in the circuit layout may be replaced in turn with spare equipment.

(d) REPEATER GAINS

- 5.06 Check the repeater gains at 1000 cycles with the potentiometers on their normal working steps. These gains should be within  $\pm 1$  db of those specified on the Repeater designation card.

(e) REPEATER TESTS

- 5.07 If the required repeater gains are not being given, a check of plate voltage, grid voltage, filament current, and filament activity may disclose the trouble. If the trouble cannot be cleared without an unreasonable service interruption, a spare repeater should be patched into the circuit. Tubes which are within the limitations

imposed by the tube tests specified in paragraphs 4.04 and 4.05 should not be replaced to correct transmission differences due to other apparatus, unless no spare repeaters are available.

- 5.08 A listening test similar to that performed quarterly may be made to observe any distortion, tendency to sing, and any hollow sound or echo which may have developed in the circuit. Distortion may be due to the repeater overloading, particularly, if the gains have been changed. In order to test the repeater for an overload, a milliammeter should be inserted in the 130-volt lead to the repeater and the plate current observed while talking is in progress over the circuit. If the repeater is overloaded, the plate current will fluctuate during the conversation, although a small amount of fluctuation (up to 2 mils) is allowable.

- 5.09 If this test shows that the repeater is not being overloaded, and if the listening test shows that the circuit sounds hollow, has an echo, or has any tendency to sing, 21-circuit balance tests should be made, and the results compared with the results of the original tests recorded on the circuit layout card. These tests may be done most satisfactorily in some such order as follows:

- (1) Measure the singing point by making a 21-circuit balance test between the complete line west and its balancing network. The line should be terminated as specified in the circuit layout card. If this test gives a singing point differing by more than 1 db in either direction from that on the circuit layout card, the balancing network should be checked to make sure that it is not defective.
- (2) To check the balancing network make a 21-circuit balance test between the regular network and a duplicate network wired or patched to the repeater in place of the line. For this purpose one of the variable networks may be patched via an interposition trunk into the Repeater

Line West jacks. In the case of a small installation of repeaters, or of a four-wire circuit where variable networks are not available, a duplicate network may be built up, using condensers and resistances, and may be patched into these jacks or wired to the proper lugs of the hybrid coil. If this test shows a singing point below 30 db, it indicates either that the network is faulty, or that the internal balance of the repeater is low. The regular network also may be tested with a 1000 cycle tone for opens, or it may be replaced by a duplicate network. In this case the duplicate network should be patched into the proper repeater network jacks or wired to the proper lugs of the hybrid coil and another 21-circuit balance test made between the west line and the duplicate network.

- (3) If these tests show the west network to be free of trouble, the internal balance of the repeater should be checked. The internal balance test should be made in the manner prescribed in paragraph 2.20 of this section of these practices, and the results should be within the limits specified in that paragraph.
- (4) Obviously if the above tests show no unbalances in the west portion of the circuit the same tests should be applied to the east line, network, and hybrid coil. In making the 21-circuit balance test of the east network a procedure similar to that described in item (2) of this paragraph should be followed with the duplicate network patched into the Repeater Line East jacks.
- (5) If both networks and the internal balance of the repeater are in a satis-

factory condition, a low singing point on a 21-circuit balance test indicates:

- (a) Line or station trouble
- (b) Change in makeup of line
- (c) Trouble in jack contacts
- (d) Trouble in wiring between line jack contacts and M.D.F.

(f) 1-WAY 2-WAY TESTS

5.10 The "1-Way 2-Way" test, which provides a more accurate indication of the balance condition of a repeatered circuit than the ordinary listening test, will be particularly helpful in the case of four-wire circuits where it is difficult to change the terminations at the hybrid coil. This test has the disadvantage of requiring the assistance of two attendants experienced in noting transmission conditions, but probably is justified in that it may show definitely that the relatively expensive 21-circuit balance tests on a four-wire circuit are not required. The "1-Way 2-Way" test described below also may prove to be valuable in testing new circuits or after circuit conditions have been changed, though it is not expected that it will be used as a routine test.

- (1) One attendant should visit the subscriber's premises and establish a normal connection over the repeatered circuit to a telephone convenient to the other attendant. The potentiometers should be adjusted to give the normal operating gains for the circuit.
- (2) The attendant at the subscriber's premises should talk into his transmitter while the circuit is cut first "1-way" and then "2-way" a number of times. Cutting the circuit "1-way" is accomplished by turning to zero the potentiometer of the amplifying element transmitting in the direc-

tion opposite to that in which the voice is being transmitted, in this case the east potentiometer. When cutting the circuit "2-way" care should be taken to see that this potentiometer is not advanced beyond the point established in (1) of this test.

- (3) If the circuit is properly laid out, if the repeaters are operating satisfactorily, and if the singing points are within satisfactory limits, there should be no noticeable difference to the attendant listening at the east end of the circuit between the "1-way" and the "2-way" conditions.
- (4) The procedure also should be carried out, of course, in the reversed direction.

#### 6. DESIGNATION OF REPEATER GAINS

6.01 Potentiometers of all special service repeaters should be marked to indicate the settings which will give the gains specified on the circuit layout card. 23-A potentiometers are equipped with a phosphor bronze strip which is circular in form and fits around the collar surrounding the slide wire shaft. The strip has a triangular projection which should be used to indicate the setting of the slide wire which gives the specified gain. On repeaters equipped with "Yaxley" potentiometers, the settings of the graduated potentiometer dials which give the specified gains should be noted on the repeater designation card, and no additional marking on the potentiometer itself will be needed.

6.02 The repeater designation card should be filled out and placed in the designation card holder. The following information should appear on the card:

Telephone number of the repeatered line.

Repeater number.

Type of circuit on which the repeater is working.

W-E potentiometer setting

W-E gain.

E-W potentiometer setting.

E-W gain.

The word "SPECIAL" in red when some other special apparatus (such as terminal ringers, composite sets, etc.) not a part of standard local telephone plant is required in the circuit. (See paragraph 3.03.)

- 6.03 The type of circuit on which the repeater is used may be indicated by such designations as "O.S.S." for P.B.X. station line, "F.E." for foreign exchange line, etc.
- 6.04 When a temporary change in gain is requested due to abnormal conditions on the circuit a red tag (Form E-855) should be attached to the potentiometer or placed in the designation card holder. Wire should not be used in attaching the tag to the repeater.
- 6.05 The repeater attendant should be advised of the nature of the abnormal condition requiring the change in gains.
- 6.06 If a red tag remains on a repeater longer than one week the question of gain should be referred to the proper supervisory people who, in turn, should review the matter of eliminating the abnormal condition with the persons responsible for its removal.
- 6.07 The following information should be shown on the red tag.

The temporary gains.

The time and date the gains were changed.

The attendant who made the changes and his authority for making them.

The reason for making the changes.

#### 7. DESCRIPTION OF RECORD FORMS

- 7.01 The following record forms have been provided for use in connection with this routine. Where any of the forms are used for recording the results of acceptance tests or service order tests the forms should be marked conspicuously "Record of Acceptance

Tests," or "Record of Service Order tests."

(a) CIRCUIT LAYOUT CARD - FORM P-941

- 7.02 This 5" x 8" card is intended to provide an accurate record of the entire repeated circuit including a sketch of the routing, the wire and cable makeup, and the equipment involved. Space is provided on the front of the card for noting the essential names, addresses, dates, order number, type of circuit, etc., as well as the required and operating gains, the two singing points, the terminations used in obtaining these singing points, and a schematic circuit of each of the balancing networks. The back of the card is reserved for the schematic of the circuit layout, which should show the length, gauge, type of loading, and terminal designation of each portion of the circuit and the location, type, and number of all equipment involved.

(b) FORM P-938

- 7.03 This form is to be used to record the results of the quarterly tube inspections and listening tests, as well as the talking tests and "1-way" "2-way" tests specified under "Service Order Tests."
- 7.04 Space is provided at the top of the form for noting the date, the central office, and the name of the person making the tests.
- 7.05 The form should be filled out by placing a check mark in each space where the tests showed no indications of trouble. In order to designate that indications of trouble were found in making a test, a cross mark surrounded by a circle, thus ⊗, should be entered in the proper space on the form.
- 7.06 If as a result of tube inspections it is necessary to replace a vacuum tube, a note to this effect should be entered in the "Remarks" column.
- 7.07 Space is provided under "Listening Tests" for indicating the nature of any trouble which may be observed. If an entry is made under any of these "Indications of Trouble," the name of the person to whom the trouble was reported (see paragraph 4.20) should be noted in the column "Reported To,"

and any supplementary information should be entered in the "Remarks" column.

(c) FORM P-939

- 7.08 This form is to be used for recording the results of acceptance, service order, and routine tests. When measured values are the result of a test they should be entered in the appropriate space on the form. On such tests as ringing, dialing, inspection, etc., a check mark should be entered on the form to indicate "no trouble found," while a cross mark surrounded by a circle, thus ⊗, should be used to indicate "trouble found." Any significant facts relating to the clearing of such trouble should be entered on the back of the form.
- 7.09 Space is provided at the top of the form for noting the date, central office, name of the tester, and type of test (Service Order, etc.)
- 7.10 An entry should be made opposite the heading "Type of Circuit" to indicate whether the repeater is used on a P.B.X. station line (indicated by the letters OSS), foreign exchange line (indicated by FE), outside extension to a main line (indicated by OSEXD), etc.
- 7.11 Space is provided opposite "Tube Tests" for noting the change in plate current when each tube is tested in the filament activity test set. If a tube is replaced as a result of the test a note to this effect should be entered in the space reserved for "Remarks," and the value entered on the form should be the plate current change for the new tube.
- 7.12 Space is provided opposite "Plate Voltage" for noting the plate voltage applied to each tube. If a dry battery is used to supply the plate current and as a result of the test a part of the battery is replaced, a note to this effect should be entered under "Remarks". The value entered on the form should be the plate voltage with the new section of the battery connected.
- 7.13 Opposite the designation "21-Circuit Balance Tests" should be entered the results of measurements of the balance between each line

SECTION K13.51

and its balancing network. In case it was necessary to rebalance the line to obtain the "Required Singing Point" an entry to that effect should be made under "Remarks," and the measured value which is entered on the form should be the singing point obtained with the new balancing network. A memorandum for the supervisor should be prepared giving the circuit of the new balancing network so that the Circuit Layout Card may be corrected.

- 7.14 In the space reserved for "Required Singing Point" should be entered the singing points in the two directions which were obtained when the repeater was installed on the existing circuit makeup.

(d) FORM E-466

- 7.15 This form is to be used to record the actual measurements whenever it becomes necessary to make gain-frequency tests of special service repeaters. Only the frequencies specified in this routine should be employed in making the tests. The measured values should be entered under "Gain-Frequency Calibration," after which the deviations from the 1000 cycle value may be derived and entered under "Deviations from 1000 Cycle Gain."

(e) FORM P-940

- 7.16 This form is to be used for the quarterly report of troubles on circuits using special service repeaters in a central office, as well as to record the semi-annual summary of such troubles. Only those troubles requiring work at the repeater (rebalancing, etc.) should be reported. That is, such troubles as broken mouth pieces,

worn out receiver cords, etc., should not be included in the report. Both the class A and class B troubles should be segregated into these four groups: Troubles due to Repeaters, to Long Line Equipment, to Outside Plant, and to Station Plant. Each of these four groups is divided into a number of possible locations for the trouble.

- 7.17 In case vacuum tubes or dry B batteries have been replaced during the period covered by a report, the number of such replacements should be entered in the space reserved for Remarks.
- 7.18 In case an A Cut or a Facility Cut has disturbed the balance of a circuit, the rebalancing of the line should be reported as a case of trouble. In addition, if the cut has been so performed as to cause a repeater sing complaint, a note to that effect should be entered under "Remarks."
- 7.19 Trouble in inside wiring or drop wire should be included under trouble due to Station Plant, and should be entered as Wiring Trouble.
- 7.20 In the space reserved for "Number of Repeaters" should be entered the number installed and the number in service at the end of the period covered by the report.
- 7.21 In order to derive for any class the "Troubles per Repeated Line", the total number of corresponding troubles as given on the form should be divided by the number of repeaters in service at the end of the report period. The result should be carried out to three decimal places.

LIST OF ACCEPTANCE AND SERVICE ORDER TESTS

	Reference (Paragraph)
ACCEPTANCE TESTS	
Current Flow Tests	2.05
Alarm Circuit Tests	2.06, 2.07
Telephone Set Operation Tests	2.08
Tube Tests	2.09, 2.10
Filament Current	2.11
Grid Voltages	2.12
Plate Voltages	2.13
1000 Cycle Measurements	
Gain of Repeaters	2.14
Wiring of Monitoring Circuits	2.18
Loss caused by 511-E Telephone Set Panels	2.19
Internal Balance Tests	2.20
Gain-Frequency Measurements	2.21
Associated Apparatus	2.24
SERVICE ORDER TESTS	
Tube Tests	3.04, 3.05
Filament Currents	3.06
Grid Voltages	3.07
Plate Voltages	3.09
1000 Cycle Gain Measurements	3.10, 3.12
Balancing Networks	3.17, 3.19, 3.24
21-Circuit Balance Tests	3.25
Talking Tests	3.31
Dialing Tests	3.32
Ringling Tests	3.33
Repeater Designation Card	3.34
Circuit Layout Card	3.35

## SCHEDULE OF MAINTENANCE TESTS

	Reference (Paragraph)
MONTHLY	
Plate Battery Voltage - When dry cells are used	4.09
QUARTERLY	
Report of Troubles on Repeatered Lines	4.25
Listening Tests	4.20
Tube Inspection	4.05
SEMI-ANNUALLY	
Summary of Troubles on Repeatered Lines	4.26
ANNUALLY	
Tube Tests	4.04
Relay and Potentiometer Contacts	4.06
Mechanical Inspection	4.07
Filament Currents	4.08
Plate Voltages	4.09
Grid Voltages	4.10
1000 Cycle Gain Tests	4.12
21-Circuit Balance Tests	4.17
Fuse Alarm Tests	4.21
Dialing Tests	4.22
Ringling Tests	4.23
Current Flow Tests	4.24
AS REQUIRED BY LOCAL CONDITIONS	
Gain Frequency Tests	4.14
21-Circuit Balance Tests when Circuit Changes Are Made	4.17
Report to Supervisory People when Red Tags Have Been Attached to Repeaters Longer Than One Week	6.06







# BELL SYSTEM PRACTICES

## SUMMARY OF REPEATER TROUBLES—SPECIAL SERVICE REPEATERS

PERIOD COVERED BY REPORT

FROM \_\_\_\_\_ TO \_\_\_\_\_

OFFICE \_\_\_\_\_

CITY \_\_\_\_\_

DIVISION \_\_\_\_\_

AREA \_\_\_\_\_

NUMBER OF REPEATERS	
INSTALLED	IN SERVICE

LOCATION OF TROUBLE		TOTAL NO. OF TROUBLES			TROUBLES PER REPEATERED LINE		
		CLASS A	CLASS B	A & B	CLASS A	CLASS B	A & B
<b>REPEATER</b>	FIL. BATTERY						
	PLATE BATTERY						
	VACUUM TUBES						
	POT. SETTINGS						
	BAL. NETWORKS						
	WIRING						
	CONTACTS						
	SIGNAL'G APP'TUS						
	MISCELLANEOUS						
	TOTAL						
<b>LONG LINE EQUIPMENT</b>	IN CENTRAL OFFICE						
	AT P B X	EQUIPMENT					
		BATT. FEED					
	TOTAL						
<b>OUTSIDE PLANT</b>	A CUTS						
	FACILITY CUTS						
	CIRCUIT FAILURES						
	TOTAL						
<b>STATION PLANT</b>	P B X						
	SUBSET						
	WIRING						
	TOTAL						

CLASS "A" TROUBLES ARE THOSE WHICH ARE REPORTED. CLASS "B" TROUBLES ARE THOSE FOUND ON ROUTINE TESTS OR INSPECTIONS.

REMARKS:

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SIGNED \_\_\_\_\_

TITLE \_\_\_\_\_

### SPECIAL SERVICE CIRCUIT LAYOUT CARD

REPEATER	
NO.	LOCATION

WORK ORDER	
NO.	DATE

NAME OF CUSTOMER \_\_\_\_\_

TYPE REPTD. CCT. \_\_\_\_\_ TEL. NO. \_\_\_\_\_

TYPE PBX. \_\_\_\_\_ CUSTOMER ADDRESS \_\_\_\_\_

ZONE SUBSET \_\_\_\_\_ SUBSET ADDRESS \_\_\_\_\_

DATE REPTR. BALANCED \_\_\_\_\_ TIME REQUIRED TO BAL. \_\_\_\_\_

TYPE LLE. \_\_\_\_\_ LLE. VOLTAGE \_\_\_\_\_ LLE. PADS \_\_\_\_\_

LOCATION OF LLE. \_\_\_\_\_

	W-E	E-W
REQUIRED GAINS		
WORKING GAINS		
POT. SETTINGS		

W. SINGING PT. \_\_\_\_\_ DB WHEN W.

LINE TERMINATED \_\_\_\_\_

E. SINGING PT. \_\_\_\_\_ DB WHEN E.

LINE TERMINATED \_\_\_\_\_

\_\_\_\_\_

SEE OVER FOR CIRCUIT LAYOUT SKETCH

#### SCHEMATIC CIRCUITS

WEST NETWORK	EAST NETWORK