164C3 AND 164C4 TELEGRAPH TRANSMISSION MEASURING SETS DESCRIPTION

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1. GENERAL

1.01 The 164C3 and 164C4 telegraph transmission measuring sets are portable instruments for measuring distortion in start-stop telegraph signals. The upper limit of capability of these sets is 750 dot cycles, or signal elements of 0.67 millisecond duration.

1.02 The 164C3 and 164C4 sets will measure teletypewriter signals in several combinations of character speed and number of elements per character. These combinations and their applications are tabulated in Table A. The 6-element code is used by teletypesetter machines. The length in milliseconds of each element or level in the 6-element code is the same as in the 5-element code. This is seen in the second column of the table. The number of words per minute rate, then, is necessarily substantially lower than the nominal rate shown by the position of the SPEED switch, as comparison of the first and fifth columns will reveal. Teletypesetter machines are operated at 53 and 66 words per minute only. An early 8-element code also used the same element length as the 5- and 6-element codes. A later 8-element code that actually operates at 100 words per minute has been accepted by the American Standards Association as standard for information interchange. Its element length is shorter than the 5-element code. Teletypewriter signal characteristics are also expressed in bauds, or bits (binary digits) per second. This is noted in the third column of the table.

TABLE A — 164 Set Capabilities and Code Information

SPEED SWITCH POSITION, NOMINAL WORDS PER MINUTE	UNIT ELEMENT LENGTH IN MILLISECONDS	BAUDS, OR BITS PER SECOND	CODE SWITCH POSITION, CODE ELEMENTS OR LEVELS PER CHARACTER	ACTUAL WPM	AVAILABLE ON	APPLICATION
60	22.0	45.5	5	61.4	Both	3-Row TTY
60	22.0	45.5	6	52.9	Both	Teletypesetter
60	22.0	45.5	8	43.7	164C3	—
75	17.6	56.8	5	76.6	Both	3-Row TTY
75	17.6	56.8	6	66.0	Both	Teletypesetter
75	17.6	56.8	8	54.5	164C3	—
100	13.5	74.2	5	100.0	Both	3-Row TTY
100	13.5	74.2	6	88.1	Both	—
100	13.5	74.2	8	71.2	164C3	—
100/8	9.1	110.0	8/100	100.0	164C4	4-Row TTY (ASA Standard)
200	6.8	148.4	5	200.0	164C3	5-Element Reperforator-Transmitter
200	6.8	148.4	6	176.2	164C3	—
200	6.8	148.4	8	142.4	164C3	—

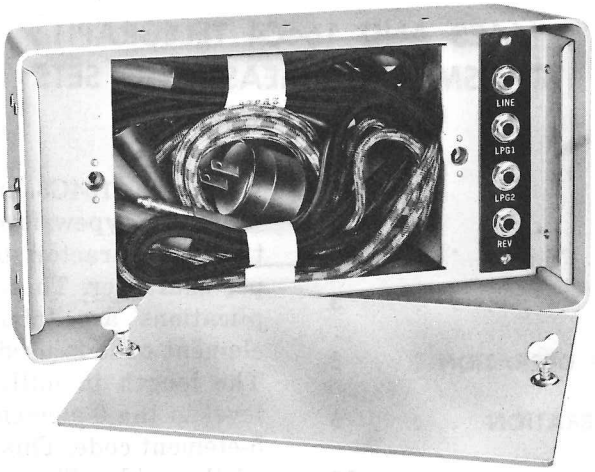


Fig. 1(a)

Fig. 1(b)

Fig. 1 – General View of Set With Cover and Cords

2. PHYSICAL DESCRIPTION

2.01 The outside dimensions of the 164C3 and 164C4 sets, excluding hardware, are approximately 11-3/4 inches wide, 5-3/4 inches high, and 13 inches deep. They weigh about 10 pounds, including the cover.

2.02 The ac power cord of each set terminates in a 3-conductor safety ground plug. This requires the use of a power plug adapter when the ac supply is available only at 2-conductor parallel-slot receptacles. A Hubbell adapter is provided for this purpose. The power cord is detachable from the face panel.

2.03 There are five different patch cords which may be used with these sets under various conditions. There is also an optional set of jacks mounted on the cover of each set which facilitates the use of the sets at a station equipped with a "red" jack. The tabulation in Fig. 17 outlines the uses of the various cords and jacks.

2.04 A compartment in the cover of each set provides space for storage of the power cord, power plug adapter, and patch cords.

2.05 CD-70886-01 gives detailed descriptions of the various circuits of the sets and their operation. It describes their applications, describes briefly their operating principles, and provides connecting information.

2.06 The faceplate engravings of the 164C3 and 164C4 sets are the same except for the extreme clockwise position of the SPEED and CODE switches. At this position the SPEED switch of the 164C3 set is engraved 200 and the CODE switch 8. The SPEED switch of the 164C4 set is engraved 100/8 and the CODE switch 8/100

3. GENERAL DESCRIPTION OF OPERATION

3.01 The following definitions are given for terms used in this section. (See Fig. 2 for illustrations.)

(a) ***Bias*** is a uniform displacement of space-to-mark signal element transitions from their proper positions in relation to the beginning of the start pulse.

(b) ***Marking bias*** is a displacement of the space-to-mark transitions so that they occur before their proper positions.

(c) ***Spacing bias*** is a displacement of the space-to-mark transitions so that they occur after their proper positions.

(d) ***End distortion*** is a uniform displacement of the mark-to-space signal element transitions from their proper positions in relation to the beginning of the start pulse.

(e) ***Marking and spacing end distortion*** are displacements of the mark-to-space transitions so that they occur later and earlier, respectively, than their proper positions.

(f) ***Fortuitous distortion*** is a random distortion of signals such as that commonly produced by interference.

(g) ***Peak distortion*** is the largest ***total*** distortion of signals noted during a period of observation.

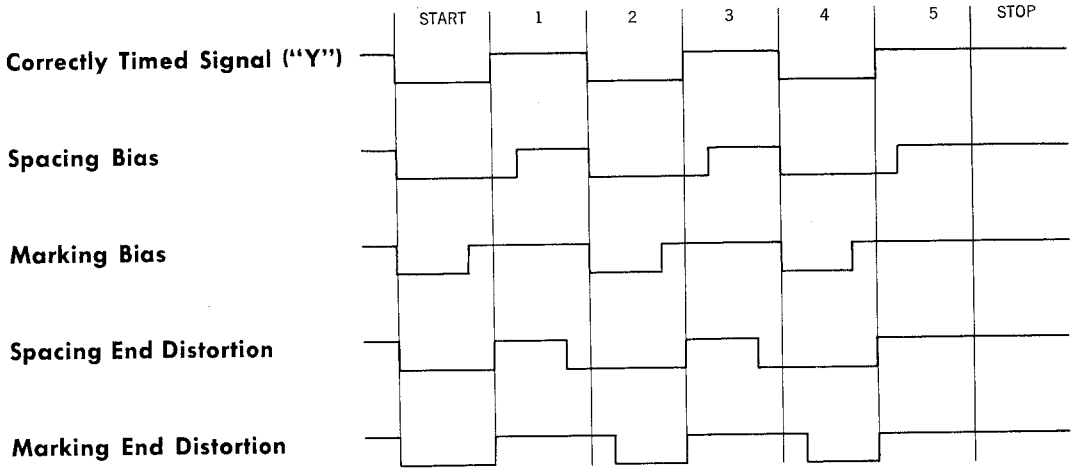


Fig. 2 – Bias and End Distortion

3.02 The 164C3 and 164C4 sets present their distortion indications as displays on the face of a cathode ray tube on which is etched a scale. There are two different types of display, the choice of which is controlled by the DISPLAY switch. The PK position of the switch gives a display which indicates the peak value of distortion during the period of observation. The PIP setting of the switch produces a display which indicates the amount of distortion occurring in every signal element. It also indicates whether the distortion observed is bias or end distortion.

3.03 For the PIP type of display, the internal circuits of the sets produce a sweep voltage which is applied to the plates causing horizontal deflection of the beam of the cathode ray tube. This sweep is triggered by the leading edge of the start element of the external signal being measured. The voltage which causes the beam to "sweep" has an isosceles shape, which causes the spot on the tube face to move from left to right and then from right to left, with uniform velocity during both directions of travel. The period of a full cycle is equal to that of a unit length element for the signal speed to be measured. Thus, the left end of the horizontal trace occurs at times corresponding to both the beginning and end of the period of a correctly timed signal element. See Fig. 3. The right end of the trace occurs at the center point of the period of a perfectly timed element. It, therefore, corresponds to a scale value of 50 per cent. The sweep circuit oscillates for a given number of cycles which is determined by the setting of the CODE switch on the face of the set: six cycles (start plus five code elements) for 5-level codes, and seven cycles (start plus six code elements) for 6-level codes. With the CODE switch in the 8- or 8/100-position, the sweep circuit oscillates for nine cycles (start plus eight code elements). In all cases the sweep circuit stops oscillating shortly after the beginning of the stop pulse.

3.04 The internal circuits of the sets produce other voltages from the signals which are being measured, and these voltages are applied to the plates of the cathode ray tube causing vertical deflection of the beam. These voltages are impulses or pips which occur at times corresponding to those at which a relay would operate and release when driven by the signal. For square signals these points correspond in time to the signal transitions. For rounded signals, they correspond to points representing relay operate values, as shown in Fig. 3. The displacement of these points above and below the nominal operate value of relay current is provided to take account of hysteresis, or magnetic lag, of normal relays. Thus the 164 sets respond to signals in the same manner as any telegraph signal receiver which has an input relay. The voltage pips produced on the face of the cathode ray tube are

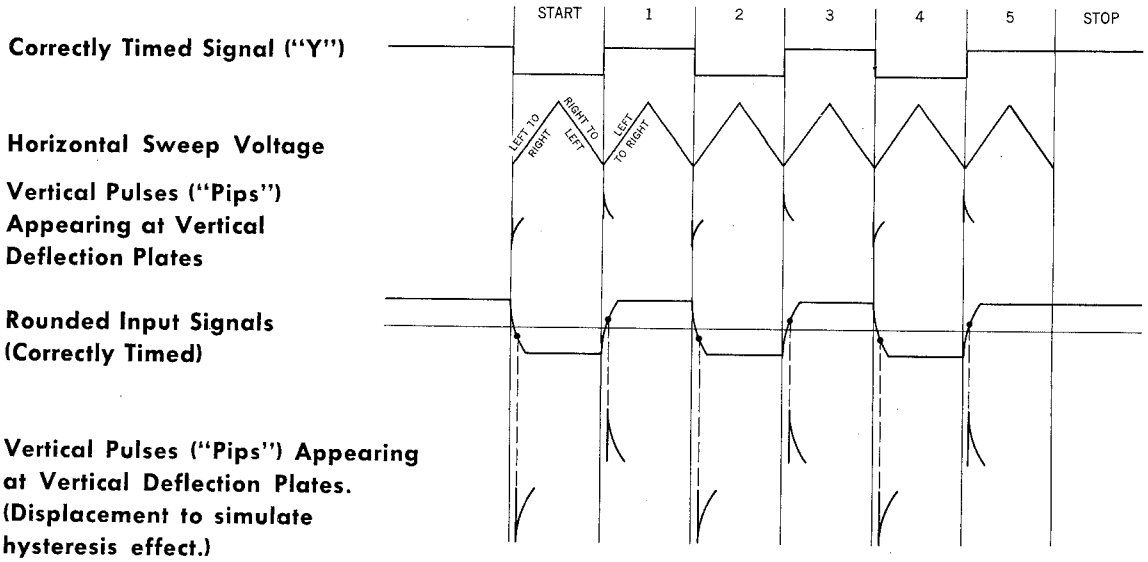


Fig. 3 – Time Relations of Signal, Horizontal Sweep, and Vertical Pulses

upward for space-to-mark transitions and downward for mark-to-space transitions. The impulses or voltage pips consist of a steep wave front followed by a slower return, or tail. If distortion causes the signal transition(s) to occur at times other than integral multiples of the pulse period as measured from the leading edge of the start pulse, then the pips which correspond to the input signal transitions will not occur at the left, or zero, end of the trace. They will appear somewhere to the right of that point, and the scale indicates the percentage displacement of a unit pulse length.

3.05 From the preceding paragraph and the definitions in 3.01 it can be seen that:

(a) Bias is indicated by the upward pips on the screen.

(b) End distortion is indicated by the downward pips.

Fig. 4 and 5 illustrate the relations of bias, end distortion, the horizontal sweep, and corresponding tube displays.

4. PRIMARY OR BASIC CALIBRATION

4.01 The primary calibration should be performed ***only*** when electron tubes have been changed, or the set has not been used for a long period of time, such as six months. It should ***not*** be performed on new sets since the factory calibrates all sets before shipment.

4.02 The primary calibration requires the following auxiliary equipment.

(a) A 1A teletypewriter test set or a 100A teletypewriter test distributor, either of which must be in good adjustment, for 5-element code calibration, or

(b) A 1B teletypewriter test set, which must be in good adjustment, for calibrating 8-element ASA codes on the 164C4 sets, or

(c) A suitable source of 6-element code signals.

(d) A dummy loop, either 62.5 ma or 20 ma.

(e) A cathode-ray oscilloscope.

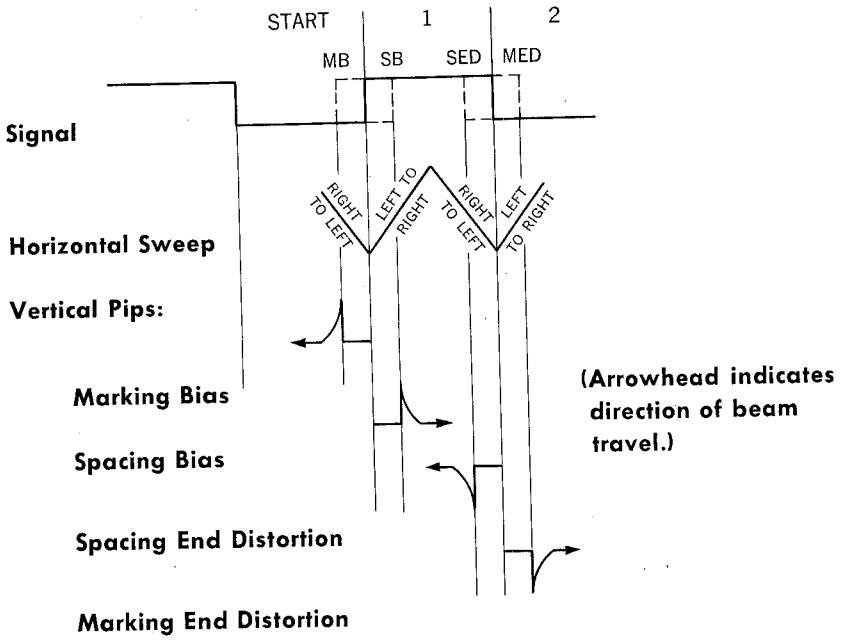


Fig. 4 – Pulses (or Pips) Caused by Different Types of Distortion

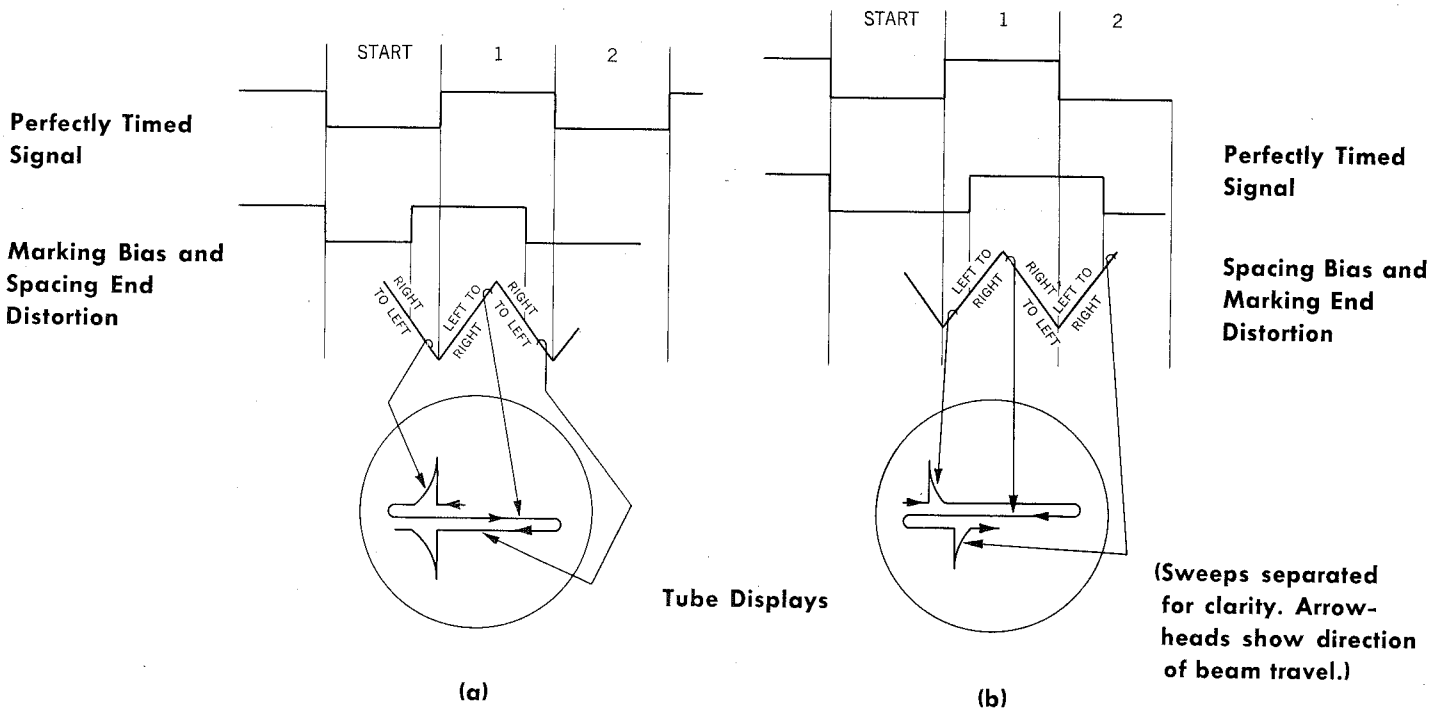


Fig. 5 – Relation of Input Signals, Sweep Voltage, and CR Tube Display

4.03 The primary calibration includes these operations.

(a) Adjustment of BIAS control so that the input amplifier will not introduce bias or distortion into the measured signal (4.08).

(b) Adjustment of the MV BAL control so that the two halves of the multivibrator waveform will be symmetrical (4.09 through 4.11).

(c) Adjustment of SWEEP LEVEL control to insure that all sweeps occurring during one character will start at the 0 scale point (4.14, 4.17, and 4.21).

(d) Adjustment of the ELEMENT control so that the period of the horizontal sweep will equal the duration of a unit pulse (element) for the speed of signals for which the set is being calibrated (4.15 and 4.18).

(e) Adjustment of the CHARACTER control so that the character timing of the set will equal that of the signals for which the set is being calibrated (4.16).

(f) Adjustment of the HOR CENTER and SWEEP AM controls so that the trace will extend from 0 to 50 on the scale (4.19 and 4.20).

Procedure

4.04 Remove the four large screws which hold the chassis in the case. See Fig. 1. Remove the chassis from the case and place it on an ***ungrounded*** support with the electron tubes up. The chassis is "hot" or off ground potential when power is on.

4.05 Set the controls as follows. (See Fig. 7.)

LOOP on ADJ

DISPLAY on PIP

SPEED on the desired speed

CODE on 5, 6, 8, or 8/100, depending on the type of signals to be used for calibration.

SWEEP AM, SWEEP LEVEL, BIAS, and all other controls in the center of their mechanical ranges.

4.06 Connect the power cord to a 115-volt, 60-cycle ac source terminated on a 3-wire safety ground outlet. If only a 2-wire outlet is available, use the 3-wire-to-2-wire adapter provided and connect the ground wire on the adapter to building ground.

Caution: Potentials as high as 800 volts are present in the set. Use care to see that test probes or leads contact only those circuit points specified.

Operate the power switch to ON.

4.07 After a one-minute warmup, adjust the FOCUS, INTENSITY, V-CENTER, and HOR CENTER controls to give a small fluorescent spot on the face of the cathode-ray tube. See Fig. 6 and 7 for locations of controls. Position the spot so that it is centered from top to bottom and at about 10 on the scale horizontally.

4.08 Slowly rotate the BIAS control until a position can be found which causes the spot to move back and forth across the face of the tube to form a horizontal line. Each time the BIAS control is moved through this position, a horizontal sweep should appear. Leave the control set as nearly as possible at this critical point. A margin of one-tenth of a turn is tolerable.

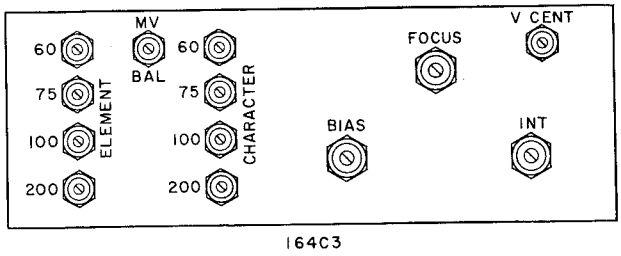
Note: A small vertical display may appear on the horizontal line. Disregard it.

4.09 Operate the power switch to OFF. Connect the vertical input (Y axis) of a cathode-ray oscilloscope to the MV BAL and NEUT test pin jacks. See Fig. 7 and 8. See that the NEUT jack connects to the return or ground side of the CRO input.

Note: The ground side of the CRO input should not be connected to ground. This means that the CRO should not be resting on a grounded support, nor should a third wire in its power cord be grounded. The frames of the CRO and the 164 set are tied together electrically by the above NEUT jack connection. They will both be off ground potential.

4.10 Operate the power switch to ON. After a one-minute warmup, operate the DISPLAY switch to BEAM OFF.

4.11 Arrange the test oscilloscope so that the horizontal sweep is free running, without the use of sync or triggering. Carefully adjust the speed of its horizontal sweep to produce a



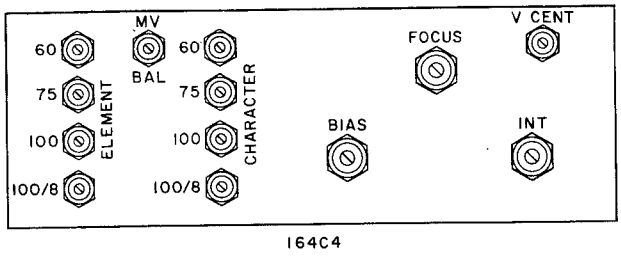


Fig. 6 – Calibration and Adjustment Potentiometers

Fig. 7(a)

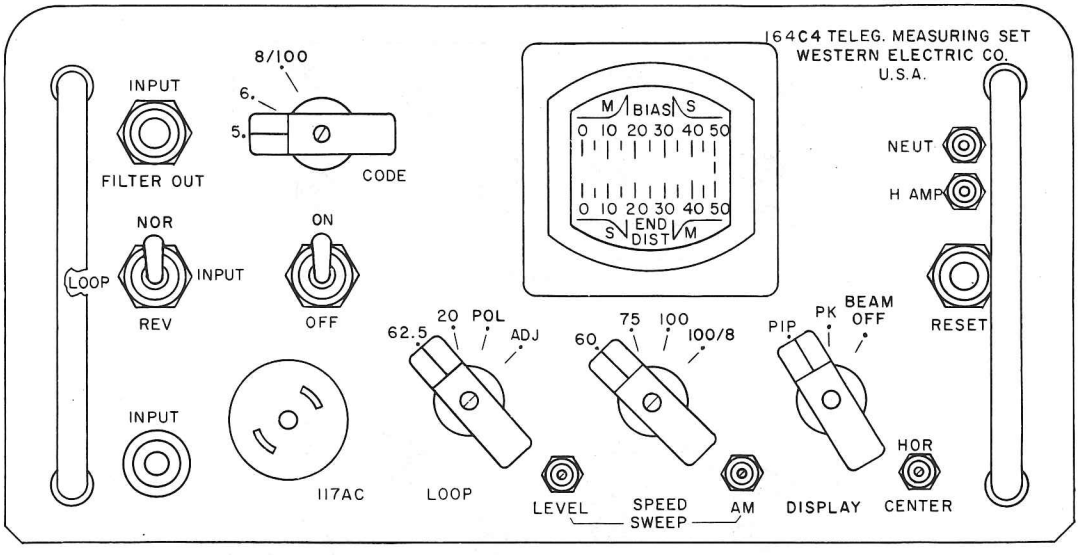


Fig. 7(b)

Fig. 7 – Face of Sets

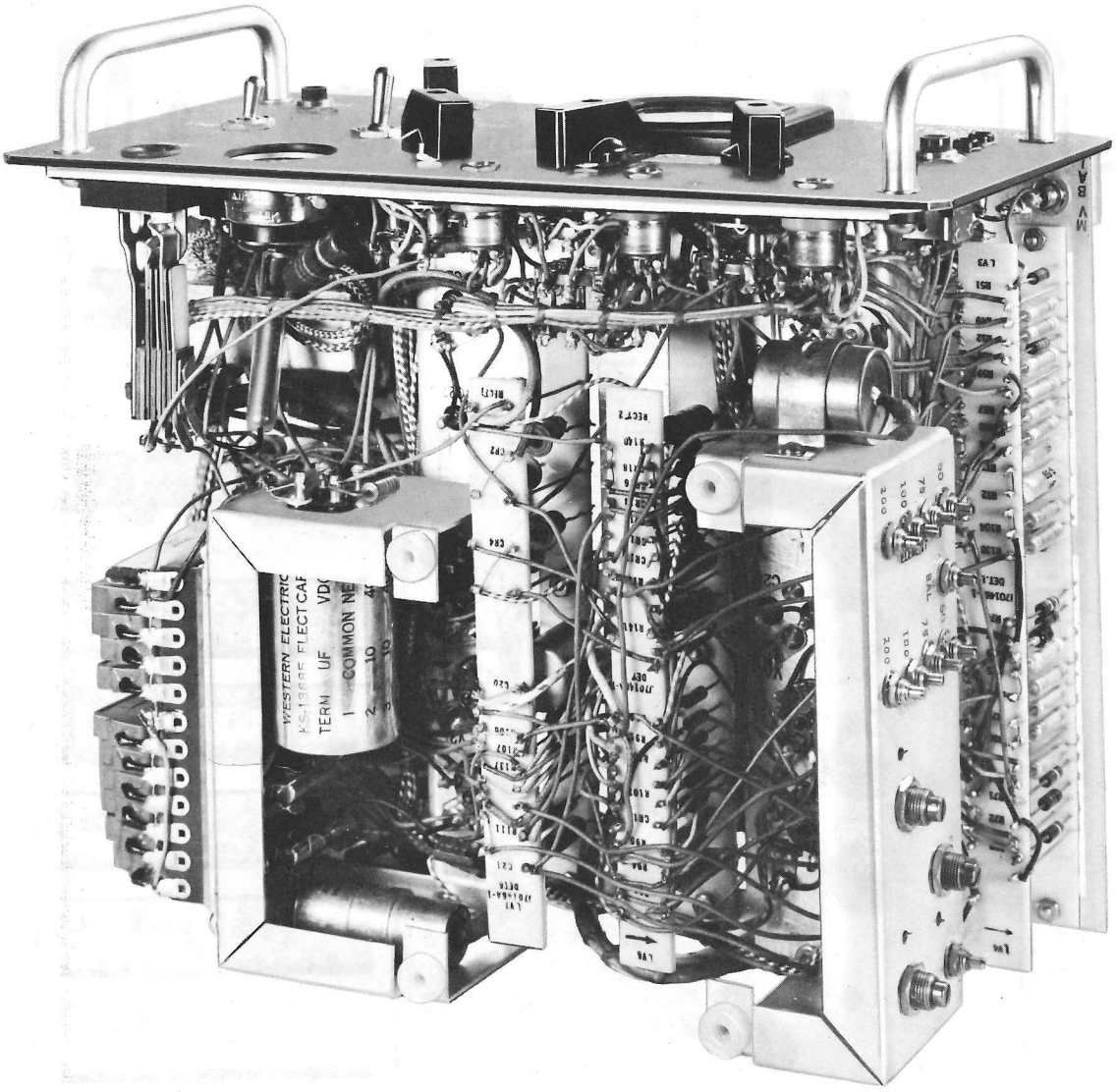


Fig. 8 – Plan View of Chassis

display corresponding approximately to that of Fig. 10, so that only a single transition region appears in the pattern. The intersection of the two traces should occur exactly midway between the upper and lower horizontal lines of the display. If not, ***use an insulated screwdriver*** to adjust the MV BAL control until a symmetrical pattern does occur. Then remove the test connections to the oscilloscope.

Note: The MV BAL control setting should be checked about every 6 months. It should also be checked whenever the V3 tube is changed.

4.12 Connect a source of undistorted test signals to a dummy loop. The 1A and 100A test sets provide 5-element 60-, 75-, or 100-speed signals, and the 1B set provides 8-element 100-speed signals. Use the 2P31A cord. See Fig. 11 and 17. Insert the 359A plug (shorter one) into the INPUT jack of the 164C3 or 164C4 set and then insert the 347A plug into the NORMAL jack of the dummy circuit. The polarity of the current in Fig. 11 is such that the NOR-REV switch should be set at NOR. If other circuit arrangements are used, set the NOR-REV switch on NOR if the voltage on the tip of the 359A

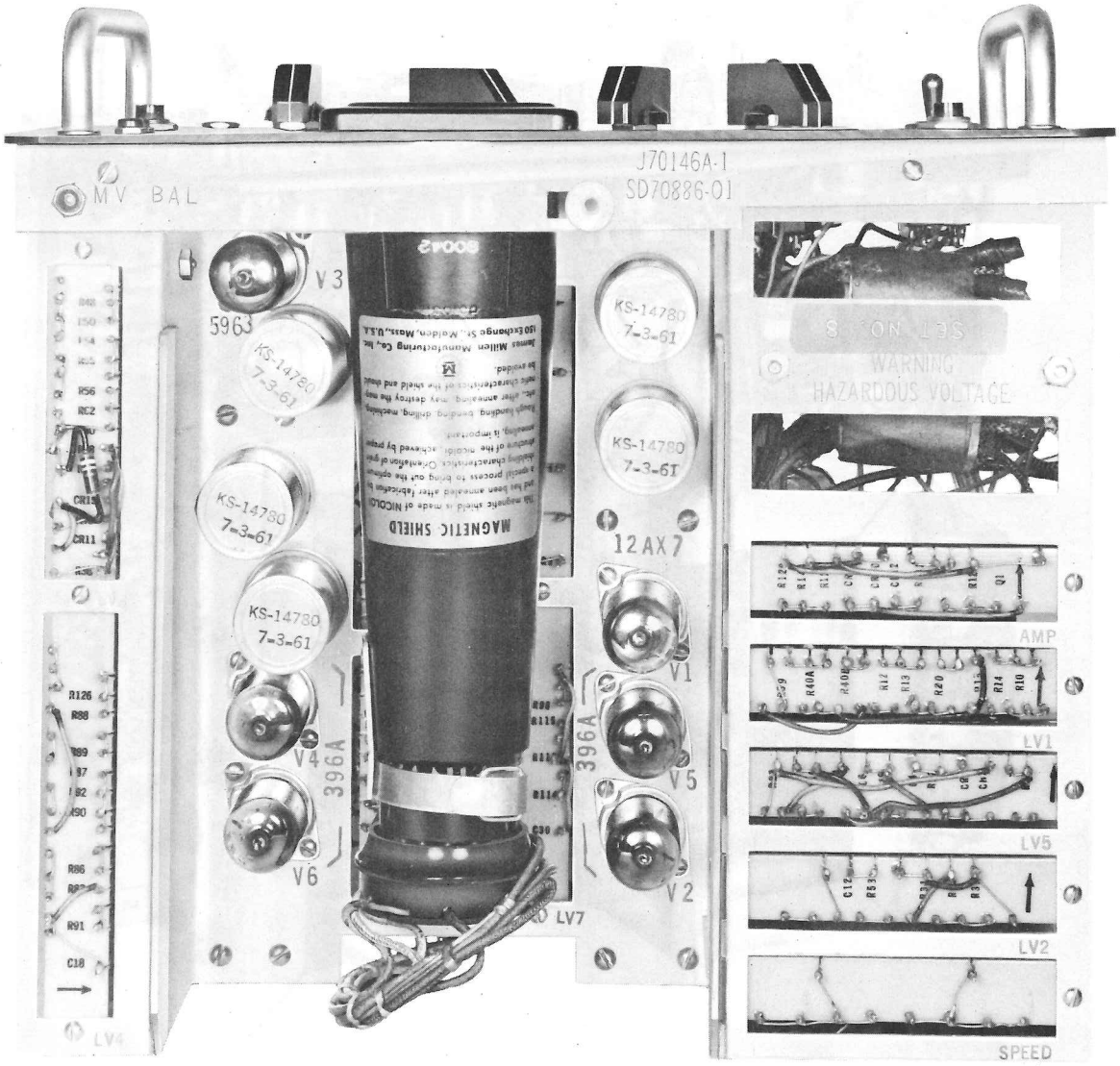


Fig. 9 – Top View of Chassis

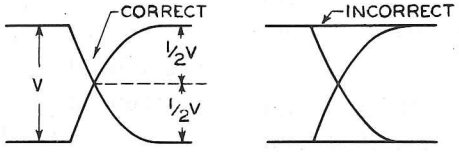


Fig. 10 – Adjustment of MV BAL Control

plug is positive and on REV if the voltage is negative. Set the LOOP switch to agree with the marking loop current. Set the SPEED switch to agree with that of the test signal source.

Note: If a 100A set is used with the 164C3 and 164C4 sets as a test signal source for 60, 75, or 100 speed, set it to send the letter "O" (SSSMM). For 200 speed on 164C3 sets use ***only*** a repeated 100 speed "M" (SSMMM). The first three spacing pulses (including the start pulse) are equal in time to six code pulses (including the start pulse) at 200 words per minute. The last four marking pulses (including the stop pulse) appear to the test set as a long stop pulse.

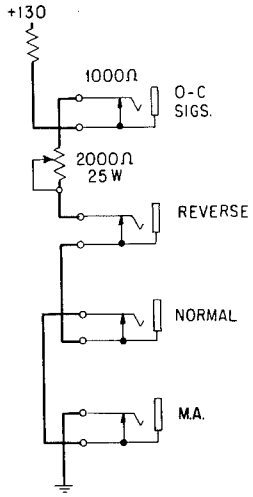


Fig. 11 – Dummy Loop

Coarse Element Adjustment

4.13 Move the DISPLAY switch to PIP, and the SPEED switch to agree with that of the test signals.

4.14 Disregard the signal pips appearing in the display and adjust the SWEEP LEVEL control so that there is a very small ***horizontal*** gap between the left end of the trace and the bright spot. See Fig. 12a.

4.15 Using the ELEMENT control which corresponds to the speed of the signals being used, try to bring all the pips to the zero end of the scale. If this cannot be done, change the setting of the CHARACTER control (for the appropriate speed) and try again. For 200 speed, use only the ***upward*** pips.

4.16 When the pips are stable and near zero on the scale, rotate the CHARACTER control clockwise until pips begin to appear upscale between 10 and 40 per cent. Then back off the CHARACTER control counterclockwise 1/3 turn from this point. If the CHARACTER control is turned all the way to the fully clockwise position and upscale pips still fail to appear, back off 1/3 turn from this point. For 200 speed, first calibrate the set at 100 speed. Then set the 200-speed CHARACTER control at the same physical angle as the 100-speed CHARACTER control.

Fine Element Adjustment

4.17 Rotate the SWEEP LEVEL control until the left end of the horizontal trace appears to separate from the bright spot at the left. See Fig. 12b or 12d. Reverse the direction of rotation ***until the gap is just short of closing.***

4.18 Adjust the appropriate ELEMENT control until the downward deflections of the trace all come as closely as possible to zero on the scale. For greatest accuracy the downward pips should just form small loops at zero on the scale. See Fig. 12c. For 200 speed use ***upward*** pips, only, and change the test character from repeated "M" to repeated "X" (MSMMM).

4.19 Adjust the HOR CENTER control so that the left end of the trace is at zero on the scale. This puts the bright spot just to the left of zero.

4.20 Adjust SWEEP AM control so that the right end of the trace extends to 50 on the scale.

4.21 Readjust the SWEEP LEVEL control as follows.

(a) Use the HOR CENTER control to move left end of trace to 5 on the scale for easier observation.

(b) Slowly rotate SWEEP LEVEL control clockwise until the left end of the trace moves about 1/8 inch away from the bright spot. See Fig. 12b or 12d.

(c) Slowly rotate SWEEP LEVEL control counterclockwise. Stop at the point where the horizontal gap is ***just short of closing.***

(d) Further counterclockwise rotation of the control will close the small gap and make the trace brighter. The correct setting is that which leaves the smallest possible horizontal gap between the left end of trace and the spot.

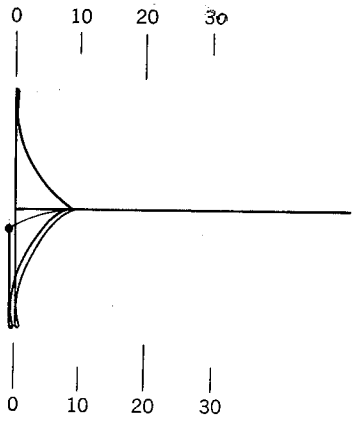
(e) Use the HOR CENTER control to restore the end of the trace to zero on the scale. Check again that the right end is at 50 on the scale, and readjust the SWEEP AM control if necessary.

4.22 Repeat the procedures in 4.10 through 4.18 for any other speeds at which it is desired to calibrate the set. Use test signals of appropriate speeds. The SWEEP AM and SWEEP LEVEL controls will require only minor readjustments.

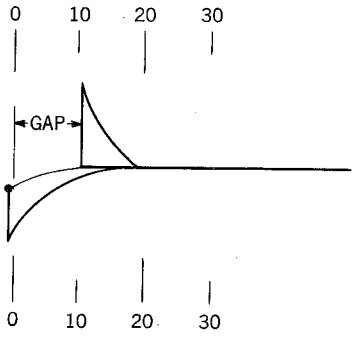
4.23 Operate the power switch to OFF. Disconnect the power cord. Restore the chassis to its case and fasten the four mounting screws securely.

5. ROUTINE CALIBRATION

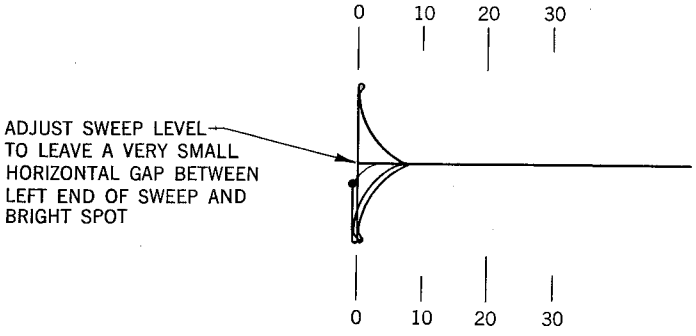
5.01 Connect the power cord of the 164C3 or 164C4 set to a source of 115 volts ac. If a 3-conductor receptacle is not available, use the Hubbell adapter, ***and be sure to connect the third wire to the building ground.***



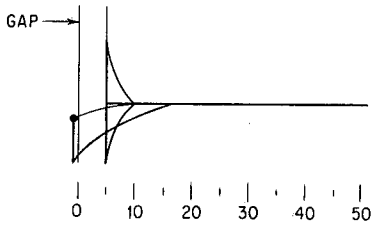
(a) Prior to "character" tuning other pips may appear upscale.



(b) Using two-transition character.



(c)



(d) Using miscellaneous signals.

Fig. 12 – Calibration Displays

5.02 Operate the switches on the face of the set to the following positions.

(a) Operate the power switch to ON.

(b) Operate the LOOP switch to the position corresponding to the current in the circuit to which the set is to be connected.

(c) Operate the SPEED switch to the position which agrees with the speed of the signals to be used.

(d) Operate the DISPLAY switch to PIP.

(e) Operate the CODE switch to match that of the signals.

(f) Operate the INPUT switch to NOR.

5.03 A small bright spot will appear and drift across the screen toward zero on the scale. After a one-minute warmup, the spot should lie somewhere between 5 and 15 on the scale. If no spot is visible, proceed as follows.

(a) Check for presence of power by observing the tube filaments through the case louvers.

(b) Adjust the HOR CENTER control to bring the spot on the screen at 5 on the scale. If no spot appears, the set requires maintenance.

5.04 Set SWEEP AM and SWEEP LEVEL controls at the centers of their ranges of rotation.

5.05 Using the 2P31A (red-gray) patch cord, insert the 359A plug (shorter one) into the INPUT jack of the set. Insert the other plug into a jack of a circuit in which teletypewriter signals are available.

5.06 A horizontal trace should appear, with pips both above and below it. Note the following, however.

(a) If no trace appears and the LOOP switch is set at 62.5 or 20, operate the NOR-REV switch to REV.

(b) If the LOOP switch is set at POL and the pips appear clustered near 40 on the scale, operate the NOR-REV switch to REV.

5.07 Adjust the HOR CENTER control so that the left end of the horizontal trace is at zero on the scale.

Note: After a one-minute warmup most of the circuitry of the set will become stabilized. However, there will be a slight drift in the horizontal centering during the first 15 minutes of operation. This will require small readjustments of the HOR CENTER control.

5.08 Adjust the SWEEP AM control so that the right end of the trace extends to 50 on the scale.

5.09 Adjust the SWEEP LEVEL control as follows. (Refer to Fig. 12a, 12b, and 12c.)

(a) Use the HOR CENTER control to move the left end of the trace to 5 on the scale for easier observation.

(b) Slowly rotate the SWEEP LEVEL control clockwise until the left end of the trace moves about 1/8 inch away from the bright spot. See Fig. 12b or 12d.

(c) Slowly rotate the SWEEP LEVEL control counterclockwise. Stop at the point where the horizontal gap is ***just short of closing.***

(d) Further counterclockwise rotation of the control will close the small gap and make the trace brighter. The correct setting is that which leaves the smallest possible horizontal gap between the left end of trace and the spot.

(e) Use the HOR CENTER control to restore the end of the trace to zero on the scale. Recheck that the right end is at 50 on the scale, and readjust it if necessary.

Note 1: Adjustment of the HOR CENTER, SWEEP AM, and SWEEP LEVEL controls does not affect the over-all calibration of the set. These three adjustments are self calibrating. If these controls are moved from their correct settings, they may be reset using ***any*** source of telegraph signals.

Note 2: The SWEEP LEVEL adjustment is simplified when the test signal is a repeated 2-transition character. The letter "O" is recommended (S-S-S-M-M).

5.10 The set is now ready for use. If the SPEED switch is moved to measure signals at speeds other than that used for the above calibration, minor readjustment of the SWEEP AM and SWEEP LEVEL controls may be necessary.

6. USE

6.01 This part describes how to connect the set to telegraph circuits and how to interpret the displays on the cathode-ray tube.

6.02 There are two broad categories of telegraph circuits in use in the plant. We shall call these relay type and electronic type circuits. The latter consists of loop circuits connected to 96A1 repeaters, 43A1 channel terminals, and 144B1 coupling units. The relay-type category includes all others. There is a difference between these two which affects transmission measurements. In relay-type circuits all the devices connected to the circuit are operated by current. In electronic-type circuits the station equipments or other gear used to terminate the loops are also operated by current. However, the modulator tube in 96A1 repeaters and 43A1 channel terminals is driven by voltage changes. In half-duplex 43A1 loops and in 96A1 loops (always half-duplex) the voltage does not have the same waveform as the current when signals are being sent toward the electronic terminal. In order to measure the quality of signals sent from a station toward an electronic terminal, it is necessary to arrange the 164C measuring sets to observe the voltage signals. When signals are sent from the terminal toward the station, the current and voltage waves are similar, and current measurements are satisfactory.

6.03 The 164C3 and 164C4 sets are arranged to measure both current and 43A1 loop voltage signals. Separate input circuits are included for each case, but both are connected to the same input jack. The input circuit for ***current*** signals is via the ***ring*** and sleeve of the input jack. Observation of such signals requires use of the 2P31A or 2P33A patch cords for connection to the circuit. These cords have a 359A plug on one end (ring sleeve only). The plug is of such length that it will connect only to the ring and sleeve of the input jack. The input circuit for ***voltage*** signals is via the ***tip*** and sleeve of the input jack. The 2P32A patch cord provided for measurement of voltage signals has a 310 (3 conductor) plug on one end. This plug is longer than the 359A so that the tip contacts the tip spring of the input jack.

6.04 When the 164C3 and 164C4 sets are used to measure relay-type circuits on a current basis, a 150-ohm resistor is in series with the telegraph circuit. The voltages developed across this resistor are applied to the grid of the first amplifier tube.

6.05 When the sets are used for measurements of electronic loops on a voltage basis, a transistor amplifier is employed between the tip of the input jack and the grid of the first amplifier tube of the circuit. This voltage measurement requires that the pin plug end of the 2P32A cord be connected to the MD and C pin jacks on the 43A1 terminal; the red cord connects to the MD jack and the black to the C jack. It is not practicable to connect the 164 set for measurements of distortion at a 96A1 repeater on signals sent from the station, since the connections to the circuit would have to be made within the repeater unit.

6.06 Fig. 13 shows connecting information for various applications of the set.

6.07 Fig. 14 shows the displays caused by various common types of distortion.

6.08 Fig. 15 shows the displays caused by speed errors in the signals.

6.09 Fortuitous hits in telegraph circuits will add to the systematic components of distortion and produce random peaks of distortion which exceed in magnitude the average value. The PK setting of the DISPLAY switch permits observation of fortuitous hits and determination of the peak value which occurs during the period of observation. Fig. 16 illustrates a peak display. Fortuitous hits will cause the trace to jump toward the right. It will drift slowly back from the peak value until it reaches the average value, or until another hit causes it to jump to the right again. Momentary operation of the RESET button will discharge the circuit which gives the peak reading and allow it to respond to new peaks. The peak indicating circuit is inoperative while the RESET button is de-

OPERATION	CONNECTING CORD(S)	CONNECT TO:	INPUT Note 1	SWITCH SETTINGS IN 164C3 + C4 SETS			DISPLAY
				LOOP	SPEED	CODE	
Primary Calibration MV BAL adjustment			Not in ckt.	ADJ	100	Not in ckt.	Both PIP and CAL
Other adjustments	2P31A	LPG jk. of dummy	NOR for + Bat. on tip REV for – Bat. on tip	Must correspond to test signals			PIP
Routine calibration	2P31A	Any source of tgh. test signals	NOR for + Bat. on tip REV for – Bat. on tip	Must correspond to test signals			PIP
Measurement in relay type TLT	2P31A	Looping jack	NOR	Must correspond to test signals			PIP for avg. bias & distortion, PK for peak distortion
Measurement of signals from station in 43A1 HDX loop (Note 3)	2P32A	Pin jks. on 43A1 term.: red to MD, black to C	Not in ckt.	62.5 Note 2		Must correspond to test signals	PIP for avg. bias & distortion, PK for peak distortion
Measurement of signals toward station in 43A1 HDX or FDX loops, or toward terminal in FDX loops only (Note 4)	2P31A	Drop 2 jk. of 43A1 TLT or	NOR	Must correspond to test signals			PIP for avg. bias & distortion, PK for peak distortion
		Any convenient series jk.	NOR for + Bat. on tip REV for – Bat. on tip	Must correspond to test signals			PIP for avg. bias & distortion, PK for peak distortion
Measurement at 15 or 19 teletypewriter station equipped with "red" jk.	2P1 or 2P2 and 2P31A	2P1 from "red" jk. to J2* jk. 2P31A from J3 or J4* to input jk. Set's "red" cord to J3 or J4* jk.	NOR for + Bat. on tip REV for – Bat. on tip	Must correspond to test signals			PIP for avg. bias & distortion, PK for peak distortion
Measurement at station with no jacks	2W44A and 2P31A	2W44A from loop to J2* jk. 2P31A from J3 or J4* to input jk.	NOR for + Bat. on tip REV for – Bat. on tip	Must correspond to test signals			PIP for avg. bias & distortion, PK for peak distortion
Measurements at 82B1 switching center	2P33A	Jacks in line cabinet	NOR for + Bat. on tip REV for – Bat. on tip	Must correspond to test signals			PIP for avg. bias & distortion, PK for peak distortion

*See Fig. 17.

Note 1. Battery polarities refer to "marking" signal condition.

Note 2. Should be set on 62.5 regardless of loop conditions.

Note 3. Should be measured with channel terminal send switch set on HM.

Note 4. Also applies to signals sent toward station in loops connected to 96A1 loop repeaters or 144B1 coupling units.

Fig. 13 – Application Information

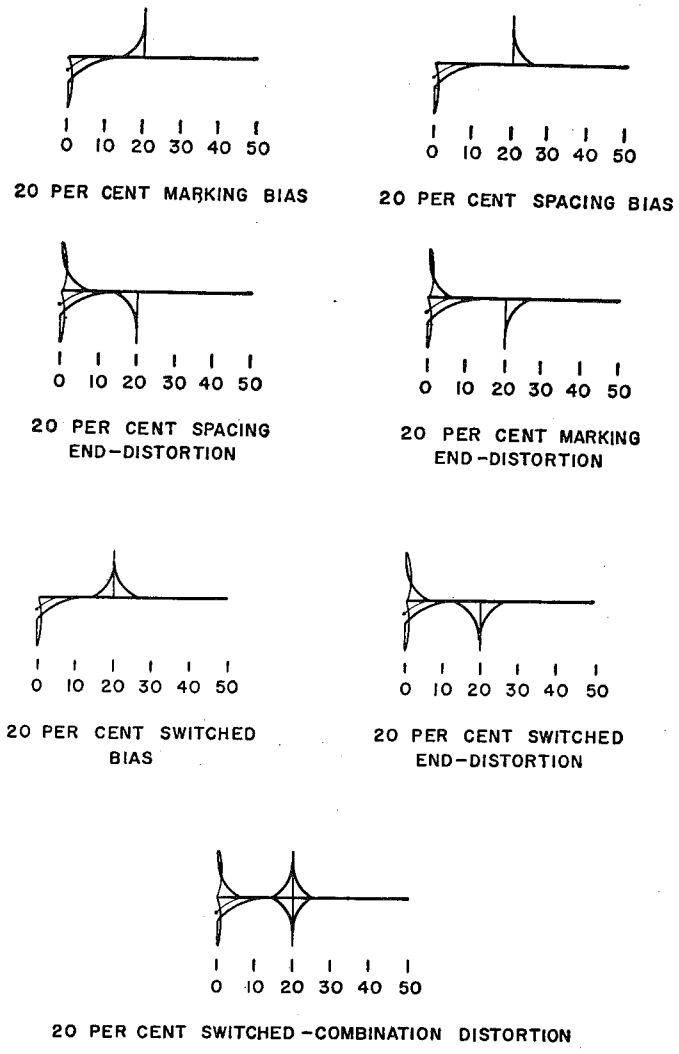


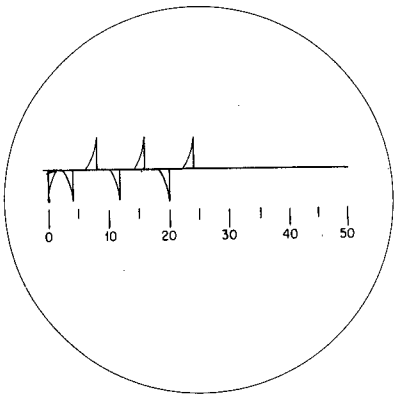
Fig. 14 – Typical Distortion Displays

pressed. The sets may be reset from a remote location by connecting a pushbutton switch having make contacts to a pair of terminals located under the cover, on the chassis, behind the RESET button.

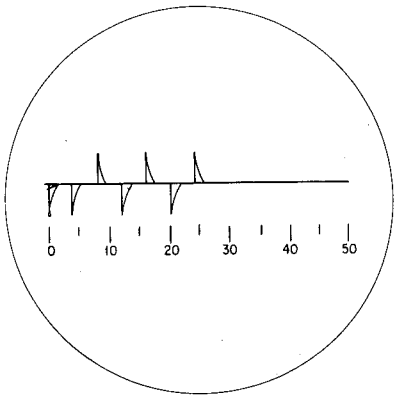
6.10 The NEUT and H AMP jacks on the face panel are provided to facilitate auxiliary monitoring of peak distortion indications.

6.11 Characteristic distortion may be determined by observation of the distortion on different repeated characters. If the average distortion value is higher for a repeated character that contains unit length pulses than it is for one which contains no unit length pulses, the difference is probably due to characteristic distortion. The following teletypewriter characters contain no unit length pulses, I, M, O, T, V, BLANK, and LETTERS.

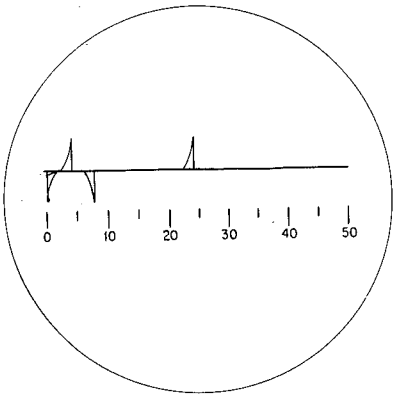
6.12 If it is suspected that relay chatter or other medium-high frequency disturbances are present on the circuit being measured, this can be checked by depressing the INPUT FILTER OUT button, which will reduce the input filtering action. Erratic indications will be observed on the set if there are any disturbances present.



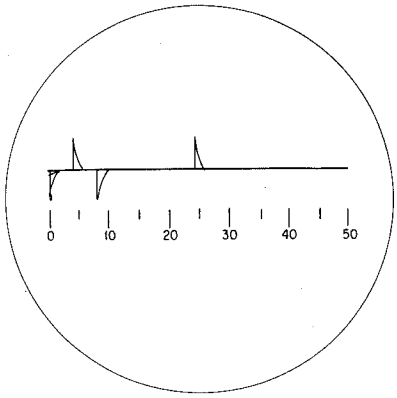
(a) Miscellaneous Signals — Transmitter 4% Fast



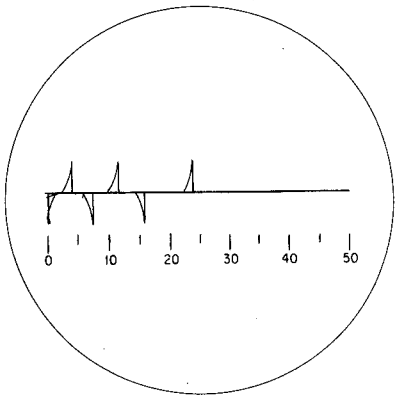
(b) Miscellaneous Signals — Transmitter 4% Slow



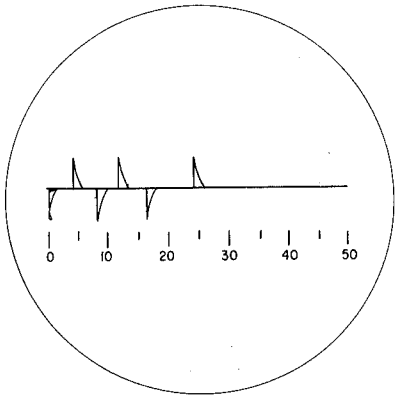
(c) Repeated "E" — Transmitter 4% Fast



(d) Repeated "E" — Transmitter 4% Slow



(e) Repeated "S" — Transmitter 4% Fast



(f) Repeated "S" — Transmitter 4% Slow

Fig. 15 – Typical Displays Caused by Speed Errors

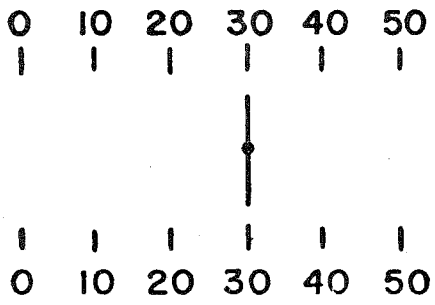


Fig. 16 – Peak Display — 30 Per Cent Distortion

7. MAINTENANCE

7.01 If maintenance information is required, refer to Section 103-823-100, Part 5. This section refers to the 164C1 set. However, the test information given applies also in general to the 164C3 and 164C4 sets. The sets differ only in equipment layout and in a few features of the character and element timing circuits.

8. REFERENCES

Circuit Drawing	SD-70886-01
Circuit Description	CD-70886-01
Specification Drawing	J70146A
Wiring Drawings	T-70886-30
164C1 Telegraph Transmission Measuring Set	103-823-100
Cable Drawings	
Local Cable No. 1	LC 215 535
No. 2	LC 215 536
No. 3	LC 215 537
No. 4	LC 215 538
No. 5	LC 215 539

EQUIPMENT	PROVIDED UNDER	CONNECTOR	CORD	CONNECTOR	CONNECTS FROM	CONNECTS TO
Set of jacks, J2, J3, J4, J5, per SD-70886-01, Fig. 2	J70146A, List 1					
2P31A cord	J70146A, List 1	347A plug	2 cond*	359A plug	TLT; J3, J4, or J5	Input jack Input jack
2P32A cord	J70146A, List 1	Pin plugs	2 cond	310 plug	MD & C jacks in 43A1 terminal	Input jack
2W44A cord	J70146A, List 1	Alligator clips	2 cond	347A plug	Loop connecting block	J2 jack
2P1 cord	Generally Available	347A plug	2 cond	347A plug	"Red" jack	J2 jack
2P33A cord	J70146A, List 1	310 plug	2 cond*	359A plug	Jacks in line cabinet at 82B1 teletypewriter switching center	Input jack
KS-14532, L1	J70146A, List 1	Hubbell 7484 conn.	3 cond	Twist-lock	117V ac outlet	117V ac jack

*Plugs are interconnected tip to sleeve.

Fig. 17 – Connecting Cords and Jacks