BELL SYSTEM PRACTICES
Teletypewriter Stations

SECTION P31.405
Issue 2, February, 1958
AT&TCo Standard

164C1 TELEGRAPH TRANSMISSION MEASURING SET

ADJUSTMENT, USE, AND MAINTENANCE

Contents **Par. No.**

1. GENERAL

1.01 This section tells how to adjust, use, and maintain 164C1 telegraph transmission measuring sets which have been modified per ES-945471, as described in Addendum Issue 2 to Issue 1 of BSP E45.438. A further modification per ES-947086 is required to correct a jitter which arises in certain applications of the 164C1 set where the set is connected to a poorly arranged dummy circuit. It is assumed that all existing sets will be modified per ES-945471 and preferably modified also per ES-947086. All sets shipped after July 8, 1957, will include both of these modifications.

1.02 This section is reissued:

(1) To describe the accuracy of the set in greater detail,

(2) To revise Part 4 in accordance with the latest information on ROUTINE ADJUSTMENTS,

(3) To revise Part 5 in accordance with the latest information on USE, and

(4) To give greater emphasis to 2.08 and 5.01, which include safety features.

Changes are indicated by marginal arrows.

1.03 The set is portable and can be patched into working teletypewriter circuits to measure the distortion present in the teletypewriter signals, without interrupting the service. It can be used to measure the total distortion of signals or of repeated test characters. Depending on the setting of the set's controls, any displacement of the transitions in the teletypewriter signals from their proper positions will be indicated on the set's cathode-ray tube by the appearance of a bright spot with a superimposed vertical line (PEAK) or by a vertical deflection from a horizontal trace (PIP). The vertical length of the pip has no significance. The greater the distortion in the signals, the farther to the right this pip or peak will appear. The distortion value, therefore, can be read directly upon a horizontal scale which is mounted in front of the cathode-ray tube and shows per cent distortion of the signals up to 50 per cent. Error in scale readings is shown in Fig. 1 and will not exceed ±3 per cent distortion.

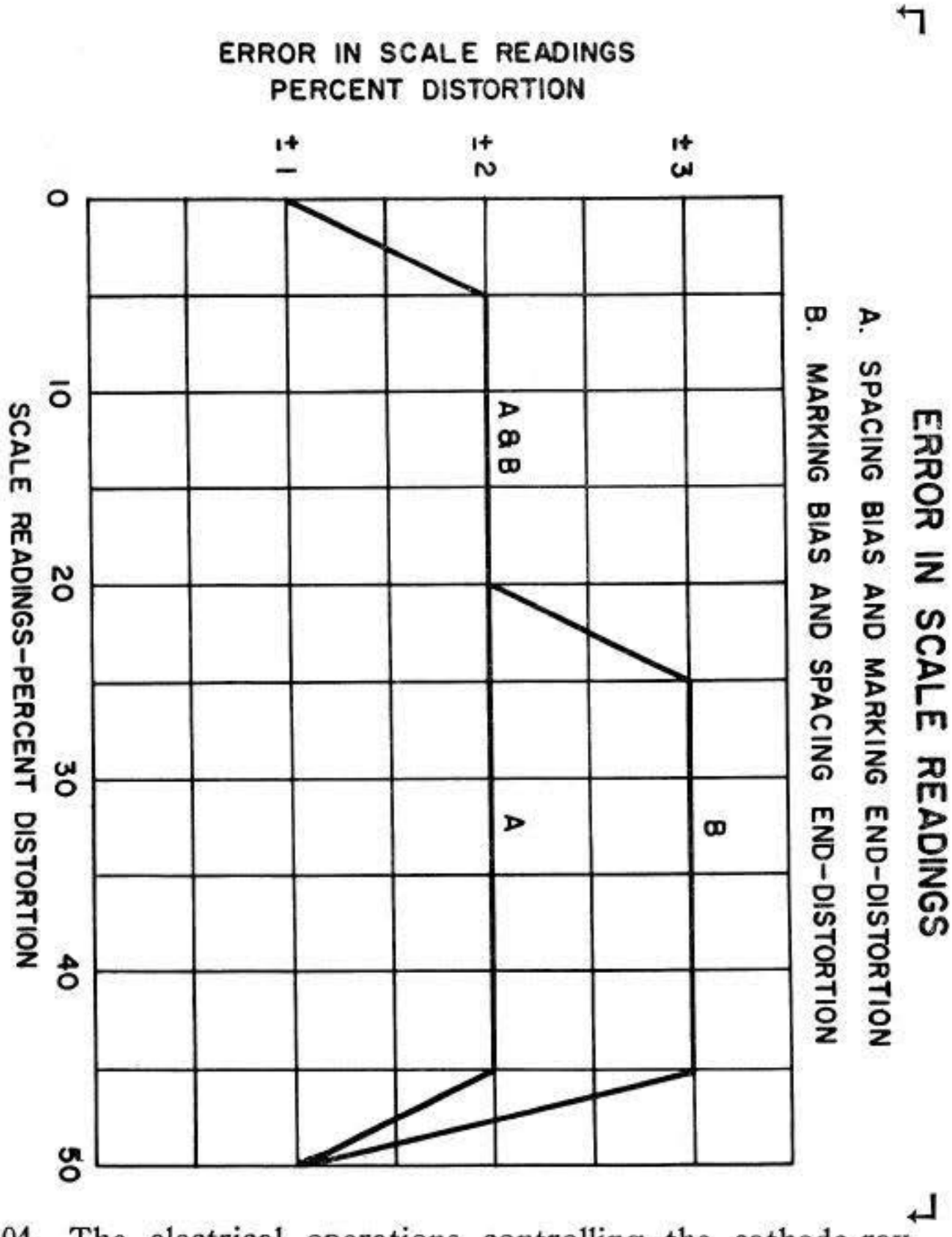


Fig. 1—Error in Scale Readings

1.04 The electrical operations controlling the cathode-ray tube exhibit are started by the first mark-to-space transition (beginning of the START element) in a teletypewriter character and stopped during the STOP element of the teletypewriter character.

1.05 A pip which points downward indicates that the corresponding signal transition is from mark to space. A pip pointing upward shows a signal transition from space to mark.

1.06 When the controls are set to show pips, the beam sweeps once from extreme left to extreme right across the face of the set's cathode-ray tube during the first half of a signal element, and then returns to the extreme left side during the second half. Thus the extreme left side of the sweep indicates both the beginning and the end of a signal element, for the cathode-ray beam appears as a continuous trace on the face of the tube.

1.07 The various types of telegraph signal distortion are described in Section P30.002. The amount of distortion is read from the horizontal scale on the scope face. The type of distortion is determined from the shape of the pip. These pips are angular in form with one vertical leg and one sloping leg. Typical shapes for marking bias, spacing bias, spacing end-distortion, and marking end-distortion are illustrated at the corners of the scale on the set's cathode-ray tube and are also shown in Fig. 2.

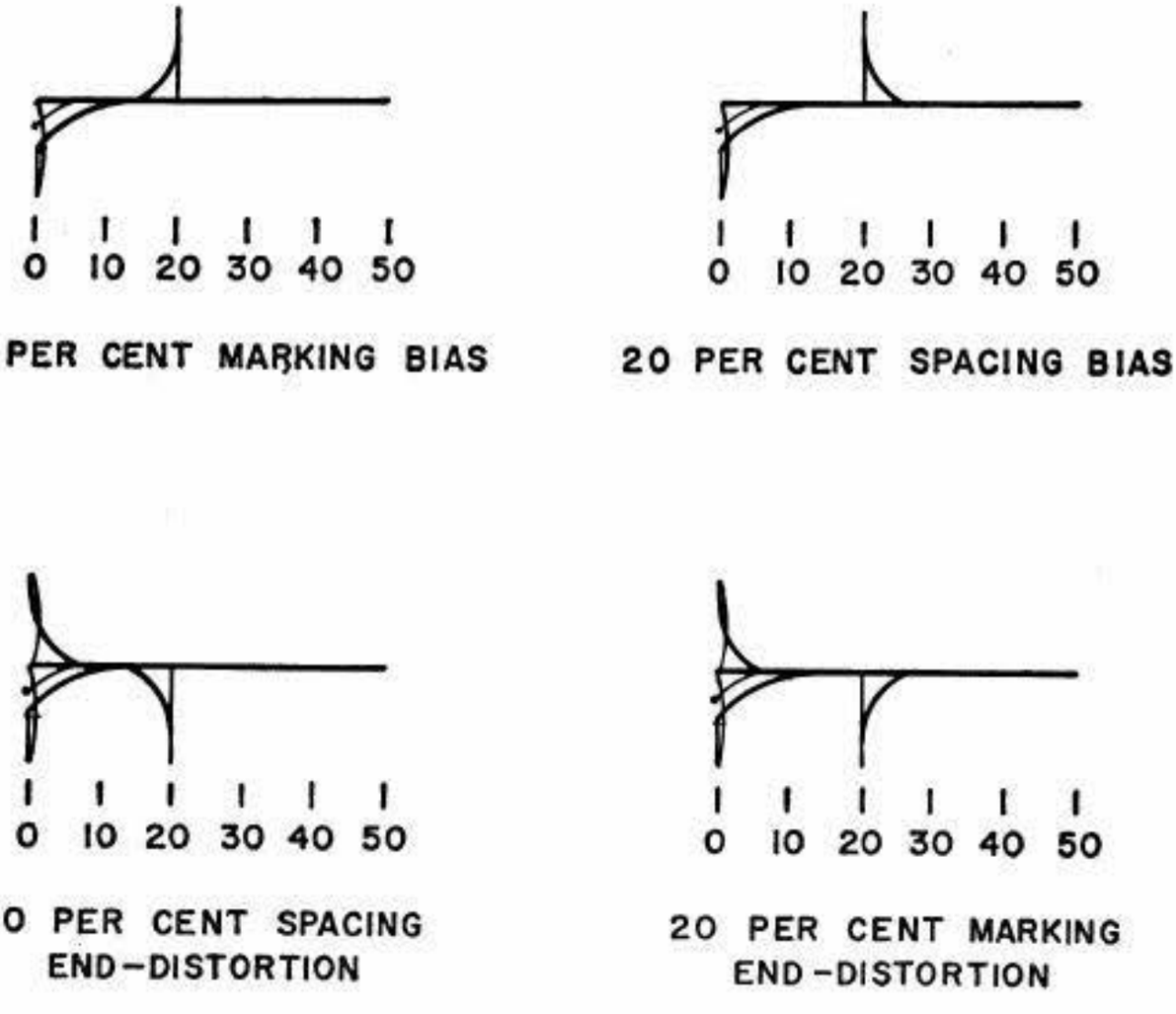


Fig. 2—Typical Shapes of Distortion Indication

1.08 Two such characteristic signals will occur in sequence when pure switched bias or pure switched end-distortion are being measured. [See Fig. 3(A).] However, when making measurements on actual transmission circuits, the display patterns will generally be a series appearing to show both bias and end-distortion, as shown in Fig. 3(B), and will usually vary as a result of random effects (fortuitous distortion) and of the changing nature of the text material being transmitted (characteristic distortion effects).

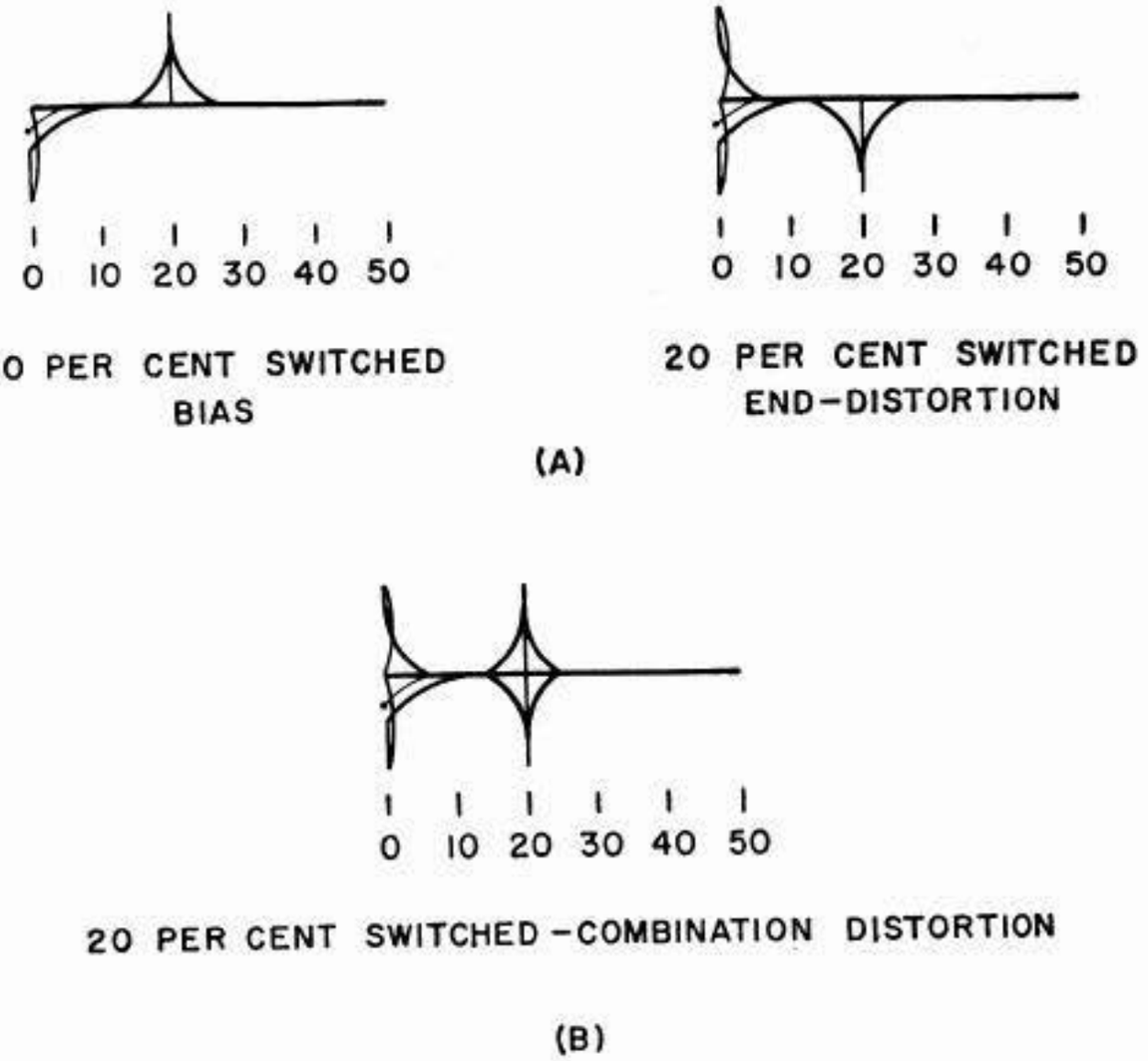


Fig. 3—Typical Shapes of Switched-distortion Indication

1.09 Fortuitous distortion is manifested by an occasional, momentary, large excursion to the right or left of the average distortion displayed on the set. A pip indicating fortuitous distortion may appear as any one of the four types of distortion shown in Fig. 2.

1.10 Characteristic distortion is indicated by a continuous jittering of the pip, perhaps as much as ±5 per cent. In that case, usually the best that can be obtained are averaged pip indications. The peak indications remains relatively steady; however, the precaution described below should be observed.

1.11 **Important:** Relay contact bounce sometimes causes a confusing type of distortion. This can be easily recognized by one or two "ghosts" appearing up-scale as high as 50 per cent, in addition to the normal signal pips usually found near scale 0. These ghost pips, which may be of a random nature, are somewhat square in shape and will jitter back and forth. Each pip will have deflection both above and below the reference line. (See Fig. 4.) If a second ghost is present, it will be narrower than the first. A common cause of such contact bounce is the connection of two or more loops in tandem, via a relay repeater. The relay receives severe current pulses, in such circuits, causing the contact bounce. These ghost pips may also indicate dirty segments or anything which produces a narrow pulse within a signal element. It is important that only the PIP display be used when observing this type of distortion. If the PEAK display is used, a reading corresponding to the location of the ghost pip will be obtained. This is erroneous in that it conceals the average distortion present in the circuit until the RESET button is depressed.

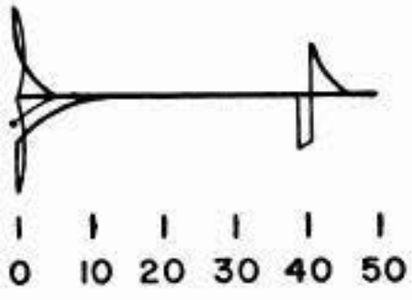


Fig. 4—Typical Ghost Pip

1.12 The bright spot with a superimposed vertical line, obtained when the DISPLAY switch is operated to PEAK, marks the greatest distortion which occurred during the series of teletypewriter signals received. (See Fig. 5.) This distortion indication can be moved back to the left end of the scale by momentary operation of the RESET key. The position taken by the spot after that will then mark the greatest distortion occurring subsequently.

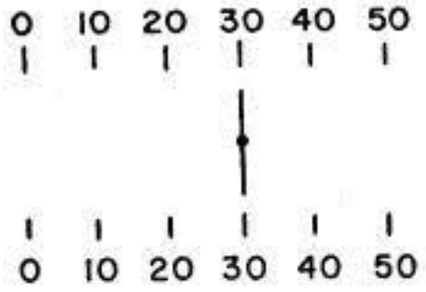


Fig. 5—Peak Display—30 Per Cent Distortion

2. DETAILS ON THE EQUIPMENT

2.01 The chassis and case of the test set are of aluminum. The set has a removable cover with a handle for carrying the set with the cover on; and two handles are mounted on the face panel of the set for use when the cover is off. The set without its cover, and neglecting projections of handles, controls, etc, is about 11 inches long, 6 inches high, and 8 inches deep. With its cover on, the set weighs about 13 pounds.

2.02 Fig. 6 shows the arrangement of the display screen and operating controls on the front panel of the set.

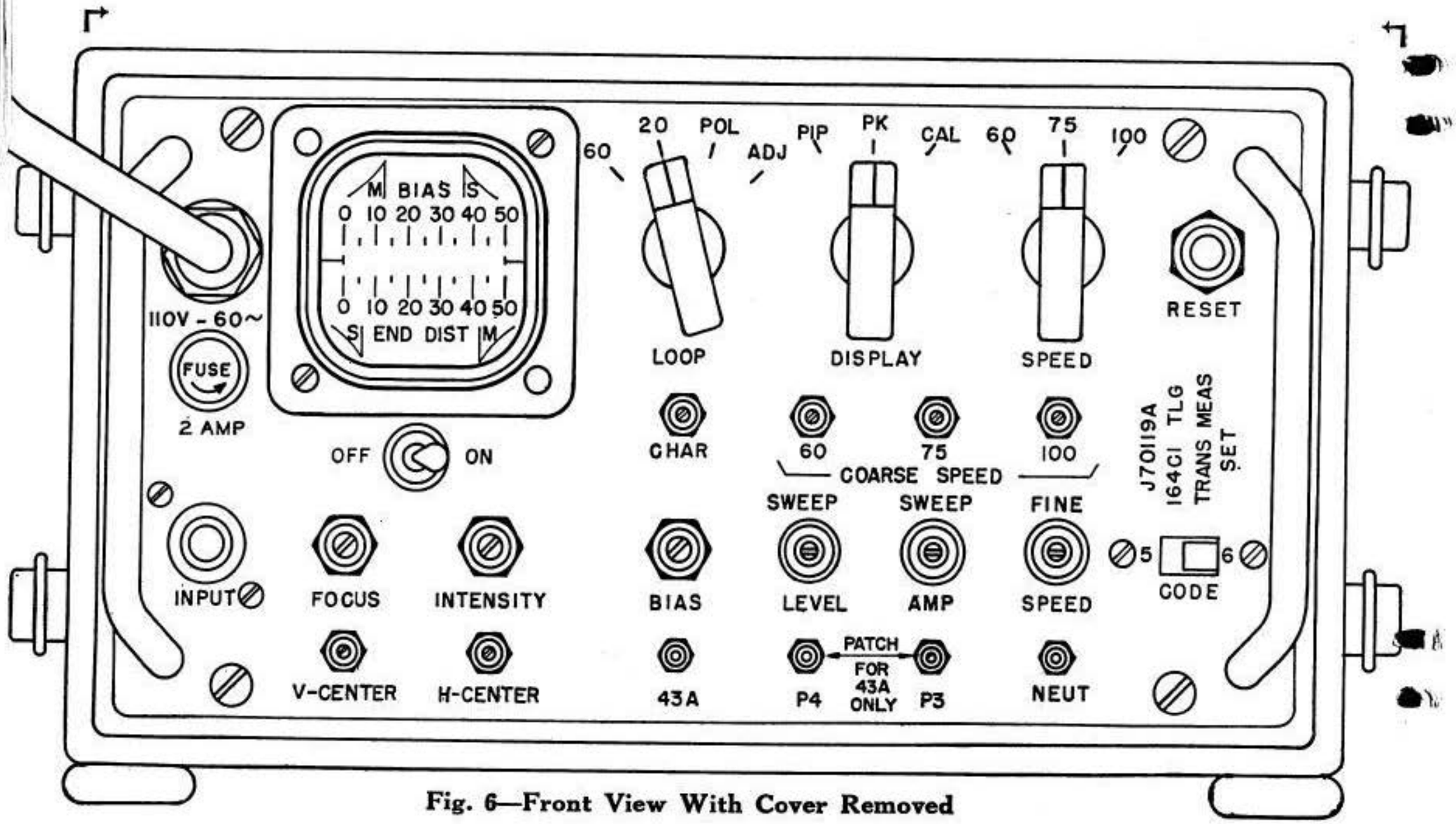


Fig. 6—Front View With Cover Removed

2.03 The power cord shown on Fig. 6 terminates in a 3-conductor (one grounding pin) plug, and requires a 3-wire grounding type convenience outlet; or an adapter when a 2-conductor receptacle is used.

2.04 Two patching cords (2-conductor type) are provided with the new sets. One is for connecting the set into a telegraph loop, and the other for connecting the set into 43A1 carrier telegraph terminal equipment. The latter cord is electrically equivalent to the three cords which will result when an old set is modified in the field by use of the ES-945471 modification kit.

2.05 Space is provided in the cover of the set for storing the power cord, a power plug adapter, two patching cords, and a single spare fuse of each of the two types required.

2.06 The chassis and face panel form an integral unit upon which all circuit components are mounted. By releasing four screws which secure the face panel to the case, the chassis may be withdrawn from the case for maintenance purposes.

2.07 All controls and pin jacks except those associated with the element timer multivibrator are located on the face panel. The element timer multivibrator pin jacks and multivibrator balance control, which require only occasional adjustment, are mounted on the chassis.

2.08 **In order to minimize interference effects in the operation of the set, the main panel of the chassis, which is the circuit neutral, is connected to the potential on the tip of the input jack on the connection from the input telegraph loop circuit. This potential may lie anywhere between +130 and —130 volts, depending upon the particular telegraph circuit. However, the side panels of the chassis, the front panel, and the case of the set are insulated from the main panel of the chassis and provision is made for connecting them to building ground through a third conductor in the power cord. Without such a ground connection, stray potentials up to 800 volts dc might appear on the exposed framework due to equipment failure, and transient loop potentials would appear during normal operation.**

2.09 To further reduce hazards to personnel, the exposed terminals of apparatus in the high voltage supply to the cathode-ray tube are covered by a removable plastic grid.

2.10 The speed switch is marked 60, 75, and 100 for 5-unit code transmission. The 60 and 75 settings correspond to the 53-wpm and 66-wpm speeds, respectively, used in 6-unit transmission.

3. CIRCUIT DESCRIPTION

3.01 For a somewhat simplified description and explanation of the circuit operation of the set see BSP E45.438, which will provide an understanding of the principles of operation of the set. If more detailed information is required on circuit operation or set components, the circuit schematic and circuit description should be consulted.

4. ADJUSTMENT

4.01 A so-called ROUTINE ADJUSTMENT as described in 4.02 through 4.09, should be performed approximately once a week unless experience indicates that the intervals may be longer. This adjustment should also be made if the downward-pointing pips indicate more than 2 or 3 per cent distortion with input signals known to be of better quality; except that if 20 per cent distortion is indicated, the set should receive complete adjustment or maintenance referred to in Part 6 of this section.

4.02 In making this ROUTINE ADJUSTMENT, signal sources should be used as follows in descending order of preference:

(1) 1A teletypewriter test set, sending a standard test message. For highest precision the set should have a new unworn face and new sharply cut woven-wire brushes.

(2) 100A teletypewriter test distributor, sending first repeated LTRS and then repeated BLANKS to refine the tuning. The wire brushes of the teletypewriter test distributor should be new and sharply cut to insure the precision of the calibration.

(3) 110A1 automatic multiple sender, 110B1 automatic multiple sender, or 110C1 multiple sender, in each case using a transmitter-distributor which does not have a clutch.

(4) 14-type transmitter-distributor. These signals are only reliable if the transmitter-distributor is in good condition and properly adjusted. Otherwise, clutch slippage will cause serious speed error.

(5) Signals obtained from a distant office, transmitted over a carrier facility. The distant office must use one of the approved sources.

(6) Effective polar signals obtained from an approved source transmitted over a dc facility of not over 10 miles of 19-gauge cable. The use of a poorer facility (such as a longer dc loop) might introduce fortuitous distortion, and the downward-pointing pips would jitter, affecting the

accuracy of the set. In this case at least 10 seconds would be required for every observation while tuning to obtain the smallest amount of scattering of the downward-pointing pips.

(7) A keyboard sending repeated SPACE signals may be used as a last resort; but the indications may be in error by as much as 5 per cent distortion.

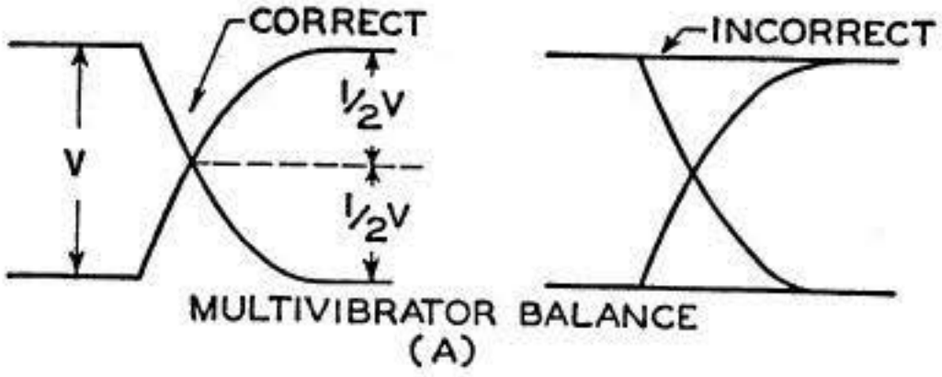
4.03 Connect to power as described in Part 5 of this section.

4.04 Connect to signal source as described in Part 5 of this section. Set the LOOP switch at 60, 20, or POL for 0.060-ampere neutral, 0.020-ampere neutral, or polar signals, to agree with loop current. Set DISPLAY switch at PIP. Set SPEED switch to agree with signals. Set CODE on 5 or 6 depending on type of signals.

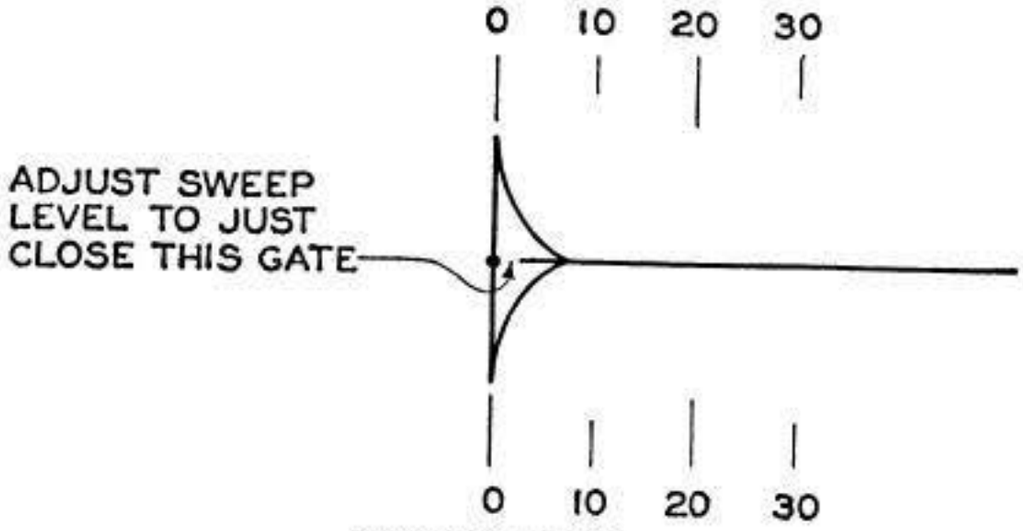
4.05 If necessary, adjust FOCUS, INTENSITY, and V CENTER to suit.

4.06 Adjust H CENTER so that the trace starts at 0 position.

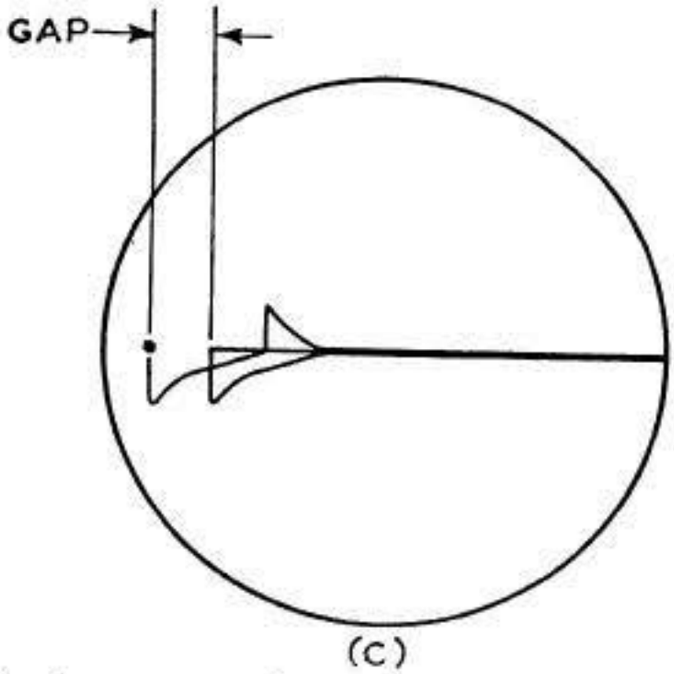
4.07 Adjust SWEEP LEVEL as indicated in Fig. 7(B) and 7(C).



MULTIVIBRATOR BALANCE
(A)



SWEEP LEVEL
(B)



(C)

NOTE: Fig. 7(C) shows gap in trace when sweep level is slightly too far to right. Reduce this gap just to zero, but do not turn sweep level control any farther to left than necessary.

Fig. 7—Calibration Displays

4.08 Adjust SWEEP AMP so that the trace ends at 50. Check that the SWEEP LEVEL adjustment has not changed.

4.09 Adjust FINE SPEED so that the downward-pointing pips are all as near 0 as possible, and barely beginning to turn around so that a small loop is formed at their tips. (See Fig. 8.) If repeated characters such as those from a 100A teletypewriter test distributor are being used, this final tuning should be done with repeated BLANKS. However, if the correct setting of FINE SPEED is more than one-quarter turn off center, it is possible that all speeds require readjustment. This should be done at an early opportunity as described for PRIMARY ADJUSTMENT which follows. In ROUTINE ADJUSTMENT, the CHAR, MV BAL, BIAS, and COARSE SPEED controls should not be disturbed.

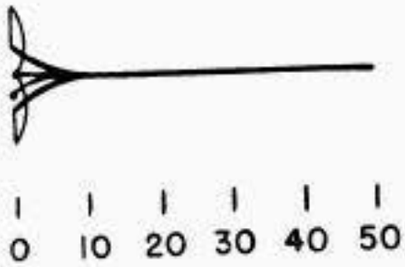


Fig. 8—Correctly Adjusted Sweep

4.10 A so-called PRIMARY ADJUSTMENT as described in 4.11 through 4.31 should be made when the set is first put into service, when any tubes are replaced, or after the set has been out of use for about a month. However, such an adjustment should not ordinarily be required oftener than every three months, or longer if experience so indicates. This adjustment has to be made where a source of undistorted signals, a dummy loop, and preferably a cathode-ray oscilloscope equivalent to the Du Mont 208 or 304 type are available. If an oscilloscope is not available, see 4.18, Note 2.

4.11 Signal sources as previously listed for ROUTINE ADJUSTMENT should be used.

4.12 Set the switches as follows:

LOOP on ADJ

DISPLAY on PIP

SPEED to agree with the signals

CODE on 5 or 6 depending on the type of signals to be used for calibration.

Set all controls in the center of their range of rotation.

4.13 Release the four large screws which are located near the ends of the handles. Remove the set chassis from the case and place it on an ungrounded framework with the electron tubes uppermost. Connect the vertical input (Y axis) of a cathode-ray oscilloscope to the MV BAL and NEUT pin jacks (located near the right rear of the chassis) with the NEUT pin jack connected to the return side of the oscilloscope input circuit.

Caution: For this test the oscilloscope input and chassis must be isolated from building ground.

4.14 Connect to power as described in Part 5 of this section.

Caution: Every precaution should be observed to avoid contact with circuit elements or terminals other than as specified.

4.15 After a few minutes warmup, adjust FOCUS, INTENSITY, V CENTER, and H CENTER controls to give a small fluorescent spot on the face of the cathode-ray tube at about the vertical center and at approximately 10 on the horizontal scale.

4.16 Slowly rotate the BIAS control until the spot moves intermittently back and forth across the face of the tube to form a horizontal line. Each time the BIAS control is moved back and forth through this point, one or more sweeps should appear. This point is the final setting, but an error of one-tenth turn would not be important.

Note: A small vertical display may be superimposed on the horizontal line.

4.17 Operate the DISPLAY switch to CAL.

4.18 Arrange the test oscilloscope for internal horizontal sweep with synchronizing control on 0, and carefully adjust the speed of the sweep so that the pattern is stationary with each downward transition of the trace crossed by an upward transition as shown in Fig. 7(A). The speed of the sweep should be slow enough so that only one transition region appears in the pattern. With an insulated screwdriver carefully adjust the MV BAL control until the region of intersection appears as an "X" with the point of intersection of the two branches of the "X" halfway between the upper and lower horizontal lines of the oscilloscope pattern. This adjustment balances the output of the multivibrator element timing tube.

Note 1: If the set is to be tuned at all three speeds, adjust MV BAL with the SPEED switch at 75.

Note 2: A major readjustment of the MV BAL control will be necessary only after changing tube V3. If tube V3 has not been changed and an oscilloscope is not

available, do not touch the MV BAL adjustment. Continue the PRIMARY ADJUSTMENT. If tube V3 has been changed and an oscilloscope is not available, set MV BAL at the center of its range. This will put the MV BAL control close enough to its correct setting so that the accuracy of the 164C1 set will not be seriously impaired.

4.19 Operate the power switch on the 164 set to OFF. Remove the test connections to the oscilloscope. Restore the chassis to the case, fastening the four mounting screws securely. Operate the power switch to ON.

4.20 Connect a resistance dummy loop, 0.020 ampere or 0.0625 ampere, to the INPUT jack with negative on the tip of the jack. This polarity is referred to as the normal connection. Set the LOOP switch to 20 or 60 (depending on the marking loop current and type of signal), the DISPLAY switch on PIP, and the SPEED on the speed of signal used.

4.21 Proceed with rough adjustment as follows:

4.22 Impress test signals on the loop.

4.23 Disregarding the pips adjust SWEEP LEVEL so that the horizontal trace almost touches the bright spot on the left.

4.24 With the COARSE SPEED control, bring all pips somewhere near the 0 end of the scale. If this cannot be done, try a different setting of the CHAR control and repeat COARSE SPEED adjustment. If repeated characters, such as those from a 100A teletypewriter test distributor, are being used for tuning, first tune with repeated LTRS. Then sharpen this tuning while sending a repeated BLANK.

Note: If it is not possible to bring all pips near scale 0, replace tube V3 with another 12AU7 and repeat 4.17 through 4.24. Refer to 4.30.

4.25 When the pips are stable, and near scale 0, the CHAR control should be rotated clockwise until pips begin to appear at higher scale readings (30 to 40 per cent). Back off one-third turn counterclockwise from this point. If pips do not appear at the higher readings set the control one-third turn from the clockwise stop.

4.26 The set is now ready for a more careful final adjustment.

4.27 Rotate the SWEEP LEVEL control until the left end of the horizontal sweep line appears to separate from the bright spot at the left, as shown in Fig. 7(C). Reverse the

direction of rotation until this gap just closes, as shown in Fig. 7(B). The bright spot appears slightly downward from the rest of the sweeps.

4.28 Adjust the SWEEP AMP and H CENTER controls to make the horizontal trace extend from 0 to 50 on the scale.

4.29 Verify that the FINE SPEED control is at the middle of its range. (This will minimize the amount of readjustment required when changing speeds.) Adjust the 60-, 75-, or 100-COARSE SPEED control (depending on the speed of signal being used for calibration) until the downward vertical deflections (PIPS) of the trace all occur as near as possible to scale 0. For greatest accuracy the downward pips should barely turn around near scale 0, forming a small loop at their tips. (See Fig. 8.) If a 1A teletypewriter test set is used (with new face and sharply cut brushes), the upward pips as well as the downward pips should be observed in tuning. If repeated characters such as those from a 100A teletypewriter test distributor are being used, this final tuning should be done with repeated BLANKS.

4.30 Without touching the FINE SPEED control (which should be left in its center), repeat 4.29 for every speed of teletypewriter signal in use in the area, using appropriate signals and settings of the COARSE SPEED control.

(1) Because of the high value of resistances used in tube V3 grid circuits, extremely minute gas concentrations in the tube can adversely affect its operation as a multivibrator. The presence of these small quantities of gas cannot be detected by conventional tube checkers. In some cases it may be impossible to tune the 164C1 set at one or more of the teletypewriter speeds. When this occurs, tube V3 should be replaced with another 12AU7 and 4.09 through 4.30 repeated.

(2) Care should be taken so that the SWEEP LEVEL adjustment is correct at all three teletypewriter speeds. Ordinarily the adjustment will be correct at the other two speeds after being set at any given speed. However, for a small percentage of the 12AU7 tubes used for V3, this will not be true. The presence of such a tube may be detected in the following manner:

(a) After the set has been tuned, preferably at all three speeds, impress 60-speed signals on the loop and adjust the SWEEP LEVEL as in 4.27.

(b) Impress higher speed signals on the loop and operate the SPEED switch to match them. Ideally,

no gap should develop at the left end of the sweep. (Refer to Fig. 7C.) However, a gap length of 2 per cent distortion may occur and should be corrected, using the SWEEP LEVEL. This effect is most noticeable when switching from 60 speed to 100 speed.

(c) If a gap of more than 2 per cent distortion develops, tube V3 should be replaced and 4.17 through 4.30 repeated.

(3) Because of the phenomena described in (1) and (2), some selection of tube V3 is required. Roughly 10 per cent of the tubes tried must be rejected.

4.31 Character timer adjustments should be made at 75 wpm if signals of this speed in 5-unit code are available (66 wpm for 6-unit code).

(1) **5-unit Code:** With a source of 5-unit code calibrating signals connected to the INPUT jack, operate the CODE switch to 5 and, starting from the fully counterclockwise position, rotate the CHAR control clockwise until some of the vertical deflections begin to appear to the right on the scale. Set the CHAR control one-third turn counterclockwise from this position. If deflections do not appear at the right of the scale, set the CHAR control one-third turn counterclockwise from the clockwise stop.

(2) **6-unit Code:** With a source of 6-unit code calibrating signals connected to the INPUT jack, operate the CODE switch to 6. Starting from the fully counterclockwise position, rotate the CHAR control clockwise until vertical deflections begin to appear to the right on the scale. Set the CHAR control one-third turn counterclockwise from this position.

(3) The one-third turn mentioned in (1) and (2) above is important. If in attempting to do this the CHAR control reaches its counterclockwise stop before completing the one-third turn, refer to MAINTENANCE.

(4) Where practicable a final check of the CHAR control should be made as follows. Using a dummy circuit to connect a 119C1 telegraph signal distorting set to the 164C1 set, send switched bias signals, signals with switched end-distortion, and signals with switched-combination distortion, all of 35 per cent distortion, into the 164C1 set. No loss of synchronism should occur. Such loss would be indicated by pips above 39 per cent distortion.

4.32 If difficulty is experienced in meeting the requirements for primary calibration, the maintenance test procedures referred to in Part 6 of this section should be applied.

5. USE

5.01 **Connect the power cord to a properly grounded 3-wire receptacle source of 115-volt, 60-cycle ac. If only a 2-wire receptacle is available, make connection by means of an adapter, such as the Hubbell 5273-L adapter, between the receptacle and the power plug. The auxiliary lead from this adapter should be connected to a reliable ground source for safety. Operate the power switch to ON and allow the set to warm up for one minute.**

5.02 Except when measuring in circuits using 43A1 carrier telegraph terminal equipment, connect INPUT jack to loop in which measurements are to be made, using a 2-conductor patching cord or other suitable means. Set the LOOP switch at 60, 20, or POL for 0.060-ampere neutral, 0.020-ampere neutral, or polar signals, to agree with loop current. Set SPEED switch to agree with loop signaling speed. Set CODE switch at 5 or 6 depending on whether the signals are in 5-unit or 6-unit code.

5.03 While signals are being received, adjust H CENTER and SWEEP AMP until the trace extends from 0 to 50 on the scale. Adjust the SWEEP LEVEL as in Fig. 7(B) and 7(C). For greatest accuracy SWEEP LEVEL and SWEEP AMP controls should be checked each time the SPEED switch is changed. The amount of readjustment, if any, should be very small.

5.04 Set the DISPLAY switch at PIP or PK depending on whether continuous or peak display of signal distortion is desired. The difference between these two kinds of display is described in Part 1 of this section which also points out the sort of information that may be obtained from each display. Read the distortion at the apex or point of the pips, not at their tail end; and at the center of the peak display bright spot.

5.05 When the telegraph loop is on a continuous mark or space, there will be no sweep across the face of the cathode-ray tube. If the loop is marking there will be a small bright dot at scale 0; if the loop is spacing the dot will be near scale 10. Because in either case the dot is deflected downward by a small amount from the path of the sweep, any burning of the screen by the spot is not important. However, if it is desired to remove the spot from the tube face, operate the DISPLAY switch to PEAK and momentarily depress the RESET button. This will move the spot to the left and off-screen. The spot can be returned to the face of the cathode-ray tube by operating the DISPLAY switch back to PIP. If keying of the loop is resumed after the spot has been moved off the screen face, the spot with a superimposed vertical line will reappear at the value of the peak distortion in the signal.

5.06 As noted in preceding paragraphs, the front panel and outer case of the set are held at building ground potential by a connection through the power cord, while the inner chassis and the return side (circuit neutral) of the measuring circuit are directly connected to the loop in which measurements are being made. The unavoidable couplings between the measuring circuit and the grounded outer case provide longitudinal paths by which voltage changes due to signaling in the loop may produce extraneous voltage impulses of various magnitudes and phases in different portions of the measuring circuit. Under certain conditions, particularly when the measuring circuit is connected in series with a resistive loop at a point which is electrically near a ±130-volt source of signals, the extraneous impulses may become visible as additional traces or "tails" associated with the distortion display.

5.07 The extraneous effects referred to in the preceding paragraph do not reduce the accuracy of the normal distortion indication, but may be somewhat objectionable from the standpoint of observation. For this reason the measuring circuit should be connected into a resistive loop at a point near ground potential whenever possible. When the transmission circuit contains even a 1/4-mile length of cable between the source of signals and the measuring circuit, the transient voltages due to signaling in the loop are sufficiently attenuated by the shunt capacitances of the cable so that the extraneous traces do not appear.

5.08 An external oscilloscope for large-scale display of distortion indications cannot be used with the modified sets.

5.09 To measure signals from the subscriber in the send loop of a 43A1 channel terminal, set LOOP switch at 60, check that there is no plug in the 164C1 INPUT jack, and use← the pin-type patching cord available for this purpose, or make← the following patches, using pin plugs:

MD of 43A1 to 43A of 164C

C of 43A1 to NEUT of 164C

P3 of 164C to P4 of 164C

Note: P3 was designated H-AMP, and P4 designated H in the unmodified sets.

5.10 Do not operate the set on top of cabinets or apparatus which feel warm, since the set is sensitive to temperature rise.

6. MAINTENANCE

6.01 If more extensive adjustment or maintenance is required than that described in Part 4 of the present section, the provisions of BSP E45.438 as given under MAINTENANCE TESTING should be followed.

7. REFERENCE TO BELL SYSTEM PRACTICES

7.01 The following BSPs contain information applicable to Section P31.405:

Title	Section
TTY Stations—Orientation and Distortion Tests...	P30.002
General Requirements and Procedures	P30.012
Tools and Maintenance Supplies	P30.301
100A Teletypewriter Test Distributor	P31.402
1A Teletypewriter Test Set	P31.403, P31.404
110A1 Automatic Multiple Sender	E45.414
110B1 Automatic Multiple Sender	E45.415
110C1 Multiple Sender	E45.413
164C1 Telegraph Transmission Measuring Set.....	E45.438 and AA282.818
Installation of TP106244 Resistor	P31.163
14-type Transmitter-Distributor	P35.102