# TG-1A SYNCHRONIZING GENERATOR

RADIO CORPORATION OF AMERICA
ENGINEERING PRODUCTS DEPARTMENT CAMDEN, N. J.

IB-36008-3

# TG-1A
# SYNCHRONIZING GENERATOR
## MI-26915

## INSTRUCTIONS



ENGINEERING PRODUCTS DEPARTMENT
RADIO CORPORATION OF AMERICA
Camden, N. J., U. S. A.

Printed in U. S. A.

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# WARNING

THE VOLTAGES EMPLOYED IN THIS EQUIPMENT ARE SUFFICIENTLY HIGH TO ENDANGER HUMAN LIFE AND EVERY REASONABLE PRECAUTION HAS BEEN OBSERVED IN DESIGN TO SAFEGUARD THE OPERATING PERSONNEL. THE POWER SHOULD BE REMOVED COMPLETELY BEFORE CHANGING TUBES OR MAKING INTERNAL ADJUSTMENTS.

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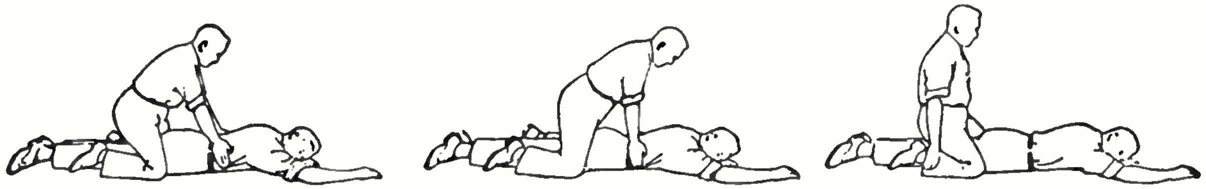
## FIRST AID IN CASE OF ELECTRIC SHOCK

1. PROTECT YOURSELF with dry insulating material.
2. BREAK THE CIRCUIT by opening the power switch or by pulling the victim free of the live conductor.

   DON'T TOUCH VICTIM WITH YOUR BARE HANDS until the circuit is broken.



(A) (B) (C)

3. LAY PATIENT ON STOMACH, one arm extended, the other arm bent at elbow. Turn face outward resting on hand or forearm.
4. REMOVE FALSE TEETH, TOBACCO OR GUM from patient's mouth.
5. KNEEL STRADDLING PATIENT'S THIGHS. See (A).
6. PLACE PALMS OF YOUR HANDS ON PATIENT'S BACK with little fingers just touching the lowest ribs.
7. WITH ARMS STRAIGHT, SWING FORWARD gradually bringing the weight of your body to bear upon the patient. See (B).
8. SWING BACKWARD IMMEDIATELY to relieve the pressure. See (C).
9. AFTER TWO SECONDS, SWING FORWARD AGAIN. Repeat twelve to fifteen times per minute.
10. WHILE ARTIFICIAL RESPIRATION IS CONTINUED, HAVE SOMEONE ELSE:
    (a) Loosen patient's clothing.
    (b) Send for doctor.
    (c) Keep patient warm.
11. IF PATIENT STOPS BREATHING, CONTINUE ARTIFICIAL RESPIRATION. Four hours or more may be required.
12. DO NOT GIVE LIQUIDS UNTIL PATIENT IS CONSCIOUS.

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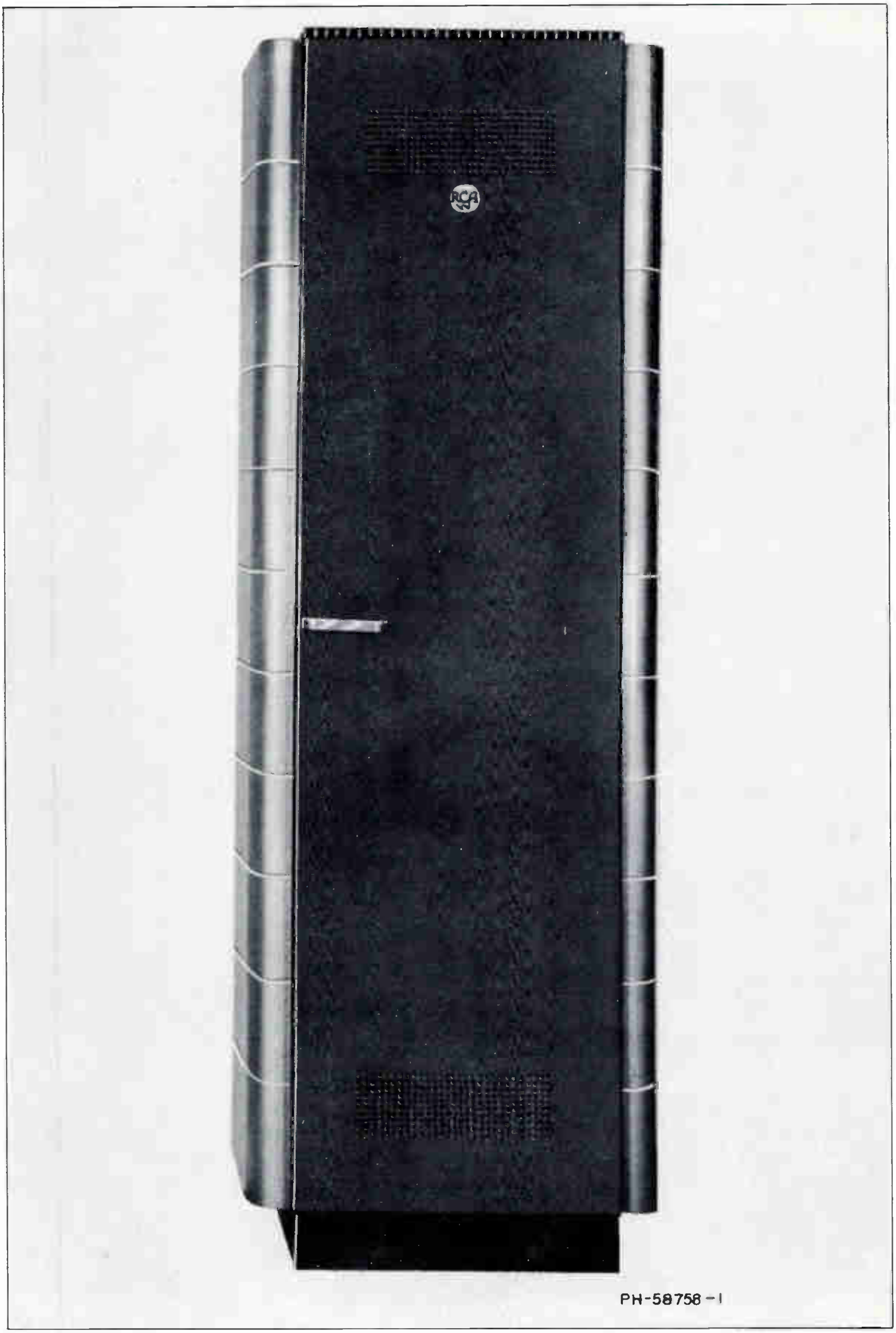



*Figure 1—Type TG-1A Synchronizing Generator (Front View)*

# SECTION I
# TECHNICAL SUMMARY

## ELECTRICAL CHARACTERISTICS

### Output Signals:

| Signal | Frequency in Cycles | Peak to Peak Voltage (across 75 ohms) |
|---|---|---|
| Horizontal Driving | 15,750 | 4 volts, +1 –0.5 |
| Vertical Driving | 60 | 4 volts, +1 –0.5 |
| Blanking | 60 and 15,750 | 4 volts, +1 –0.5 |
| Synchronizing | 60 and 15,750 | 4 volts, +1 –0.5 |
| CRO synchronizing | 30 and 7875 | 4 volts, +1 –0.5 except during 30 cycle pulse 8 volts, +2 –1 |

### Power Supply Requirements:

| | |
|---|---|
| Line Rating | 105-125 volts, 60 cycles, single-phase |
| Allowable line frequency variations | 59 to 61 cycles |
| Power Consumption | 450 watts |

## TUBE COMPLEMENT

### Pulse Former:

| Item | Type | Quan. | Symbol Designation | Class of Tube |
|---|---|---|---|---|
| 1 | 6H6 | 8 | V1, V2, V9, V12, V16, V19, V20, V23 | Receiving |
| 2 | 6AC7 | 4 | V6, V7, V14, V15 | Receiving |
| 3 | 6SL7GT | 7 | V3, V5, V21, V25, V26, V28, V29 | Receiving |
| 4 | 6SN7GT | 9 | V8, V10, V11, V13, V17, V18, V22, V24, V27 | Receiving |
| 5 | 1B3GT/8016 | 1 | V4 | |
| 6 | 3KP1 | 1 | V30 | Cathode Ray |

### Pulse Shaper:

| Item | Type | Quan. | Symbol Designation | Class of Tube |
|---|---|---|---|---|
| 1 | 6SL7GT | 13 | V35, V36, V37, V43, V44, V46, V47, V48, V49, V50, V51, V52, V54 | Receiving |
| 2 | 6AC7 | 6 | V32, V33, V38, V39, V41, V42 | Receiving |
| 3 | 6SN7GT | 2 | V31, V53 | Receiving |
| 4 | 6L7 | 4 | V34, V40, V45, V58 | Receiving |
| 5 | 6AG7 | 5 | V55, V56, V57, V59, V60 | Receiving |

## MECHANICAL SPECIFICATIONS

| | Length | Width | Depth | Weight |
|---|---|---|---|---|
| Cabinet Rack | 84″ | 22″ | 18″ | 218 lbs. |
| Pulse Former | 29 23/32″ | 19″ | 10″ | 39 3/4 lbs. |
| Pulse Shaper | 29 23/32″ | 19″ | 9″ | 51 1/2 lbs. |
| Regulated Power Supply | 10 15/32″ | 19″ | 12 1/2″ | 58 lbs. |
| Filter Panel | 1 23/32″ | 19″ | 6″ | 3 1/2 lbs. |
| Terminal Board Chassis | 5 7/32″ | 19″ | 5 1/4″ | 3 1/2 lbs. |

## SECTION II
## EQUIPMENT

The complete Type TG-1A Synchronizing Generator includes the following components:

| Quantity | Description | RCA Reference |
|---|---|---|
| 1 | Synchronizing Generator Rack (includes next four items) | MI-26815 |
| | Pulse Former | MI-26100 |
| | Pulse Shaper | MI-26110 |
| | Regulated Power Supply | MI-21523-C |
| | Filter Unit | MI-26270 |
| *2 | Side Panel | MI-30541-G84 |
| *1 | Front Door (ventilated) | MI-30536-G84 |
| *1 | Monogram | MI-30596 |
| 1 | Rear Door (ventilated) | MI-30536-G84 |
| 1 | Tube, Cathode Ray (RCA-3KP1) | MI-26650 |
| ** | Set of Replacement Tubes | MI-26677 |
| 1 | Instruction Book | IB-36008 |

* Optional.
** Specify number of parts.

## SECTION III
## DESCRIPTION

### PURPOSE

The primary purpose of Type TG-1A Synchronizing Generator is to furnish a television pickup system with signals of suitable amplitude, waveshape and frequency so that an RMA Standard picture signal will result. The generator produces four signals properly synchronized to produce a 525-line, 30-frame interlaced picture signal. These four signals are (1) Horizontal Driving, (2) Vertical Driving, (3) Blanking and (4) RMA Synchronizing.

The generator also produces a signal composed of pulses at half horizontal scanning frequency and half vertical scanning frequency. This signal may be used to synchronize the sweep frequencies of associated monitoring oscilloscopes so that two complete cycles of the signal may be observed.

All output circuits are designed to be terminated in 75 ohms.

### CONSTRUCTION

The generator can be divided both electrically and mechanically into three separate units, the pulse former, the pulse shaper and the regulated power supply.* Each unit is built on a recessed type chassis. The three units are mounted in a standard broadcast cabinet rack from top to bottom in the order named. The units are connected electrically by means of cables and connectors J1 in the pulse former, J1 and J2 in the pulse shaper and J2 in the power supply. All tubes and controls are accessible from the front of the cabinet by opening a hinged door. A hinged door in the rear affords access to the circuit components.

Whenever convenient, resistors and capacitors which have one side grounded are located on the tube sockets or the chassis. All other components are located on terminal boards near the associated tubes, except capacitors larger than 0.1 mfd., which are mounted on the chassis.

Filament power for all tubes in the pulse former and the pulse shaper except for the Indicator, V30, and the high-voltage rectifier, V4, is obtained from transformers T1 and T2, located at the bottom of the shaper chassis.

Plate voltage is supplied to both pulse former and pulse shaper from the regulated power supply through connectors J1 and J2 on the shaper chassis. High voltage and filament voltage for the cathode-ray tube indicator V30 are obtained from transformers T11 and the rectifier tube V4.

The 117-volt a-c power for all units in the rack is controlled by circuit breaker S1, located between the filament transformers at the bottom of the shaper chassis.

On the bottom panel-rear a terminal block is mounted. The terminals on this block are assigned to the following:

| | |
|---|---|
| #1 and #2 | 105-125 V., 60 cycle power supply |
| #3 and #4 | External phase shift control (To be jumpered when the external control is not used) |
| #5 | External synchronizing voltage |
| #6 | Ground—to be connected to ground bus of the system |

### CIRCUITS

#### Pulse Former

The Pulse Former contains circuits necessary to generate 31,500-cycle pulses, 15,750-cycle pulses and 60-cycle pulses. There are also circuits to produce a signal composed of 30-cycle and 7875-cycle pulses timed so that the 30-cycle pulse occurs midway between the 60-cycle pulses and the 7875-cycle pulse occurs midway between 15,750-cycle pulses. The timing of the

* The Type 580-D Regulated Power Supply is described in IB-36078.

pulses is accomplished by deriving all pulses from the 31,500-cycle pulses.

The 31,500-cycle pulses are formed by driving a two-stage clipper, V8, with the sine-wave output of the master oscillator, V11. The output of the clipper is fed through connector J1 to the Pulse Shaper.

The output of the 31,500-cycle clipper is also fed through a buffer stage, V14, to a counter circuit, V19 and V18, which reduces the frequency 2 to 1. The resulting 15,750-cycle pulse is then amplified by the second triode of V18 and fed to the Pulse Shaper.

In order to reduce the frequency from 31,500-cycles to 60-cycles, four counter circuits are used. The pulse from the 31,500-cycle clipper is fed through a buffer, V6, to a 7 to 1 counter, V9 and V10. The second triode of V10 amplifies the resulting 4500-cycle pulse and feeds it to a 5 to 1 counter, V12 and V13. The second triode of V13 amplifies the 900-cycle pulse and feeds it to a 5 to 1 counter, V16 and V17. The second triode of V17 amplifies the 180-cycle pulse and feeds to a 3 to 1 counter, V20 and V24. The resulting 60-cycle pulse is amplified in the second triode of V24 and forwarded to the Pulse Shaper.

A cathode-ray tube indicator, V30, is provided for a quick and accurate check of the frequency division in each counter. Signal is fed to the vertical amplifier, V5, from a single-pole, six-position switch, S2. Each of the six positions on the switch receives a portion of the stair-step wave of voltage that appears on the cathode of the corresponding counter diode. The number of steps indicates the ratio of frequency division in the counter circuit. Since the horizontal deflection plates in V30 are grounded, the vertical deflection created by the stair-step voltage on the vertical deflection plates creates a series of dots on the screen which corresponds to the number of steps.

Four methods of frequency control for the master oscillator are available by use of the two-pole, four-position switch S1.

The first position of the switch grounds the control grids of the oscillator and reactance tubes, V11 and V15. This establishes a free-running condition in the oscillator circuit.

The second switch position locks the oscillator to the 60-cycle power supply. The lock-in is maintained by comparing the 60-cycle pulse from the counters with a signal from the 60-cycle power source in a phase detector circuit consisting of transformer T2 and the discriminator circuit composed of tubes V1 and V2. The d-c voltage developed by the discriminator as a result of any phase differences between the 60-cycle pulse and the 60-cycle power source varies the bias on the control grid of the reactance tube V15, thereby correcting frequency variations. A choice of four time constants is available with the use of the single-pole, four-position switch S3. The time constant used depends on the frequency stability of the power source.

The third switch position permits frequency control from an external source. It is necessary that the external signal be a d-c voltage similar to that obtained from the discriminator when 60-cycle lock-in control is used, since the signal is applied to the control grid of the reactance tube V15.

The fourth switch position couples the output of a crystal controlled oscillator, V3, to the control grid of the master oscillator. The frequency of the crystal oscillator is 94,500 cycles, the third harmonic of the master oscillator frequency. The control grid of the reactance tube is grounded in this position.

The 7875-cycle component of the CRO synchronizing voltage is developed by feeding the output of the 31,500-cycle clipper, V8, through a special type buffer, V22, to a 4 to 1 counter, V23 and V27. Since this buffer does not reverse the polarity of the pulse, a delay equal to the width of a 31,500-cycle pulse is introduced with respect to the 15,750-cycle pulse from V18. The second triode of V27 amplifies the pulse and feeds it to one grid of the mixer tube V26.

The 30-cycle component of the CRO synchronizing voltage is derived from the 60-cycle pulse output of V24, which is fed through a cathode follower buffer, V21, to a 60-cycle multivibrator, V25. The output of the multivibrator is differentiated and fed through a buffer, V21. The trailing edge of this pulse appears in the output of the buffer as a positive pulse which synchronizes the multivibrator V29 at 30-cycle intervals occurring midway between the 60-cycle pulses used to trigger V25. The output pulse is applied to the second grid of the mixer tube V26. The 7875-cycle pulse and the 30-cycle pulse are mixed in the common plate resistor R-52 of V26 and the resulting combined signal is fed to the Pulse Shaper.

**Pulse Shaper**

The 15,750-cycle and 31,500-cycle signals from the Pulse Former are each fed to a separate delay line in the Pulse Shaper. Of the ten multivibrators in the pulse shaper three are synchronized by the 60-cycle pulse from the Pulse Former through connector J1, four are synchronized by pulses from the 15,750-cycle delay line and two are synchronized by pulses from the 31,500-cycle delay line.

Horizontal Driving pulses are generated by using pulses from the 15,750-cycle delay line to synchronize the Horizontal Driving Multivibrator V54. The positive pulse from the multivibrator is fed to the grid of the Horizontal Driving Output tube V60. The amplitude of the pulse is sufficient to bias the tube beyond cut-off thereby clipping off all of the negative portion. A positive pulse is taken from the cathode of V60 and fed to the coaxial connector J5, while a negative pulse is supplied to connector J6 through coupling capacitor C149.

Two tubes are required to generate the Vertical Driving signals. The Vertical Driving Multivibrator V49 is synchronized by the 60-cycle pulse from the Pulse Former. A positive pulse from the multivibrator drives the Vertical Driving Output tube, V55. The driving pulse is of sufficient amplitude to cause the tube to be biased beyond cutoff, thereby removing the negative portion of the pulse. A positive pulse is obtained from the cathode circuit at connector J12 and a negative pulse from the plate through blocking capacitor C160 and connector J11.

The blanking signal is a composite signal consisting of 60-cycle and 15,750-cycle pulses. The 15,750-cycle pulses are generated by the Horizontal Blanking Multivibrator V48, which is synchronized by a negative pulse from the delay line. The 60-cycle pulses are generated by the Vertical Blanking Multivibrator V37, which is synchronized by the negative 60-cycle pulse from the pulse former. Positive pulses from each multivibrator are applied to the two grids of the Blanking Clipper and Mixer V44. The two signals are mixed on the common load resistor R79, and the mixed signal is fed to the Final Blanking Clipper V50. The sides of the Horizontal pulses are steepened by peaking coil L67 in the plate circuit of V50 and the combined signal is applied to the Blanking Output tube V56. The positive blanking output signal is taken from the cathode circuit of V56 through connector J10. The negative blanking signal is taken from the plate circuit through blocking capacitor C156 and connector J9.

The RMA Synchronizing signal is developed by mixing ten signals at various stages. The main mixing occurs when four signals, three of which are composite signals, are applied across the common plate load resistor, R114 of Sync. Mixers V46, V47 and V52. At this point the leading edge of the equalizing pulse becomes the leading edge of both the horizontal synchronizing pulse and the vertical synchronizing pulse.

The first of the four signals on R114 is produced in the Equalizing Pulse Multivibrator V33 and V39, which is synchronized by a pulse from the 31,500-cycle delay line through the buffer V31. The positive pulse from the multivibrator is clipped twice in the clipper V46 and fed to the common load resistor R114.

The second of the signals consists of 15,750-cycle horizontal synchronizing pulses keyed by 60-cycle pulses. The horizontal synchronizing pulses are obtained from the Horizontal Pulse Multivibrator V41 and V42, which is synchronized by a pulse from the 15,750-cycle delay line through the buffer V35. A positive pulse from the multivibrator output is applied to the first grid of the mixer V40, while a 60-cycle negative pulse is applied to the third grid. The output of the mixer consists of 15,750-cycle pulses except during the intervals of the 60-cycle pulses. The signal is applied to a clipper, V52, which feeds common load resistor R114.

The 60-cycle negative keying pulse referred to above is generated in the Number of Equalizing Pulses Multivibrator V28, which is located on the Pulse Former chassis for mechanical symmetry and convenience. This multivibrator is synchronized by the 60-cycle pulse from the Pulse Former and its output is fed through connector J1 to the clipper V35 in the Pulse Shaper. The negative keying pulse is obtained from the plate of the clipper.

The third signal is also composed of 15,750-cycle pulses keyed by the 60-cycle signal from the Number of Equalizing Pulses Multivibrator. The 15,750-cycle pulse is produced by the Notching Pulse Multivibrator V36, which is synchronized by a pulse from the delay line. The two signals are mixed in V34, the output of which is applied to a clipper, V47. The second stage of the clipper feeds the common load resistor R114. This signal has the notching pulse present except during the 60-cycle keying interval.

The fourth signal is a complex one that consists of groups of six 31,500-cycle pulses recurring at a 60-cycle rate. The 31,500-cycle pulses are generated in the Vertical Pulse Multivibrator V32 and V38, synchronized by a pulse from the 31,500-cycle delay line through a buffer, V31. It is necessary that the groups contain six **complete** vertical pulses, consequently the leading edge of the 60-cycle pulse must fall between adjacent 31,500-cycle pulses, and not during these pulses. This requirement makes necessary a somewhat complex circuit.

A negative pulse is obtained from the Vertical Pulse Delay Multivibrator V43, which is synchronized by the 60-cycle negative pulse from the Pulse Former. This pulse is differentiated and applied to the number two control grid of the mixer V45, where the trailing edge of the pulse becomes a positive keying pulse. A narrow, 31,500-cycle pulse is applied to number one control grid of the mixer from the Vertical Pulse Multivibrator V38 and V32 and appears on the plate as a group of negative 31,500-cycle pulses which occur during the interval of the 60-cycle keying pulse. The first of these pulses synchronizes the number of Vertical Pulses Multivibrator V51. The positive output of this multivibrator is applied to the number one grid of the mixer V58, while a wide positive 31,500-cycle pulse from the Vertical Pulse Multivibrator is applied to the number two control grid. This latter pulse is obtained from the inverted form of the wave which was used to trigger the Number of Vertical Pulses Multivibrator V51. The multivibrator V51 will be triggered only sometime during the narrow interval between vertical pulses and a whole vertical pulse will always appear at the beginning of the group of six.

The negative output of the mixer V58 is applied to the Sync. Mixer and Clipper V52 from which it is fed to the common load resistor R114.

The complex signal resulting from the four signals being mixed is applied to the Final Sync. Clipper V53. In the second stage of the clipper, peaking coil L66 is used to steepen the edges of the pulses. This signal is fed from the clipper to the Sync. Output tube V59. The positive RMA Synchronizing signal is available from the cathode through coaxial connector J7, and the negative signal is available from the plate through coaxial connector J8.

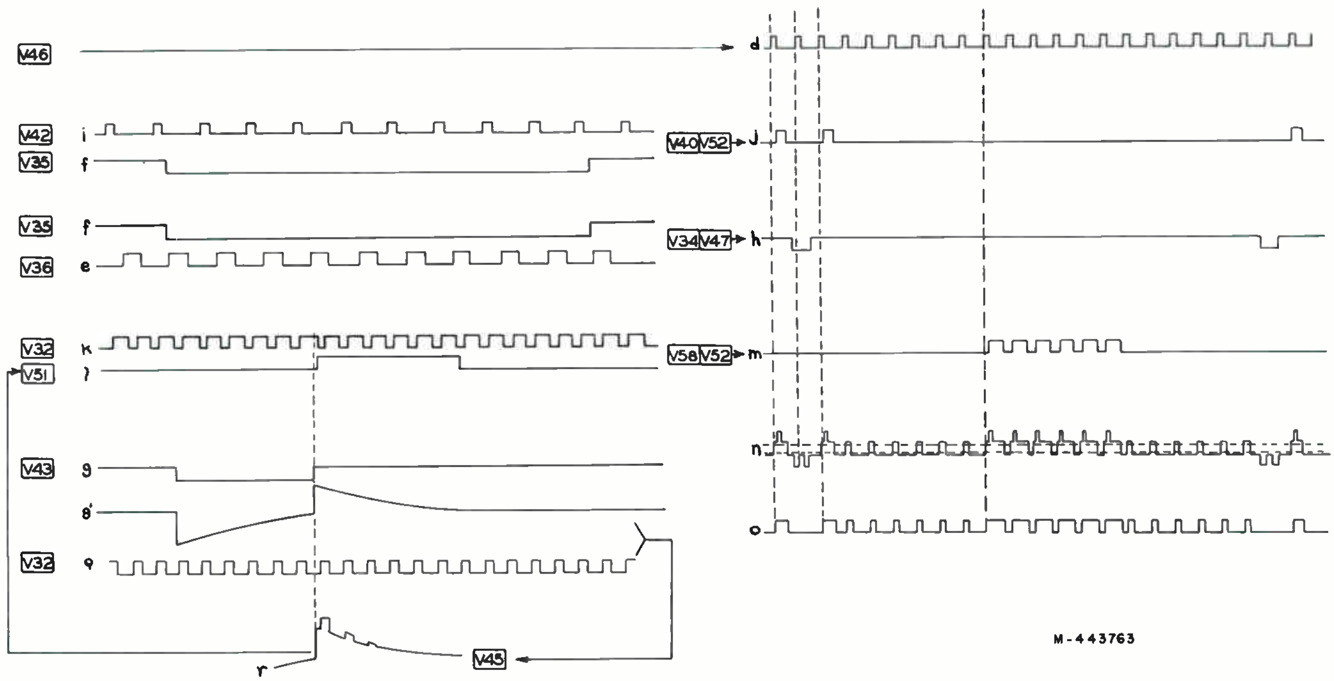



*Figure 2—Development of Synchronizing Signal*

A graphical description of the development of the RMA Synchronizing signal is included under THEORY OF OPERATION.

## THEORY OF OPERATION

### Generating the RMA Synchronizing Signal

The RMA Synchronizing Signal is a combination of 15,750-cycle pulses and 31,500-cycle pulses that recur at a 60-cycle rate. The timing and the width of all pulses must be very stable and accurately controlled.

Figure 2 traces the development of the signal from the final resultant **o** back through the various mixing operations to the originating multivibrator. The diagram shows that wave **o** is obtained by clipping wave **n** along the two dotted lines. Wave **n** is formed by adding together four signals, waves **d, j, h** and **m.** All except wave **d** are formed by combinations of other waveforms.

Pulses of waveform **d** which remain unaltered and become the equalizing pulses, are generated and shaped in tubes V33, V39 and V46. The waveform **h** is the result of adding together waves **f** and **e.** The pulses in wave **e** are generated in the Notching Pulse Multivibrator V36 and are finally used to remove alternate equalizing pulses except during the vertical synchronizing interval. Since the notching pulses are unwanted when the equalizing and vertical synchronizing pulses are present they are removed by wave **f.** The notching pulses are applied to the second control grid of the mixer V34 while the 60-cycle pulse, wave **f,** is applied to the first control grid. The tube is cut off during the pulse of wave **f** but allows wave **e** to pass between pulses. The output of V34 has the waveform **h.**

The pulses in wave **j** are used to form the horizontal synchronizing pulses by combining with the pulses of wave **d.** The front edge of the equalizing pulse, wave **d,** becomes the front edge of the horizontal synchronizing pulse in wave **n.** The horizontal pulses are not used during the vertical synchronizing interval and therefore must be removed during that period. The pulses of wave **i** are generated in tubes V41 and V42 and are applied to the first control grid of the mixer V40. The negative 60-cycle pulse, wave **f,** is used to cut off V40 during the vertical synchronizing interval. The output waveform of V40 after inversion in V52 becomes wave **j.**

As was the case with the horizontal synchronizing pulse, the front edge of the equalizing pulse becomes the front edge of the vertical synchronizing pulse in waveform **n.** Wave **m** is derived by mixing waves **k** and **l** in the mixer V58. Wave **k** is the output waveform of the Vertical Pulse Multivibrator V32 and V38. Wave **l,** however, is generated in a more complex process designed to insure that the series of six vertical pulses shall start with a whole pulse.

Wave **g** is generated in the Vertical Pulse Delay Multivibrator V43 and is differentiated in the RC combination R139-C136 to produce wave **g'** which is applied to one grid of the Mixer V45. Wave **q,** which is simply wave **k** inverted, is applied to another grid of V45. The output is composed of a few narrow pulses from wave **q** keyed in by the differentiated trailing edge of wave **g'.** This output is represented in wave **r,** with phase inversion in V45 ignored. The first narrow negative pulse, whether it is whole or partial, will trigger the Number of Vertical Pulses Multivibrator V51. Therefore V51 may be triggered only during the interval of the narrow pulse, which means during the interval **between** adjacent wide pulses of wave **k.**

The 60-cycle positive pulse **l,** generated by V51, controls the mixer V58 so that the tube conducts only during the pulse. Pulses of wave **k** are applied to another mixer grid. The multivibrator V51 is adjusted so that six whole pulses of wave **k** will appear in the output of V58 to produce wave **m** across the resistor R114.

Waves **d, j, h** and **m** are mixed on a common load resistor, R114, across which waveform **n** appears. The wave **n** is first clipped along the lower dotted line then across the upper dotted line in the two-stage Final Sync. Clipper V53. The output of the clipper, waveform **o,** is applied to the Sync. Output tube V59, from which both positive and negative signals are obtained.

### Counter Circuits

Since all six counter circuits in the Pulse Former perform in a similar manner, it is necessary to describe the operation of only one. The 4500-cycle counter V9-V10 which divides the master oscillator frequency by seven, will be used as the example. In the following discussion, the diode in V9 consisting of the plate at terminal three and the cathode at terminal four will be called the first diode, and the diode consisting of the plate at terminal five and the cathode at terminal eight will be called the second diode.

The 31,500-cycle pulses applied to the grid of V6 are of sufficient amplitude to drive the tube throughout its range from cutoff to saturation. The tube may therefore be considered as a variable resistance ranging from a low value when the positive pulse is on the grid to a very high value when the negative pulse is applied.

Assume that the capacitors C43 and C42 are completely discharged and that the grid of V6 is at maximum positive. The "B" supply voltage is now divided between the low resistance of the tube and plate load resistor R59 causing a minimum voltage $E_{p_1}$ to exist at the plate and across C44.

When the grid is driven beyond cutoff the low plate resistance is removed and the plate voltage goes to a maximum $E_{p_2}$, causing the second diode to conduct and the capacitors C44, C43 and C42 to charge to the new valve $E_{p_2}$. Since C44 already has a charge $E_{p_1}$ only the increment $E_{p_2}$-$E_{p_1}$ will be added to the three capacitor combination. Since the increment will be divided in inverse proportion to capacity only about $\frac{1}{40}$ of it will appear across C43 and C42 at the cathode of the second diode.

When the grid voltage goes positive again, shunting R59 with the low tube resistance, the plate voltage will return to $E_{p_1}$ and the first diode will conduct, discharging C44 back to the value $E_{p_1}$. Since the second diode will not conduct on the negative swing of the plate voltage, the charge on C43 and C42 will remain constant until the plate voltage goes to $E_{p_2}$ again when it will receive a fresh charge only slightly smaller than the first. On an oscilloscope with a time sweep, the voltage on the cathode of the second diode would appear as a series of stair-steps, with each step representing one cycle of the applied voltage. The large capacitor C42, in series with C43, receives a small portion of the total charge across the combination C43-C42, and provides a monitoring signal for the indicator tube V30.

The cathode of the second diode is connected to the grid of the blocking oscillator V10 through the low-impedance winding of transformer T7. Cathode bias for V10 is developed across the bleeder combination consisting of R61, R62 and R63. This bias voltage is set so that the front edge of the seventh step of the counter voltage applied to the grid is sufficient to trigger the blocking oscillator. During the ensuing positive swing of the grid voltage, the grid draws current and discharges capacitor C43, and forces the grid beyond cutoff, where it remains until the tube is triggered by the next series of seven steps.

The grid of the blocking oscillator is directly coupled to the grid of the amplifier, the second triode of V10. This tube is so connected that only the blocking oscillator pulse is amplified. This 4500-cycle pulse is amplified to approximately 230 volts and applied to the next counter diode, V12.

### 60-Cycle Lock-in Circuit

The frequency of the master oscillator V11 is determined by the tank circuit formed by coil assembly T3, capacitor C12 and an automatically adjustable impedance due to the plate current of the reactance tube V15.

The control grid of the reactance tube V15 is excited by the voltage developed across the capacitor C85, which is charged by the current resulting from the oscillator tank voltage applied to the capacity-resistance network C8, R138 and C85. This current is substantially in phase with the tank voltage. Since the voltage developed across the capacity C85 lags the current flowing in it by 90°, the grid voltage and hence the plate current of the reactance tube lags the voltage of the tank circuit. Thus, the output impedance may be considered to have the natue of a virtual inductance, which may be varied over a limited range by changes in the transconductance of the tube, controlled by variation of the effective grid bias of the tube V15.

Bias for the reactance tube is obtained from the 60-cycle lock-in circuit, which compares the 60-cycle output pulse from the counters with the 60-cycle supply voltage, and converts any phase difference into a d-c voltage.

The 60-cycle supply voltage is applied through a 2 to 1 step-down transformer, T1, and a phase shift network, C86 and R1, to the grid of the clipper V3. The 60-cycle square wave output of the clipper is applied to a bridge circuit consisting of four diodes (V1 and V2) and transformer T2. (See Figure 3.) One corner of the bridge is connected to the center arm of the AFC Time Constant switch S3. The

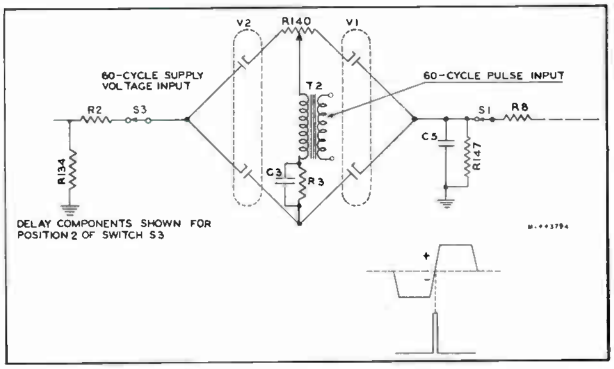



*Figure 3—Lock-in Bridge Circuit*

opposite corner of the bridge is connected to the 60-cycle position of the Frequency Control Switch S1. Since the center arm of S1 is connected to the control grid of the reactance tube V15 through resistor R8, it is possible to insert in the grid return circuit several different resistance-capacitance combinations by use of the four positions of the AFC Time Constant switch S3.

The 60-cycle pulse from the counter circuits is applied to the two remaining corners of the bridge. The pulse is taken from the input of the 60-cycle pulse multivibrator V28 and applied to transformer T2 through the buffer V7. The secondary of T2 is connected in series with the parallel combination R3-C3, across the two corners.

When the 60-cycle pulse occurs all of the diodes are caused to conduct, thus making possible a transfer of current in either direction between the input and output corners of the bridge. The 60-cycle pulse also creates a charge across the combination R3-C3 which is negative toward the double-plate corner of the bridge. This charge keeps the diodes non-conducting during the interval between pulses.

The master oscillator frequency is adjusted to 31,500 cycles when the voltage on the reactance tube is zero. If the frequency is exactly 31,500 cycles, the square wave voltage applied to the bridge will be passing through zero when the pulse from the counters causes the diodes to conduct. No current will pass through the bridge circuit under these conditions.

When the frequency is slightly higher than 31,500 cycles, the resultant 60-cycle pulse will occur sooner, while the square wave voltage is negative. Current will be passed through the bridge, placing a negative charge on capacitor C5 and therefore on the grid of the reactance tube, thereby reducing the mutual conductance which in turn increases the virtual inductance shunted across the tank circuit with a resulting decrease in the frequency of the master oscillator.

A similar action takes place when the frequency falls below 31,500 cycles. The pulses occur after the square wave has passed through zero and is in the positive half of the cycle. Current will pass through the bridge in such a direction as to place a positive charge on the capacitor C5 causing the mutual conductance of the reactance tube to increase and thereby decreasing the virtual inductance shunting the tank circuit thus raising the oscillator frequency.

The speed at which the charge on the reactance tube follows changes in the relation between supply voltage and master oscillator frequencies depends on the size of the R-C combination in the grid return circuit of the reactance tube. Switch S3 provides time constant adjustments which may be used where necessary to match similar time constants in associated equipment.

## SECTION IV
## INSTALLATION

The component chassis of the Synchronizing Generator are mounted securely in the cabinet rack at the factory and are shipped in a single crate. When the front door (MI-30536-G84) and the side panels (MI-30541-G84) are required they are shipped in two separate crates.

Remove the cabinet rack, front door and side panels from the crates. Attach the side panels to the cabinet rack with bolts and nuts along the front and rear of the rack just inside the door. Bolt the front door hinges to the rack and slide the door on to the hinges. Holes are provided in the rack so that the door may be hung to open from either side of the rack.

Loosen the two Dzus fasteners on the 3KP1 tube shield located on the rear of the pulse former chassis and remove the shield. Place the 3KP1 tube in the shield and tighten the two thumbscrews enough to prevent the tube from dropping out of the shield. Fasten the tube and shield to the chassis by means of the Dzus fasteners and place the socket on the tube. When used, the crystal should also be placed in its socket.

Inspect all cable connections to insure continuity of circuits between the various chassis. Connect the 117-volt supply to terminals 1 and 2 of the terminal block located at the bottom of the rack. Measure the voltage at terminals 1 and 2. If there is an appreciable variation in either direction from 117 volts, change the primary connection on each filament transformer to the proper tap to give 6.3 volts across each secondary winding.

Turn the power switch in the regulated power supply to the ON position. Turn the load switch to the position marked 80-400MA.

Turn on the synchronizing generator by closing the circuit breaker S1 in the pulse shaper. Adjust the plate supply voltage to 250 volts.

**Counter Circuit Adjustments**

1. Set the FREQUENCY CONTROL switch to the OFF position.

2. Rotate the COUNTER INDICATOR switch to the 15,750-2 position and adjust the FREQUENCY CONTROL—15,750 PULSES until two dots appear on the indicator tube. Adjust FOCUS control so that dots are large and easy to see. The CRO tube should be biased off with the BRIGHTNESS control when not in use.

**Note:** If the dots are not in a vertical line, loosen the thumbscrews on the 3KP1 tube shield at the rear of the chassis, rotate the tube to the proper position and retighten the screws.

3. Rotate the COUNTER INDICATOR switch to the 4500-7 position and adjust the FREQUENCY CONTROL –4500 PULSES until seven dots appear on the indicator tube.

4. Rotate the COUNTER INDICATOR switch to the 900-5 position and adjust the FREQUENCY CONTROL –900 PULSES until five dots appear on the indicator tube.

5. Rotate the COUNTER INDICATOR switch to the 180-5 position and adjust the FREQUENCY CONTROL –180 PULSES until five dots appear on the indicator tube.

6. Rotate the COUNTER INDICATOR switch to the 60-3 position and adjust the FREQUENCY CONTROL –60 PULSES until three dots appear on the indicator tube.

7. Rotate the COUNTER INDICATOR switch to the 7875-4 position and adjust the FREQUENCY CONTROL –7875 PULSES until four dots appear on the indicator tube.

At this point it is necessary to use a portable oscilloscope for adjusting the 31,500-cycle oscillator to its "on frequency" condition as follows:

1. Connect a 60-cycle sine wave source of suitable amplitude to the horizontal deflection terminals of the oscilloscope.

2. Connect the 60-cycle pulse output of the synchronizing generator to the vertical deflection terminals then proceed as follows:

a. Adjust the plug in the oscillator transformer (T3) to the extreme clockwise position.

b. Set the AFC TIME CONSTANT switch to position 4 and the FREQUENCY CONTROL switch to the 60-cycle position.

c. Connect a vacuum tube voltmeter across C5, and observe the voltage. Adjust R140 until the voltage is zero.

d. Operate the FREQUENCY CONTROL switch to the OFF position.

3. Adjust the plug in the oscillator transformer T3 until the 60-cycle pulse from the synchronizing generator remains approximately stationary. The 31,500-cycle oscillator is now on frequency.

4. Set the FREQUENCY CONTROL switch (top of cabinet) to the 60-cycle position.

Check the frequency of the 30-cycle multivibrator by observing the output pulse on an oscilloscope with a 60-cycle sine wave sweep, or by using an external oscillator of known frequency for comparison.

5. Set the CRO-SYNC switch to the OFF position.

**Pulse Circuit Adjustments**

Six adjustments are necessary to obtain the desired synchronizing signal. Observe the signal at pin [illegible] of V53 and adjust the CLIPPING LEVEL CONTROL (R114) to the position at which the amplitude is 22.5 volts peak-to-peak. The following adjustments should be made while observing the signal.

1. Adjust the NUMBER OF EQUALIZING PULSES control until the total of equalizing and vertical synchronizing pulses equals eighteen.

2. Adjust the VERTICAL PULSE DELAY control until six equalizing pulses occur before the first vertical synchronizing pulse.

3. Adjust the NUMBER OF VERTICAL PULSES control until six vertical synchronizing pulses appear in the vertical synchronizing pulse interval.

The remaining three adjustments should be made while observing the synchronizing signal across the 75-ohm termination. Adjust the width of the equalizing pulse, the vertical pulse and the horizontal pulse by means of the respective designated controls located at the top of the pulse shaper. See Figure 4 and Appendix I for RMA standard pulse width measurements.

Check the amplitude of all output pulses. All pulses should read 4 volts peak-to-peak. (See ELECTRICAL CHARACTERISTICS.)

Adjust the vertical driving, horizontal driving, vertical and horizontal blanking pulses to the required width by rotating the corresponding width controls located at the top of the pulse shaper. (For most uses it is recommended that the vertical and horizontal driving widths be 0.04V and 0.10H respectively.) These adjustments should be made while observing the signals which appear across the 75-ohm output terminations.

No pulse width adjustments are necessary for the CRO Synchronizing signal, but an amplitude check should be made.

Several methods of measuring the width of pulses are explained in Appendix I.

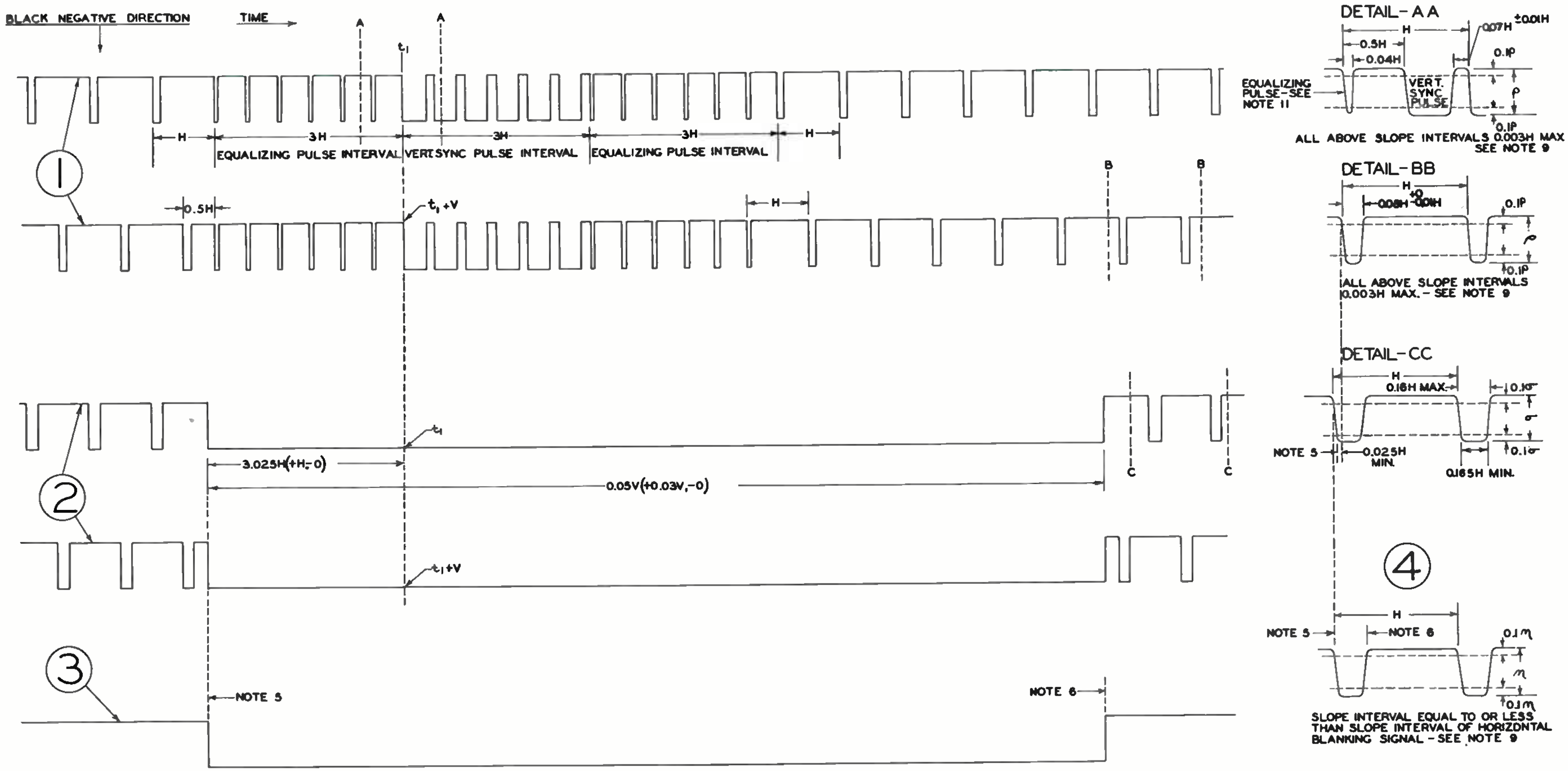
**Phase Shift Control**

When motion picture films are used as program material in conjunction with an intermittent

# RECOMMENDED SYNCHRONIZING GENERATOR WAVEFORMS

1- SYNCHRONIZING SIGNAL 2- BLANKING SIGNAL 3-VERTICAL DRIVING SIGNAL 4- HORIZONTAL DRIVING SIGNAL

ALL SIGNAL AMPLITUDES TO BE MORE THAN 3.5 VOLTS AND LESS THAN 8.0 VOLTS ACROSS 75 OHMS. BOTH SIGNAL POLARITIES SHALL BE AVAILABLE. POSITIVE POLARITY NOT SHOWN AND PULSE WIDTHS NOT TO SCALE.




NOTE:-

1- H=TIME FROM START OF ONE LINE TO START OF NEXT LINE.
2- V=TIME FROM START OF ONE FIELD TO START OF NEXT FIELD.
3- LEADING AND TRAILING EDGES OF VERTICAL DRIVING AND VERTICAL BLANKING SIGNALS SHOULD BE COMPLETE IN LESS THAN 0.1H.
4- ALL TOLERANCES AND LIMITS SHOWN IN THIS DRAWING APPLY FOR LONG TIME VARIATIONS ONLY AND NOT FOR SUCCESSIVE CYCLES.
5- TIMING ADJUSTMENT, IF ANY, MUST INCLUDE THIS CONDITION.
6- HORIZONTAL AND VERTICAL DRIVING PULSE WIDTHS ARE ADJUSTABLE FROM ONE HALF TO ONE TIMES THEIR RESPECTIVE BLANKING PULSE WIDTHS.
7- THE TIME RELATIONSHIP AND WAVEFORM OF THE BLANKING AND SYNCHRONIZING SIGNALS SHALL BE SUCH THAT THEIR ADDITION WILL RESULT IN A STANDARD RMA SIGNAL. THE TIME RELATIONSHIP MAY BE ADJUSTABLE BUT MUST INCLUDE THIS CONDITION.
8- THE STANDARD RMA VALUES OF FREQUENCY AND RATE OF CHANGE OF FREQUENCY FOR THE HORIZONTAL COMPONENTS OF THE SYNCHRONIZING SIGNAL AT THE OUTPUT OF THE PICTURE LINE AMPLIFIER SHALL ALSO APPLY TO THE HORIZONTAL COMPONENTS OF THE OUTPUT SIGNALS FROM THE RECOMMENDED SYNCHRONIZING GENERATOR.
9- ALL SLOPE INTERVALS TO BE MEASURED BETWEEN 0.1 AND 0.9 AMPLITUDE REFERENCE LINES.
10- THE TIME OF OCCURRENCE OF THE LEADING EDGE OF ANY HORIZONTAL PULSE 'N' OF ANY GROUP OF TWENTY HORIZONTAL PULSES APPEARING ON ANY OF THE OUTPUT SIGNALS FROM A RECOMMENDED SYCHRONIZING GENERATOR SHALL NOT DIFFER FROM 'NH' BY MORE THAN 0.0008H WHERE H IS THE AVERAGE INTERVAL BETWEEN THE LEADING EDGES OF THE PULSES AS DETERMINED BY AN AVERAGING PROCESS CARRIED OUT OVER A PERIOD OF NOT LESS THAN 20 NOR MORE THAN 100 LINES.
11- EQUALIZING PULSE AREA SHALL BE BETWEEN 0.45 AND 0.5 OF THE AREA OF A HORIZONTAL SYNC. PULSE.
12- THE OVERSHOOT ON ANY OF THE PULSES MUST NOT EXCEED 2%.

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APPROVED JAN 22.1946
REVISED OCT. 9, 1946

*Figure 4—Standard Synchronizing Generator Waveforms*

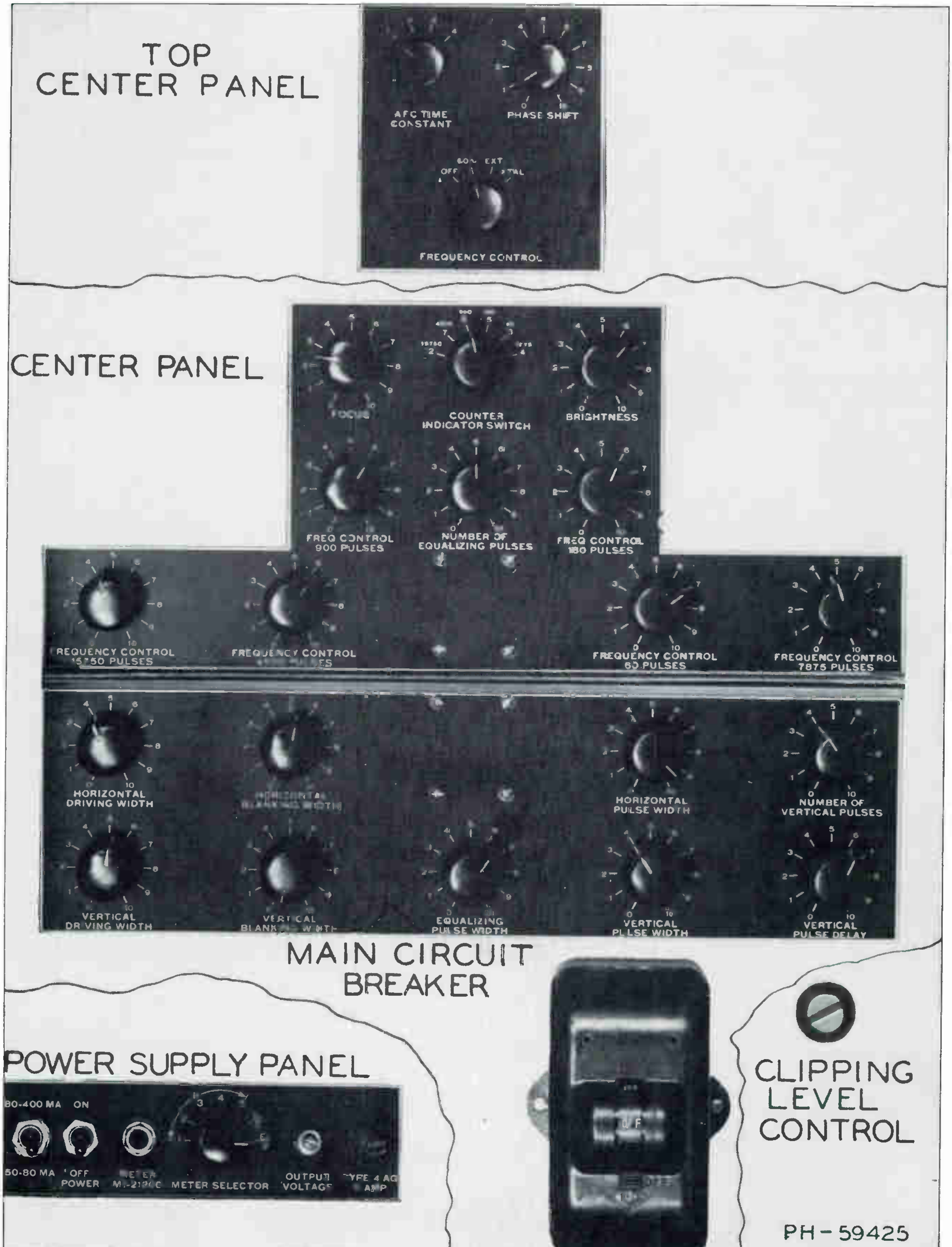



*Figure 5—Controls*

type film projector and iconoscope film camera it is necessary that the film projector be synchronous and phased with the iconoscope-deflection system within approximately 4 degrees, so that the period during which the projector shutter exposes the iconoscope to light falls within the interval of the vertical blanking pulse. If this requirement is not fulfilled spurious light streaks will appear in the transmitted picture because of the abrupt light change on the mosaic during the time it is being scanned. The above condition is established by driving the projector with a synchronous motor operating on the same 60-cycle power system as the synchronizing generator.

As explained elsewhere in this manual (under DESCRIPTION) the 60-cycle output of the synchronizing generator is compared and automatically adjusted to the frequency of the 60-cycle power supply system. It is therefore necessary only to adjust the phase of the synchronizing pulses of the synchronizing generator relative to that of the 60-cycle supply so that the projector shutter opening occurs at the proper time as pointed out above. The Phase Shift control R-1 at the top of the synchronizing generator provides the means for this adjustment.

Provision is made for connecting in a remote phase shift control at terminals #3 and #4 of the terminal board at the rear of the bottom panel of the synchronizing generator. The jumper must be removed from these terminals when using such remote control.

# SECTION V
# OPERATION

### TO START THE EQUIPMENT

1. Place the circuit breaker on the Pulse Shaper panel in the ON position.

2. Place the power switch on the Regulated Power Supply panel in the ON position.

The generator should be in normal operation within one and one-half minutes.

### TO CHECK THE COUNTER CIRCUITS

1. Rotate the FREQUENCY CONTROL switch (top of cabinet) to the OFF position.

2. Rotate the COUNTER INDICATOR switch to each of its six positions, noting the number of dots on the indicator for each position. The number of dots in each case should correspond to the lower (single digit) number stencilled at each switch position.

### TO STOP THE EQUIPMENT

1. Place the circuit breaker in the OFF position.

### TERMINATING POSITIVE OUTPUT CONNECTORS

When using the NEGATIVE output from any of the dual output terminals, terminate the corresponding POSITIVE output terminal with a special 75-ohm connector plug. The plugs are furnished with the equipment.

# SECTION VI
# MAINTENANCE

All circuits have been designed so that the associated tubes and components are operating with a conservative safety factor, thus insuring a long life for tubes and components and a minimum of circuit failure.

When it is necessary to service the generator, it is usually possible to make repairs with the chassis mounted in the cabinet.

**WARNING:** VOLTAGES USED IN SOME CIRCUITS OF THE SYNCHRONIZING GENERATOR ARE DANGEROUS TO LIFE. EXTREME CARE SHOULD BE EXERCISED WHEN MAKING VOLTAGE MEASUREMENTS. SHOULD IT BECOME NECESSARY TO REPLACE A COMPONENT, THE CIRCUIT BREAKER SHOULD BE OPENED BEFORE ANY WORK IS BEGUN. HIGH VOLTAGE FOR THE CRO IS INTERLOCKED ON THE REAR DOOR.

The amplitude and pulse widths of the output signals should be checked periodically as aging of tubes may cause some small variation. Also aging of tubes may cause unwanted pulses to appear in the positive region of the output signal. This may be overcome by adjusting the clipping level control.

In most cases failure of the equipment will be traceable to tube failure. The following table lists typical symptoms of failure and suggested remedies. If a failure is traced to a definite circuit and the tube is not found defective, check the associated circuit components.

## TROUBLE SHOOTING CHART

| Symptom | Check |
|---|---|
| No signal at any output terminal. | Plate supply. V11 and V8. |
| All horizontal (15,750-cycle) signals absent. | V14, V19 and V18. |
| All vertical (60-cycle) signals absent. | V6, V9, V10, V12, V13, V16, V17, V20, V24.<br><br>**Note:** The defective counter circuit may be isolated by turning the FREQUENCY CONTROL switch to the OFF position and checking each counter on the Indicator tube. One dot on the screen indicates defective counter. |
| No spot on Indicator with BRIGHTNESS control at full clockwise. | Continuity of V30 heater.<br>V30 heater voltage.<br>(**Caution:** HEATER is 1000 volts negative to ground.)<br>Measure negative high voltage.<br>Continuity of V4 heater. |
| No vertical deflection in Indicator. | V5. |
| No vertical driving signal. | V49 and V55. |
| No horizontal driving signal. | V54 and V60. |
| No blanking signal. | V56, V50, V44, V48 and V37. |
| No horizontal blanking signal. | V48. |
| No vertical blanking signal. | V37. |
| No synchronizing signal. | V53 and V59. |
| No equalizing pulses. | V31, V33, V39 and V46. |
| Horizontal sync. pulse half normal width; HORIZONTAL PULSE WIDTH control ineffective. | V35, V41, V42, V40 and V52. |
| Horizontal pulses appear where equalizing pulses should appear. | V28 and V35. |
| Equalizing pulses appear between horizontal pulses. | V36, V34 and V47. |
| Unwanted pulses in positive region in sync. output. | Adjust Clipping Level Control. |
| No CRO signal. | V26 and V57. |
| No 7875-cycle signal in CRO. | V22, V23 and V27. |
| No 30-cycle signal in CRO. | V21, V25 and V29. |

## D-C VOLTAGE CHART FOR STUDIO PULSE FORMER

D-C SUPPLY 250 VOLTS — LINE VOLTAGE, 117 VOLTS, A-C — FILAMENT VOLTAGE, 6.3 VOLTS A-C

| TUBE | | | PLATE | | | GRID | | | CATHODE | | | SCREEN | | | TUBE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOL | TYPE | FUNCTION | OPERATING CONDITIONS | | | OPERATING CONDITIONS | | | OPERATING CONDITIONS | | | OPERATING CONDITIONS | | | TYPE | SYMBOL |
| | | | PIN | NORMAL | NO SIGNAL | PIN | NORMAL | NO SIGNAL | PIN | NORMAL | NO SIGNAL | PIN | NORMAL | NO SIGNAL | | |
| V1 | 6H6 | DISCRIMINATOR | 3 | -6.6 | 1.4 | — | — | — | 4 | 0 | 2.0 | — | — | — | 6H6 | V1 |
| | | | 5 | 0 | 2.0 | — | — | — | 8 | 28.5 | 2.5 | — | — | — | | |
| V2 | 6H6 | DISCRIMINATOR | 3 | -6.6 | 0.7 | — | — | — | 4 | 0 | 0 | — | — | — | 6H6 | V2 |
| | | | 5 | 0 | 0 | — | — | — | 8 | 28.5 | 2.5 | — | — | — | | |
| V3 | 6SL7-GT | CRYSTAL OSCILLATOR & CLIPPER | 2 | 238 | 211 | 1 | -88 | -0.56 | 3 | 0 | 0.03 | — | — | — | 6SL7-GT | V3 |
| | | | 5 | 242 | — | 4 | -13.2 | — | 6 | 0 | — | — | — | — | | |
| V4 | 1B3-GT/ 8016 | HIGH VOLTAGE RECTIFIER | † | -980 | — | — | — | — | — | 180 | — | — | — | — | 1B3-GT/ 8016 | V4 |
| V5 | 6SL7-GT | AMPLIFIER | 2 | 155 | 180 | 1 | 0 | 0 | 3 | 1.43 | 1.47 | — | — | — | 6SL7-GT | V5 |
| | | | 5 | 150 | 185 | 4 | 0 | 0 | 6 | 1.43 | 1.47 | — | — | — | | |
| V6 | 6AC7 | BUFFER | 8 | 211 | 226 | 4 | -0.5 | — | 5 | 3.5 | 2.42 | 6 | 100 | 165 | 6AC7 | V6 |
| V7 | 6AC7 | BUFFER | 8 | 250 | 250 | 4 | -0.6 | -0.72 | 5 | 0.1 | 0.1 | 6 | 72 | 62.3 | 6AC7 | V7 |
| V8 | 6SN7-GT | CLIPPER | 2 | 133 | 144 | 1 | -58 | 0 | 3 | 3.58 | 3.15 | — | — | — | 6SN7-GT | V8 |
| | | | 5 | 170 | 100 | 4 | -52 | -0.38 | 6 | 0.05 | 0.1 | — | — | — | | |
| V9 | 6H6 | COUNTER | 3 | 0 | 0 | — | — | — | 4 | 2.9 | 1.23 | — | — | — | 6H6 | V9 |
| | | | 5 | 2.9 | 1.23 | — | — | — | 8 | 7.6 | 1.32 | — | — | — | | |
| V10 | 6SN7-GT | BLOCKING OSCILLATOR & AMPLIFIER | 2 | 78 | 210 | 1 | 7.6 | 0 | 3 | 17.5 | 14.2 | — | — | — | 6SN7-GT | V10 |
| | | | 5 | 200 | 238 | 4 | 7.6 | 0 | 6 | 17.5 | 14.2 | — | — | — | | |
| V11 | 6SN7-GT | 31.5KC OSCILLATOR | 2 | 190 | — | 1 | -15 | — | 3 | 15 | — | — | — | — | 6SN7-GT | V11 |
| | | | 5 | 220 | — | 4 | 0 | — | 6 | 15 | — | — | — | — | | |
| V12 | 6H6 | COUNTER | 3 | 0 | 0 | — | — | — | 4 | 3.5 | 1.25 | — | — | — | 6H6 | V12 |
| | | | 5 | 3.5 | 1.25 | — | — | — | 8 | 12 | 1.82 | — | — | — | | |
| V13 | 6SN7-GT | BLOCKING OSCILLATOR & AMPLIFIER | 2 | 169 | 216 | 1 | 12 | 0 | 3 | 34 | 32 | — | — | — | 6SN7-GT | V13 |
| | | | 5 | 248 | 248 | 4 | 12 | 0 | 6 | 34 | 32 | — | — | — | | |
| V14 | 6AC7 | BUFFER | 8 | 215 | 224 | 4 | -0.2 | 0 | 5 | 3.8 | 2.45 | 6 | 88 | 157 | 6AC7 | V14 |
| V15 | 6AC7 | REACTANCE TUBE | 8 | 215 | 225 | 4 | 0.4 | 0.18 | 5 | 3.14 | 3.28 | 6 | 130 | 128 | 6AC7 | V15 |
| V16 | 6H6 | COUNTER | 3 | 0 | 0 | — | — | — | 4 | 3.9 | 1.10 | — | — | — | 6H6 | V16 |
| | | | 5 | 3.9 | 1.1 | — | — | — | 8 | 13.2 | 1.11 | — | — | — | | |
| V17 | 6SN7-GT | BLOCKING OSCILLATOR & AMPLIFIER | 2 | 204 | 216 | 1 | 15 | 0 | 3 | 35.6 | 34.6 | — | — | — | 6SN7-GT | V17 |
| | | | 5 | 250 | 247 | 4 | 15 | 0 | 6 | 35.6 | 34.6 | — | — | — | | |
| V18 | 6SN7-GT | BLOCKING OSCILLATOR & AMPLIFIER | 2 | 31.2 | 125 | 1 | 1.87 | -5.1 | 3 | 6.38 | 57 | — | — | — | 6SN7-GT | V18 |
| | | | 5 | 131 | 108 | 4 | -3.48 | 0 | 6 | 6.38 | 57 | — | — | — | | |
| V19 | 6H6 | COUNTER | 3 | 0 | 0 | — | — | — | 4 | 1.0 | 0.51 | — | — | — | 6H6 | V19 |
| | | | 5 | 1.0 | 0.51 | — | — | — | 8 | 1.85 | 1.28 | — | — | — | | |
| V20 | 6H6 | COUNTER | 3 | 0 | 0 | — | — | — | 4 | 1.43 | 1.33 | — | — | — | 6H6 | V20 |
| | | | 5 | 1.43 | 1.33 | — | — | — | 8 | 7.5 | 1.75 | — | — | — | | |
| V21 | 6SL7-GT | BUFFER | 2 | 250 | 250 | 1 | 9.5 | 9.15 | 3 | 17 | 14.9 | — | — | — | 6SL7-GT | V21 |
| | | | 5 | 233 | 234 | 4 | -0.75 | -0.02 | 6 | 0.03 | 0.03 | — | — | — | | |
| V22 | 6SN7-GT | BUFFER | 2 | 132 | 112 | 1 | 5.7 | 7.92 | 3 | 8.35 | 8.3 | — | — | — | 6SN7-GT | V22 |
| | | | 5 | 250 | 250 | 4 | 0.1 | 0 | 6 | 8.35 | 8.3 | — | — | — | | |
| V23 | 6H6 | COUNTER | 3 | 0 | 0 | — | — | — | 4 | 3.0 | 0.65 | — | — | — | 6H6 | V23 |
| | | | 5 | 3.0 | 0.65 | — | — | — | 8 | 5.0 | 3.2 | — | — | — | | |
| V24 | 6SN7-GT | BLOCKING OSCILLATOR & AMPLIFIER | 2 | 178 | 218 | 1 | 7.7 | 0 | 3 | 25.2 | 24.2 | — | — | — | 6SN7-GT | V24 |
| | | | 5 | 242 | 250 | 4 | 7.7 | 0 | 6 | 25.2 | 24.2 | — | — | — | | |
| V25 | 6SL7-GT | MULTIVIBRATOR | 2 | 200 | 223 | 1 | -30.5 | -25.2 | 3 | 0 | 0 | — | — | — | 6SL7-GT | V25 |
| | | | 5 | 192 | 175 | 4 | -15.3 | -8.3 | 6 | 0 | 0 | — | — | — | | |
| V26 | 6SL7-GT | MIXER | 2 | 185 | 200 | 1 | 0 | 0 | 3 | 1.48 | 1.19 | — | — | — | 6SL7-GT | V26 |
| | | | 5 | 185 | 200 | 4 | -0.2 | 0 | 6 | 1.9 | 1.37 | — | — | — | | |
| V27 | 6SN7-GT | BLOCKING OSCILLATOR & AMPLIFIER | 2 | 114 | 119 | 1 | 0.1 | 0 | 3 | 12.5 | 7.1 | — | — | — | 6SN7-GT | V27 |
| | | | 5 | 52 | 190 | 4 | 5.0 | -19.2 | 6 | 11.5 | 8.85 | — | — | — | | |
| V28 | 6SL7-GT | MULTIVIBRATOR | 2 | 188 | 190 | 1 | -13.7 | -6.0 | 3 | 0 | 0 | — | — | — | 6SL7-GT | V28 |
| | | | 5 | 172 | 172 | 4 | -0.8 | -0.15 | 6 | 0 | 0.02 | — | — | — | | |
| V29 | 6SL7-GT | MULTIVIBRATOR | 2 | 155 | 154 | 1 | -4.2 | -3.1 | 3 | 0 | 0.01 | — | — | — | 6SL7-GT | V29 |
| | | | 5 | 238 | 240 | 4 | -26.8 | -26.0 | 6 | 0 | 0 | — | — | — | | |
| V30 | 3KP1 | INDICATOR | * | 0 | | | -930 | | — | -900 | — | ** | -575 | — | 3KP1 | V30 |

ALL D-C VOLTAGE MEASUREMENTS MADE WITH AN RCA VOLTOHMYST, JR.

† VOLTAGE AT TUBE CAP

* SECOND ANODE

** FIRST ANODE

P-735662

*Figure 6—Pulse Former, D-C Voltage Chart*

# D-C VOLTAGE CHART FOR STUDIO PULSE SHAPER

D-C SUPPLY 250 VOLTS — LINE VOLTAGE, 117 VOLTS — FILAMENT VOLTAGE, 6.3 VOLTS, A-C

| TUBE | | | PLATE | | | GRID | | | CATHODE | | | SCREEN | | | TUBE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | OPERATING CONDITIONS | | | OPERATING CONDITIONS | | | OPERATING CONDITIONS | | | OPERATING CONDITIONS | | | | |
| SYMBOL | TYPE | FUNCTION | PIN | NORMAL | NO SIGNAL | PIN | NORMAL | NO SIGNAL | PIN | NORMAL | NO SIGNAL | PIN | NORMAL | NO SIGNAL | TYPE | SYMBOL |
| V31 | 6SN7-GT | BUFFER | 2 | 250 | 250 | 1 | 0 | 0 | 3 | 11.2 | 10.7 | — | — | — | 6SN7-GT | V31 |
| | | | 5 | 250 | 250 | 4 | 0 | 0 | 6 | 8.7 | 8.8 | — | — | — | | |
| V32 | 6AC7 | PART OF VERTICAL PULSE MULTIVIBRATOR | 8 | 190 | 179 | 4 | -10.5 | -0.6 | 5 | .03 | 0.11 | 6 | 46.3 | 56.7 | 6AC7 | V32 |
| V33 | 6AC7 | PART OF EQUALIZING PULSE MULTIVIBRATOR | 8 | 185 | 157 | 4 | -5.1 | -0.2 | 5 | 0 | 0.08 | 6 | 38.5 | 64.8 | 6AC7 | V33 |
| V34 | 6L7 | MIXER | 3 | 185 | 177 | 5* | -4.5 | -0.2 | 8 | 0.1 | 0.07 | 4 | 85 | 85 | 6L7 | V34 |
| V35 | 6SL7-GT | CLIPPER AND BUFFER | 2 | 250 | 250 | 1 | 15.8 | 12.5 | 3 | 17.3 | 14.4 | — | — | — | 6SL7-GT | V35 |
| | | | 5 | 248 | 233 | 4 | -11.4 | -0.4 | 6 | 0 | 0.05 | — | — | — | | |
| V36 | 6SL7-GT | NOTCHING PULSE MULTIVIBRATOR | 2 | 155 | 161 | 1 | -2.88 | 27 | 3 | 0 | 0.03 | — | — | — | 6SL7-GT | V36 |
| | | | 5 | 158 | 165 | 4 | -4.7 | -3.35 | 6 | 0 | 0 | — | — | — | | |
| V37 | 6SL7-GT | VERTICAL BLANKING MULTIVIBRATOR | 2 | 145 | 165 | 1 | -0.7 | 2 | 3 | 0.05 | 0.02 | — | — | — | 6SL7-GT | V37 |
| | | | 5 | 165 | 183 | 4 | -18.3 | -8.0 | 6 | 0 | 0 | — | — | — | | |
| V38 | 6AC7 | PART OF VERTICAL PULSE MULTIVIBRATOR | 8 | 118 | 105 | 4 | -0.7 | 0 | 5 | 0.1 | 0.12 | 6 | 46.3 | 56.8 | 6AC7 | V38 |
| V39 | 6AC7 | PART OF EQUALIZING PULSE MULTIVIBRATOR | 8 | 175 | 177 | 4 | -0.5 | -0.1 | 5 | 0.1 | 0.1 | 6 | 39 | 47 | 6AC7 | V39 |
| V40 | 6L7 | MIXER | 3 | 245 | 242 | 5* | -1.0 | -0.35 | 8 | 0 | 0.01 | 4 | 83 | 23.3 | 6L7 | V40 |
| V41 | 6AC7 | PART OF HORIZONTAL PULSE MULTIVIBRATOR | 8 | 198 | 188 | 4 | -6.25 | -0.35 | 5 | 0.02 | 0.11 | 6 | 49 | 56 | 6AC7 | V41 |
| V42 | 6AC7 | PART OF HORIZONTAL PULSE MULTIVIBRATOR | 8 | 155 | 137 | 4 | -0.45 | -0.1 | 5 | 0.1 | 0.11 | 6 | 49 | 61 | 6AC7 | V42 |
| V43 | 6SL7-GT | VERTICAL PULSE DELAY MULTIVIBRATOR | 2 | 155 | 163 | 1 | 0.5 | 0.1 | 3 | 0 | 0.03 | — | — | — | 6SL7-GT | V43 |
| | | | 5 | 175 | 181 | 4 | -13.8 | -3.3 | 6 | 0 | 0 | — | — | — | | |
| V44 | 6SL7-GT | BLANKING MIXER AND CLIPPER | 2 | 247 | 233 | 1 | -4.03 | -0.38 | 3 | 0 | 0.04 | — | — | — | 6SL7-GT | V44 |
| | | | 5 | 247 | 233 | 4 | -8.25 | -0.38 | 6 | 0 | 0.05 | — | — | — | | |
| V45 | 6L7 | MIXER | 3 | 249 | 249 | 5* | 0 | 0 | 8 | 14.2 | 11.9 | 4 | 58.5 | 85.9 | 6L7 | V45 |
| V46 | 6SL7-GT | SYNC MIXER AND CLIPPER | 2 | 222 | 221 | 1 | -1.15 | -0.33 | 3 | 0.05 | 0.04 | — | — | — | 6SL7-GT | V46 |
| | | | 5 | 249 | 236 | 4 | -13.7 | -0.38 | 6 | 0 | 0.04 | — | — | — | | |
| V47 | 6SL7-GT | SYNC MIXER AND CLIPPER | 2 | 247 | 243 | 1 | -9.8 | -0.34 | 3 | 0 | 0.04 | — | — | — | 6SL7-GT | V47 |
| | | | 5 | 222 | 220 | 4 | -3.95 | -0.53 | 6 | 0 | 0.03 | — | — | — | | |
| V48 | 6SL7-GT | HORIZONTAL BLANKING MULTIVIBRATOR | 2 | 162 | 161 | 1 | -0.98 | -0.78 | 3 | 0.05 | 0.02 | — | — | — | 6SL7-GT | V48 |
| | | | 5 | 164 | 164 | 4 | -2.7 | -2.57 | 6 | 0 | 0.02 | — | — | — | | |
| V49 | 6SL7-GT | VERTICAL DRIVE MULTIVIBRATOR | 2 | 133 | 112 | 1 | -0.3 | 0.48 | 3 | 0.03 | 0.05 | — | — | — | 6SL7-GT | V49 |
| | | | 5 | 182 | 146 | 4 | -16 | -3.2 | 6 | 0 | 0.02 | — | — | — | | |
| V50 | 6SL7-GT | BLANKING CLIPPER | 2 | 205 | 205 | 1 | -3.7 | -0.7 | 3 | 0.02 | 0.02 | — | — | — | 6SL7-GT | V50 |
| | | | 5 | 205 | 205 | 4 | -3.7 | -0.7 | 6 | 0.02 | 0.02 | — | — | — | | |
| V51 | 6SL7-GT | NUMBER OF VERTICAL PULSES MULTIVIBRATOR | 2 | 162 | 162 | 1 | 0.13 | 0.25 | 3 | 0.04 | 0.03 | — | — | — | 6SL7-GT | V51 |
| | | | 5 | 180 | 180 | 4 | -9.6 | -3.58 | 6 | 0 | 0 | — | — | — | | |
| V52 | 6SL7-GT | SYNC MIXER AND CLIPPER | 2 | 222 | 218 | 1 | -1.03 | -0.35 | 3 | 0.02 | 0.03 | — | — | — | 6SL7-GT | V52 |
| | | | 5 | 222 | 218 | 4 | -0.55 | -0.4 | 6 | 0.02 | 0.03 | — | — | — | | |
| V53 | 6SN7-GT | SYNC CLIPPER | 2 | 235 | 125 | 1 | -16.8 | -0.4 | 3 | 0.01 | 0.15 | — | — | — | 6SN7-GT | V53 |
| | | | 5 | 138 | 140 | 4 | -3.15 | -1.5 | 6 | 0.11 | 0.1 | — | — | — | | |
| V54 | 6SL7-GT | HORIZONTAL DRIVE MULTIVIBRATOR | 2 | 111 | 113 | 1 | -0.25 | -0.47 | 3 | 0.06 | 0.04 | — | — | — | 6SL7-GT | V54 |
| | | | 5 | 130 | 147 | 4 | -4.1 | -3.25 | 6 | 0.02 | 0.01 | — | — | — | | |
| V55 | 6AG7 | VERTICAL DRIVE OUTPUT | 8 | 208 | 94 | 4 | -23 | 0 | 5 | 0.67 | 2.35 | 6 | 208 | 208 | 6AG7 | V55 |
| V56 | 6AG7 | BLANKING OUTPUT | 8 | 210 | 204 | 4 | -25.8 | 0 | 5 | 6.15 | 7.35 | 6 | 236 | 235 | 6AG7 | V56 |
| V57 | 6AG7 | CRO SYNC OUTPUT | 8 | 220 | 182 | 4 | -9.5 | 0.05 | 5 | 16 | 4.68 | 6 | 220 | 182 | 6AG7 | V57 |
| V58 | 6L7 | MIXER | 3 | 248 | 250 | 5* | 0 | 0 | 8 | 6.85 | 5.67 | 4 | 70 | 47 | 6L7 | V58 |
| V59 | 6AG7 | SYNC OUTPUT | 8 | 229 | 202 | 4 | -91 | 0.4 | 5 | 3.25 | 7.9 | 6 | 250 | 250 | 6AG7 | V59 |
| V60 | 6AG7 | HORIZONTAL DRIVE OUTPUT | 8 | 222 | 199 | 4 | -18.5 | 0 | 5 | 4.3 | 7.93 | 6 | 250 | 250 | 6AG7 | V60 |

ALL D-C VOLTAGE MEASUREMENTS MADE WITH RCA VOLTOHMYST, JR.

* GRID CAP VOLTAGE

P-775664

| TUBE | NORMAL | NO SIGNAL |
|---|---|---|
| V34 | -1.4 | -0.56 |
| V40 | -1.0 | 0 |
| V45 | 0 | 0 |
| V58 | -6.0 | 0 |

*Figure 7—Pulse Shaper, D-C Voltage Chart*

# APPENDIX I

## Methods of Measuring High Frequency Pulse Width

### Microsecond Markers

A convenient method of measuring 31,500- and 15,750-cycle pulse involves the use of an RCA Type 715-A Oscilloscope or an equivalent which has a horizontal sweep on which it is possible to place one microsecond markers.

External synchronizing should be used on the oscilloscope to insure a wide phase shift of the pulse to be measured with respect to the marker pulses. The signal for synchronizing can be obtained from the delay line in the pulse shaper. The pulse to be measured should be applied to the vertical amplifier, and the synchronizing gain control adjusted until the start of the pulse coincides with one of the one microsecond markers. The pulse width can then be determined by counting the number of markers that occur during the pulse.

There is some chance for error in this method because it is necessary to estimate the time between adjacent markers when the end of the pulse is not coincident with a marker.

### Sine Wave Sweep

A 15,750-cycle sine wave which is synchronous with the pulses to be measured may be used for horizontal deflection of the oscilloscope. The pulse to be measured is applied to the vertical amplifier and phased so that the pulse occurs during the most linear portion of the sine wave.

The picture on the screen of the oscilloscope is an end view of a circle with an arc dropped from it due to the occurrence of the pulse. Since the pulse occurs during the most linear portion of the sine wave sweep, the length of the chord subtended by the arc appears in true length on the screen. The circumference of the circle can be determined by multiplying the length of the sweep (the diameter of the circle) by Pi.

The width of the pulse in per cent is determined by the following equation:

$$\%\ \text{width} = \frac{\text{length of arc}}{\text{circumference}} \times 100$$

Let $c$ = the length of the chord

$d$ = the diameter of the circle

$\theta$ = the angle subtended at the center of the circle by the arc expressed in radians

From the geometry of a circle:

$$\text{length of arc} = \frac{d\theta}{2}$$

$$\text{and } \theta = 2 \text{ arcsine } \frac{c}{d}$$

$$\text{and length of arc} = d \text{ arcsine } \frac{c}{d}$$

therefore % width =

$$\frac{d \text{ arcsine } \frac{c}{d}}{\pi d} \times 100 = \frac{\text{arcsine } \frac{c}{d}}{\pi} \times 100$$

or in terms of degrees,

$$= \frac{\text{arcsine } \frac{c}{d}}{180°} \times 100$$

For very small angles the sine is equal to the angle expressed in radians. The difference between the sine of the angle and the angle is very small for angles encountered in synchronizing generator pulse measurements. This difference may be neglected and the equation for % width becomes

$$\%\ \text{width} = \frac{c}{\pi d} \times 100$$

### Duration of Pulses in Microseconds

(H = 63.5 microseconds)

| Pulse | Time in Microseconds |
|---|---|
| Horizontal Sync. | 5.08 ± 0.6 |
| Vertical Sync. | 27.5 ± 0.6 |
| Vertical Serration | 4.45 ± 0.6 |
| Horizontal Blanking | 10.5 to 11.4 |
| Horizontal Drive | 5.25 to 11.4 |
| Equalizing | 2.5 |
| Front Porch (Blanking) | 1.59 |

**Warning:** For accurate measurements it is absolutely necessary that the pulses occur during the most linear portion of the sine wave sweep (i.e., center of horizontal sweep).

## Methods of Measuring Low Frequency Pulse Width

### Sine Wave Sweep

The method of using the sine wave sweep for the horizontal deflection of the oscilloscope when measuring the 60 cycle pulses is especially convenient when the synchronizing generator is locked in to the power line.

The same procedure of measuring is used for 60-cycle pulses as was explained for 15,750-cycle pulses, and the same precautions must be taken to insure accurate results.

## REPLACEMENT PARTS LIST

When ordering replacement parts, please give Symbol, Description, and Stock Number of each item ordered. The part which will be supplied against an order for a replacement item may not be an exact duplicate of the original part, however, it will be a satisfactory replacement, differing only in minor mechanical or electrical characteristics. Such differences will in no way impair the operation of the equipment. When ordering replacement electrolytic capacitors, be sure to order the correct mounting plates.

### PULSE SHAPER

| Symbol No. | Description | Stock No. |
|---|---|---|
| C1 | Capacitor, fixed, mica, 100 mmf ±10%, 500 volts | 39628 |
| C2 to C32 | Capacitor, fixed, mica, 200 mmf ±5%, 500 volts | 51914 |
| C33, C34 | Capacitor, same as C1 | |
| C35 to C65 | Capacitor, same as C2 | |
| C66 | Capacitor, same as C1 | |
| C67 | Capacitor, fixed, oil-treated, 0.01 mfd ±10%, 600 volts | 51628 |
| C68 | Capacitor, fixed, oil-treated, 0.10 mfd ±10%, 400 volts | 67910 |
| C69 | Capacitor, fixed, mica, 470 mmf ±10%, 500 volts | 39644 |
| C70 | Capacitor, same as C67 | |
| C71 | Capacitor, fixed, oil-filled, 1.0 mfd ±10%, 600 volts | 56124 |
| C72 | Capacitor, same as C67 | |
| C73 | Capacitor, same as C71 | |
| C74A, C74B* | Capacitor, dry, electrolytic, 20-20 mfd -10% +50%, 450 volts | 34889 |
| C76 | Capacitor, same as C71 | |
| C77, C78 | Capacitor, same as C67 | |
| C79 | Capacitor, same as C71 | |
| C80 | Capacitor, same as C67 | |
| C81, C82 | Capacitor, same as C68 | |
| C83 | Capacitor, fixed, mica, 56 mmf ±5%, 500 volts | 39622 |
| C84 | Capacitor, same as C67 | |
| C85 | Capacitor, same as C71 | |
| C86, C87 | Capacitor, same as C67 | |
| C88, C89 | Capacitor, same as C68 | |
| C90 | Capacitor, fixed, mica, 68 mmf ±10%, 500 volts | 51338 |
| C91 | Capacitor, same as C67 | |
| C92A, C92B* | Capacitor, same as C74A, C74B | |
| C93 | Capacitor, same as C71 | |
| C95, C96, C97 | Capacitor, same as C67 | |
| C98 | Capacitor, same as C71 | |
| C99A, C99B | Capacitor, fixed, oil-filled, 0.5-0.5 mfd +20% -10%, 600 volts | 51916 |
| C101 | Capacitor, fixed, mica, 56 mmf ±10%, 500 volts | 50399 |
| C102 | Capacitor, fixed, oil-treated, 0.05 mfd ±10%, 400 volts | 69565 |
| C103 | Capacitor, same as C71 | |
| C104A, C104B* | Capacitor, same as C74A, C74B | |
| C105 | Capacitor, same as C68 | |
| C106 | Capacitor, fixed, oil-treated, 0.005 mfd ±10%, 500 volts | 51917 |
| C107 | Capacitor, fixed, mica, 560 mmf ±10%, 500 volts | 51918 |
| C108 | Capacitor, same as C68 | |
| C109 | Capacitor, fixed, oil-filled, 0.25 mfd ±20%, 600 volts | 51608 |
| C110 | Capacitor, same as C67 | |
| C111 | Capacitor, fixed, mica, 220 mmf ±10%, 500 volts | 67562 |
| C112 | Capacitor, same as C68 | |
| C113 | Capacitor, same as C67 | |
| C114, C115, C116, C117, C118 | Capacitor, same as C71 | |
| C119A, C119B* | Capacitor, same as C74A, C74B | |
| C120 | Capacitor, same as C71 | |
| C122 | Capacitor, same as C67 | |
| C123 | Capacitor, same as C71 | |
| C124A, C124B* | Capacitor, same as C74A, C74B | |
| C125A, C125B* | Capacitor, same as C74A, C74B | |
| C127A, C127B* | Capacitor, same as C74A, C74B | |
| C128 | Capacitor, same as C68 | |
| C129 | Capacitor, fixed, mica, 680 mmf ±10%, 500 volts | 51919 |
| C130 | Capacitor, same as C109 | |
| C131 | Capacitor, same as C68 | |
| C132A, C132B* | Capacitor, same as C74A, C74B | |
| C133 | Capacitor, same as C67 | |
| C134 | Capacitor, same as C107 | |
| C135 | Capacitor, same as C71 | |
| C136 | Capacitor, fixed, mica, 1000 mmf ±10%, 500 volts | 68954 |
| C138 | Capacitor, same as C68 | |
| C139 | Capacitor, same as C129 | |
| C140 | Capacitor, same as C109 | |
| C141 | Capacitor, same as C68 | |
| C142 | Capacitor, same as C67 | |
| C143 | Capacitor, same as C68 | |
| C144 | Capacitor, fixed, mica, 150 mmf ±10%, 500 volts | 39632 |
| C145 | Capacitor, same as C67 | |
| C146 | Capacitor, same as C71 | |
| C147 | Capacitor, same as C67 | |
| C148 | Capacitor, same as C71 | |
| C149 | Capacitor, same as C109 | |
| C150 | Capacitor, same as C71 | |
| C152, C153 | Capacitor, same as C71 | |
| C154‡ | Capacitor, dry, electrolytic, 1000 mfd +40% -10%, 25 volts | 59891 |
| C155, C156‡ | Capacitor, dry, electrolytic, 125 mfd +40% -10%, 350 volts | 93406 |
| C157‡ | Capacitor, same as C154 | |
| C158 | Capacitor, same as C71 | |
| C159 | Capacitor, fixed, oil-treated, 0.02 mfd ±10%, 400 volts | 69564 |
| C160** | Capacitor, same as C74A, C74B | |
| C162 | Capacitor, same as C71 | |
| C164 | Capacitor, same as C68 | |
| C165 | Capacitor, fixed, mica, 2200 mmf ±10%, 500 volts | 39660 |
| C166 | Capacitor, same as C107 | |
| C167 | Capacitor, same as C109 | |
| C168 | Capacitor, same as C68 | |
| C169 | Capacitor, same as C71 | |
| C170** | Capacitor, same as C74A, C74B | |
| J1 | Connector, female, 15 contacts | 51927 |
| J2 | Connector, male, 10 contacts | 51928 |
| J3 to J12 | Connector, coaxial, chassis mounting | 51800 |
| J20 to J24 | Coaxial termination | 54256 |

* Mounting Plate only, steel ............ Dwg. No. 85559-2
** Mounting Plate only, phenolic ........ Dwg. No. 85558-2 Stock No. 28452
‡ Mounting Plate only, phenolic ........ Dwg. No. 85558-3 Stock No. 18469

## REPLACEMENT PARTS LIST—Continued

| Symbol No. | Description | Stock No. |
|---|---|---|
| L1 to L64 | Coil assembly, delay line | 51920 |
| L65 | Coil assembly, 1.18 MH. | 51921 |
| L66, L67 | Coil assembly, 2.0 MH. | 51922 |
| R1, R2 | Resistor, fixed, composition, 1000 ohms ±10%, 1 watt | 71916 |
| R3 | Resistor, fixed, composition, 22,000 ohms ±10%, 1 watt | 71989 |
| R4 | Resistor, fixed composition, 150,000 ohms ±10%, 1 watt | 31895 |
| R5, R6 | Resistor, fixed, composition, 270,000 ohms ±10%, 1 watt | 19232 |
| R7, R8 | Resistor, fixed, composition, 10 ohms ±10%, 0.5 watt | 34761 |
| R9 | Resistor, fixed, composition, 1 megohm ±10%, 0.5 watt | 30652 |
| R10 | Resistor, same as R1 | |
| R11 | Resistor, same as R3 | |
| R12 | Resistor, fixed, composition, 10.000 ohms ±10%, 1 watt | 71914 |
| R13 | Resistor, same as R9 | |
| R14 | Resistor, same as R7 | |
| R15 | Resistor, same as R9 | |
| R16 | Resistor, fixed, composition, 22.000 ohms ±10%, 2 watts | 72629 |
| R17 | Resistor, same as R12 | |
| R18, R19, R20 | Resistor, fixed composition, 1800 ohms ±10%. 1 watt | 38875 |
| R21 | Resistor, same as R9 | |
| R22, R23 | Resistor, same as R7 | |
| R24 | Resistor, same as R9 | |
| R25 | Resistor, fixed, composition, 5600 ohms ±10%, 1 watt | 38886 |
| R26 | Resistor, fixed, composition, 6800 ohms ±10%, 1 watt | 38887 |
| R27 | Resistor, same as R7 | |
| R28 | Resistor, fixed, composition, 56,000 ohms ±10%, 0.5 watt | 30650 |
| R29 | Resistor, fixed, composition, 820 ohms ±10%, 1 watt | 68025 |
| R30 | Resistor, fixed, composition, 1200 ohms ±10%, 1 watt | 38896 |
| R31 | Resistor. fixed, composition, 100.000 ohms ±10%, 1 watt | 72635 |
| R32 | Resistor, same as R7 | |
| R33 | Resistor, fixed, composition, 150,000 ohms ±5%, 1 watt | 31895 |
| R34 | Resistor variable, composition, 5000 ohms ±10%, 2 watts | 51923 |
| R35 | Resistor, fixed, composition, 18,000 ohms ±10%. 1 watt | 18757 |
| R36 | Resistor, same as R9 | |
| R37 | Resistor, same as R7 | |
| R38 | Resistor. fixed, composition, 3900 ohms ±10%, 1 watt | 38894 |
| R39 | Resistor, fixed, composition, 100,000 ohms ±10%, 0.5 watt | 3252 |
| R40 | Resistor. fixed, composition, 4700 ohms ±10%, 0.5 watt | 30494 |
| R41 | Resistor, fixed, composition, 2700 ohms ±10%, 1 watt | 14421 |
| R42 | Resistor. same as R25 | |
| R43 | Resistor, same as R1 | |
| R44 | Resistor. same as R7 | |
| R45 | Resistor, fixed, composition, 22.000 ohms ±10%, 0.5 watt | 30492 |
| R46 | Resistor fixed. composition, 3300 ohms ±10%, 1 watt | 71986 |
| R47 | Resistor. fixed composition, 4700 ohms ±10%, 1 watt | 71987 |
| R48 | Resistor. same as R31 | |
| R49 | Resistor. same as R7 | |
| R50 | Resistor. fixed, composition, 220,000 ohms ±5%, 1 watt | 54449 |
| R51 | Resistor, same as R34 | |
| R52 | Resistor, fixed, composition, 27,000 ohms ±10%, 1 watt | 71990 |
| R53 | Resistor, fixed, composition, 1 megohm ±10%, 1 watt | 71993 |
| R54 | Resistor, same as R7 | |
| R55 | Resistor, fixed, composition, 330,000 ohms, ±10%, 1 watt | 38892 |
| R56 | Resistor, same as R9 | |
| R57 | Resistor, same as R12 | |
| R58 | Resistor, same as R18 | |
| R59 | Resistor, same as R39 | |
| R60 | Resistor, same as R40 | |
| R61 | Resistor, same as R31 | |
| R62 | Resistor, same as R1 | |
| R63 | Resistor, fixed, composition, 1000 ohms ±10%, 0.5 watt | 34766 |
| R64 | Resistor, fixed, same as R38, 3900 ohms ±10%, 1 watt | 38894 |
| R65 | Resistor, fixed, same as R25, 5600 ohms, ±10%, 1 watt | 38886 |
| R66 | Resistor, same as R47 | |
| R67 | Resistor, same as R25 | |
| R68 | Resistor, same as R7 | |
| R69 | Resistor, fixed, composition, 5600 ohms ±10%, ½ watt | 30734 |
| R70 | Resistor, same as R29 | |
| R71 | Resistor, same as R30 | |
| R72 | Resistor, fixed, composition, 82,000 ohms ±10%, 1 watt | 52609 |
| R73 | Resistor, same as R7 | |
| R74 | Resistor, fixed, composition, 33,000 ohms ±5%, 1 watt | 38892 |
| R75 | Resistor, same as R34 | |
| R76 | Resistor, fixed, composition, 270,000 ohms, ±5%, 1 watt | 19232 |
| R77 | Resistor, same as R9 | |
| R78 | Resistor, same as R7 | |
| R79 | Resistor, same as R18 | |
| R80 | Resistor, same as R7 | |
| R81 | Resistor, same as R9 | |
| R82 | Resistor, fixed, composition, 47,000 ohms ±10%, 1 watt | 71988 |
| R83 | Resistor, same as R3 | |
| R84, R85 | Resistor, same as R25 | |
| R86 | Resistor, same as R53 | |
| R87 | Resistor, same as R76 | |
| R88 | Resistor, variable, composition, 100,000 ohms ±10%, 2 watts | 51924 |
| R89 | Resistor, fixed, composition, 68,000 ohms ±5%, 0.5 watt | 14138 |
| R90, R91 | Resistor, same as R7 | |
| R92 | Resistor, fixed, composition, 2.2 megohms ±10%, 0.5 watt | 30649 |
| R93, R94 | Resistor, same as R3 | |
| R95 | Resistor, same as R55 | |
| R96 | Resistor, same as R76 | |
| R97 | Resistor, same as R88 | |
| R98 | Resistor. fixed, composition, 82,000 ohms ±5%, 0.5 watt | 8064 |
| R99, R100 | Resistor, same as R7 | |
| R101 | Resistor, fixed, composition, 39,000 ohms ±10%, 0.5 watt | 30147 |
| R102 | Resistor, fixed, composition, 1500 ohms ±10%. 1 watt | 72762 |
| R103 | Resistor, same as R3 | |
| R104 | Resistor, same as R41 | |
| R105 | Resistor, same as R9 | |
| R106, R107 | Resistor, same as R7 | |
| R108, R109 | Resistor, same as R9 | |
| R110 | Resistor, same as R7 | |
| R111 | Resistor, same as R18 | |
| R112 | Resistor, same as R9 | |
| R113 | Resistor, same as R7 | |

| Symbol No. | Description | Stock No. |
|---|---|---|
| R114 | Resistor, variable, composition, 2000 ohms ±10%, 2 watts | 51925 |
| R115 | Resistor, same as R12 | |
| R116 | Resistor, same as R18 | |
| R117 | Resistor, fixed, composition, 560,000 ohms ±10%, 1 watt | 32726 |
| R118 | Resistor, fixed, composition, 15,000 ohms ±10%, 0.5 watt | 36714 |
| R119 | Resistor, same as R28 | |
| R120 | Resistor, same as R9 | |
| R121, R122 | Resistor, same as R12 | |
| R123 | Resistor, same as R3 | |
| R124, R125 | Resistor, same as R25 | |
| R126 | Resistor, same as R53 | |
| R127 | Resistor, same as R7 | |
| R128 | Resistor, same as R76 | |
| R129 | Resistor, same as R88 | |
| R130 | Resistor, fixed, composition, 100,000 ohms ±5%, 0.5 watt | 3252 |
| R131 | Resistor, same as R7 | |
| R132 | Resistor, same as R92 | |
| R133 | Resistor, same as R12 | |
| R134 | Resistor, same as R25 | |
| R135 | Resistor, fixed, same as R52 | |
| R136 | Resistor, same as R55 | |
| R137 | Resistor, fixed, composition, 33,000 ohms ±10%, 0.5 watt | 30685 |
| R138 | Resistor, fixed, composition, 470,000 ohms ±10%, 1 watt | 72521 |
| R139 | Resistor, same as R39 | |
| R140 | Resistor, same as R3 | |
| R141, R142 | Resistor, same as R25 | |
| R143 | Resistor, same as R53 | |
| R144 | Resistor, same as R7 | |
| R145 | Resistor, fixed, composition, 220,000 ohms ±10%, 1 watt | 54449 |
| R146 | Resistor, same as R88 | |
| R147 | Resistor, fixed, composition, 82,000 ohms ±10%, 0.5 watt | 8064 |
| R148 | Resistor, same as R7 | |
| R149 | Resistor, same as R92 | |
| R150 | Resistor, same as R3 | |
| R151 | Resistor, fixed composition, 15,000 ohms ±10%, 1 watt | 70723 |
| R152 | Resistor, same as R52 | |
| R153 | Resistor, fixed, composition, 180,000 ohms ±5%, 1 watt | 12356 |
| R154 | Resistor, same as R88 | |
| R156, R157 | Resistor, same as R7 | |
| R158 | Resistor, fixed, composition, 27,000 ohms, ±10%, ½ watt | 30409 |
| R159, R160 | Resistor, same as R47 | |
| R161 | Resistor, same as R3 | |
| R162 | Resistor, same as R25 | |
| R163 | Resistor, same as R53 | |
| R164 | Resistor, fixed, composition, 100 ohms ±10%, 1 watt | 31215 |
| R165 | Resistor, fixed, composition, 270 ohms ±10%, 0.5 watt | 30929 |
| R166 | Resistor, fixed, composition, 56 ohms ±10%, 0.5 watt | 34762 |
| R167 | Resistor fixed, composition, 2700 ohms ±10%, 2 watts | 33855 |
| R168 | Resistor, same as R9 | |
| R169 | Resistor, same as R7 | |
| R170 | Resistor, fixed, composition, 8200 ohms ±10%, 2 watts | 43493 |
| R171 | Resistor, fixed, composition, 2200 ohms ±10%, 1 watt | 71991 |
| R172 | Resistor, same as R9 | |
| R173 | Resistor, same as R7 | |
| R174 | Resistor, fixed, composition, 10,000 ohms ±10%, 2 watts | 44294 |
| R175 | Resistor, same as R9 | |
| R176 | Resistor, fixed, composition, 100 ohms ±10%, ½ watt | 34765 |
| R177 | Resistor, same as R165 | |
| R178 | Resistor, same as R166 | |
| R179 | Resistor, same as R167 | |
| R180 | Resistor, fixed, composition, 220 ohms ±10%, 0.5 watt | 5201 |
| R181 | Resistor, same as R167 | |
| R182 | Resistor, same as R165 | |
| R183 | Resistor, same as R53 | |
| R184 | Resistor, same as R164 | |
| R185 | Resistor, fixed, composition, 8200 ohms ±10%, 1 watt | 38888 |
| R186 | Resistor, fixed, composition, 10 megohms ±10%, 0.5 watt | 30992 |
| R187, R188 | Resistor, same as R7 | |
| R189 | Resistor, same as R176 | |
| R190 | Resistor, same as R174 | |
| R191 | Resistor, same as R164 | |
| R192 | Resistor, fixed, composition, 2.2 megohms ±10%, 1 watt | 38898 |
| R193 | Resistor, same as R164 | |
| R194 | Resistor, same as R3 | |
| R195, R196 | Resistor, same as R25 | |
| R197 | Resistor, same as R33 | |
| R198 | Resistor, same as R88 | |
| R199 | Resistor, fixed, composition, 10,000 ohms ±5%, 0.5 watt | 3078 |
| R200 | Resistor, same as R53 | |
| R201, R202 | Resistor, same as R7 | |
| R203 | Resistor, same as R92 | |
| R204 | Resistor, same as R3 | |
| R205 | Resistor, same as R92 | |
| R206 | Resistor, same as R164 | |
| R207 | Resistor, fixed, composition, 47,000 ohms ±10%, 0.5 watt | 30787 |
| R208 | Resistor, same as R167 | |
| R209, R210 | Resistor, same as R38 | |
| R211 | Resistor, same as R82 | |
| R212, R213 | Resistor, same as R166 | |
| R214 | Resistor, same as R180 | |
| R215 | Resistor, fixed, composition, 180 ohms ±10%, 1 watt | 2736 |
| R216 | Resistor, same as R12 | |
| R217 | Resistor, same as R1 | |
| S1 | Circuit breaker, 115 volt a-c; nominal load, 10 amperes; minimum trip point, 12.5 amperes ±10% | 51926 |
| T1, T2 | Transformer, primary tapped, 109, 117, 125 volts, 50/60 cycle a-c; two secondary windings each 6.5/7.5 volts, 6 amperes | 58660 |
| X31 to X60 | Socket, tube, standard octal, saddle mounted | 54414 |
| | Grommet, lead | 33139 |
| | Knob control | 30075 |
| | Jack, tip | 18348 |

## PULSE FORMER

| Symbol No. | Description | Stock No. |
|---|---|---|
| C1 | Capacitor, fixed, oil-filled, 1.0 mfd ±10%, 600 volts | 56124 |
| C3, C4 | Capacitor, same as C1 | |
| C5 | Capacitor, fixed, oil-filled, 4 mfd −10% +20%, 600 volts | 52983 |
| C6 | Capacitor, same as C1 | |
| C7 | Capacitor, fixed, mica, 68 mmf ±10%, 500 volts | 51338 |
| C8 | Capacitor, fixed, mica, 470 mmf ±10%, 500 volts | 39644 |
| C9, C10, C11 | Capacitor, fixed, oil-treated, 0.1 mfd ±10%, 400 volts | 67910 |
| C12 | Capacitor, fixed, mica, 120 mmf ±5%, 500 volts | 39630 |
| C13, C14, C15 | Capacitor, fixed, oil-treated, 0.01 mfd ±10%, 600 volts | 51628 |

| Symbol No. | Description | Stock No. |
|---|---|---|
| C16 | Capacitor, fixed, oil-filled, 0.25 mfd ±20%, 600 volts | 51608 |
| C17 | Capacitor, same as C13 | |
| C18 | Capacitor, same as C1 | |
| C19 | Capacitor, fixed, mica, 10 mmf ±10%, 500 volts | 72615 |
| C20 | Capacitor, same as C13 | |
| C21A, C21B | Capacitor, fixed, oil-filled, 0.5-0.5 mfd +20% –10%, 600 volts | 51916 |
| C22 | Capacitor, same as C13 | |
| C23 | Capacitor, fixed, mica, 1000 mmf ±10%, 500 volts | 68954 |
| C24 | Capacitor, fixed, mica, 27 mmf ±10%, 500 volts | 68757 |
| C25 | Capacitor, fixed, oil-treated, 0.05 mfd ±10%, 400 volts | 69565 |
| C26 | Capacitor, fixed, mica, 390 mmf ±10%, 500 volts | 68542 |
| C27, C28 | Capacitor, same as C13 | |
| C29A, C29B | Capacitor, same as C21A, C21B | |
| C30 | Capacitor, same as C13 | |
| C31 | Capacitor, same as C23 | |
| C32 | Capacitor, same as C24 | |
| C33 | Capacitor, same as C25 | |
| C34 | Capacitor, same as C13 | |
| C35 | Capacitor, same as C25 | |
| C36* | Capacitor, dry, electrolytic, 20-20 mfd –10% +50%, 450 volts | 34889 |
| C37 | Capacitor, same as C13 | |
| C38 | Capacitor, fixed, mica, 820 mmf, 500 volts | 51932 |
| C39 | Capacitor, same as C9 | |
| C40 | Capacitor, same as C13 | |
| C41A, C41B | Capacitor, same as C21A, C21B | |
| C42 | Capacitor. fixed, oil-treated, 0.015 mfd ±10%, 400 volts | 51930 |
| C43 | Capacitor, same as C23 | |
| C44 | Capacitor, same as C24 | |
| C45 | Capacitor, same as C25 | |
| C46 | Capacitor, same as C1 | |
| C47 | Capacitor, fixed, oil-treated, 0.02 mfd ±10%, 400 volts | 69564 |
| C48 | Capacitor, same as C23 | |
| C49 | Capacitor, same as C24 | |
| C50 | Capacitor, same as C25 | |
| C51 | Capacitor, same as C1 | |
| C52 | Capacitor, same as C47 | |
| C53 | Capacitor, same as C23 | |
| C54 | Capacitor, same as C24 | |
| C55 | Capacitor, same as C25 | |
| C56 | Capacitor, same as C1 | |
| C57 | Capacitor, same as C47 | |
| C58 | Capacitor, same as C23 | |
| C59 | Capacitor, same as C24 | |
| C60 | Capacitor, same as C25 | |
| C61 | Capacitor, same as C1 | |
| C62 | Capacitor, same as C13 | |
| C63 | Capacitor, same as C9 | |
| C64* | Capacitor, same as C36 | |
| C65 | Capacitor, same as C16 | |
| C66 | Capacitor, same as C9 | |
| C67 | Capacitor, fixed. mica, 680 mmf ±10%, 500 volts | 51919 |
| C68 | Capacitor, same as C16 | |
| C69, C70 | Capacitor, fixed, oil-filled, 0.5 mfd ±10%, 1000 volts | 56122 |
| C71 | Capacitor, same as C13 | |
| C72, C73 | Capacitor, same as C25 | |
| C74, C75 | Capacitor, same as C9 | |
| C76 | Capacitor, same as C13 | |
| C77 | Capacitor, fixed, mica, 2700 mmf ±10%, 500 volts | 65400 |

| Symbol No. | Description | Stock No. |
|---|---|---|
| C78 | Capacitor, fixed, mica, 4700 mmf ±10%, 500 volts | 66645 |
| C79 | Capacitor, fixed, mica, 3900 mmf ±10%, 500 volts | 39646 |
| C80 | Capacitor, same as C67 | |
| C81, C82 | Capacitor, same as C13 | |
| C83 | Capacitor, fixed, mica, 560 mmf ±10%, 500 volts | 51918 |
| C84 | Capacitor, same as C23 | |
| C85 | Capacitor, fixed, mica, 1800 mmf ±5%, 500 volts | 52784 |
| C86 | Capacitor, same as C9 | |
| C87 | Capacitor, same as C83 | |
| C88, C89 | Capacitor, same as C13 | |
| C91 | Capacitor, fixed, mica, 150 mmf ±10%, 500 volts | 39632 |
| J1 | Connector, male | 51942 |
| R1 | Resistor, variable, carbon, 100,000 ohms, 2 watts | 51934 |
| R2 | Resistor, fixed, composition, 10,000 ohms ±10%, 1 watt | 71914 |
| R3 | Resistor, fixed, composition, 4.7 megohms ±10%, 1 watt | 19480 |
| R4 | Resistor, fixed, composition, 68,000 ohms ±10%, 1 watt | 38897 |
| R5 | Resistor, fixed, composition, 82,000 ohms ±10%, 1 watt | 52609 |
| R6 | Resistor, fixed, composition, 1 megohm ±10%, 0.5 watt | 30652 |
| R7 | Resistor, fixed, composition, 10 ohms ±10%, 0.5 watt | 34761 |
| R8 | Resistor, same as R2 | |
| R9 | Resistor, fixed, composition, 820 ohms ±5%, 0.5 watt | 30158 |
| R10 | Resistor, fixed, composition, 47,000 ohms ±5%, 1 watt | 71988 |
| R11 | Resistor, fixed, composition, 56,000 ohms ±5%, 1 watt | 17440 |
| R12 | Resistor, fixed, composition, 15,000 ohms ±10%, 1 watt | 70723 |
| R13 | Resistor, fixed, composition, 470,000 ohms ±10%, ½ watt | 30648 |
| R14 | Resistor, fixed, composition, 6800 ohms ±10%, 0.5 watt | 14659 |
| R15 | Resistor, fixed, composition, 470,000 ohms ±10%, 1 watt | 72521 |
| R16 | Resistor, fixed, composition, 39,000 ohms ±10%, 1 watt | 71084 |
| R17 | Resistor, same as R6 | |
| R18 | Resistor, same as R7 | |
| R19 | Resistor, fixed, composition, 15,000 ohms ±10%, 2 watts | 68935 |
| R20 | Resistor, fixed, composition, 1 megohm ±10%, 1 watt | 71993 |
| R21 | Resistor, same as R19 | |
| R22 | Resistor, fixed, composition, 10,000 ohms ±10%, 1 watt | 71914 |
| R23 | Resistor, fixed, composition, 2200 ohms ±10%, 1 watt | 71991 |
| R24 | Resistor, same as R7 | |
| R25 | Resistor, fixed, composition, 2.2 megohms ±10%, 0.5 watt | 30649 |
| R26 | Resistor, same as R20 | |
| R27 | Resistor, fixed, composition, 100 ohms ±10%, 1 watt | 31215 |
| R28 | Resistor, fixed, composition, 470 ohms ±10%, 0.5 watt | 30499 |
| R29 | Resistor, fixed, composition, 100,000 ohms ±10%, 1 watt | 72635 |
| R30 | Resistor, fixed, composition, 6800 ohms ±10%, 1 watt | 38887 |
| R31 | Resistor, fixed, composition, 1.5 megohms ±10%, 1 watt | 47967 |

* Mounting Plate only, steel ............Dwg. No. 85559-2

| Symbol No. | Description | Stock No. |
|---|---|---|
| R32 | Resistor, fixed, composition, 2700 ohms ±5%, 0.5 watt | 30730 |
| R33 | Resistor, variable, carbon, 5000 ohms, 2 watts | 51923 |
| R34 | Resistor, fixed, composition, 390,000 ohms ±5%, 1 watt | 32725 |
| R35 | Resistor, fixed, composition, 47,000 ohms ±10%, 1 watt | 71988 |
| R36 | Resistor, same as R20 | |
| R37 | Resistor, same as R29 | |
| R38 | Resistor, fixed, composition, 560 ohms ±10%, 0.5 watt | 5164 |
| R39 | Resistor, same as R6 | |
| R40 | Resistor, same as R19 | |
| R41 | Resistor, fixed, composition, 270,000 ohms ±10%, 1 watt | 19232 |
| R42 | Resistor, fixed, composition, 2200 ohms ±5%, 0.5 watt | 34767 |
| R43 | Resistor, same as R33 | |
| R44 | Resistor, fixed, composition, 150,000 ohms ±5%, 1 watt | 31895 |
| R45 | Resistor, same as R25 | |
| R46 | Resistor, same as R29 | |
| R47 | Resistor, fixed, composition, 4700 ohms ±10%, 1 watt | 71987 |
| R48 | Resistor, same as R29 | |
| R49 | Resistor, fixed, composition, 100,000 ohms ±10%, 0.5 watt | 3252 |
| R50 | Resistor, same as R38 | |
| R51 | Resistor, fixed, composition, 5600 ohms ±10%, 1 watt | 38886 |
| R52 | Resistor, same as R30 | |
| R53 | Resistor, same as R6 | |
| R54 | Resistor, fixed, composition, 680 ohms ±10%, 0.5 watt | 12262 |
| R55 | Resistor, same as R20 | |
| R56 | Resistor, same as R27 | |
| R57 | Resistor, same as R28 | |
| R58 | Resistor, same as R29 | |
| R59 | Resistor, same as R30 | |
| R60 | Resistor, same as R31 | |
| R61 | Resistor, fixed, composition, 5600 ohms ±5%, 0.5 watt | 30734 |
| R62 | Resistor, same as R33 | |
| R63 | Resistor, fixed, composition, 180,000 ohms ±5%, 1 watt | 12356 |
| R64 | Resistor, same as R35 | |
| R65 | Resistor, same as R31 | |
| R66 | Resistor, fixed, composition, 4700 ohms ±5%, 0.5 watt | 30494 |
| R67 | Resistor, same as R33 | |
| R68 | Resistor, fixed, composition, 56,000 ohms ±5%, 2 watts | 28741 |
| R69 | Resistor, same as R35 | |
| R70 | Resistor, same as R31 | |
| R71 | Resistor, fixed, composition, 8200 ohms ±5%, 0.5 watt | 14250 |
| R72 | Resistor, same as R33 | |
| R73 | Resistor, fixed, composition, 68,000 ohms ±5%, 1 watt | 38897 |
| R74 | Resistor, same as R35 | |
| R75 | Resistor, same as R31 | |
| R76 | Resistor, fixed, composition, 3900 ohms ±5%, 0.5 watt | 30694 |
| R77 | Resistor, same as R33 | |
| R78 | Resistor, same as R11 | |
| R79 | Resistor, same as R22 | |
| R80 | Resistor, fixed, composition, 1000 ohms ±10%, 1 watt | 71916 |
| R81 | Resistor, fixed, composition, 22,000 ohms ±10%, 1 watt | 71989 |
| R82 | Resistor, same as R51 | |
| R83 | Resistor, same as R25 | |
| R84 | Resistor, same as R7 | |
| R85 | Resistor, fixed, composition, 56,000 ohms ±5%, 0.5 watt | 30650 |
| R86 | Resistor, fixed, composition, 2.2 megohms ±10%, 1 watt | 38898 |

| Symbol No. | Description | Stock No. |
|---|---|---|
| R87 | Resistor, variable, carbon, 100,000 ohms, 2 watts | 51924 |
| R88 | Resistor, fixed, composition, 680,000 ohms ±5%, 1 watt | 52012 |
| R89 | Resistor, same as R51 | |
| R90 | Resistor, same as R81 | |
| R91 | Resistor, same as R29 | |
| R92 | Resistor, same as R41 | |
| R93 | Resistor, variable, carbon, 50,000 ohms, 2 watts | 51944 |
| R94 | Resistor, same as R87 | |
| R95 | Resistor, same as R29 | |
| R96, R97 | Resistor, fixed, composition, 5.6 megohms ±10%, 1 watt | 71026 |
| R98 | Resistor, same as R35 | |
| R99 | Resistor, fixed, composition, 1500 ohms ±10%, 1 watt | 72762 |
| R100 | Resistor, same as R35 | |
| R101 | Resistor, same as R25 | |
| R102 | Resistor, same as R28 | |
| R103 | Resistor, same as R25 | |
| R104 | Resistor, same as R6 | |
| R105 | Resistor, fixed, composition, 4700 ohms ±10%, 0.5 watt | 30494 |
| R106 | Resistor, same as R35 | |
| R107 | Resistor, same as R7 | |
| R108 | Resistor, same as R25 | |
| R109 | Resistor, fixed, composition, 680,000 ohms ±10%, 0.5 watt | 30562 |
| R110 | Resistor, same as R7 | |
| R111 | Resistor, same as R99 | |
| R112 | Resistor, same as R35 | |
| R113 | Resistor, same as R6 | |
| R114 | Resistor, same as R7 | |
| R115 | Resistor, same as R47 | |
| R116 | Resistor, same as R81 | |
| R117 | Resistor, same as R35 | |
| R118 | Resistor, same as R7 | |
| R119 | Resistor, fixed, composition, 1.8 megohms ±10%, 0.5 watt | 11769 |
| R120 | Resistor, fixed, composition, 1.2 megohms ±10%, 0.5 watt | 30162 |
| R121 | Resistor, same as R7 | |
| R122 | Resistor, same as R35 | |
| R123 | Resistor, same as R30 | |
| R124 | Resistor, same as R51 | |
| R125 | Resistor, same as R41 | |
| R126 | Resistor, same as R16 | |
| R127 | Resistor, same as R7 | |
| R128 | Resistor, same as R28 | |
| R129 | Resistor, same as R47 | |
| R130 | Resistor, same as R20 | |
| R131 | Resistor, fixed, composition, 3.9 megohms ±10%, 1 watt | 44046 |
| R132 | Resistor, same as R7 | |
| R133 | Resistor, same as R47 | |
| R134 | Resistor, same as R15 | |
| R135 | Resistor, fixed, composition, 27,000 ohms ±10%, 1 watt | 71990 |
| R136 | Resistor, same as R14 | |
| R137 | Resistor, fixed, composition, 56,000 ohms ±10%, 0.5 watt | 30650 |
| R138 | Resistor, fixed, composition, 560,000 ohms ±5%, 1 watt | 32726 |
| R139 | Resistor, fixed, composition, 10 megohms ±10%, 0.5 watt | 30992 |
| R140 | Resistor, variable, carbon, 10,000 ohms ±10% | 93175 |
| R141 to R146 | Resistor, same as R139 | |
| R147 | Resistor, same as R25 | |
| S1 | Switch, frequency control | 51941 |
| S2 | Switch, counter indicator | 18720 |
| S3 | Switch, AFC time constant | 51941 |
| S4 | Switch, DPDT | 93263 |
| T1 | Transformer, phase | 58835 |

## REPLACEMENT PARTS LIST—Continued

| Symbol No. | Description | Stock No. | Symbol No. | Description | Stock No. |
|---|---|---|---|---|---|
| T2 | Transformer, vertical | 51936 | T11 | Transformer, power | 58834 |
| T3 | Coil Assembly, 31.5 kc., oscillator | 51937 | X1 to X29 | Socket, tube | 54414 |
| T4 | Coil Assembly, 94.5 kc., oscillator | 51938 | X30 | Socket, CRO tube | 54272 |
| T5 to T10 | Transformer, horizontal oscillator | 51939 | X0 | Socket, crystal | 17340 |
| | | | | Knob, control | 30075 |
| | | | | Mirror, CRO reflector | 51945 |
| | | | | Ring, rubber, for mirror assembly | 51946 |

## REGULATED POWER SUPPLY

(See IB-36078 for Parts List)

## FILTER UNIT

| | | | | | |
|---|---|---|---|---|---|
| ‡ | Capacitor, dry, electrolytic, 125 mfd −10% +40%, 350 volts | 18434 | | Resistor, fixed, wire wound, 50 ohms, 25 watts | 53838 |
| | Connector, male, 4 contact | 52107 | | Resistor, fixed, composition, 100,000 ohms ±10%, 1 watt | 72635 |

## SYNCHRONIZING GENERATOR RACK

| | | | | | |
|---|---|---|---|---|---|
| | Connector, male, 15 contact, connecting cable | 53412 | J2 | Connector, female, 6 contact | 51595 |
| | Connector, female, 15 contact, connecting cable | 51943 | J5 | Connector, female, 2 contact | 4573 |
| | | | J13 | Connector, female, 10 contact | 51929 |
| | | | | Connector, female, 4 contact | 52108 |

* Mounting Plate only, phenolic ........ Dwg. No. 85558-3 Stock No. 18469
** Mounting Plate only, steel ............ Dwg. No. 85559-2
‡ Mounting Plate only, steel ........ Dwg. No. 85559-3

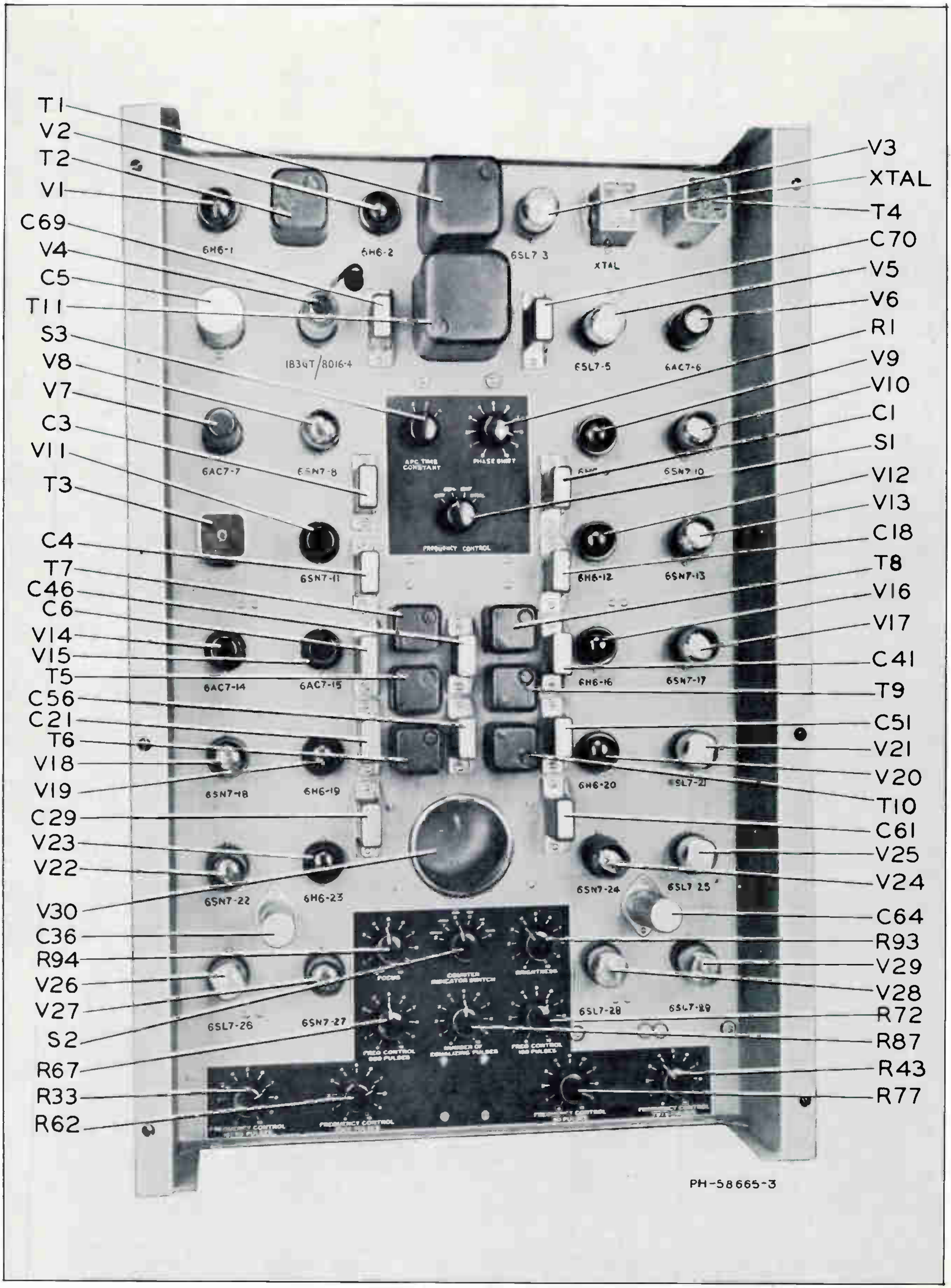



*Figure 8—Pulse Former, Front View*

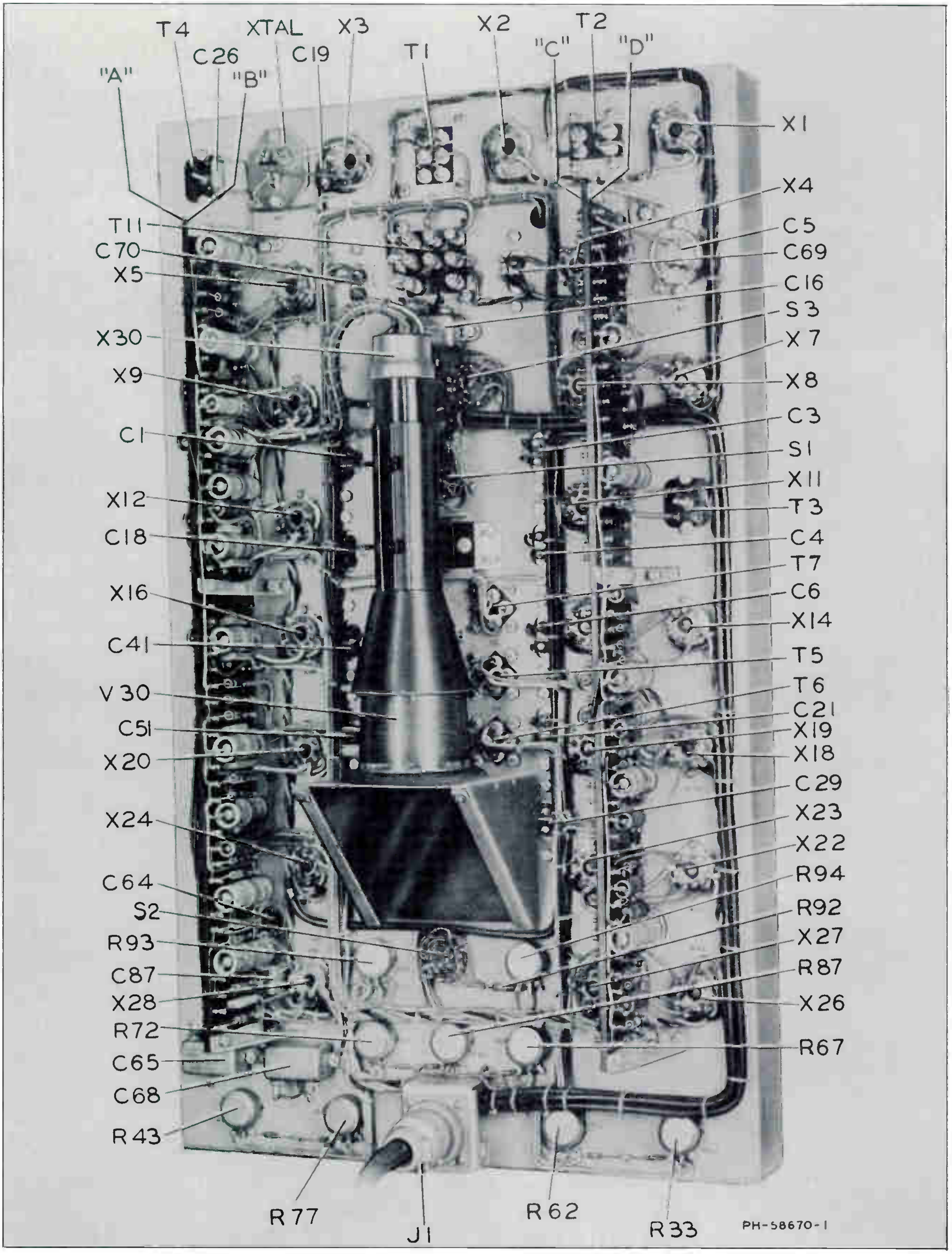



*Figure 9—Pulse Former, Rear View*

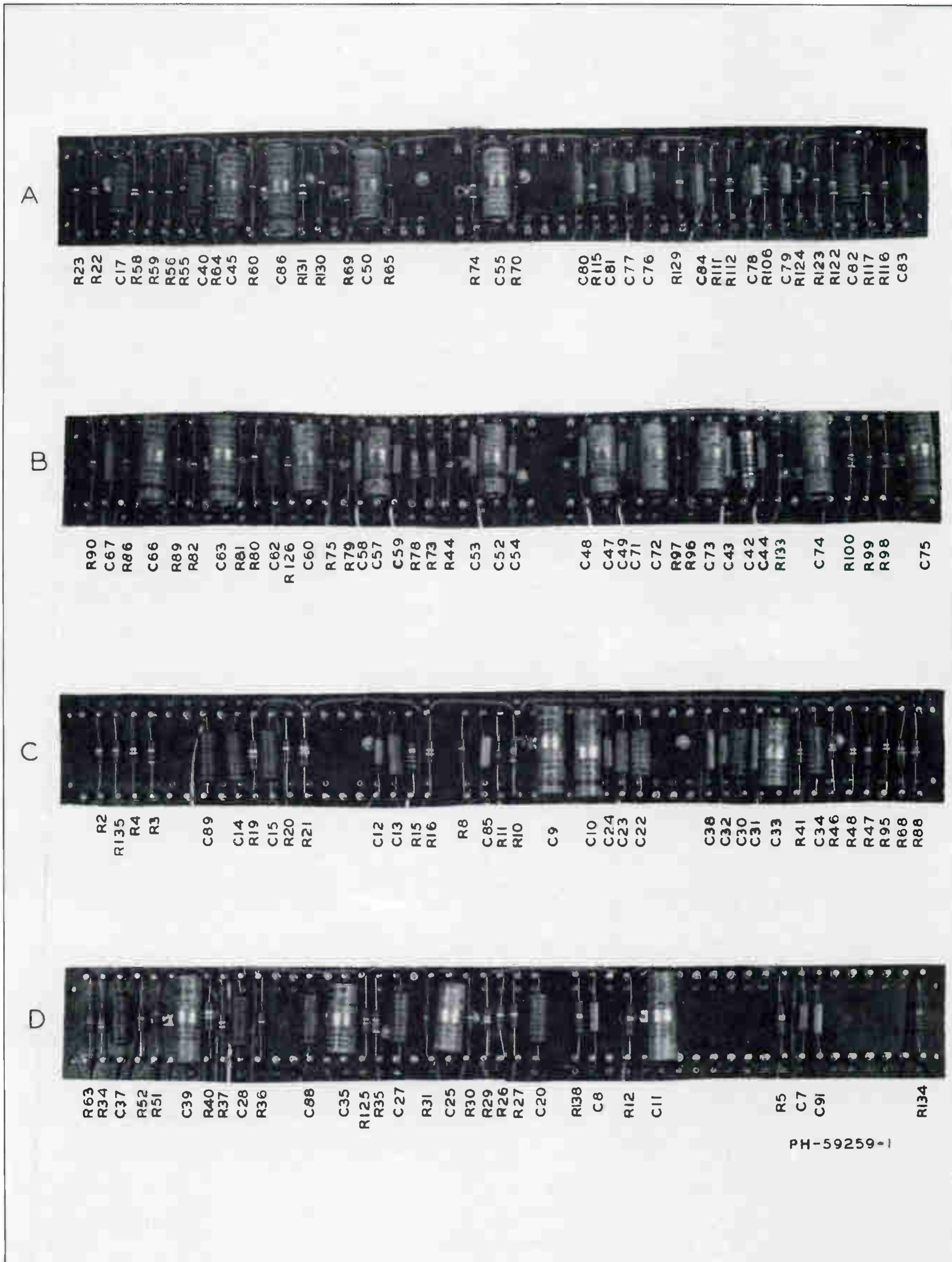



*Figure 10—Pulse Former, Resistor Boards*

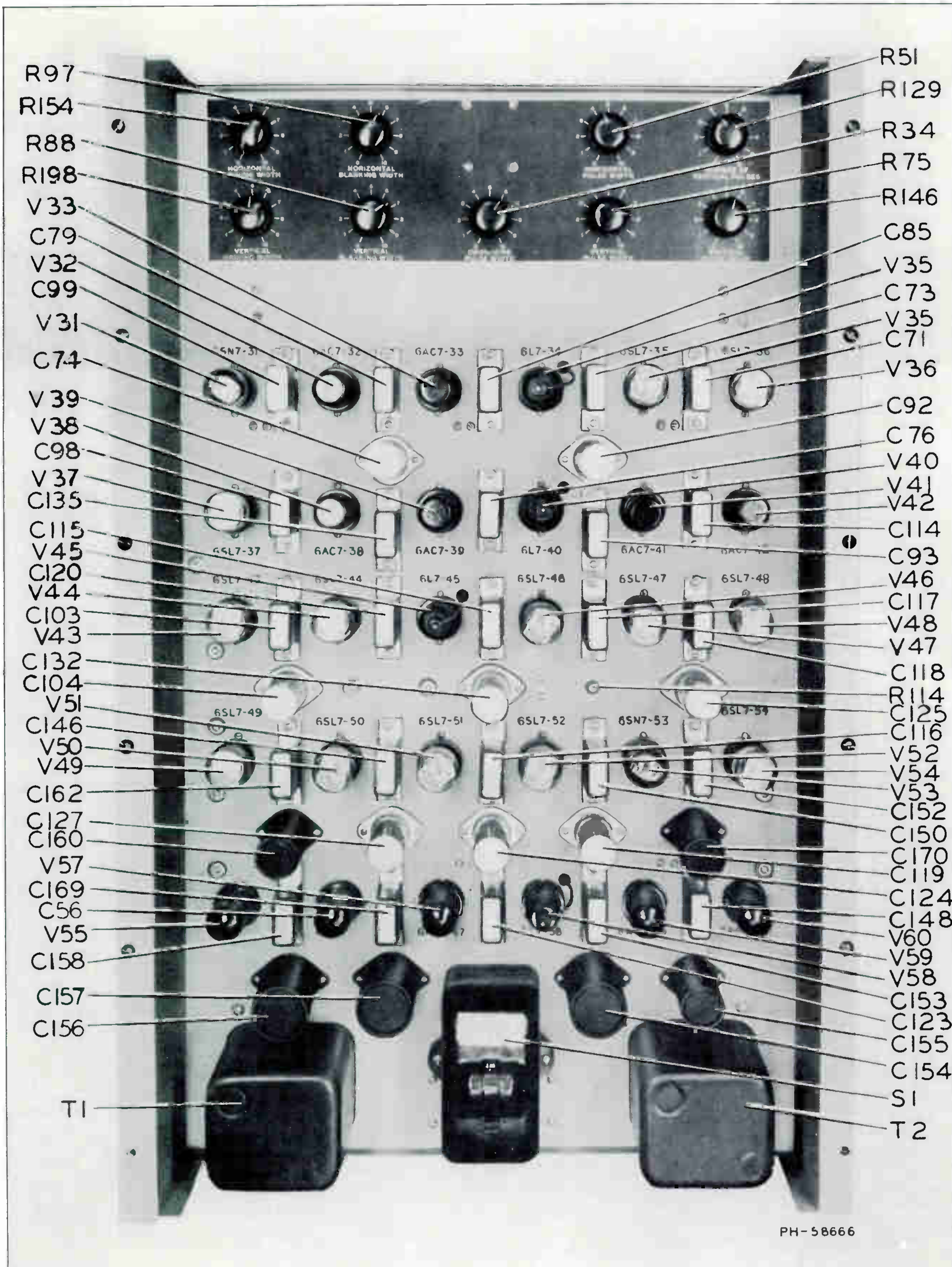



*Figure 11—Pulse Shaper, Front View*

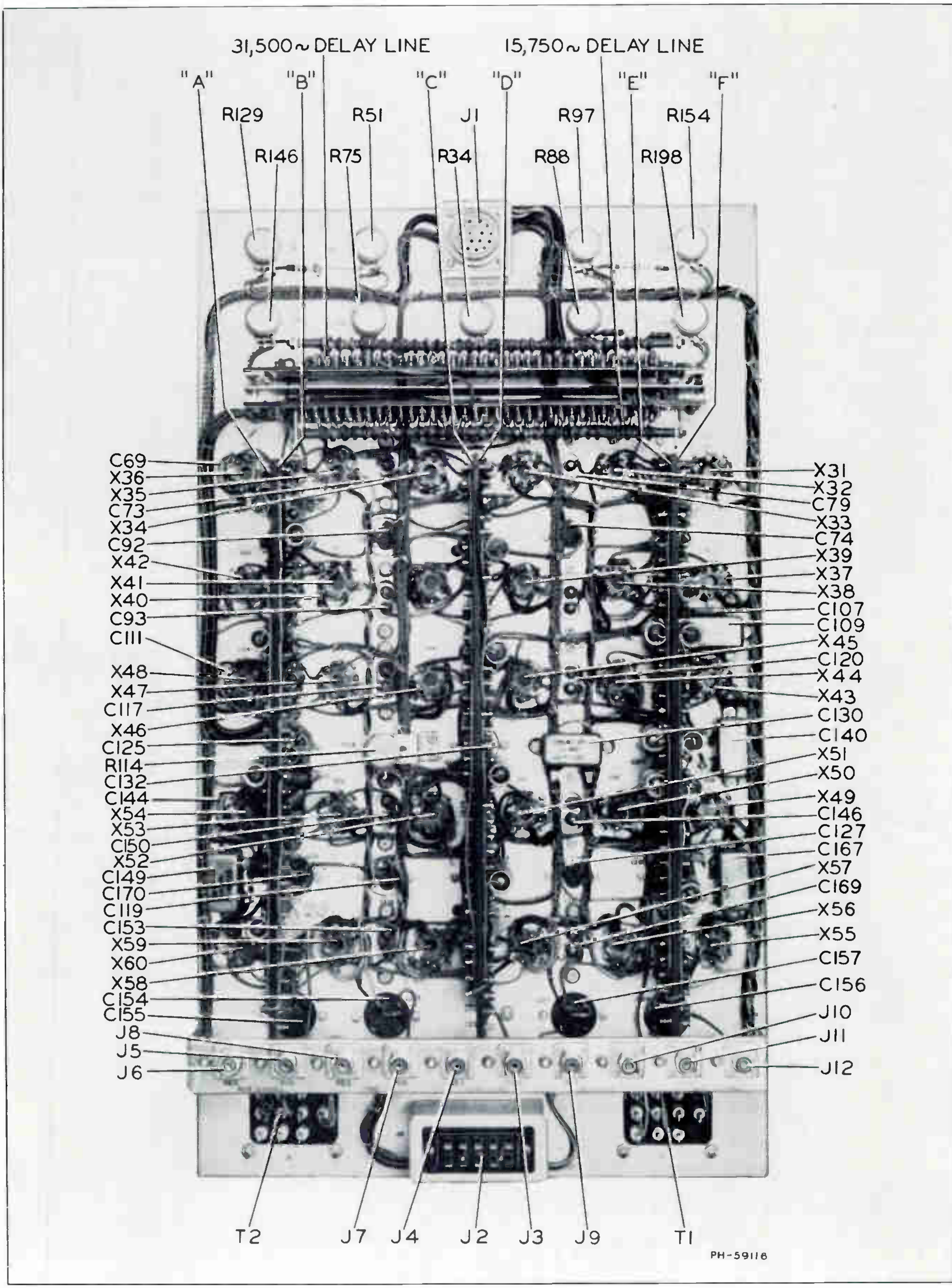



*Figure 12—Pulse Shaper, Rear View*

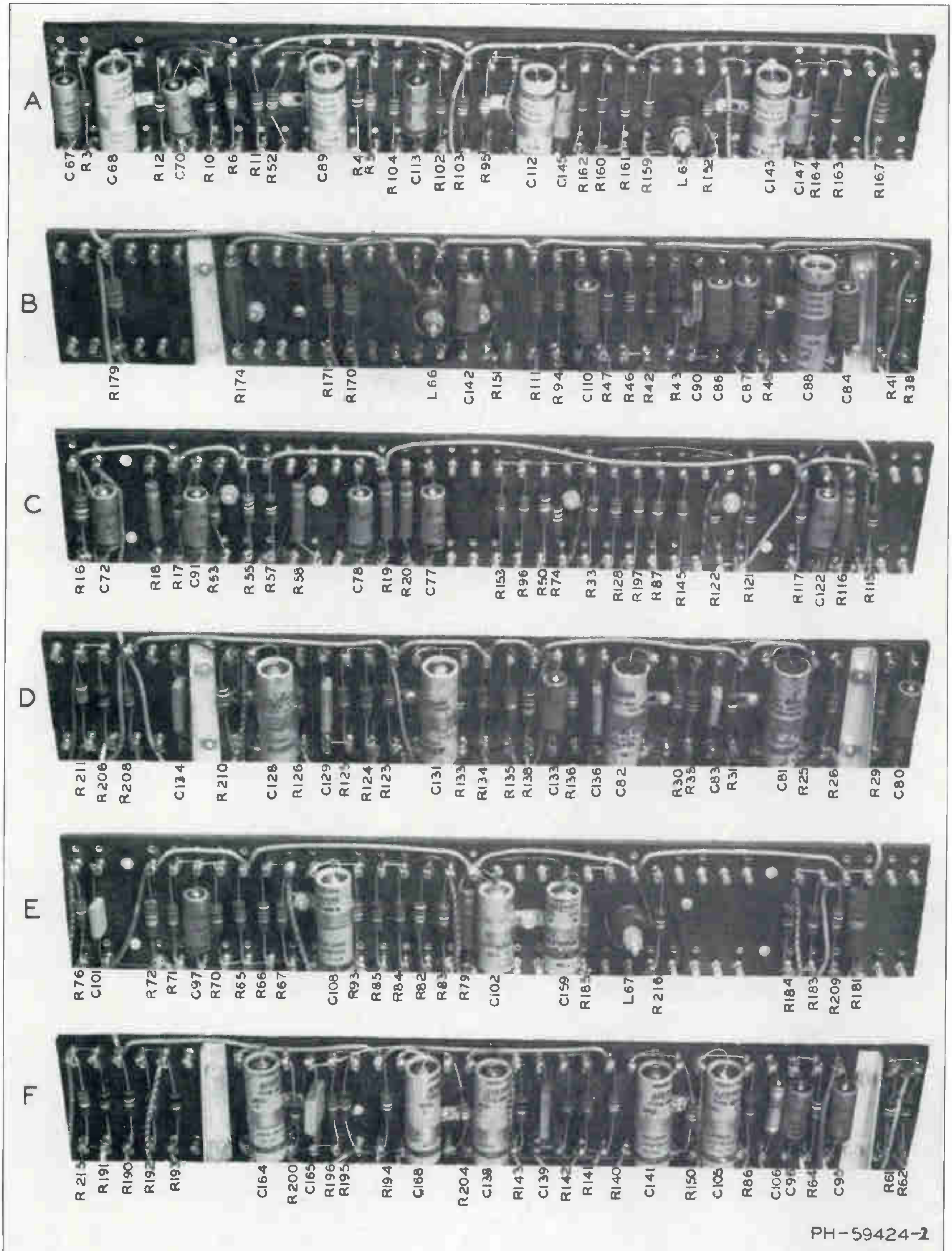
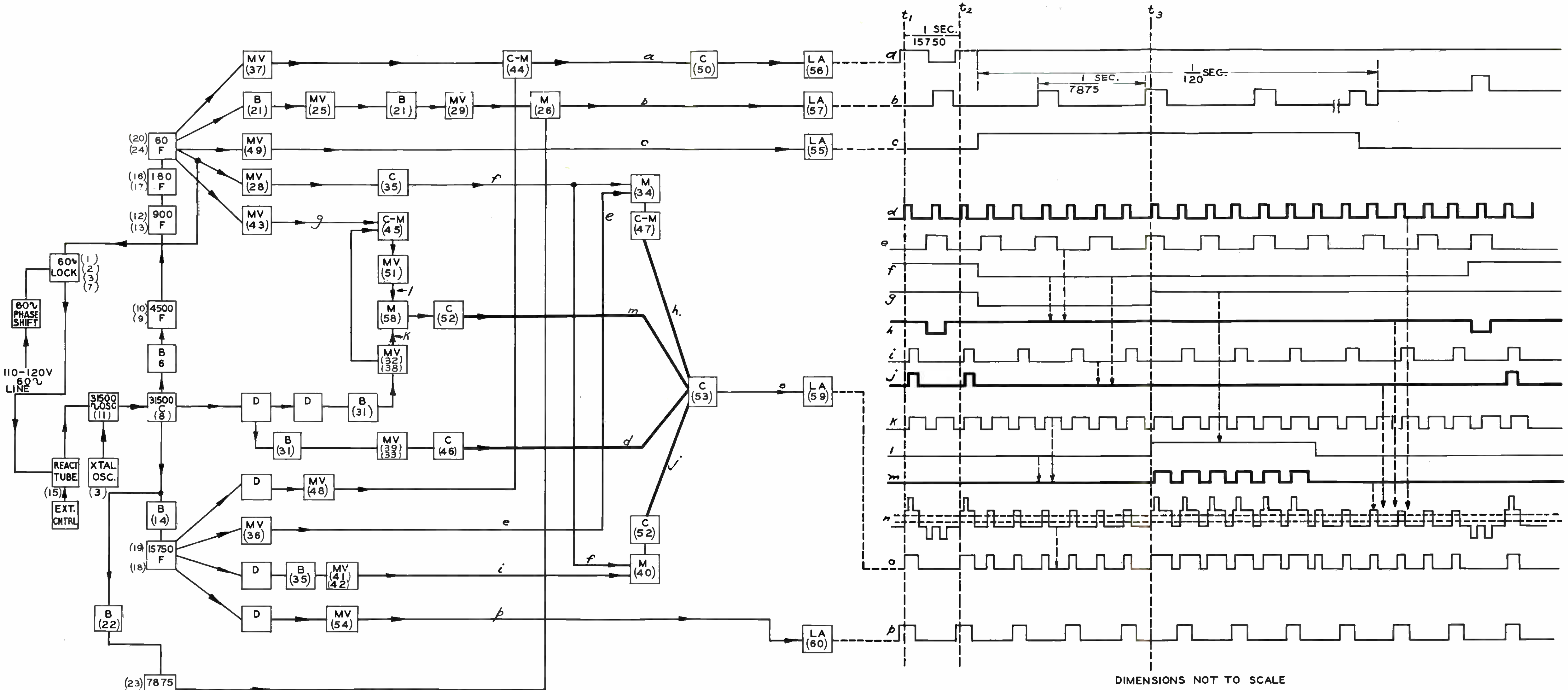



*Figure 13—Pulse Shaper, Resistor Boards*




## SYMBOLS

B- BUFFER
F- FREQUENCY DIVIDING CIRCUIT
MV- MULTIVIBRATOR
C - CLIPPER
M - MIXER
LA- LINE AMPLIFIER
OO - NUMBERS IN PARENTHESES INDICATE TUBE POSITIONS IN RACK & ON SCHEMATIC DIAGRAM T-619205 & W-302985
D - DELAY NETWORK

## NOTES

ARROWS ON SOLID LINES INDICATE DIRECTION OF TRAVEL OF PULSES.
LETTERS *a*, *b* ETC. NEAR SOLID LINES INDICATE WAVESHAPES.
ARROWED DOTTED LINES INDICATE WAVES COMBINED TO PRODUCE OTHER WAVES, OR "WAVES" RESULTING FROM "KEYING." FOR EXAMPLE: WAVES *e* & *f* ARE COMBINED TO PRODUCE WAVE *h*.
WAVES *d*, *h*, *j* & *m* (HEAVY LINES) ARE MIXED IN COMMON PLATE RESISTOR OF CLIPPERS 46, 47, 52-52, TO PRODUCE WAVE *n*.
WAVE *n* IS CLIPPED AT LEVELS INDICATED BY DOTTED LINES TO PRODUCE WAVE *o*.

## CONTROLS

60~ LOCK—"ON"-"OFF" SWITCH (S-1)-TIME CONSTANT SWITCH (S-3)
60~ PHASE SHIFT—PHASE SHIFT CONTROL
15750 F —— FREQUENCY CONTROL, 15750 PULSES
31500 OSC — FREQUENCY CONTROL 31500 CYCLES
4500 F —— FREQUENCY CONTROL 4500 PULSES
900 F —— FREQUENCY CONTROL 900 PULSES
180 F —— FREQUENCY CONTROL 180 PULSES
60 F —— FREQUENCY CONTROL 60 PULSES
7875 F —— FREQUENCY CONTROL 7875 PULSES
MV 54 —— HORIZ. DRIVING WIDTH
MV 49 — VERTICAL DRIVING WIDTH
MV 48 — HORIZ. BLANKING WIDTH
MV 37 — VERTICAL BLANKING WIDTH
MV 42 — HORIZ. PULSE WIDTH
MV 43 — VERTICAL PULSE DELAY
MV 28 — NUMBER OF EQUALIZING PULSES
MV 39 — EQUALIZING PULSE WIDTH
MV 51 — NUMBER OF VERTICAL PULSES
MV 32 — VERTICAL PULSE WIDTH

## OUTPUTS

WAVE *a* - BLANKING
WAVE *b* - OSCILLOSCOPE / SYNCHRONIZING
WAVE *c* - VERTICAL DRIVING
WAVE *p* - HORIZ. DRIVING
WAVE *o* - SYNCHRONIZING (RMA)

POSITIVE OR NEGATIVE POLARITY AVAILABLE
4-VOLTS PEAK TO PEAK 75-OHMS IMPEDANCE

## BLOCK DIAGRAM AND WAVE SHAPES FOR TELEVISION SYNCHRONIZING GENERATOR MI-26915

T-619286

*Figure 14—Block Diagram and Waveforms*

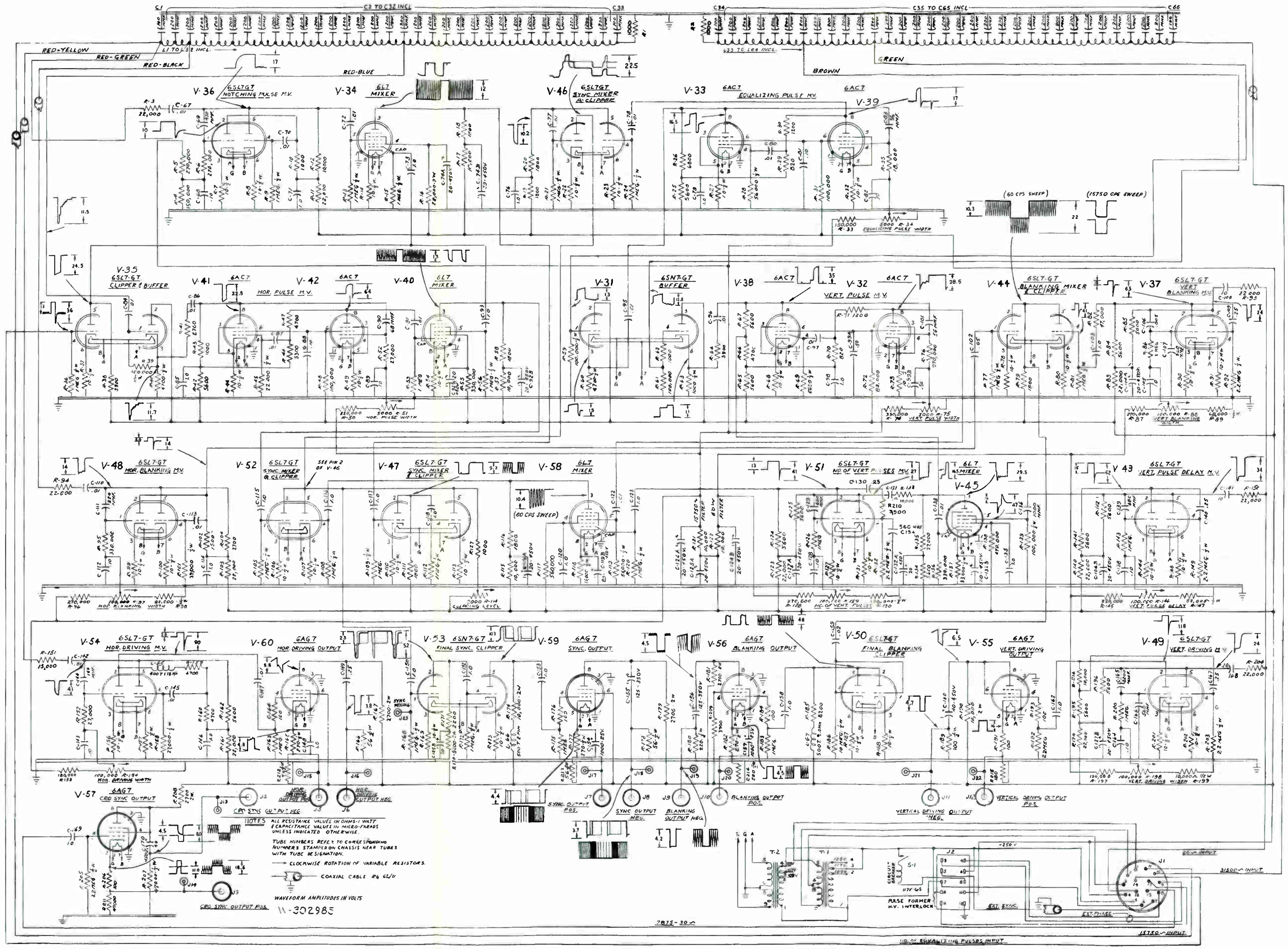



Figure 16—Pulse Shaper, Schematic Diagram

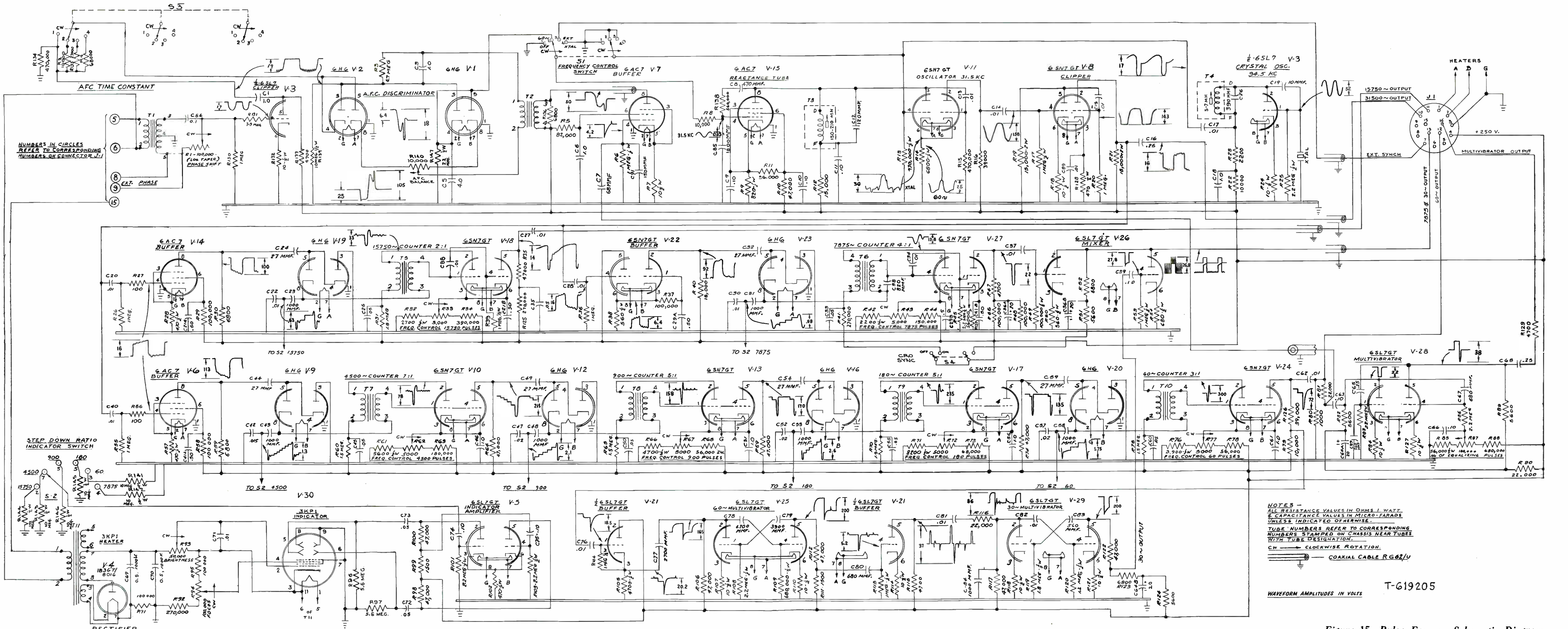



*Figure 15—Pulse Former, Schematic Diagram*

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