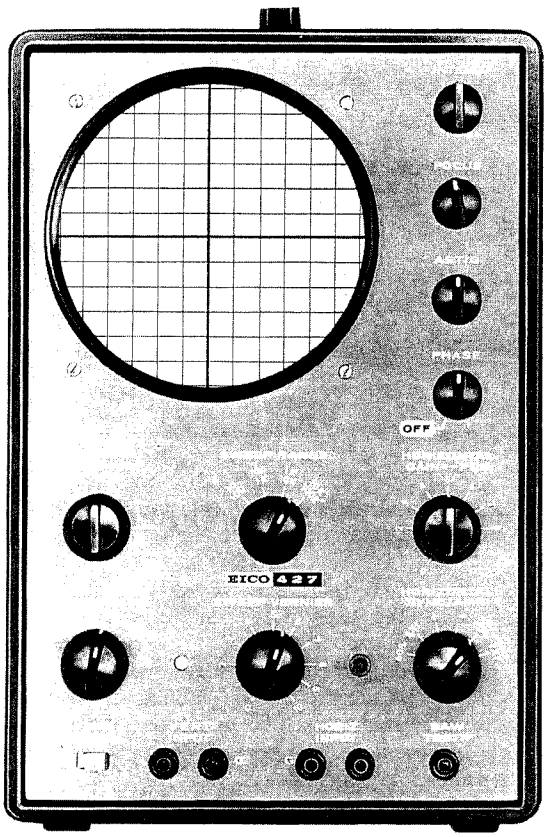
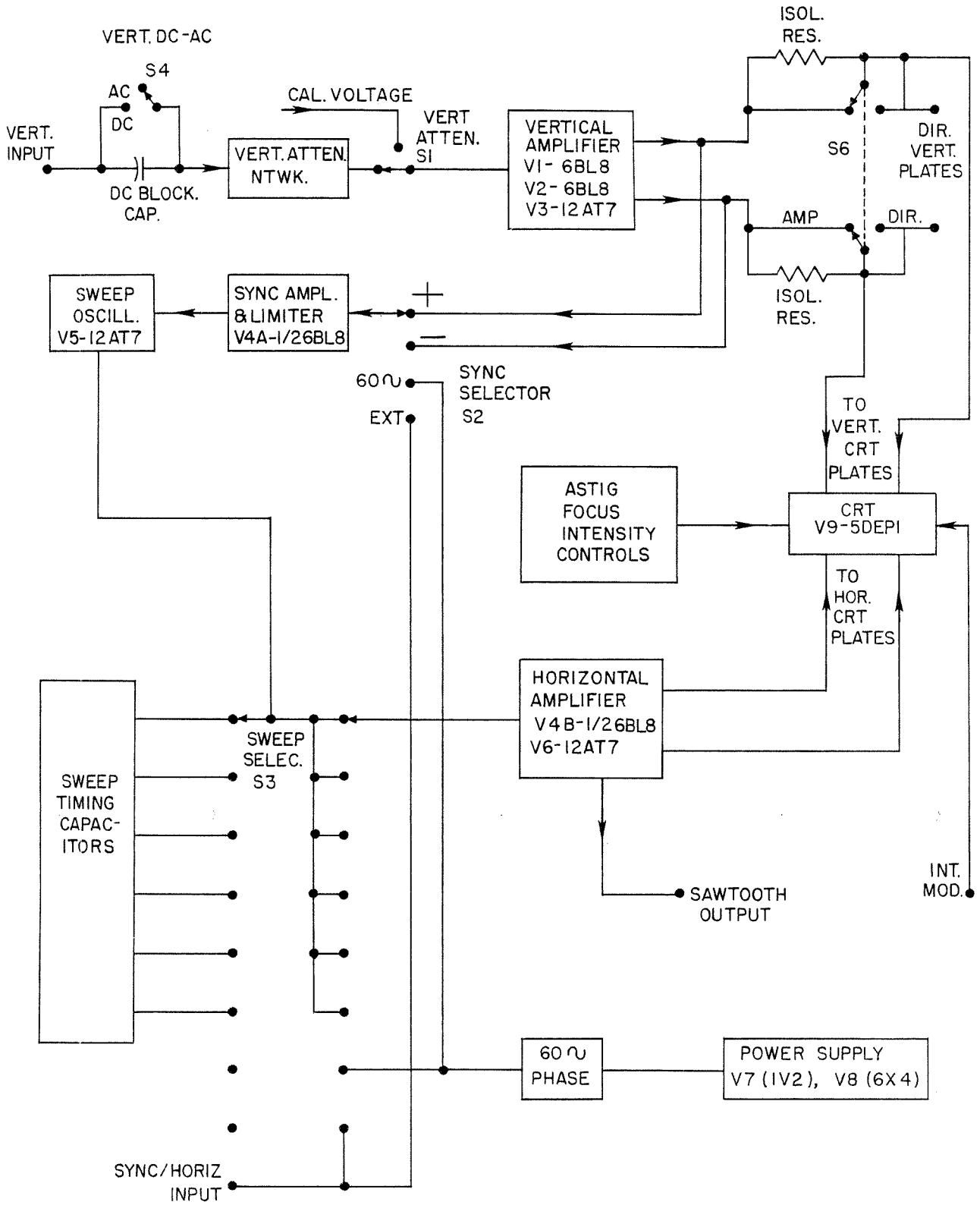
TABLE OF CONTENTS



EICO ELECTRONIC INSTRUMENT CO, INC.
33-00 NORTHERN BLVD.
LONG ISLAND CITY 1, N.Y.

OSCILLOSCOPE 427

Figure 11. Block Diagram



SECTION I. FEATURES AND SPECIFICATIONS

The Model 427 is a general purpose oscilloscope employing advanced, high-quality circuit techniques refined and cost-reduced through years of development work by EICO. While low-priced enough for beginners, the Model 427 has all the control facilities and performance quality demanded in general laboratory work, production testing, audio and ultra-sonic development and servicing, ham shacks, and advanced home workshops. Rugged, simple mechanical construction, plus clean open circuit layout make this scope easy to build even by a novice.

1-1 FEATURES

1. Vertical amplifier direct-coupled for minimum phase distortion, and push-pull for maximum linearity, throughout (6 stages in 3 push-pull pairs).

2. Choice of direct or capacitive input coupling.

3. One internal bias adjust, and a dc balance adjust on the panel, for simple adjustment to optimum performance.

4. Four-position (plus CAL) frequency compensated vertical input attenuator.

5. Saw-tooth (15V p-p, adjustable by HOR GAIN control) output jack on panel for connection to vertical input jack when adjusting the frequency compensation trimmers.

6. INTENSITY, FOCUS, and ASTIGMATISM controls on the front panel.

7. Sharp, clean trace-free of blooming.

8. Instantaneous, drift-free positioning permits centering any part of a trace expanded to 30cm vertically or 20cm horizontally.

9. Easy, direct connection to vertical deflection plates without need of removing and replacing shorting links or wires. Test leads are simply plugged into rear jacks, and switch turned from AMPLIFIER to DIRECT PLATES.

10. INTENSITY MODULATION input (2 meg input Z approx., 20V ms for blanking beam).

1-2. SPECIFICATIONS

Vertical Amplifier: Flat from DC to 500kc – 6db at 1Mc; sensitivity 10mv p-p or 3.5mv rms per cm; direct or capacitive input coupling; fine attenuator, plus a four postion, frequency compensated coarse attenuator providing sensitivities of 10mv p-p/cm, 100mv p-p/cm, 1V p-p/cm, 10V p-p/cm; one calibration voltage input position at which a 60 cps 40mv p-p square wave is injected; input impedance IM ohms shunted by 30mmf on all attenuation ranges; positioning range permits centering any part of trace expanded to three times CRT diameter.

Horizontal Amplifier: Flat from 2cps to 450kc; sensitivity 0.5V p-p or 0.18V rms per cm; cathode follower input with fine attenuator in output; input impedance 10M ohms shunted by 40mmf. Positioning range permits centering any part of trace expanded to 2X CRT diameter.

Sweep Circuit: Recurrent sweeps from 10cps to 100kc in four overlapping ranges; special TV VERT & HOR positions (30 & 7875cps); minimum ratio of forward sweep time to retrace time 15:1, synchronization may be internal pos., internal neg., 60 cps, or external; synchronization is fully automatic on all ranges and modes; full retrace blanking.

Tubes: 3-6BL8, 3-12AT7, 5DEP1 CRT (NE2 Neon 1 Amp calibrator)

Power Supply: 1-6X4 low-voltage rect.; 1-1V2 high voltage rect.

Power Requirements: 105-125V 60cps; 55W drain

Size (HWD): 12-1/2" x 8-1/2" x 16-7/16"

Weight: Approximately 26 lbs.

1-3. FUNCTIONS OF CONTROLS AND TERMINALS

The oscilloscope controls and terminals are easy to use once their functions are understood.

If the controls are divided into specific groups, for purposes of explanation, it will be easier to understand and keep in mind just what these functions are.

The INTENSITY, FOCUS, and ASTIGMATISM controls together control the appearance of the trace. The INTENSITY knob controls the brightness of the trace and the FOCUS knob controls the sharpness or definition of the trace on the scope screen. The ASTIGMATISM control affects spot shape and is used to obtain a trace of uniform thickness. Proper adjustment of these controls should give a trace formed from a thin bright line or an undeflected spot of light that is tiny, round, and bright. These controls interact to an extent; that is, adjustment of the FOCUS knob is usually necessary when the setting of the INTENSITY knob is changed.

The VERTICAL POSITION and HORIZONTAL POSITION controls adjust the location of the trace on the screen. Turning the HORIZONTAL POSITION knob shifts the trace left or right, and turning the VERTICAL POSITION knob moves the trace up or down.

The VERTICAL-ATTENUATOR provides a choice

of no attenuation or three decade steps of frequency-compensated attenuation of the input voltage fed to the vertical amplifier. Each attenuation is obtainable with either direct coupling provided to the vertical amplifier (at DC position of VERTICAL AC-DC slide switch) or capacitive coupling to the vertical amplifier (at AC position of VERTICAL AC-DC slide switch). At the .01 position, the amplitude of the signal voltage is unchanged (no attenuation). At either .1, 1, 10V/cm position, the amplitude is attenuated by a ratio of 10:1, 100:1, and 1000:1 respectively. At the CALibrator position, a 40 millivolt peak-to-peak square wave at power line frequency is fed to the vertical amplifier.

The VERTICAL GAIN control allows continuous adjustment of the vertical amplifier gain. It is used with the VERT. ATTENUATOR selector to adjust trace height to the desired value and to set up the vertical amplifier for voltage measurements.

The SYNC SELECTOR has four positions to permit selection of sync voltages for the sweep oscillator. At the "+" and "-" positions, the synchronizing voltage is taken internally from the vertical amplifier. (At "-", sweep trace flyback starts during the negative-going excursion of the voltage applied to the vertical amplifier; at "+", the sweep trace flyback starts during the positive-going excursion of the voltage applied to the vertical amplifier). At the EXT. position, an external synchronizing voltage applied between the SYNC/HORIZ. terminal and ground is fed to the sweep oscillator. At the 60 CPS position, an ac signal of power line frequency is taken from the power supply and applied to the sweep oscillator to sync it at line frequency. The PHASE control is effective in the 60 CPS position of the SYNC SELECTOR and permits phase adjustment of the 60 cps sync voltage to shift the starting point of the waveform display to any desired point on the waveform. The a-c power switch is located on the PHASE control, and the unit is turned on by turning the PHASE control clockwise from OFF.

The SWEEP SELECTOR selects the frequency band over which the SWEEP VERNIER can be varied for frequency adjustment of the internal linear sweep, and also serves as the horizontal input selector. In the four most counter-clockwise positions, the numbers above the position markers are the upper and lower limits of the band (approximately) covered by the SWEEP VERNIER at the particular position. The VERT-TV and HOR-TV positions are designed to eliminate the need for repeated adjustment of the SWEEP VERNIER in tv work. If, with the SWEEP SELECTOR set at the VERT-TV position, the SWEEP VERNIER is set to display two full cycles of a 60 cps signal to obtain a sweep frequency of 30 cps, turning the SWEEP SELECTOR to HOR-TV will result in a sweep frequency of 7875 cps without readjustment of the SWEEP VERNIER. At either of the two most clockwise positions of the SWEEP SELECTOR, SINE-60 CPS and EXT-HOR, the sweep oscillator is disabled. At the SINE-60 CPS position, an a-c signal of power line frequency is taken from the power supply and applied to the input of the horizontal amplifier. The PHASE control described above controls the phase shift of the line frequency voltage used for sinusoidal sweep. At the EXT.-HOR. position, an external signal voltage applied between the SYNC/HORIZ. terminal and ground is applied to the input of the horizontal amplifier.

The VERT. INPUT terminals provide for connection of external signals to the vertical amplifier.

An external voltage for purpose of intensity (Z-axis) modulation may be applied between INTENSITY MODULATION jack and ground on the rear panel. Never apply an intensity modulating signal that is large enough to swing the grid of the cathode ray tube positive, or the life of the tube may be greatly shortened. Positive grid swing is indicated by noticeable defocusing of the trace during the positive phase of the intensity modulating signal.

A sawtooth voltage from the output of the sweep circuit oscillator is available between the SAWTOOTH terminal and ground. The frequency of the sawtooth is, of course, variable by the SWEEP SELECTOR and SWEEP VERNIER controls. The amplitude is variable by the HOR. -GAIN control.

A pair of pin jacks, J7 and J8 designated VERTICAL PLATES are provided at the rear to accommodate direct connections to the vertical plates when this is necessary for accurate display of high frequency waveforms requiring a bandwidth exceeding that of the vertical amplifier. A pair of .01, 1KV capacitors (C1, C10) block the internal B+ voltage from appearing at the pin jacks. The AMPL.-DIR. slide switch S6 adjacent to the pin jacks permits quick and convenient use of the VERT. PLATES pin jack connections, since, by throwing the switch to DIR., it is immediately possible to use these connections; the switch must be set at the AMPL. position whenever signals applied to the VERT. INPUT terminals on the front panel are to be observed.

1-4. NOTES ON CONTROLS AND TERMINALS

1. Proper trace definition will be obtained if the astigmatism control is correctly adjusted, and the scope is not operated in strong fields such as are found near transformers, transmitters, and power generating equipment, etc., which may distort the electron beam that produces the trace.

2. A sharply focused short line or a small spot of high intensity should not be permitted to remain stationary on the screen for any considerable length of time (more than 1/2 minute) or the screen will be burned. A trace of excessively high intensity will burn the screen in 3 to 5 minutes. These burned portions of the screen will no longer fluoresce and are useless for observation. If it is required to have a fixed trace on the screen for a long period, reduce the intensity of the trace to a minimum.

3. When the VERT. AC-DC switch is set in the DC position, the dc component of any signal fed to the vertical amplifier will be amplified along with the ac component of the signal and be reflected on the screen by a proportional vertical movement of the trace. The direction of trace movement depends on the polarity of the dc component. Therefore, when going from observation of a pure ac wave to one containing dc or vice versa, it may be necessary to use the VERT-POS control to bring the trace back to center screen. The

dc component of a signal has no effect at the AC position of the VERT AC-DC switch.

4. Trimmer capacitors C2A, C2B, and C2C are used for compensating the vertical step attenuator at the 10, 1, and .1 positions respectively. See MAINTENANCE section for procedure.

5. Potentiometer R12 is the DC BALANCE adjustment accessible through the front panel. When R12 is adjusted properly, there will be no shifting up or down of the trace on turning the VERT. GAIN control from minimum to maximum with no input signal to the vertical amplifier. See MAINTENANCE section for adjustment procedure.

6. The "+" and "-" positions of the SYNC SELECTOR allow the synchronization of any type of non-sinusoidal waveform.

7. The EXT. position of the SYNC SELECTOR is for use with generators or other devices which have sync outputs.

8. The PHASE control action in the 60 CPS position of the SYNC SELECTOR is useful when observing discriminator "S" curves.

9. The PHASE control action in the SINE-60 CPS position of the SWEEP SELECTOR permits use of generators that do not have phase-controlled 60 cps sinusoidal sweep outputs or dispensing with connections to such outputs when they are available.

10. Trimmer C31 must be adjusted initially in kit instruments to display two full cycles of a 15750 cps signal at the TV-HOR. position after the SWEEP VERNIER has been set to display two full cycles of a 60 cps signal at the TV-VERT. positions. See MAINTENANCE section.

11. At maximum gain settings, the sensitivity of the amplifiers is very high. Under these conditions stray pickup may produce patterns on the screen when no signal source is connected to the vertical input terminals. This is normal and does not interfere with the scope operation.

SECTION II. OPERATIONS

NOTE: To obtain proper results with your 'scope, it is advisable to become acquainted with the functions and correct use of the panel controls and terminals by making some simple tests. These tests will also assure you that the instrument is in proper working condition. Do not attempt this procedure with kits before all final checks have been completed and all initial adjustments have been made as described in the MAINTENANCE section.

1. Set the INTENSITY, VERT. GAIN, and HOR. GAIN controls at their furthest counter-clockwise positions.

2. Set the FOCUS, ASTIG., VERT.-POS., and HOR.-POS. controls at the center of their ranges. All other controls may be set at any position.

3. Insert the power cord into a 105-125 volt, 50-60 cycle ac outlet.

WARNING

This instrument will not operate, or operate improperly, and even be seriously damaged if connected to any other type of power line (such as dc, 25 cycle ac, or an ac line above 125 volts).

4. Turn the PHASE control clockwise (on), at which the pilot lamp should light. Allow the unit to warm up for about a minute. Then gradually turn the INTENSITY control clockwise until a spot appears somewhere on the screen of the screen of the cathode-ray tube. If the spot does not appear, adjust the VERT.-POS. and HOR.-POS. controls slightly, as it may be off screen.

5. Adjust the VERT.-POS. and HOR.-POS. controls until the spot is in the exact center of the screen, and then adjust the FOCUS control and ASTIGMATISM control for the sharpest image. Notice that for every setting of the INTENSITY control, there is a best setting for the FOCUS control. The finest focus is usually obtained at low intensity.

6. Set the SWEEP SELECTOR at any of the internal sweep positions. Now advance the setting of the HOR. GAIN control gradually, and note that the spot extends to a horizontal line. This is the linear horizontal sweep.

7. Set the SWEEP SELECTOR at EXT.-HOR. Notice that the horizontal line returns to a spot, as the horizontal amplifier is now connected to the SYNC HOR. INPUT binding posts. Any signal applied to the SYNC HOR. INPUT terminals will cause the line to lengthen horizontally in proportion to the peak value of the applied signal.

8. Set the SWEEP SELECTOR at SINE-60 CPS. The horizontal line on the screen is the 60-cycle sine sweep. The phase of this sweep is adjusted by the PHASE control. To check this, set the VERT.-ATTEN. switch to CAL. Adjust the VERT. GAIN and HOR. GAIN controls until the pattern is a few inches high across. The pattern on the screen is a stationary rectangle because the vertical and horizontal inputs are identical in frequency. Rotate the PHASE control and notice that because of the changing phase difference between the vertical and horizontal inputs, the rectangle changes its shape.

9. Set the SYNC SELECTOR at +, the VERT. ATTENUATOR at CAL, the SWEEP SELECTOR at 10-100, the SWEEP VERN. control at 0. Now adjust the VERT.-GAIN and HOR.-GAIN controls until the pattern extends about two-thirds the width and the height of the cathode-ray tube. The pattern will not

be clear because of its rapid horizontal drift. Advance the setting of the SWEEP VERNIER gradually until a single clipped sine wave of power line frequency appears and remains stationary on the screen.

NOTE 1: In rotating the SWEEP VERNIER, it will be noticed that the drift of the pattern slows down as certain critical frequencies are approached, and then reverses direction when the critical frequency is passed. At these critical frequencies, a clear pattern can be discerned. These critical sweep frequencies are sub-multiples of the signal frequency, or the signal frequency itself (when only one cycle of the signal is displayed). The pattern may be locked in at sub-multiples of the signal frequency when it is desired to view more than one cycle of the signal. The sweep frequency is equal to the signal frequency divided by the number of complete cycles displayed on the screen. For example, if two complete cycles of the 60 cps signal are displayed, the sweep frequency is 30 cps.

NOTE 2: At low sweep frequencies, flickering of the pattern is normal due to the slow writing speed of the spot and the persistance of the screen, which together are insufficient to cause the motion to blend into a fixed image.

10. With the single clipped sine wave pattern locked in, switch the SYNC SELECTOR from + (INT.) to - (INT.). The same waveform should appear, but displaced by 180°.

11. With the single clipped sine wave pattern locked in, switch the SYNC SELECTOR to the 60 CPS position. Turn the PHASE control and note the shift in starting point of the displayed waveform.

12. Set up the 'scope controls as in Paragraph 8, adjusting the PHASE control for a rectangle. Then set the INTENSITY control at minimum. From an audio oscillator, apply about 10 volts at 300 cps between the INT. MOD. jack on rear of chassis and ground, and then gradually advance the INTENSITY control until a broken line rectangle is seen on the screen. Adjust the frequency of the audio oscillator carefully, until the broken lines stand still, and note that there are 5 such lines. This indicates that the ratio between the frequency applied to the INT. MOD. jack and the frequency applied to the VERTICAL amplifier (60 cps) is 5. The INT. MOD. jack may be used for inserting timing markers on a trace or determining the frequency of an unknown signal.

CAUTION

In any application where a signal is applied to the INT. MOD. jack, the INTENSITY control should just be set at minimum and then advanced until the desired intensity is obtained.

13. To operate the internal calibrator for measuring peak-to-peak voltage, use the following procedure: (p-p) is an abbreviation for peak-to-peak).

MEASUREMENT OF P-P VOLTAGES (a). Set the VERT. ATTEN. at CAL. This operation injects a 40mV p-p square wave of power line frequency into the vertical input circuit at a point following the vertical step attenuator but preceding the vertical gain control. (b). Set the SYNC SELECTOR at "+" and the HOR. GAIN control at zero (so that the pattern on the screen is simply a vertical line). (c). Adjust the VERT. GAIN and VERT. POS. controls until the vertical line extends exactly 4 cm. (Each division is 1 cm on the calibrated screen).

You have now standardized the sensitivity of the vertical amplifier to permit direct p-p voltage measurements up to 100V. Do not touch the VERT. GAIN controls while voltage measurements are being made, as any disturbance of the setting makes it necessary to recalibrate the vertical amplifier. Any p-p voltage up to 100V is read by multiplying the VERT. ATTEN. switch setting (.01, .1, 1, 10V/cm) by the vertical extension in screen divisions (centimeters).

MEASUREMENT OF P-P VOLTAGES ABOVE 100 VOLTS: Steps a and b are the same as when measuring voltages under 100 volts p-p. In step c, however, the VERT. GAIN control is adjusted for a deflection that is a convenient fraction (4 cm). At most, this deflection should be as many times smaller than 4 cm as the expected value of the unknown voltage is larger than 100 volts p-p. The VERT. ATTEN. is then set at 10V/cm and the p-p deflection of the unknown signal is read off the calibrated screen. EXAMPLE: The deflection set at calibration is 2 divisions or 2 cm. With the VERT. ATTEN. set at 10V cm, the p-p deflection of the unknown signal is 4 divisions or 4 cm. The amplitude of the signal is equal to (4/2) X 100 = 200 volts p-p.

NOTE: If the signal under observation is a sine wave (only), the rms value of the amplitude may be obtained by dividing the p-p value by 2.8.

SECTION III. APPLICATIONS

GENERAL: The oscilloscope is an instrument designed for viewing electrical oscillations and transients. Phenomena having a repetition rate from a few cycles per second to several megacycles per second may be displayed on a scope.

WAVEFORM INVESTIGATION: When the output of the internal sweep generator is fed to the horizontal channel, the pattern on the screen is actually a graph showing the variation with time of the instantaneous amplitude of the signal applied to the vertical channel. The sweep frequency is usually a sub-harmonic of the singal frequency, so that several complete cycles of the signal are displayed on the screen.

DISPLAY OF WAVEFORMS: Displaying a waveform means obtaining a picture that shows how the amplitude of the signal under observation varies with time. It is generally most convenient to use a time-base signal that varies linearly with time, so that equal intervals of time are represented on the screen by equal intervals of distance along the same axis. The sawtooth output of the sweep generator gives such

a time-base on the horizontal axis, the time (in seconds) represented by the overall horizontal deflection being equal to the reciprocal of the sweep frequency (in cycles per second).

Apparently, if the frequency of the observed signal is equal to the sweep frequency, one complete cycle will be observed on the screen. If the frequency of the applied signal is twice the sweep frequency, two complete cycles will be obtained on the screen and so on. Fig. 1 is a projection drawing of a sine wave applied to the vertical plates and a sawtooth wave of the same frequency applied to the horizontal plates. Fig. 2 is a projection drawing showing the resultant pattern when the frequency of the sawtooth is one-half that employed in Fig. 1.

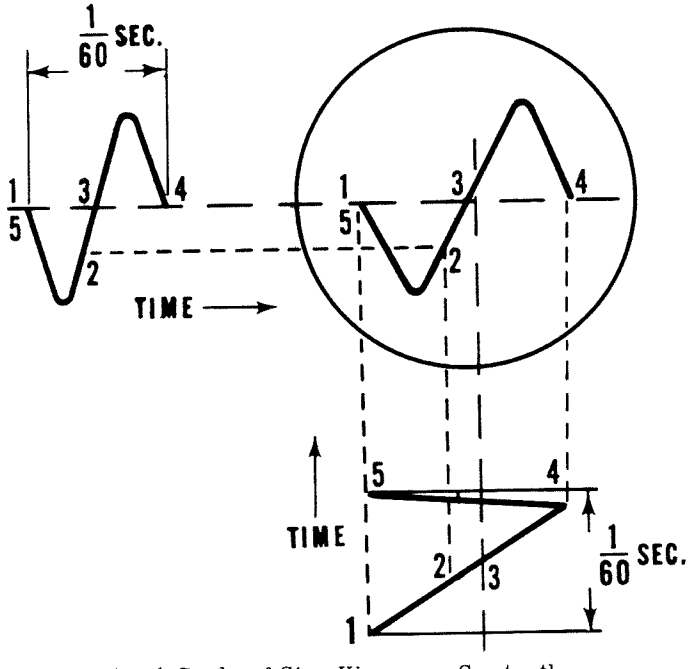


Figure 1. 1 Cycle of Sine Wave vs. Sawtooth

In these figures, points that occur simultaneously are numbered the same. The circle represents the tube screen. If simultaneous projections were drawn from every point on each wave, the intersections would trace out the sine waves shown in the circles. The sections of the sawtooth between 1 and 4 in Fig. 1 and between 1 and 9 in Fig. 2 are the sweep sections during which the displays are produced. The sections of the sawtooth between 4 and 5 in Fig. 1 and between 9 and 10 in Fig. 2 are the sections during which the beam is returned very rapidly to the starting point at the left-hand side of the screen. The return trace appears on the screen as a fine horizontal line.

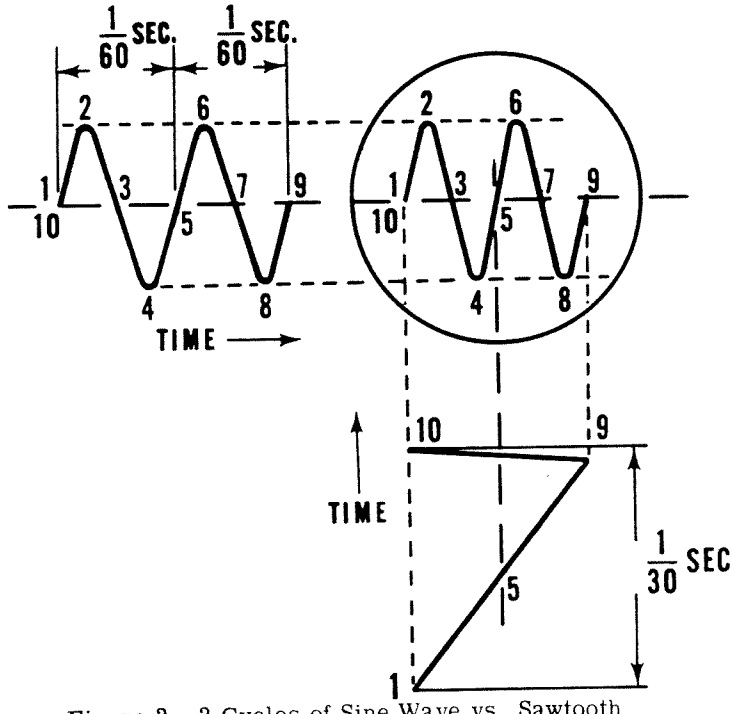


Figure 2. 2 Cycles of Sine Wave vs. Sawtooth

LISSAJOUS PATTERNS: Another type of fundamental pattern is obtained when both the vertical and horizontal deflection voltages are sinewaves that are related in frequency as follows: one frequency is a whole number of times larger than the other; one frequency is a simple fraction of the other. When one or the other of these conditions is fulfilled, stationary closed-loop patterns are obtained. These patterns are called Lissajous figures after the 19th century French scientist. They are particularly useful in determining the frequency ratio between two sinewave signals. If the frequency of one signal is known, the frequency of the other signal can be easily determined from the frequency ratio. Usually the known signal is applied to the horizontal channel and the unknown signal to the vertical channel. The shape of the pattern changes with the phase relationship between the known and unknown signals. For example, all the patterns shown in Fig. 3 (and those intermediate) are possible with a frequency ratio of 1:1 if the phase differences indicated exist.

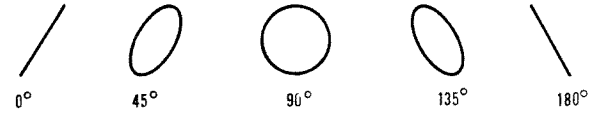


Figure 3. 1:1 Ratio of Lissajous Patterns

In general to determine frequency ratio from the Lissajous figure, count the number of points of tangency to horizontal and vertical lines, drawn or imagined (see Fig. 4). Points of tangency at the top of the figures result from the unknown frequency applied to the vertical channel. Those at the side of the figure result from the known frequency applied to the horizontal axis. As a matter of fact, the following relationship holds true in all cases:

$$\frac{\text{V axis freq}}{\text{H axis freq}} = \frac{\text{V pts of tangency}}{\text{H pts of tangency}}$$

As an example, take Fig. 4c, which shows four points of tangency at the top and one point at the side. This indicates that the unknown frequency applied to the vertical axis is four times the known frequency. In Fig. 4f, one point of tangency at the top and four at the side indicate that the unknown frequency is one-fourth the known frequency.

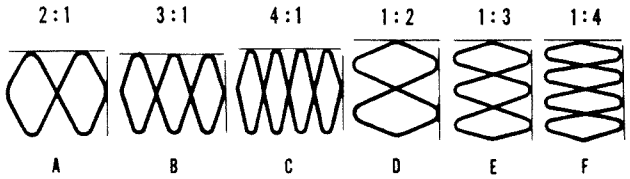


Figure 4. Lissajous Patterns

Model 377 Audio Generator or Model 488 Electronic Switch can be used to check amplifiers as to frequency response, phase shift, transient response, deficient design, or faulty components. The equipment is set up as shown in Fig. 5.

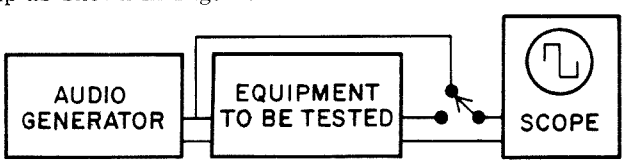


Figure 5. Equipment Test Block Diagram

First, a means of comparison, the square wave output from the Audio Generator is viewed on the 'scope. The horizontal sweep of the 'scope should be adjusted so that at least two full cycles can be seen on the screen. (Fig. 6a shows one full cycle of a perfect square wave). The 'scope is then connected to the output of the amplifier under test so that the modified square wave can be viewed on the screen. Possible output wave shapes are shown in Fig. 6b to 6i, and the significance of each waveshape is explained below.

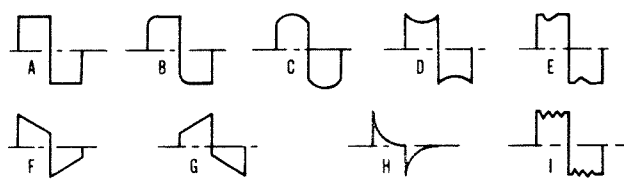


Figure 6. Sample Output Wave Shapes

Fig. 6b shows "rounding" of the leading edge of the square wave. This indicates a drop off in gain at high frequencies. "Rounding" will generally be observable when there is a substantial drop in the gain by the tenth harmonic (or less). Therefore, if a 2kc square wave fed to the amplifier is reproduced on the 'scope without "rounding", the amplifier is flat to 10 x 2kc = 20kc.

Fig. 6c shows the effect of increased gain and Fig. 6d shows the effect of decreased gain at the square wave frequency. Fig. 6e indicates lowered gain at a narrow frequency band. If the square wave frequency is brought into this narrow frequency band, Fig. 6d will result.

The effect of phase shift in the amplifier is shown in Figs. 6f and 6g. If, at low frequencies, there is phase shift in the leading direction, the square wave will be tilted as in Fig. 6f. If there is phase shift in the lagging direction, the top of the square wave will be tilted as in Fig. 6g. The steepness of the tilt is proportional to the amount of phase shift. Phase shift is not important in audio amplifiers, although the ear is not entirely insensitive to it. In television and 'scope amplifiers, however, phase shift should not be tolerated.

Fig. 6h shows the pulse output from the amplifier that results when the square wave has undergone differentiation. This will happen when the grid resistor or the coupling condenser is too low in value or if the coupling condenser is partially open. Lastly, Fig. 6i, shows a square wave with damped oscillations following the leading edge. This results when a high frequency square wave is fed to an amplifier in which distributed capacities and lead inductances resonate at low frequencies. In television and 'scope amplifiers it may result from an undamped peaking coil.

High fidelity audio amplifiers may be given a rapid check by testing first with a square wave of fundamental frequency not less than 3 to 4 times the low frequency limit of the amplifier (3db point) and then with a square wave of fundamental frequency which may be anywhere between 1/100 to 1/10 of the high frequency limit of the amplifier depending upon how many harmonics are considered necessary to produce an acceptable version of a square waveform. Usually, square waves of fundamental frequency from 40 to 60 cps and 1000 to 2000 cps are employed to cover the range up to 20,000 cps.

To insure correct results, the following is suggested: Connect the proper value of load across the amplifier output terminals; use low capacitance cable for connecting the generator to the amplifier input; if the amplifier has a high impedance input, use a 1 meg isolating resistor between the generator and the amplifier, shunted by a .001mfd capacitor if there is capacitance present in the amplifier input; set the generator output to an ample value but be sure not to overload the amplifier. The square wave signal is fed to the amplifier input and the scope is connected across the amplifier load. Use the internal linear sweep to observe the waveform. Note that tone controls have a very marked effect on square wave response and should be set to the "flat" positions unless it is desired to observe their effect. Note, also, that low fidelity and p. a. amplifiers will not reproduce the square waveform.

Video amplifiers may be square wave tested in the same manner as described for testing audio amplifiers. The test frequencies might be 60 cps for the low and 25,000 cps for high frequency end.

SERVICING TV RECEIVERS: One major use of the scope in tv servicing is alignment in conjunction with a TV-FM Sweep Generator. First, the IF stages are aligned, and then the RF and local oscillator stages, following the same general method and theory of alignment is described in the sweep generator instruction manuals. The specific methods of alignment depend on the receiver, and the manufacturer's service instruction should always be followed.

Another major use of the scope is to check the waveform of the complex tv signal as it passes through the receiver. The exceptional fidelity of the Model 427 scope is very important in this application, since you must be able to observe small variations in waveform in order to localize and correct the cause of poor picture quality. Here again the set manufacturer provides representative waveforms to be expected at specific points in a specific model of receiver. These waveform pictures are furnished for the entire receiver, with the exception of the tuner portion. EICO manufactures a complete line of high quality oscilloscope probes meeting all the requirement for waveform observation in any part of a tv receiver.

Keep in mind that two basic frequencies are involved in checking waveform of signals in tv receivers. The vertical or field frequency is 60 cps. Any waveform check, except with the horizontal oscillator, its differentiator network, and the horizontal amplifier stages, can generally be made using an internal linear sweep frequency of 30 cycles to show two complete fields of the signal. To examine the horizontal pulse shape, or the operation of the horizontal deflection system, it is generally suitable to use an internal linear sweep frequency of 7875 cps, again to show two complete lines of the signal. The TV-VERT. position (30 cps) and the TV-HOR. position (7875 cps) on the SWEEP SELECTOR were provided to permit rapid changeover from one basic tv sweep frequency to the other without need for other control readjustments.

SECTION IV. MAINTENANCE

4-1. GENERAL

Included in this section are instructions for internal adjustments, trouble-shooting, and part replacement. All internal adjustments must be performed in the order given on completed kit instruments before they can be placed in use. The same procedure will serve for periodic readjustments in both kit and factory-wired instruments when required by component aging or replacement.

4-2. REMOVAL FROM CABINET

To remove the instrument from the cabinet, first disconnect it from the power line and remove the two No. 8 sheet metal (Type Z) screws at the top and the two No. 8-32 x 3/8 machine screws at the bottom of the cabinet rear. Then slide the chassis out the front of the cabinet.

WARNING

The voltages in this instrument are dangerous. Take caution to avoid personal contact with these voltages when the instrument is being operated outside of its cabinet. Remember that capacitors may remain charged to dangerously high voltages for a considerable time after power has been removed.

4-3. INTERNAL ADJUSTMENTS

The need for repetition of any of the following adjustments after the instrument has been in use can be determined by referring to the trouble-shooting chart. Therefore, no reference will be made here to the symptoms which indicate readjustment is necessary.

a) Insert the AC plug in the 115 volt AC line outlet and turn the power on by rotating the PHASE control clockwise from OFF. While the scope is warming up, set the panel controls as follows: INTENSITY, FOCUS, VERT.-POS., HOR.-POS., PHASE, SWEEP VERNIER, VERT. GAIN, HOR. GAIN, to approximate middle of rotation; SWEEP SELECTOR at "10-100"; VERT. ATTENUATOR to CAL.; SYNC. SELECTOR to "+".

b) Adjust the vertical amplifier bias potentiometer, R14 by first setting the VERT. GAIN control fully clockwise. Then connect a VTVM from pin 7 of either tube V1 or V2 to ground and adjust the bias potentiometer, R14, for a d-c bias reading of 2.5 volts. Bias potentiometer, R14 and tubes V1 and V2 are called out in Fig. 7.

c) Adjust panel controls for a stationary pattern of several 60 cps clipped sine waves (approximate overall pattern dimensions: 2" high, 3" wide). Jointly adjust the ASTIG. control and the FOCUS control until a sharp trace with the greatest possible uniformity of thickness is obtained.

d) Short the VERT.-INPUT terminals. Set the VERT. ATTENUATOR to the 10V/cm position (either DC or AC) and the VERT. GAIN control for minimum gain. Adjust the VERT.-POS. control for a trace vertically at dead center. Now set the VERT. GAIN control for maximum gain and adjust the DC BALANCE control R12 (screwdriver adjustment on front panel) until the trace is returned vertically to dead center. Repeat until no vertical shift in the trace can be detected when the VERT. GAIN control is rotated from minimum to maximum.

e) Stray capacities shunting the resistive components in each of the vertical input attenuator networks would result in frequency discrimination were not each of these attenuator networks frequency-compensated by an individual trimmer. These trimmers are accessible through holes in the left front bracket; uppermost

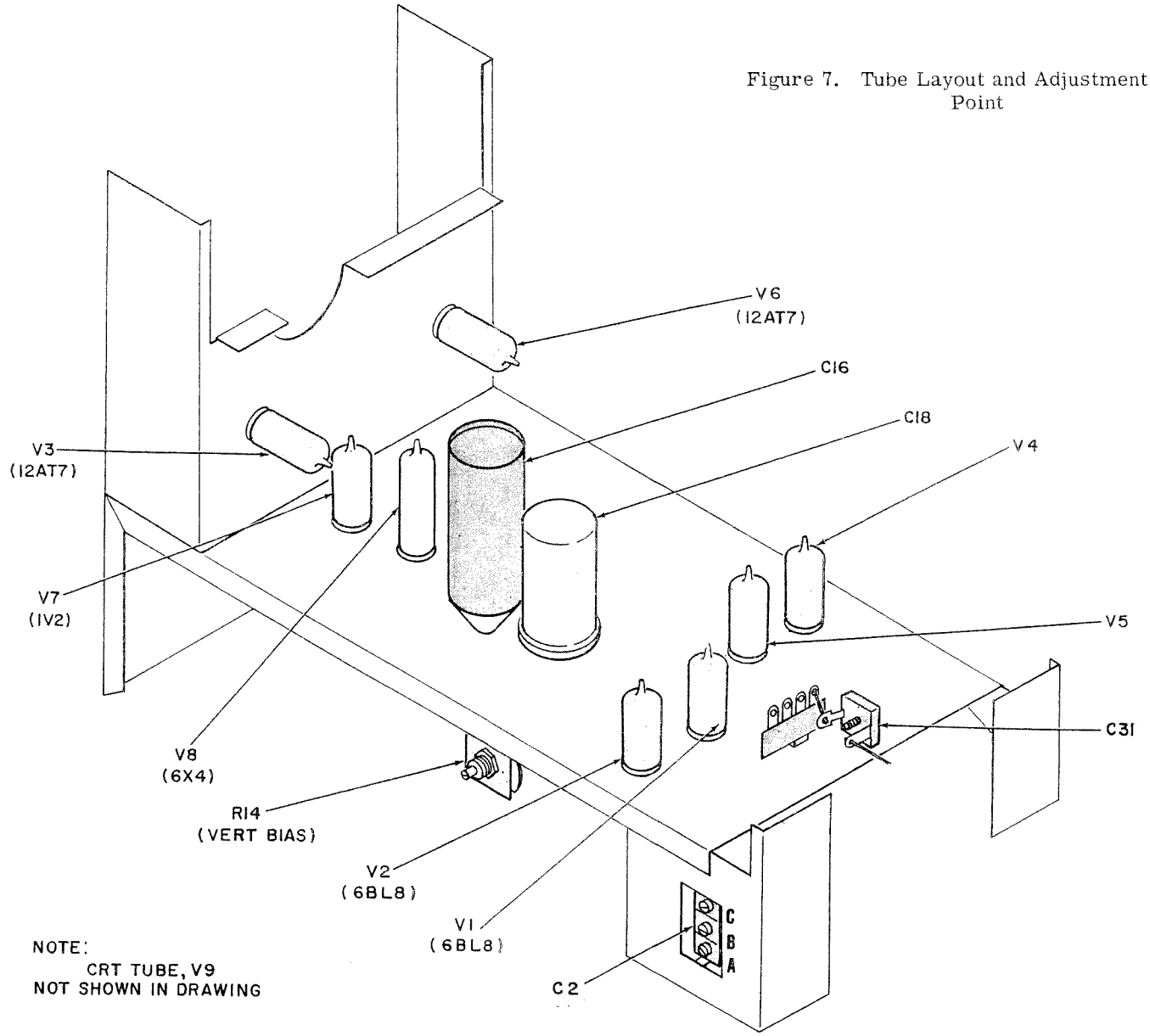


Figure 7. Tube Layout and Adjustment Point

trimmer C2A for the 10V/cm VERT. ATTEN. position, middle trimmer C2B for the 1V/cm VERT. ATTEN. position, and lowest trimmer C2C for the .1V/cm VERT. ATTEN. position.

Method of adjusting trimmers: Connect a jumper between the SAWTOOTH and VERT. -INPUT terminals. Set the SYNC. SELECTOR to "+" and the SWEEP SELECTOR at the 1K-10K position, the SWEEP VERNIER at 0. Now set the VERT. ATTENUATOR selector at .1V/cm (either DC or AC) and then use the panel controls to obtain a centered, focused trace (adjust VERT. & HOR. GAIN controls to obtain a trace entirely on the screen). With the trimmer C2C adjusted improperly, the trace will appear either as in Fig. 8a or Fig. 8b. If this is the case, adjust the uppermost trimmer C2C until the hook disappears and the trace is a straight line as in Fig. 8c.

Now set the VERT. ATTENUATOR selector at 1V/cm (either AC or DC) and adjust trace as above. With the middle trimmer C2B adjusted improperly, the trace will again appear as in Fig. 8a or Fig. 8b. If this is the case, adjust the middle trimmer C2B until the hook disappears and the trace appears as in Fig. 8c.

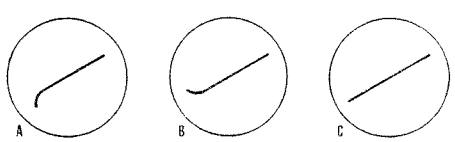


Figure 8. Trimmer Adjust Pattern

Now set the VERT. ATTENUATOR selector 10V/cm (either AC or DC). With the trimmer C2A adjusted improperly, the trace will again appear as in Fig. 8a or Fig. 8b. If this is the case, adjust lowest trimmer C2A until the hook disappears and the trace appears as in Fig. 8c.

A much to be preferred method of adjustment, when the equipment is available, is to apply a square

wave of approximately 1kc fundamental frequency to the VERT. INPUT terminals and adjusting each trimmer in turn, with the VERT. ATTENUATOR selector set at the corresponding position, for best possible square wave reproduction. Internal sweep is employed and the panel controls set for several stationary square waves on the screen before adjusting the trimmers for proper frequency compensation.

Under-compensation and over-compensation are indicated square waves appearing as in Figs. 9a and 9b respectively. Proper compensation is indicated by square waves appearing as in Fig. 9c.

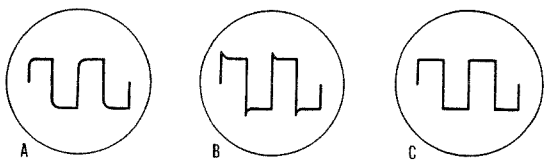


Figure 9. Trimmer Adjust Pattern (square wave)

f) Adjustment of TV-HOR. sweep trimmer: Set the SWEEP SELECTOR at TV-VERT. Then set the VERT. ATTENUATOR to CAL., and adjust the SWEEP VERNIER to obtain a stationary pattern of two complete cycles on the screen indicating a 30 cps sweep frequency. Now turn the SWEEP SELECTOR to the TV-HOR. position and apply a 15, 750 cps signal taken from the horizontal section of any tv set to the VERT. INPUT terminals. Adjust the VERT. ATTENUATOR & VERT. GAIN controls to obtain a drifting pattern entirely on screen but do not touch the SWEEP VERNIER. Now adjust trimmer C31 until a stationary pattern of two complete cycles is obtained on the screen, indicating a 7875 cps sweep frequency. This completes the adjustment. Now, whenever the SWEEP VERNIER is set to produce a 30 cps sweep (indicated by two cycles of 60 cps signal) with the SWEEP SELECTOR set at TV-VERT. turning the SWEEP SELECTOR to TV-HOR. without touching the SWEEP VERNIER will automatically give a 7875 cps sweep.

4-4. TROUBLE-SHOOTING THE 427 OSCILLOSCOPE

The block diagram of the 427 (Fig. 11) should aid in isolating the circuit in which the trouble is located. Once this is done, reference should be made to the appropriate section of the complete schematic (Fig. 12). The next step is to localize the trouble in the particular section to the tube circuit involved and then to try a replacement tube. If the trouble is not eliminated, voltage checks should be made using the schematic diagram (Fig. 12).

As an aid in localizing trouble, common symptoms together with their possible causes and remedies have been listed in groups corresponding to the major sections of the instrument (Fig. 10). Of course, all possible troubles could not be included in the chart and the make-up of the chart has been based on the assumption that the instrument has worked properly at some previous time. Keep in mind that in trouble-shooting, the main endeavor is to find and eliminate the source. of the trouble. Recurrence of a trouble usually indicates that the effect, not the cause has been remedied.

4-5. TUBE REPLACEMENT

Tube location is shown in Fig. 7. Readjustment will be required when replacing V1, V2, or V3. When the CRT is replaced, it must be rotated until the horizontal trace is level.

4-6. FUSE REPLACEMENT

A 1 Amp fuse is located in the fuse holder on the rear chassis apron. If the fuse should blow, the component that has failed and caused the excessive current drain must be found and replaced before a new fuse is inserted.

Figure 10. Trouble Shooting Chart

POWER SUPPLY

Pilot light fails to light	PHASE switch in OFF position No AC line voltage Pilot lamp open Fuse defective Power Transformer defective Broken lead/or leads in the filament path	Turn PHASE switch clockwise Trace line failure Replace I1 Replace F1 Replace T1 Repair defective connections
Fuse, F1, blows when AC power is turned on	Shorted AC line cable on the primary side of the power transformer Defective rectifier tubes Defective filter capacitors Short in filament connections	Repair the short Check V7, V8. Replace if bad Check C16, C18, for low resistance or short. Replace if necessary Check filament connections for shorts. Repair if necessary.

POWER SUPPLY (Cont'd.)

Some or all filaments fail to light	Defective tube or tubes Broken lead from power transformer Power transformer defective	Replace tube or tubes* Check with an ohmmeter for continuity. Repair if necessary Replace

CRT CIRCUIT

No spot on CRT screen	High voltage rectifier tube, V7, defective Filament leads broken No voltage on second anode Note: Spot may be deflected off screen. Adjust V-POS. control for equal voltages from CRT pins 6 & 7 to ground (V. defl. plates) and H. POS. control for equal voltages from CRT pins 9 & 10 to ground (H. defl. plates). The spot should then be centered. If either adjustment is impossible, refer to the vertical or horizontal amplifier sections.	Replace Repair Check circuit. Repair if necessary
No spot on CRT screen (All CRT voltages correct)	Defective CRT (V9)	Replace (V9)
Retrace blanking inoperative	C12 open Broken lead from the sweep frequency generator to the cathode of V9.	Replace Check if necessary
No focusing	R32 defective R31 defective Note: R32 is the focusing potentiometer. Its action is dependent on the setting of the astigmatism potentiometer R31. For best focus, both pots must be adjusted simultaneously as an initial adjustment.	Replace Replace
No horizontal positioning	Refer to horizontal amplifier	
No vertical positioning	Refer to vertical amplifier	
Astigmatism control inoperative	R31 defective	Replace

SWEEP CIRCUIT

No sweep (hor. ampl. checks O. K.)	Sweep Selector switch is not set to sweep positions Lead or leads broken V5 defective S3 defective R51 defective Check R50, R52, R53, R62-R65 V4A shorted	Set Sweep Selector to any of the sweep positions. Check and repair if necessary Replace Check. Replace if necessary Check. Replace if necessary Replace if necessary Replace
Sweep inoperative on some ranges	One of C25-31 defective S3 defective	Replace the defective capacitor* Replace

SWEEP CIRCUIT (Cont'd.)		
Incorrect sweep frequency obtained at TV-HOR. position	C31 out of adjustment	Adjust C31
Loss of synchronization	V4-A deflective S2 defective C29 open Sync. leads defective	Replace V4 Check. Replace if necessary Replace Replace
VERTICAL AMPLIFIER		
With appropriate signal applied to INPUT, no vertical displacement of the trace results.	Defective S1 One or more tubes defective One or more components in the vertical amplifier defective	Check. Replace if necessary Check V1, * V2, V3, *. Replace if defective Check resistors and potentiometers with ohmmeter. Replace if defective
Signal distorted; unable to balance	R12 defective	Replace
No vertical positioning	R13A defective	Replace R13
VERT. GAIN control affects position of trace	DC unbalance	Balance with R12
No vertical signal in AC attenuator pos.; O.K. in DC pos.	C1 open	Replace C1
Square wave (1kc) distorted on 10, 100, 1000V pos. of the attenuator	C2A, C2B, C2C out of adjustment	Adjust C2A, C2B, C2C
DC balance impossible; all components O.K.	One of the tubes in vertical amplifier out of tolerance	Interchange V1 and V2 Note: If this does not improve the balance, try one or more replacement tubes.
No vertical gain adjust	R13B defective	Replace R13
Trace "jumps" on CRT screen in vertical direction	Loose connection in vertical amplifier section One of the tubes "microphonic"	Repair Tap tubes lightly. Replace the one which is "microphonic".
No trace when VERT. ATTENUATOR at CAL. position	Broken connection from CAL circuit to S1 Defective I2, R43-46	Repair Repair
HORIZONTAL AMPLIFIER		
No horizontal deflection; sweep checks O.K. and SWEEP SELECTOR in one of SWEEP positions	C24 open V4B or V6 defective C18B shorted C23 open R57B defective S3 defective	Replace Check and replace if bad Replace Replace Replace Replace

HORIZONTAL AMPLIFIER (Cont'd.)

No horizontal positioning	R59, R60, R56, R49 defective C21 shorted R57A defective	Check and replace if necessary Replace Replace
Horizontal deflection present but distorted	C18B open C21 open V6 defective R47, R48 defective	Replace Replace Replace Replace

*Indicates replacement of component in this group makes it necessary to repeat some part of the initial adjustment procedure.

SECTION V. EICO's SERVICE POLICY

If you are experiencing trouble that you cannot diagnose yourself, you are invited to avail yourself of the EICO Service Consultation Department. The consultant handling your inquiry will make every effort to diagnose the cause of your particular difficulty based on the information that you provide. Please be as thorough as possible. Include the following information about your unit:

a) Have you made a thorough check of the wiring, checking also for cold solder joints, or accidental shorting between parts, or to chassis? (Check to see whether a bare wire or lead extends far enough to be shorted when the bottom plate is put on).

b) Have you checked that the proper tube or transistor is in each socket, and also making proper contact in the socket? Are all shields firmly in place?

c) Does the trouble occur at one time or one operating situation, but not at another time or operating situation? Be as specific as possible in this respect.

d) If the unit is of the type that involves alignment or calibration, be as specific as possible as to what you have done or not done with regard to these requirements. If the unit incorporates tuned circuits stated to be factory pre-aligned, did you change any settings? If so, what alignment procedure did you use?

e) Have you observed any pecularity about a part? If a part appears charred or otherwise damaged by excessive heat, please say so. If you think you have damaged a particular part in the assembly or wiring, please say so. In conjunction with the symptoms, the consultant may be able to determine whether such a part is likely to be defective.

f) Have you gone through any trouble-shooting procedure that may be provided? If your manual includes a table of contacts made at each switch position, have you checked out the switches accordingly (if the trouble is such that doing this would be appropriate)? Have you been able to make checks of the operating voltages and/or resistances, if this is appropriate, and your manual provides a table of voltages and resistances? What are the results of these checks? Also, have you taken any other trouble-shooting approaches? What have been the results?

g) If this is high fidelity equipment, please state the type (magnetic, ceramic, crystal) of phono cartridge you are using and/or the make and model number. State the make and model of your record changer, or turntable and tone arm. Are the speakers in the same cabinet with your electronic equipment? If so, describe the cabinet and the placement of the components. Please state the make and model of your speakers.

In addition, list any code numbers in red under the words INSTRUCTION MANUAL on the cover of the book provided with your unit. If there are no red code numbers, state this specifically. If the unit bears a serial number, it is essential that you include this also.

PARTS REPLACEMENT

If it appears that a component is defective, and you desire a replacement from EICO, address your correspondence to our Customer Service Department.

If you are claiming the right to a no-charge replacement under the terms and conditions of the warranty, it is required that you shall have sent in the registration card within 10 days of the date of purchase, and that you send back the defective part transportation prepaid. EICO will make the necessary replacement at no charge for parts eligible under the terms and conditions of the warranty. In returning tubes, pack them very carefully to avoid breakage in shipment. Broken tubes will not be replaced. Please read the warranty on the subject of parts eligible for replacement.

Further information required on a part returned to the factory for a no-charge replacement under the terms and conditions of the warranty is as follows:

a) Model number and serial number, if any, of unit. Also any code numbers in red under the words INSTRUCTION MANUAL on the cover of the book supplied with the unit.

b) Stock number and description of part as given on the parts list. If the part is not listed (of itself) in the parts list, it means that the part is integral with a sub-assembly. If the sub-assembly is not sealed, and the defective part is definitely identified and easily replaceable (not more than two connections), you may request replacement for the particular part. If the sub-assembly is sealed, or if the defective part is not definitely identified or is not easily replaceable (more than two connections), then remove the sub-assembly and return it to EICO (less any tubes) for repair or replacement, if your unit is in warrantee. If your unit is out of warrantee, you are generally advised to order a replacement sub-assembly.

c) Describe as completely as possible the nature of the defect, or your reason for requiring replacement.

FACTORY REPAIR SERVICE

EICO maintains a Factory Repair Service Department for in-warranty or out-of-warranty repair of EICO equipment. It is intended to serve those customers who are not adequately familiar with electronics to make use of the EICO Service Consultation facilities, or whose difficulties cannot be solved by correspondence.

For all out-of-warranty units, there is a minimum labor and handling fee. For the Model No. 427, this fee is $12.50. Charges for components replaced are additional to the minimum fee.

For in-warranty completed kit units, there is a minimum labor and handling fee. For the Model No. 427, this fee is $12.50. There is no charge for a replaced defective part provided that the terms and conditions of the warranty for no charge replacement are not violated in the judgement of EICO.

For in-warranty factory-wired units, there is no labor and handling fee if the unit complies with the terms and conditions of the warranty in the judgement of EICO. However, if the terms and conditions of the warranty are violated, then there will be charged to customer a minimum labor and handling fee plus the cost of parts replaced.

In all cases, the unit must be sent to the factory transportation prepaid, and the unit will be returned to the customer transportation collect.

The services rendered for the minimum labor and handling fee are the correction of any minor wiring errors (not extensive corrections or re-wiring), the labor involved in replacing defective parts, and any adjustments, alignment, or calibration procedures that would normally be performed on a factory-wired unit. Units not wired according to instructions, or modified in any way, or showing evidence of the use of acid core solder, will not be serviced and will be returned to the customer forthwith.

Units requiring extensive corrections or re-wiring will incur an additional labor charge which will be set by EICO. The customer will be informed of this situation and written authorization from the customer will be required before the work is done.

Please note: minimum labor and handling fees are subject to revision at any time.

LOCAL REPAIR FACILITIES

Out-of-warranty repair work may also be performed by authorized service stations as well as the EICO factory. A list of authorized service stations is provided with this manual. The roster of stations may change from time to time, and if considerable time has elapsed since you purchased your unit, you are advised to contact the station you choose before sending the unit to them for repair. Use of a local service station will often result in faster service, and, usually, lower transportation costs.

It is necessary that you comply with the Shipping Instructions that follow when sending in a unit for service.

SHIPPING INSTRUCTIONS

You are strongly advised to retain the original shipping carton and inserts in the case that re-shipment is required for service or any other purpose. The carton may be collapsed, for storage in as small a space as possible. In very many cases, the same carton is used for kit and factory-wired units so that the kit carton will serve for re-shipment of the completed kit.

To submit a unit for service, either to the factory or an authorized service station*, fill out completely the Service Work Order from provided with the manual. Pack the unit very carefully, preferably in the original shipping carton with the original inserts.

If this is not possible, use a strong oversize carton, preferably wood, allowing at least 3 inches of resilient packing material such as shredded paper or excelsior, to be inserted between all sides of the unit and the carton. Seal the carton with strong gummed paper tape or strong twine, or both. Include the Service Work Order in the carton and in addition, attach a tag to the instrument on which is printed your name and address and brief reference to the trouble experienced. Affix "FRAGILE" or "HANDLE WITH CARE" labels to at least four sides of the carton, or print these words large and clear with a bright color crayon. Ship by prepaid Railway Express or parcel post to:

EICO Electronic Instrument Co., Inc.
33-00 Northern Blvd.
Long Island City 1, New York
Attention: Service Department

Include your name and address on the outside of the carton. Return shipment will be made transportation charges collect. Note that a carrier cannot be held liable for damages in transit, if packing, IN HIS OPINION, is insufficient.

*Authorized service stations are for out-of-warranty units only, unless the station is specifically noted on the List of Authorized Service Stations to be authorized for other work.

EICO THE EICO WARRANTY EICO

The Electronic Instrument Company, Inc., hereafter referred to as EICO, warrants that, for a period of 90 days from the date of purchase, any EICO kit will be free of defects in parts, and that any EICO factory-wired unit will be free of defects in parts and workmanship. For an EICO kit, EICO's obligation is limited to those parts which are returned transportation prepaid to the factory without further damage, and in the judgement of EICO are either originally defective or have become defective in normal use. For an EICO factory-wired unit, EICO's obligation is limited to those parts, sections, or the entire unit which is returned transportation prepaid to the factory without further damage, and in the judgement of EICO are either originally defective or have become defective in normal use.

The warranty does not apply to any parts damaged in the course of handling, assembling, or wiring by the customer, or damaged due to abnormal usage or in violation of instructions or reasonable practice, or further damaged to a consequential degree in return shipment. Furthermore, the foregoing warranty is made only to the original customer, and is and shall be in lieu of all other warranties, whether expressed or implied, and of all other obligations or liabilities on the part of EICO, and in no event shall EICO be liable for any anticipated profits, consequential damages, loss of time, or other losses incurred by the customer in connection with the purchase or operation of EICO products or components thereof.

The registration card, which accompanies each EICO kit or factory-wired unit, must be filled in and returned to the company within 10 days after the date of purchase. This warranty applies only to registered units.

SECTION VI. PARTS LIST

SYM. NO.	STOCK#	AM'T.	DESCRIPTION
CAPACITORS			
C1	20015	1	capacitor, paper, .25mfd, 600V
C2A, B, C	29514	1	capacitor, trimmer, 3 x 13mmf
C3	22519	1	capacitor, disc, .01mfd, 500V, 10%
C4	22521	1	capacitor, disc, .001mfd, 500V, 10%
C5	22509	1	capacitor, disc, 100mmf, 500V, 10%
C6, 7, 8, 9	22020	4	capacitor, tubular, 5mmf, 500V
C10, 11	22573	2	capacitor, disc, .01mfd, 1KV, 10%
C12	20077	1	capacitor, paper, .05mfd, 1500V, 10%
C13	22583	1	capacitor, disc, .01mfd, 2KV, 10%
C14, 15	20055	2	capacitor, tubular, .1mfd, 1600V
C16	24025	1	capacitor, electrolytic, 40/40/300mfd
C17	22550	1	capacitor, disc, 600mmf, 500V, 10%
C18	24027	1	capacitor, electrolytic, 20/20/30mfd-200V
C19, 20	22020	2	capacitor, tubular, 5mmf, 500V
C21	20050	1	capacitor, paper, .25mfd, 200V
C22	22509	1	capacitor, disc, 100mmf, 500V, 10%
C23	23028	1	capacitor, elec., tubular, 50mfd, 150V
C24,	20044	1	capacitor, paper, .25mfd, 400V, 10%
C25	20029	1	capacitor, molded, .15mfd, 400V, 10%
C26	20023	1	capacitor, molded, .015mfd, 400V, 10%
C27	20017	1	capacitor, molded, .0015mfd, 400V, 10%
C28	22509	1	capacitor, disc, 100mmf, 500V, 10%
C29	22560	1	capacitor, disc, .05mfd, 500V, GMV
C30	20015	1	capacitor, paper, .25mfd, 600V
C31	29507	1	capacitor, trimmer, 5-80mmf
C32	21001	1	capacitor, mica, 270mmf, 500V, 10%
FUSE			
F1	91002	1	fuse, 1 Amp
NEON BULBS			
I1	97715	1	bulb, neon indicator
I2	92008	1	bulb, NE-2H
JACKS			
J1, 2, 3, 4, 5	52006	5	binding post assembly
J6, 7, 8	50028	3	jack
SWITCHES			
S1	60105	1	switch, rotary
S2	60118	1	switch, rotary
S3	60119	1	switch, rotary
S4	62015	1	switch, slide, SPST
S5		1	switch, ON-OFF, SPST (Part of 18074)
S6	62000	1	switch, slide, DPST
TRANSFORMER			
T1	30043	1	transformer, power

PARTS LIST (Cont'd.)

TERMINAL STRIPS

TB1	54025	1	terminal strip, 4 post, 3 right
TB2	54008	1	terminal strip, 4 post
TB3	54013	1	terminal strip, 1 post left with ground
TB4	54018	1	terminal strip, 4 post with ground
TB5	54019	1	terminal strip, 2 post right
TB6	54004	1	terminal strip, 2 post with ground
TB7	54018	1	terminal strip, 4 post with ground
TB8	54002	1	terminal strip, 1 post right with ground
TB9	54006	1	terminal strip, 3 post, 2 right
TB10	54008	1	terminal strip, 4 post
TB11	54018	1	terminal strip, 4 post with ground
TB12	54006	1	terminal strip, 3 post, 2 right
TB13	54007	1	terminal strip, 3 post, 2 right with ground
TB14	54013	1	terminal strip, 1 post left with ground
TB15, 16	54001	2	terminal strip, 1 post right
TB17	54023	1	terminal strip, 2 post left with ground
TB18	54006	1	terminal strip, 3 post, 2 right
TB19	54003	1	terminal strip, 2 post
TB20	54000	1	terminal strip, 1 post left
TB21	54014	1	terminal strip, 3 post, 2 left
TB22	54003	1	terminal strip, 2 post
TB23	54004	1	terminal strip, 2 post with ground
TB24	54009	1	terminal strip, 2 blank, upright

TUBES

V1, 2	90071	2	tube, 6BL8/ECF80
V3	90012	1	tube, 12AT7/ECC81
V4	90071	1	tube, 6BL8/ECF80
V5, 6	90012	2	tube, 12AT7/ECC81
V7	90030	1	tube, 1V2
V8	90036	1	tube, 6X4/EZ90
V9	90084	1	tube, CRT, 5DEP1

SOCKETS

XF1	97804	1	fuseholder
XV1, 2, 3, 4, 5, 6, 7	97025	7	socket, nine pin miniature
XV8	97022	1	socket, seven pin miniature
XV9	97026	1	socket, CRT, 12 pin

RESISTORS

R1	10407	1	resistor, 1MΩ, 1/2W, 10% (brown, black, green, silver)
R2	10537	1	resistor, 1MΩ, 1/2W, 5% (brown, black, green, gold)
R3	11566	1	resistor, 1000Ω, 1/2W, 5% (brown, black, red, gold)
R4	11577	1	resistor, 990KΩ, 1/2W, 5% (white, white, yellow, gold)
R5	11500	1	resistor, 10KΩ, 1/2W, 5% (brown, black, orange, gold)
R6	11576	1	resistor, 900KΩ, 1/2W,5% (white,black, yellow, gold)
R7	11527	1	resistor, 100KΩ, 1/2W, 5% (brown, black, yellow, gold)
R8, 9	10439	2	resistor, 100Ω, 1/2W, 10% (brown, black, brown, silver)
R10, 11	10420	2	resistor, 3300Ω, 1/2W, 10% (orange, orange, red, silver)
R12	18073	1	potentiometer, 10KΩ, SS linear
R13A, B	18064	1	potentiometer, conc., 5K/4K linear
R14	16000	1	potentiometer, 2KΩ, linear
R15, 16	10439	2	resistor, 100Ω, 1/2W, 10% (brown, black, brown, silver)
R17, 18	10956	2	resistor, 10KΩ, 2W, 10% (brown, black, orange, silver)
R19, 20	10849	2	resistor, 47KΩ, 1W, 10% (yellow, violet, orange, silver)
R21, 22	10439	2	resistor, 100Ω, 1/2W, 10% (brown, black, brown, silver)

PARTS LIST (Cont'd.)

R23	14513	1	resistor, 5000Ω, 5W, 10%
R24, 25, 26	10851	3	resistor, 22KΩ, 1W, 10% (red, red, orange, silver)
R27, 28	10431	2	resistor, 470KΩ, 1/2W, 10% (yellow, violet, yellow, silver)
R29, 30	10407	2	resistor, 1MΩ, 1/2W, 10% (brown, black, green, silver)
R31, 32	16011	2	potentiometer, 2MΩ, linear
R33	10838	1	resistor, 3.3MΩ, 1W, 10% (orange, orange, green, silver)
R34	10842	1	resistor, 680KΩ, 1W, 10% (blue, grey, yellow, silver)
R35	18066	1	potentiometer, 500KΩ, CCW, 10%
R36	10431	1	resistor, 470K, 1/2W, 10% (yellow, violet, yellow, silver)
R37	10407	1	resistor, 1MΩ, 1/2W, 10% (brown, black, green, silver)
R38	10434	1	resistor, 2.2MΩ, 1/2W, 10% (red, red, green, silver)
R39	10417	1	resistor, 220KΩ, 1/2W, 10% (red, red, yellow, silver)
R40	10969	1	resistor, 1800Ω, 2W, 10% (brown, grey, red, silver)
R41	14501	1	resistor, 1000Ω, 5W, 10%
R42, 43	10409	2	resistor, 560KΩ, 1/2W, 10% (green, blue, yellow, silver)
R44	11579	1	resistor, 2MΩ, 1/2W, 5% (red, black, green, gold)
R45	10537	1	resistor, 1MΩ, 1/2W, 5% (brown, black, green, gold)
R46	11566	1	resistor, 1000Ω, 1/2W, 5% (brown, black, red, gold)
R47, 48	10849	2	resistor, 47KΩ, 1W, 10% (yellow, violet, orange, silver)
R49	10878	1	resistor, 8200Ω, 1W, 10% (grey, red, red, silver)
R50	10956	1	resistor, 10KΩ, 2W, 10% (brown, black, orange, silver)
R51	18106	1	potentiometer, 15MΩ, linear
R52	11530	1	resistor, 800KΩ, 1/2W, 5% (grey, black, yellow, gold)
R53	10849	1	resistor, 47KΩ, 1W, 10% (yellow, violet, orange, silver)
R54, 55	10439	2	resistor, 100Ω, 1/2W, 10% (brown, black, brown, silver)
R56	10410	1	resistor, 100KΩ, 1/2W, 10% (brown, black, yellow, silver)
R57A, B	18065	1	potentiometer, 10K/50K, linear
R58	10426	1	resistor, 33KΩ, 1/2W, 10% (orange, orange, orange, silver)
R59	10417	1	resistor, 220KΩ, 1/2W, 10% (red, red, yellow, silver)
R60	10421	1	resistor, 6800Ω, 1/2W, 10% (blue, grey, red, silver)
R61	10852	1	resistor, 15KΩ, 1W, 10% (brown, green, orange, silver)
R62	10453	1	resistor, 18KΩ, 1/2W, 10% (brown, grey, orange, silver)
R63	10956	1	resistor, 10KΩ, 2W, 10% (brown, black, orange, silver)
R64	10424	1	resistor, 22KΩ, 1/2W, 10% (red, red, orange, silver)
R65	10452	1	resistor, 8200Ω, 1/2W, 10% (grey, red, red, silver)
R66	10855	1	resistor, 4700Ω, 1W, 10% (yellow, violet, red, silver)
R67	10419	1	resistor, 270KΩ, 1/2W, 10% (red, violet, yellow, silver)
R68	10439	1	resistor, 100Ω, 1/2W, 10% (brown, black, brown, silver)
R69	10435	1	resistor, 2.2MΩ, 1/2W, 10% (red, red, green, silver)
R70	10432	1	resistor, 1000Ω, 1/2W, 10% (brown, black, red, silver)
R71	10422	1	resistor, 68KΩ, 1/2W, 10% (blue, grey, orange, silver)
R72	18074	1	potentiometer, 100K, SPST switch

MOUNTING HARDWARE

40000	41	nut, hex, No. 6-32
40001	12	nut, hex, 3/8"
40007	18	nut, hex, No. 4-40
40008	4	nut, hex, No. 8-32
40016	1	nut, hex, 1/2"
40017	2	nut, Tinnerman, No. 8-32
40019	10	nut, Tinnerman, No. 6-32
40027	2	nut, Tinnerman, No. 8, Z angle bracket
40034	4	nut, Tinnerman, No. 4-40
41003	6	screw, No. 8-32 x 3/8
41008	2	screw, No. 6-32 x 1/2
41047	4	screw, No. 8, Type Z
41086	47	screw, No. 6-32 x 5/16
41089	10	screw, No. 6-32 x 3/16
41090	20	screw, No. 4-40 x 5/16
41091	2	screw, No. 4-40 x 1/4, Fl. Hd.
42000	5	washer, lock, 3/8"
42001	10	washer, flat, 3/8"
42002	39	washer, lock, No. 6

PARTS LIST (Cont'd.)

42007	18	washer, lock, No. 4
42008	4	washer, lock, No. 8
42012	3	nut, star
42029	1	washer, rubber, 1/2"
42511	1	retainer, neon indicator
43000	2	lug, No. 6
43001	2	lug, 3/8 pot.
43004	5	lug, No. 8

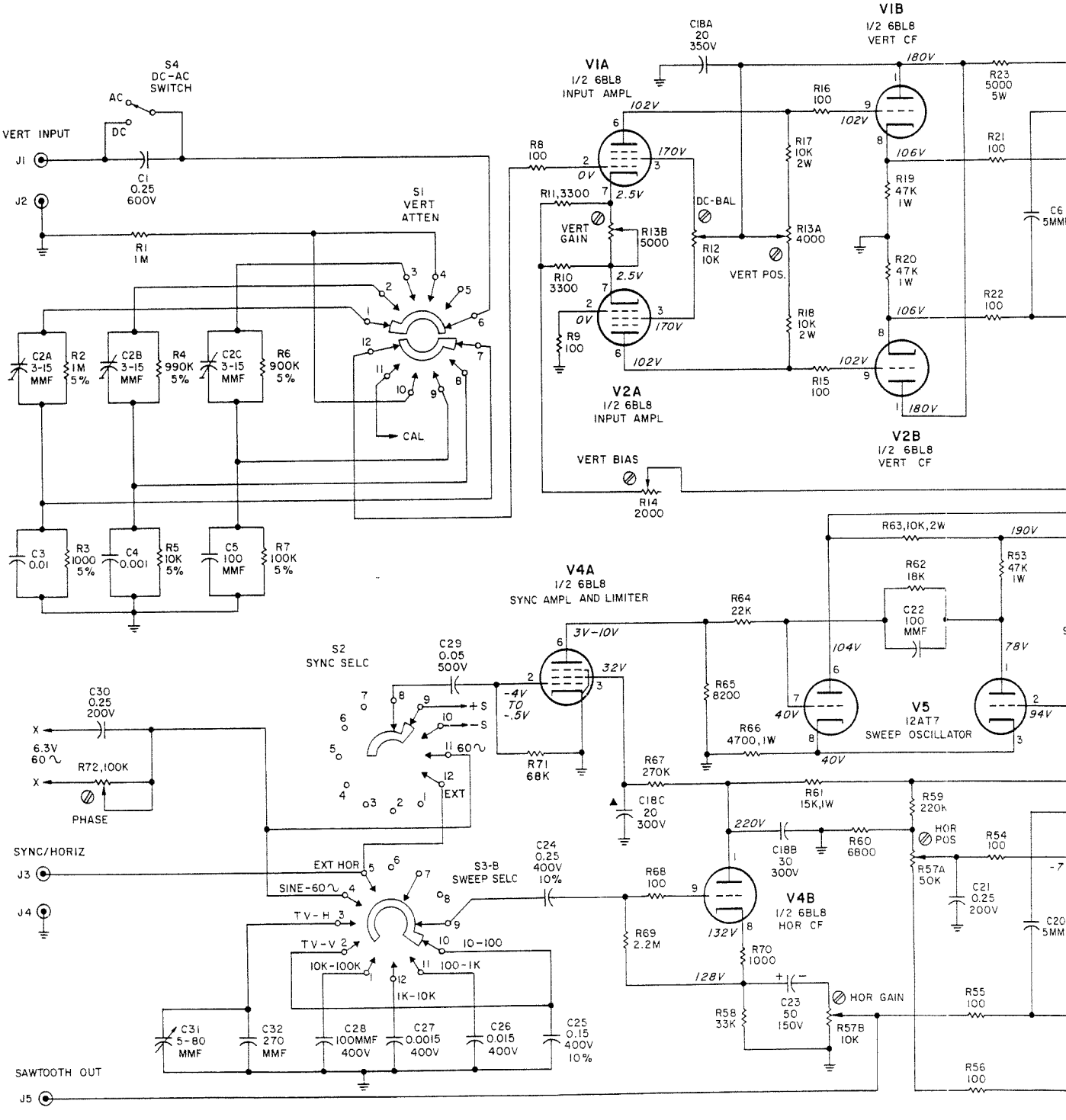
SHEET METAL

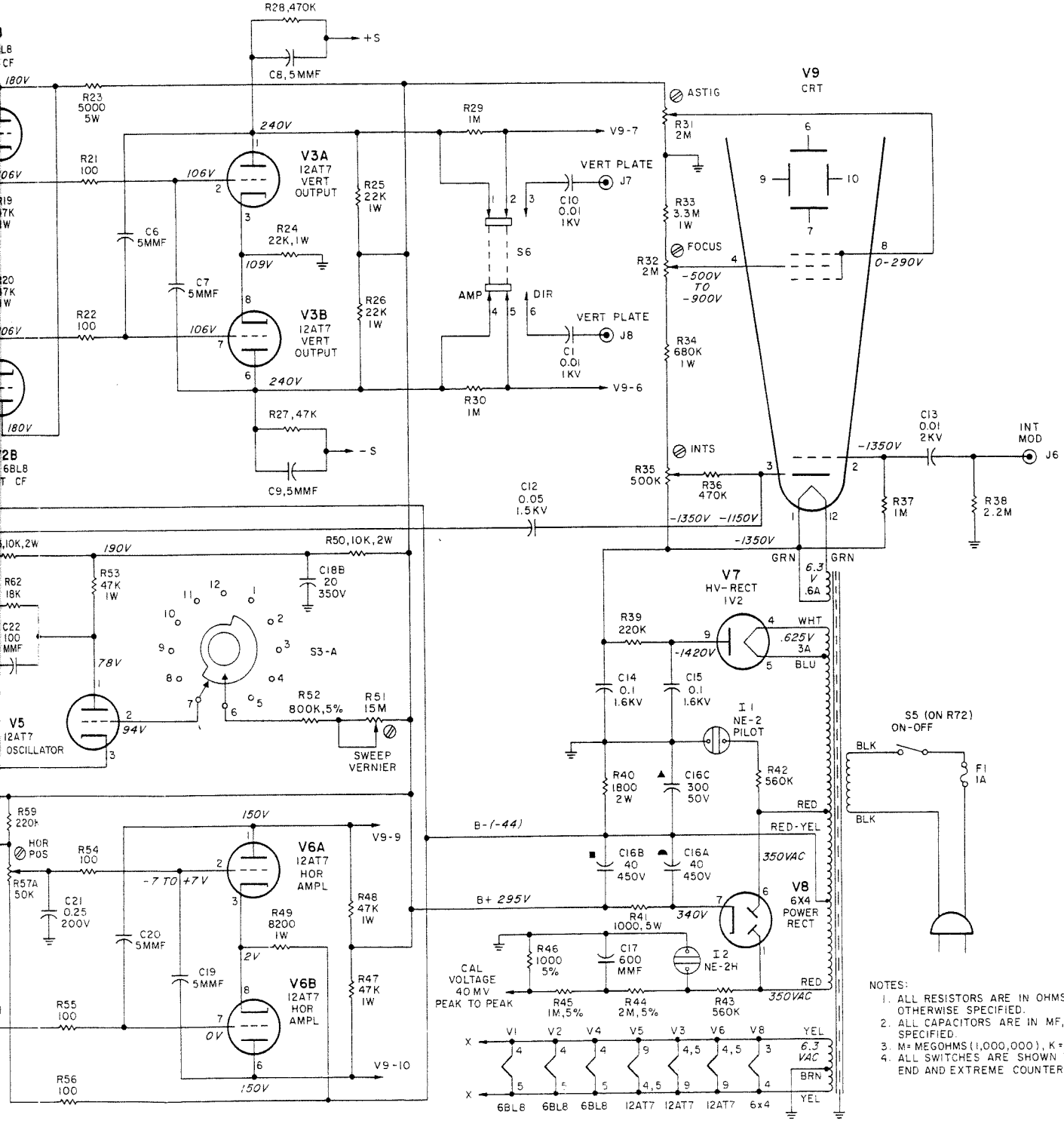
80074	1	panel, front
81219	1	chassis, main
81220	1	bracket, right
81221	1	bracket, left
81222	1	chassis, rear
81255	1	shield with lugs
81256	2	bracket, clamp CRT
81324	1	bezel, rear
81353	1	bracket, rear
81355	1	bracket, frame
81356	2	support, frame
81914	1	bracket, single pot.
81917	1	bracket, double pot.
86007	1	frame
88077	1	cabinet

MISCELLANEOUS

46001	3	grommet, rubber small
46003	3	grommet, rubber large
46016	4	foot, plastic
53036	4	knob, large dark grey
53037	4	knob, small dark grey
53040	2	knob, outer concentric
53041	2	knob, inner concentric
57004	1	line cord
59004	1	screen, green
59303	1	felt strip, CRT
59306	1	neck piece, CRT
59508	1	plate, capacitor mounting
82101	1	strain relief
87007	1	handle, plastic
89259	1	label, nomenclature
89647	1	bezel, plastic
89679	2	bracket, handle mounting
89680	2	bracket, bottom mounting
66116	1	manual of instructions
66373	1	manual of construction (steps and figures)

Figure 12. Schematic Diagram





NOTES:

1. ALL RESISTORS ARE IN OHMS, 1/2W, 10%, UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MF, 10%, UNLESS OTHERWISE SPECIFIED.
3. M= MEGOHMS (1,000,000), K = KILOHMS (1,000).
4. ALL SWITCHES ARE SHOWN VIEWED FROM THE SHAFT END AND EXTREME COUNTER-CLOCKWISE POSITIONS.

MODEL 427 ADDENDUM

Please make the following changes to your Construction Manual:

Parts List, Page 16: Remove C6, 7 from 22020, capacitor, tubular, 5mmf, 500V, (Change amount to 2).
Page 17: Change R10, 11 to 10963 resistor, 3300 ohms, 2W, 10%
Page 17: Change R14 to 17004 potentiometer 2K, 2W, 20%, wirewound
Page 18: Change R23 to 14312 resistor, 2500 ohms, 10W, 10%

Schematic, Page 20: Remove C6, 5mmf & C7, 5mmf from the circuit.
Change R23 to 2500-10W.
Change R10 and R11 to 3300, 2W.

If you have a kit, please make the following changes in your Construction Steps Manual:

Page 10, Fig. 1C, Step 16: Change (16000) to (17004)
Page 21, Fig. 11C, Step 16: Change R11 to 3300, 2W, 10%.....
Page 22, Fig. 11C, Step 21: Change R10 to 3300, 2W, 10%.....
Page 23, Fig. 12C, Step 15: Change R23 to 2500 ohms, 10W, 10%
Page 26, Fig. 15C, Step 10 & 11: Delete Steps 10 and 11 entirely.

Construction Page 15C: Remove C6 (Step 10) & C7 (Step 11) from the Construction figure.

Construction figures 1C, Page 2: Step 16, (R14) - Change "16000" to "17004".

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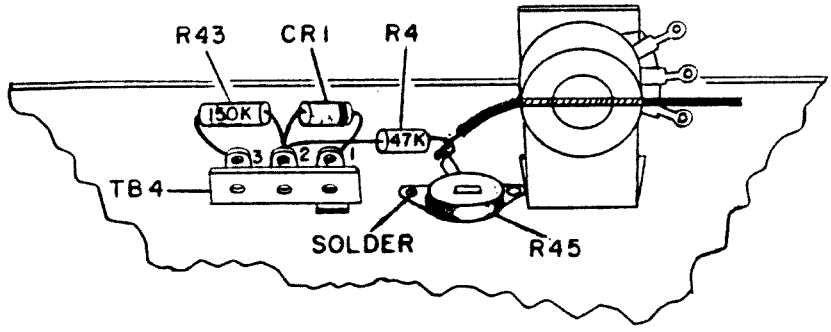
MODEL 427 ADDENDUM (Cont'd.)

Please use the following drawing as a supplement to figures 1C & 9C for the preceding changes described:



Please make the following changes in your Construction Figures Manual:

Page 14, Fig. 13C: Change the disc, cap., C32 (Step 10) to 470mmf disc cap.

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MODEL 427 ADDENDUM

Instruction Book (Page 9, Figure 7).

Change V4 (12AT7) to read: V4 (6BL8)

Change V5 (6BL8) to read: V5 (12AT7)

Capacitor C2 — Reverse letters A & C

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MODEL 427 ADDENDA

INSTRUCTION BOOK

Page 16, Parts List, Change C32 to read: 22541 capacitor, disc, 470mmf, 10%

Page 20, Schematic, Change C32 to read: 470mmf

Change R56 to read: 100K

If you have the 427 kit, change the Construction Book Steps.

Page 24, Step 10, Change 270mmf (rectangle) mica capacitor to read:

470mmf disc capacitor

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