

BELL SYSTEM PRACTICES
Teletypewriter and Manual Telegraph
Station and P.B.X.
Installation and Maintenance

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161A1 TELEGRAPH STATION TEST SET

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1. GENERAL

1.01 This section describes the testing method employed with the 161A1 telegraph station test set and gives detailed instructions for connection of the test set to telegraph circuits and teletypewriters.

1.02 This set is designed for convenient use in connection with maintenance of telegraph circuits to teletypewriter stations, especially those located at outlying points. It may also find use at central offices in testing toll telegraph circuits and circuits extending to outlying points. Although not specifically designed for the purpose, it may also be used in testing circuits used for Morse operation.

1.03 A measurement of the bias of recurring signals produced by teletypewriter keyboards may also be obtained with this set. Fortuitous effects such as those produced by clutch action, gear imperfections, etc., are not measured directly.

1.04 Since the test set is to be used at telegraph stations as well as at central offices, and since when testing stations cooperation will be required between the central office attendant and the maintenance man at the station, identical information for use of the set is contained in both the P Series and the E Series of Bell System Practices. Because the set is designed primarily for use at stations, however, the

information is presented primarily from the viewpoint of use at the station. The procedure for testing at central offices is generally similar, and such modifications as are required may readily be made if the general procedure described herein is understood.

1.05 The keys and face equipment of the 161A1 test set are shown in Fig. 1.

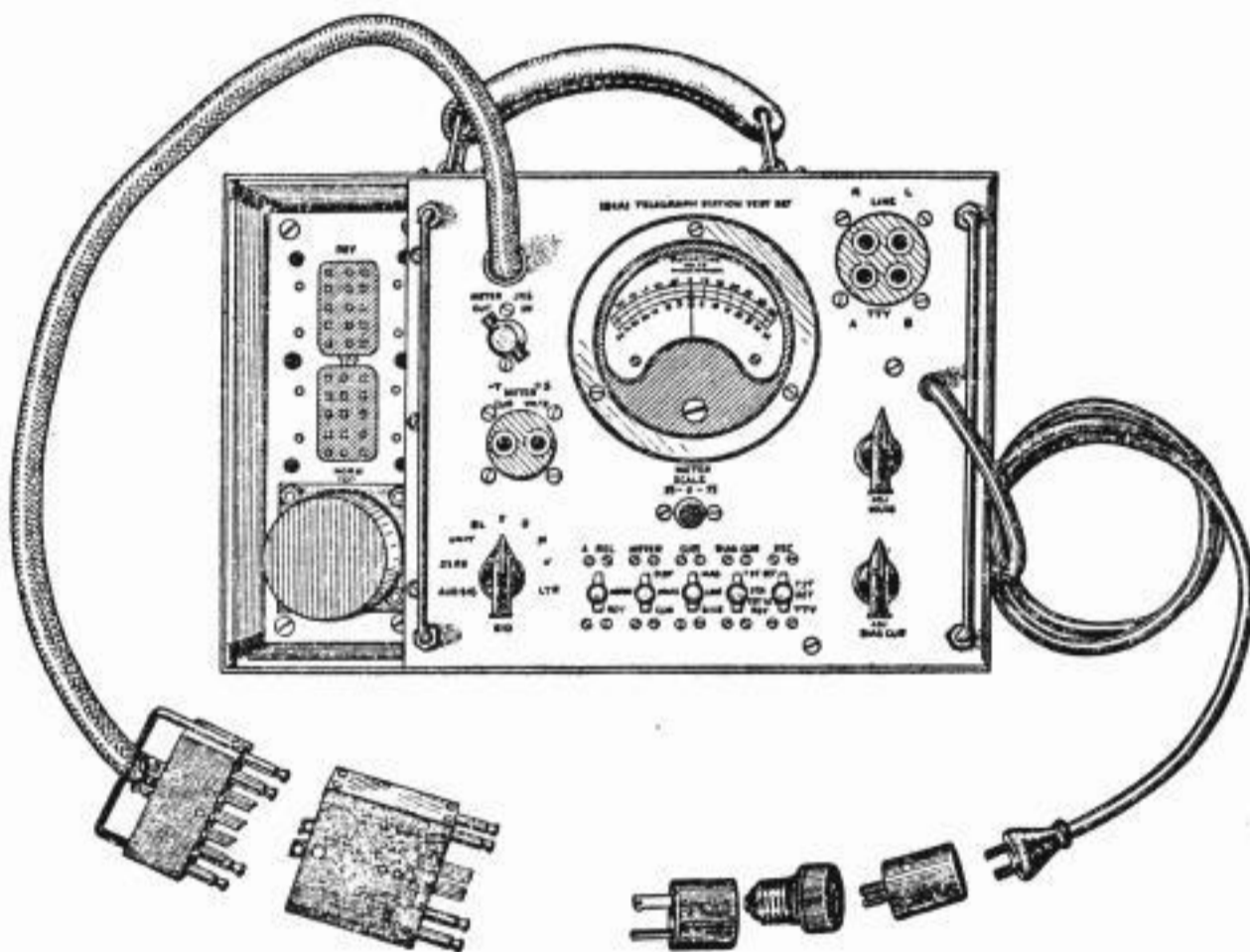


Fig. 1—161A1 Telegraph Station Test Set Showing Face Equipment

2. GENERAL TESTING METHOD

2.01 In locating and remedying transmission impairments with this set, measurements are made of the components of distortion, rather than of the total distortion, in order to provide the tester with direct and useful indications of the probable cause of the impairments. Trouble conditions arising from improper operating currents, interference, unfavorable circuit layout, improper relay adjustment, repeater trouble, etc., may be readily identified.

2.02 It is generally advantageous to follow a prescribed procedure in measuring the component effects during a complete check of transmission at an outlying point. This procedure is as follows:—

1. Check operating currents.
2. Measure systematic distortion and relay bias.
3. Measure interference.
4. Measure the distorting effect of the interference.

2.03 The meter indication of current, voltage and distortion will normally be given on the 140-0-140 (upper) scale. Whenever indications less than 35 are obtained, especially in the measurement of distortion, the **METER SCALE** button should be depressed and the reading made on the 35-0-35 (lower) scale.

2.04 In making tests it will be necessary to communicate frequently between the two ends of the connection. The circuit under test may be used for this purpose or a separate communication circuit may be established.

2.05 In arranging for communication between the two ends of a teletypewriter circuit advantage should be taken of the convenience afforded by the send-receive feature of the set. The methods for connection to the telegraph circuits, given later in Part 5, generally include connections to the set which enable the tester to restore the circuit to its normal operating condition by merely operating the **REC** key from **TST SET** to **TTY**.

2.06 For connection to the telegraph circuit and teletypewriter, two methods are available:

- (1) By means of the relay plug with or without adapter.
- (2) By means of patch cords from jacks or terminals of the circuit or teletypewriter to jacks of the test set.

Details are covered in Part 5 of this section.

Note: The adapter is held to the relay plug by means of springs which snap into position. When removing the adapter these springs should be depressed by pressing on the two bright buttons simultaneously. One of these buttons is seen on the view of the adapter in Fig. 1.

2.07 In addition to connection to the telegraph circuit under test, it is necessary to connect to a source of 115 volt power, either a-c or d-c.

2.08 Connection to the power circuit should be made by means of the polarity plug on the power cord of the set. This plug will fit practically all power outlets at cus-

tomers' premises and power outlets at the newer central offices. For the older central offices, it will be necessary to use adapters which are furnished with the set. To the right in the lower part of Fig. 1 is the power cord with its plug and adapters.

2.09 Because the three relay connecting blocks in the set are in parallel, only one relay should be used in the test set at a time. Also, the relay plug should not be inserted into a relay connecting block when connection to the station set or circuit is made by means of a standard cord and plug.

2.10 The set is designed for use in a horizontal position but may be used in a vertical position if this is more convenient. When so used, the set should be blocked up to avoid closing the ventilation holes on the side of the box on which it rests.

3. TRANSPORTING THE SET

3.01 The set is arranged to be conveniently carried complete with all accessories. It has been provided with a cover of improved design having a practically smooth exterior. This results from the use of hook-type fasteners inside the cover which engage the rod-type handles of the set.

3.02 To remove the cover, use the thumbs, pressing the latch buttons toward the cover and toward their respective ends of the cover, thus releasing the cover. To replace the cover, place it over the casing with the latch buttons at their outer positions; with the thumbs of both hands, press a button of each latch downward and toward the center of the cover to hook the latches. Care should be taken that the cords, plugs, etc., are properly placed in the set so as not to obstruct the cover.

3.03 When arranging the set for transportation, plug the 215A relay into its connecting block, then coil the relay-plug cord 1-1/2 turns clockwise, (lying flat on the set panel and between the handles) and passing the near end of the left handle and to the left of the polar relay with this cord, plug it to the middle connecting block. Place the power cord adapters (screwed together to form two items) over the other connecting block. Place the relay-plug adapter over the power cord adapters with its terminals toward the back of the casing. Coil the four patching cords in a compact manner and tuck them between the polar relay and the relay-plug adapter. The power supply cord should then be coiled in a counter-clockwise direction, lying flat on the panel between the handles with its plug passed through the left handle and into the space to the right of the polar relay, near

the front. The cover can now be placed and latched as described above.

4. DETAILED DESCRIPTION OF VARIOUS TESTS

4.01 This part describes the operations at the measuring set itself when making the tests listed in Part 2.

Preliminary Checks

4.02 No calibration or check of the test set itself is required other than to observe the position of the meter needle when the set is disconnected from the power and telegraph circuit. If it does not rest at zero, it should be made to do so by means of the zero-adjustment on the meter.

4.03 The source of signals used in connection with tests to an outlying point should be checked before the set is transported to the outlying point if the best accuracy is desired. A suitable source of test signals is a tape transmitter, although a teletypewriter keyboard may be used if the calibration errors as determined below are small.

4.04 **Procedure:** The procedure for checking the source of signals is as follows:

(1) Arrange for a local circuit containing either 130 or 260 volts telegraph battery and regulating resistance to limit the current to 60 milliamperes. Use a 215A (or equivalent) relay in the test set.

(2) Patch from the L jack of the 161 set to the local circuit and patch the source of signals into the local circuit. The source of signals should be arranged so that about 75 repetitions of each of the test characters may be obtained conveniently.

(3) Operate the METER key to CUR, the CUR key to BIAS and the BIAS CUR key to TST SET, and adjust the ADJ BIAS CUR potentiometer to cause the meter to indicate 30 milliamperes biasing current.

(4) Operate the METER key to VOLTS and adjust the ADJ VOLTS potentiometer to cause the meter to indicate 90 volts (red line on the meter) which is the correct voltage for measuring systematic distortion.

(5) Operate the METER key to DIST and set the SIG switch to the character being sent from the distributor.

(6) Depress the METER SCALE button and after allowing a few seconds for a steady indication, read the meter and record the reading and its sign (either plus or minus).

- (7) Measure all of the test characters which are to be used in testing at the station. It is generally best to test the signals in the following order, BL, T, O, M, V, LTR. If RS and UNIT signals are to be used, they should also be tested.
- (8) Operate the A REL key to REV and repeat the measurements of all the signal combinations.
- (9) Subtract the reversed readings from the normal readings algebraically and divide the result by 2 to obtain the amount of bias in the relay.
- (10) Add the normal and reversed readings algebraically and divide the result by 2 to obtain the error in the signals.

An example of a computation to obtain the relay bias and error in the signals is given below.

	BL	T	O	M	V	LTR
Normal	0	+1	+1	+2	0	+1
Rev.	+1	+1	+2	+2	+3	+2
Relay Bias	$-\frac{1}{2}$	0	$-\frac{1}{2}$	0	$-1\frac{1}{2}$	$-\frac{1}{2}$
Error in Signals	$+\frac{1}{2}$	+1	$+1\frac{1}{2}$	+2	$+1\frac{1}{2}$	$+1\frac{1}{2}$

The relay bias in this case is small. Unless extreme accuracy is desired bias up to 1 or 1-1/2% may be neglected. Larger bias should be removed by adjustment of the relay.

The error in the signals is also small and errors of these magnitudes may ordinarily be neglected. If the errors are to be used as corrections, their signs should be changed and the values then added algebraically to the results of the measurements at the station.

Detailed Tests

4.05 The method of connection to the telegraph circuit or station depends on the type of circuit or station. Detailed information in this connection is given below in Part 5.

Operating Currents

4.06 When measuring operating currents in nearly all circuits where line current flows for marking and there is no line current for spacing, the marking current is indicated to the right on the meter. Line relay biasing current normally indicates to the right also. The meter normally indicates current on the 140-0-140 scale. To increase

the sensitivity for small currents first make sure that the indication is not over 35 mils, then depress the **METER SCALE** button and read the meter on the 35-0-35 scale.

Operating Currents Using Relay-Plug Connection

4.07 Procedure:

- (1) **Line Current**—Operate the **METER** key to **CUR** and the **CUR** key to **LINE**. This connects the meter directly in series with the loop or line. Read the current as indicated on the meter.
- (2) **Station Bias Current**—Operate the **METER** key to **CUR**, the **CUR** key to **BIAS** and the **BIAS CUR** key to **STA**. Read the current as indicated on the meter.
- (3) **Bias Current Supplied by Test Set Rectifier**—Operate the **METER** key to **CUR**, the **CUR** key to **BIAS**, and the **BIAS CUR** key to **TST SET** or **TST SET REV**, depending upon whether the bias current is to be normal or reversed. Read the current as indicated on the meter. When the current is supplied from the test set, its value may be adjusted by the **ADJ BIAS CUR** potentiometer.
- (4) **Magnet or Local Current**—Operate the **METER** key to **CUR** and the **CUR** key to **MAG**. Read the current on the meter.

Operating Currents—Cord-and-Plug Method

4.08 Procedure:

- (1) **Line Current**—Operate the **METER** key to **CUR** and the **CUR** key to **LINE**. Read the current on the meter.
- (2) **Bias Current Supplied from the Station**—This cannot be read unless the meter is used as an external meter and connection made to the bias circuit of the station set or teletypewriter using the cord and plug. Insert the plug in the **METER CUR** jack and operate the **METER JKS** key to **IN** and the **METER** key to **CUR**.

Measurement of Current or Voltage in External Circuits

4.09 The meter may be used in any external circuit to measure up to 140 milliamperes or 140 volts.

4.10 Procedure:

- (1) Connect from the circuit to be measured using a cord and plug. Insert the plug into the **METER CUR** or **METER VOLTS** jack depending upon whether current or voltage is to be measured.

- (2) Operate the METER JKS key to IN and the METER key to CUR or VOLTS as required.
- (3) Read current or voltage on the meter. If the reading is less than 35, the METER SCALE key may be depressed and the reading made on the 35-0-35 scale.

Systematic Distortion and Relay Bias

4.11 Procedure:

- (1) Connect the test set to the circuit as described in Part 5 for the particular circuit or station under test.
- (2) Operate the METER key to CUR, the CUR key to BIAS and the BIAS CUR key to STA. Note that the bias current is at its normal value.
- (3) Operate the METER key to VOLTS and adjust the ADJ VOLTS potentiometer to cause the meter to indicate at 90 (red line on meter) volts, thus providing the correct voltage to the distortion measuring circuit.

Note: Departures of several volts from 90 volts will not appreciably affect the accuracy of measurement provided there is no considerable change in voltage during the measurement.

- (4) Operate the METER key to DIST, set the SIG switch to the BL character and request the distant station to send recurring "blank" characters.
- (5) If the meter indication is 35 or less on the 140-0-140 scale while the signals are being received, depress the METER SCALE button and note the meter indication. This is the percentage systematic distortion including the bias. Record the reading and its sign (positive or negative).
- (6) Repeat 4 and 5 for all of the selected test characters, setting the SIG switch to the character being received in each case.

Note: If the connections are made as described in Part 5 the distant station may be requested to change signals and perform other operations by operating the REC key to TTY and using the teletypewriter for communication purposes in the normal manner.

- (7) To obtain the relay bias, reverse the connections to the relay (by operating the A REL key to REV or by removing the B relay from the NORM to the REV connecting block in the test set) and repeat the measurements of the selected characters.

- (8) The relay bias is obtained by subtracting the reverse readings from the normal readings algebraically and dividing by 2, as described above under Preliminary Checks.

Interference

4.12 Interference may be considered as any extraneous current which affects the telegraph circuit. It may be due to crossfire from adjacent telegraph circuits, power induction, earth currents, etc.

Any **A-C type of interference** such as crossfire and power induction is measured as follows:—

4.13 **Procedure:**

- (1) Arrange to have the line circuit in a steady marking or spacing condition.
- (2) Connect the test set to the line circuit as described in Part 5 for the particular circuit under test.
- (3) Operate the METER key to CUR and the CUR key to LINE. Note the line current as indicated by the meter.
- (4) Operate the CUR key to BIAS and the BIAS CUR key to TST SET and turn the SIG switch to AUD SIG.
- (5) Adjust the ADJ BIAS CUR potentiometer until the bias current as indicated on the meter is substantially equal to the line current.

If crossfire or similar interference is present, the relay armature will chatter and this will be evidenced by clicks in the telephone receiver contained in the test set.

If power interference is present, the relay armature will buzz and the telephone receiver will emit a continuous buzz.

- (6) Increase the bias current slightly above the point where the receiver noise stops and then reduce the current slowly until only occasional response is heard and note the reading of the milliammeter at this point.
- (7) Reduce the bias current slightly below the point where the noise stops and then increase the bias current until the noise is just heard. Note the reading of the milliammeter.
- (8) The peak value of the interference as interpreted by the relay is equal to one-half the difference between the two readings.

Note: When large values of interference are present, it is desirable to reduce the line current to zero by substituting ground for the line batteries at both ends of the line. Then in step (7) instead of reducing the bias current, it must be reversed by operating the BIAS CUR key to TEST SET REV. The peak value of interference is then the average of the normal and reversed reading.

4.14 Comparatively steady interfering effects such as earth currents and leakage currents are measured as follows:

4.15 **Procedure:**

- (1) For **measuring earth currents** arrange to have ground substituted for the batteries at both ends of the line.
- (2) Operate the METER key to CUR and the CUR key to LINE and read the earth current on the milliammeter.

Note: This reading includes any leakage current from another circuit to the circuit under test.

4.16 **Procedure:**

- (1) For **checking leakage conditions** arrange to connect battery to the line at one station and ground at the other.
- (2) Operate the METER key to CUR and the CUR key to LINE and read the current on the milliammeter.

Leakage is indicated when there is a difference between the line current read at the outlying point and that read at the central office.

Distorting Effect of Interference (Wave Shape)

4.17 To obtain an idea of the distorting effect of the interference the biasing current of the receiving relay may be changed from its normal value by an amount equal to the peak value of the interference while receiving reversals or any of the selected test characters. The change in bias caused is an indication of the distorting effect of the interference.

4.18 **Procedure:**

- (1) Connect the test set to the circuit as described in Part 5 for the particular circuit or station under test.
- (2) If the received signals are polar, measure the bias current of the test set. Adjust the ADJ BIAS CUR potentiometer to cause the bias current to be zero as indicated by the meter.

- (3) If the received signals are open-and-close, measure the steady line current, then adjust the ADJ BIAS CUR potentiometer until the meter indicates one-half the steady marking line current.
- (4) Request RS or any of the test characters from the distant station.
- (5) Operate the METER key to DIST and set the SIG switch corresponding to the received signal. Make note of the bias which is indicated directly on the meter.
- (6) Operate the METER key to CUR and increase the biasing current from its normal value by an amount equal to the peak value of the interference as previously determined under "Interference."
- (7) Operate the METER key to DIST and again make note of the indicated bias.
- (8) Operate the METER key to CUR and reduce the bias current from normal by an amount equal to the peak value of the interference.

In polar operated circuits the biasing effect should be reversed for this condition by operating the BIAS CUR key to TST SET REV and then checking the bias current to insure that it is of the same amount as before but in the opposite direction.

- (9) Operate the METER key to DIST and make note of the indicated bias.
- (10) Average the amount of change caused in the bias by increasing and decreasing the bias current by the amount of interference. This result is taken as the amount of distortion likely to be experienced with miscellaneous signals assuming a receiving relay was used between the line or loop and the teletypewriter magnet.
- (11) It is obvious that a number of readings of bias may be made for different values of bias current while receiving the signals and the results plotted to show the effect of changing the bias current over a considerable range. This may be of use for future reference in testing on the particular circuit in question.

Test of Teletypewriter Keyboards

4.19 Keyboard testing with this set is essentially a measurement of bias of recurring signals produced by the keyboard in a free running condition. No direct indication is afforded as to the extent of the fortuitous distortion such as may be caused by irregular clutch action and gear imperfections when typing by hand. As described later in this part, an indirect indication of this may be obtained pro-

vided a 118A1 set is available at the distant central office.

It is expected that when bias constitutes the major part of the distortion, this test may result in worthwhile improvement in the keyboard signals. However, the following procedure should not be regarded as replacing existing practices specifying mechanical limits for adjustment.

4.20 Procedure:

- (1) Arrange the receiving relay of the test set to be operated by the keyboard signals in a suitable circuit as follows.

In the case of a loop circuit where no local circuit is available, the test-set relay should be substituted for the receiving relay of teletypewriters equipped with line relays and for the magnet of teletypewriters not so equipped, and any inductance or spark killer which is normally connected at the receiving station should be removed. For loops up to about 17 miles in length there will be a negligible error (less than 1%) in the result when testing under this condition. For loops beyond 17 miles, the error amounts to about +2% and this may be corrected for if the best accuracy is desired. If the spark killer is left connected around the sending contacts, these errors become +2-1/2% and +3-1/2%, respectively.

- (2) On machines provided with a break lock mechanism, place a piece of paper between the break lock contacts which are used to short-circuit the keyboard contacts.

- (3) Operate the METER key to DIST. Set the SIG switch at UNIT.

- (4) After depressing the teletypewriter key corresponding to the desired signal, hold open the start-stop contact. Then obtain recurring signals by holding or blocking the clutch lever eccentric in a depressed position. Observe the bias as indicated on the meter.

- (5) Measure the bias of the Nos. 1, 2, 3, 4 and 5 selecting pulses in turn, proceeding as above. In most teletypewriters these pulses are produced by operating the E, line feed, space, carriage return, and T keys, respectively.

Note: It should be noted that in some machines the bias result for a particular signal may vary by 1 or 2% distortion depending on the time at which the clutch engages. At least four checks should be made with random engagement of the clutch and the average result used as the bias.

(6) Check the readings obtained in 5 but with the relay reversed in order to eliminate relay bias. The relay bias is obtained as described under "Systematic Distortion and Relay Bias," above.

Requirement

Each of the five pulses shall be adjusted to have no more than $\pm 1\%$ net distortion by adjusting the outer (heavy) contact springs using the regular adjusting tool for this purpose.

Note: It is better to have slight positive distortion than negative in order to avoid breaks in the characters due to lack of "overlap."

(7) Measure the bias of BL, T, O, M, V and LTR combinations as sent from the keyboard. On machines not equipped with "blank" keys (such as the 26 type) move all the locking levers to the spacing side to obtain the BL combination.

Requirement

The result should not be predominantly marking or spacing. Adjustment of the start-stop contact will affect the bias of these combinations bearing in mind that any adjustment has twice the effect on the BL combination as compared to that on the remaining five combinations.

(8) An additional check of keyboard transmission is obtained by measuring the E, line feed, space, carriage return, and T characters (stop pulse plus one selecting pulse in each character) with the SIG switch at T.

Note: It is improbable that a keyboard having small systematic distortion will show serious breaks or holes in the combination due to lack of overlap when the pulses are combined to make the various characters. A check of this is conveniently made by sending recurring LETTERS characters and attempting to find an upper orientation limit on the teletypewriter. The presence of an upper limit below the mechanical limit of the typing unit indicates serious breaks in the character.

A check on fortuitous distortion may be obtained by measuring the keyboard signals as received at the distant central office on a 118A1 measuring set. In such a test the total distortion of the recurring signals mentioned above should be compared with the total distortion obtained when typing miscellaneous characters.

Equalization and Wave Shaping Tests

4.21 Equalization and wave shaping tests are made for the purpose of detecting and reducing excessive systematic distortion. For these tests it is desirable to obtain the selected characters from a tape transmitter or other suitable distributor of good condition. However, they may be obtained from a keyboard whose systematic errors have been accurately measured with the test set provided the results at the distant station are corrected by the amount of the errors.

4.22 Procedure:

- (1) Check the source of signals at the central office as described under "Preliminary Checks" above.
- (2) Measure systematic distortion as described above using the selected characters.

Requirement

The equalization is satisfactory if the distortion of any of the selected characters does not differ by more than ± 1 to 2% distortion from the average result for all of the characters. Usually the departure from the average can be reduced to less than 1%.

Use of Keyboard Signals for Checking of Typing Units of Teletypewriters

4.23 After the line has been checked and is in proper condition, an overall check including the teletypewriter at the station may be made with biased signals from the central office as described in other Practices.

When tests with biased signals are not practicable, local orientation tests may be made at the station using the keyboard signals after they have been checked thoroughly, provided the teletypewriter is equipped with a pulling magnet. (Both orientation limits cannot usually be obtained with holding magnets.) It is best to send test sentences at an even rate in making such tests. However, irregular clutch action if present will affect the results; this condition may be avoided by using recurring characters such as R or Y or both.

4.24 Procedure Using Keyboard Signals

- (1) Check the keyboard signals as specified above under tests of keyboard signals.
- (2) When sending test sentences or recurring R's and Y's, check the orientation limits of the teletypewriter when it is connected into a local test circuit or the equivalent. The procedure for obtaining orientation limits is covered in other Practices.

5. CONNECTIONS TO TELEGRAPH CIRCUITS

General

5.01 As mentioned in Part 2, connection of the test set to a telegraph circuit or a station set may be made in either of two ways. One method is to insert the relay plug with or without adapter in place of the sending or receiving relay; this method will be referred to as "relay-plug method." The second method involves patching with standard patch cords having plugs at both ends or with W2F cords having a plug at one end and clips at the other.

5.02 The relay-plug method of connection may be used where there is a receiving relay at the station or teletypewriter. This method is the preferred method from the standpoint of convenience and is satisfactory except in some cases an error of from 1 to perhaps 5% distortion may be introduced in measuring bias.

5.03 For best accuracy in the measurement of bias, it is recommended that the connection be made using patch cords to substitute the test set for the receiving device in two cases (1) when the receiving device is operated on an open-and-close basis from a receiving relay. In this case the effect of armature travel time is normally added into the bias and since it affects the margin of the receiving device, it is usually desirable to include it in the measurement, (2) where rectifier arrangements are used to supply the required direct current and where there is no balancing load connected to the spacing contact of the receiving relay. In this case the operating currents are altered noticeably when using the relay-plug method of connection.

At Teletypewriter Stations

5.04 Since testing at outlying teletypewriter stations may involve either TWX circuits or private line circuits detailed information is given below covering both of these.

5.05 With present arrangements the teletypewriter magnet at the subscriber station is either directly in series in the loop (or line) or is operated on an open-and-close basis from a receiving relay contained either in the teletypewriter or in the subscriber set.

5.06 Where **there is a receiving relay** the relay-plug method of connection is employed for the measurement of operating currents, interference, wave shape and generally for keyboards. It may also be used to obtain the systematic distortion of received signals but for best accuracy, the magnet of the teletypewriter is replaced by the test-set relay using patch cords or W2F cords.

5.07 Where **there is no receiving relay** it is necessary to use patch cords or W2F cords in any case. For teletypewriters with pulling magnets, the procedure for measuring operating currents, interference and wave shape is to insert the receiving relay of the test set in series with the magnet, and for systematic distortion and keyboard testing the magnet is replaced by the test-set relay. For teletypewriters with holding magnets connected for either 20 or 60 milliamperes operation, the procedure for all tests is to replace the magnet by the test-set relay.

5.08 It should be noted that the 215A relay which is normally carried with the set is not suitable for testing in 20 milliamperes circuits. Whenever such circuits are to be tested a suitable relay which has been well adjusted should be carried with the set.

Procedures:

5.09 General procedures covering connection to the various circuits of subscriber sets and stations are given below. These are designated as A1, A2, B1, B2, etc., for convenient reference to Tables A and B.

Procedures for Replacing the Line or Receiving Relay with the Test Set Relay

5.10 A1 Insert relay plug in place of **receiving relay** of subscriber set and insert receiving relay into 161A1 test set.

A2 Insert relay plug in place of **line relay** of teletypewriter and insert line relay in 161A1 test set.

A3 Insert relay plug in place of **sending relay** of subscriber set and insert sending relay in 161A1 test set.

Procedures for Replacing the Magnet of the TTY with the Test Set Relay

Note: The teletypewriter will run open when the REC key of the 161A1 test set is in the TST position and connections are made as below, but this does not interfere with the test.

5.11 B1 (By patching to 120A1, 120B1 and 128A1 sets)
(1) Remove the double plug terminating the TTY from its jack and insert it into the (A) and (B) (TTY) jacks of the 161A1 test set with the knurled side of plug adjacent to the (A) jack.

(2) Patch from the (A) and (B) jacks of the 120A1 or 120B1 set or the left and right-hand (TTY) jacks of the 128A1 set to the (R) and (L) line jacks, respectively, of the test set.

B2 (By disconnecting wires of 15 or 19 TTY with line relay)

(1) Remove all the wires from terminals 45 and 46. Identify the two wires which do not connect to the magnet.

(2) Using a W2F cord, clip the red tracer wire (sleeve) to the wire removed from terminal 46 and the white tracer wire (tip) to the wire removed from terminal 45.

(3) Insert the plug of the W2F cord into the (R) (LINE) jack of the 161A test set.

(4) For the talking connection use another W2F cord and clip to the wires connecting to the magnet (which were also removed from terminals 45 and 46) and insert the plug of the W2F cord into the (B) (TTY) jack of the 161A1 test set.

B3 (By disconnecting wires of 14 TTY with line relay)

(1) Remove the yellow wire from terminal 46 and the white wire from terminal 45.

(2) Using a W2F cord, clip the red tracer wire (sleeve) to terminal 46 and the white tracer wire (tip) to terminal 45 and insert the plug of the W2F cord into the (R) (LINE) jack of the 161A1 test set.

(3) For the typing connection use a W2F cord and clip to the wires which were removed and which connect to the magnet and then insert the plug of the W2F cord into the (B) (TTY) jack of the 161A1 test set.

B4 (By patching for 14, 15 or 19 TTY's without line relay)

(1) Remove the plug terminating the TTY from its jack and insert it into the (A) (TTY) jack of the 161A1 test set.

(2) Patch from the (RED) jack of the TTY table to the (L) (LINE) jack of the 161A1 test set when the TTY has a holding magnet connected for 60 or 20 milliamperes operation and to the (R)

(LINE) jack of the 161A1 test set when the TTY has a pulling magnet.

B5 (By patching at 26 TTY **without** line relay)

(1) Using a W2F cord, clip the white tracer wire to terminal 5 and the red tracer wire to terminal 4 of the 12F connecting block of the TTY table.

(2) Insert the plug of the W2F cord into the (L) (LINE) jack of the 161A1 test set when the magnet is connected for 60 milliamperes operation and to the (R) (LINE) jack when it is connected for 20 milliamperes operation.

(3) Remove the TTY plug from its jack in the table and connect a W2F cord to the plug by clipping the white tracer wire to the diagonal terminal and the red tracer wire to the straight terminal.

(4) Insert the plug of the second W2F cord into the (A) (TTY) jack of the 161A1 test set.

B6 (Disconnecting wires at 26 TTY **with** line relay)

(1) Remove the orange lead from TTY terminal 12 and the white lead from terminal 15.

(2) Using a W2F cord clip the white tracer wire to the orange lead and the red tracer wire to the white lead.

(3) Insert the plug of the W2F cord into the (L) (LINE) jack.

(4) Using another W2F cord, clip onto TTY terminals 12 and 15 and insert the plug of the W2F cord into the (A) (TTY) jack of the 161A1 test set.

Procedure for Inserting Test Set in Series with Magnet of TTY without Line Relay

Note: With these procedures it is not necessary to operate the REC key of the 161A1 test set to TTY in order to communicate.

5.12 C1 (For 14, 15 or 19 TTY)

(1) Remove red TTY plug from (RED) jack of TTY table.

(2) Insert the plug into the (R) (LINE) jack of the 161A1 test set.

(3) Patch from (RED) jack of table to the (L) (LINE) jack of the 161A1 test set.

C2 (For 26 TTY)

- (1) Using a W2F cord, clip the white tracer wire to terminal 5 and the red tracer wire to terminal 4 of the 12F connecting block of the TTY table.
- (2) Insert the plug of the W2F cord into the (L) (LINE) jack of the 161A1 test set.
- (3) Remove the TTY plug from its jack in the table.
- (4) Using a W2F cord clip the white tracer wire to the diagonal terminal and the red tracer wire to the straight terminal.
- (5) Insert the plug of the second W2F cord into the (R) (LINE) jack of the 161A1 test set.

Procedure for Keyboard Test for Duplex Connected TTY

5.13 D1 (By patching at duplex connected 14, 15 or 19 TTY)

- (1) Remove plug from BLACK jack of TTY table in case of 14 and 15 TTY and RED jack in case of 19 TTY.
- (2) Insert the plug in the (L) (LINE) jack of the 161A1 test set.
- (3) Patch from the (R) (TTY) jack of the 161A1 test set to the BLACK jack of the TTY table in the case of 14 and 15 TTY's and to the RED jack in the case of 19 TTY's.

Connections at TWX Stations

5.14 Use Table A.

Connections at Private Line Stations

5.15 Use Table B.

At Central Offices

TWX Circuits

5.16 Testing at TWX central offices will usually be done at the regular testboards operated in conjunction with the central offices. These boards have teletypewriters, usually 14 type machines with line relays, and the testing procedure is simply to patch the circuit under test to the testboard and terminate it in the teletypewriter. Then connect to the 161A1 test set using the relay-plug method of connection for relay bias, biasing current and distortion measurements. In case of line-current, wave-shape and interference testing

it will be necessary to terminate the circuit at the central office in the relay of the 161A1 test set either by a cord-and-plug connection specially arranged or by inserting a relay plug in place of the line relay of a cord circuit repeater associated with the circuit under test.

Private Line Teletypewriter Circuits

5.17 For the usual test of systematic distortion and possibly keyboard testing the relay of the 161A1 test set should be inserted directly into the local circuit of the terminating repeater using regular patch cords. If in some cases it is desired to test interference, wave-shape and operating currents, it will be necessary to use the relay-plug method of connection at the terminating repeater itself.

Morse Circuits

5.18 Although the 161A1 test set is specifically designed for the testing of teletypewriter circuits, it may be used to test Morse circuits by inserting the test-set relay in series with the key and sounder of the Morse circuit and using the regular teletypewriter test signals. Interference, wave-shape and line-current testing must, of course, be done using the relay-plug connection in case the telegraph circuit is terminated by a repeater.

Keyboard Testing

5.19 For testing keyboards of teletypewriters equipped with line relays at central offices, use may be made of a dummy test circuit of the proper current using the relay-plug method of connection. Where the teletypewriter has no line relay, the test set should be connected in place of the magnet of the teletypewriter as specified under TWX stations for the particular type of machine involved and the machine then connected into a dummy circuit simulating the local test condition.

TABLE A
For TWX Stations
 Recommended Procedures for Connection Between Station Set and 161A1 Test Set
 (Procedures designated by A1, A2, B1, B2, etc., are described under 5.10-5.13 inclusive)
 Type of Station Type of Test

Type of Station	For Tests of Current, Interference, Wave Shape and for Typing	For Tests of Systematic Distortion and for Typing	For Tests of Keyboard Signals
120A1 (20 mil 14 & 15 TTY) & 120B1 (20 mil 19 TTY) 120C1 & 120D1 (15 & 19 TTY) With line relays	A1 A2 B4	B1 B2 B4	A1 and operate 120 set to local test. A2 B4
Without line relays, with holding magnet 122A2 (14, 15 & 19 TTY)	See 126A2	See 126A2	As for 126A2 but operate subset key to "Regular Service" to obtain 30 mil bias current. See 126A2
124A1 (14 & 15 TTY) 126A2 (also 125A1 & A2, & 126A1) (14, 15, 19 & 26 TTY) For TTY's with line relays, 14 TTY 15 & 19 TTY 26 TTY	See 126A2 A2 A2 A2	See 126A2 B3 B2 B6	A2 } Operate TTY to local test A2 } if available. A2
For TTY's without line relays, with holding magnets 15 & 19 TTY 26 TTY	B4 B5 A2 A1	B4 B5 B3 for 14 TTY B2 for 15 & 19 TTY B1	B4 B5 A2 and operate TTY to local test.
126B1 (upset duplex 14, 15 & 19 TTY with line relays) 128A1 (14 & 15 TTY)	A1	B4 for 15 & 19 TTY, A3 and operate local test key of sub- B5 for 26 TTY, A3 and operate local test key of sub- B3 for 14 TTY, A3 and operate local test key of sub- B2 for 15 TTY, A3 and operate local test key of sub-	A3 and operate local test key of sub- set to TEST. A3 and operate local test key of sub- set to TEST. A3 and operate local test key of sub- set to TEST.
128C1 (15, 19 & 26 TTY)	A1		
130A1 (14 & 15 TTY)	A2 (Note—Current readings are to left on meter).		

TABLE B
For Private Line Stations
 Recommended Procedures for Connection Between Station Set and 161A1 Test Set
 (Procedures designated by A1, A2, B1, B2, etc., are described under 5.10-5.13 inclusive)

Type of Station	Type of Test	For Tests of Current, Interference, Wave Shape and for Typing	For Tests of Systematic Distortion and for Typing	For Tests of Keyboard Signals
Upsset Duplex				
No standard connections available for this service. Connections as given below for "Single Operation" may apply.				
TTY's modified for Type A Polar (14, 15 & 19 TTY's)		A2 (no bias current normally)	B4 for 14 TTY, B2 for 15 & 19 TTY	A2 and put station in local test condition.
1 Way Polar (14, 15 & 26 TTY with line relays)		A2 (No talk) (No bias current normally)	B3 for 14 TTY, B2 for 15, B6 for 26	
128B2 (14, 15 & 19 TTY)	A1		B4 and remove bias current in test set when polar rec.	A3 and use local test circuit of sub-scriber set if available.
Duplex Operation (& Split Loops)				
14, 15 & 19 TTY				
For TTY's with line relays, 14 TTY	A2	A2	B3	D1
15 & 19 TTY	A2		B2	D1
For TTY's without line relays, with pulling magnets 14 TTY				
15 & 19 TTY	C1	C1	B4	D1
For TTY's without line relays, with holding magnets 15 & 19 TTY	B4	B4	B4	D1

TABLE B—Cont.
For Private Line Stations
 Recommended Procedures for Connection Between Station Set and 161A1 Test Set
 (Procedures designated by A1, A2, B1, B2, etc., are described under 5.10-5.13 inclusive)

Type of Station	Type of Test			For Tests of Keyboard Signals	
	For Tests of Current, Inter- ference, Wave Shape and for Typing	For Tests of Systematic Distortion and for Typing	2-Wire Lines or 1-Wire to Ground	1-Wire to Battery	
Single Operation (14, 15, 19 & 26 TTY) For TTY's with line relays					
14 TTY	A2	B3		B3 }	A2 and operate to local test, if local test is available.
15 & 19 TTY	A2	B2		B2 }	
26 TTY	A2	B6		B6 }	
For TTY's without line relays, with pulling magnets					
14 TTY	C1	B4		B3 }	Same as for systematic distortion. Use local test circuit if available.
15 & 19 TTY	C1	B4		B2 }	
For TTY's without line relays, with holding magnets					
15 & 19 TTY	B4	B4		B2 }	Same as for systematic distortion.
26 TTY	B5	B5		B6 }	