714-2

INSTRUCTION MANUAL

DIC

I - 0008

TYPE

105

SQUARE-WAVE GENERATOR

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

83

INSTRUCTION MANUAL

Serial Number 7576

DIC-I-0008

CERADOR

TYPE

105

SQUARE-WAVE GENERATOR

Tektronix, Inc.

S.W. Millikan Way • P. O. Box 500 • Beaverton, Oregon • Phone MI 4-0161 • Cables: Tektronix

Tektronix International A.G.

Terrassenweg 1A • Zug, Switzerland • PH. 042-49192 • Cable: Tekintag, Zug Switzerland • Telex 53.574

070-371

363

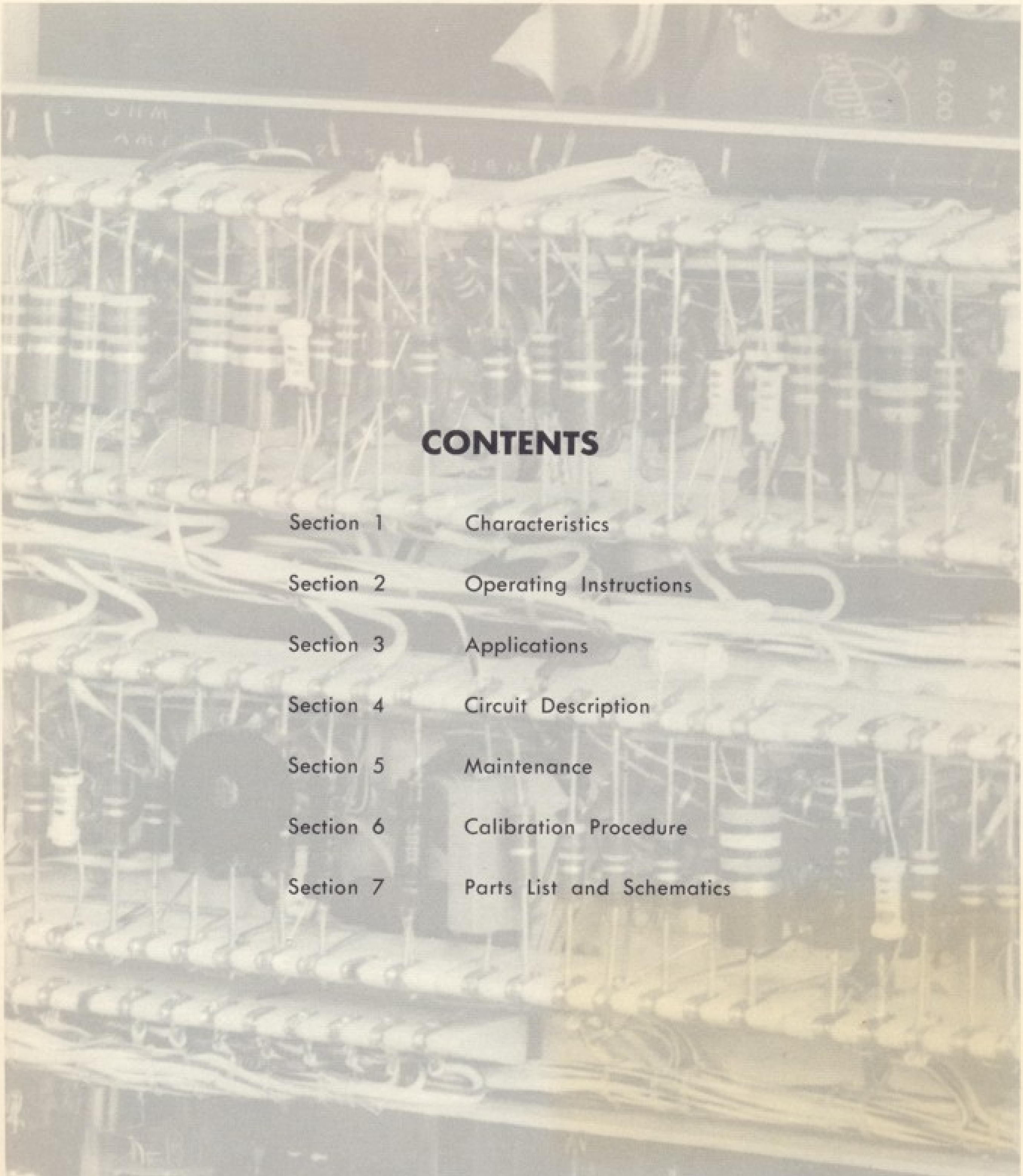
WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

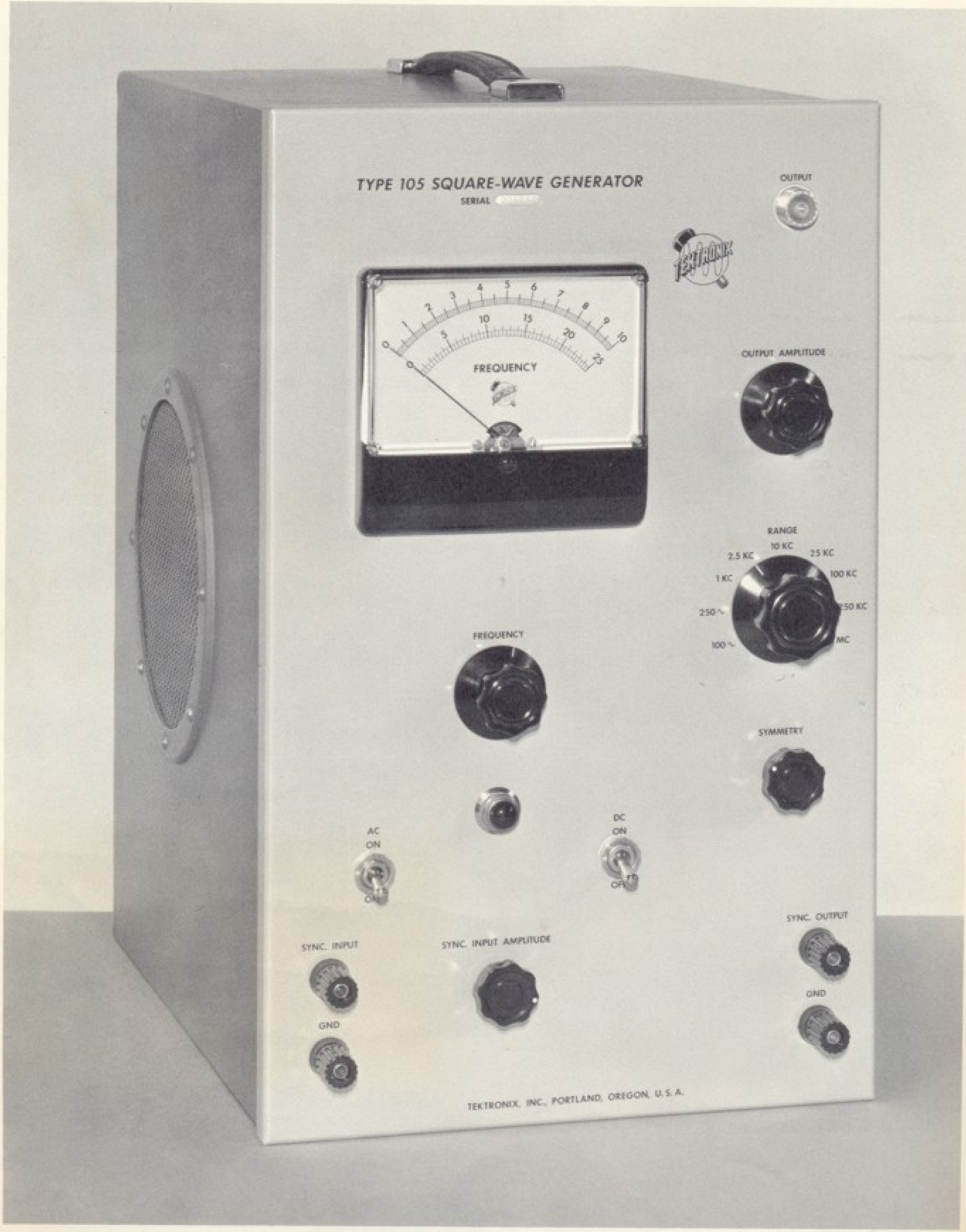
Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

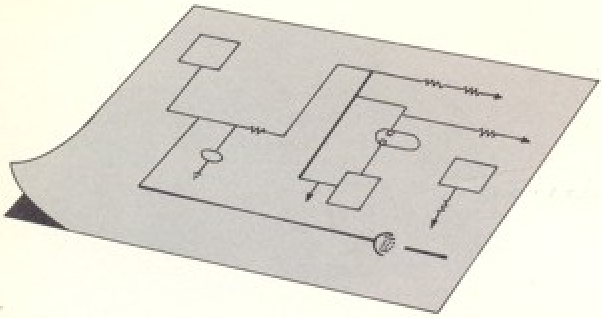
Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.



CONTENTS


TYPE 105 SQUARE-WAVE GENERATOR
SERIAL
OUTPUT
TEKTRONIX
FREQUENCY
OUTPUT AMPLITUDE
RANGE
10 KC
2.5 KC
25 KC
1 KC
100 KC
250 ~
250 KC
100 ~
MC
FREQUENCY
SYMMETRY
AC
ON
OFF
DC
ON
OFF
SYNC. INPUT
SYNC. INPUT AMPLITUDE
SYNC. OUTPUT
GND
GND
TEKTRONIX, INC., PORTLAND, OREGON, U. S. A.



SECTION 1

CHARACTERISTICS

GENERAL DESCRIPTION

The Tektronix Type 105 Square-Wave Generator is a compact, versatile instrument providing precision square waves at any desired frequency from 25 cycles to 1 megacycle. Short rise time, excellent waveform, variable amplitude control, accurate indication of frequency and many other features are combined to make the Type 105 an ideal instrument for development and production testing of amplifiers and other electronic equipment. Wide range and flexibility of operation qualify the Type 105 for highly specialized laboratory and research applications as well as general purpose uses.

CHARACTERISTICS

Frequency Range

25 cycles to 1 mc continuously variable.

Rise and Fall Time (10% to 90%)

0.02 microseconds with 93-ohm output load.

Output Amplitude

10 to 100 volts peak to peak across internal 600-ohm load. 1.5 to 15 volts peak to peak with 93-ohm external termination load.

Output Current Available for External Load

16 to 160 ma.

Accuracy of Frequency Indication

±3% of full scale.

Sync. Output Amplitude

5 volts.

Sync. Input Requirement

Sinewaves of 3 v to 45 v peak to peak. Pulses or square waves of 1 v to 10 v peak amplitude.

Power Requirements

105-125 or 210-250 volts, 50-60 cycles, 250 watts.

Dimensions

10″ wide, 16½″ high, 14″ deep.

Weight

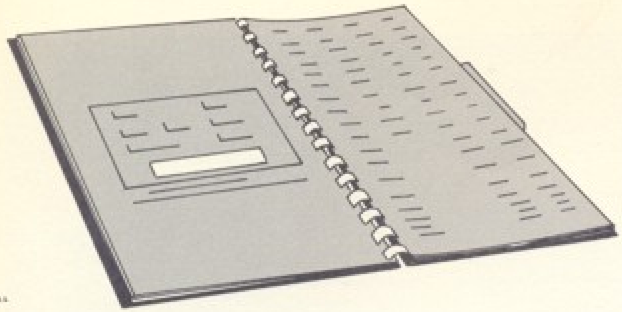
35 lbs.

Finish

Panel, photoetched aluminum with black letters.
Cabinet, blue vinyl.

Accessories Included

1—3-Conductor power cord, 161-010
1—Adapter, BNC-to-binding post, 103-033
1—3- to 2-Wire adapter, 103-013
1—Clip lead adapter, BNC, 013-076
1—93 Ω Cable, BNC both ends, 012-075
1—93 Ω Termination, BNC, 011-056
2—Instruction Manuals, 070-371



SECTION 2

OPERATING INSTRUCTIONS

ADJUSTING THE CONTROLS

General

You can operate the Type 105 in any normal indoor location, or in the open if the instrument is protected from moisture. If the instrument has been exposed to dampness, you should leave it in a warm room until it is thoroughly dry before you operate it.

CAUTION

It is important that you allow adequate ventilation of the instrument, in order to prevent excessive interior temperatures. Provide a clearance of at least one inch on the left-hand side of the instrument for air intake to the fan. Whenever you operate the Type 105 in its case, you must have the four mounting feet in place on the bottom of the instrument to provide spacing for air exhaust. Be sure to allow adequate spacing around the bottom of the instrument.

If you use the Type 105 for a single application, with only one set of control settings, check the instrument periodically at all control settings to be sure that it is in normal operating condition. When you operate the controls you also help prevent accumulation of dirt and tarnish on their contacts.

The components of the Type 105 are well-supported and the adjustments are stable, so that the instrument is suitable for portable operation. However, don't subject the Type 105 to excessive vibration or rough handling.

CONVERTING TO 234 VOLT OPERATION

Remove the short jumper leads from the power transformer terminals 1 to 2 and 3 to 4. Now, using one of the short leads just removed, connect terminals 2 and 3. The fan is connected from terminal 1 to a tap on the transformer, terminal 17, and should not be changed.

Power Switches

A main power switch marked AC ON-OFF applies or removes power for the entire instrument. In addition, a separate switch marked DC ON-OFF is provided to control the internal dc supply circuits when the AC switch is turned ON.

When you first operate the instrument, have both the AC switch and the DC switch turned OFF. Turn on the AC switch first; after a 30-second warm-up period, turn on the DC switch. In this way, you assure maximum tube life.

CAUTION

The output waveform from the Type 105 can produce a painful shock. It is best to turn the DC switch OFF before you make or change connections to the OUTPUT connector.

Frequency Adjustment

You can set the repetition frequency of the output waveform of the Type 105 by means of the RANGE switch and the continuously variable FREQUENCY control. The repetition frequency is indicated by a meter that provides two scales per decade. Read the meter scale whose upper limit corresponds to the setting of the RANGE switch. For the most accurate meter reading, use settings of the RANGE and FREQUENCY controls such that the meter reading is in the upper 75 percent of the scale.

Symmetry

You can use the SYMMETRY control to adjust the time duration of the positive portion of the output square wave with respect to the duration of the negative portion, with only a small change in repetition frequency. In other words, you can use the SYMMETRY control to adjust the duty factor of the output waveform.

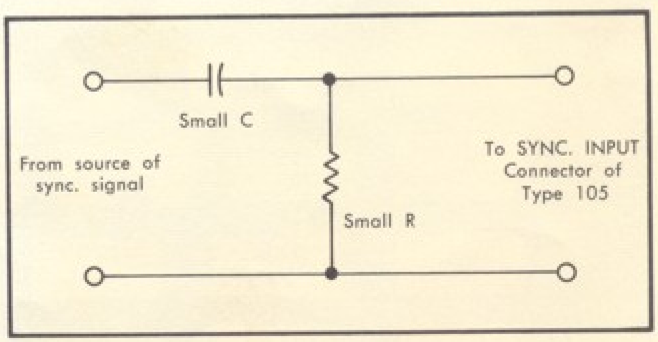


Fig. 2-1. Differentiating network useful with certain nonsinusoidal synchronizing waveforms.

Sync. Input Connector

You can synchronize the output waveform of the Type 105 with the output waveform from a frequency standard

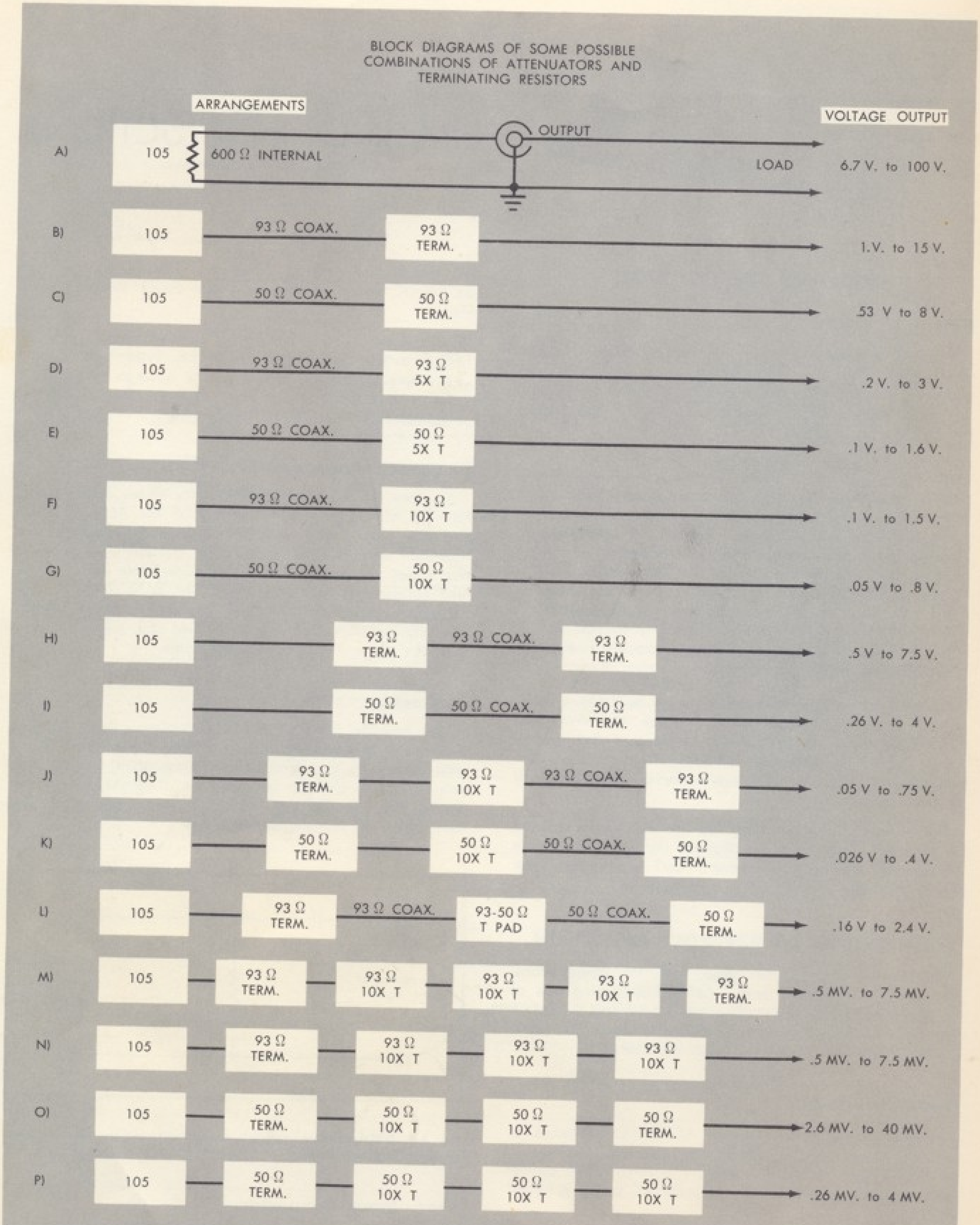


Fig. 2-2. Certain combinations of terminating resistors, attenuator pads and cables.

or other equipment by applying the synchronizing waveform to the SYNC. INPUT connector of the Type 105.

Although the Type 105 will synchronize well with a wide variety of waveforms, you might sometimes need to connect a differentiating network (Fig. 2-1) between the source of a nonsinusoidal synchronizing signal and the SYNC. INPUT connector to convert certain synchronizing waveforms into short pulses.

A positive-going synchronizing signal in the range from 3 to 45 volts is suitable. If the synchronizing signal is greater than about 45 volts, connect a suitable voltage divider between the source of the synchronizing signal and the SYNC. INPUT connector. In this way you can reduce the signal applied to the SYNC. INPUT connector to a value between 3 and 45 volts.

After you have connected the source of synchronizing signal to the SYNC. INPUT connector, you can effect synchronization as follows:

Start with the SYNC. INPUT AMPLITUDE control full left (counterclockwise). Then turn this control slowly to the right until synchronization occurs. It is usually best to leave the SYNC. INPUT AMPLITUDE control as far left as is consistent with stable synchronization.

Sync. Output Connector

You can use the output from the SYNC. OUTPUT connector of the Type 105 to synchronize other equipment with the output waveform of the Type 105. The synchronizing signal from the SYNC. OUTPUT connector has a peak-to-peak value of about 5 volts.

Output Amplitude Control

You can use the OUTPUT AMPLITUDE control to effect continuously variable control of the amplitude of the square-wave output of the Type 105.

The range of output voltages obtainable depends upon the amount of external load resistance you connect across the output connector. Block diagrams of some typical combinations of attenuator pads, terminating resistors, and cables are shown in Fig. 2-2, along with typical resulting ranges of peak-to-peak output voltages. For the best output waveform, you should use a combination such that, for the output voltage you want, the OUTPUT AMPLITUDE control is in the right-hand portion of its range.

Certain terminating resistors, attenuator pads and cables suitable for use with the Type 105 are listed in Table 2-1.

TABLE 2-1
Tektronix Accessories for the Type 105

011-045	50 ohm terminating resistor 1.5 watts.
011-047	93 ohm terminating resistor 1.5 watts.
011-031	50 ohm 10 X T 10:1 attenuator.
011-032	50 ohm 5 X T 5:1 attenuator.
011-035	93 ohm 10 X T 10:1 attenuator.
011-036	93 ohm 5 X T 5:1 attenuator.
011-042	93 to 50 ohm minimum loss terminator.
012-001	50 ohm RG58A/U coaxial cable with UHF connectors each end.
012-003	93 ohm RG62A/U coaxial cable with UHF connectors each end.

Initial Operation

To place the Type 105 in operation for the first time, the following procedure is suggested.

1. Turn the AC and DC switches OFF. Set the SYMMETRY control to midrange. Set the RANGE switch to 1 KC.

2. Connect the power-input cable to the Type 105 and to a source of 117-volt 50-to-60 cycle power (or to a source of 234-volt 50-to-60 cycle power if the power transformer is connected for 234-volt operation). Turn the AC switch ON. This will cause the fan to operate and the tubes to heat.

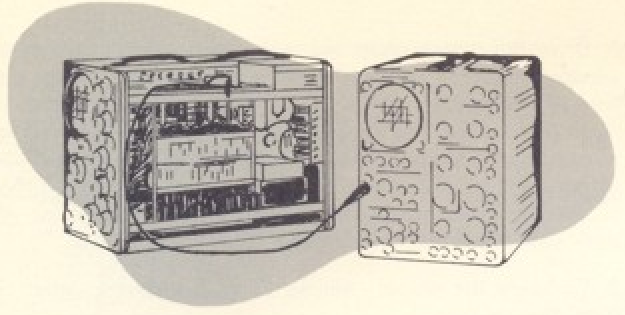
3. Connect the 93-ohm output cable to the OUTPUT connector. Connect the 93-ohm terminating resistor to the free end of the cable. Connect the output end of the terminating resistor to the vertical-input connector of the oscilloscope. Connect the SYNC. OUTPUT connector to the TRIGGER INPUT connector of the oscilloscope. Turn on the oscilloscope and adjust it for external triggering and for a sweep rate of .2 mSEC/CM (or .2 mSEC/DIV.).

4. Turn the DC switch ON. Adjust the FREQUENCY control for full-scale deflection of the FREQUENCY meter.

5. Adjust the OUTPUT control of the Type 105 and the VOLTS/CM (or VOLTS/DIV.) control of the oscilloscope for a convenient amount of vertical deflection on the cathode-ray-tube screen. You should now observe several cycles of the square-wave output of the Type 105 on the cathode-ray-tube screen.

6. Adjust the SYMMETRY control for equal positive- and negative-going portions of the displayed waveform.

The repetition frequency of the displayed square wave is close to 1 kilocycle. You can observe square waves of other repetition frequencies by adjusting the RANGE and FREQUENCY controls on the Type 105.



SECTION 3

APPLICATIONS

IMPORTANT

To avoid misleading observations or measurements when you are using your Type 105 Square-Wave Generator, be sure that the instrument is properly maintained and operated. Carefully observe the operating instructions given here. Your attention is particularly called to the section titled "Possible distortion of waveform".

One of the applications of a square-wave generator is in the testing and adjustment of the vertical amplifier and delay line of an oscilloscope. The Type 105 is suited to this use with many types of oscilloscopes. However, the risetime of the Type 105, although short, is not short enough for satisfactory results when you are testing or adjusting the vertical amplifier or delay line in an oscilloscope whose vertical-deflection-system bandwidth greatly exceeds 10 megacycles. Your Tektronix Field Engineer or Engineering Representative will be glad to make specific recommendations.

Risetime and Falltime

The risetime of the square-wave output of the generator is taken as the time required for the output voltage to rise from 10 percent of its maximum value to 90 percent of its maximum value (Fig. 3-1). The falltime of the output waveform is taken as the time required for the output voltage to fall from 90 percent of its maximum value to 10 percent of its maximum value. The risetime of the waveform, under given conditions, will not necessarily be equal to the falltime.

The risetime of the output waveform from the Type 105 depends upon various factors, including the values of external resistance and shunt capacitance you connect across the OUTPUT connector. The risetime of the output square wave is nominally 0.02 microsecond (20 nanoseconds), and the actual risetime will not be greater than this value when the shunt capacitance is small.

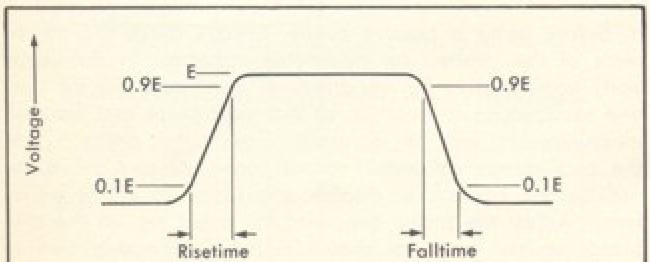


Fig. 3-1. Illustrating risetime and falltime of a square wave of voltage.

Risetime Measurements

One of the applications of the Type 105 is its use, in conjunction with a suitable oscilloscope, to observe and measure the transient responses of amplifiers and other signal-transmitting devices.

An important feature of the transient response of a device is its risetime. To measure the risetime of a device,

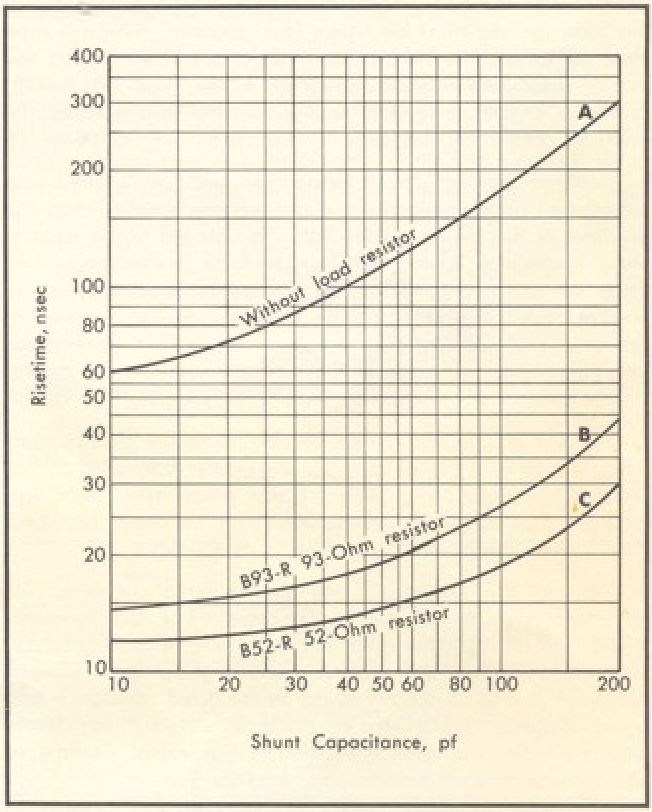


Fig. 3-2. Illustrating the effects upon the risetime of the output waveform of the Type 105 when you connect various values of load resistance and shunt capacitance to the OUTPUT connector. These measured results are representative only, and are intended to convey the general effect of resistance and capacitance changes in typical cases.

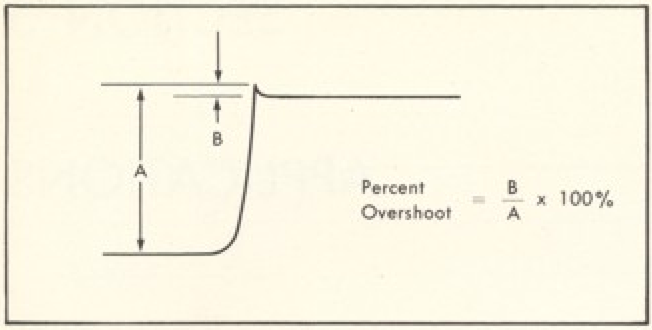


Fig. 3-3. Illustrating overshoot on the leading edge of a square wave.

you would theoretically feed into its input terminals a perfect square wave (one that "jumped" instantly from its most negative voltage to its most positive voltage). Then you would observe with your oscilloscope the time interval required for the output voltage of the device to rise from 10 percent of its maximum value to 90 percent of its maximum value. This time interval would be called the risetime of the device.

It is impossible, however, to generate an input square wave that jumps instantly from its initial value to its final value (that is, we cannot generate an input square wave whose risetime is zero). Furthermore, the risetime of the oscilloscope itself is greater than zero, and this risetime of the oscilloscope must be taken into account. We will now describe a risetime-measurement technique that permits the use of square-wave generators (such as the Type 105) having risetimes greater than zero and that takes into account the risetime of the oscilloscope.

For best results, use a generator and an oscilloscope whose individual risetimes are appreciably shorter than the risetime of the device under test. You should use a square-wave generator whose output waveform is essentially free from overshoot (Fig. 3-3). The Type 105 is satisfactory in this respect.[1] Furthermore, the accuracy of the method to be described will be affected if the square-wave response of either the oscilloscope or the device under test has appreciable overshoot, say, more than 2 or possibly 3 percent.

It is not usually convenient to determine the actual operating risetimes of the square-wave generator and of the oscilloscope separately. The method given here takes into account the composite effects of these separate risetimes. The risetime-measurement method is as follows:

1. Observe the risetime of the square-wave output of the generator directly on the oscilloscope[2]. For this measurement, you should terminate the generator with a load resistance and shunt capacitance (including the input capacitance of the oscilloscope) equal to the load resistance and shunt capacitance provided by the input circuit of the device you are going to test. We call this equivalent risetime of the generator and oscilloscope together T_{RE}.

[1]The square-wave output voltage of the Type 105 starts at a negative value and rises to zero (or ground) voltage, then drops again to the negative value.

[2]It is not usually convenient to determine the actual operating risetimes of the square-wave generator and of the oscilloscope separately. The method given here takes into account the composite effects of these separate risetimes.

2. Drive the device under test with the output of the square-wave generator. Use the oscilloscope to observe the risetime of the output waveform of the device under test. For the measurement, you should terminate the device under test with a load (including the input resistance and capacitance of the oscilloscope) whose characteristics are similar to those of the load into which the device normally oprbates. We shall call this observed risetime T_{RO}.

3. Compute the actual risetime T_R of the device under test from the relation[3]

$$T_R = (T_{RO}^2 — T_{RE}^2)^{1/2}$$

In the above measurements, use sweep rates such that the leading edge of the displayed waveform rises at an angle appropriate for accurate observations . . . roughly 45 degrees. In many risetime measurements, you might use horizontal sweep rates of the order of 0.02 μSEC/CM. When you are using these faster sweeps, it becomes important to set the TRIGGERING LEVEL control on your oscilloscope as far left as possible consistent with stable triggering. In this way you display as much of the lower flat portion of the square wave as possible, so that the rising portion does not occur in the first one or two horizontal divisions of the display where a major part of any sweep nonlinearity ordinarily appears.

You can reduce errors due to parallax by placing your eye so that the reflection of its iris, seen in the cathode-ray tube face, is directly behind the point you are observing.

In making risetime measurements, you might want to use a special graticule having the minor divisions scribed completely across the graticule (or at least extended in the areas where you observe the 10-percent and 90-percent points). The larger number of lines might render the graticule somewhat unsuitable for general use, but it permits close observations for risetime measurements.

Possible Distortion of Waveform

This information is included to help you avoid certain conditions that might give you misleading results in the use of your square-wave generator.

1. Proper use of probes

a. Before using a passive probe, always check the adjustment of the probe. An adjustable capacitor in the probe body compensates for variations in input capacitance from one oscilloscope to another, so that your pulse and transient measurements will be accurate. Touch the probe tip to the oscilloscope calibrator output connector and adjust the oscilloscope controls to display several cycles of the waveform. Adjust the probe capacitor for a flat top on the calibrator square wave, as shown in the righthand picture of Fig. 3-4.

[3]It should be noted in passing that the formula given here is actually an approximation. But the results are sufficiently accurate for most purposes. (See G. E. Valley and H. Wallman, "Vacuum Tube Amplifiers," pages 77-79, McGraw-Hill Book Company, Inc., New York, 1948).

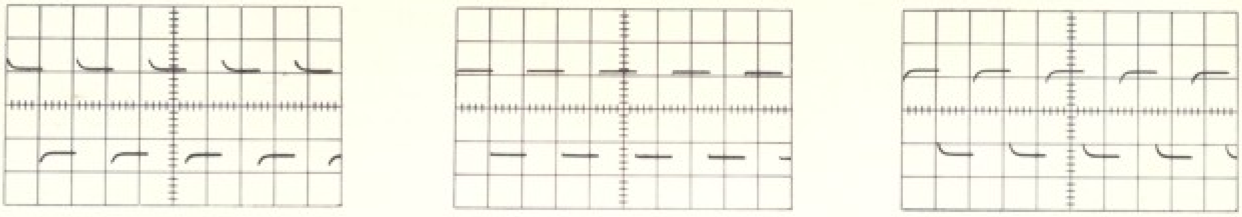


Fig. 3-4. Probe adjustments. Adjust the variable capacitor in the probe body so that the display of the calibrator waveform has a flat top as shown in the right-hand picture.

b. Use a probe of a type specified for the oscilloscope. For example, if you are using an oscilloscope whose vertical-deflection-system bandwidth greatly exceeds 10 megacycles, and if you use a probe intended for oscilloscopes having a smaller vertical-deflection-system bandwidth, you might observe a spurious "ringing" or damped oscillation along the top of the displayed square wave (Fig. 3-5). This spurious ringing might lead you to suspect a fault in the square-wave generator, in the oscilloscope, or in the equipment you are testing, whereas the actual difficulty lies in the use of an improper probe.

c. In using a cathode-follower probe, be careful not to use an input amplitude to the probe that exceeds the rated signal-handling capability of the probe. If you thus overdrive the probe, a clipping action can result that might mask certain signal variations or give an incorrect indication of signal amplitude. In particular, you should not use an attenuator between the cathode-follower probe and the vertical-input connector on the oscilloscope.

2. Compensation of voltage dividers on the VOLTS/CM (or VOLTS/DIV) switch.

You might observe overshoot or rolloff at the corners of displayed square waves if the internal capacitors, used to compensate the voltage dividers on the VOLTS/CM or VOLTS/DIV switch in the oscilloscope, are not correctly adjusted. Depending upon the repetition rate of the square-wave the nature of the voltage-divider misadjustment, the waveform distortions might resemble those occurring when the probe is incorrectly compensated (see Fig. 3-4). This trouble, of course, calls for a maintenance adjustment of these capacitors.

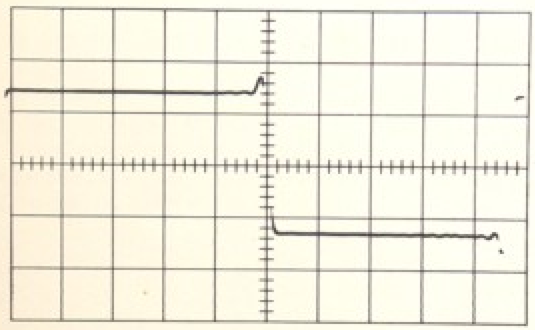


Fig. 3-5. Illustrating spurious ringing (damped oscillation) that might occur as a result of the use of a probe that is unsuited to the oscilloscope.

3. Ringing of LC circuits

The risetime of the square-wave output of the Type 105 is short enough to cause "ringing" (damped oscillations) in an LC circuit whose resonant frequency is less than about 30 megacycles. These oscillations appear along the flat top of a square wave displayed on the oscilloscope. Precautions you can take to avoid this trouble include (1) use of short leads to connect the generator or its output cable or termination to the load, and (2) use of proper terminating resistors or pads at both ends of the generator output cable (see diagrams H through P, Fig. 2-2).

4. Cathode-interface impedance

When the output electron tubes in the Type 105 have been used for a long time, they might develop a fault known as cathode-interface impedance. This condition produces a

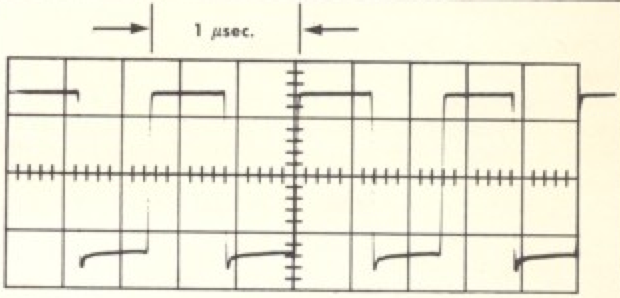
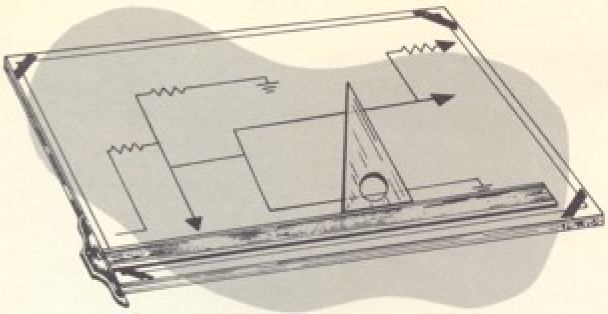


Fig. 3-6. Distortion in output waveform of the Type 105 resulting from cathode-interface impedance in aging tubes in the Type 105.

jagged appearance along the early part of the lower or negative flat portion of the waveform. (Fig. 3-6). If you are using only the rising edge and the flat top of the square wave in your tests and measurements, you can neglect this waveform distortion. But if you need to observe the trailing edge and the flat bottom of the waveform, you should replace V6, V7 and V8 in your Type 105, as required, to correct the waveform distortion. (Incidentally, there might normally be a slight negative-going overshoot at the corner preceding the lower flat portion of the square wave.)



SECTION 4

CIRCUIT DESCRIPTION

GENERATOR CIRCUITS

The generator circuits of the Type 105 consist essntially of a conventional multivibrator signal source followed by two limiter-amplifier stages which, in turn, drive the output stage. The unconventional circuitry by which the Type 105 attains the rise time of less than .02 microseconds with no overshoot on the flat-top portion of the square wave, includes: direct coupling between stages, high-frequency compensation, the use of high-transconductance low-capacitance tubes, and an inverted output amplifier having the plate connected to ground through the load resistor.

Multivibrator

V1 and V2 are connected in a symmetrical plate-to-grid-coupled multivibrator circuit, with various time-constant networks inserted in the grid circuit by the RANGE Switch, SW1. These networks consist of combinations of capacitors C3 through C12 with resistors R7 through R24. Resistors R4, R5, R27 and R28 are parasitic suppressors. Variation of the frequency generated by the multivibrator in each position of SW1 is accomplished by returning the lower ends of the grid resistors to the FREQUENCY potentiometer, R6, which applies a voltage varying from zero to plus 150 V.

Symmetrical output of the multivibrator is attained by varying the cross-connected dual potentiometer, R25, which changes the screen potential of V1 with reference to the screen potential of V2. These relative (and opposite) changes in screen potential cause corresponding changes in the plate current of V1 and V2, therefore changing the duration of the positive portion of the multivibrator waveform with respect to the negative. This provides compensation for variation in tubes and other components, so that the two parts of the square wave can be set equal to each other in time duration.

CAUTION

Do not attempt to convert the Type 105 into a pulse generator by increasing the range of the symmetry control. Tubes and other components might be damaged.

R25.4 is a variable resistor which simultaneously increases or decreases the screen voltage on both multivibrator tubes, thus setting a limit on the maximum frequency of each range step for the particular pair of multivibrator tubes in use. This adjustment is made only when changing multivibrator tubes. See Maintenance Section.

At the higher frequencies, C1 and C13 compensate for degeneration across R1 and R30. C1.1 and C11.1 also provide compensation and improvement in the rise-time characteristics of the multivibrator on the four higher-frequency ranges. Output from the multivibrator is taken across R29, in the cathode of V2, and this signal is fed to the grid of the shaping amplifier.

Shaping Amplifier

The shaping amplifier, V3, is directly coupled from the cathode of V2. A cathode resistor, R32, bypassed by C14, provides self bias in case of multivibrator failure. A shunt-compensating inductance, L1, is placed in series with R31, the plate-load resistor, to increase the rate of rise of the amplified multivibrator waveform. The plate of the shaping amplifier is coupled, by C15, to the grids of the driver amplifier.

Driver Amplifier

The driver amplifier consists of two tubes, V4 and V5, connected in parallel with appropriate parasitic suppressors, R35, R36, R37, R38, R39, and R40. The grid-bias network does not prevent V4 and V5 from drawing plate current. This steady plate current will then bias the grids of the output amplifier stage to cutoff and prevent excessive dissipation therein. The dissipation in V4 and V5 is well within recommended limits during this condition.

The screen-grid potential for V4 and V5 is provided by a series screen-resistor network consisting of R42 and R43, with R43 bypassed to ground by C16 and C17A. The un-bypassed portion of the series screen resistor, R42, feeds a sample of the square wave, via a coupling capacitor, C20, into the grid of the meter amplifier, V9.

The shaping amplifier drives the grids of V4 and V5 alternately between zero and cutoff, thus clipping a portion of the waveform in the grid circuit of the driver amplifier. A shunt-compensating inductance, L2, in series with load resistor R41 compensates for the effects of stray circuit capacitances, increasing the rate of rise of the output voltage. The signal from the plates of V4 and V5 is directly connected to the grids of the output amplifier.

Output Amplifier

The output amplifier employs three tubes, V6, V7 and V8, connected in parallel. R44, R45, R46, R47, R48, R49, R50 and R51 are parasitic suppressors. The cathodes are bypassed to ground by C18, C18.1 and C19. The three grids are directly connected to the plates of V4 and V5 and are driven between zero and cutoff potential by that stage. The

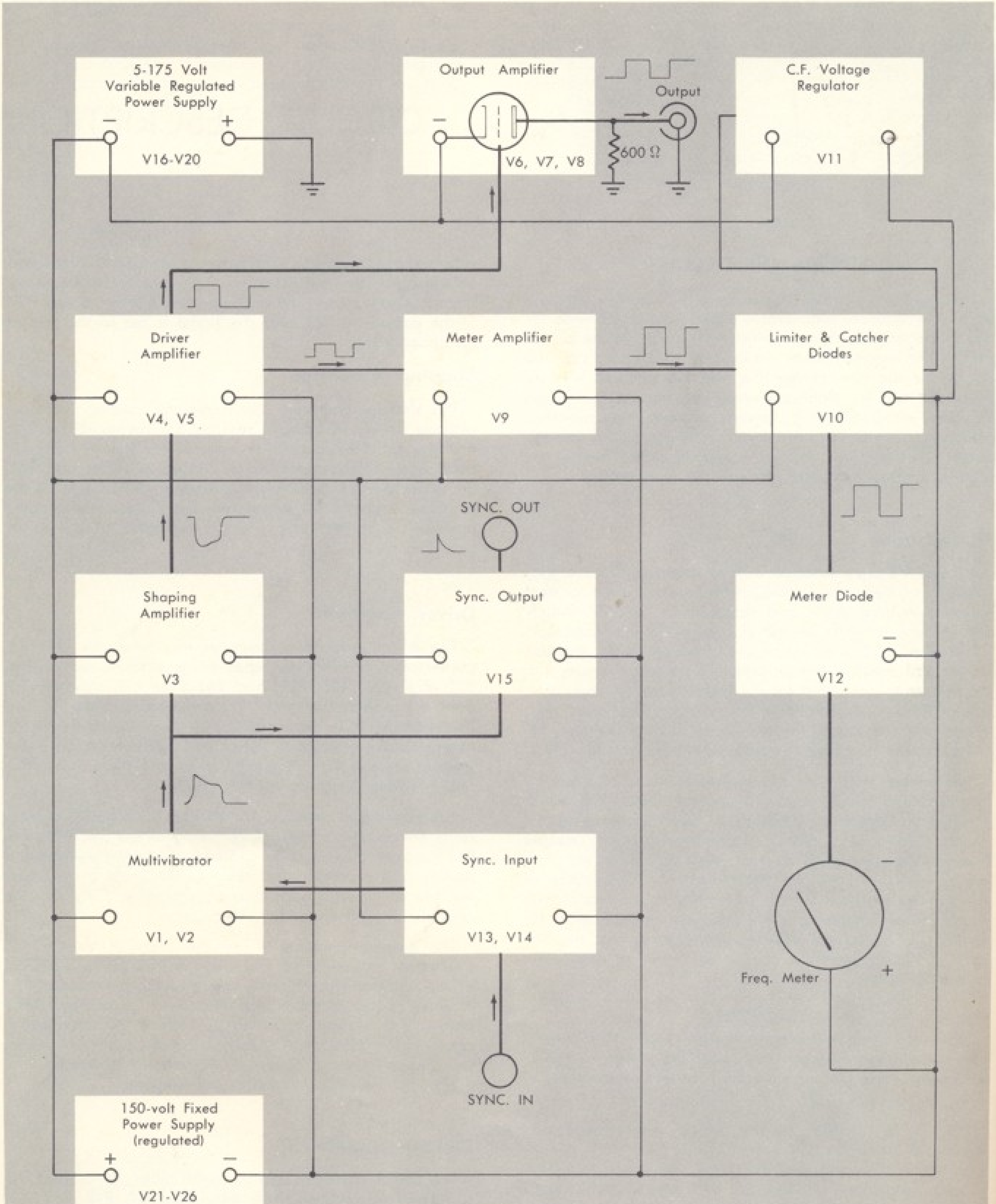


Fig. 4-1. Block diagram of the Type 105.

plate load resistor consists of an internal resistor, R54, paralleled with desired external terminating resistor, pad, or combination. See Operating Instructions Section.

The amplitude of the output waveform is controlled by varying the screen-grid potential of V6, V7 and V8 by varying the dc negative voltage applied to the cathodes of these three tubes. This is accomplished by the OUTPUT AMPL control R98, located in the variable power supply circuit.

FREQUENCY-METER CIRCUITS

The meter circuit of the Type 105 Square Wave Generator provides a direct indication of the output repetition rate of square waves generated. A sample of the square wave being generated is taken across R42, in the screen circuit of the driver tubes V4 and V5, and is coupled to V9 by capacitor C20 and resistor R59 which form a grid-leak bias network. This signal is amplified by V9. L3 is used to improve rise time.

One section of V10 constitutes a clamp diode (pins 2 and 5) which prevents the plate of V9 from rising above the supply voltage. The plate will attempt to do this because of the collapsing field of L3. The plate of V9 is "caught" by the plate-catcher diode (pins 1 and 7 of V10). V11 is a cathode-follower voltage-regulator tube which determines the potential at which the plate of V9 will be caught by V10. The METER ADJ. potentiometer R63, in conjunction with limit resistors R62 and R64, permits adjustment of the potential on the cathode of V11 so that V9 generates a square wave of constant 65-volt amplitude.

A capacitor, selected from C23 to C31 by RANGE switch sections SW1-G and SW1-H, is charged on each positive excursion of the square wave because the meter diode V12 (pins 2 and 5) clamps switch arm SW1-H at "common ground" potential (actually to the —160 to —320 volt bus plus a small voltage drop across R66). The negative excursion of the square-wave cycle then discharges the selected capacitor through meter M1 (resistance approximately 5,000 ohms). M1 has a special temperature-compensated movement of 200-microampere basic sensitivity. A shunt resistor is connected in parallel with the meter movement by the RANGE selector switch section SW1-I. Either the resistor or the capacitor is made variable for each range to provide calibration adjustment.

The charge on a capacitor represents a certain quantity of electrons (coulombs). Since each cycle of the square wave drives one charge through the meter, the meter (reading current) will indicate the number of charges per second, or the number of cycles per second. Resistors R65 and R66 provide a bias on the meter diode tube (pin 5) which "bucks out" the effect of diode current.

SYNC CIRCUITS

Sync Input

Sync signals fed to the SYNC INPUT binding post are coupled through capacitor C32 to the grid of sync amplifier tube V13. Variable grid bias for this tube is provided for by the SYNC AMPL control, R80 in the cathode circuit. Resistor R79 provides a fixed minimum bias to protect the tube. Bias voltages greater than cut off can be provided because of the current through R81, so that large sync signals can be accommodated. C33 bypasses the cathode bias resistors for high frequencies. The amplified sync signal at the plate of V13 is coupled to the plate of multivibrator tube V1 through diode V14. This diode disconnects the multivibrator from the sync amplifier while V1 is in conduction. This feature prevents another sync impulse from reaching V1 until the multivibrator has completed its cycle.

Sync Output

Output synchronizing signals are available from a front-panel binding post and are developed by a cathode follower, V15, driven from the signal across the cathode resistor of V1, the first multivibrator tube.

To protect the operator from electrical shock, a blocking capacitor, C34, is provided to isolate the SYNC OUTPUT binding post from —160 v to —320 v bus. R83 serves to differentiate low-frequency square-wave signals.

POWER SUPPLY CIRCUITS

150-Volt Fixed Power Supply

The fixed power supply of the Type 105 employs tubes V21 and V22 in a full-wave rectifier circuit. This is followed by a conventional voltage regulator circuit in which a portion of the output voltage is compared with a fixed dc potential derived from a voltage reference tube, V26. The difference between these two voltages is then amplified in V25 and applied to the grids of the series regulator tubes, V23 and V24, in such a way as to oppose the original change which unbalanced the regulator circuit. Potentiometer R111 (ADJ to 150 V) with limit resistors R110 and R112 selects the portion of the output voltage which is coupled directly to the grid of the comparator-amplifier tube V25 by R109. The cathode of V25 is held constant by the voltage reference tube V26. Suitable screen voltage for V25 and ionizing voltage for V26 is supplied by the divider R107 and R108. The plate of V25 is coupled to the grids of the series regulator tubes V23 and V24 through parasitic suppressors R105 and R106, with R104 serving as the plate load for the tube. Suppressor resistors R102 and R103 tie the screen grids of V23 and V24 to their respective plates for operation as triodes. C43 and C44 provide low-impedance paths for transients, so that the regulator will accommodate the rapid load changes of the generator circuits. A large by-pass capacitor, C45, further stabilizes the regulator output.

The fixed power supply floats below chassis ground at a potential determined by the output voltage of the variable power supply.

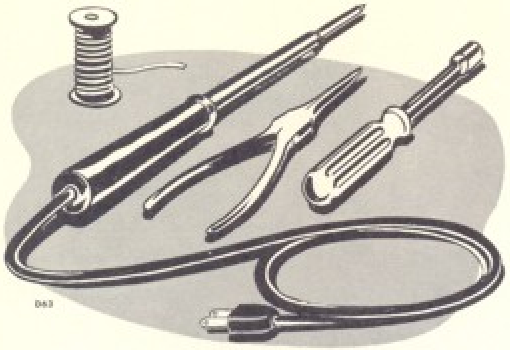
Variable Power Supply

Rectified current is supplied by V16 and V17 to a regulator circuit employing V18, V19 and V20.

The operation of this regulator circuit is similar to the fixed power supply regulator. Regulated −150 volts dc obtained from the fixed power supply is applied across resistor network R91, R92 and R95 and serves as a reference voltage for V20 cathode. The front-panel OUTPUT control, R98, in conjunction with R97 and potentiometer R99 marked ADJ 175 V form a network which applies a sample of the output voltage to the grid of V20. Any change in the grid voltage is amplified and applied to the grids of V18 and V19, thus stabilizing the output voltage at a value determined by the setting of R98. R99 permits compensation for variation of tubes and other components. See Maintenance Section.

DC Power Switch

The DC switch, SW3A and SW3B, opens both the fixed and variable power supplies. This feature permits changing output terminations, tube replacement, etc., without shock hazard, when it would be undesirable to open the AC power switch, SW2.



SECTION 5

MAINTENANCE

Cleaning

At regular intervals all accumulated dust should be cleaned from the instrument. The use of dry air under moderate pressure in conjunction with a brush having long, soft bristles is recommended. Solvents should not be used to clean the instrument. However, the case, panel and fan may be cleaned with mild soap and water.

CAUTION

Remove the power cord and allow sufficient time for the bleeders to discharge the filter capacitors before cleaning is undertaken.

Fan Motor

To protect the fan motor bearings, they should be lubricated every three or four months with a few drops of light machine oil.

Visual Inspection

You should visually inspect the entire generator every few months for possible circuit defects. These defects may include loose or broken connections, damaged binding posts, improperly seated tubes, scorched wires or resistors, missing tube shields, or broken terminal strips as well as many others. For most of these troubles, the remedy is apparent, but particular care must be taken when scorched components are detected. Scorched parts are often the result of other, less apparent, defects in the circuit. Therefore, it is essential that you determine the cause of overheating before replacing scorched parts in order to prevent damage to the new components.

Recalibration

The Type 105 Square Wave Generator is a stable instrument, and will provide many hours of trouble-free operation. To insure the reliability of measurements obtained with the Type 105 we suggest that you recalibrate the instrument after each 500 hours of operation, (or every six months if used intermittently). A complete step-by-step procedure for recalibrating the instrument is presented in the Calibration Procedure section of this manual.

REMOVING AND REPLACING PARTS

Removal of the Case

Set the generator face downward on a padded flat surface, remove the four screws holding the rubber feet, then lift off the case. On models with the fan mounted on the case, reach inside and unplug the fan motor before completely removing the case from the instrument.

CAUTION

After replacing the case, be sure the fan is operating, otherwise some components may be subject to destructive temperatures.

Standard Components

Tektronix will supply replacement components at current net prices. However, since most of the components are standard electronic and radio parts you can probably obtain them locally faster than they can be shipped from the Tektronix factory at Beaverton, Oregon. Before ordering replacement parts be sure to consult the Instruction Manual to see what tolerances are required.

Selected Components

We specially select some of the components whose values must fall within prescribed limits, by sorting through our regular stocks. The components so selected will have standard RETMA color coding showing the value and tolerance of the stock they were selected from, but they will not in general be replaceable from dealer's stocks.

Checked Tubes

To obtain maximum reliability and performance we check some of the vacuum tubes in our instruments for such characteristics as microphonics, balance, transconductance, etc. We age other tubes to stabilize their characteristics. Since there are no well defined standards of tube performance we have established our own arbitrary standards and have developed equipment to do this checking. These checked tubes can be purchased through our local Field Engineering Offices or directly from the factory in Beaverton, Oregon.

HOW TO ORDER PARTS

Replacement parts may be purchased at current net prices from your local Tektronix Field Office or from the factory. Most of the parts can be obtained locally. All of the structural parts, and those parts noted in the parts list "Manufactured by Tektronix", should be ordered from Tektronix.

When ordering from Tektronix include a complete description of the part, and its 6-digit part number. Give the type, serial number, and modification number (if any) of the instrument for which it is ordered.

If the part which you have ordered has been replaced by a new or improved part, the new part will be shipped instead. Tektronix Field Engineers are informed of such changes. Where necessary replacement information comes with new parts.

NOTE

Always include the instrument TYPE and SERIAL NUMBER in any correspondence concerning this instrument.

GENERAL INFORMATION

Color Coding

We use color-coded wires in the instruments to help identify the various circuits. These wires will be either a solid color or will be a solid color (including black and white) with one or more colored stripes. The colored stripes are "read" in the same manner as the RETMA resistor color code. In the case of multiple stripes the wide stripe is read first.

The negative-supply bus wires are black and the stripes indicate the supply voltage. For example, the negative-supply voltage is 150 volts and is carried by a black wire coded brown-green (1-5-0). The —5 to —175 V is on a black, violet lead.

The main-voltage leads to the power transformer are yellow and coded brown-brown-brown (1-1-1).

The tube heater leads are white and coded 6-1, 6-2, 6-3, etc., not to indicate that the voltages are different but to differentiate between circuits.

In other respects the color coding will vary from instrument to instrument. In general all signal-carrying leads are white and coded with a single colored stripe. In a few places where the number of leads exceeded the capabilities of single-strip coding we have used solid-color leads.

SOLDERING AND CERAMIC STRIPS

Many of the components in your Tektronix instrument are mounted on ceramic terminal strips. The notches in these strips are lined with a silver alloy. Repeated use of excessive heat, or use of ordinary tin-lead solder will break down the silver-to-ceramic bond. Occasional use of tin-lead solder will not break the bond if excessive heat is not applied.

If you are responsible for the maintenance of a large number of Tektronix instruments, or if you contemplate frequent parts changes, we recommend that you keep on hand a stock of solder containing about 3% silver. This type of solder is used frequently in printed circuitry and should be readily available from radio-supply houses. If you prefer, you can order the solder directly from Tektronix in one-pound rolls. Order by Tektronix part number 251-514.

Because of the shape of the terminals on the ceramic strips it is advisable to use a wedge-shaped tip on your soldering iron when you are installing or removing parts from the strips. Fig. 5-1 will show you the correct shape for the tip of the soldering iron. Be sure to file smooth all surfaces of the iron which will be tinned. This prevents solder from building up on rough spots where it will quickly oxidize.

When removing or replacing components mounted on the ceramic strips you will find that satisfactory results are obtained if you proceed in the manner outlined below.

1. Use a soldering iron of about 75-watt rating.

2. Prepare the tip of the iron as shown in Fig. 5-1.

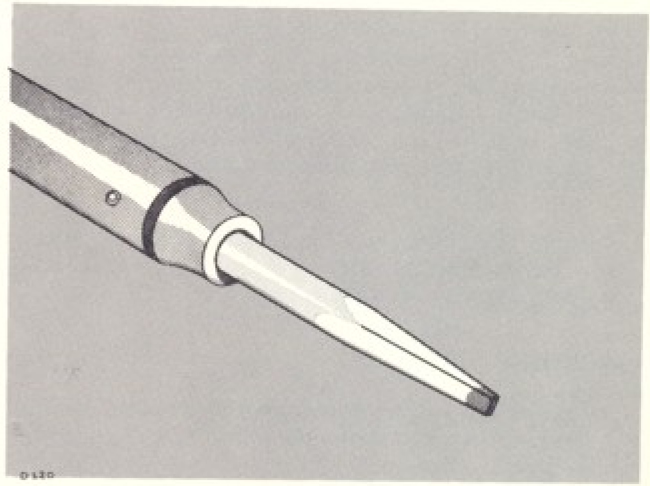


Fig. 5-1. Soldering iron tip correctly shaped and tinned.

3. Tin only the first 1/16 to 1/8 inch of the tip. For soldering to ceramic terminal strips, tin the iron with solder containing about 3% silver.

4. Apply one corner of the tip to the notch where you wish to solder (see Fig. 5-2).

5. Apply only enough heat to make the solder flow freely.

6. Do not attempt to fill the notch on the strip with solder; instead, apply only enough solder to cover the wires adequately, and to form a slight fillet on the wire as shown in Fig. 5-3.

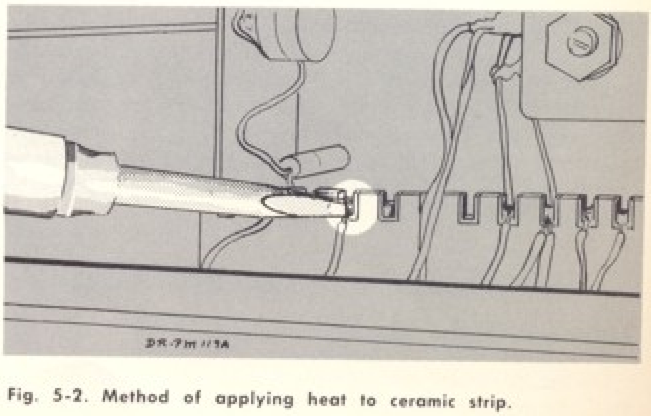


Fig. 5-2. Method of applying heat to ceramic strip.

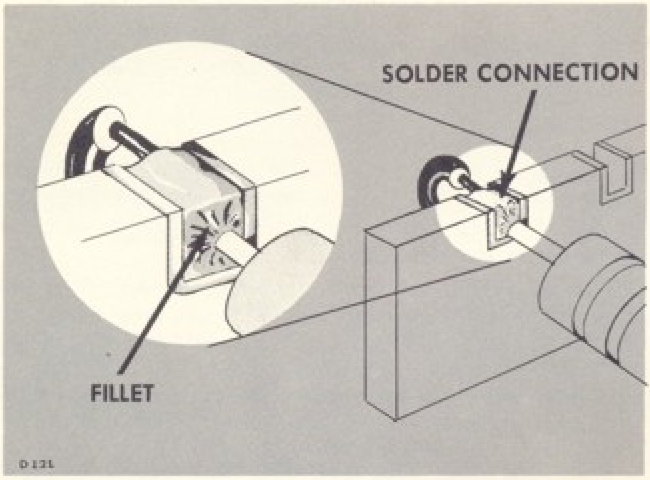


Fig. 5-3. Note the slight fillet formed on a correctly soldered joint.

In soldering to metal terminals (for example, pins on a tube socket) a slightly different technique should be employed. Prepare the iron as outlined above, but tin with ordinary tin-lead solder. Apply the iron to the part to be soldered as shown in Fig. 5-4. Use only enough heat to allow the solder to flow freely along the wire so that a slight fillet will be formed as shown in Fig. 5-3.

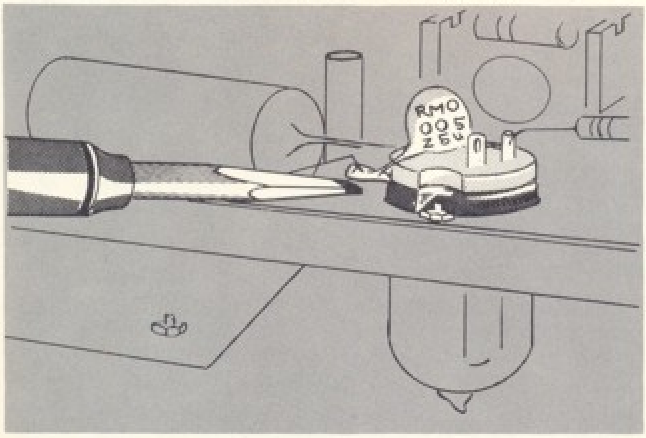


Fig. 5-4. Soldering to a metal pin.

General Soldering Considerations

When replacing wires in terminal slots clip the ends neatly as close to the solder joint as possible. In clipping the ends of wires take care the end removed does not fly across the room as it is clipped.

Occasionally you will wish to hold a bare wire in place as it is being soldered. A handy device for this purpose is a short length of wooden dowel, with one end shaped as shown in Fig. 5-5. In soldering to terminal pins mounted in plastic rods it is necessary to use some form of "heat sink" to avoid melting the plastic. A pair of long-nosed pliers (see Fig. 5-6) makes a convenient tool for this purpose.

Ceramic Strips

Two distinct types of ceramic strips have been used in Tektronix instruments. The earlier type mounted on the chassis by means of #2-56 bolts and nuts. The later type is mounted with snap-in, plastic fittings. Both styles are shown in Fig. 5-7.

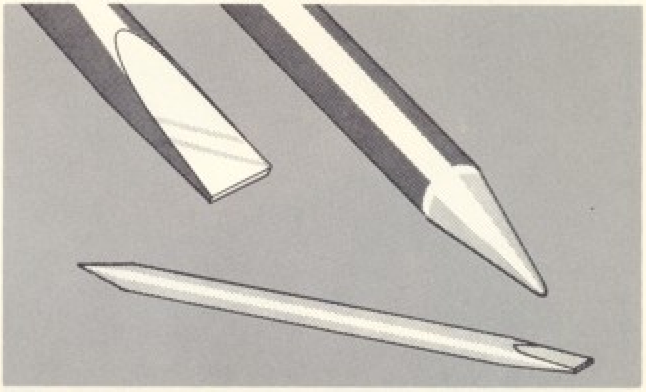


Fig. 5-5. A wooden dowel shaped for use as a soldering aid.

To replace ceramic strips which bolt to the chassis, screw a #2-56 nut onto each mounting bolt, positioning the nut so that the distance between the bottom of the nut and the bottom of the ceramic strip equals the height at which you wish to mount the strip above the chassis. Secure the nuts to the bolts with a drop of red lacquer. Insert the bolts through the holes in the chassis where the original strip was mounted, placing a #2 star lockwasher between each nut and the chassis. Place a second set of #2 flat washers on the protruding ends of the bolts, and fasten them firmly with another set of #2-56 nuts. Place a drop of red lacquer over each of the second set of nuts after fastening.

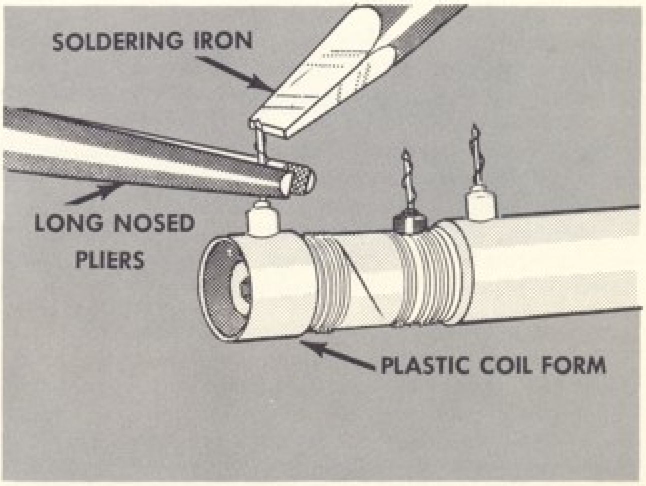


Fig. 5-6. Long-nosed pliers used as a heat sink.

Mounting Later Ceramic Strips

To replace ceramic strips which mount with snap-in plastic fittings, first remove the original fittings from the chassis. Assemble the mounting post on the ceramic strip. Insert the nylon collar into the mounting holes in the chassis. Carefully force the mounting posts into the nylon collars. Snip off the portion of the mounting post which protrudes below the nylon collar on the reverse side of the chassis.

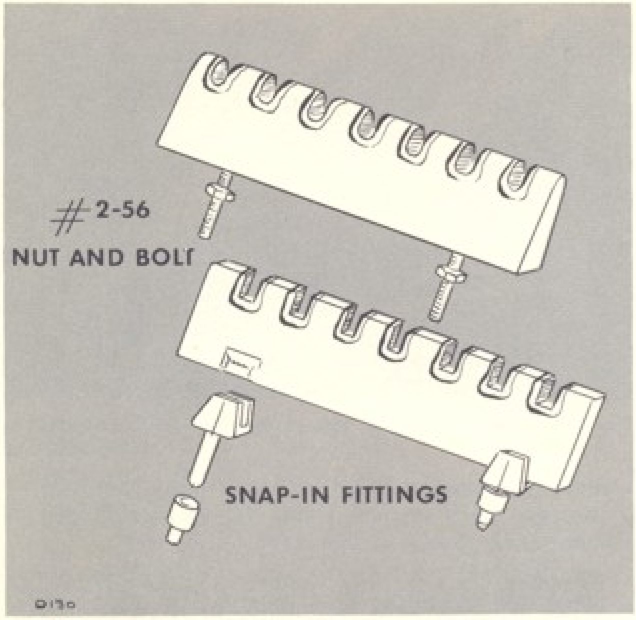


Fig. 5-7. Old and new styles of ceramic strips. The newer ceramic strips mount in nylon collars.

NOTE

Considerable force may be necessary to push the mounting rods into the nylon collars. Be sure that you apply this force to that area of the ceramic strip directly above the mounting rods.

TROUBLESHOOTING

The 105 instruments are relatively troublefree. You should not experience much need for extensive troubleshooting. In troubleshooting, however, you should remember that these are complex electronic instruments, and there is no easy way to locate trouble. A thorough understanding of circuit operation is the best aid in troubleshooting.

The first step in troubleshooting the instrument should be to determine whether the input voltages at the various points are correct. Refer to the schematic diagram for the instrument to determine the connections. If the voltages are incorrect remove the plug from the power socket to determine whether the trouble is in the power supply or in the multivibrator. If the trouble appears to be in the multivibrator, look for overheated components. If no burned or blackened parts are in evidence try replacing all the tubes at once with new tubes. If replacement of all the tubes cures the trouble, you can then return the original tubes to their sockets one at a time until the defective tube is located.

Failure of the instrument to operate correctly will probably be due to tube deterioration rather than from component failure. The circuits are relatively insensitive to minor tube variations, but relatively more sensitive to power-supply voltages.

OPERATIONAL CHECKS

1. Frequency Coverage

The FREQUENCY control of the Type 105 should have enough range to allow the operator to adjust the output over the ranges marked on the RANGE switch. To check the operation of this control set the front-panel controls of the instrument to the positions described at the beginning of Step 5 of the Calibration Procedure. This will provide a display of the 100 cycle square wave.

Turn the FREQUENCY control full left. When the control is in this position the meter needle should drop below 2.5 on the upper scale. Next, turn the FREQUENCY control full right. The meter needle should move to a position above the upper end of the meter scale. Repeat this procedure for all output ranges.

If the frequency range is inadequate it will be necessary to carry out Step 3, 4 and 5 of the Calibration Procedure.

2. Sync Output Amplitude

The amplitude of the pulse available at the SYNC. OUTPUT connector is approximately 5 volts—a convenient trigger amplitude for synchronizing another circuit with the Type 105.

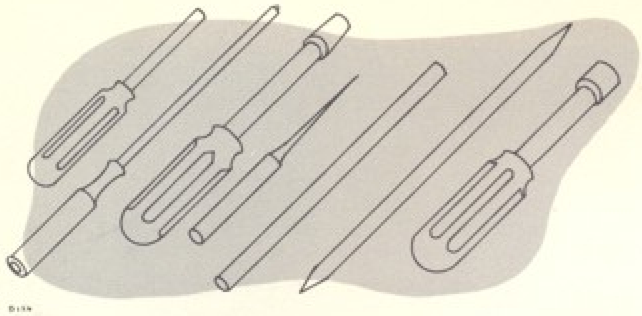
To measure the amplitude of the sync. output pulse use the connections and front-panel control settings described in Step 5 of the Calibration Procedure for obtaining a 10 kc square wave. Switch the MODE switch of the Type CA Plug-in to B ONLY, and disconnect the "T" connector from the input of this channel. Set the VOLTS/CM switch of CHANNEL B to 2. Adjust the FREQUENCY control of the Type 105 to give a full scale meter reading. Using an 18 inch test lead, connect the Sync Output connector of the Type 105 to the input of CHANNEL B on the Type CA. The amplitude of the positive of the pulse should be at least five volts.

Insufficient amplitude at the SYNC. OUTPUT connector may be caused by low screen voltage on the multivibrator tubes, V1 and V2—see Step 4 of the Calibration Procedure. If it is necessary to change the screen voltage it will also be necessary to perform Step 5 of the Calibration Procedure, since a change in the multivibrator screen voltage will be reflected as a change in the output frequency.

3. Output Amplitude

To provide sufficient amplitude for use with a large variety of terminating resistors, the Type 105 has a minimum output amplitude of 15 volts, peak-to-peak (with 93-ohm termination). The output amplitude can be measured as follows:

Display a 1 megacycle square wave in the test oscilloscope as described in Step 5 of the Calibration Procedure. Remove one of the 93 Ω Terminating Resistors from the Type P93 Coaxial Cable connected to the Type CA, and reconnect the cable directly to the input of CHANNEL A. Switch the MODE switch of the Type CA to A ONLY. Turn the OUTPUT AMPLITUDE control of the Type 105 full right. Carefully measure the peak-to-peak amplitude of the square wave. The minimum allowable amplitude is 15 volts; however, the peak-to-peak value obtained with most instruments will exceed this by several volts and does not indicate faulty operation of any circuit.



SECTION 6

CALIBRATION PROCEDURE

General

Normally, it will not be necessary to make all of the adjustments described in these instructions at any one time. However, any adjustments you make should be made in the indicated sequence.

EQUIPMENT REQUIRED

The following equipment or its equivalent, is necessary for a full recalibration of the Type 105.

1. Test oscilloscope, Tektronix Type 540 Series, and Type CA Plug-In Unit.

The use of the Tektronix Type 540 Series is recommended, since its operating specifications will permit all of the measurements described in this procedure. If a Tektronix Type 540 Series is not available, an oscilloscope having the following characteristics may be substituted:

Calibrated vertical-deflection factors from 5 millivolts per division to 5 volts per division.

Calibrated sweep rates from .1 microseconds to 2 milliseconds per division.

Bandpass of 24 megacycles.

Dual-trace operation.

2. Time-Mark Generator, Tektronix Type 180A.

If a Type 180A is not available, a time-mark generator which has the following characteristics may be substituted: 1-, 5-, 10- 50-, 100-, and 500-microseconds and 1- and 5-millisecond time marker outputs having an amplitude of at least one volt.

3. DC voltmeter of at least 20,000 ohms per volt, calibrated for an accuracy of $\pm 1\%$ at 150 and 175 volts. Be sure your meter is accurate. Few meters have the required accuracy after long periods of use.

4. Accurate rms-reading ac voltmeter, 0-150 volts, calibrated for an accuracy of $\pm 1\%$ at 105, 117, and 125 volts.

5. Autotransformer (Powerstat, Variac, etc.) capable of varying the line voltage to the instrument being calibrated from 105 to 125 volts, and rated at three amperes.

6. Miscellaneous interconnecting cables and terminating resistors.

If you are using the equipment recommended in this list, you will need two 93 ohm Coaxial Cables, two 93 ohm Terminating Resistors, a test lead about 18 to 24 inches long terminated in banana plug connectors, a coaxial "T" connector and a 013-003 clip-lead adapter.

7. Low-capacitance, insulated alignment screwdrivers.

CALIBRATION PROCEDURE

1. Power Supply Output Voltages

There are two voltage adjustments in the Type 105; the first, the A—150-volt supply, is used as a reference voltage, and the second, the —175 volt supply, determines the amplitude of the square-wave output. In the instructions that follow, we describe a method of adjusting the output voltages of these supplies.

To prepare the Type 105 for recalibration, remove the instrument from the cabinet. It will be easier to make some of the adjustments if you also remove the fan blades at this time. If the instrument is not enclosed in the cabinet it may be operated safely for short periods of time without the fan blades.

The output voltage of the —175 volt supply is variable and changes with the setting of the front-panel controls. The measurements and adjustments required in this step are based upon the following front-panel control settings.

OUTPUT AMPLITUDE	full left (counterclockwise)
RANGE	10 KC
FREQUENCY	mid-range
SYMMETRY	mid-range
AC	OFF
DC	OFF
SYNC. INPUT AMPLITUDE	full left

Connect the Type 105 to the autotransformer output, switch the AC switch to ON, and adjust the autotransformer output voltage to 117 volts. Allow the instrument about one minute to warm up and then switch the DC switch to ON.

The output voltage of the A—150-volt supply is measured with respect to the A Supply. The points for making this measurement are shown in Fig. 6-3. Set this voltage to exactly —150 volts by means of the ADJ TO 150 V control. Take care in making this adjustment, since the remainder of the calibration will not be accurate unless this voltage is correct.

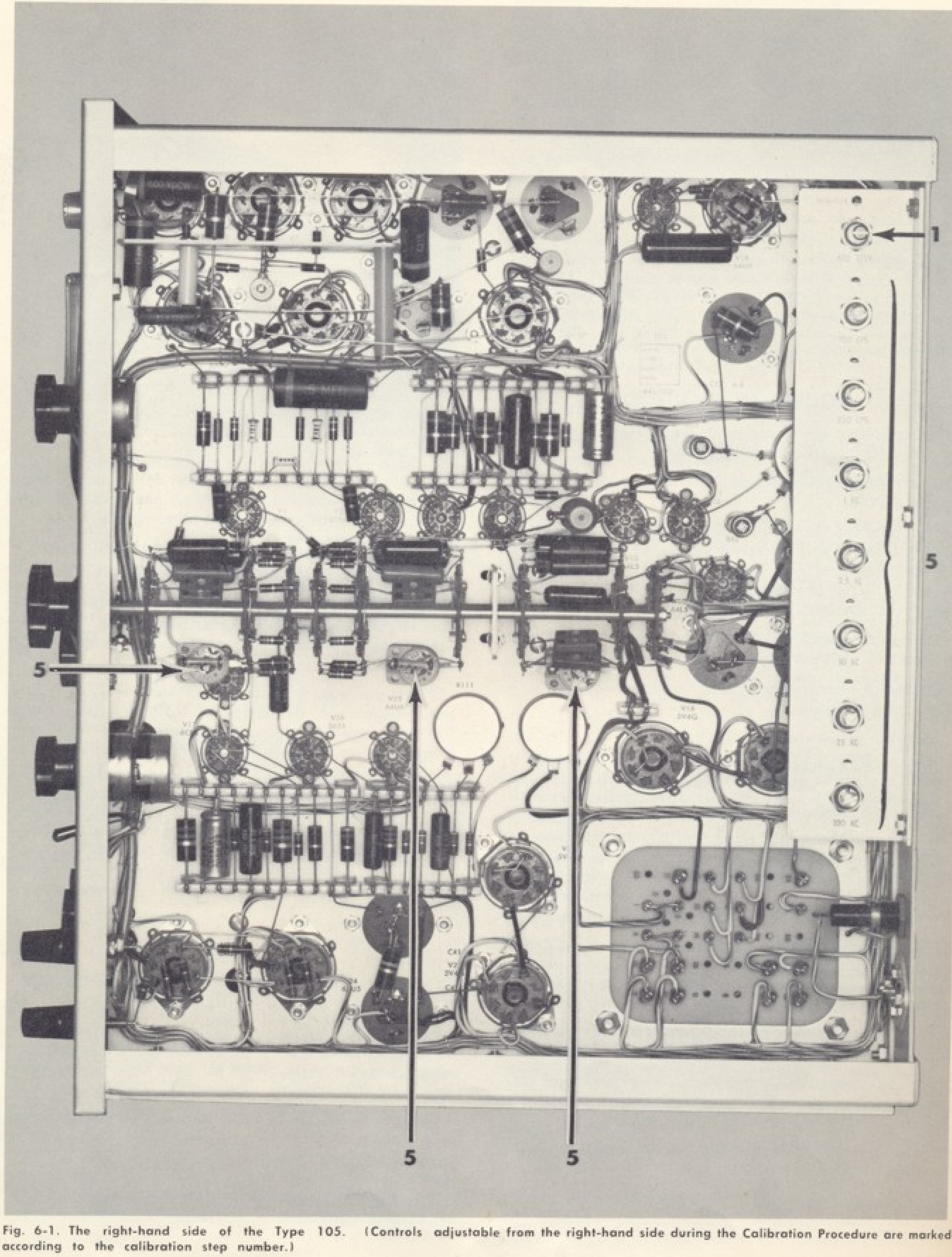


Fig. 6-1. The right-hand side of the Type 105. (Controls adjustable from the right-hand side during the Calibration Procedure are marked according to the calibration step number.)

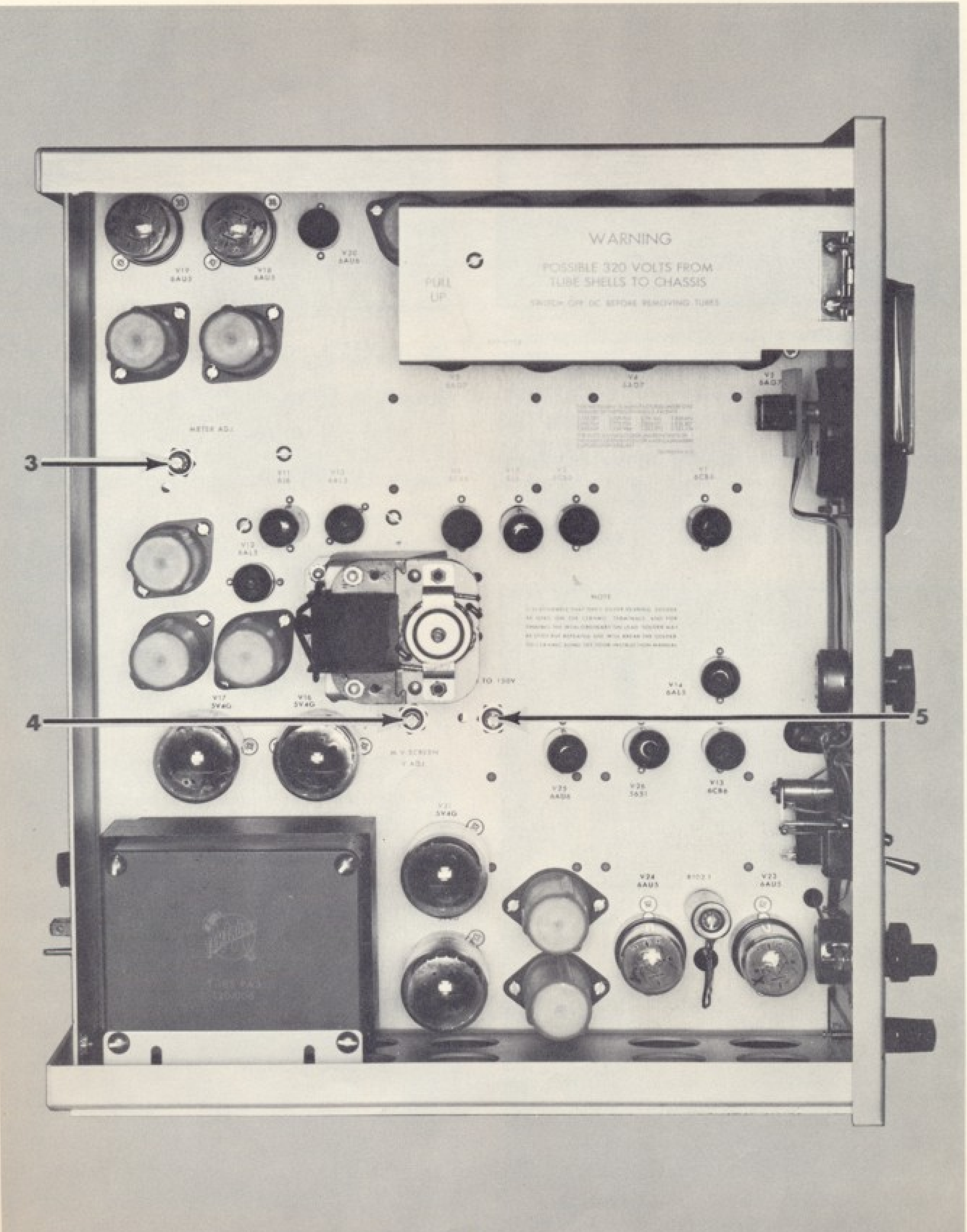


Fig. 6-2. The left-hand side of the Type 105. (Controls adjustable from the left-hand side of the Type 105 during the Calibration Procedure are marked. Note that the fan blade has been removed to facilitate access to the controls.)

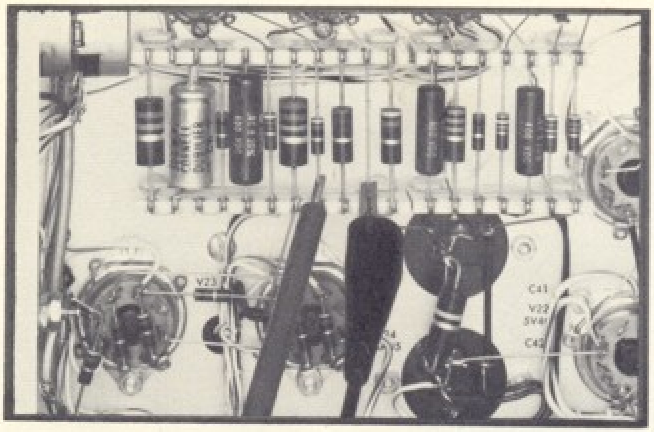


Fig. 6-3. Measuring the output voltage of the A-150-volt supply. The meter leads are shown connected to the correct points for measuring the output voltage of the A-150-volt supply.

The output voltage of the A Supply (—5 to —175 volts) is measured with respect to ground and the test points for measuring this voltage are shown in Fig. 6-4. The control marked ADJ. 175 V as shown in Fig. 6-1 adjusts this voltage range. To do so, first set the OUTPUT AMPLITUDE control to the full left position. Now, connect the voltmeter leads as shown in Fig. 6-4. It should now be possible to adjust

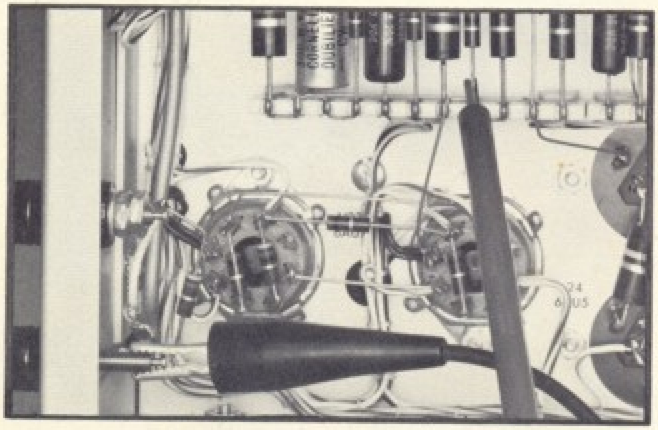


Fig. 6-4. Measuring the output voltage of the A supply. The meter leads are shown connected to the correct points for measuring the output voltage of the A supply.

the voltage to —5 volts or less, by turning the ADJ. 175 V control. If it is not possible to adjust the voltage below —5 volts, change V18 and/or V19. Set the voltage to —6 volts. Now change the voltmeter to one of the high (200 volts or higher) ranges and then turn the OUTPUT AMPLITUDE control to the full right position. The voltage should now read —175 volts. If it is within one or two volts, adjust the 175 V adjustment to put it on exactly 175. Now check the voltage at the full left position of the OUTPUT AMPLITUDE control. It should be between —5 and —7 volts. If it is not, it will be necessary to change R98.1 as shown in Fig. 6-5. If the voltage is above 7 volts, decrease the value of R 98.1 and if it is below 5 volts, increase the value of R98.1 until the voltage will vary from —175 at full right

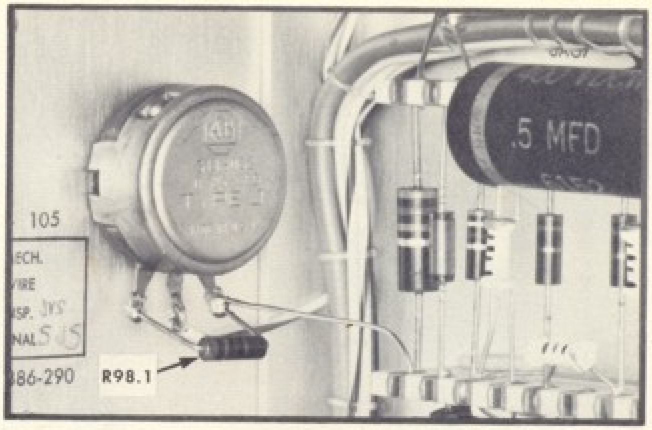


Fig. 6-5. R98.1 is located on the OUTPUT AMPLITUDE control and determines the range of the control.

setting of the OUTPUT AMPLITUDE control to —5 to —7 volts at full left setting of the OUTPUT AMPLITUDE control.

2. Power Supply Regulation

It is important that the operation of the Type 105 be unaffected by normal line-voltage variations. The regulating circuits in the power supply should hold the output voltages constant for all line voltages within the range from 105 to 125 volts. A convenient way to check for proper operation of the regulator circuits is to measure the ripple amplitude on the two supplies. Ripple in excess of 80 millivolts, peak-to-peak, on the A—150-volt supply and in excess of 60 millivolts, peak-to-peak, on the A supply is an indication of faulty operation.

To measure the ripple amplitude accurately, it is necessary to connect the ripple signal to the test oscilloscope input connector without introducing attenuation or extraneous signals. A shielded lead is the simplest means of doing this. A 93 ohm Coaxial Cable and a Type A-100 clip-lead Adapter are convenient for this purpose.

With the Type CA Plug-In installed in the test oscilloscope, and while it is warming up, set the front-panel controls as follows:

Type 540 Series Oscilloscope:

STABILITY	*PRESET
TRIGGERING LEVEL	Not used in AUTOMATIC mode
TRIGGERING MODE	AUTOMATIC
TRIGGER SLOPE	+LINE
TIME/CM	5 MILLISEC
5X MAGNIFIER	OFF
HORIZONTAL DISPLAY	NORMAL OR A
SQUARE-WAVE CALIBRATOR (black knob)	OFF
HORIZONTAL POSITIONING	centered
POWER	ON

Type CA:

MODE	B ONLY
AC-DC (Channel B)	AC
POLARITY (Channel B)	NORMAL
VERTICAL POSITION (Channel B)	centered
VOLTS/CM (black knob—Channel B)	.05
VARIABLE (red knob—Channel B)	CALIBRATED

The controls for the A Channel of the Type CA may be left in any position, since the A channel will not be used in this step.

At low square-wave frequencies, the multivibrator waveform is evident on the power supply output. Set the front-panel controls of the Type 105 to the positions described in Step 1.

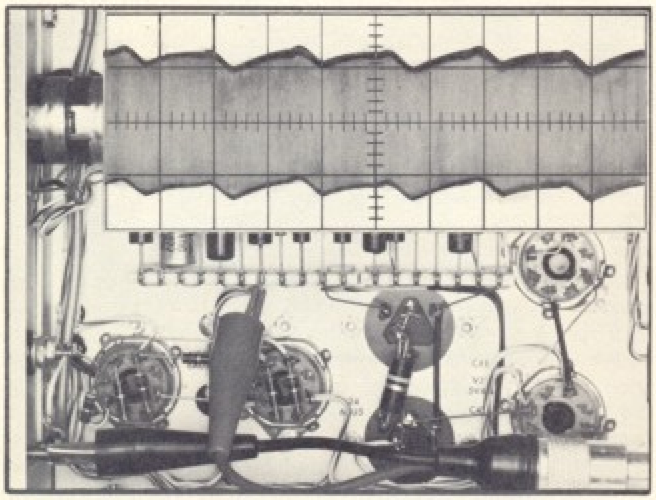


Fig. 6-6. Measuring the ripple present on the A supply.

Connect the shielded test lead to the test oscilloscope CHANNEL B input connector. To measure the ripple on the A—150-volt supply, connect the test-lead ground connection to ground (be sure the Type 105 OUTPUT AMPLITUDE control is turned full left), and connect the center (red) conductor to the A—150 supply. The 120-cycle ripple displayed on the test oscilloscope (approximately six cycles on the graticule) should not exceed 50 millivolts, peak-to-peak, as the autotransformer output is varied from 105 to 125 volts.

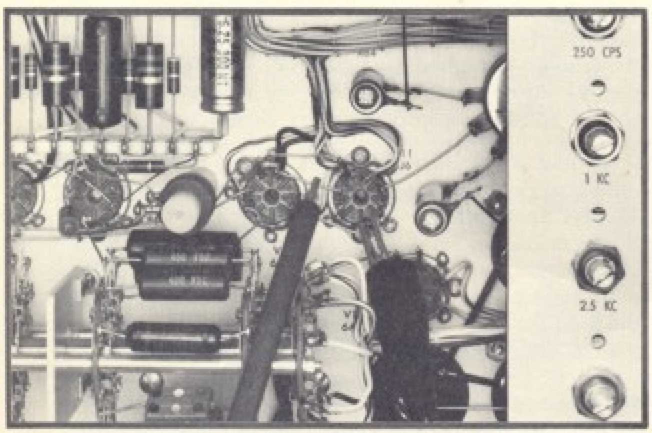


Fig. 6-7. Measuring the voltage across the metering diode. The meter leads are connected to pins 1 and 7 of V11. The METER ADJ. control is adjusted for a meter reading of 65 volts.

To measure the ripple on the A Supply, connect the test-lead outer connector to the chassis, and connect the center conductor to the A Supply as shown in Fig. 6-6. The ripple observed at this point should not exceed 60 millivolts, peak-to-peak, as the autotransformer output is varied from 105 to 125 volts.

Return the Autotransformer Output to 117 volts.

3. Frequency-Meter DC Adjustment

Dc voltages in the meter circuit are controlled by V11, a cathode-follower voltage regulator, and the METER ADJ. control determines the operating voltage on this regulator tube. To provide the proper meter-circuit voltages, the METER ADJ. control must be adjusted for a voltage drop across the regulator tube of exactly 65 volts (see Fig. 6-7).

4. Multivibrator Screen-Voltage Adjustment

Current flowing through the multivibrator tubes V1 and V2 determines the output amplitude of the synchronizing voltage, and partially determines the output frequency

Fig. 6-8. Measuring the multivibrator screen voltage. Pins 6 of V1 and V2 are shorted together with a shorting strap. The meter leads are connected between the multivibrator screens and the A-150-volt supply. The M.V. SCREEN ADJ. control is adjusted for a meter reading of 80 volts.

range of the Type 105. The M.V. SCREEN V. ADJ. control enables us to set this current for optimum performance of the multivibrator and associated circuits.

To make this adjustment, short together the screens of V1 and V2 (pins 6), and measure from this point to the A—150-volt supply (pin 7 of V26). Adjust the M.V. SCREEN V. ADJ. control for a difference voltage of exactly 80 volts.

5. Frequency-Meter Calibration

The meter circuits are calibrated to indicate the actual output frequency of the square-wave generator. A separate meter adjustment is provided for each frequency range. The following procedure describes a means of calibrating the meter circuits. To perform this step set the front-panel controls of the instruments as follows:

TABLE 1

Type 180A:

SIGNAL SELECTOR	MARKERS
MILLISECOND MARKERS	5, ON
POWER	ON
TRIGGER RATE SELECTOR	10 KC
POWER	ON

Type 105:

OUTPUT AMPLITUDE	full left
RANGE	100
FREQUENCY	mid range
SYMMETRY	mid range
AC	ON
DC	OFF
SYNC. INPUT AMPLITUDE	full left

Test oscilloscope:

STABILITY	full right
TRIGGERING LEVEL	full right
TRIGGER MODE	AC SLOW
TRIGGER SLOPE	+INT.
TIME/CM	1 MILLISEC
5X MAGNIFIER	OFF
HORIZONTAL DISPLAY	NORMAL OR A
AMPLITUDE CALIBRATOR	.5 VOLTS
HORIZONTAL POSITIONING	centered
POWER	ON

Type CA

MODE	ALTERNATE

Set controls in the CHANNEL A block as follows:

AC-DC	AC
POLARITY	NORMAL
VERTICAL POSITION	centered
VOLTS/CM (black knob)	10
VARIABLE (red knob)	CALIBRATED

Set controls in the CHANNEL B block as follows:

AC-DC	AC
POLARITY	NORMAL
VERTICAL POSITION	centered
VOLTS/CM (black knob)	1
VARIABLE (red knob)	CALIBRATED

Terminate the Type P93 Coaxial Cable at both ends with a Type B93-R Terminating Resistor and connect it between the OUTPUT connector of the Type 105 and the CHANNEL A input connector on the Type CA Plug-In. Connect the coaxial "T" connector to the CHANNEL B input connector, connect the SIGNAL OUTPUT connector of the Type 180A to the "T" connector with a coaxial cable, and connect the other side of the "T" connector to the Type 105 SYNC. INPUT connector with an 18-inch lead. (See Fig. 6-9.)

Turn the DC switch on the Type 105 to ON.

Table 1 gives the control setting changes for each instrument used in a check of the meter calibration. The general procedure to follow in making the adjustments is outlined below.

With the controls set as indicated get a stable display on the oscilloscope. Adjust the FREQUENCY control on the Type 105 for a display on the oscilloscope similar to the one shown in Fig. 6-10. This display indicates that the Type 105 output frequency is slightly below the Type 180A output frequency. Turn the SYNC. INPUT AMPLITUDE control slowly to the right. As this control is turned, the square wave will synchronize with the time marks. This synchronization will be indicated by a pronounced movement of the square wave. When the frequency of the square wave is synchronized with that of the time marks a slight change in symmetry will be noticed. Figure 6-11 shows this condition. A large change in symmetry as shown in Fig. 6-12 indicates that the SYNC. INPUT AMPLITUDE control has been turned too far. If this occurs, turn the control back to the left to achieve correct synchronization as shown in Fig. 6-11.

As an example of how to use Table 1, the 100 cycle range of the Type 105 is set up as follows.

Adjust the Type 105 OUTPUT AMPLITUDE control for a square-wave display of about two-centimeters vertical deflection. Position the square wave near the top of the graticule. Position the time-marks directly below the square-wave display. Turn the STABILITY control slowly to the left until the display disappears. Then, turn the TRIGGERING LEVEL control slowly to the left until the display reappears. This should result in a stable display similar to Fig. 6-9.

With a stable display of the square wave and the time marks on your test oscilloscope, adjust the Type 105 FREQUENCY control for a display similar to Fig. 6-10. When this is done the Type 105 output frequency is slightly below 100 cycles. Adjust the SYNC. INPUT AMPLITUDE control until the frequency of the square wave is synchronized with the frequency of the time marks as described above. When this is done you will see exactly 3 time marks for each complete cycle of the square wave. Now adjust the control marked 100 CPS (on the row of controls at the rear of the instrument) for a meter reading of exactly 10.

Symmetry and frequency of the 1 megacycle square wave output are controlled by C11 and C12, a pair of variable

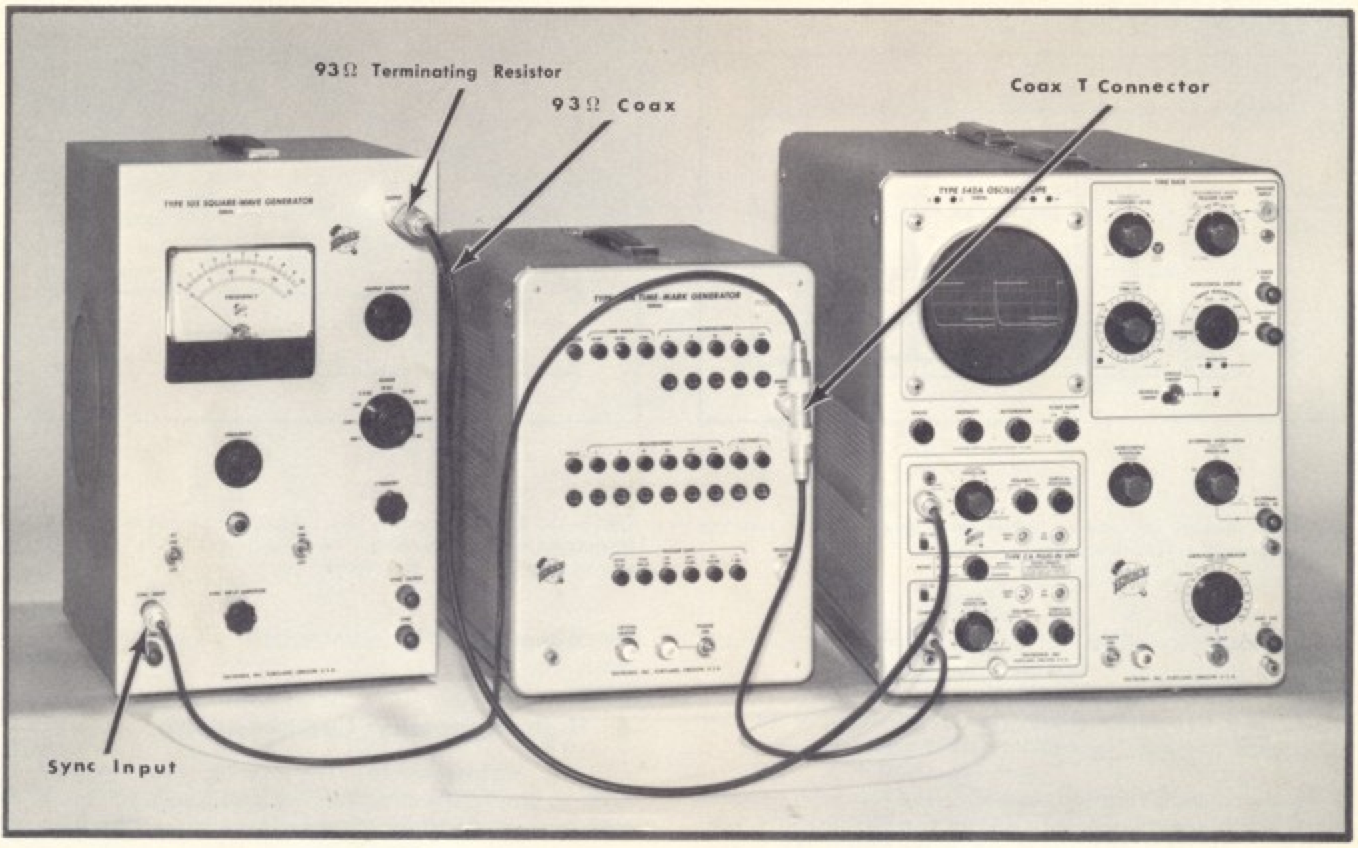


Fig. 6-9. Interconnection of equipment necessary for calibrating meter circuits.

capacitors mounted on the forward sections of the RANGE switch (see Fig. 6-1). Since this adjustment, once made, is extremely stable, it is not likely that they will require much attention. Lack of sufficient frequency coverage, or poor symmetry, indicates the need for adjustment.

Adjustment of C11 and C12 should be made after adjusting the meter calibration on the 1 megacycle range of the Type 105. Set the frequency indication as described above, and then check the symmetry of the square wave displayed on the test oscilloscope to be sure that it is satisfactory. Satisfactory symmetry has been attained when the positive and negative portions of the square wave are equal, with the SYMMETRY control between the nine and three o'clock positions. If the symmetry of the one megacycle wave

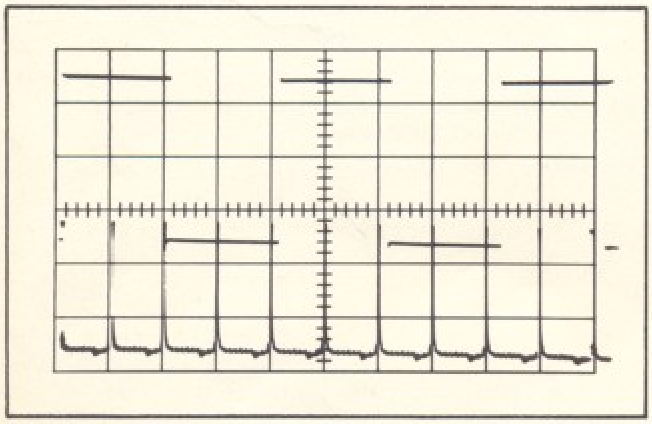


Fig. 6-10. Display of square waves and time marks preliminary to synchronizing the Type 105 with the Type 180A. Note that the square wave frequency is lower than the frequency of the time marks.

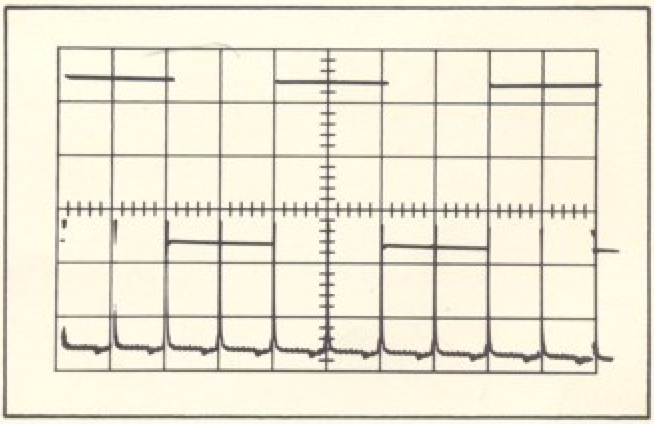


Fig. 6-11. Display of square waves and time marks after synchronzing the Type 105 with the Type 180A. Although the square wave may not be symmetrical its frequency is identical with the time mark frequency.

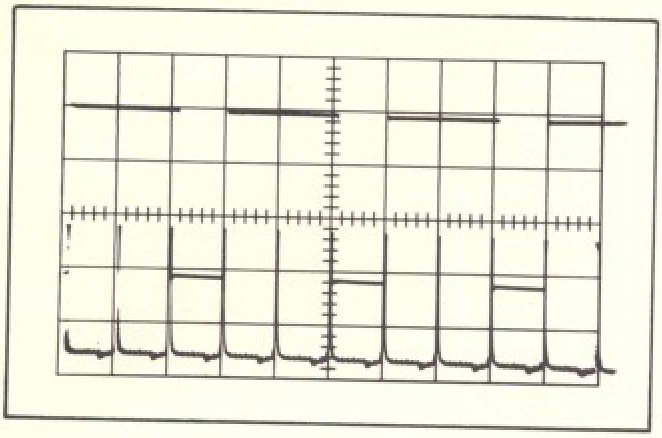


Fig. 6-12. Display of square waves and time markers resulting from excessive synchonizing voltage.

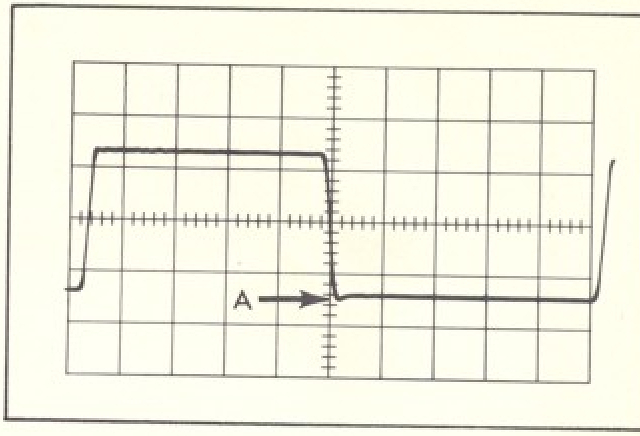


Fig. 6-13. Coil L2 controls the negative overshoot on the high frequency output waveform. L2 is adjusted while observing the one-megacycle output waveform.

is not satisfactory adjust C11 and C12 until the positive and negative portions of the square wave are equal.

C11 and C12 affect the frequency coverage of the one megacycle range as well as its square-wave symmetry.

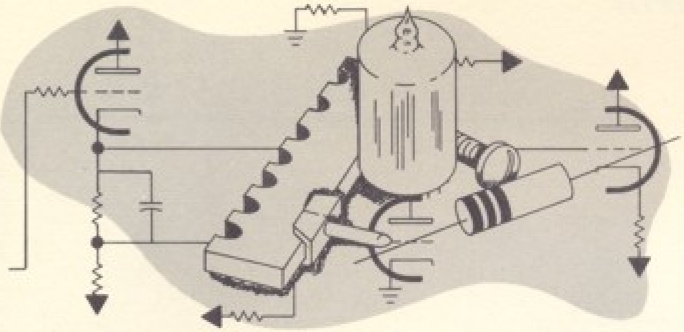
To check the frequency coverage turn the SYNC. INPUT AMPLITUDE control full left. Rotate the FREQUENCY control from full left to full right. When the FREQUENCY control is positioned full left the meter needle should rest below the 2.5 mark on the upper meter scale. When the FREQUENCY control is full right the meter needle should rest above the upper end of the scale. If the meter needle does not move to these two positions adjust C11 and C12 until it does. When C11 and C12 are correctly adjusted they should both be in approximately the same physical position. Minor adjustments of either C11 or C12 may be made to bring the symmetry into the desired ratio. (Usually with the half cycles equal when the SYMMETRY control is at mid-range.)

After the adjustment of C11 and C12 is completed repeat the calibration of the one megacycle range of the frequency meter.

6. High Frequency Compensation

L2, a high-frequency compensating coil, controls the amount of overshoot on the negative-going portion of the square wave. To check the adjustment of the high frequency compensation, use the front-panel control settings given in Step 5 of the Calibration Procedure. Connect the instruments as described in Step 5 with the exception of the Type 180A, which will not be needed for this adjustment.

Use the settings given in Table 1 to display 1 megacycle square waves on the test oscilloscope. Switch the Type CA MODE switch to A ONLY. Adjust the STABILITY and TRIGGERING LEVEL controls for a stable display. Position the display on the crt screen so that the falling edge of the square wave may be observed. Fig. 6-13 shows the desired waveform. If the display you see does not match this, adjust L2 until it does. The display will be observed to change its shape at point A on Fig. 6-13 as L2 is adjusted.



SECTION 7

PARTS LIST AND SCHEMATICS

ABBREVIATIONS

Cer.	Ceramic	p	Pico, or 10^{-12}
Comp.	Composition	PMC	Paper, metal cased
EMC	Electrolytic, metal cased	Poly.	Polystyrene
EMT	Electrolytic, metal tubular	Prec.	Precision
f	Farad	PT	Paper, tubular
F & I	Focus and Intensity	PTM	Paper, tubular, moulded
G	Giga, or 10^9	S/N	Serial number
GMV	Guaranteed minimum value	T	Turns
h	Henry	TD	Toroid
K or k	Kilohms, or kilo (10^3)	Tub.	Tubular
M or meg	Megohms, or mega (10^6)	v	Working volts DC
μ	Micro, or 10^{-6}	Var.	Variable
m	Milli, or 10^{-3}	w	Watt
n	Nano, or 10^{-9}	w/	With
Ω	Ohm	WW	Wire-wound

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number.

000X Part removed after this serial number.

*000-000 Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, also reworked or checked components.

Use 000-000 Part number indicated is direct replacement.

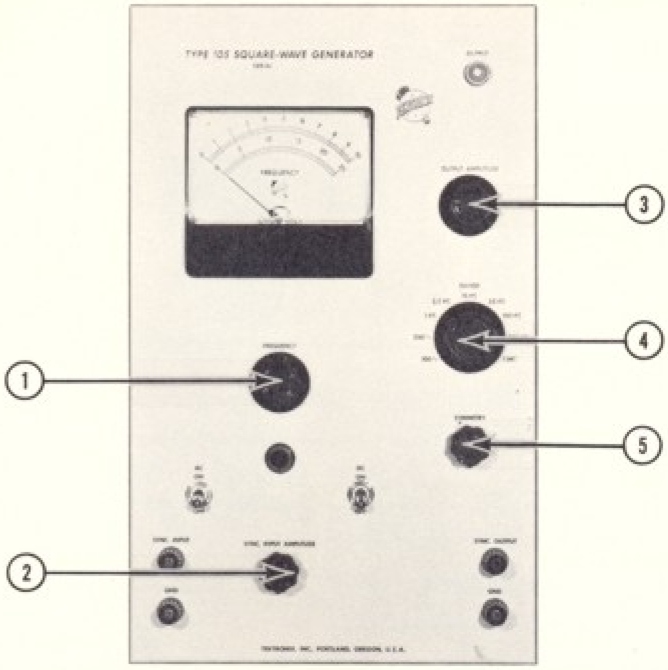
HOW TO ORDER PARTS

Replacement parts are available from or through your local Tektronix Field Office.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Field Office will contact you concerning any change in part number.

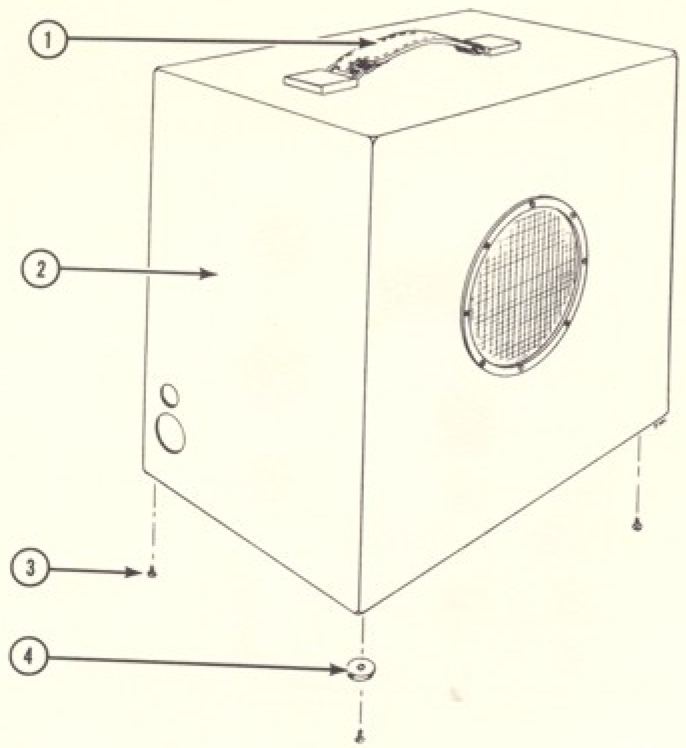
KNOBS



REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	366-007				FREQUENCY
2.	366-510				SYNC. INPUT AMPLITUDE
3.	366-007				OUTPUT AMPLITUDE
4.	366-008				RANGE
5.	366-510				SYMMETRY

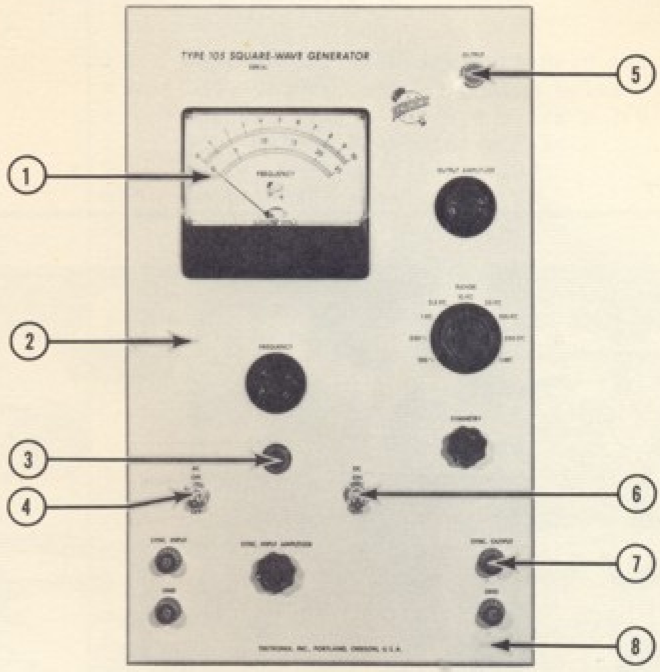
ⒶⒶ

CABINET



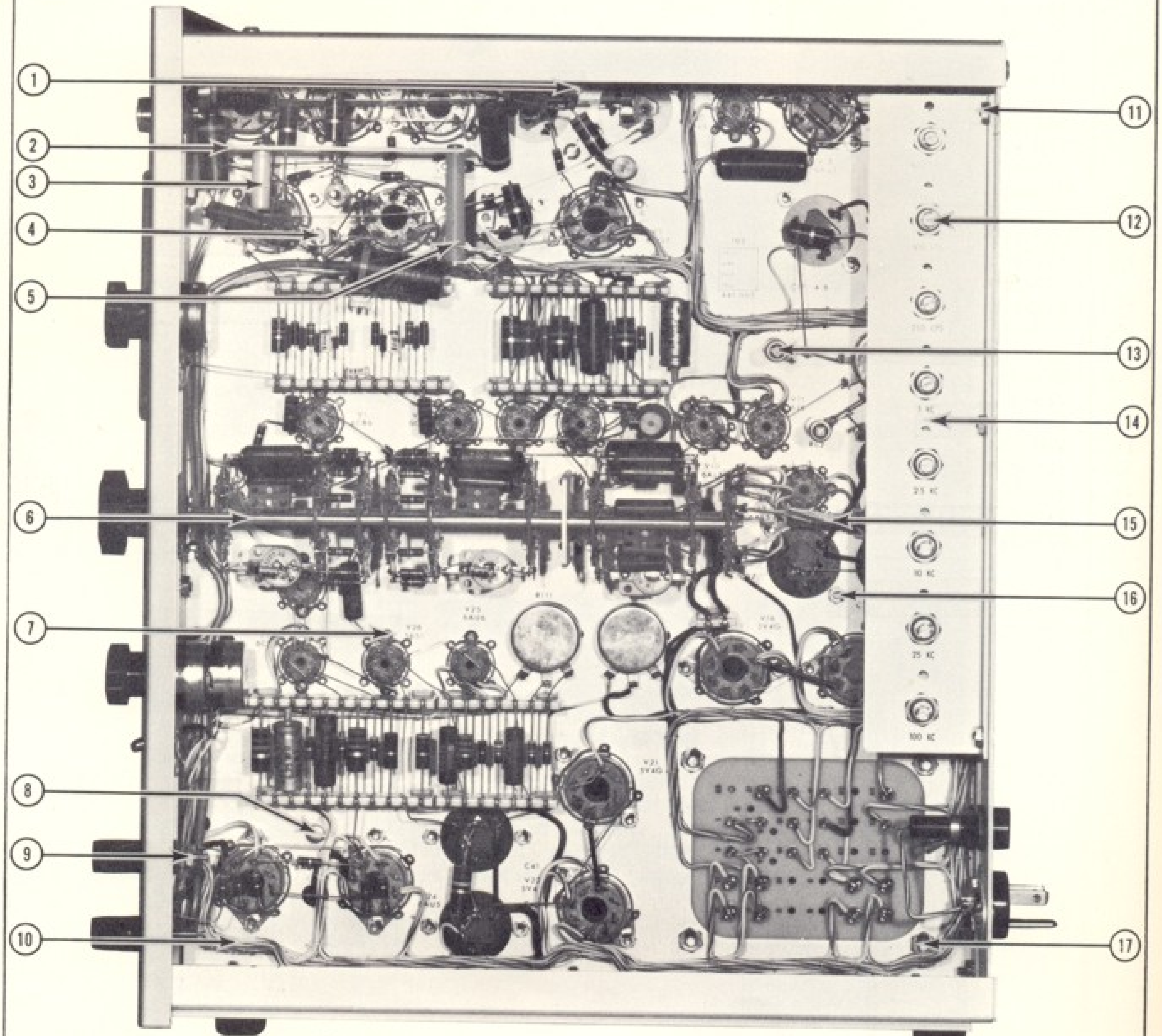
REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	367-001			1	HANDLE, pakawa leather
2.	437-002	101	5225	1	CABINET, blue wrinkle
	437-048	5226		1	CABINET, blue vinyl
3.	211-540			4	SCREW, 6-32 x 1/2 in. truss HS
4.	348-001			4	FOOT, rubber, 1 in.

FRONT



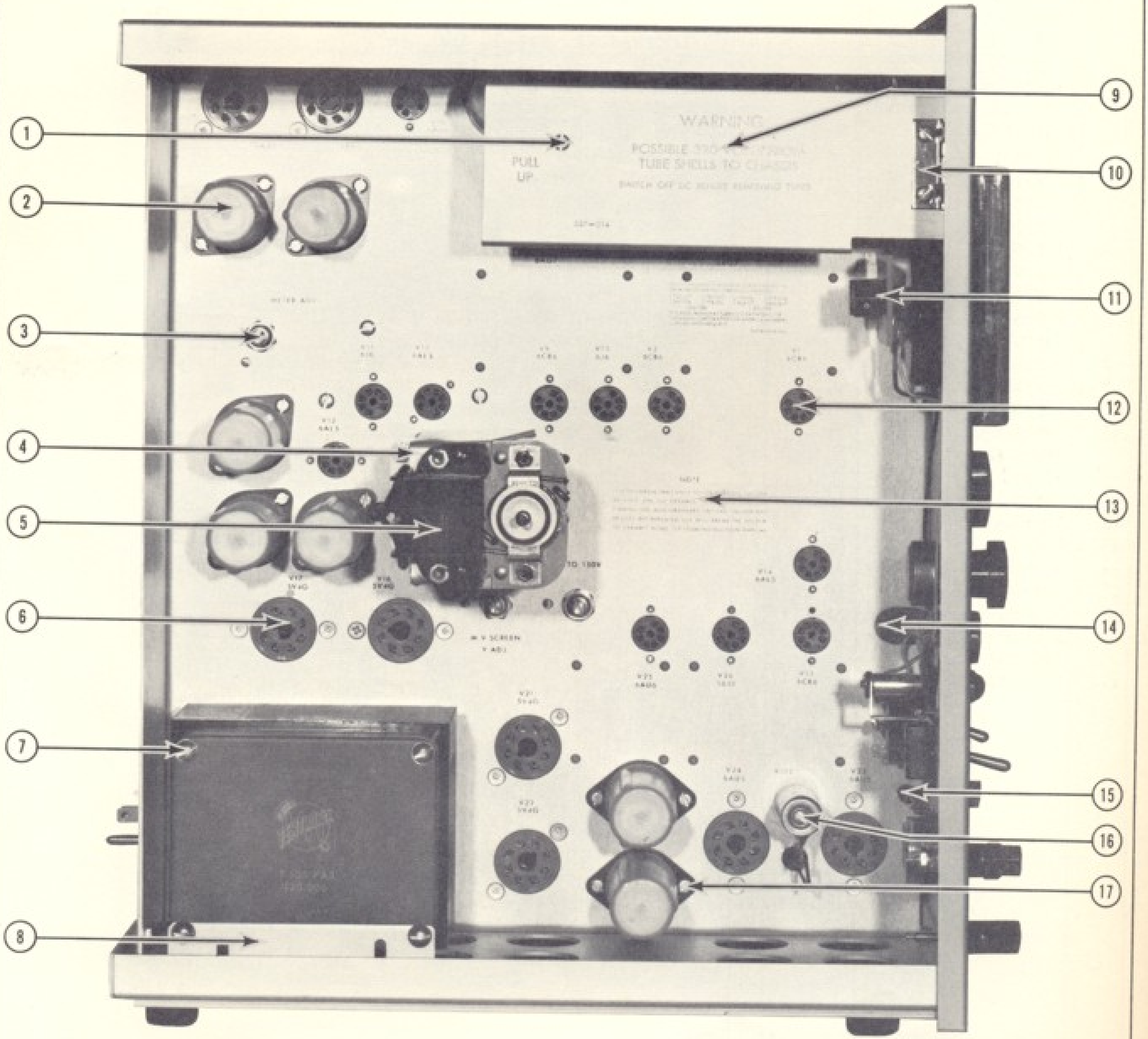
REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	Q T Y.	DESCRIPTION
1.	050-012	101	3674	1	METER, 0-200 μ, 4000 Ω, int. res.
	149-014	3675		1	METER, 0-200 μ, 4000 Ω, int. res.
2.	333-006	101	3674	1	PANEL, front
	333-453	3675		1	PANEL, front
3.	136-025			1	SOCKET, light, jewel, drake
	378-518			1	JEWEL, light, pilot, red drake
4.	260-134			1	SWITCH, toggle, 1 pole, 1 thro molded
	210-473			1	NUT, switch brass, 15/32-32 x 5/64 in. 12 sided
5.	131-012			1	CONNECTOR, Chassis mount, coax
6.	260-014			1	SWITCH, 2 pole, 2 thro, molded
	210-473			1	NUT, switch, brass, 15/32-32 x 5/64 in. 12 sided
7.	129-047			4	POST, binding, 5 way ass'y
8.	212-040			9	SCREW, 8-32 x 3/8 in. FHS 100° Phillips (under panel)

RIGHT SIDE



REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	385-090			1	ROD, nylon, 5/16 dia. x 1-9/16 in.
	210-202			3	LUG, solder, SE6, w/2 wire holes
2.	337-029			1	SHIELD, alum., 1-3/4 x 4-1/2 x 7/8 in.
3.	385-038			1	ROD, nylon, 5/16 dia. x 1 in.
	211-507			7	SCREW, 6-32 x 5/16 in. BHS
	210-006			49	LOCKWASHER, steel, int. #6
4.	211-504			2	SCREW, 6-32 x 1/4 in. BHS
	210-204			1	LUG, solder, DE6
	385-061			1	ROD, nylon, 5/16 dia. x 1-3/4 in.
5.	385-060			1	ROD, nylon, 5/16 dia. x 1-3/4 in., w/pin
6.	260-057			1	SWITCH, wired
	262-003			1	SWITCH, unwired
7.	213-044			24	SCREW, thread cutting, 5-32 x 3/16 in. Pan HS
8.	212-004			1	SCREW, 8-32 x 5/16 in. BHS
9.	210-206			5	LUG, solder, SE10, long
10.	179-030	101	3468	1	CABLE, harness, power
	179-189	3469		1	CABLE, harness, power
11.	210-458			10	NUT, keps, steel, 8-32 x 11/32 in.
12.	210-413			8	NUT, hex, brass, 3/8-32 x 1/2 in.
	210-840			8	WASHER, steel, .390, 10 x 9/16 in. OD
13.	211-553			2	SCREW, 6-32 x 1-1/2 in. RHS
	210-601			2	EYELET, brass, tapered barrel.
	210-478			2	NUT, hex, alum., 6-32 x 5/16 in.
14.	406-034			1	BRACKET, alum., 1-15/16 x 10-5/8 x 5/8 in. HI
15.	179-031			1	CABLE, harness, pot board
16.	210-407			49	NUT, hex, brass, 6-32 x 1/4 in.
17.	210-445			4	NUT, hex, steel, 10-32 x 3/8 x 1/8 in.thick
	210-010			4	LOCKWASHER, steel, int. #10

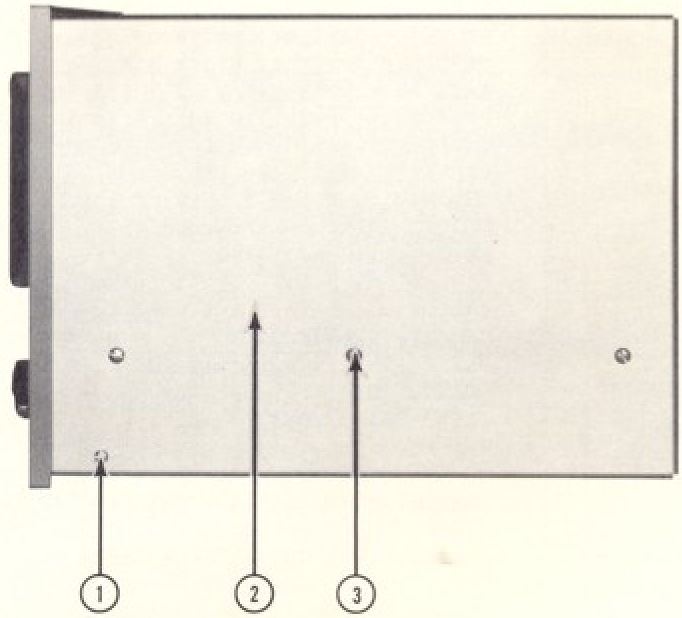
LEFT SIDE


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
WARNING
TUBE SHELLS TO CHASSIS
PULL UP
NOTE
TO 150V

LEFT SIDE

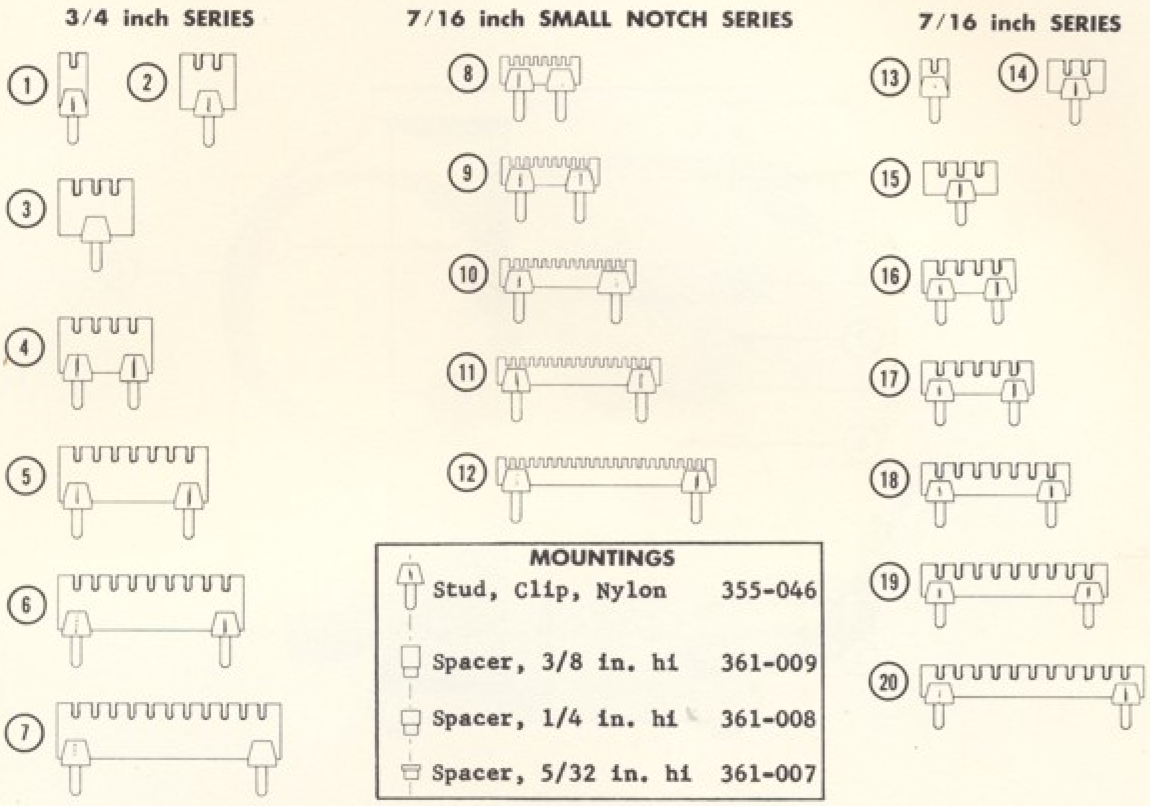
REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	211-507			4	SCREW, 6-32 x 5/16 in. BHS
	134-013			1	PLUG, banana female, 6-32 in. tap
	385-023			1	ROD, alum., 1/4 x 3-1/4 in.
2.	200-257			10	COVER, capacitor, polyethylene, 1.000 ID x 2-9/16 in.
	200-357				COVER, capacitor, black plastic, 1.000 ID x 9/16 in.
3.	210-413			3	NUT, hex, brass, 3/8-32 x 1/2 in.
	210-840			3	WASHER, steel, .390 ID x 9/16 in. OD
4.	406-033	101	3822	1	BRACKET, alum. fan mtg.
	406-338	3823		1	BRACKET, alum. fan mtg.
	348-004	3823		1	GROMMET, rubber, 3/8 in.
5.	050-003	101	3822	1	MOTOR, Alliance, flatted shaft
	147-018	3823		1	MOTOR, Alliance, flatted shaft
	369-002	101	2220	1	FAN, alum. 5 in. .173 bore hole
	369-010	2221		1	FAN, alum. 5 in. .183 bore hole
6.	136-011			14	SOCKET, STM8 ground
	211-538			19	SCREW, 6-32 x 5/16 in. FHS, 100° Phillips
7.	212-540			4	SCREW, 10-32 x 5-1/2 in. RHS
	210-009			4	LOCKWASHER, steel, int. #10
	210-812			4	WASHER, fiber
8.	406-241			1	BRACKET, alum. 1 x 4-1/4 x 3/4 in. (Transformer Support)
9.	337-014			1	SHIELD, alum. 2-3/4 x 7-1/2 x 1/2 in.
10.	214-001			1	HINGE, 1-1/2 x 1 in.
11.	386-264	101	3675	1	PLATE, bakelite, 1-1/2 x 2-3/4 in.
	366-036			2	KNOB, small black
	386-815	3676		1	PLATE, bakelite, 1-1/2 x 2-3/4 in.
	366-067			2	KNOB, small black
12.	136-008			12	SOCKET, STM7G
13.	441-005			1	CHASSIS, power
14.	348-006			1	GROMMET, rubber, 3/4 in.
15.	348-002			1	GROMMET, rubber, 1/4 in.
16.	212-037			1	SCREW, 8-32 x 1-3/4 in. Fil HS
	210-809			1	WASHER, brass, centering
	210-462			1	NUT, hex, 8-32 x 1/2 in.
17.	211-534			19	SCREW, 6-32 x 5/16 in. PHS, w/lockwasher

TOP



REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	211-507			1	SCREW, 6-32 x 5/16 in. BHS
	210-457			1	NUT, keps, steel, 6-32 x 5/16 in.
2.	387-517			1	PLATE, alum. 9-9/16 x 13 x 3/4 in.
3.	212-023			3	SCREW, 8-32 x 3/8 in. BHS
	210-458			3	NUT, keps, steel, 8-32 x 11/32 in.

TEKTRONIX CERAMIC STRIPS AND MOUNTINGS

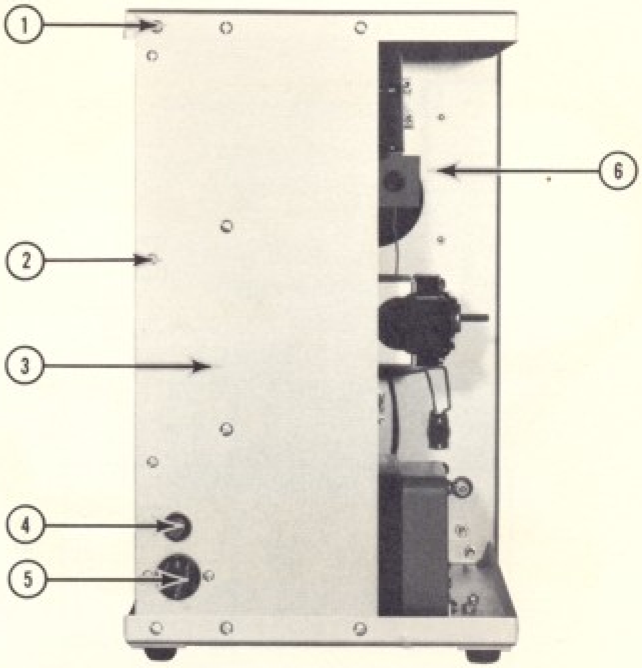


REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	Q T Y.	DESCRIPTION
1.	124-100				STRIP, 3/4 in. x 1 notch
2.	124-086				STRIP, 3/4 in. x 2 notch
3.	124-087				STRIP, 3/4 in. x 3 notch
4.	124-088				STRIP, 3/4 in. x 4 notch
5.	124-089				STRIP, 3/4 in. x 7 notch
6.	124-090				STRIP, 3/4 in. x 9 notch
7.	124-091				STRIP, 3/4 in. x 11 notch
8.	124-149				STRIP, 7/16 in. x 7 notch (small notch)
9.	124-148				STRIP, 7/16 in. x 9 notch (small notch)
10.	124-147				STRIP, 7/16 in. x 13 notch (small notch)
11.	124-146				STRIP, 7/16 in. x 16 notch (small notch)
12.	124-145				STRIP, 7/16 in. x 20 notch (small notch)
13.	124-118				STRIP, 7/16 in. x 1 notch
14.	124-119				STRIP, 7/16 in. x 2 notch
15.	124-092				STRIP, 7/16 in. x 3 notch
16.	124-120				STRIP, 7/16 in. x 4 notch
17.	124-093				STRIP, 7/16 in. x 5 notch
18.	124-094				STRIP, 7/16 in. x 7 notch
19.	124-095				STRIP, 7/16 in. x 9 notch
20.	124-106				STRIP, 7/16 in. x 11 notch

NOTE:

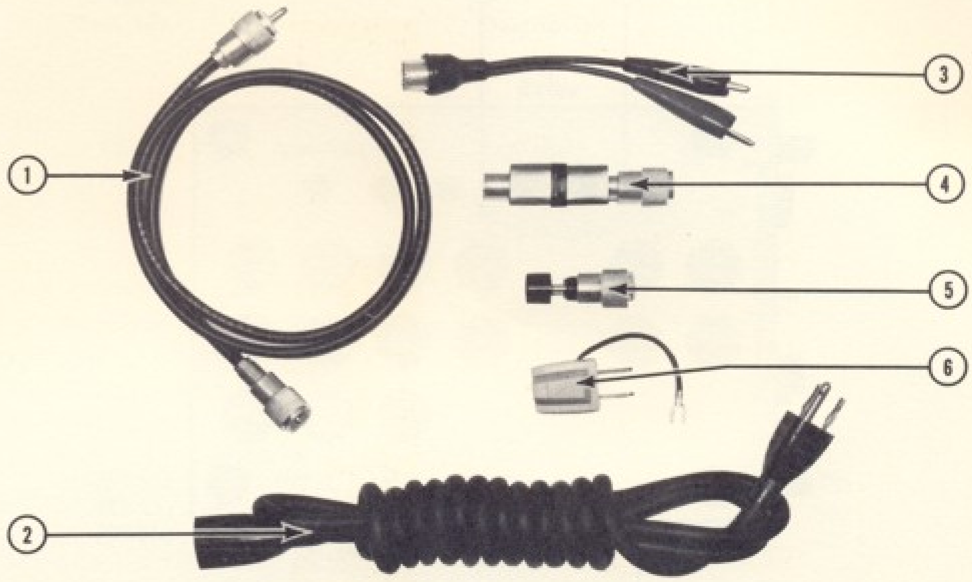
1. Clip-mounted ceramic strips are direct replacements for hardware mounted strips.
2. Each strip has the necessary studs mounted to it; but spacers must be ordered separately.
3. When ordering for replacement, include a description of part, part number, instrument type and serial number.

REAR



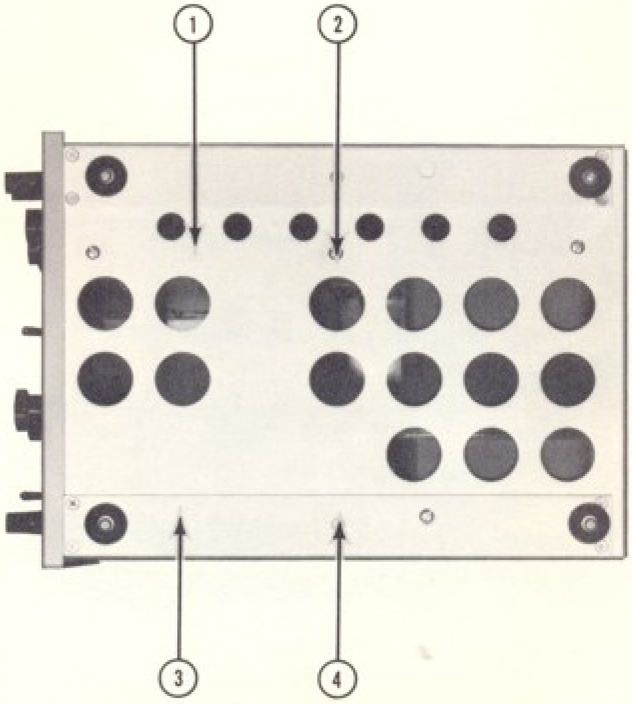
REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	211-023			8	SCREW, 8-32 x 3/8 in. BHS
	210-458			8	NUT, keps, steel, 8-32 x 11/32 in.
2.	211-507			5	SCREW, 6-32 x 5/16 in. BHS
	210-457			5	NUT, keps, steel, 6-32 x 5/16 in.
3.	387-501			1	PLATE, alum. 6 x 15-3/8 in.
4.	352-001	101	1221	1	HOLDER, fuse ass'y, 4AG
	352-002	1222		1	HOLDER, fuse ass'y, 3AG
5.	131-010	101	3995	1	CONNECTOR,2 wire motor base
	131-102	3996		1	CONNECTOR, 3 wire motor base
6.	386-290			1	PLATE, sub panel

ACCESSORIES



REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	012-003			1	CABLE, output
2.	161-010			1	CORD, power, 16 ga. 8 ft., 3 wire
3.	013-003			1	ADAPTER, A100 clip lead
4.	011-048			1	TERMINATION, 93 Ω
5.	013-004			1	ADAPTER, A510 binding post
6.	103-013			1	ADAPTER, power, cord, 3 to 2 wire

BOTTOM



REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY.	DESCRIPTION
1.	387-516			1	PLATE, alum. 9-9/16 x 13 x 3/4 in.
2.	211-559			10	SCREW, steel, 6-32 x 3/8 in. FHS 100°, Phillips
	210-006			10	LOCKWASHER, steel, int. #6
	210-407			10	NUT, hex. brass, 6-32 x 1/4 in.
3.	386-258			2	PLATE, alum. 1-3/8 x 12-1/2 in.
4.	212-023			4	SCREW, 6-32 x 3/8 in. BHS
	210-458			4	NUT, keps, steel, 8-32 x 11/32 in.

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description					S/N Range
		Bulbs					
B1	150-001	Incandescent #47 Pilot Light					

Capacitors

Tolerance ±20% unless otherwise indicated.
Tolerance of all electrolytic capacitors are as follows (with exceptions):
3 V — 50 V = —10%, +250%
51 V — 350 V = —10%, +100%
351 V — 450 V = —10%, + 50%

Ckt. No.	Tektronix Part No.	Description					S/N Range
C1	281-523	100 pf	Cer.		350 v		
C1.1	281-513	27 pf	Cer.		500 v		
C2	285-510	.01 μf	MT		400 v		
C3		.047 μf	MT		400 v	10%	
C4		.047 μf	MT		400 v	10%	
C5		.0047 μf	Mica		500 v	10%	
C6	Timing Series	.0047 μf	Mica		500 v	10%	
C7	use *295-052†	470 pf	Mica		500 v	10%	
C8		470 pf	Mica		500 v	10%	
C9		56 pf	Mica		500 v	10%	
C10		56 pf	Mica		500 v	10%	
C11	use 281-012	7-45 pf	Cer.	Var.			
C11.1	281-518	47 pf	Cer.		500 v		
C12	use 281-012	7-45 pf	Cer.	Var.			
C13	281-523	100 pf	Cer.		350 v		
C14	290-049	1000 μf	EMC		15 v		
C15	285-537	.5 μf	MPT		400 v		
C16	285-510	.01 μf	MT		400 v		
C17A,B	290-036	2 x 20 μf	EMC		450 v		
C18	use 285-527	.1 μf	MPT		600 v		
C18.1	use 285-527	.1 μf	MPT		600 v		X189-up
C19	290-036	2 x 20 μf	EMC		450 v		
C20	285-519	.047 μf	MT		400 v		
C22	285-527	.1 μf	MPT		600 v		
C23	285-527	.1 μf	MPT		600 v		
C24	285-519	.047 μf	MT		400 v		
C25	285-510	.01 μf	MT		400 v		
C26	285-506	.0047 μf	MT		400 v		
C27	285-501	.001 μf	MT		600 v		
C28	use 283-522	470 pf	Mica		500 v	10%	
C29	283-505	100 pf	Mica		500 v	10%	

† Selected with R7 thru R22.

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C30	use 281-012	7-45 pf	Cer.	Var.			
C31	use 281-012	7-45 pf	Cer.	Var.			
C32	285-511	.01 μf	PTM		600 v		
C33	290-000	6.25 μf	EMT		300 v		
C34	283-000	.001 μf	Disc Type		500 v		
C36	290-036	2 x 20 μf	EMC		450 v		
C37	290-036	2 x 20 μf	EMC		450 v		
C38	290-036	2 x 20 μf	EMC		450 v		
C39	285-526	.1 μf	MT		400 v		
C40	290-036	2 x 20 μf	EMC		450 v		
C41	290-036	2 x 20 μf	EMC		450 v		
C42	290-036	2 x 20 μf	EMC		450 v		
C43	285-510	.01 μf	MT		400 v		
C44	285-510	.01 μf	MT		400 v		
C45	290-036	2 x 20 μf	EMC		450 v		
C85	290-000	6.25 μf	EMT		300 v		X1718-up

Fuses

F1	use 159-005	3 Amp 3AG Slo-Blo for 117 v oper.	
	159-003	1.6 Amp 3AG Slo-Blo for 234 v oper.	

Inductors

L1	*108-021	7.5 μh			
L2	*114-027	.88-1.4 μh		Var.	
L3	*108-025	990 μh			
L5	*108-057	8.8 μh			X2195-up
L26	*108-057	8.8 μh			X2195-up
LR1	*108-118	12 μh	wound on 33 Ω, 1 w resistor		X2908-up

Meter

M1	use *050-012	Replacement Kit	101-3674
	149-014	0-200 μ Amps	3675-up

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R1	301-182	1.8 k	½ w	5%	
R2	302-391	390 Ω	½ w		
R3	304-182	1.8 k	1 w		101-3681
	303-162	1.6 k	1 w	5%	3682-up
R4	302-470	47 Ω	½ w		

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R5	302-470	47 Ω	½ w				
R6	311-026	100 k	2 w	Var.		FREQUENCY	
R7		1.5 meg	½ w				
R8		1.5 meg	½ w				
R9		560 k	½ w				
R10		560 k	½ w				
R11		1.5 meg	½ w				
R12		1.5 meg	½ w				
R13		560 k	½ w				
R14	Timing Series	560 k	½ w				
R15	use *295-052†	1.5 meg	½ w				
R16		1.5 meg	½ w				
R17		560 k	½ w				
R18		560 k	½ w				
R19		1.8 meg	½ w				
R20		1.8 meg	½ w				
R21		680 k	½ w				
R22		680 k	½ w				
R23	302-394	390 k	½ w				
R24	302-394	390 k	½ w				
R25A,B	use 311-014	2 x 5 k	2 w	Var.	WW	SYMMETRY	
R25.1	use 304-822	8.2 k	1 w				101-209X
R25.2	306-273	27 k	2 w				
R25.3	304-472	4.7 k	1 w				101-209X
R25.4	311-015	10 k		Var.	WW	MV SCREEN V. ADJ.	X210-up
R25.5	304-472	4.7 k	1 w				X546-up
R26	304-182	1.8 k	1 w				101-3681
	303-162	1.6 k	1 w			5%	3682-up
R27	302-470	47 Ω	½ w				
R28	302-470	47 Ω	½ w				
R29	302-391	390 Ω	½ w				
R30	301-182	1.8 k	½ w			5%	
R31	306-331	330 Ω	2 w				
R32	306-151	150 Ω	2 w				
R33	302-470	47 Ω	½ w				
R34	302-105	1 meg	½ w				
R35	302-470	47 Ω	½ w				
R36	302-470	47 Ω	½ w				
R37	302-100	10 Ω	½ w				
R38	302-470	47 Ω	½ w				
R39	302-470	47 Ω	½ w				
R40	302-100	10 Ω	½ w				
R41	306-181	180 Ω	2 w				
R42	302-561	560 Ω	½ w				
R43	306-222	2.2 k	2 w				
R44	302-270	27 Ω	½ w				
R44.5	302-270	27 Ω	½ w				X600-up
R45	302-270	27 Ω	½ w				

†Selected with C3 thru C10.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R46	302-100	10 Ω	½ w				
R47	302-470	47 Ω	½ w				
R48	302-100	10 Ω	½ w				
R49	302-470	47 Ω	½ w				
R50	302-100	10 Ω	½ w				
R51	302-470	47 Ω	½ w				
R52	306-101	100 Ω	2 w				101-1389X
R53	306-101	100 Ω	2 w				101-1389X
R54	306-101	100 Ω	2 w				101-1389
	308-015	600 Ω	10 w		WW	5%	1390-up
R55	306-101	100 Ω	2 w				101-1389X
R56	306-101	100 Ω	2 w				101-1389X
R57	306-101	100 Ω	2 w				101-1389X
R58	302-470	47 Ω	½ w				
R59	302-105	1 meg	½ w				
R60	304-472	4.7 k	1 w				
R61	306-562	5.6 k	2 w				
R62	308-021	4.5 k	10 w		WW	5%	
R63	311-015	10 k		Var.	WW	METER ADJ.	
R64	308-023	10 k	10 w		WW	5%	
R65	306-273	27 k	2 w				
R66	302-271	270 Ω	½ w				
R67	311-012	5 k		Var.	WW	100 CPS	
R68	311-012	5 k		Var.	WW	250 CPS	
R69	311-012	5 k		Var.	WW	1 KC	
R70	311-012	5 k		Var.	WW	2.5 KC	
R71	311-012	5 k		Var.	WW	10 KC	
R72	311-012	5 k		Var.	WW	25 KC	
R73	311-012	5 k		Var.	WW	100 KC	
R74	302-681	680 Ω	½ w				
R76	302-470	47 Ω	½ w				
R77	302-105	1 meg	½ w				
R78	304-152	1.5 k	1 w				
R79	302-471	470 Ω	½ w				
R80	311-012	5 k		Var.	WW	SYNC. AMPL.	
R81	306-183	18 k	2 w				
R82	306-562	5.6 k	2 w				
R83	302-472	4.7 k	½ w				
R85	302-471	470 Ω	½ w				X1718-up
R87	306-224	220 k	2 w				
R88	302-470	47 Ω	½ w				
R89	302-470	47 Ω	½ w				
R90	302-105	1 meg	½ w				
R91	302-102	1 k	½ w				
R92	306-123	12 k	2 w				

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.			Description			S/N Range
R93	302-102	1 k	½ w				
R94	302-102	1 k	½ w				
R95	304-562	5.6 k	1 w				
R96	302-563	56 k	½ w				
R97	304-683	68 k	1 w				
R98	311-032	250 k	2 w	Var.		OUTPUT AMPLITUDE	
R98.1†							
R99	311-026	100 k	2 w	Var.		ADJ. 175 V	
R99.1†							
R101	306-224	220 k	2 w				
R102	302-470	47 Ω	½ w				
R102.1	308-040	1.5 k	25 w		WW	5%	X313-up
R103	302-470	47 Ω	½ w				
R104	302-105	1 meg	½ w				
R105	302-102	1 k	½ w				
R106	302-102	1 k	½ w				
R107	302-102	1 k	½ w				
R108	304-333	33 k	1 w				
R109	302-474	470 k	½ w				
R110	use 302-393	39 k	½ w				
R111	311-015	10 k		Var.	WW	ADJ. —150 V	
R112	302-473	47 k	½ w				

Switches

	Unwired	Wired			
SW1	260-057	*262-003	Rotary	RANGE	
SW2	260-134		Toggle	AC	ON
SW3	260-014		Toggle	DC	ON

Transformers

T1	*120-006	Plate and Heater Supply

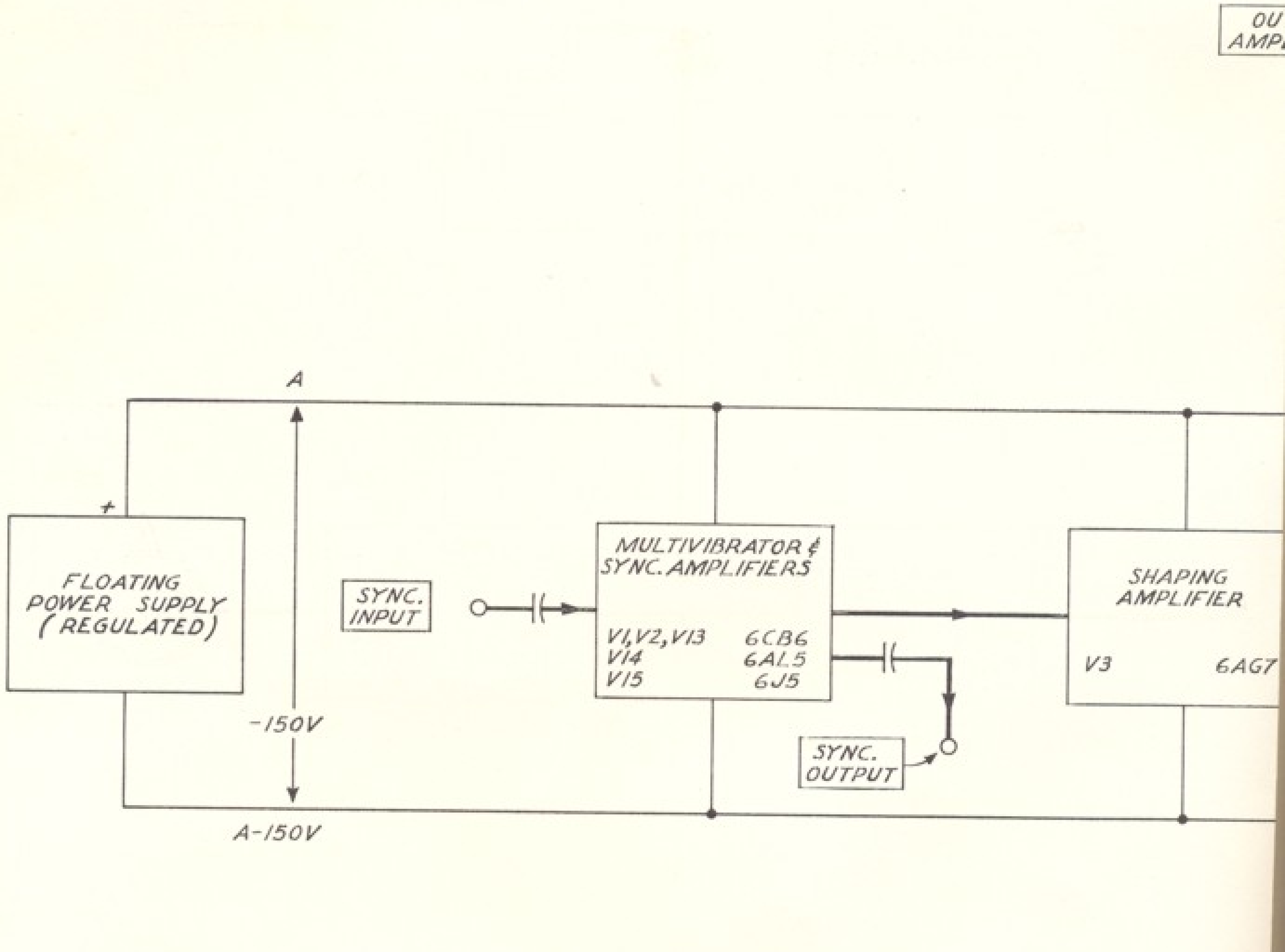
Electron Tubes

V1, V2	*157-020	6CB6	matched pair
V3	154-012	6AG7	
V4	154-012	6AG7	
V5	154-012	6AG7	

†Added when needed at the time of instrument calibration.

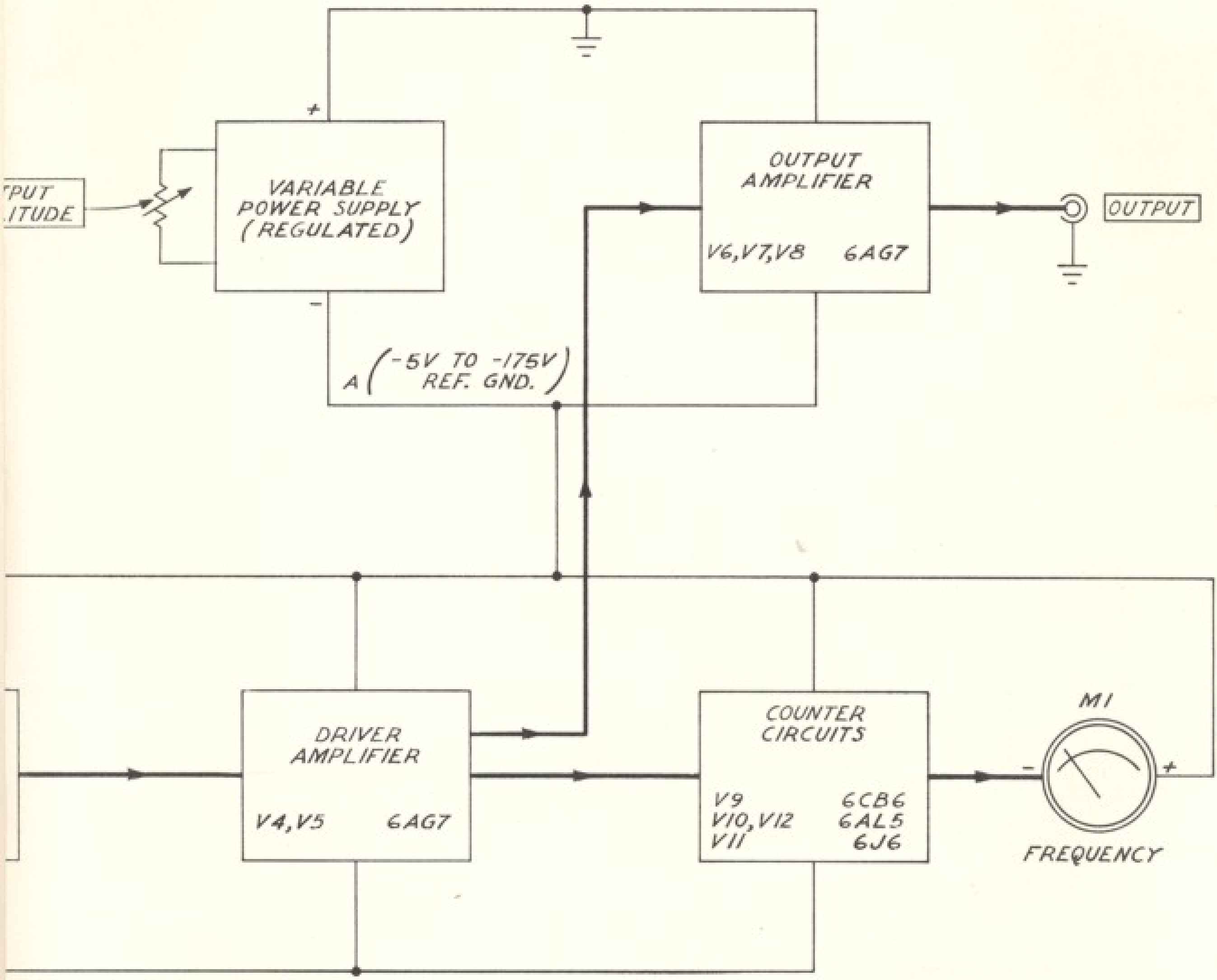
Electron Tubes *(Cont'd)*

Ckt. No.	Tektronix Part Number	Description	S/N Range
V6	154-012	6AG7	
V7	154-012	6AG7	
V8	154-012	6AG7	
V9	Use *157-005	6CB6 Checked	
V10	154-016	6AL5	
V11	154-032	6J6	
V12	154-016	6AL5	
V13	154-030	6CB6	
V14	154-016	6AL5	
V15	154-032	6J6	
V16	154-008	5V4G	
V17	154-008	5V4G	
V18	154-021	6AU5GT	
V19	154-021	6AU5GT	
V20	154-022	6AU6	
V21	154-008	5V4G	
V22	154-008	5V4G	
V23	154-021	6AU5GT	
V24	154-021	6AU5GT	
V25	154-022	6AU6	
V26	154-052	5651	



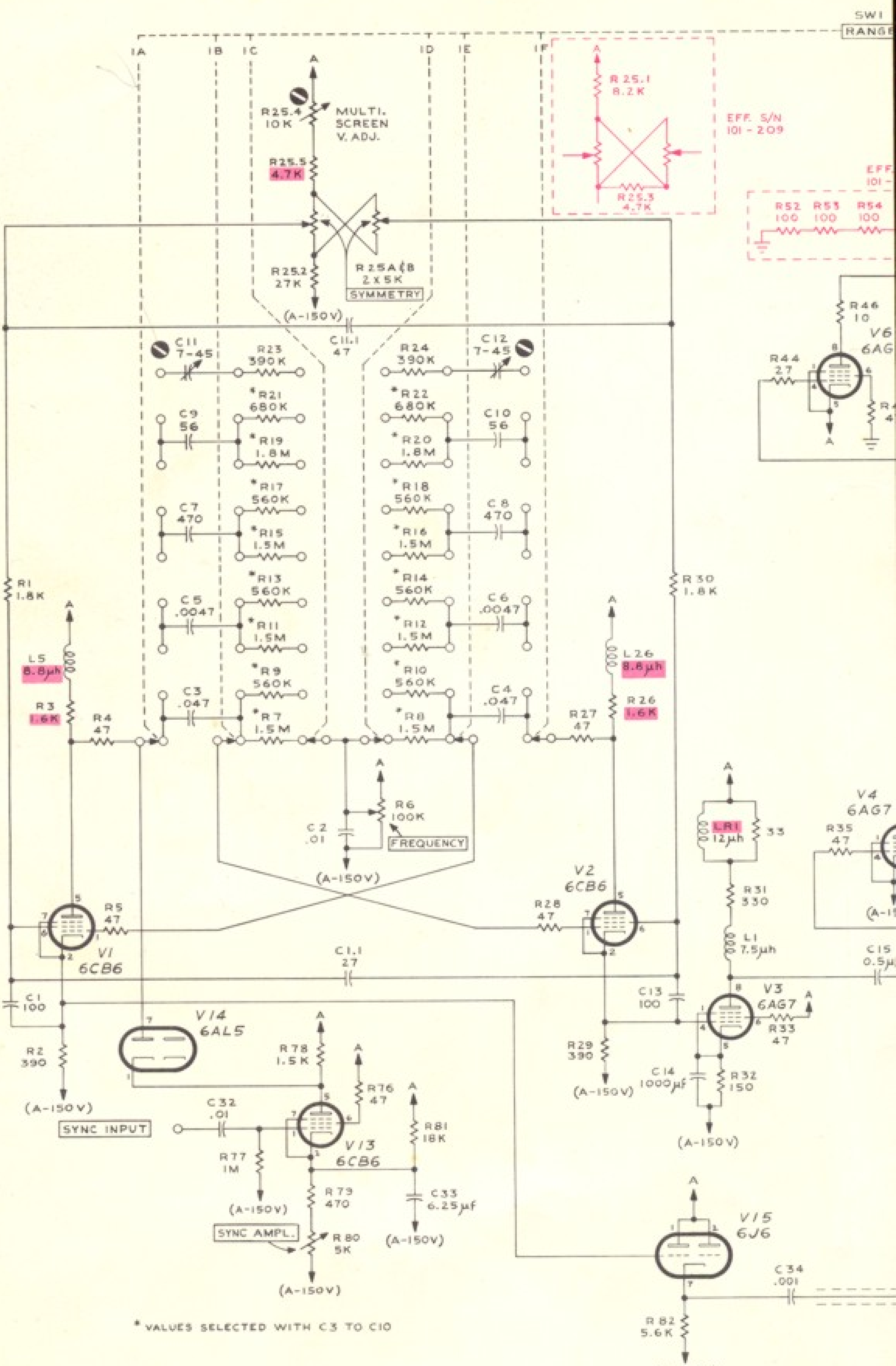
TYPE 105 SQUARE-WAVE GENERATOR

AA

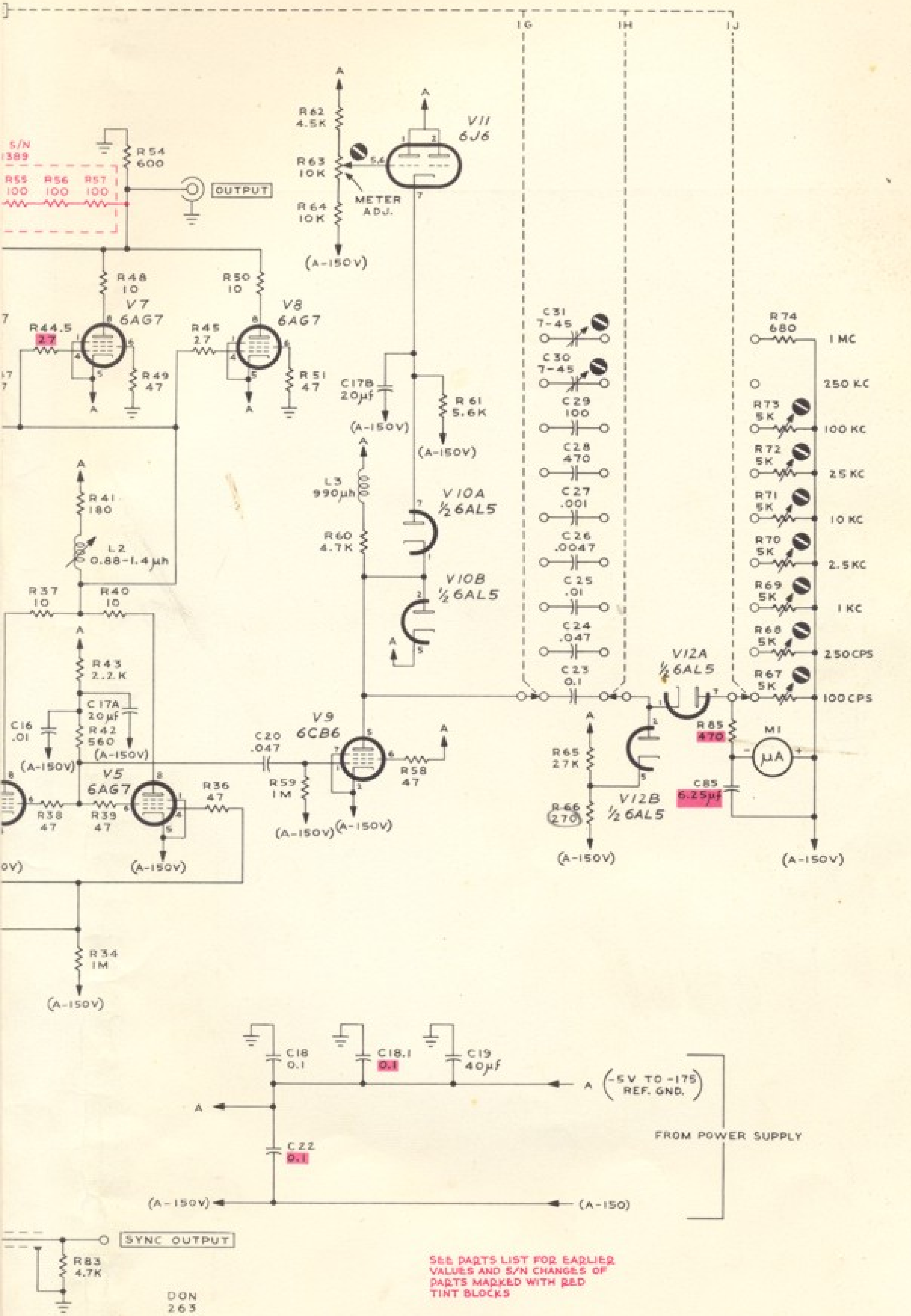


BLOCK DIAGRAM

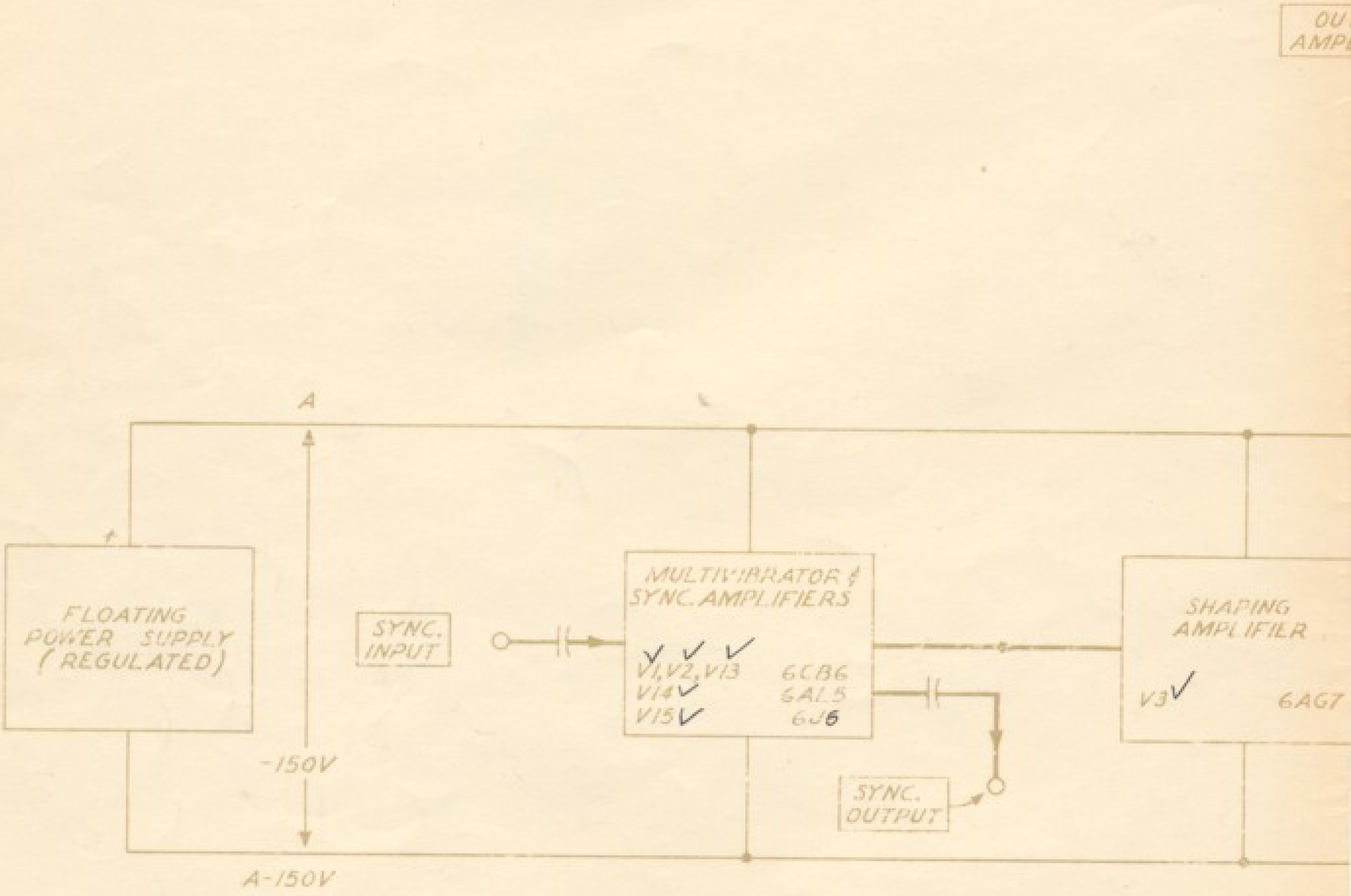
263
KF



TYPE 105 SQUARE WAVE GENERATOR

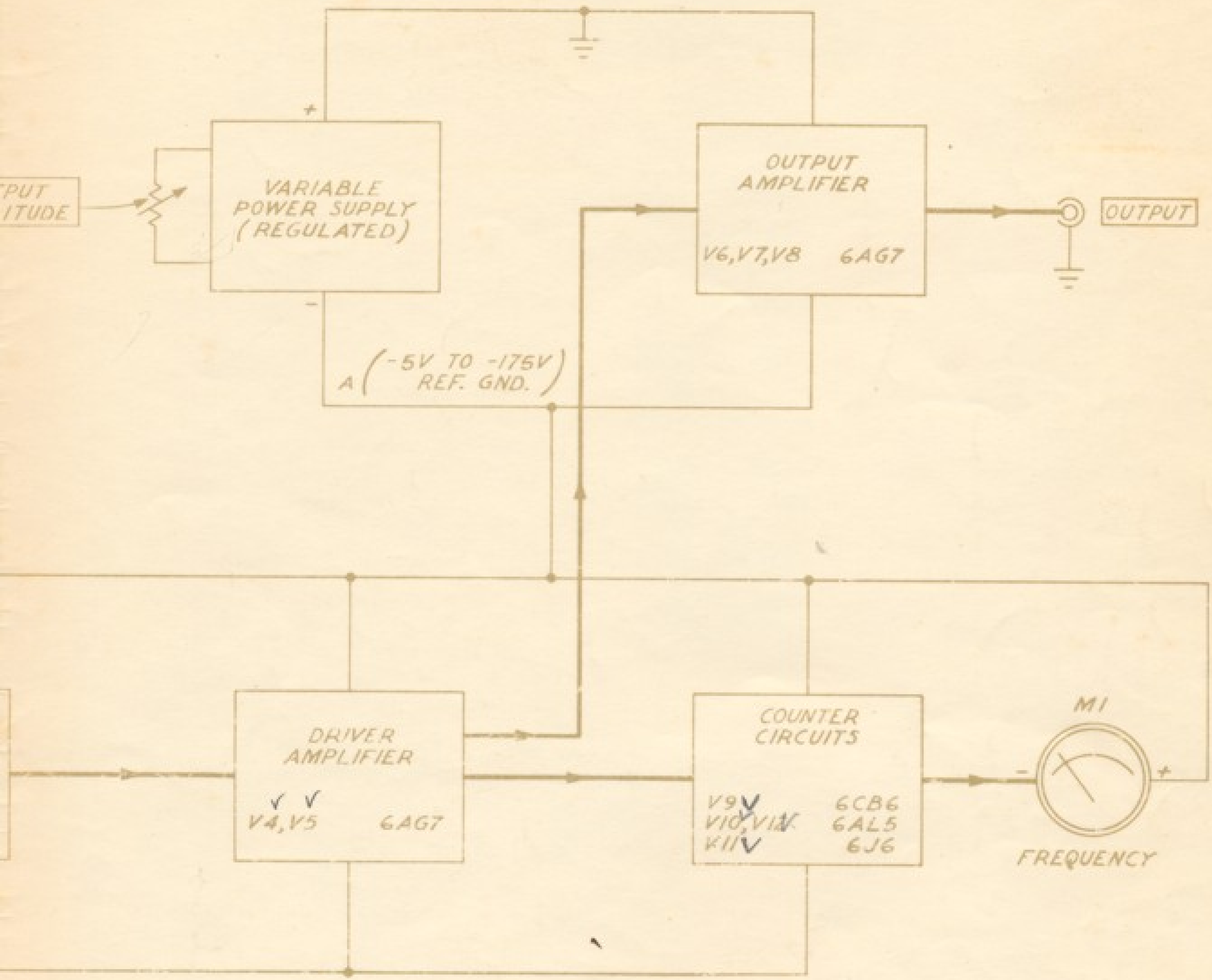


GENERATOR AND FREQUENCY METER



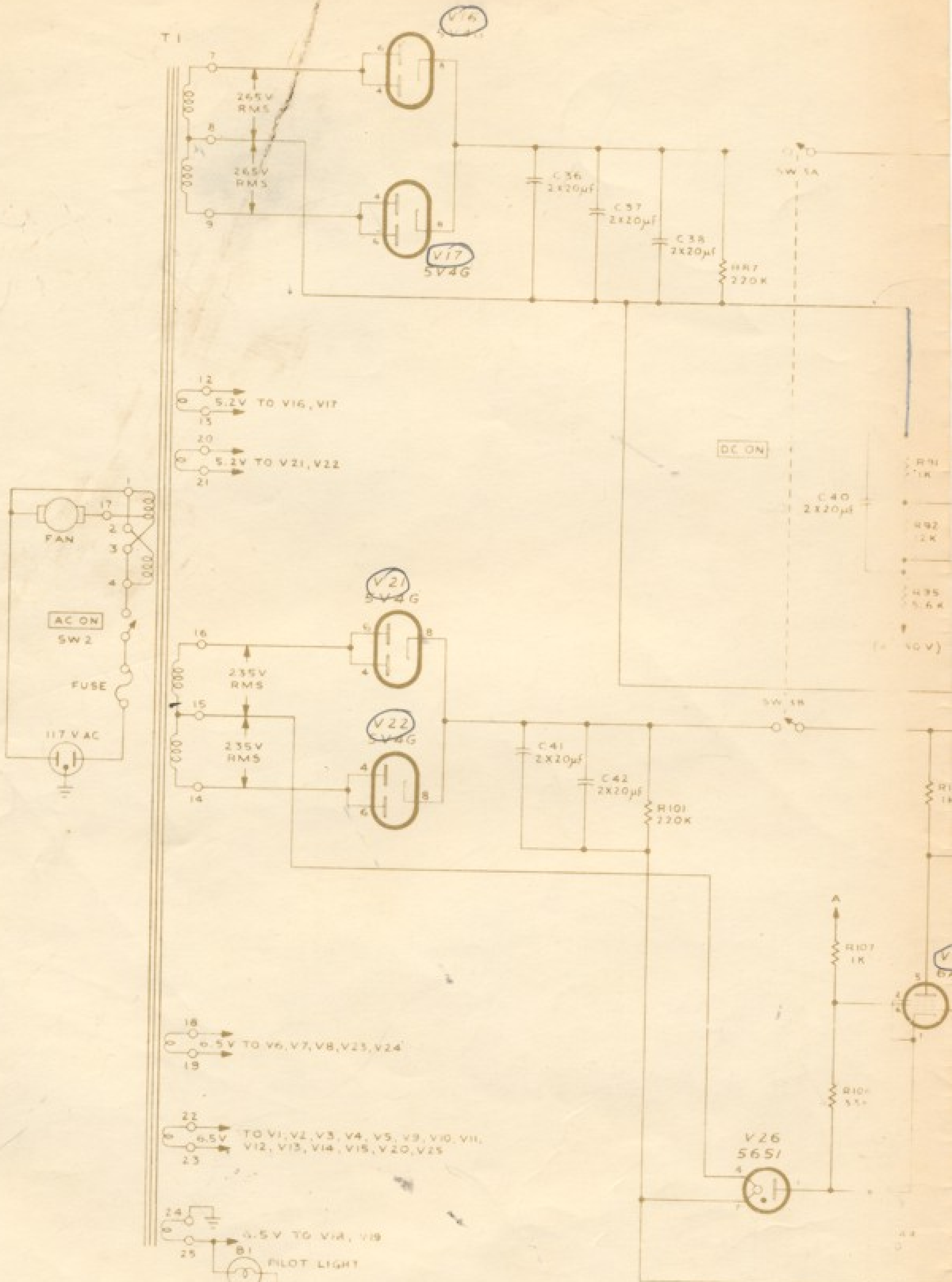
TYPE 105 SQUARE-WAVE GENERATOR

AA



BLOCK DIAGRAM

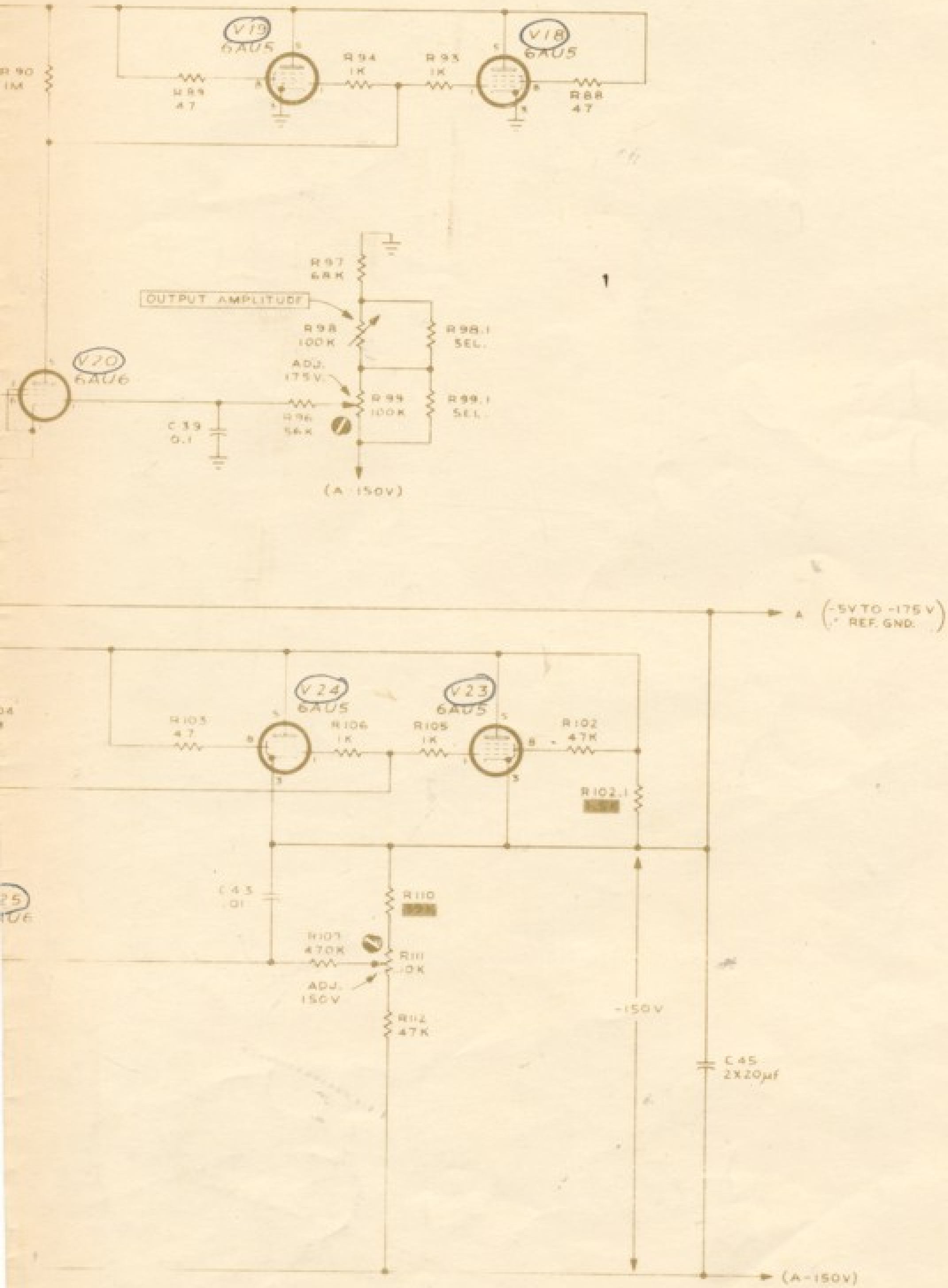
263
KF



TYPE 105 SQUARE WAVE GENERATOR

AA

D I C - I - 0008

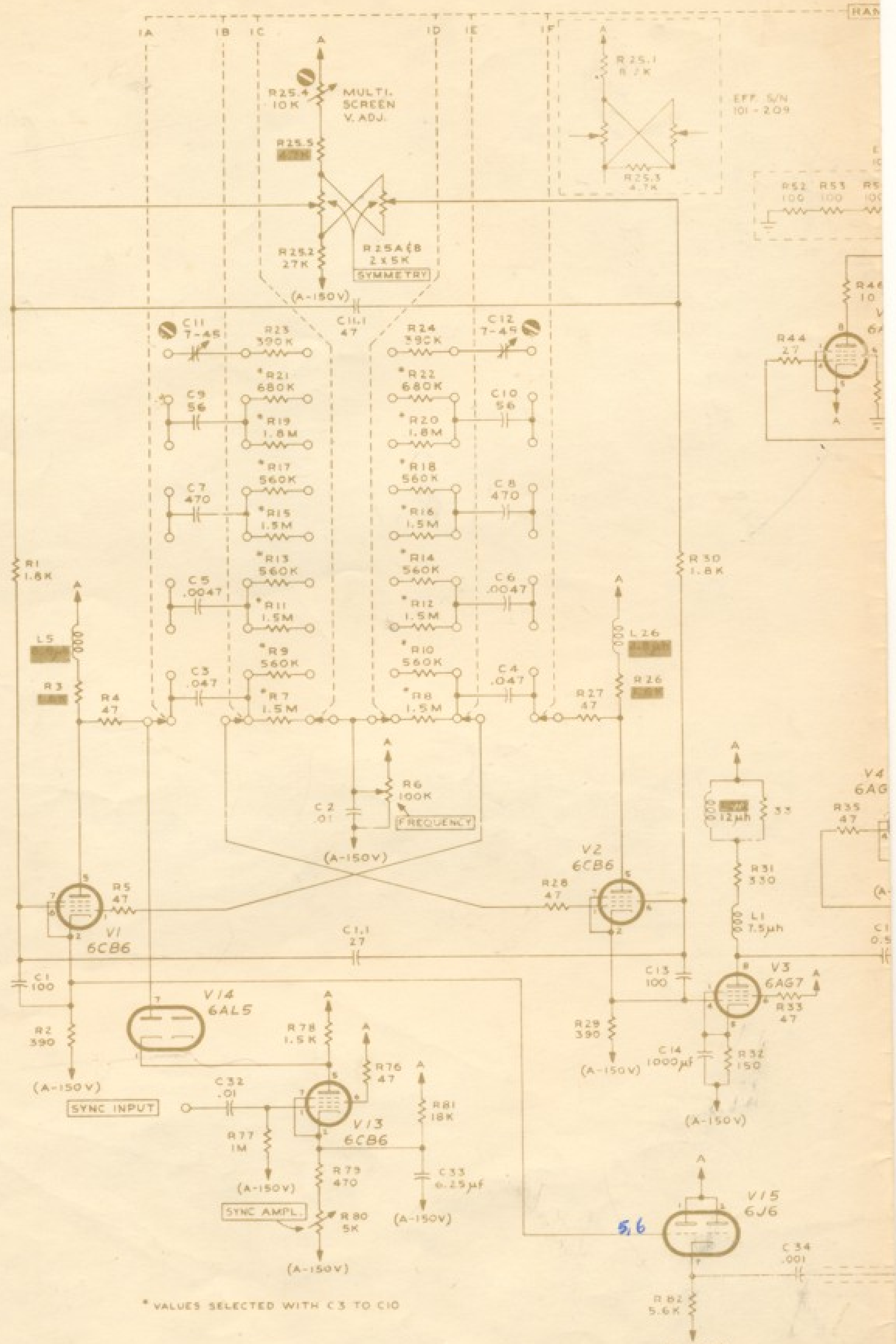


SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

ECN
263

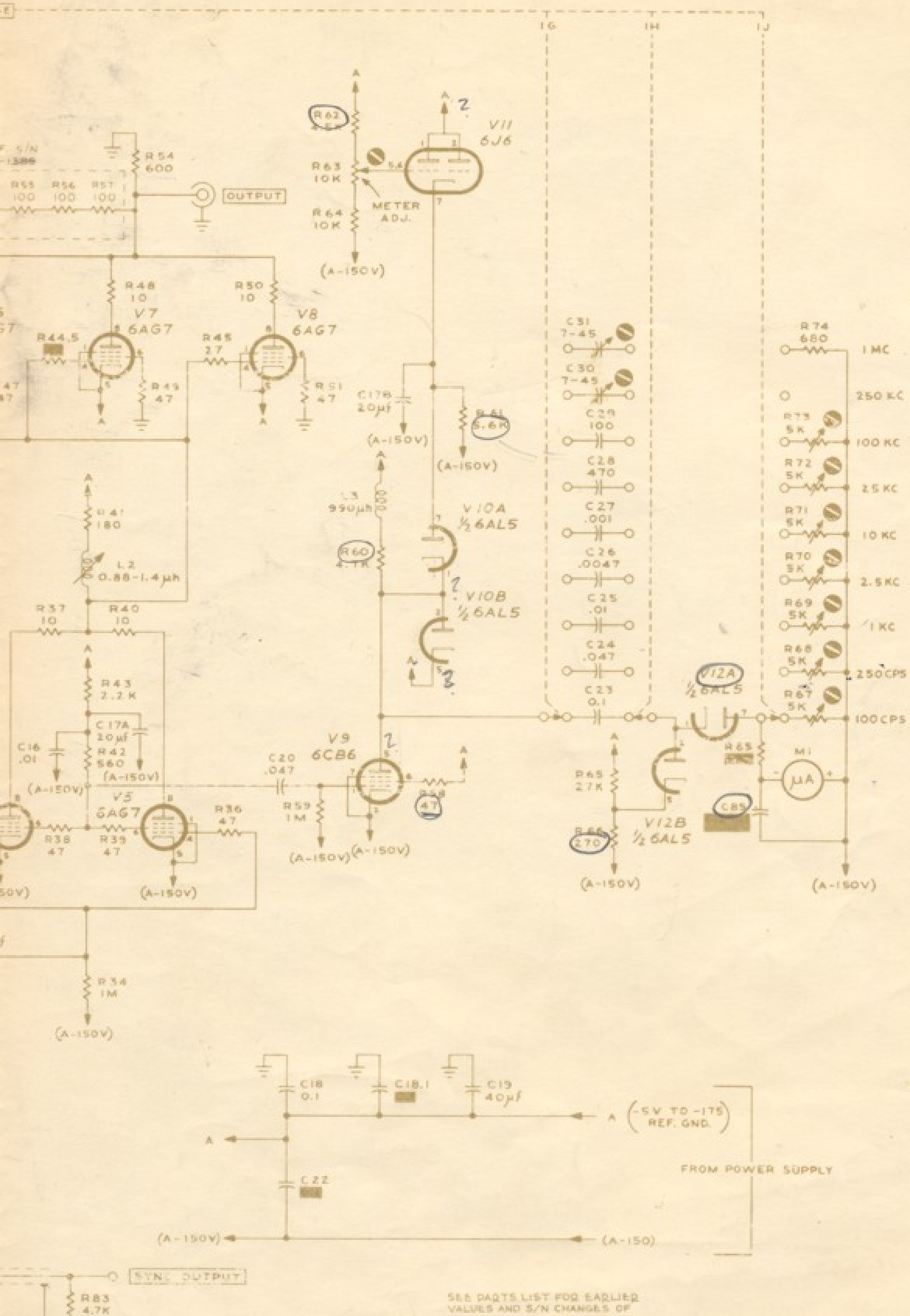
POWER SUPPLY

POWER SUPPLY



* VALUES SELECTED WITH C3 TO C10

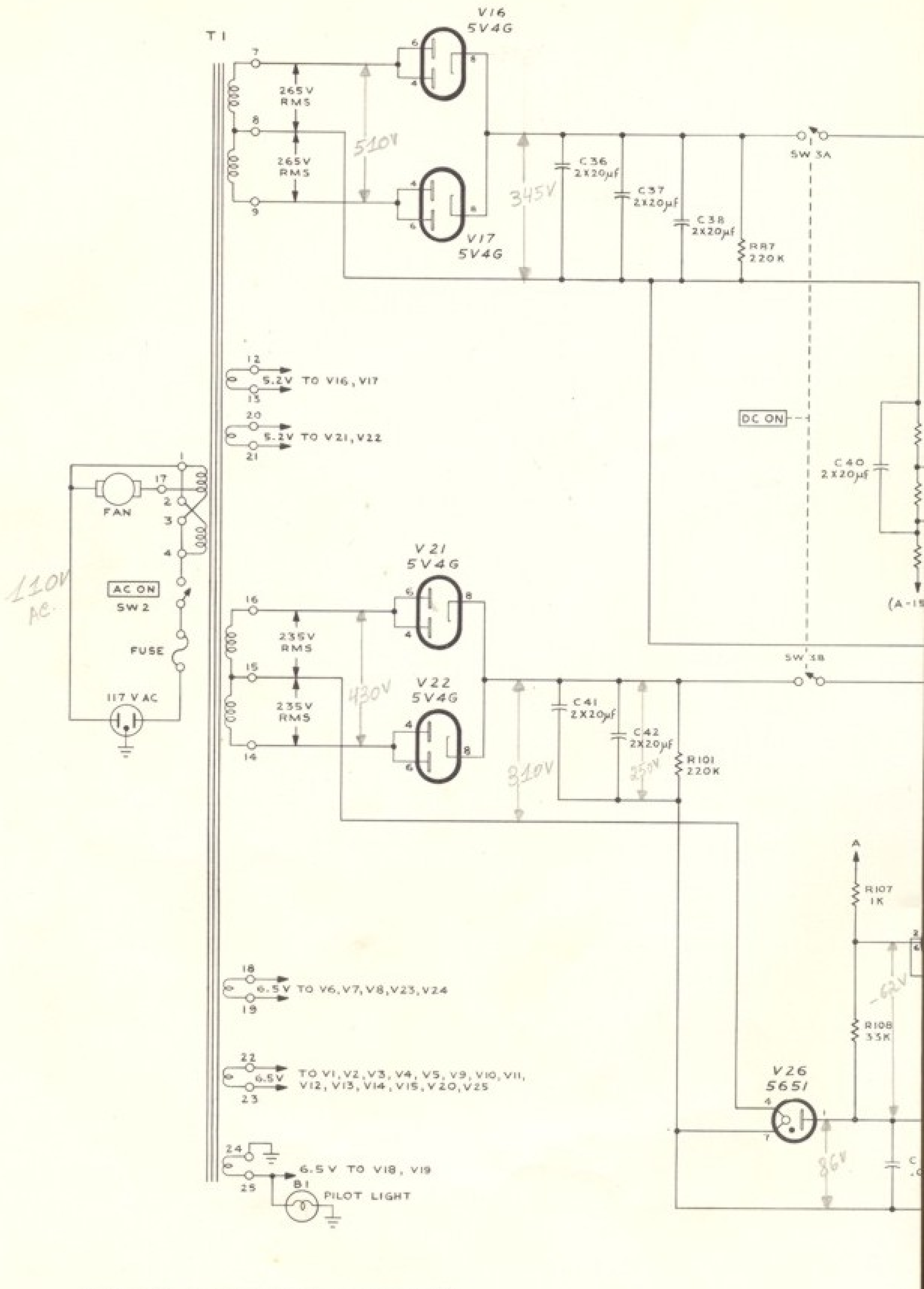
TYPE 105 SQUARE WAVE GENERATOR



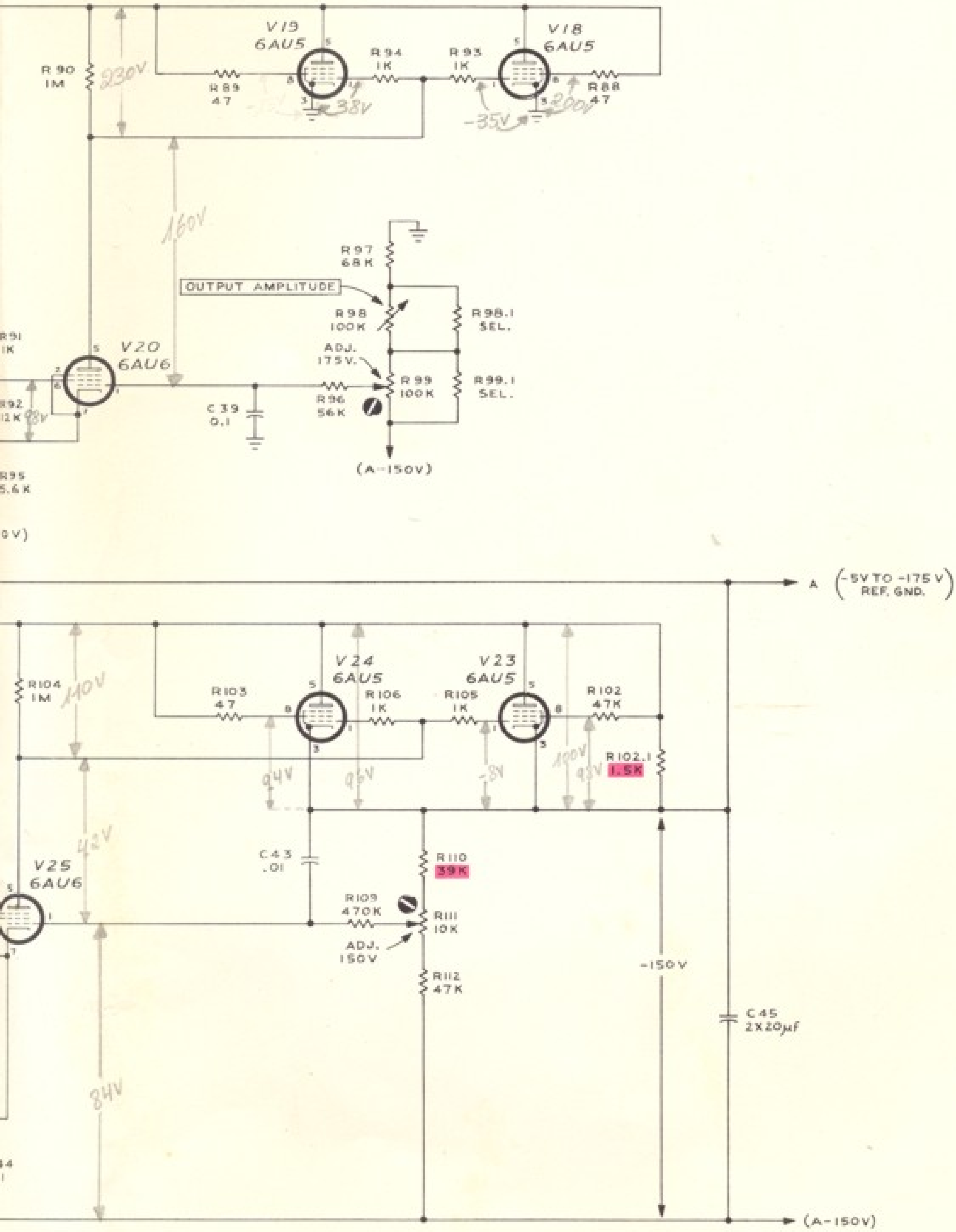
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

DON
263

GENERATOR AND FREQUENCY METER



TYPE 105 SQUARE WAVE GENERATOR



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

DON
263

POWER SUPPLY

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE 105 - TENT. S/N 7298

PARTS LIST CORRECTION

CHANGE TO:

SW1	260-584	*262-622	Rotary	RANGE