HOW TO ADJUST THE VERTICAL AMPLIFIER AND DELAY LINE OF A 540-SERIES OSCILLOSCOPE

NOTICE

The delay line and vertical amplifier should not require frequent readjustment. These adjustments require adequate equipment and appreciable care. The adjustments are best effected by persons who have had Tektronix factory training in this work. You should not undertake such adjustments unless there is a definite need for them as indicated by tests indicated below.

GENERAL PROCEDURE AND REQUIRED EQUIPMENT

The standard procedure for adjusting the transient response of the vertical-deflection system, including the plug-in preamplifier, includes two principal operations. These are

1. Testing the vertical-deflection system of the oscilloscope itself, excluding the plug-in preamplifier, by means of the Type 53/54P Plug-In Test Unit, and making any needed adjustments. These tests and adjustments are described in the present publication.

2. And testing the response of the plug-in preamplifier, inserted in a properly adjusted 540-Series oscilloscope, by means of the Type 107 Square-Wave Generator, and making any needed adjustments. These adjustments are described in separate publications covering various types of plug-in preamplifiers.

If you have more than one plug-in preamplifier or 540-Series oscilloscope, and if you carry out the two operations listed above on all your 540-Series oscilloscopes and all your plug-in preamplifiers, you will then be able to use any of your plug-in preamplifiers with any of the oscilloscopes and still get optimum transient response with any preamplifier-oscilloscope combination.

You will need the following equipment when you follow the standard procedure in checking the vertical amplifier and delay line in the oscilloscope itself.

1. Instruction Manual for your oscilloscope.

2. Tektronix Type 54/54P Plug-In Test Unit with Instruction Manual.

3. 53/54-Series or 53-Series plug-in preamplifier of any type.

4. Dc voltmeter or vacuum-tube voltmeter (at least 20,000 ohms per volt), calibrated for an accuracy of 1% at 13 volts, and for an accuracy of 2% at 1350 volts. (Few portable voltmeters have comparable accuracy, particularly after a period of use. Be sure your voltmeter is accurate.)

5. Tektronix Type EP53A Gain Set Adapter.

6. Tektronix No. 003-007 Alignment Tool (see Fig. 1).

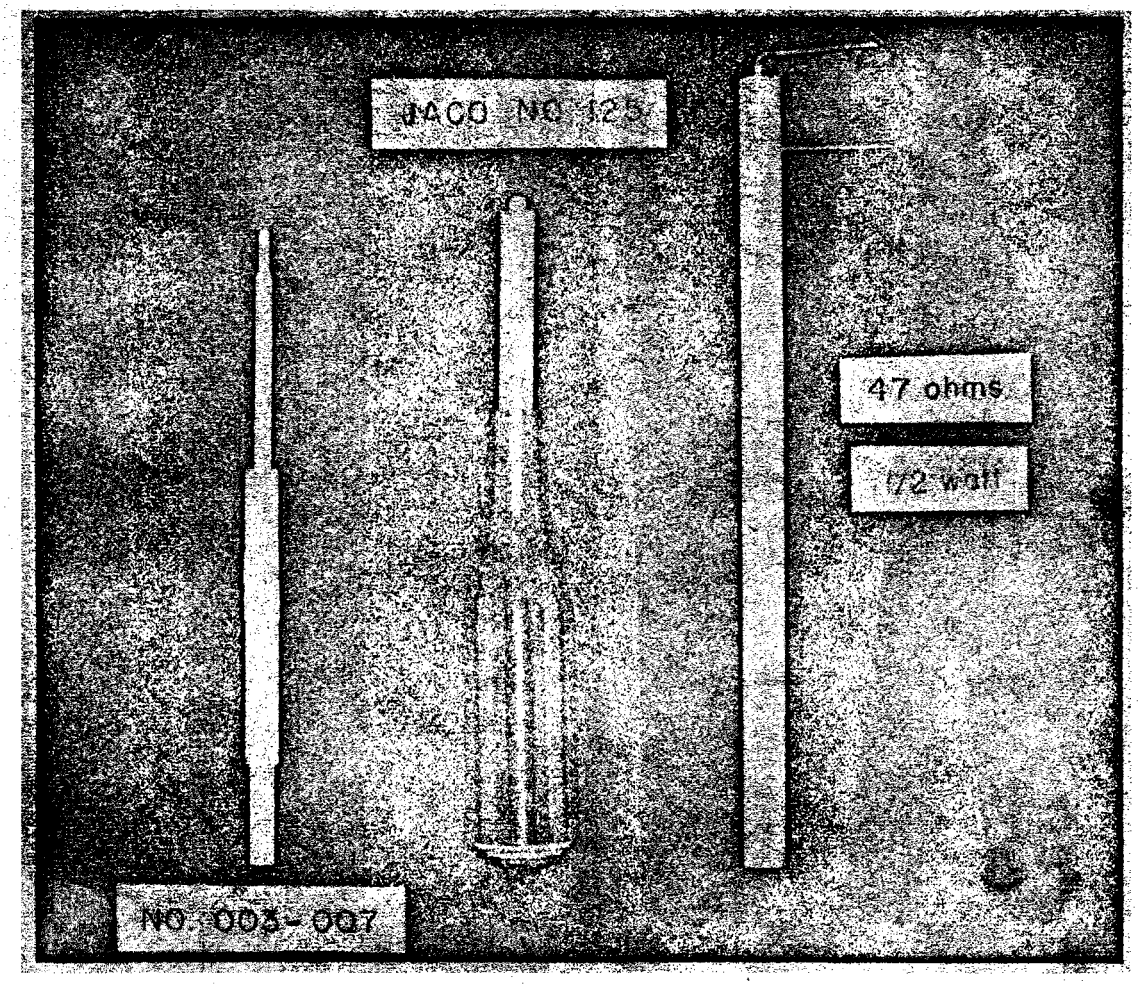

Fig. 1. Certain items listed for testing and alignment of 540-Series oscilloscopes.

7. Insulated alignment screwdriver, such as Jaco No. 125 with 1½-inch shank (see Fig. 1).

8. 47-ohm ½-watt composition resistor, taped or mounted on end of plastic rod about 6 inches long (see Fig. 1).

9. Test lead about 18 inches long, fitted with a banana plug at each end (such as Tektronix No. 012-013).

PRELIMINARY CHECKS AND ADJUSTMENTS

How to display the output waveform of the Type 53/54P

1. Insert the Type 53/54P Plug-In Test Unit into the oscilloscope. Position the oscilloscope physically so that one or the other of the UP arrows on the Type 53/54P points upward.

2. Set the controls as follows:

POWER	OFF
HORIZONTAL DISPLAY	INTERNAL SWEEP (Type 541) or MAIN SWEEP NORMAL (Type 545)

Main Sweep controls:

TRIGGER SLOPE	+INT.
TRIGGERING MODE	AC FAST
TRIGGERING LEVEL	full right or full left
STABILITY	PRESET*
TIME/CM	.1 MICROSEC
MULTIPLIER	2

Plug-in unit controls:

COIL CURRENT	OFF
AMPLITUDE	0
VERTICAL POSITION	centered

*If the STABILITY control on your oscilloscope doesn't have a PRESET position, turn the STABILITY control full right.

3. Turn the oscilloscope POWER switch ON and allow a few minutes for the oscilloscope to warm up to operating temperature. If the STABILITY control on your oscilloscope doesn't have a PRESET position, turn the STABILITY control slowly toward the left until the trace disappears, then two or three degrees farther to the left.

4. Turn the AMPLITUDE control on the Type 53/54P 90 degrees right. Turn the COIL CURRENT switch ON. Turn the Main Sweep TRIGGERING LEVEL control slowly toward 0 until you observe a stable display having the general appearance of Fig. 2, including the entire rising portion of the waveform at the left-hand part of the graticule. Adjust the FOCUS and INTENSITY controls for the sharpest possible trace. Set the AMPLITUDE control for a suitable amount of vertical deflection (for example, 3 centimeters. Adjust the VERTICAL POSITION control so that the display is centered vertically on the graticule.

How to check the transient response of the vertical-deflection system

Before making any adjustments, read or scan this entire section on "How to

check the transient response of the vertical-deflection system," in order to familiarize yourself with the general nature and scope of the adjustments that may be required.

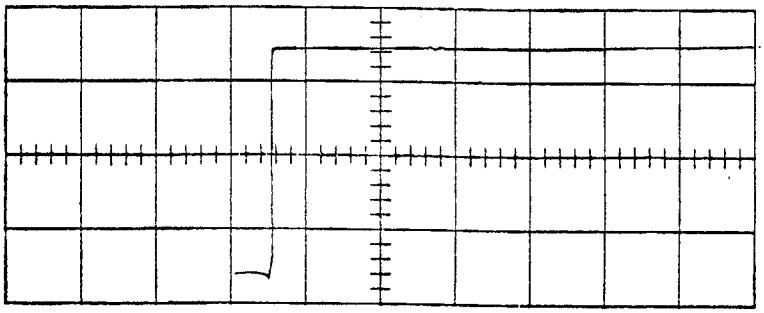

Fig. 2. Appearance of the display on a properly adjusted oscilloscope.

Things to look for in the display are:

1. Does the waveform have a sharp dip over a short region to the right of the corner (Fig. 3)? If it does, the fault likely lies in

V1050 and/or V1052	in Type 541 Oscilloscopes having serial numbers lower than 6475, or
	in Type 545 Oscilloscopes having serial numbers lower than 9292.
V1033 and/or V1043	in Type 541 Oscilloscopes having serial numbers 6475 or higher, or
	in Type 545 Oscilloscopes having serial numbers 9292 or higher.

Change the above tubes as required to remove this dip from the display.

2. a. Does the waveform have a sloping characteristic following the corner (Fig. 4)? If it does, the fault likely lies in

V1025 and/or V1040	in Type 541 Oscilloscopes having serial numbers lower than 6475, or in Type 545 Oscilloscopes having serial numbers lower than 9292.
V1014 and/or V1024	in Type 541 Oscilloscopes having serial numbers 6475 or higher, or in Type 545 Oscilloscopes having serial numbers 9292 or higher.

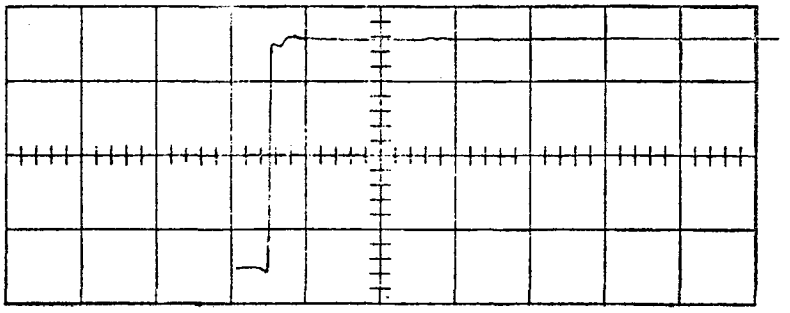

Fig. 3. Illustrating sharp dip in waveform caused by defective V1033 and/or V1043 (V1050 and/or V1052 in older oscilloscopes).

Change the above tubes as required to remove the sloping characteristic from the display.

b. In Type 541 Oscilloscopes having serial numbers 6475 or higher, and in Type 545 Oscilloscopes having serial numbers 9292 or higher, insert the Type EP53A Gain Set Adapter between the Type 53/54P Plug-In Unit and its interconnecting plug in the oscilloscope. Connect the test lead from the CAL. OUT connector to the connector in the Type EP53A. Set the Main Sweep TIME/CM switch to 1 MILLISEC and leave the MULTIPLIER at 2. Set the SQUARE-WAVE CALIBRATOR controls to .2 VOLTS. Turn the TRIGGERING MODE switch to AUTOMATIC (or AC AUTO.). If the TRIGGERING MODE switch has an AC AUTO. position, rather than an AUTOMATIC position, turn the Main Sweep STABILITY control full right; then turn the Main Sweep STABILITY control slowly toward the left until you get a stable display of the calibrator waveform. If the tops of the square waves in the display slope appreciably downward

toward the right, change V1014 and/or V1024 so that the waves have flat tops.

Now remove the Type 53/54P, the Type EP53A and the test lead. Reinsert the Type 53/54P with its interconnecting plug directly inserted in the

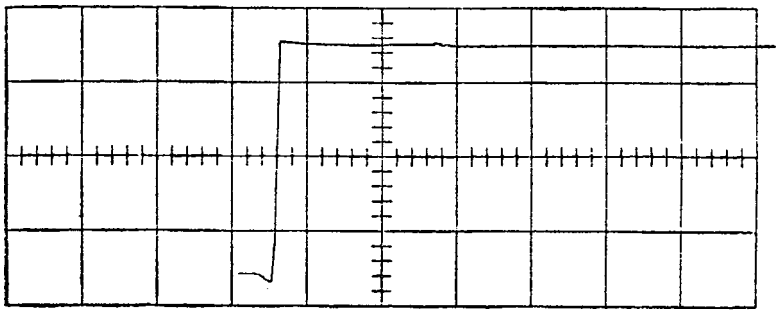

Fig. 4. Illustrating sloping characteristic in the waveform caused by defective V1014 and/or V1024 (or V1025 and/or V1040 in older oscilloscopes).

interconnecting plug of the oscilloscope itself. Readjust the controls to display the output waveform of the Type 53/54P as described above under the heading "How to display the output waveform of the Type 53/54P."

3. Does the general "level" of the early part of the top of the waveform (say the first 2 or 2½ centimeters) rise or fall noticeably (Fig. 5)? Now turn the MULTIPLIER control to 5. Is a section of the display noticeably lower than the rest of the display (Fig. 6)? If either of these faults exists, proceed directly to the part of this publication headed "Detailed adjustment of the vertical amplifier and delay line."

   Now reset the MULTIPLIER control to 2.

4. Are there any excessive wrinkles along the flat top of the displayed waveform (Fig. 7)? Wrinkles normally will not exceed about 1 tracewidth in amplitude. Excessive wrinkles can cause aberrations in the display of a fast waveform. Wrinkles along the flat top of the displayed square wave might result from gradual changes in delay-line adjustments caused by vibration. Wrinkles as severe as those in the display of Fig. 7 would perhaps appear only if the oscilloscope were subjected to excessive vibration or shock, or to severe temperature variations. Figure 7 illustrates a case where the entire delay line needs readjustment. In a case like this, proceed directly to the section

on "Detailed adjustment of the vertical amplifier and delay line."

NOTE: Do not confuse the above case of severe wrinkles in the display with the normal slight termination bump discussed next.

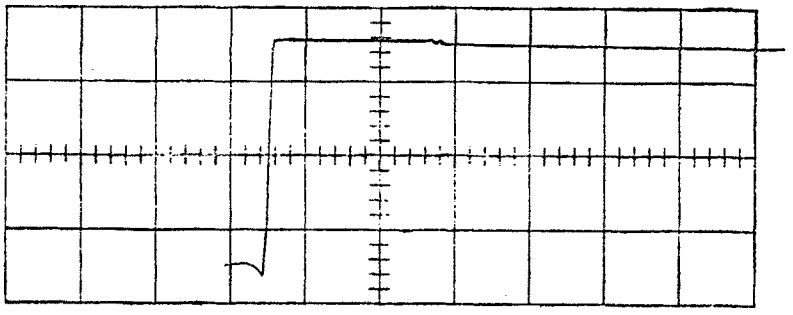

Fig. 5. Illustrating a "rising" general "level" of early part of waveform. A "falling" level is also possible. These conditions require detailed readjustment.

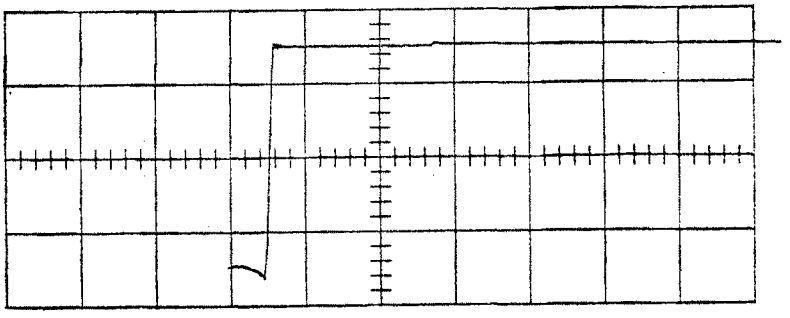

Fig. 6. Here a section of the display is noticeably lower than the rest of the display. This condition requires detailed readjustment.

5. There will often be a slight wrinkle called a "termination bump" in the displayed waveform, located about 2½ centimeters to the right of the corner of the waveform (see Fig. 2). Does the termination bump appreciably exceed about 2 tracewidths in amplitude (as in Fig. 8)? Or are there perhaps two or three other small bumps along the flat top of the waveform as shown in Fig. 8--and as contrasted to the severely wrinkled display of Fig. 7? If so, reset the

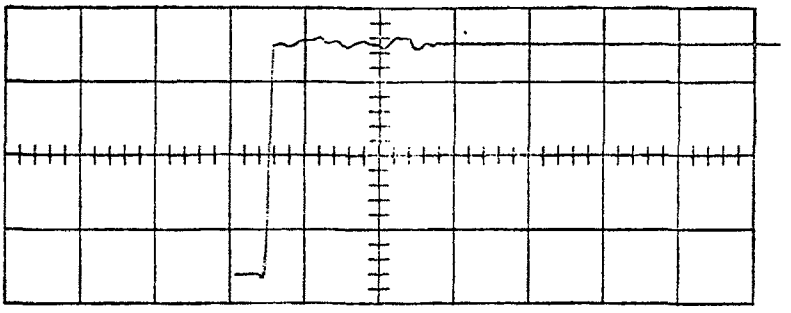

Fig. 7. Illustrating severe wrinkles along flat top of waveform. This condition requires detailed adjustment.

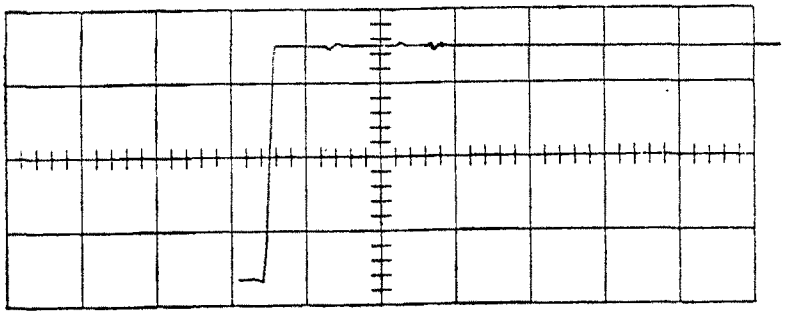

Fig. 8. Illustrating excessive termination bump; also some other small bumps. These defects can be removed by minor readjustments, described here in Part 5 of the text.

following adjustments as necessary to reduce the bump(s), using the No. 003-007 tool:

C1073, C1075, C1076, C1077, C1084, C1093, C1103, C1113, C1123, C1133, and the 5 or 6 delay-line capacitors nearest the vertical amplifier	in Type 541 Oscilloscopes having serial numbers lower than 6475, or in Type 545 Oscilloscopes having serial numbers lower than 9292;
	OR
C1075, C1077, C1078, L1071, L1073, C1104, C1124, C1144, C1164, C1184, C1204, and the 5 or 6 delay-line capacitors nearest the vertical amplifier	in Type 541 Oscilloscopes having serial numbers 6475 or higher, or in Type 545 Oscilloscopes having serial numbers 9292 or higher.

IMPORTANT NOTICE

a. Make only small changes at any one time in the setting of a given adjustment. Typically, an individual change will be only a small fraction of a turn--usually little more than a "touch." Such an adjustment should raise or lower the corresponding part of the display less than the width of the trace.

b. At the sweep rate you are using (TIME/CM: 1 MICROSEC; MULTIPLIER: 2), the above adjustments will affect only the portion about 2½ centimeters long to the right of the corner of the displayed waveform. When you are adjusting delay-line capacitors, the portion of the wave affected by a particular adjustment can be identified by a small bump on the waveform that occurs when you apply to that capacitor even the tiny additional capacitance due to the wire bit in the alignment tool.

c. The adjustments interact. Work always for maximum smoothness in the display. Don't expect any single adjustment change to get the correct display height at a given point. Rather, work back and forth over a range of a few adjustments at a time, making very small changes in the setting of any one adjustment.

d. Before adjusting the slug in an inductor, be sure that the tool is completely engaged with the slug, or you might break the slug. This would necessitate replacing the slug or the entire inductor. If the slug sticks unduly, you can initially use a metal 5/64" metal allen wrench to free it--again being careful to engage the wrench completely with the slug before turning it.

As a result of the above adjustments, a region of the flat-top part of the waveform just to the right of the corner, will probably be a little higher or lower than the rest of the wave top (Fig. 9). Carefully readjust the delay-line capacitors nearest the cathode-ray tube to bring this part of the waveform to the same "level" as that of the rest of the top of the waveform. Follow the instructions given above under the heading "Important Notice." You will probably not have to adjust the inductors between the delay line and the cathode-ray-tube vertical-deflection plates.

6. Does the leading edge of the waveform, at the left-hand end of the graticule, appear normal? If the oscilloscope is correctly adjusted, the leading edge of the waveform will rise steeply as shown in Fig. 2, and the corner will be sharp without appreciable rolloff or overshoot.

   If there is appreciable rolloff due to maladjustment or malfunctioning of the vertical-deflection system, as shown in Fig. 10, then fast-rising waveforms will not be properly displayed. Furthermore, the high-frequency response of the instrument will be less than normal.

   If there is appreciable overshoot due to maladjustment or malfunctioning of the vertical-deflection system, as shown in Fig. 11, then fast-rising waveforms will not be properly displayed. Furthermore, the high-frequency response of the instrument will be excessive, so that you might get misleading indications in your normal use of the oscilloscope.

   If there is either a rolloff or an overshoot at the corner of the waveform, carefully readjust the controls listed below, following the instructions given in Part 5 above under the heading "Important Notice." Use the No. 003-007 tool. Notice that the inductor adjustments are listed in pairs. Final settings should be such that the physical position of the slug in any inductor is approximately the same as that of the slug of the inductor paired with it. Adjust for the sharpest corner in the displayed waveform and for the steepest rise in the leading edge.

L1254 and L1255 L1021 and L1042 L1022 and L1041 (if adjustable) The 2 or 3 delay-line capacitors nearest the cathode-ray tube	in Type 541 Oscilloscopes having serial numbers lower than 6475, or in Type 545 Oscilloscopes having serial numbers lower than 9292.

OR

L1345 and L1355 L1014 and L1024 L1036 and L1046 The 2 or 3 delay-line capacitors nearest the cathode-ray tube	in Type 541 Oscilloscopes having serial numbers 6475 or higher, or in Type 545 Oscilloscopes having serial numbers 9292 or higher.

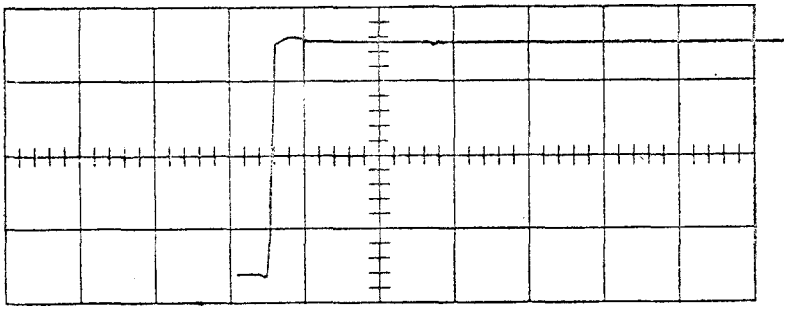

Fig. 9. The part of the waveform near the corner has been raised as a result of adjustments to reduce an originally excessive termination bump. Alternatively, the region near the corner may be lowered, rather than raised.

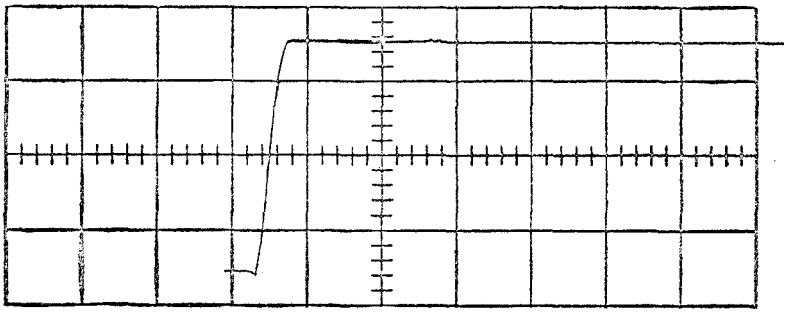

Fig. 10. Illustrating rolloff at corner of waveform.

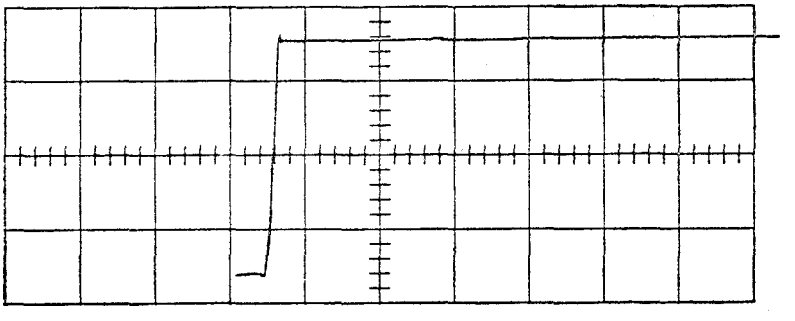

Fig. 11. Illustrating overshoot at corner of waveform.

When the adjustments are completed, the corner and the leading edge of the displayed waveform should look like those of Fig. 2.

DETAILED ADJUSTMENT OF THE VERTICAL AMPLIFIER AND DELAY LINE

You should not undertake the detailed adjustment of the vertical amplifier and delay line unless the checks previously described have shown the detailed adjustment to be necessary. If the detailed adjustment is necessary, carry out the steps in the order given below.

How to adjust the output voltage of the high-voltage supply

Operate the oscilloscope with the Type 53/54P or any plug-in preamplifier in place. Connect the voltmater between ground and the -1350-volt output of the high-voltage supply (available at the first left-hand terminal of the ceramic strip adjacent to the CRT GEOM ADJ control). Adjust the HV ADJ control for a reading of -1350 volts.

How to adjust the crt GEOM. ADJ. control

Use a plug-in preamplifier of any type. Apply more vertical signal from the calibrator than is needed to cover the graticule vertically. Position the display vertically so that the flat tops of the square waves are off the screen both above and below the graticule lines. Turn up the INTENSITY control so that the spot, moving rapidly in the vertical direction, makes a visible trace. Now set the GEOM. ADJ. control (near the rear of the top deck) so that the vertical traces near the ends of the graticule are as nearly straight and vertical as possible.

As a further check on the GEOM. ADJ. adjustment, remove the calibrator signal and position a free-running trace first to the uppermost graticule line and then to the lowest graticule line. The trace should lie along the upper and the lower graticule lines without noticeable upward or downward bowing. A retouching of the GEOM. ADJ. control should clear up any normal amount of bowing.

The GEOM. ADJ. adjustment is often rather broad. Within the limits of its range giving satisfactory results under the two paragraphs next above, use that setting which gives the least noticeable flare on the screen (when the SWEEP LENGTH control on the top deck of the oscilloscope, and the positioning controls, are set so that the display lies entirely within the graticule lines.

How to check the vertical-deflection factor of the cathode-ray tube

This step applies only to Type 541 Oscilloscopes having serial numbers lower than 6475, and to Type 545 Oscilloscopes having serial numbers lower than 9292. In these oscilloscopes, the vertical-deflection factor of the cathode-ray tube must be between 6.25 and 6.75 volts per centimeter. This results in a setting of the GAIN ADJ. control (described later) that preserves the excellent trans-

ient response inherent in the oscilloscope. To determine the deflection factor of the cathode-ray tube, you will have to measure the voltage difference necessary, at the vertical-deflection plates, to move the beam from the top to the bottom line of the graticule. Do this as follows:

1. Place the Type 53/54P Plug-In Unit in the oscilloscope. Turn the COIL CURRENT OFF. Position a free-running trace to the top line of the graticule. Measure with the voltmeter the voltage between the vertical-deflection plates. Now position the trace to the bottom graticule line and again measure the voltage between the vertical-deflection plates, remembering to reverse your voltmeter connections. This voltage will be approximately 13 volts. Add the two voltage readings and divide the sum by four. The result is the vertical-deflection factor of the cathode-ray tube. If this falls between 6.25 and 6.75 volts per centimeter, proceed to the operation given later under the heading "How to check for certain faults in the tubes."

2. If the vertical-deflection factor does not fall between 6.25 and 6.75 volts per centimeter, it will be necessary to adjust the vertical-shield voltage on the cathode-ray tube so that it does. Refer to Fig. 12 for the location of resistors R863 and R864. By increasing the resistance of R863 or by decreasing the resistance of R864, you can reduce the vertical-shield voltage and thus

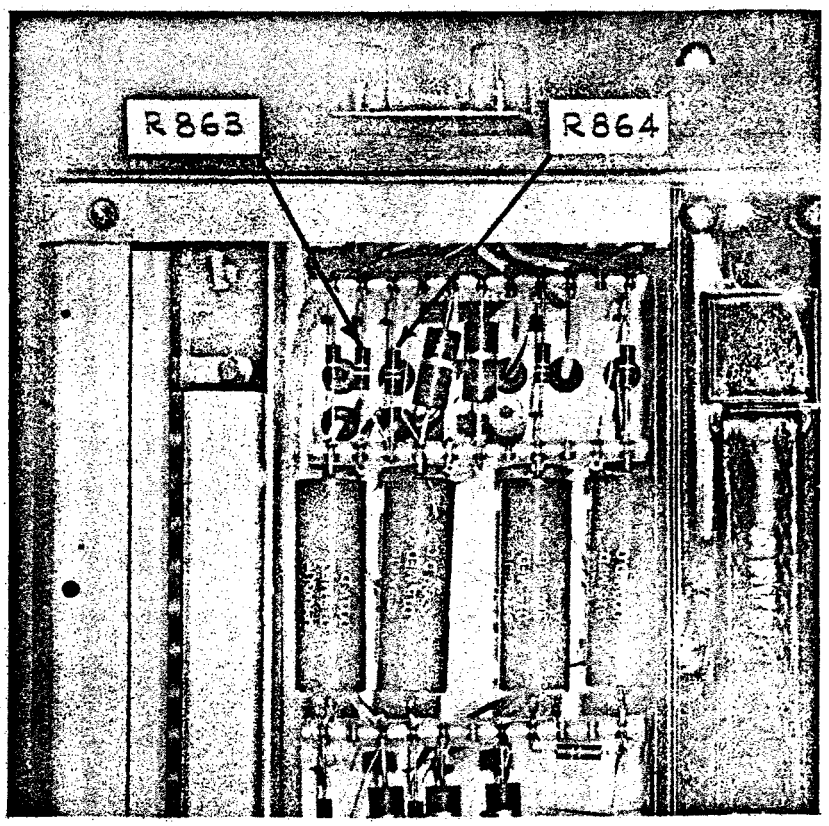

Fig. 12. Locations of R863 and R864, shown with focus-and-intensity shield removed.

reduce the vertical-deflection factor of the cathode-ray tube. Decreasing the resistance of R863 or increasing the resistance of R864 will increase the vertical-deflection factor. The vertical-shield voltage at the junction of R863 and R864 must measure between 260 and 265 volts after you have made any necessary changes in either of these resistors. Furthermore, the total resistance of R863 and R864 should not be changed by more than 10%. Recheck the preceding operation, under the heading "How to adjust the crt GEOM. ADJ. control," if you changed either R863 or R864.

How to check for certain faults in the tubes

Display the waveform of the Type 53/54P Plug-In Test Unit, as described previously under the heading "How to display the output waveform of the Type 53/54P." Check for faulty tubes as described in Parts 1 and 2 under "How to check the transient response of the vertical-deflection system," explained previously.

How to check the vertical-deflection system for balance

Insert a plug-in preamplifier of any type in the oscilloscope. Remove the bezel from the oscilloscope graticule, but leave the graticule in place. Operate the oscilloscope with a free-running trace. Use no vertical-deflection (INPUT) signal. Short-circuit the vertical-deflection plates to each other. Adjust the graticule cam so that the trace lies along the horizontal center line of the graticule. Remove the short circuit from the vertical-deflection plates, and short-circuit Pins 1 and 3 of the interconnecting socket for the plug-in unit. The vertical position of the trace should now be within 1 centimeter of the graticule horizontal center line. If it is not, the vertical-deflection system is not balanced, and you should proceed directly to the step below headed "How to balance the vertical-deflection system." If the trace is within 1 centimeter of the graticule horizontal center line, omit the next step headed "How to balance the vertical-deflection system," and readjust the graticule cam so that the trace is fully visible when positioned both to the top and to the bottom graticule lines by means of the VERTICAL POSITION control.

How to balance the vertical-deflection system

If, in the preceding step, you found that the vertical-deflection system is out of balance, proceed as follows:

1. In Type 541 Oscilloscopes having serial numbers lower than 6475, or in Type 545 Oscilloscopes having serial numbers lower than 9292, locate the junction of R1052 and L1081 (here referred to as point a), and locate the junction of R1054 and L1082 (referred to as point b). In Type 541 Oscilloscopes having serial numbers 6475 or higher, or in Type 545 Oscilloscopes having serial numbers 9292 or higher, locate the junction of R1039 and L1103 (referred to as point a), and locate the junction of R1049 and L1113 (referred to as point b).

2. Using the 47-ohm resistor mounted on the plastic rod, connect point a to point b. The trace should lie within 1 minor graticule division of the graticule horizontal center line. If it does not, connect the (-) terminal of an accurate voltmeter (using the 3-volt range) to either end of the short-circuiting 47-ohm

resistor. Connect the (+) lead of the voltmeter successively to Pin 2 of each of the following tubes:

Type 541--serial lower than 6475 or Type 545--serial lower than 9292	Type 541--serial 6475 or higher or Type 545--serial 9292 or higher
V1060	V1064
V1080	V1114
V1090	V1134
V1100	V1154
V1110	V1174
V1120	V1194
V1130	V1214

In each case, the voltmeter reading should be within the range from 0.9 to 1.6 volts. If it is not, change one or both of the tubes in the push-pull pair involved so that the reading falls within the range from 0.9 to 1.6 volts. In oscilloscopes covered by the left-hand column above, you can usually get best results by using Tektronix tested tubes (6CB6, Tektronix No. 157-037).

3. In Type 541 Oscilloscopes having serial numbers lower than 6475, or in Type 545 Oscilloscopes having serial numbers lower than 9292, locate the junction of R1021 and L1022 (referred to as point c), and locate the junction of R1042 and L1041 (referred to as point d). In Type 541 Oscilloscopes having serial numbers 6475 or higher, or in Type 545 Oscilloscopes having serial numbers 9292 or higher, locate the junction of R1036 and L1036 (referred to as point c), and locate the junction of R1046 and L1046 (referred to as point d).

4. Using the 47-ohm resistor mounted on the plastic rod, connect point c to point d. The trace should lie within ½ centimeter of the horizontal center line. If it does not, replace V1050 or V1052 in Type 541 Oscilloscopes having serial numbers lower than 6475 or in Type 545 Oscilloscopes having serial numbers lower than 9292; or replace V1033 or V1043 in Type 541 Oscilloscopes having serial numbers 6475 or higher, or in Type 545 Oscilloscopes having serial numbers 9292 or higher.

5. This Part 5 applies only to Type 541 Oscilloscopes having serial numbers 6475 or higher, and Type 545 Oscilloscopes having serial numbers 9292 or higher. Using the 47-ohm resistor mounted on the plastic rod, connect Pin 2 of V1033 to Pin 2 of V1043. The trace should lie within ½ centimeter of the horizontal center line. If it does not, use the ohmmeter to check that the values of R1036 and R1046 are equal. If the resistors are equal in value, but if the trace still does not lie within ½ centimeter of the horizontal center line, change V1033 or V1043.

6. Using a short piece of wire, short-circuit Pin 1 of the interconnecting socket for the plug-in preamplifier to Pin 3 of that socket. The trace should now lie within 1 centimeter of the horizontal center line. If it does not, replace V1025 or V1040 in Type 541 Oscilloscopes having serial numbers below 6475 or in

Type 545 Oscilloscopes having serial numbers below 9292; or replace V1014 or V1024 in Type 541 Oscilloscopes having serial numbers 6475 or higher or in Type 545 Oscilloscopes having serial numbers 9292 or higher.

How to readjust the graticule cam

Now readjust the graticule cam if necessary so that the trace is fully visible when positioned both to the top and to the bottom graticule lines by means of the VERTICAL POSITION control. Replace the bezel.

How to adjust the DC SHIFT COMP control

1. Set the AC-DC switch (or the INPUT SELECTOR switch) of the plug-in preamplifier to DC. Position the trace to the bottom graticule line.

2. Connect a 1.5-volt cell (or an ohmmeter) getween GND and the INPUT or CHANNEL connector of the plug-in preamplifier. Adjust the VOLTS/CM switch and the VARIABLE control so that the trace moves to a position about 1 minor division below the top graticule line.

3. Set the Main Sweep TIME/CM switch to 1 SEC and the MULTIPLIER switch to 1, so that you see a slow-moving free-running trace.

4. Now, as the spot moves slowly across the graticule, momentarily break the battery connection about every 2 seconds (that is each time the spot has moved about 2 centimeters across the graticule). If the tops of the resulting rectangular-wave display are not flat, readjust the DC SHIFT COMP control so that they are.

How to check the operation of the vertical beam-position indicators

1. With the VERTICAL POSITION control, position the beam just above and then just below the scribed portion of the graticule, and check that in each case the proper beam-position-indicator lamp is lighted. If it is not, proceed as follows.

2. a. In Type 541 Oscilloscopes having serial numbers below 6475 or in Type 545 Oscilloscopes having serial numbers below 9292, replace V1025 or V1040 as required to get proper operation of the beam-position-indicator lamps. If this tube replacement is necessary, repeat Part 6 of the step headed "How to balance the vertical-deflection system," above.

OR

b. In Type 541 Oscilloscopes having serial numbers 6475 or higher, or in Type 545 Oscilloscopes having serial numbers 9292 or higher, replace V1084 as required to get proper operation of the beam-position-indicator lamps. If changing V1084 does not readily make the vertical beam-position-indicator lamps operate properly, and if R1083 and R1087 have values of 330K, you should try changing one or both of these resistors to 390K.

How to test the oscilloscope vertical-deflection system for microphonics

Remove the plug-in preamplifier and replace it with the Type 53/54P. Operate the oscilloscope with a free-running trace and with the COIL CURRENT turned off in the Type 53/54P. Operate the Main Sweep MULTIPLIER switch rather rapidly throughout its range, and note whether the resulting mechanical vibration causes any "ringing" or periodic type of microphonics in the display. If it does, you can often isolate the microphonic tube by tapping on the individual tubes with the finger. Usually, the difficulty will be found in the input stage of the vertical amplifier. Replace vertical-amplifier tubes as necessary to cure the microphonic condition. If it becomes necessary to change tubes because of microphonics, repeat previous checks for balance and for beam-position-indicator operation, and for waveforms, involving the tubes you changed.

How to set the GAIN ADJ. control

Insert the Type EP53A Gain Set Adapter between the Type 53/54P and the interconnecting socket on the oscilloscope. With the test lead, connect the CAL. OUT connector to the receptacle of the Type EP53A. Set the calibrator controls for .2 VOLTS. Set the Main Sweep TIME/CM control to 1 MILLISEC and the MULTIPLIER to 1. Get a stable display of the calibrator square wave. With the screwdriver, adjust the GAIN ADJ. control so that the vertical deflection caused by the calibrator square wave occupies just 2 centimeters on the graticule.

How to check for compression in the vertical system

The 2-centimeter deflection provided by the square-wave calibrator signal should not be reduced by more than ¼ minor graticule division when the display is raised to the top of the graticule or lowered to the bottom of the graticule by means of the VERTICAL POSITION control.

How to check for cathode-interface impedance

The tops of the waveforms displayed in the previous two steps should be flat. If the tops of the waveforms slope downward to the right, this indicates cathode-interface impedance in V1025 or V1040 (Type 541 Oscilloscopes having serial numbers lower than 6475 or Type 545 Oscilloscopes having serial numbers lower than 9292), or in V1014 or V1024 (Type 541 Oscilloscopes having serial numbers 6475 or higher or Type 545 Oscilloscopes having serial numbers 9292 or higher. If you have to change these tubes to eliminate the interface problem, recheck Part 6 of the step headed "How to balance the vertical-deflection system," above. Also recheck the steps headed "How to check the operation of the vertical beam-position indicators," "How to test the oscilloscope vertical-deflection system for microphonics," "How to set the GAIN ADJ. control," and "How to check for compression in the vertical system."

How preset the inductors in the vertical-deflection system

CAUTION: When you are adjusting inductor slugs having allen-wrench openings (hexagonal wrench openings), be sure the No. 003-007 tool is completely engaged with the slugs before attempting to turn the slugs, or you might break the slugs. This would necessitate replacement of the slugs or of the entire inductors. If the slug

sticks unduly, you can initially use a metal 5/64" allen wrench to free it--again being careful to engage the wrench completely with the slug before turning it.

In Type 541 Oscilloscopes having serial numbers lower than 6475 or in Type 545 Oscilloscopes having serial numbers lower than 9292, preset L1254 and L1255 so that the slugs are barely outside the coils (toward the outer part of the oscilloscope). Preset the slugs in L1022 and L1041 (if these inductors are adjustable in your oscilloscope) so that the slugs are just entering the coils (from the lower side). Preset the slugs in L1021 and L1042 to a position about halfway inside their coils, from the chassis top.

OR

In Type 541 Oscilloscopes having serial numbers 6475 or higher, or in Type 541 Oscilloscopes having serial numbers 9292 or higher, preset L1354 and L1355 so that the slugs are barely outside the coils (toward the outer part of the oscilloscope). Preset the slugs in L1014 and L1041 so that the slugs are just entering the coils (from the lower side). Preset the slugs in L1036 and L1046 to a position about half-way inside their coils, from the chassis top.

How to adjust the delay line

1. Remove the Type EP53A and the test lead. Insert the Type 53/54P directly into the oscilloscope interconnecting socket. Display the output waveform of the Type 53/54P as previously described under the heading "How to display the output waveform of the Type 53/54P." Set the Main Sweep TIME/CM control to .1 MICROSEC and the MULTIPLIER to the red 5-2 setting. Adjust the FOCUS, INTENSITY and ASTIGMATISM controls for the sharpest possible trace. Set the AMPLITUDE control of the Type 53/54P for a vertical deflection of 2 centimeters. With the HORIZONTAL POSITION control, locate the leading edge of the waveform near the horizontal center of the graticule.

2. Use the No. 003-007 tool to adjust the delay-line capacitors. Start with the red MULTIPLIER knob in the full-right position. Observe the following instructions carefully:

   a. The delay-line components including the capacitors have an appreciable voltage on them. Do not touch the components.

   b. Delay-line capacitors near the top of the oscilloscope affect the early part of the displayed wave, toward the left-hand end of the display. Lower capacitors affect the later parts of the display. The portion of the wave affected by a particular capacitor can be identified by the very slight "bump" occurring when that capacitor is touched by the wire-screwdriver end of the No. 003-007 tool.

   c. Make only a small change at any one time in the setting of a given capacitor. Typically, an individual change will be only a small fraction of a turn---usually little more than an "touch." Such an adjustment should raise or lower the corresponding part of the display less than the width of the trace.

   d. In adjusting the delay-line capacitors, the following objectives should be

kept in mind: (1) to reduce the wrinkles in the top of the display to a minimum--not more than about 1 tracewidth in amplitude, and (2) to make the part of the display that is affected by the delay line flat and consistent in "level" with the rest of the flat top. When you turn the red MULTIPLIER knob full right, the delay line affects about the first 2½ centimeters of the display to the right of the corner of the waveform. After every few capacitor adjustments, turn the red MULTIPLIER full left, so that the section of the display affected by the delay line occupies only about the first 3/4 centimeter to the right of the corner of the displayed waveform. This allows you better to compare the general "level" of the part of the waveform affected by the delay line with the "level" of the rest of the waveform. Then you can turn the red MULTIPLIER knob full right again, and continue your adjustments. Keep in mind that you might not be able completely to eliminate the "termination bump" discussed in the section headed "How to check the transient response of the vertical-deflection system," above.

e. The adjustments interact. Work always for maximum smoothness in the display. Don't expect any single adjustment change to get the correct display height at a given point. Rather, work back and forth over a range of a few adjustments at a time, making very small changes in the setting of any one adjustment.

f. Make the necessary adjustments to get the termination bump as small as possible (as discussed in the section on "How to check the transient response of the vertical-deflection system," above.

How to adjust for proper leading edge and waveform corner

Make the adjustments described under Item 6 in "How to check the transient response of the vertical-deflection system," above, in order to get the steepest rise to the leading edge and the sharpest corner in the waveform without rolloff or overshoot.