

143A1 AND 143A2 REGENERATIVE TELEGRAPH REPEATERS

TESTS AND ADJUSTMENTS

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G. Speed	7	1.01 This section contains tests and adjustments for maintaining the 143A1 and the 143A2 regenerative telegraph repeaters. The 143A2 repeater has application to No. 2-type electronic hub circuits operating on +60 volts mark and -30 volts space or No. 1-type electronic hub circuits operating on +40 volts mark and -40 volts space. The 143A1 repeater will operate on only No. 1-type electronic hub circuits of +40 volts mark and -40 volts space. The repeaters, which are of demountable design, are basically similar.	
H. 7.00-Pulse Unit Code Adapter Adjustment	9	1.02 This section is reissued to include test and adjustment information for 143A2 repeaters arranged for 7.00-pulse unit code or 11.00-pulse unit code.	
4. SUPPLEMENTAL TESTS	9	1.03 The only test of a routine nature is the periodic check of oscillator stop current which is made at the repeater bay. All other tests and adjustments are undertaken only as a result of observations made at the serviceboard or testboard. If a repeater fails to meet the requirements at a testboard or serviceboard, proceed as follows.	
A. General	9	(a) Without removing the repeater from the bay, measure and adjust the oscillator-stop current.	
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(b) If the proper oscillator-stop current cannot be obtained or if a correct adjustment of the oscillator-stop current fails to clear the trouble and bench testing facilities are not available, additional checks including speed, decrement, and replacement of tubes may be made at the repeater bay.

(c) If the proper oscillator-stop current cannot be obtained or if a correct adjustment of the oscillator-stop current fails to clear the trouble and bench testing facilities are available, the repeater should be removed from the bay and investigated at the test bench.

2. APPARATUS

2.01 The following equipment is required for performing the tests in this section.

- *1—165A1 (143A1 only) or 165A2 Test Set
- 1—911-Type Test Sentence Generator; or 1A Teletypewriter Test Set arranged for 60-speed operation (for 5- or 6-unit code repeaters) or 1B Teletypewriter Test Set arranged for 100-speed operation (for 8-unit code repeaters).
- 1—DuMont Oscilloscope Type 208, 304, or equivalent
- 1—KS-14510, L1 Meter (Triplett Model 630D)
- 1—KS-13753 Tube Puller

1—Pin Straightener—Cat. No. J15 (Mfd. by Star Expansion Products Corp., 147 Cedar St., New York, N. Y.) or equivalent

*Two power receptacles are required at the test bench. One of these is a conventional 110-volt ac power receptacle and the other is an Amphenol S11 socket, supplied with the test set, for use with the M11E conductor cord (6 feet long). The 165A1 test set is not arranged for testing 143A2 repeaters or 143A1 repeaters from which the FIL V ADJ potentiometer has been removed.

3. TESTS AND ADJUSTMENTS

A. General

3.01 The only routine measurement which is undertaken at the repeater while the repeater is mounted in the bay is the measurement and adjustment of oscillator stop current. This may be done without removing the repeater from service provided the repeater is in the idle condition, that is, steadily marking so that the meter reading will be steady. Connecting the milliammeter into the OSC STOP CUR jack will not interfere with the operation of the regenerative repeater. The stop current should be checked at the time of installation, at periods of one day after installation, one week after installation, and at monthly intervals thereafter. The current should also be adjusted whenever tube V5 is replaced and should be checked one day after replacement and one week later. Test E provides the procedures for making the oscillator stop current test.

B. Preparatory Procedure

STEP	PROCEDURE
1	Connect the 165A1 or 165A2 test set to ac and dc power receptacles and to the repeater under test. Two M11E cords are provided for connecting the test set to dc power and to the repeater under test.
2	Operate the BAT key of the test set to ON.

STEP	PROCEDURE
3	Examine the electron tubes and determine that both filaments of each tube are lighted to normal brilliancy. It is assumed that FIL V ADJ potentiometer R22 has been properly adjusted when a 165A2 set is used.
4	Inspect the repeater for loose wires, poorly soldered connections, or burned apparatus.

C. Tube Substitution

STEP	PROCEDURE
1	Remove the repeater from the bay, if necessary, and substitute new tubes for the existing ones. Use a tube puller for removing the tubes and straighten bent tube pins with a pin straightener.
2	Return the repeater to the bay.
3	If the distortion and errors cease, restore the repeater to service. If distortion or teletypewriter errors or both persist, continue with the tests.

D. Tube Tests

STEP	PROCEDURE
	Caution: Do not remove tubes from the repeater unless BAT key is in the OFF position.
1	Operate the test set BAT key to OFF.
2	Operate the ac power toggle switch to ON.
3	Remove each tube from the repeater and connect it to tube socket 396A TUBE TST of the test set. Use a tube puller for removing the tubes and if tube pins have been bent, straighten them with a pin straightener.
4	Connect the KS-14510 meter to TUBE TST M jack of the test set and arrange to use the 10-mA scale.
5	Operate PLT CUR key of the test set to its 6.5—10 MA (165A1) or COND (165A2) position. This applies zero grid bias to the tube elements.

STEP	PROCEDURE
6	<p>After allowing time for the filaments to become heated, check that the KS-14510 meter reads at least 6.0 mA (165A1) or 5.0 mA (165A2) while TRIODE key is in its LT and RT positions. (See note under Step 9.)</p> <p><i>Note:</i> When using a 165A1 test set, disregard the upper current limit indicated by the PLT CUR key designation. The TRIODE key applies plate battery to the left and right tube triodes when in the LT and RT positions, respectively, and satisfactory meter readings indicate that both triodes of the tube have satisfactory emission.</p>
7	<p>Operate PLT CUR key to its 0—0.5 MA (165A1) or CUTOFF (165A2) position. This applies a 5.3-volt (165A1) or a 7-volt (165A2) negative grid bias to the tube elements.</p> <p><i>Note:</i> Observe that the KS-14510 meter reads less than 0.8 mA (165A1) and 0.5 mA (165A2) when the TRIODE key is in its LT and RT positions and when a 165A1 test set is used, disregard the 0.5-mA limit indicated by the PLT CUR key designation.</p>
8	<p>If the test set is a 165A2, hold the TRIODE key operated to its SHORT position. The KS-14510 meter should read zero and thereby indicate that there is no internal short circuit between the cathodes and either the heater or the grids of the tube.</p>
9	<p>With TRIODE key operated to its SHORT position, tap the tube lightly with the fingers and observe the meter. If the meter deflects intermittently in response to the tapping, the tube is defective.</p> <p><i>Note:</i> If the tubes meet these requirements, restore them to the repeater. Replace any tubes that fail to meet the requirements. It is desirable that tube V1 have a plate current for both tube triodes of at least 7.0 mA, as measured with a 165A2 test set in Step 6 above.</p>
10	<p>Disconnect the KS-14510 meter from the TUBE TST M jack.</p>
11	<p>Operate BAT key to ON.</p>

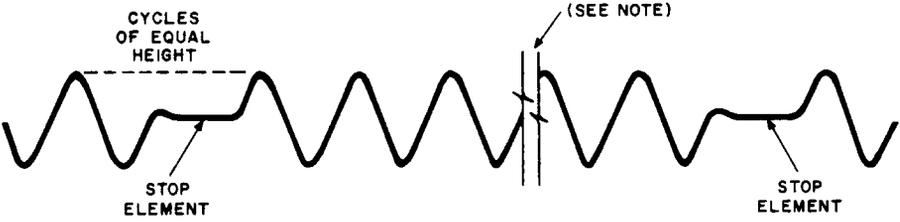
E. Oscillator Stop Current

STEP	PROCEDURE
1	<p>Connect the KS-14510 meter to the OSC STOP CUR jack of the repeater.</p> <p><i>Note:</i> The patch may be made with a P2CW cord equipped with a 347-type plug on one end and two Herman H. Smith No. 201 insulated solderless tip plugs, one red and one black, on the other end. The sleeve conductor of the 347-type plug is connected to the red plug and the tip conductor is connected to the black plug.</p>

STEP	PROCEDURE															
2	Send a steady marking signal into the repeater by operating the IN key of the test set to MARK.															
3	Adjust the STOP CUR ADJ potentiometer until the stop current is correct for the particular position of the SPEED switch, as indicated in Table A. If the repeater has been disconnected, allow about 5 minutes for the tubes to warm before adjusting the stop current.															
4	<p>After making the adjustment, disconnect the KS-14510 meter.</p> <p style="text-align: center;">TABLE A</p> <table border="1"> <thead> <tr> <th>SPEED SWITCH POSITION</th> <th>REPEATER ARRANGEMENT</th> <th>STOP CURRENT</th> </tr> </thead> <tbody> <tr> <td>60</td> <td>5- or 6-Unit Code</td> <td>4.50 \pm.3 Milliamperes</td> </tr> <tr> <td>75</td> <td>5- or 6-Unit Code</td> <td>3.55 \pm.2 Milliamperes</td> </tr> <tr> <td>100</td> <td>5- or 6-Unit Code</td> <td>2.75 \pm.2 Milliamperes</td> </tr> <tr> <td>100</td> <td>8-Unit Code</td> <td>1.8 \pm.1 Milliamperes</td> </tr> </tbody> </table>	SPEED SWITCH POSITION	REPEATER ARRANGEMENT	STOP CURRENT	60	5- or 6-Unit Code	4.50 \pm .3 Milliamperes	75	5- or 6-Unit Code	3.55 \pm .2 Milliamperes	100	5- or 6-Unit Code	2.75 \pm .2 Milliamperes	100	8-Unit Code	1.8 \pm .1 Milliamperes
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100	5- or 6-Unit Code	2.75 \pm .2 Milliamperes														
100	8-Unit Code	1.8 \pm .1 Milliamperes														

F. Decrement

STEP	PROCEDURE
	<p>Note: Two methods for adjusting the decrement potentiometer are shown, Steps 1 through 3 using a Triplet 650 VTVM and Steps 4 through 15 using a DuMont Oscilloscope Type 208, 304, or equivalent. Before using the method in Steps 4 through 15, the oscilloscope must be calibrated in accordance with the Oscilloscope Calibration procedure in Part 4B.</p>
1	Arrange the Triplet 650 meter to read ac volts and connect it between ground and binding post TST on the regenerative repeater.
2	Send a steady spacing signal to the repeater and adjust DECREMENT potentiometer until the meter reads 3.0 \pm 0.2 volts on the 5-volt scale.
3	Disconnect the meter from the repeater.
	<p>Note: If a Sylvania polymeter is used, the reading should be 3.5 volts on the 10-volt scale.</p>
4	Perform Steps 5 through 8 for repeaters arranged for 5- or 6-unit code.

STEP	PROCEDURE												
5	Connect 165 test set PROBE lead to binding post TST of the repeater.												
6	At repeater, operate SPEED switch to 60.												
7	With the 911-type test sentence generator or 1A set connected to the 165 test set and arranged for 60-speed operation, operate 165 test set IN key to SIG.												
8	Send undistorted blank signals from the 911-type test sentence generator or 1A set.												
9	Perform Steps 10 through 13 for repeaters arranged for 8-unit code.												
10	At 165 test set, connect PROBE lead to binding post TST of the repeater.												
11	At repeater, operate SPEED switch to 100.												
12	With the 911-type test sentence generator or 1B set connected to the 165 test set and arranged for 100-speed operation, operate 165 test set IN key to SIG.												
13	Send undistorted blank signals from the 911-type test sentence generator or 1B set.												
14	Adjust the oscilloscope Y-AXIS GAIN and FINE FREQUENCY controls until a picture approximately like that of Fig. 1 is obtained.												
15	<div style="text-align: center;">  <p>NOTE: THE NUMBER OF SINE WAVE CYCLES BETWEEN THE STOP ELEMENTS IS DETERMINED BY THE REPEATER ARRANGEMENT AS FOLLOWS:</p> <table border="0"> <tr> <td>7.00 PULSE UNIT CODE</td> <td>—</td> <td>6 CYCLES</td> </tr> <tr> <td>7.42 " " " "</td> <td>—</td> <td>7 " "</td> </tr> <tr> <td>8.62 " " " "</td> <td>—</td> <td>8 " "</td> </tr> <tr> <td>11.00 " " " "</td> <td>—</td> <td>10 " "</td> </tr> </table> </div> <p>At repeater, adjust DECREMENT potentiometer until the sine wave cycles before and after the stop element (horizontal segment) of the picture appear equal in amplitude.</p>	7.00 PULSE UNIT CODE	—	6 CYCLES	7.42 " " " "	—	7 " "	8.62 " " " "	—	8 " "	11.00 " " " "	—	10 " "
7.00 PULSE UNIT CODE	—	6 CYCLES											
7.42 " " " "	—	7 " "											
8.62 " " " "	—	8 " "											
11.00 " " " "	—	10 " "											

G. Speed

STEP	PROCEDURE
	<p>With Weston Milliammeter</p> <p><i>Note:</i> This method of checking and adjusting the oscillator speed requires that the oscillator stop current and decrement adjustments be made precisely for the particular speed under test before making the speed observations. Checking the speed with this method when the oscillator stop current and decrement have been adjusted at some other speed should not be attempted. A check should be made to ensure that the milliammeter zero adjustment is precisely set before making speed observations.</p> <p>1 Connect the meter to the OSC STOP CUR jack.</p> <p>2 Send unbiased teletypewriter signals into the repeater.</p> <p><i>Note:</i> If the speed is correct, the meter will vibrate about an average reading of 0.25 mA for 60 speed, 0.20 mA for 75 speed, or 0.15 mA for 100 speed (5- or 6-unit code repeaters) and 0.10 mA for 100 speed (8-unit code repeaters). If the meter does not vibrate at the desired current value, it is an indication that the speed adjustment is not correct and should be corrected in accordance with Step 4 below.</p> <p>With 911-Type Distortion Measuring Set or 118-Type Transmission Measuring Set</p> <p>3 Send unbiased teletypewriter test signals through the repeater from the serviceboard or testboard and observe the output on the 911-type distortion measuring set, or the 118-type transmission measuring set.</p> <p><i>Note:</i> If the signals repeated by the repeater do not exceed ± 2.5 percent bias and 6 ± 2 percent distortion for a repeater arranged for 7.00-pulse unit code or ± 2.5 percent bias and 5 percent distortion for repeaters arranged for 7.42-, 8.62-, or 11.00-pulse unit codes, it is indicated that the speed of the oscillator is satisfactory for the speed under test. If the speed is not correct, as indicated by excessive bias and distortion indications, readjust the speed in accordance with Step 4 for minimum bias and distortion indications within the limits mentioned above.</p> <p>4 Change the strapping of capacitors C32 to C49 for a 143A1 repeater, C28 to C45 for a 143A2 5- or 6-unit code repeater, or C61 to C78 for a 143A2 8-unit code repeater (terminals 1 to 18), as required, until the meter reading is correct in Step 2 or the bias and distortion readings in Step 3 are zero for each speed.</p> <p><i>Note:</i> Increasing the capacity will lower the meter reading in Step 2 or make the bias more spacing in Step 3 during speed adjustment. It should be noted which strapping combination exists in the set before the change is made. Then a combination having more or less capacity may be selected, as required.</p>

STEP	PROCEDURE																															
5	<p>With 165A2 Test Set</p> <p>With the 1A set arranged for 60-speed operation (for 5- or 6-unit code repeaters) or the 1B set arranged for 100-speed operation (for 8-unit code repeaters) and connected to the SIG and STROB jacks of the 165 test set, operate IN key to SIG.</p>																															
6	<p>Send the type of signals indicated in the third column of Table B below corresponding to the repeater speed setting in the first column.</p>																															
<p>TABLE B</p>																																
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="width: 15%;">REPEATER SPEED SETTING</th> <th rowspan="2" style="width: 20%;">REPEATER ARRANGEMENT</th> <th rowspan="2" style="width: 15%;">SENT CHARACTER 60-SPEED</th> <th colspan="2" style="width: 50%;">LENGTH OF RECEIVED MARKING ELEMENT</th> </tr> <tr> <th style="width: 25%;">BEGINNING</th> <th style="width: 25%;">END</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">60</td> <td>5- or 6-Unit Code</td> <td>Blank, 42% M Bias</td> <td>Stop 0%</td> <td>142 Stop</td> </tr> <tr> <td style="text-align: center;">75</td> <td>5- or 6-Unit Code</td> <td>T, 42% M Bias</td> <td>Four — 81%</td> <td>142 Stop</td> </tr> <tr> <td style="text-align: center;">100</td> <td>5- or 6-Unit Code</td> <td>O, 42% M Bias</td> <td>Three — 68.5%</td> <td>142 Stop</td> </tr> <tr> <td style="text-align: center;">100</td> <td>8-Unit Code</td> <td style="text-align: center;">—</td> <td style="text-align: center;">—</td> <td style="text-align: center;">—</td> </tr> </tbody> </table>						REPEATER SPEED SETTING	REPEATER ARRANGEMENT	SENT CHARACTER 60-SPEED	LENGTH OF RECEIVED MARKING ELEMENT		BEGINNING	END	60	5- or 6-Unit Code	Blank, 42% M Bias	Stop 0%	142 Stop	75	5- or 6-Unit Code	T, 42% M Bias	Four — 81%	142 Stop	100	5- or 6-Unit Code	O, 42% M Bias	Three — 68.5%	142 Stop	100	8-Unit Code	—	—	—
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100	8-Unit Code	—	—	—																												
7	<p>Observe the output of the repeater on the stroboscope and set the end of each repeated marking element in line with scale marking 142 of the STOP element. The beginning of each marking element should be in line with the scale marking indicated in the fourth column within ± 2 percent.</p>																															
8	<p>If the above requirements are not met, try other combinations of capacitors C32 to C49 (143A1 repeaters), C28 to C45 (143A2 5- or 6-unit code repeaters) or C61 to C68 (143A2 8-unit code repeaters) until the beginning of each marking element is in line with the scale marking indicated in Table B within ± 2 percent.</p> <p>Note: Pulses that are too long indicate that the oscillations are too fast and more capacitance is needed. If the pulses are too short, the capacitance should be reduced.</p>																															
9	<p>After adjustment of the tuning of a 143A2-type repeater arranged for 7.00-pulse unit code, it is necessary to readjust V11 at each of the speed settings.</p>																															
10	<p>At each of the above speeds, check stability by operating test key K2 to STAB. The marking element should appear as in Step 7 above without any noticeable increase in unsteadiness.</p>																															

H. 7.00-Pulse Unit Code Adaptor Adjustment

STEP	PROCEDURE
	<p><i>Note:</i> For 143A2 repeaters arranged for 7.00-pulse unit code, there is an adjustment of the timer providing the stop pulse in the repeated signal. The timer must be set correctly for each speed so that the amount of distortion that the repeater can tolerate will not be decreased.</p>
1	Arrange a 911-type test sentence generator or 1A teletype test set to send a repeated R character to the repeater with 45-percent spacing bias.
2	Adjust each of the resistors at each of the speeds (R106 for 100 speed, R114 for 75 speed and R115 for 60 speed) to a just fail point . That is, when the distortion jumps to a high value. If no fail point occurs, leave the resistors at their factory setting .

4. SUPPLEMENTAL TESTS

A. General

4.01 The following tests provide more detailed procedures which are useful in isolating specific trouble causes. Failure to meet the requirements of the following tests indicates trouble

which should be repaired by authorized maintenance personnel in accordance with established local procedures. Once the repeater has been repaired, the tests and adjustments in Part 3 should be performed before the repeater is returned to service.

B. Oscilloscope Calibration

STEP	PROCEDURE
1	Connect binding posts SCOPE and GND of the test set to the SIGNAL INPUT and GROUND binding posts, respectively, of the Y-axis amplifier of the oscilloscope.
2	Operate the SCOPE key of the test set to the CAL position.
3	Operate test set BAT key to ON.
4	At oscilloscope, operate the BEAM and POWER switches to ON.
5	Operate the Y-AXIS AMPLIFIER to INPUT UNDER 250V RMS.
6	Operate Y-AXIS GAIN control to zero.
7	Set SYNC SIGNAL AMPLITUDE switch to zero.
8	Increase the Y-axis gain gradually until a sine wave is seen.

STEP	PROCEDURE
9	Carefully adjust the FINE FREQUENCY control until a sine wave trace of 5 cycles is observed. This is a picture of the ac power supply voltage appearing on the ungrounded end of the secondary winding of transformer T1 of the test set.
10	Adjust the size of the picture by turning the Y-AXIS GAIN control.
11	Turn the Y-POSITION control until the picture is symmetrical with respect to the Y-axis.
12	Turn the Y-AXIS GAIN control until the peak-to-peak level of the sine wave is four small divisions of 0.4 inch on the screen of the oscilloscope.
	<i>Note:</i> Since the calibrating wave is 20 volts peak-to-peak, the oscilloscope is now set to read alternating current voltages so that every 0.1 inch of amplitude (fine lines of screen) is equal to 5 volts and every 1 inch of amplitude (heavy lines of screen) is equal to 50 volts. This calibration will hold only as long as the Y-AXIS GAIN control is not disturbed.
13	Operate the 165 test set SCOPE key to TST to connect the oscilloscope to binding post PROBE of the test set. The scope is now ready to measure the peak-to-peak oscillatory voltage appearing at any point in the repeater circuit to which the test set PROBE lead may be connected.
14	Check the oscilloscope calibration at any time by operating the test set SCOPE key to its CAL position and observing that the peak-to-peak amplitude of the sine wave remains equal to four small divisions on the screen.

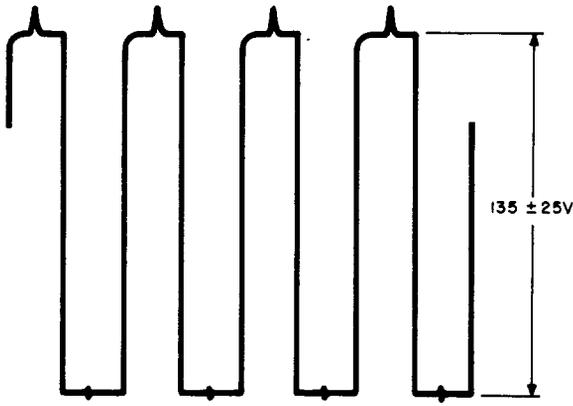
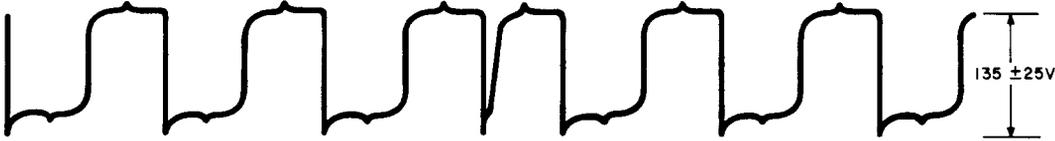
C. Pulse Test

STEP	PROCEDURE
	<i>Note:</i> If repeater is equipped for 8.62-pulse unit code, arrange it for 7.42-pulse unit code by removing tube V10.
1	If repeater is arranged for 7.42- or 11.00-pulse unit code, connect test set GND 1 to repeater TP1.
2	If repeater is arranged for 7.00-pulse unit code, connect test set GND 1 to repeater TP7.
3	Connect test set PROBE lead to repeater TP2 to observe the pulses on the plate of the pulse tube.
4	If the repeater is arranged for 7.00- or 7.42-pulse unit code, operate the SPEED switch to 60 and adjust the oscilloscope FINE FREQUENCY control until 8 cycles remain steady. The waveshape and voltage amplitude should appear as shown in Fig. 2.

STEP	PROCEDURE
5	<div> </div> <p style="text-align: center;">Fig. 2</p> <p>If the repeater is arranged for 11.00-pulse unit code, operate the SPEED switch to 100 and adjust the oscillator FINE FREQUENCY control until 12 cycles remain steady. The waveshape and voltage amplitude should appear as shown in Fig. 3.</p> <div> </div> <p style="text-align: center;">Fig. 3</p>

D. First Count Test

STEP	PROCEDURE
1	<p>Note: If repeater is equipped for 8.62-pulse unit code, arrange it for 7.42-pulse unit code by removing tube V10.</p> <p>If repeater is arranged for 7.42- or 11.00-pulse unit code, connect test set GND 1 to repeater TP1.</p> <p>If repeater is arranged for 7.00-pulse unit code, connect test set GND 1 to repeater TP7.</p> <p>If a 143A1 repeater is being tested, also connect test set GND 2 to repeater TP3.</p> <p>Connect test set PROBE lead to repeater TP4.</p> <p>If the repeater is arranged for 7.00- or 7.42-pulse unit code, operate the SPEED switch to 60. The waveshape and amplitude should appear as shown in Fig. 4. Readjust the oscilloscope FINE FREQUENCY control, if necessary, to obtain 4 cycles.</p>

STEP	PROCEDURE
6	<p>If the repeater is arranged for 11.00-pulse unit code, operate the SPEED switch to 100. The waveshape and amplitude should appear as shown in Fig. 5. Readjust the oscilloscope FINE FREQUENCY control, if necessary, to obtain 6 cycles.</p> <div style="text-align: center;">  <p>Fig. 4</p> </div> <div style="text-align: center;">  <p>Fig. 5</p> </div>

E. Second Count Test

STEP	PROCEDURE
1	<p><i>Note:</i> If repeater is equipped for 8.62-pulse unit code, arrange it for 7.42-pulse unit code by removing tube V10.</p> <p>If repeater is arranged for 7.42- or 11.00-pulse unit code, connect test set GND 1 to repeater TP1.</p>
2	<p>If repeater is arranged for 7.00-pulse unit code, connect test set GND 1 to repeater TP7.</p>
3	<p>If a 143A1 repeater is being tested, also connect test set GND 2 to repeater TP3.</p>

STEP	PROCEDURE
4	Connect test set PROBE lead to repeater TP5.
5	<p>If the repeater is arranged for 7.00- or 7.42-pulse unit code, operate the SPEED switch to 60. The waveshape and amplitude should appear as shown in Fig. 6 with little or no readjustment of the oscilloscope FINE FREQUENCY control.</p> <div style="text-align: center;"> </div> <p style="text-align: center;">Fig. 6</p>
6	<p>If the repeater is arranged for 11.00-pulse unit code, operate the SPEED switch to 100. The waveshape and amplitude should appear as shown in Fig. 7 with little or no readjustment of the oscilloscope FINE FREQUENCY control.</p> <div style="text-align: center;"> </div> <p style="text-align: center;">Fig. 7</p>

F. Third Count Test

STEP	PROCEDURE
1	<p><i>Note:</i> If repeater is equipped for 8.62-pulse unit code, arrange it for 7.42-pulse unit code by removing tube V10.</p> <p>If repeater is arranged for 7.42- or 11.00-pulse unit code, connect test set GND 1 to repeater TP1.</p>

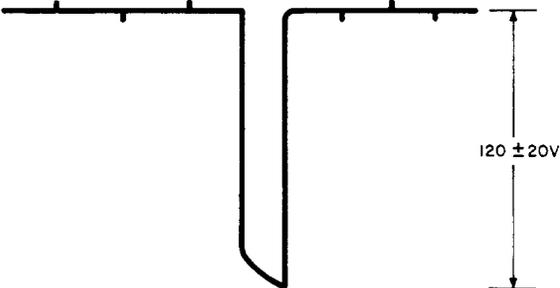
STEP	PROCEDURE
2	If repeater is arranged for 7.00-pulse unit code, connect test set GND 1 to repeater TP7.
3	If a 143A1 repeater is being tested, also connect test set GND 2 to repeater TP3.
4	Connect test set PROBE lead to repeater TP6.
5	<p>If the repeater is arranged for 7.00- or 7.42-pulse unit code, operate the SPEED switch to 60. The waveshape and amplitude should appear as shown in Fig. 8 with little or no readjustment of the oscilloscope FINE FREQUENCY control.</p> <div> <p>The figure shows a single rectangular pulse on a horizontal baseline. The pulse has a sharp leading edge and a sharp trailing edge. A vertical dimension line to the right of the pulse indicates its amplitude, labeled as 135 ± 25V.</p> </div> <p style="text-align: center;">Fig. 8</p>
6	<p>If the repeater is arranged for 11.00-pulse unit code, operate the SPEED switch to 100. The waveshape and amplitude should appear as shown in Fig. 9 with little or no readjustment of the oscilloscope FINE FREQUENCY CONTROL.</p> <div> <p>The figure shows a double rectangular pulse on a horizontal baseline. The pulse consists of two identical rectangular pulses separated by a gap. Each pulse has a sharp leading edge and a sharp trailing edge. A vertical dimension line to the right of the second pulse indicates its amplitude, labeled as 135 ± 25V.</p> </div> <p style="text-align: center;">Fig. 9</p>

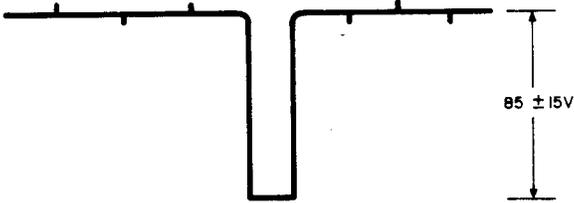
G. Fourth Count Test

STEP	PROCEDURE
1	<p><i>Note:</i> This test applies only to a 143A2 repeater arranged for 11.00-pulse unit code.</p> <p>Connect test set GND 1 to repeater TP1.</p>

STEP	PROCEDURE
2	Connect test set PROBE lead to repeater TP12.
3	Operate SPEED switch to 100. The waveshape and amplitude should appear as shown in Fig. 10 with little or no readjustment of the oscilloscope FINE ADJUSTMENT control.
 <p>Fig. 10</p>	

H. Stop Pulse Test

STEP	PROCEDURE
<p>Note: If repeater is equipped for 8.62-pulse unit code, arrange for 7.42-pulse unit code by removing tube V10.</p>	
1	Connect test set GND 1 lead to repeater TP1.
2	If repeater is a 143A1, also connect test set GND 2 to TP3.
3	Connect test set PROBE to repeater TP7.
4	<p>If the repeater is arranged for 7.00- or 7.42-pulse unit code, operate the SPEED switch to 60. The waveshape and voltage amplitude should appear as shown in Fig. 11 for a 143A1 repeater and as shown in Fig. 12 for a 143A2 repeater arranged for 7.00- or 7.42-pulse unit code.</p>  <p>Fig. 11</p>

STEP	PROCEDURE
5	<p>If a 143A2 repeater is arranged for 11.00-pulse unit code, operate the SPEED switch to 100. The waveshape and voltage amplitude should be as shown in Fig. 13.</p> <div style="text-align: center;">  <p>Fig. 12</p> </div> <div style="text-align: center;">  <p>Fig. 13</p> </div>

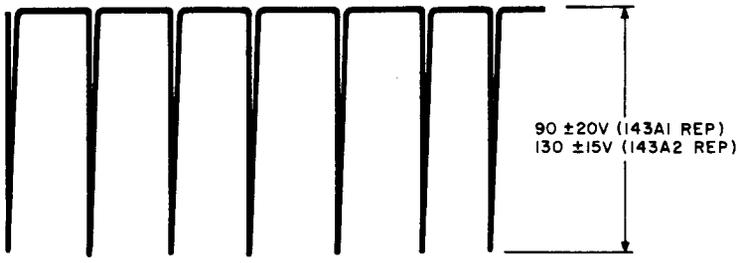
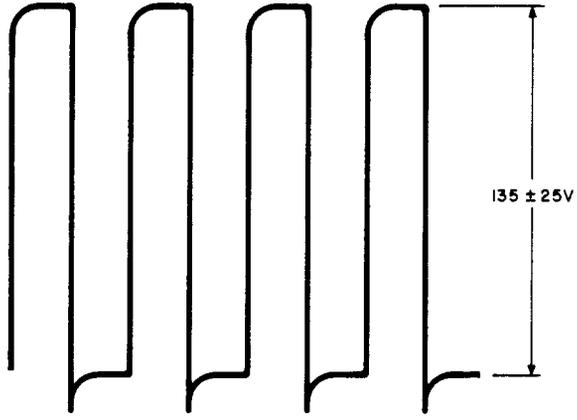
I. Input Test

STEP	PROCEDURE																											
1	<p>Note: If repeater is equipped for 8.62-pulse unit code, arrange for 7.42-pulse code by removing tube V10.</p> <p>Make the voltmeter tests indicated in Tables C and D without connecting test set GND 1, GND 2, or -130V lead to the repeater. Table C applies to the 143A1 repeater and Table D applies to the 143A2 repeater.</p> <p>Operate IN key of the test set to MARK or SPACE, as indicated under <i>Input Signal</i>.</p> <div style="text-align: center;"> <p>TABLE C</p> <p>143A1 REPEATER</p> <table border="1"> <thead> <tr> <th rowspan="2">TEST</th> <th rowspan="2">INPUT SIGNAL</th> <th colspan="2">(USE 300V SCALE)</th> <th rowspan="2">READING (VOLTAGE OF PLATE OR GRID)</th> </tr> <tr> <th>VOLTMETER +</th> <th>VOLTMETER -</th> </tr> </thead> <tbody> <tr> <td>(1)</td> <td>Mark</td> <td>Pin 7 V1</td> <td>GND 1</td> <td>Near 0</td> </tr> <tr> <td>(2)</td> <td>Mark</td> <td>Pin 6 V1</td> <td>GND 1</td> <td>12 ± 6 V</td> </tr> <tr> <td>(3)</td> <td>Space</td> <td>Pin 6 V1</td> <td>GND 1</td> <td>112 ± 6 V</td> </tr> <tr> <td>(4)</td> <td>Space</td> <td>Pin 7 V1</td> <td>GND 1</td> <td>-38 ± 4 V</td> </tr> </tbody> </table> </div>	TEST	INPUT SIGNAL	(USE 300V SCALE)		READING (VOLTAGE OF PLATE OR GRID)	VOLTMETER +	VOLTMETER -	(1)	Mark	Pin 7 V1	GND 1	Near 0	(2)	Mark	Pin 6 V1	GND 1	12 ± 6 V	(3)	Space	Pin 6 V1	GND 1	112 ± 6 V	(4)	Space	Pin 7 V1	GND 1	-38 ± 4 V
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(1)	Mark	Pin 7 V1	GND 1	Near 0																								
(2)	Mark	Pin 6 V1	GND 1	12 ± 6 V																								
(3)	Space	Pin 6 V1	GND 1	112 ± 6 V																								
(4)	Space	Pin 7 V1	GND 1	-38 ± 4 V																								
2																												

STEP	PROCEDURE																																								
<p>TABLE D</p> <p>143A2 REPEATER</p> <table border="1"> <thead> <tr> <th rowspan="2">TEST</th> <th rowspan="2">INPUT SIGNAL</th> <th colspan="2">(USE 300V SCALE)</th> <th rowspan="2">READING (VOLTAGE OF PLATE OR GRID)</th> </tr> <tr> <th>VOLTMETER +</th> <th>VOLTMETER -</th> </tr> </thead> <tbody> <tr> <td>(1)</td> <td>Mark</td> <td>Pin 7 V3</td> <td>GND 1</td> <td>-59 ±2 V</td> </tr> <tr> <td>(2)</td> <td>Mark</td> <td>TP8</td> <td>GND 1</td> <td>-34 ±15 V</td> </tr> <tr> <td>(3)</td> <td>Mark</td> <td>TP3</td> <td>GND 1</td> <td>113 ±10 V</td> </tr> <tr> <td>(4)</td> <td>Space</td> <td>TP8</td> <td>GND 1</td> <td>+98 ±10 V</td> </tr> <tr> <td>(5)</td> <td>Space</td> <td>Pin 7 V3</td> <td>GND 1</td> <td>-89 ±10 V</td> </tr> <tr> <td>(6)</td> <td>Space</td> <td>TP3</td> <td>GND 1</td> <td>-33 ±15 V</td> </tr> </tbody> </table>					TEST	INPUT SIGNAL	(USE 300V SCALE)		READING (VOLTAGE OF PLATE OR GRID)	VOLTMETER +	VOLTMETER -	(1)	Mark	Pin 7 V3	GND 1	-59 ±2 V	(2)	Mark	TP8	GND 1	-34 ±15 V	(3)	Mark	TP3	GND 1	113 ±10 V	(4)	Space	TP8	GND 1	+98 ±10 V	(5)	Space	Pin 7 V3	GND 1	-89 ±10 V	(6)	Space	TP3	GND 1	-33 ±15 V
TEST	INPUT SIGNAL	(USE 300V SCALE)		READING (VOLTAGE OF PLATE OR GRID)																																					
		VOLTMETER +	VOLTMETER -																																						
(1)	Mark	Pin 7 V3	GND 1	-59 ±2 V																																					
(2)	Mark	TP8	GND 1	-34 ±15 V																																					
(3)	Mark	TP3	GND 1	113 ±10 V																																					
(4)	Space	TP8	GND 1	+98 ±10 V																																					
(5)	Space	Pin 7 V3	GND 1	-89 ±10 V																																					
(6)	Space	TP3	GND 1	-33 ±15 V																																					

J. Selector Modulator Test

STEP	PROCEDURE
<p><i>Note:</i> If repeater is equipped for 8.62-pulse unit code, arrange it for 7.42-pulse unit code by removing tube V10.</p>	
<p>143A1 Repeater</p>	
1	Connect test set GND 1 lead to repeater TP1 to cause continuous output by the oscillator.
2	Connect GND 2 to repeater TP7 to disable the counting circuit.
3	With repeater SPEED switch set to 60, connect test set PROBE lead to repeater TP8.
4	Operate test set IN key to MARK and observe the waveshape on the oscilloscope. The waveshape should be similar to that shown in Fig. 14 in form and voltage amplitude.
5	Move test set PROBE lead to repeater TP3. The oscilloscope picture should be a smooth trace with no pulses of any kind.

STEP	PROCEDURE
	 <p style="text-align: center;">90 ± 20V (143A1 REP) 130 ± 15V (143A2 REP)</p>
	<p>Fig. 14</p>
6	<p>Change the input to spacing by operating test set IN key to SPACE and note that the waveshape shown in Fig. 14 appears.</p>
7	<p>Move PROBE lead back to repeater TP8 and note that the wave is smooth with no visible pulses.</p>
	<p>143A2 Repeater</p>
8	<p>At test set, connect -130V lead to pin 3 of repeater tube V3. For 143A2 arranged for 7.00-pulse unit code also connect GND 1 to TP7.</p>
9	<p>Connect PROBE lead to repeater TP9.</p>
10	<p>Operate the IN key to SPACE and observe that the oscilloscope waveshape is similar to that of Fig. 15.</p>
	 <p style="text-align: center;">135 ± 25V</p>
	<p>Fig. 15</p>

K. Counter Starting Circuit

STEP	PROCEDURE
1	<p><i>Note:</i> If repeater is equipped for 8.62-pulse unit code, arrange it for 7.42-pulse unit code by removing tube V10.</p> <p>If repeater is arranged for 7.42- or 11.00-pulse unit code, connect test set GND 1 to repeater TP1.</p>
2	If repeater is arranged for 7.00-pulse unit code, connect test set GND 1 to repeater TP7.
3	If a 143A1 repeater is being tested, also connect test set GND 2 to repeater TP3.
4	Connect test set PROBE lead to repeater TP4. The waveshape and amplitude of the pulse should appear as shown in Fig. 4.
5	If the repeater is a 143A1, remove test set GND 2 from repeater TP3.
6	If the repeater is a 143A2, arranged for 7.00-pulse unit code, remove test set GND 1 from repeater TP7.
7	If the repeater is a 143A2 arranged for either pulse unit code, connect test set GND 2 to repeater TP9.
8	At the oscilloscope, adjust the FINE FREQUENCY control slightly in a clockwise direction to bring the new picture to a standstill. For a repeater arranged for 7.42- or 11.00-pulse unit code, the waveshape and amplitude should appear as shown in Fig. 16. Note that one of the square waves is half as wide as the other three. For a repeater arranged for 7.00-pulse unit code, the waveshape and amplitude should appear as shown in Fig. 17.

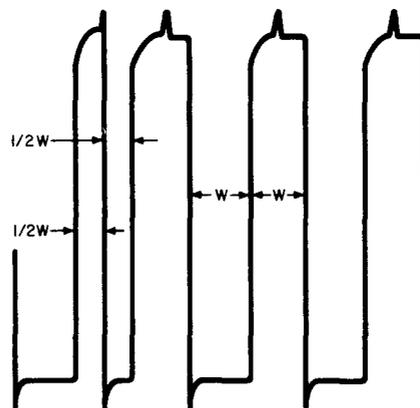
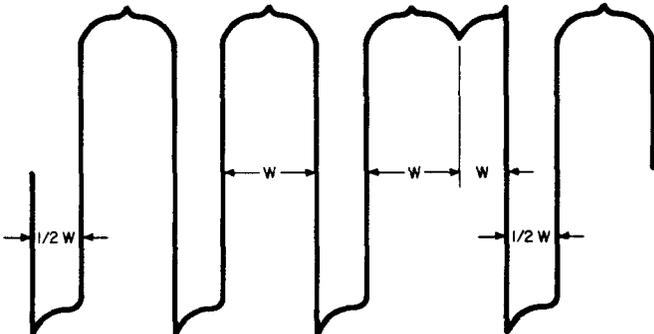


Fig. 16

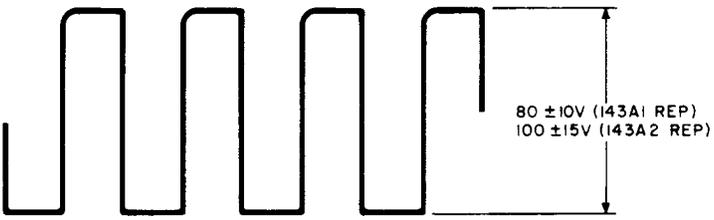
STEP	PROCEDURE
	 <p>Fig. 17</p>

L. Selection Hold Test

STEP	PROCEDURE
	<p>Note: If repeater is equipped for 8.62-pulse unit code, arrange for 7.42-pulse unit code by removing tube V10. This test applies to the 143A1 repeater only.</p> <ol style="list-style-type: none"> <li>1 At test set, connect GND 1 lead to repeater TP1 to cause continuous output by the oscillator. <li>2 At repeater, connect TP3 to TP8 using a double-ended clip lead. <li>3 Connect test set PROBE lead to TP9 of repeater. <li>4 At test set, operate IN key to MARK and observe that the oscilloscope waveshape is similar to that of Fig. 15. <li>5 Switch the input from marking to spacing and observe that the picture does not change.

M. Output Test

STEP	PROCEDURE
	<p>Note: If the repeater is equipped for 8.62-pulse unit code, arrange for 7.42-pulse unit code by removing tube V10.</p>

STEP	PROCEDURE
<p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p>	<p>143A1 Repeater</p> <p>Connect test set GND 1 lead to TP1 of repeater to cause continuous output by the oscillator.</p> <p>At repeater, connect TP3 to TP8 using a double-ended clip lead.</p> <p>At test set, touch PROBE lead to the sleeve of the STROB jack, removing the stroboscope cord from the STROB jack, if necessary. The picture should be similar in shape and voltage amplitude to that of Fig. 18.</p> <p>143A2 Repeater</p> <p>Operate IN key of the test set to SPACE.</p> <p>At test set, connect -130V lead to pin 3 of tube V3 of the repeater. For 143A2 arranged for 7.00-pulse unit code also connect GND 1 to TP7.</p> <p>Connect PROBE lead to pin 2 of tube V1 of the repeater.</p> <p>Disconnect the patching cord from STROB jack of the test set. The oscilloscope picture should be similar to that of Fig. 18.</p> <div style="text-align: center;">  </div> <p style="text-align: center;">Fig. 18</p>

N. Oscillator Stop Test

STEP	PROCEDURE
<p>1</p> <p>2</p> <p>3</p>	<p><i>Note:</i> If repeater is equipped for 8.62-pulse unit code, arrange for 7.42-pulse unit code by removing tube V10.</p> <p>Connect voltmeter + to repeater TP1.</p> <p>Connect voltmeter - to repeater pin 4 of coil L1.</p> <p>Operate test set IN key to MARK.</p>

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STEP	PROCEDURE
4	Connect -130V lead of test set to pin 3 of tube V6 of repeater. The voltmeter reading should be $23 \pm 12V$.
5	At the test set, operate the IN key to SPACE and observe that the meter reading is $15 \pm 10V$.
6	Disconnect -130V lead.
7	Connect GND 2 lead to repeater TP7. The voltmeter reading should be $23 \pm 12V$.
8	Operate IN key to MARK and observe that the voltmeter reading is $120 \pm 5V$.

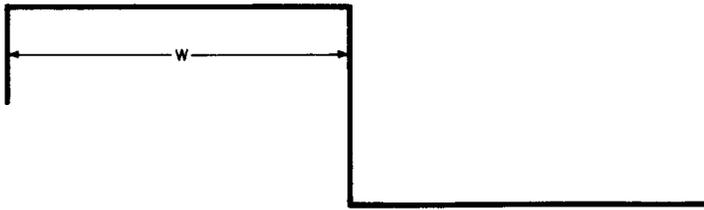
O. Marking Restore Test

STEP	PROCEDURE								
	<p><i>Note:</i> If repeater is equipped for 8.62-pulse unit code, arrange for 7.42-pulse unit code by removing tube V10.</p>								
1	Operate the test set IN key to MARK.								
2	Disconnect all test leads from the repeater.								
3	The repeater should remain connected to the test set, and BAT key of the test set should be operated to ON.								
4	If the repeater is a 143A2, connect -130V lead to pin 3 of V2.								
5	<p>Measure the voltage across R33 (143A1 repeater) or R24 (143A2 repeater) by connecting voltmeter + to pin 2 of V4 and voltmeter - to pin 2 of V5. The voltage should be as follows:</p>								
	<table> <thead> <tr> <th>REPEATER TYPE</th> <th>VOLTAGE READING BETWEEN</th> </tr> </thead> <tbody> <tr> <td>143A1</td> <td>0.5 and 0.8 V</td> </tr> <tr> <td>143A2 (7.00- or 7.42-pulse unit code)</td> <td>0.3 and 0.6 V</td> </tr> <tr> <td>143A2 (11.00-pulse unit code)</td> <td>0.4 and 1.2 V</td> </tr> </tbody> </table>	REPEATER TYPE	VOLTAGE READING BETWEEN	143A1	0.5 and 0.8 V	143A2 (7.00- or 7.42-pulse unit code)	0.3 and 0.6 V	143A2 (11.00-pulse unit code)	0.4 and 1.2 V
REPEATER TYPE	VOLTAGE READING BETWEEN								
143A1	0.5 and 0.8 V								
143A2 (7.00- or 7.42-pulse unit code)	0.3 and 0.6 V								
143A2 (11.00-pulse unit code)	0.4 and 1.2 V								

P. 8.62-Pulse Unit Code Test

STEP	PROCEDURE
	<p><i>Note:</i> This test applies only to repeaters which are wired for operation with the 8.62-pulse unit code.</p>
1	Verify that tube V10 is installed in repeater.
2	Operate SPEED switch to 75.
3	With the sending contacts and stroboscope of the 1A teletypewriter test set connected to the test set SIG and STROB jacks respectively, operate IN key of the test set to SIG.
4	With the 1A set arranged to send 60-speed signals, send repeated blank signals having 10 percent marking bias and observe the output of the regenerative repeater on the stroboscope.
5	Adjust the stroboscope so that the end of each repeated marking (stop) element is in line with scale marking 142 on the end of the STOP segment. The start of each repeated marking element should be in line with scale marking 60 in the FIVE segment.

Q. V11 Timing Circuit Test

STEP	PROCEDURE
	<p><i>Note:</i> This test applies only to 143A2 repeaters arranged for 7.00-pulse unit code.</p>
1	Connect test set GND 1 lead to repeater TP7.
2	Connect test set probe lead to repeater TP2.
3	Operate SPEED switch to 60 and adjust FINE FREQUENCY control of oscilloscope until one cycle of the pulse remains steady as shown in Fig. 19. Record the width of the positive pulse.
	
Fig. 19	

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STEP	PROCEDURE
4	Remove test set PROBE lead from repeater TP2 and GND 1 lead from TP7.
5	Operate IN key on test set to SPACE.
6	Connect test set PROBE lead to pin 4 of tube V11 and adjust R106 for a trace as shown in Fig. 19. Adjust R106 until the width of the positive pulse is the same as that recorded in Step 3.
7	Repeat Steps 1 through 6 for 75- and 100-speed settings, adjusting R114 for 75 speed and R115 for 100 speed.