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TG-10A

Field Synchronizing Generator Equipment

MI-26920

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

IB-36093

TG-10A

FIELD SYNCHRONIZING GENERATOR EQUIPMENT

MI-26920

INSTRUCTIONS

Manufactured by
RADIO CORPORATION OF AMERICA
ENGINEERING PRODUCTS DEPARTMENT
Camden 2, New Jersey, U.S.A.

Printed in U.S.A.

IB-36093

FIRST AID

WARNING!

Operation of electronic equipment involves the use of high voltages which are dangerous to life. Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside the equipment with voltage supply on. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors, etc. To avoid casualties, always discharge and ground circuits prior to touching them.

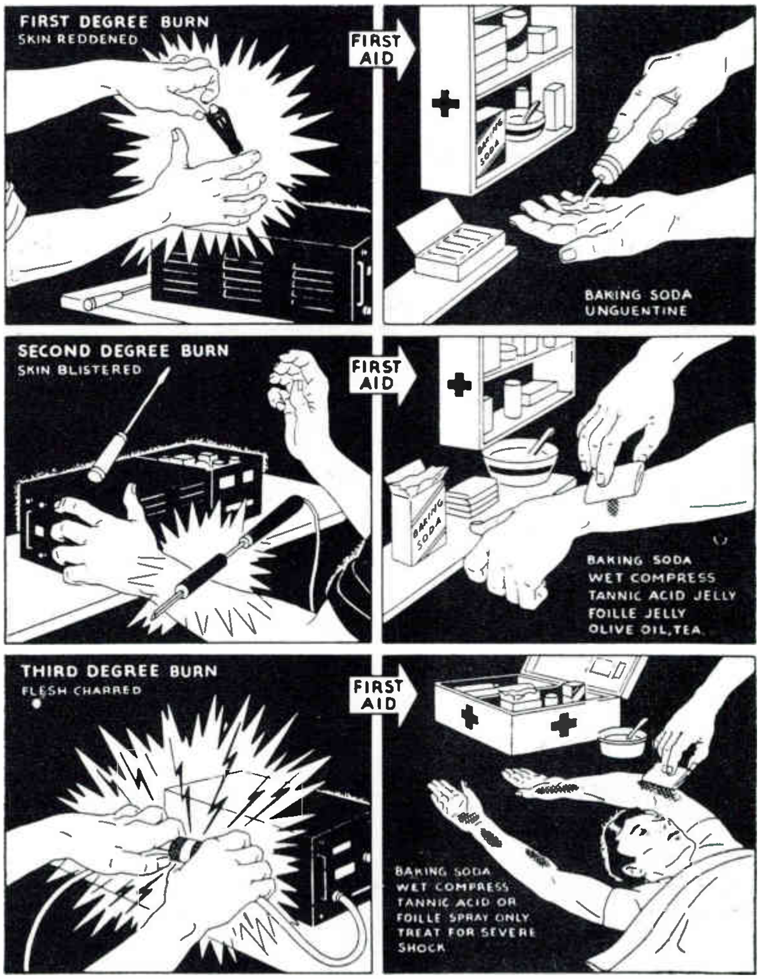
ABOUT FIRST AID

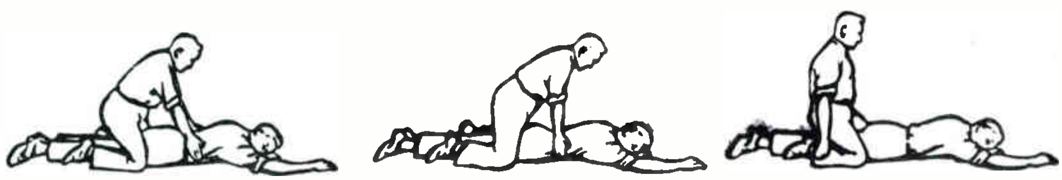
Personnel engaged in the installation, operation and maintenance of this equipment or similar equipment are urged to become familiar with the following rules both **in theory and in the practical application thereof.** It is the duty of every radioman to be prepared to give adequate First Aid and thereby prevent avoidable loss of life.

PRONE-PRESSURE METHOD OF RESUSCITATION

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 PATIENTS 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.

REPLACEMENT PARTS
AND
ENGINEERING SERVICE

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.

Service parts may be ordered through the local Broadcast Equipment Sales Representative, his office, or directly from the Service Parts Order Service Bldg. 60, 19th and Federal Streets, Camden, N. J. Emergency orders may be phoned, telegraphed, or teletyped to RCA Emergency Service, Bldg. 60, Camden, N. J. (Telephone: Woodlawn 3-8000).

ELECTRON TUBES

Replacement tubes should be ordered from local distributors or the nearest RCA tube warehouse.

RCA tube warehouses are located at the following addresses:

34 Exchange Place
Jersey City 2, New Jersey

589 E. Illinois Street,
Chicago 11, Illinois

420 S. San Pedro Street
Los Angeles 13, California

If, for any reason, it is desired to return tubes, please return them to the place of purchase. If this is not convenient, please notify your RCA serving warehouse so that Return Authorization may be forwarded to you.

PLEASE DO NOT RETURN TUBES DIRECTLY TO RCA WITHOUT AUTHORIZATION AND SHIPPING INSTRUCTIONS.

It is important that complete information regarding each tube (including type, serial number, hours of service, and reason for its return) be given.

When tubes are returned, they should be shipped to the address specified on the Return Authorization form. A copy of the Return Authorization and also a Service Report for each tube should be packed with the tubes.

ENGINEERING SERVICE

RCA field engineering service is available at current rates. Request for field engineering service may be addressed to the local Broadcast Equipment Sales Engineer or the RCA Service Company, Inc. Communications Service Division, Camden, N. J. Telephone: Gloucester 3-4560 during working hours; emergency service is provided through Woodlawn 3-8000.

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LIST OF ILLUSTRATIONS

TECHNICAL SUMMARY

ELECTRICAL SPECIFICATIONS

Field Pulse Former and Field Pulse Shaper:

Input-A-C Power

98-129 volts, 50/60 cycles, single phase	325 watts

Output-

Horizontal driving pulses, 15,750 cycles	4 volts, peak-to-peak, +1 -0.5 volt, 75-ohm impedance
Vertical driving pulses, 60 cycles	
Blanking pulses, RMA Standard; 60 and 15,750 cycles	
Synchronizing pulses, RMA Standard; 60; 15,750; 31,500 cycles	

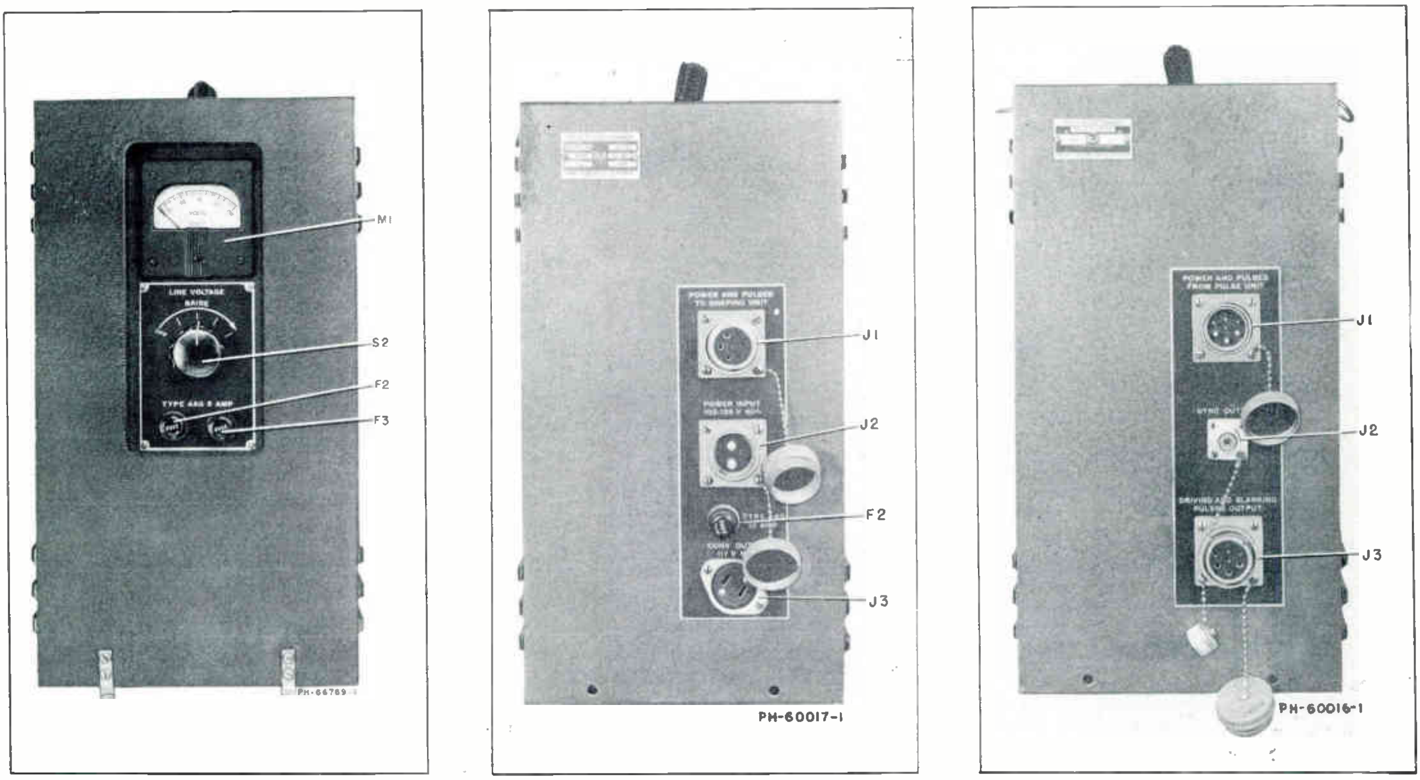


Figure 1 -- Field Pulse Former, Front and Rear Views; Field Pulse Shaper, Rear View

TUBE COMPLEMENT

EQUIPMENT	RCA TYPE											Total Tubes
	2BP1	5V4	6AC7	6AG7	6AS7G	6H6	6L7	6SL7GT	6SN7GT	5691	OD3	
Field Pulse Former	1	2	4		1	7		3	7		2	27
Field Pulse Shaper			6	4			4	12	2	2		30
Total per Type	1	2	10	4	1	7	4	15	9	2	2	57

For tube functions see Figures 2, 5, 14, 15, or 16.

FUSE COMPLEMENT

Power Line 10-Ampere
Convenience Outlet 5-Ampere
Pulse Former and Shaper 5-Ampere

MECHANICAL SPECIFICATIONS

	Field Pulse Former	Field Pulse Shaper
Height-overall	18-1/2"	18-1/2"
Width	8-1/2"	8-1/2"
Length	26"	26"
Weight	67 lbs.	53 lbs.

EQUIPMENT

The Field Synchronizing Generator Equipment, RCA Reference Number MI-26920, consists of the following items:

Quantity	Description	RCA Reference
1	Pulse Former	MI-26105
1	Pulse Shaper	MI-26115
1	Power Distribution Box	MI-26260
2	Shock Mount (for pulse former and shaper)	MI-26510-1
1	Set of Cables	MI-26735

The following may be ordered separately:

Spare Set of Tubes for Pulse Former MI-26684
Spare Set of Tubes for Pulse Shaper MI-26685

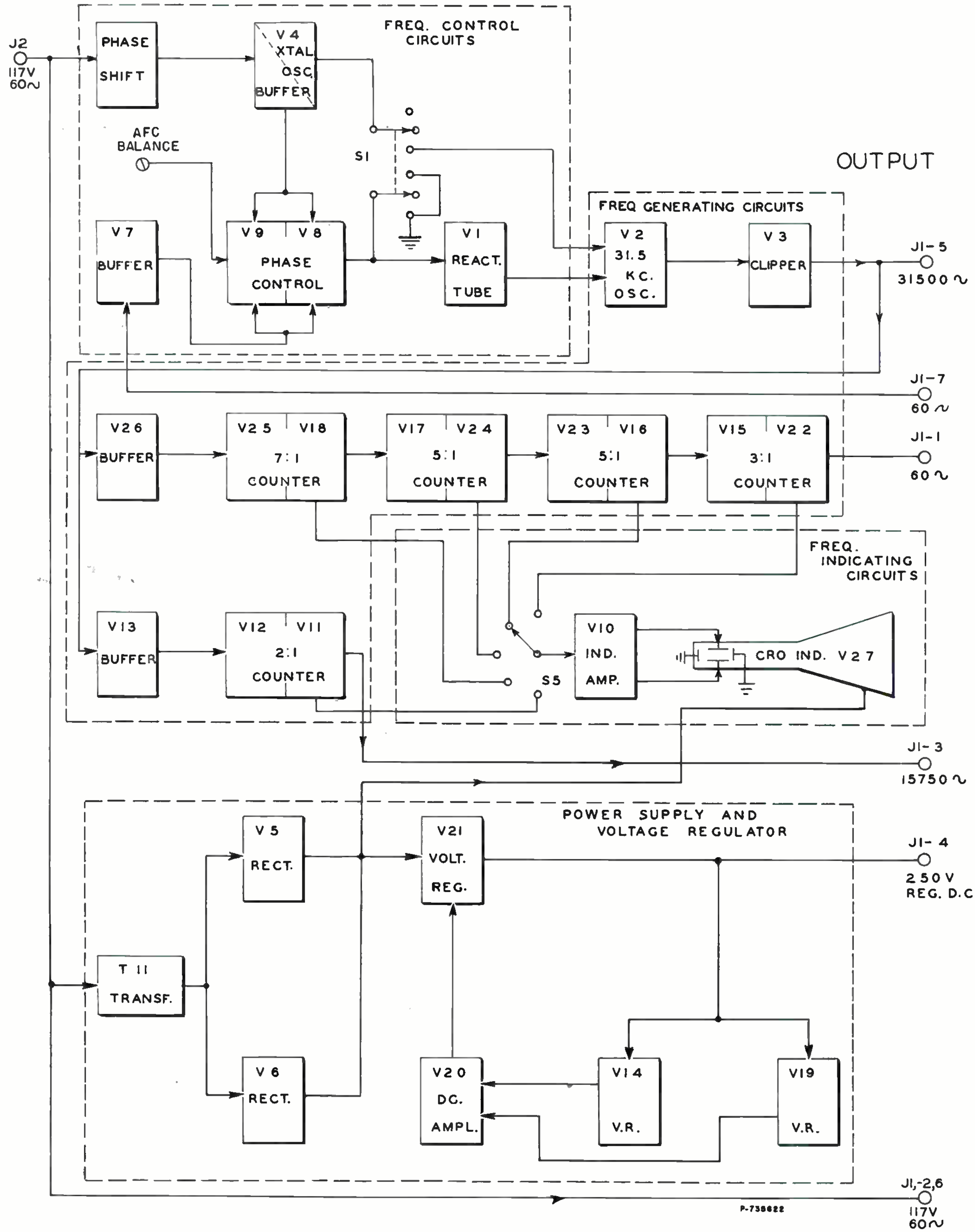


Figure 2 -- Block Diagram, Field Pulse Former

DESCRIPTION

GENERAL

Two units, the Field Pulse Former and Field Pulse Shaper, constitute the synchronizing pulse generating equipment for field use. As the names imply, the pulse former generates and fixes the timing of the pulses, while the pulse shaper converts the pulses into horizontal and vertical driving pulses as well as providing the standard RMA synchronizing and blanking signals. For reference, and as an aid to understanding operation of these two units, the RMA recommended synchronizing generator waveforms are shown on Figure 9. The block diagram, Figure 14, includes both the pulse former and pulse shaper.

FIELD PULSE FORMER

For convenience in description, the circuits in the pulse former are divided as follows:

Frequency-generating
Frequency control
Counter and frequency-indicating
60-cycle lock-in power supply and voltage-regulating

Reference should be made to the block diagram, Figure 2, to the pulse former illustrations, Figures 10, 11; and to the schematic diagram, Figure 15.

Frequency-Generating Circuits

The pulse former generates and establishes the relative timing or phase relationship of pulses at three different frequencies: 60; 15,750; and 31,500 cycles. The pulses are properly timed with respect to each other by deriving them from a common master oscillator. The frequency of this oscillator may be controlled either by automatic comparison with the frequency of the power line input, or by a crystal-controlled oscillator operating at the third harmonic frequency.

The master oscillator, V2, has its free-running frequency determined by inductance T3, capacitor C12, and the impedance presented by the plate circuit of reactance tube V1. The output of V2 drives an amplifier and clipper, V3, which is coupled to pin number 5 of the output connector, J1, furnishing the 31,500-cycle pulses required in the pulse shaper.

The 31,500-cycle output of V3 is also fed through a buffer tube, V13, to a 2-to-1 counter circuit, V12 and the first triode of V11, which divides the frequency by two. The resulting 15,750-cycle pulse is amplified by the second triode in V11 and coupled to pin number 3 of the output connector J1.

The 60-cycle frequency required in the output is derived from the 31,500-cycle output of the oscillator by a series of four counter or frequency-dividing stages: Thus, the 31,500-cycle pulse from the clipper, V3, is fed through buffer stage V26 to a 7-to-1 counter circuit formed by V25 and V18. The second triode in V18 amplifies the resulting 4,500-cycle pulse which is coupled to the 5-to-1 counter circuit, V17 and V24. For reduction to 180 cycles, the 900-cycle amplified pulse from V24 is sent to a second 5-to-1 counter circuit formed by V23 and V16. Final frequency division is obtained in the 3-to-1 counter circuit, consisting of V15 and V22, which derives the 60-cycle output from the 180-cycle pulses. The amplified output from V22 is coupled to pin number 1 of connector J1.

Frequency-Control Circuits

In addition to the free-running condition, two methods of frequency control may be employed with the master oscillator, V2, by means of frequency control switch S1. With S1 in the first position, the grid of reactance tube V1 is grounded, and the crystal oscillator, V4, is cut off by opening the cathode circuit. Oscillator, V2, then operates at the natural frequency of the resonant circuit formed by T3, C12, and plate of V1.

When placed in the second position, switch S1 locks the oscillator to the 60-cycle power supply, as explained later in this section under "60-Cycle Lock-In Circuit." In this switch position the crystal oscillator is also biased to cut-off.

The third position of S1 permits the crystal oscillator section of V4 to operate, driving the grid of master oscillator V2 and holding its frequency constant. The grid of the reactance tube, V1, is grounded in this position of the switch. Frequency of the crystal oscillator circuit in V4 is 94,500 cycles, the third harmonic of the master oscillator frequency.

Counter and Frequency-Indicating Circuits

Since all five counter circuits in the pulse former perform in a similar manner, the operation of only one will be described. The 4500-cycle counter, V25-V18, which divides the master oscillator frequency by seven, will be used as the example. In the following discussion, the section in V25 consisting of the plate at terminal three and the cathode at terminal four will be called the first diode, and the section consisting of the plate at terminal five and the cathode at terminal eight will be called the second diode. The simplified schematic diagram is shown in Figure 3.

The 31,500-cycle pulses applied to the grid of V26 are of sufficient amplitude to drive the tube from cut-off 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 high value when the negative pulse is applied.

Assuming that capacitors C25 and C24 are completely discharged and that the grid of V26 is at maximum positive, the "B" supply voltage is divided between the low resistance of the tube and plate load resistor R34, causing a minimum voltage E_{P1} to exist at the plate and across C23. Under steady state conditions, the first diode is conducting at this time, and hence E_{P1} also exists across C23.

When the grid is driven beyond cut-off, the plate resistance is increased and the plate voltage goes to a maximum, E_{P2}, causing the second diode to conduct and the capacitors C23, C25, and C24 to charge to the new value, E_{P2}. Capacitor C23 already has a charge, E_{P1}, and only the increment, E_{P2}-E_{P1}, will be added to the three-capacitor combination. Since the increment will be divided in inverse proportion to capacity, only about 1/40 of it will appear across C25 and C24 at the cathode of the second diode.

When the grid voltage again goes positive, shunting R34 with the low tube resistance, the plate voltage will return to E_{P1} and the first diode will conduct, discharging C23 back to the value E_{P1}. Since the second diode will not conduct on the negative swing of the plate voltage, the charge on C25 and C24 will remain constant until the plate voltage rises to E_{P2} 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, C24, in series with C25, receives a small portion of the total charge across the C25-C24 combination, and provides a monitoring signal for indicator tube V27.

The cathode of the second diode is connected to the grid of blocking oscillator V18 through the low-impedance winding of transformer T5. Cathode bias for V18 is developed across the bleeder combination consisting of R36, R37, and R38. 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, discharges capacitors C24 and C25, and forces the grid beyond cut-off, where it remains until the tube is triggered by the next series of seven steps.

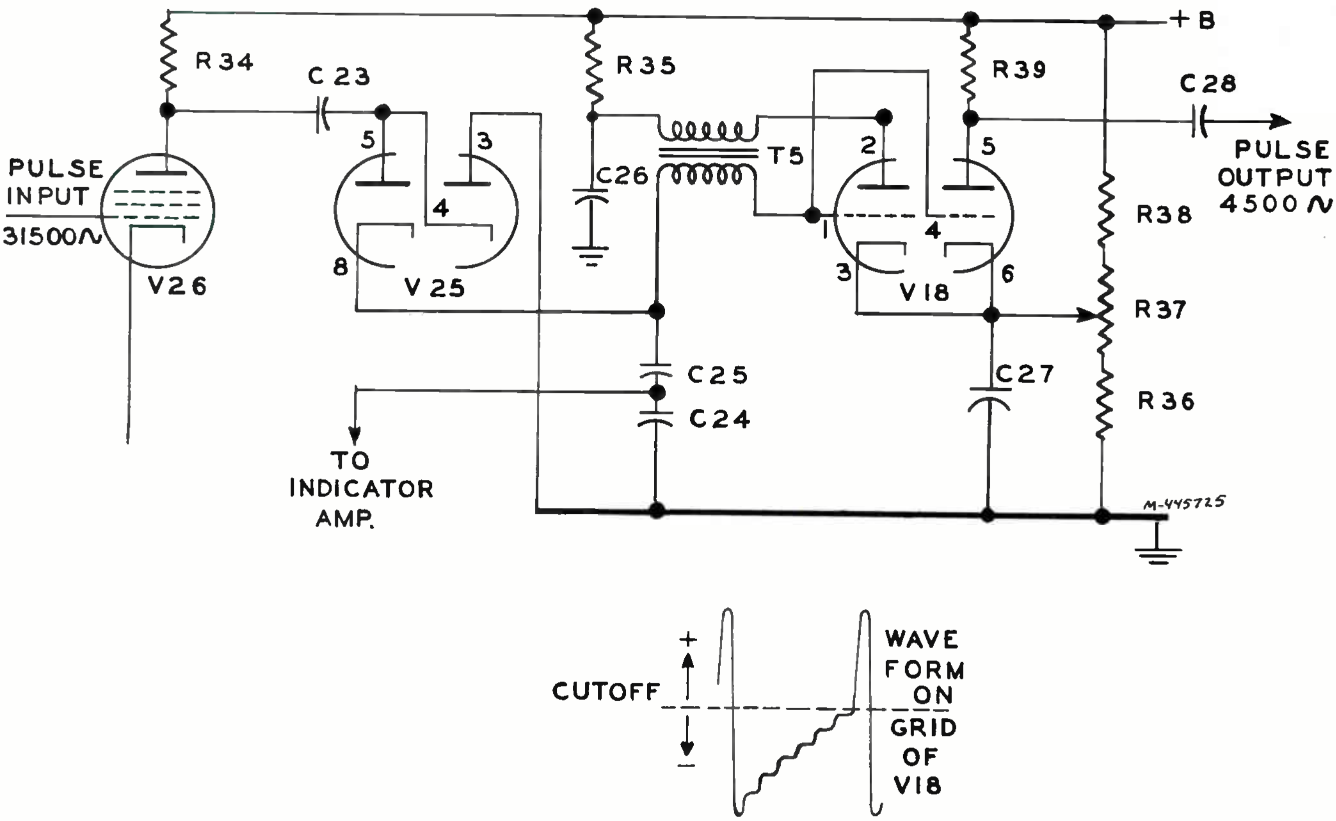


Figure 3 -- Simplified Schematic Diagram, 7:1 Counter Circuit; Pulse Former

The grid of the blocking oscillator is directly coupled to the grid of the amplifier, the second triode section of V18. This section is connected so that only the blocking oscillator pulse is amplified, to approximately 230 volts, and applied to the next counter diode, V17.

A 2-inch cathode ray indicator tube, V27, is used for checking the frequency division in the counter circuits. This tube, visible when the right side panel is lowered, is shown on Figure 10. A ratio-indicator switch, S5, has five positions, each connected to the cathode circuit of one of the five counter diodes. By placing the switch in any given position the voltage (waveform shaped like a flight of steps) that appears on the cathode of the corresponding diode will be impressed on the grid of one section of the indicator amplifier, V10. The output of this section is coupled to one of the vertical deflection plates of CRO tube, V27. A portion of the output of the first section is fed into the second section of the tube and its output, of opposite polarity, is coupled to the other vertical deflection plate of V27.

The number of steps in the waveform applied to V10 indicates the ratio of the frequency division in the counter circuit. Since there is no horizontal deflection, the vertical deflection created by the stair-step voltage results in a series of dots in a line on the screen of the CRO tube, indicating the frequency division.

Two potentiometers are connected in a voltage-dividing network: R79 to adjust the focus of the spot on the CRO screen, and R80 to control the brightness.

The dots representing the frequency divisions in the counter circuits may be viewed on the V27 screen by use of COUNTER INDICATOR SWITCH S5 and one of the five frequency controls. These frequency controls are marked as shown in the table which follows.

FIELD PULSE FORMER COUNTER CIRCUITS

Counter Circuit	Output Freq.	Position of Switch S5	Dots on V27	Frequency Controls	
				Symbol	Designation
31,500/2	15,750	15,750-2	2	R62	15,750 PULSES
31,500/7	4,500	4,500-7	7	R37	4,500 PULSES
4,500/5	900	900-5	5	R42	900 PULSES
900/5	180	180-5	5	R47	180 PULSES
180/3	60	60-3	3	R52	60 PULSES

60-Cycle Lock-In Circuit

The control grid of reactance tube V1 is excited by the voltage developed across capacitor C60, which is charged by applying the current from the oscillator tank voltage to the capacity-resistance network C9, R90, and C60. This current is substantially in phase with the tank voltage. Since the voltage developed across capacitor C60 lags the current flowing in it by 90 degrees, 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 nature 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 tube V1.

Bias for the reactance tube is obtained from the 60-cycle lock-in circuit, shown in simplified form in Figure 4. This circuit 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 step-down transformer, T1, and phase shift network, C1 and R1, to the grid of the clipper, V4. The 60-cycle square-wave output of the clipper is applied to a bridge circuit consisting of four diodes, V9 and V8, and transformer T2. One

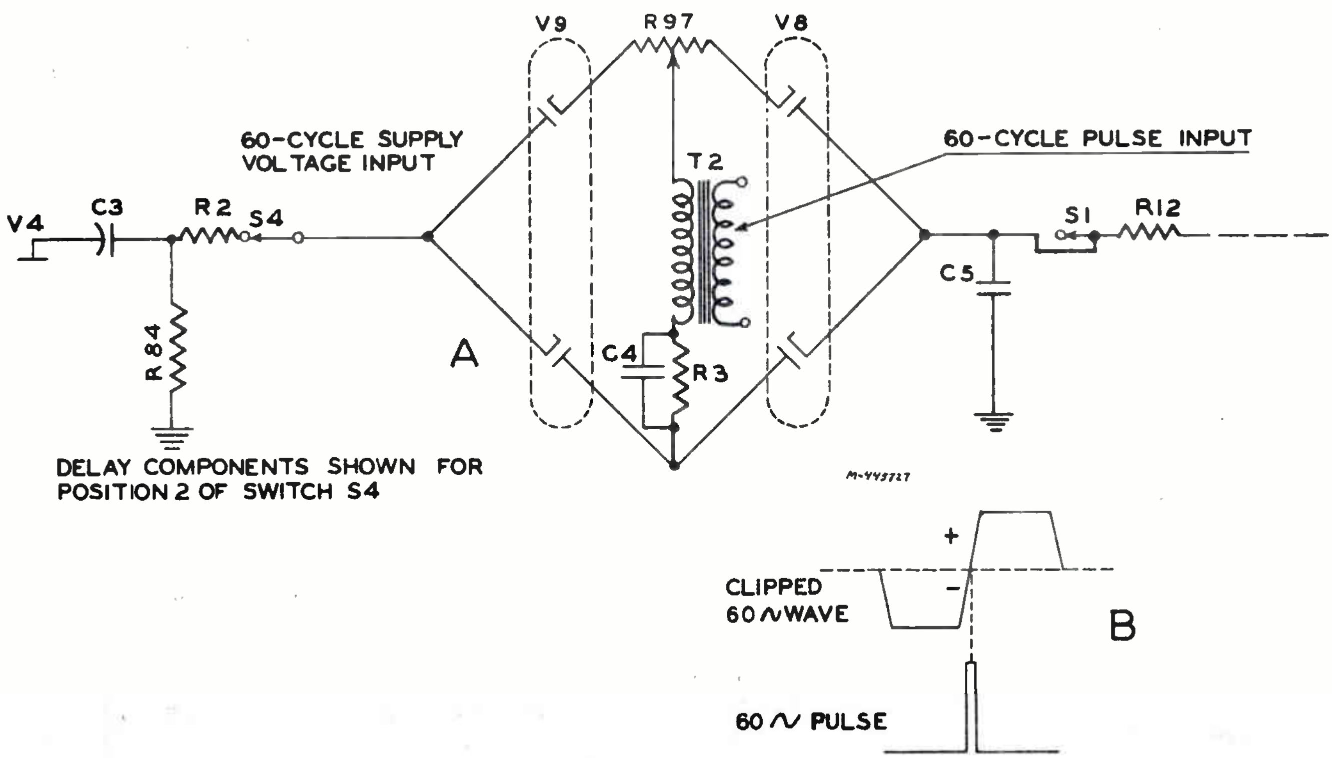


Figure 4 -- Simplified Schematic Diagram, 60-Cycle Lock-In Circuit; Pulse Former

corner of the bridge is connected to the output of V4 through switch S4 and associated resistors, R2, R85, or R86. The opposite corner of the bridge is connected to capacitors C5 and to the grid of V1 through switch S1. The 60-cycle pulse from the counter circuits is taken from the input of the 60-cycle pulse multivibrator, V30 in the pulse shaper, and applied to transformer T2 through buffer V7 and J1-7 in the pulse former and shaper. One end of the secondary of T2 is connected in series with the parallel combination, R3-C4, across one of the remaining two corners of the bridge circuit. The other end of the secondary is connected to the arm of the AFC BALANCE potentiometer, R97, which is connected in the remaining corner of the bridge circuit. See Figure 4.

When the 60-cycle pulse occurs, all of the diodes conduct, 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-C4 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 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. This reduces the mutual conductance which, in turn, increases the virtual inductance shunted across the tank circuit, with a resulting decrease in the master oscillator frequency.

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 when it is in the positive half of the cycle. Current will pass through the bridge in such direction as to place a positive charge on capacitor C60, causing the mutual conductance of the reactance tube to increase. This decreases 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 frequency depends upon the size of the R-C combination in the grid return circuit of the reactance tube. Switch S4 provides time-constant adjustments which may be used to match similar time constants in associated equipment.

Power Supply and Voltage Regulating

Power for operation of the pulse former and pulse shaper is obtained from a power supply in the pulse former case. One transformer, T11, provides heater current for the pulse former and plate voltages for both synchronizing units. Power input from J1 to the transformer primary may range from 98 to 129 volts, a-c, 50 to 60 cycles. A convenience outlet is provided, protected by a 10-ampere fuse, F1. An interlock switch, S3, and two 5-ampere fuses F2 and F3, are connected in the leads to the primary of T1. Pin 4 of J1 is used for plate voltage output to the pulse shaper.

The transformer primary is tapped at four points, selected by voltage-adjusting switch, S2, which also has an OFF position. In adjusting the transformer for line-voltage variations it is necessary only to rotate the switch until the meter pointer falls within the red lines since the voltmeter is connected to the 117-volt primary tap.

Full-wave rectification is accomplished by double-diodes V5 and V6. The rectified output is filtered and fed directly to the CRO tube. The portion required for plate supply to the other tubes passes through voltage-regulating tube V21.

Voltage-regulating tube V21 has its two triode sections connected in parallel so that the current flow from plate to cathode is in series with the current output of the power supply. Tube V21 then acts as a series resistor, adjustable by means of grid potential, which is controlled by the d-c amplifier tube, V20. The two gaseous-regulating tubes, V14 and V 19, serve to establish fixed potentials

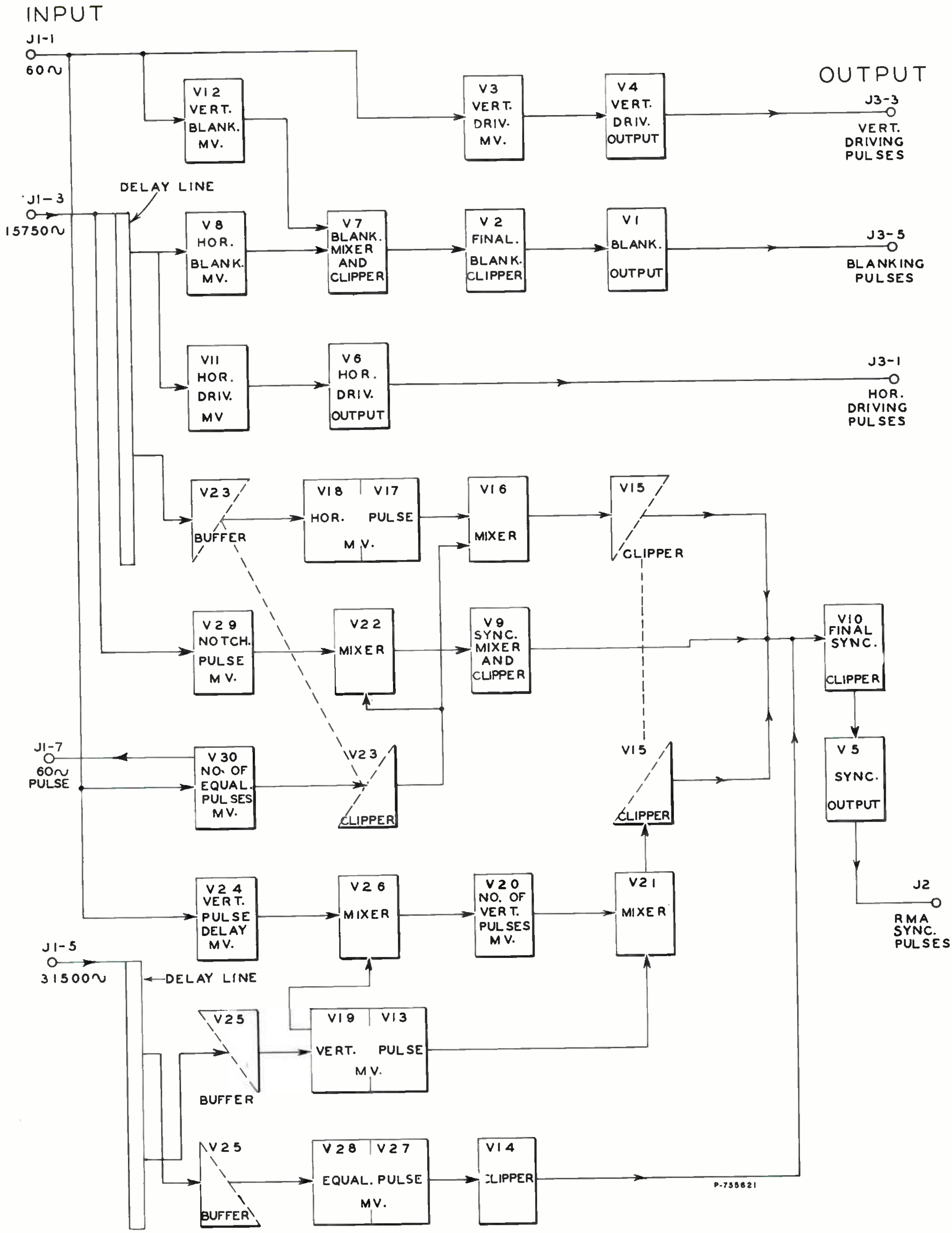


Figure 5 -- Block Diagram, Field Pulse Shaper

in V20 to permit the voltage-regulating action. Tube V14 is connected to maintain the cathode of the left-hand section of V20 at a constant potential with respect to the high side of the output. Tube V19 holds the cathode of the other section of V20 at a constant voltage with respect to ground and establishes a fixed voltage on the grid of the left-hand section of V20.

The regulating circuit functions so that an increase in load that causes a drop in output voltage results in a drop in potential across R66 and a reduction in the cathode voltage of V20 with respect to the grid. The grid potential is fixed by the action of V19. The relative increase of positive potential on the grid results in an increase of current through the tube and R70, thereby causing a drop in plate voltage. Reduction of plate voltage in the left-hand section of V20 also reduces the positive grid potential of the second section of this tube. This reduces the current drain through R72 with a resultant increase in positive voltage on the grids of V21, decreasing its plate resistance and raising the output voltage of the power supply to compensate for the increased load.

FIELD PULSE SHAPER

The pulse-shaping unit converts the pulses developed in the pulse former into horizontal and vertical driving pulses, and by a procedure of mixing, shaping, and clipping provides standard RMA synchronizing and blanking signals. Reference should be made to the block diagram in Figure 5, the pulse shaper views, Figures 1, 12, 13; and the schematic diagram, Figure 16.

Pulses are fed into the pulse shaper at the following frequencies:

31,500 cycles (master oscillator frequency).
15,750 cycles (horizontal scanning frequency).
60 cycles (vertical scanning frequency).

The pulse shaper develops:

Horizontal Driving Pulse, 15,750 cycles.
Vertical Driving Pulse, 60 cycles.
RMA Blanking Pulse, mixed 60 and 15,750 cycles.
RMA synchronizing signal.

Horizontal Driving Pulse

The driving pulse for line-frequency scanning is developed by using a 15,750-cycle pulse to synchronize a horizontal-driving multivibrator, V11. The pulses from the pulse former are fed into a delay line in the pulse shaper, consisting of multiple capacitor-shunted inductances L1 to L32, the line being tapped to feed the multivibrator, V11. The positive pulse from V11 is coupled to the grid of output tube V6, amplitude of the pulse being sufficient to drive V6 beyond cut-off, thereby clipping the negative portion of the input waveform. The negative pulse formed in the output of the tube is coupled to pin 1 of connector J3.

Vertical Driving Pulse

The field-frequency driving pulse is formed in a similar manner. The 60-cycle input synchronizes the vertical driving multivibrator, V3. A positive pulse from V3 drives the output tube V4 to cut-off, clipping the negative portion of the input pulse. The clipped pulse in the output of V4 is coupled to pin 3 of connector J3.

RMA Blanking Pulse

The RMA blanking pulse is a combination of 60-cycle and 15,750-cycle pulses. The 15,750-cycle component is generated in the horizontal blanking multivibrator, V8, which is synchronized by a negative pulse from the delay line. The 60-cycle pulses for the composite blanking signal are developed by the vertical blanking multivibrator, V12, triggered by 60-cycle pulses from the pulse former. Positive pulses from both multivibrators are applied to the two grids in clipper and mixer tube V7. The two signals are mixed on the common load resistor R91 and the resultant signal fed to the final blanking clipper, V2. Edges of the pulses are steepened by the peaking coil, L67, in the plate of V2, and coupled to the blanking output tube, V1. The desired blanking signal of negative polarity from V1 is connected to pin 5 of the output connector, J3.

RMA Synchronizing Signal

The RMA synchronizing signal is developed by mixing signals at various stages. This procedure requires the development of four signals, three of which are composite signals. Final mixing of the four signals across a common load resistor and clipping of the resulting signal, provide the waveform required in a standard synchronizing signal. The waveforms of the various signals and the combinations formed are shown in Figure 6.

The first of the four signals is generated in the equalizing pulse multivibrator, comprising tubes V27 and V28, which is synchronized by a 31,500-cycle pulse from the delay line in the input circuit through buffer tube V25. This delay line is similar to that employed with the 15,750-cycle pulses. Positive pulses from the multivibrator are clipped twice in V14 and appear across the adjustable load consisting of R126 and R220.

The second signal consists of 15,750-cycle horizontal synchronizing pulses keyed by 60-cycle pulses. Horizontal synchronizing pulses are obtained from the horizontal pulse multivibrator, V18 and V17, which is synchronized by a pulse from the 15,750-cycle delay line through buffer tube V23. The positive output pulse of the multivibrator is fed to the first grid of mixer V16.

The 60-cycle keying is generated in the number-of-equalizing-pulses multivibrator, V30, which is synchronized by a 60-cycle pulse from the pulse former, and coupled to clipper V23. A negative keying pulse is obtained from the plate of V23 and coupled to the third grid in mixer V16. The mixer tube then develops 15,750-cycle pulses in the output except during the interval when the 60-cycle pulse is applied to its third grid. The resultant signal is clipped in tube V15 and developed across the adjustable load.

The third signal is also composed of 15,750-cycle pulses keyed by a 60-cycle pulse from the number-of-equalizing-pulses multivibrator, V30. The 15,750-cycle pulse is produced by the notching pulse multivibrator, V29, synchronized by a pulse from the delay line. The 60-cycle signals from V23 and the 15,750-cycle signals from V29 are mixed in V22 and fed to a clipper, V9. The output of V9, which feeds the adjustable load, has the notching pulse present in the intervals between the 60-cycle keying pulses.

The fourth signal 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, V13 and V19, which is synchronized by a pulse from the 31,500-cycle delay line through buffer V25. Outputs of the multivibrator are fed to mixers V26 and V21. Since the groups must contain six complete vertical pulses, the leading edge of the 60-cycle pulse must fall between adjacent 31,500-cycle pulses and not during these pulses.

Negative 60-cycle pulses obtained from the vertical pulse delay multivibrator, V24, are synchronized by 60-cycle pulses from the pulse former. When the pulses are differentiated the trailing edges of the pulses become positive keying pulses, and are applied to the third grid of mixer V26.

Narrow 31,500-cycle pulses are applied to the first grid of V26 from the multivibrator V19 and V13, as previously mentioned. The output of V26 consists of 31,500-cycle pulses occurring during the 60-cycle keying pulse interval. The first of these pulses having sufficient amplitude is used to synchronize the number-of-vertical-pulses multivibrator V20. The positive output of V20 is applied to number-one grid (cap) of the mixer V21, while wide, positive, 31,500-cycle pulses from the vertical pulse multivibrator, V13 and V19, are applied to the number three grid (pin 5) of V21. This latter signal is the inverted form of wave used to trigger the number-of-vertical-pulses multivibrator, V20. Multivibrator V20 will be triggered only during the short interval between vertical pulses, and a whole vertical pulse will always appear at the beginning of the group of six.

The negative output of mixer V21 is fed to the synchronizing mixer and clipper, V15, the output of which appears across the adjustable load.

The complex signal resulting from the four signals applied simultaneously to the adjustable load, R126-R220, is coupled to the final synchronizing clipper V10. In the second stage of the clipper, the peaking coil, L66, is used to steepen the sides of the pulses. The signal is then fed to the synchronizing output tube, V5, then coupled to the synchronizing output connector, J2.

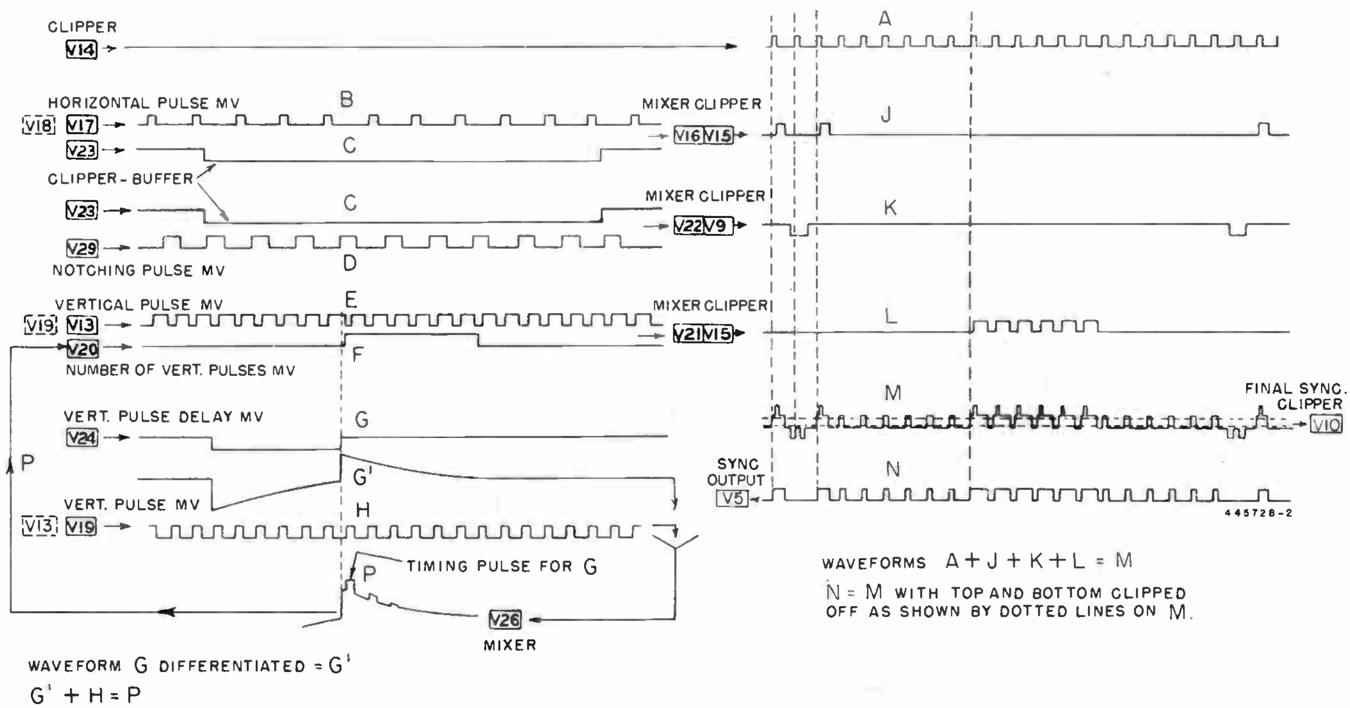


Figure 6 -- Forming RMA Standard Sync Signal (in shaper unit)

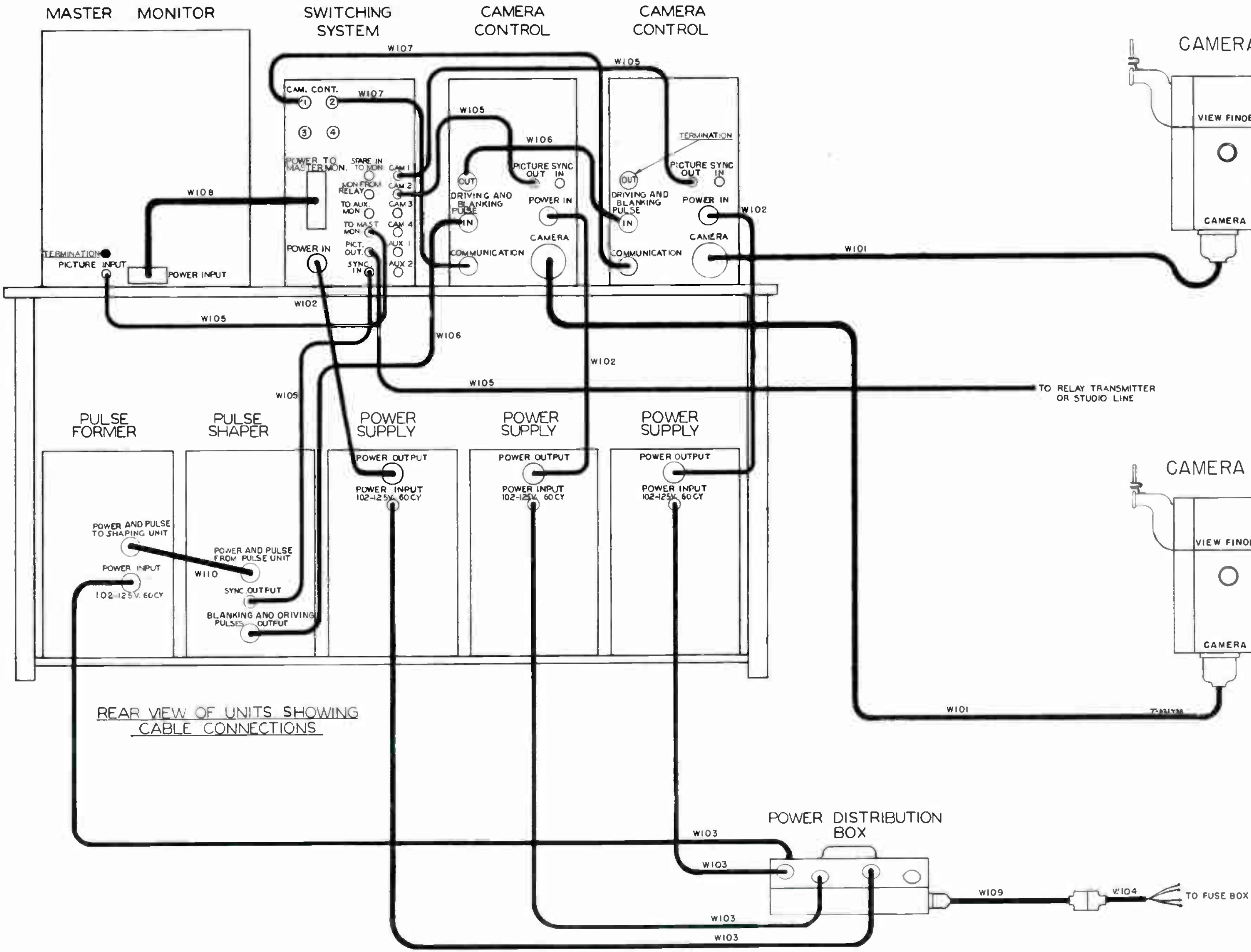


Figure 7 -- Interconnections, Field Pick-Up Television Equipment

INSTALLATION

GENERAL

Upon receipt of the equipment, the units should be unpacked and inspected for any damage that may have occurred in transit. Shipping lists should be checked to insure that all quantities are correct.

Before attempting to put the equipment into operation in the system, it is necessary to make certain preliminary adjustments and to determine the operating status of each unit in order to locate any derangements caused by shipping.

INITIAL ADJUSTMENTS

Preparation

Remove the side panels from the pulse former and pulse shaper cases by rotating the cowl fasteners at the top edge of the panels a quarter turn, swinging the panels away from the case to clear the interlock plug prongs, and then lifting them off the three spring studs at the bottom of the cases. This will open the interlock switch, which may be shorted for test purposes by removing the pronged plug from the clips on the side panel and inserting it in the interlocks.

Check the fuses, F2 and F3, located on the front panel of the Field Pulse Former to make certain they are in place. Rotate **LINE VOLTAGE** switch, S2, on the front of the case to the **OFF** position. For testing, a temporary connection from a 115-volt power source may be made to the **POWER INPUT** receptacle, at the rear of the pulse former. The 10-foot power cable may be used for the purpose by plugging one end into the receptacle and arranging temporary connections to the power lines at the other end of the cable.

Plug one end of the seven-conductor cable into the top receptacle, **POWER AND PULSES TO PULSE SHAPER** on the pulse former, then attach the other end of the cable to the top receptacle, **POWER AND PULSES FROM PULSE FORMER**, on the pulse shaper.

As a dummy load for the equipment, attach the termination plug to the **DRIVING AND BLANKING PULSES OUTPUT** receptacle on the pulse shaper.

Counter Adjustments

Close the switch at the power source and rotate **LINE VOLTAGE** switch, S2 on the pulse former, until the meter pointer indicates between the two red lines on the scale. Allow the units to heat for several minutes and proceed with the following adjustments on the pulse former:

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

2. Adjust the **BRIGHTNESS** control until the dots appear on the screen, then adjust the **FOCUS** control until the dots are the desired width. Adjust **FOCUS** control so that dots are distinct. The **CRO** tube should be biased off with the **BRIGHTNESS** control when not in use. When in use, it is desirable to defocus the **CRO** tube somewhat to avoid burning the screen.

3. Rotate the **COUNTER INDICATOR** switch to the 15750-2 position and adjust the **FREQUENCY CONTROL 15750 PULSES** until two dots appear on the indicator tube.

4. 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.

5. 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.

6. 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.

7. 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.

After completing the preceding adjustments, recheck each control to be sure that it is at the center of the available control range.

Master and Crystal Oscillator Adjustments

These oscillators have been adjusted at the factory prior to shipment. Should any readjustments be required, refer to the **MAINTENANCE** section.

Shaper Unit Adjustments

All the shaper adjustments have been made, and the locknuts tightened, prior to shipment. Before using the sync generator for the first time, all the adjustments should be checked, then readjusted if necessary, as described in the **MAINTENANCE SECTION.**

Having made all the necessary preliminary adjustments the sync generator is ready for interconnection with the balance of the Field Pick-Up system.

INTERCONNECTIONS

Figure 7 shows interconnections for a system using more than one camera and including a switching unit. If only one camera chain is used, connect the **SYNC OUTPUT** cable, W106, from the shaper to the **SYNC INPUT** jack on the camera-control. Connect the termination plug to the **DRIVING AND BLANKING PULSES OUT** jack on the camera control. The sync generator is now ready for operation.

INSTALLATION OF SHOCKMOUNTS

Shockmount assemblies are for use when the equipment is installed in mobile units or when located where shock or vibration may affect the life or operation of the units. To attach the shockmount to a case engage holes in the lower back edge of the case with the spring-actuated pins on one end of the shockmount. Then engage the tapered collars of thumbscrews on the other end of the shockmount with extended lugs on the lower front edge of the case.

O P E R A T I O N

TO START THE EQUIPMENT

To place the sync generator in operation turn the **LINE VOLTAGE RAISE** switch to the position that will cause the meter to indicate between the two red lines on the meter scale.

It is advisable to apply power to the sync generator at least 30 minutes prior to the start of the program. This allows the equipment to warm up and stabilize. The equipment should not be shut off unnecessarily once it has been turned on.

AUTOMATIC FREQUENCY CONTROL (AFC)

Set the **FREQ CONTROL** switch for the desired mode of operation and the **AFC TIME CONST** switch to the highest time constant that will cause the equipment to operate in a satisfactory manner.

PHASE SHIFT CONTROL

The **PHASE SHIFT** control is used only for film programs. For that application the control is used to adjust the vertical driving signal for the camera so that it is in phase with the projector.

TO STOP THE EQUIPMENT

To stop the equipment, place the **LINE VOLTAGE RAISE** switch in the **OFF** position.

MAINTENANCE

WARNING

The voltages employed in this equipment are sufficiently high to endanger life. Every reasonable precaution has been observed to safeguard maintenance personnel. Power should be removed completely before making internal repairs.

Make certain power is off and capacitors are discharged before touching any component. Be very careful when touching tubes. A serious burn can result from carelessly touching tubes that have been in operation for a considerable length of time.

When making resistance measurements, turn power off. When testing voltages with the interlocks bypassed, use well-insulated test probes.

GENERAL

The Field Sync Generator has been conservatively designed for continuous operation. With ordinary care a minimum of service will be required to keep the equipment in satisfactory operation. To avoid interruptions due to equipment failure during operation, a regular schedule of inspection should be established.

Since the equipment will probably be subjected to conditions of excessive dust and moisture by reason of its use in the field, a periodic inspection routine should be established to assure the removal of dust and other extraneous substances that may cause current leakage or arc-over between high-potential points. The equipment units should be cleaned and dusted thoroughly during inspection periods. All bushings and terminal boards, should be kept free of dust.

All cable connections should be checked periodically and tightened when necessary. Make certain all ground connections are tight. A spare set of cables will facilitate cable maintenance.

When fuses are renewed, the fuse cartridge caps should be clean to insure good contact and to prevent fuse heating due to contact resistance.

When improper operation is experienced, make certain all controls are properly adjusted. This is the most frequent cause of improper operation. The use of elaborate test equipment is not always a necessity if correct trouble-shooting procedure is followed. The cause of faulty operation may often be detected by visual inspection of wiring and components.

The amplitude and pulse widths of the output signals should be checked periodically, as aging of tubes may cause small variations or unwanted pulses to appear in the sync signal. The latter condition may be remedied by adjusting the **CLIPPING LEVEL** control.

Defective counter circuits 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 a defective counter. No spots on the indicator with **BRIGHTNESS** control all the way clockwise may be due to defective heater or low heater voltage on V27.

ROUTINE MAINTENANCE

The most effective way of assuring continuous satisfactory operation of the equipment is to initiate a regular schedule of maintenance. All performance data should be recorded on previously-prepared forms so that a continuous record of all parts of the equipment will be available. A suggested schedule follows:

DAILY - Note any abnormal conditions such as position of knobs. A general inspection should be made immediately after shut-down. Check for signs of overheating in all parts of the equipment.

WEEKLY - Clean internal and external parts of the equipment. Inspect and tighten all cable connections. Check adjustment of the equipment controls and readjust if necessary.

MONTHLY - Check all tubes in the equipment, noting the tube tester readings on previously-prepared forms. Record and compare all cable socket voltages. As far as possible, tube failure should be anticipated by keeping a log of tube life. Spare tubes should be available for immediate use in the event of an obvious failure.

SERVICE ADJUSTMENTS - PULSE FORMER

Master Oscillator

Should it become necessary to adjust the master oscillator coil, T3, due to replacement, proceed as follows:

1. Turn on the equipment, allow a 5-minute warm-up period, then set the master oscillator core of coil T3, to approximately midway between maximum clockwise and maximum counter-clockwise positions.

2. Set the **FREQUENCY CONTROL** switch in **OFF** position.

3. Connect a 60-cycle sine wave source of suitable amplitude to the horizontal deflection terminals of an oscilloscope. (Internal 60 cycle sweep of oscilloscope may be used.)

4. Connect the oscilloscope vertical input to the SYNC output terminal at the rear of the pulse shaper (or to any other signal terminal where the 60-cycle vertical blanking or driving pulses are present).

5. Switch power onto the units and adjust the plug on the oscillator coil T3, shown on Figure 10, until the 60-cycle pulse from the pulse former remains approximately stationary. The 31,500-cycle oscillator will then be set at the correct frequency. Disconnect oscilloscope and reset the frequency control switch to either 60-cycle or crystal position as required. Turn power off.

AFC Balance Adjustment

To adjust the AFC Balance control, R97, proceed as follows:

1. Connect the vertical input cable of an oscilloscope to pin 1 of J1 or to C43. Set the horizontal sweep of the oscilloscope to line frequency (sine wave).

2. Turn the equipment power on and allow a warmup period of at least 5 minutes.

3. Turn the **FREQ CONTROL** switch to the **OFF** position and the **AFC TIME CONST** switch to position 4.

4. Turn the core of T3 to its extreme clockwise position, and **FREQ CONTROL** switch to 60 cycles, then connect a VoltOhmyst or similar vacuum-tube voltmeter across C5.

5. Using a screwdriver, adjust the AFC Balance Potentiometer, R97 on Figure 11, until the voltage reading on the meter falls between 0 and +0.05. Allow a short time for the voltage to

stabilize, then turn the **FREQ CONTROL** switch to **OFF.**

6. Note that a pulse slowly moves around the perimeter of the oscilloscope pattern, adjust the core of T3 for minimum drift of the pulse.

7. Check for proper 60 cycle "lock-in" as evidenced by the stationary position of the pulse on the oscilloscope pattern. Note that as the **AFC** time constant is increased, the "lock-in" period is also increased. If the 60 cycle "lock-in" appears to be abnormal, check the reactance tube, V1, for grid current (gassy tube); if there is no evidence of grid current, readjust the **AFC** balance potentiometer as in step 5.

8. Reset the panel controls to the desired position, shut the power off and disconnect the test equipment.

Crystal Oscillator Adjustment

To adjust the crystal oscillator, connect a VoltOhmyst or similar instrument to pin 1 of V4; tune the crystal oscillator coil, T4; for maximum voltage indication on the meter, then turn the core of the coil two turns in the counterclockwise direction. Maximum voltage is approximately between 70 and 100 volts.

SERVICE ADJUSTMENTS - PULSE SHAPER

General

Adjustment of the 11 controls in the pulse shaper should be periodically checked and readjusted if necessary. When a tube in any circuit is replaced, it is advisable to recheck the adjustments of all circuits. Methods for measuring pulse widths are described farther on in this section.

Pulse Shaper Adjustments

To check and readjust the pulse shaper controls proceed as follows:

1. Connect the pulse shaper to the pulse former, terminate the **SYNC OUTPUT** jack with 75 ohms; connect the pulse termination plug, supplied with the equipment, to the **DRIVING AND BLANKING PULSES OUTPUT** jack; then connect the power cable to the **POWER INPUT** jack on the pulse former and to a suitable power outlet. Turn the power on and allow at least 5 minutes for the equipment to warm up.

2. Remove the side covers, plug in the interlock shorting-bar, then connect the vertical input terminals of an oscilloscope to pin 2 of V9. Use the 60-cycle sine-wave horizontal sweep for the following adjustments:

a. Adjust the **NUMBER OF EQUALIZING PULSES** control until the total of equalizing and vertical sync pulses equals eighteen.

b. Adjust the **VERTICAL PULSE DELAY** control until six equalizing pulses occur before the vertical sync pulse.

c. Adjust the **NUMBER OF VERTICAL PULSES** control until six vertical sync pulses appear in the vertical sync pulse interval.

d. The amplitude of the signal at V9, pin 1, should be adjusted to approximately 22.5 volts, peak-to-peak, by means of the CLIPPING LEVEL control, R126, identified on Figure 12.

3. Connect the vertical input terminals of the oscilloscope to the SYNC OUTPUT termination, then using any desired method for pulse width measurement, see "MEASURING PULSE WIDTH", adjust the controls for the following RMA standard pulse widths:

NOTE

H =Time from start of one line to start of next line or 63.5 microseconds. V = 1/60 second. Pulse widths are measured at points shown on Figure 9 (10% below maximum amplitude).

a. EQUALIZING PULSE WIDTH ---- 4% H (2.5 microseconds)

b. VERTICAL PULSE WIDTH ---- 46% H (27.3 microseconds)

c. HORIZONTAL PULSE WIDTH ---- 8% H (5.0 microseconds)

4. Without removing the pulse termination plug adjust the following:

a. Connect the oscilloscope to pin 1 of J3 and adjust the HORIZONTAL DRIVING WIDTH to 10% H (6.4 microseconds).

b. Connect the oscilloscope to pin 3 of J3 and adjust the VERTICAL DRIVING WIDTH to 4% V.

c. Connect the oscilloscope to pin 5 of J3, then adjust the HORIZONTAL BLANKING WIDTH to 17.5% H, (11.0 microseconds), and the VERTICAL BLANKING WIDTH to 7.5% V.

5. Lock ALL the controls.

6. To check the "front porch", temporarily connect the blanking output, J3-5, to the SYNC OUTPUT jack, J2, then connect the oscilloscope to the SYNC OUTPUT jack. Compare the waveform with Figure 8.

If an adjustment is necessary, this may be accomplished by moving the red-black and red-yellow wires along the delay line formed by capacitors C1 to C32 and coils L1 to L32. These components are shown on the pulse shaper schematic diagram, Figure 16. **CARE SHOULD BE TAKEN TO INSURE THAT THE 15,750-CYCLE COUNTER CIRCUIT IS PROPERLY ADJUSTED BEFORE DELAY LINE CHANGES ARE MADE.**

7. Shut the power off, disconnect the oscilloscope, remove the terminations and interlock shorting-bar, then replace the side covers. This completes the adjustment of the Field Shaper.

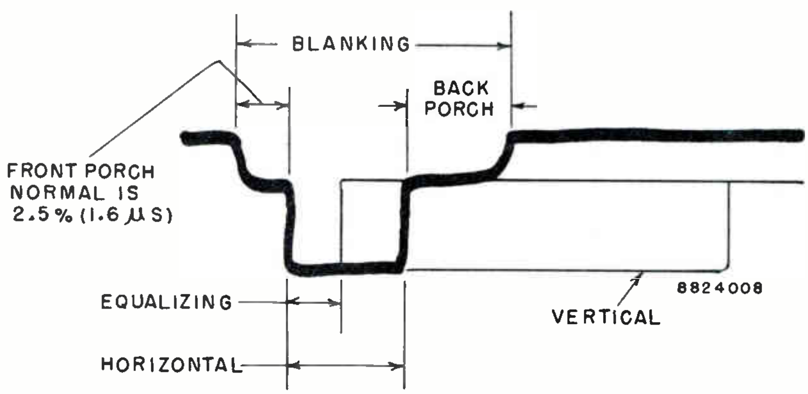


Figure 8 -- Front Porch Measurement (see text)

MEASURING PULSE WIDTH

Horizontal Sweep with Microsecond Markers

A convenient method of measuring 31,500 and 15,750-cycle pulses utilizes an RCA Type 715-A Oscilloscope, or 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 some pulse delay with respect to the beginning of the sweep. The synchronizing signal can be obtained from the input end of 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; 15,750 and 31,500 cycles

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 oscilloscope screen is an edge 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 3.1416.

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

$$\text{Per cent width} = \frac{\text{length of arc}}{\text{circumference}} \times 100 = \frac{c}{\pi d} \times 100$$

where: c = length of arc
d = diameter of circle
π = 3.14

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.

Sine Wave Sweep - 60 cycles

The method of using a sine wave sweep for horizontal deflection when measuring 60-cycle pulses is especially convenient when the synchronizing equipment is locked to the power line. The same procedure of measuring is used for 60-cycle pulses as was followed for 15,750-cycle pulses, and the same precautions must be taken to insure accurate results. Since the widths of the 60-cycle pulses vary from 500 microseconds to 2000 microseconds, it is not practicable to use one-microsecond markers as a measuring device.

A convenient method is to use a flexible scale, calibrated in millimeters, to measure the diameter of the circle (d) and the width of the pulse (c). For example:

d = 60 mm.
c = 15 mm.

$$\text{Per cent width} = \frac{c}{\pi d} \times 100 = \frac{15 \times 100}{3.14 \times 60} = 8\%$$

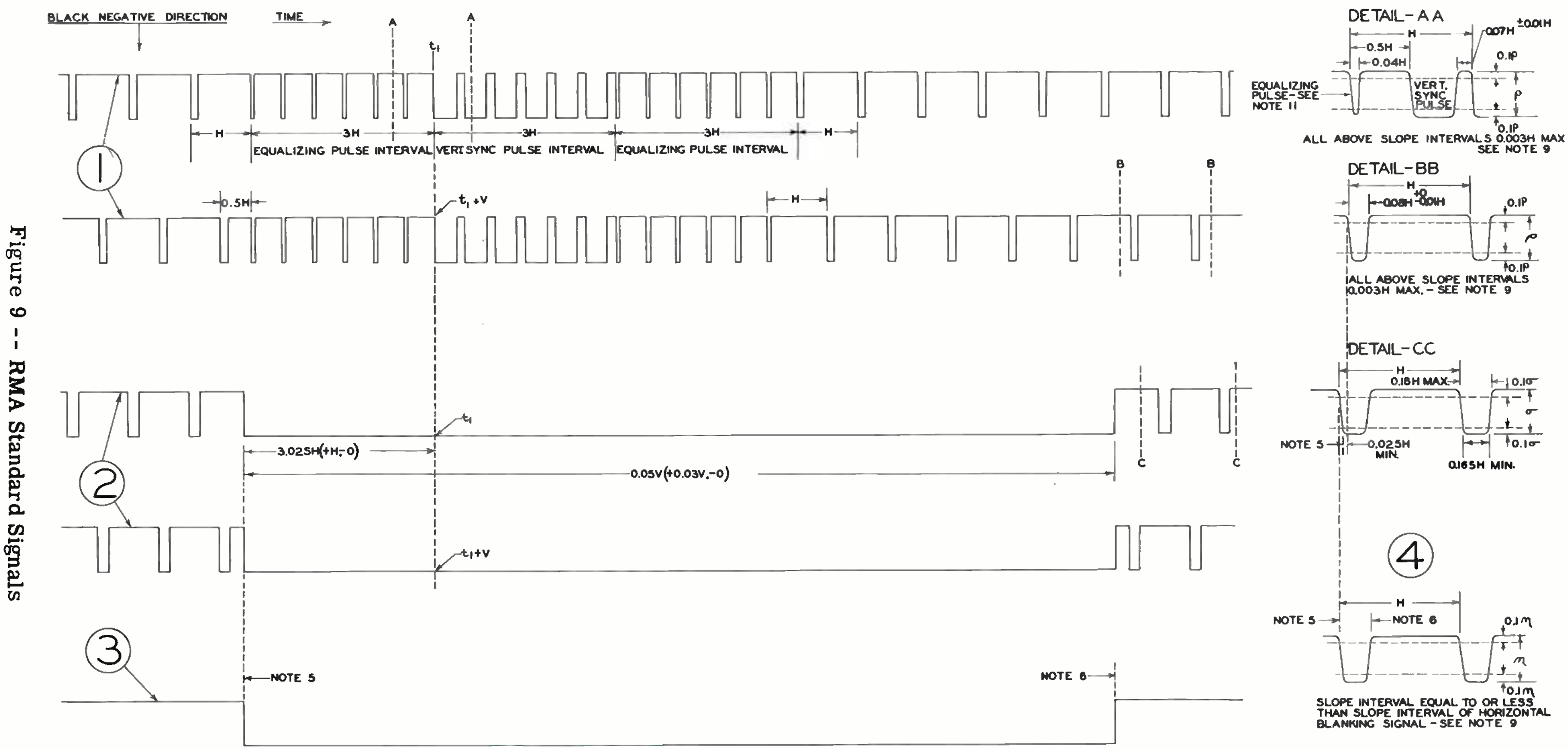
Any unit of length may be used. For ease of measuring, a transparent scale should be used.

When using this method bear in mind that the "per cent width" in the formula now refers to 1/60 of a second or the time for one picture field.

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%

RMA SUBCOMMITTEE ON STUDIO FACILITIES
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Figure 9 -- RMA Standard Signals

TROUBLE SHOOTING

General

Although the Field Synchronizing Generator contains 57 tubes, there are no difficult trouble shooting problems involved. Maintenance personnel will find that the illustrations in this instruction book generally pertain to trouble shooting. The "TROUBLE SHOOTING CHART - TUBE REPLACEMENT," should help to isolate a defective tube quickly.

Pulse Former

The block diagrams, Figures 2 and 14; schematic diagram, Figure 15; PULSE FORMER D-C VOLTAGE CHART, and the photographs, Figures 1, 10, and 11; will aid in trouble shooting and identifying components in the pulse former. The schematic diagram includes waveforms.

Since the pulse former generates its own signal and also contains a cathode-ray indicator tube, it is best to start trouble shooting by observing the counter-circuit indications on the cathode ray tube.

Note that the block diagram, Figure 2, is divided into sections by dotted lines, therefore trouble shooting should be completed in one section before proceeding to another. It is suggested that tests be made in the following order:

1. Check counter circuits on indicator. If indicator is inoperative, proceed with steps 2 and 3 otherwise proceed with step 4.
2. Power supply section.
3. Frequency indicating section.
4. Frequency generating section.
5. Frequency control section.
6. Check signals at J1.

Pulse Shaper

The pulse shaper is the more complicated of the sync generator units. However, MOST TROUBLES ARE DUE TO TUBE FAILURE. As an aid to trouble shooting, the following illustrations and charts are included in this book.

1. Block diagrams, Figures 5 and 14.
2. Waveforms on Figures 6, 9, 14, and 16.
3. Schematic Diagram Figure 16.
4. Pulse Shaper, D-C Voltage Chart.
5. Pulse Shaper Trouble Shooting Chart.
6. Photographs, Figures 1, 12, and 13.

Defective circuits can usually be isolated by the signal tracing method without resorting to the trouble shooting chart, which involves removing all the tubes then replacing them several at a time. This chart should be used only for isolating severe and obscure defects in the sync output signal.

TROUBLE SHOOTING CHART - TUBE REPLACEMENT

PULSE FORMER

Step No.	Sympton	Check Tube Numbers	Remarks
1	No spot on CRO indicator tube	a. 27	Check positions of **FOCUS** and **BRIGHTNESS** controls
		b. 5, 6, 14, 19, 20, 21	Check power input
2	Single spot on CRO tube, all positions of **INDICATOR SWITCH**	1, 2, 3, 10	
3	Only one spot on CRO for:		
	a. 15750 - 2:1 counter	11, 12, 13	
	b. 4500 - 7:1 counter	18, 25, 26	
	c. 900 - 5:1 counter	17, 24	7:1 counter checked ok
	d. 180 - 5:1 counter	16, 23	First 5:1 counter checked ok
	e. 60 - 3:1 counter	15, 22	Second 5:1 counter checked ok
4	Does not lock-in on 60-cycle	1, 7, 8, 9	Check 60 cycle input from pulse shaper at J1-7 on pulse former
5	Does not lock-in on crystal	V4	Check power line frequency if possible, then check free running frequency of master oscillator (**FREQ CONTROL** switch in the **OFF** position); 60-cycle output should not deviate from power line by more than one cycle

PULSE SHAPER*

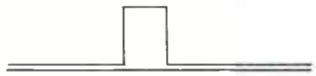
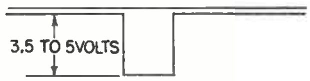
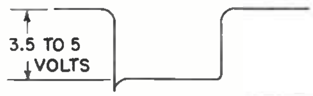
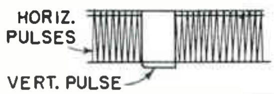
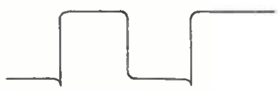
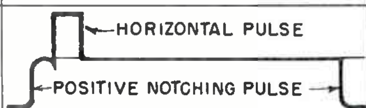
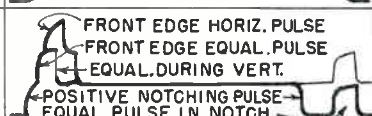
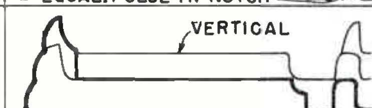
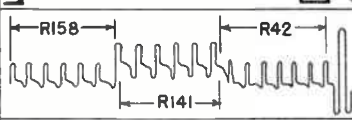
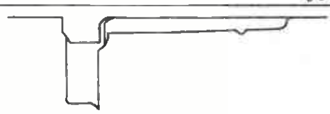
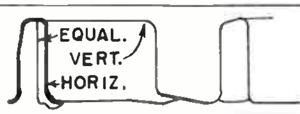
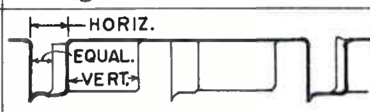
Step No.	Sympton	Check Tube Numbers	Remarks
1	No vertical drive	3, 4	
2	No vertical blanking	12	Horizontal ok
3	No horizontal blanking	8	Vertical ok; Delay line ok
4	No blanking signal	1, 2, 7, 8, 12	
5	No horizontal drive	6, 11	Check delay line
6	Sync Signal:		
	a. No Sync Signal	5, 10	
	b. No horizontal pulses; Horizontal sync pulse half normal width; **HORIZONTAL PULSE WIDTH** control ineffective	15, 16, 17, 18, 23	
	c. No equalizing pulse	25, 27, 28, 14	Check delay line
	d. Horizontal pulses appear where equalizing pulses should appear	30, 23	
	e. Equalizing pulses appear between horizontal pulses	29, 22, 9	Check delay line
	f. Unwanted pulses in positive region of sync output		Adjust clipping level control

*NOTE: If pulse former is functioning properly and more than one signal is missing at the shaper output, check the interconnecting cable between the two units.

PULSE SHAPER TROUBLE SHOOTING CHART

CONDITIONS

1. Pulse former connected to pulse shaper, with PULSE FORMER ADJUSTED FOR NORMAL OPERATION, 75-ohm terminations on J2 and J3 of pulse shaper.
2. Mark "V" numbers on tubes of pulse shaper, remove tubes, turn power on, allow at least 5-minute warm-up, then proceed with tests.
3. All voltages on chart are peak-to-peak.

Step No.	Install Tube No.	Connect Vertical Input of Oscillo-scope to	Oscilloscope Horizontal Sweep Frequency in Cycles	Waveform	Remarks
1	30	V23-4	60 (sine wave)		Pulse width adjustable by: NUMBER OF EQUAL. PULSES, R42
2	3, 4	J3-3	60 (sine wave)		Adjustable by: VERTICAL DRIVING WIDTH, R212. 4% (normal setting)
3	6, 11	J3-1	15, 750		Adjustable by: HORIZONTAL DRIVING WIDTH, R166. RMA std. 10% (6.4 us)
4	1, 2, 7, 8, and 12	J3-5	15, 750		Pulse width adjustable by: HORIZONTAL BLANKING WIDTH, R110. RMA std. 17.5% (11.0 us)
5	-	J3-5	60 (sine wave)		Pulse width adjustable by: VERTICAL BLANKING WIDTH, R100. RMA std. 7.5%
6	9, 22, 23 and 29	V15-2	15, 750		Amplitude adjustable by Clipping Level Control, R126. One complete notching cycle is 63.49 us
7	15, 16, 17, and 18	V15-2	15, 750 (triggered sweep)		
8	14, 25, 27, and 28	V15-2	15, 750		The 2:1 counter control in the pulse former must be in the center of the two-count range. SEE NOTE 1.
9	13, 19, 20, 21, 24, and 26	V15-2	15, 750		Adjust Clipping Level Control for 22.5 volts peak-to-peak
10	-	V15-2	15, 750		Adjust R158, R141, and R142 for six pulses in each group
11	10	V10-5	15, 750		
12	-	V10-2	15, 750		
13	5	J2 (75-ohm termina-tion)	15, 750		

NOTE 1: In order to obtain desired timing, adjustment of the delay-line tap (red/blue wire) may be necessary after 2:1 counter is adjusted.

PARTS LIST

FIELD SYNCHRONIZING GENERATOR

FOR ORDERING INFORMATION SEE PAGE 4

SYMBOL NO.	DESCRIPTION	DRAWING NO.	STOCK NO.
	FIELD PULSE FORMER, MI-26105		
C1	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C2	Not Used		
C3, C4	Capacitor, 1.0 mf, 600 volts	K-895406-3	56124
C5	Capacitor, 4.0 mf, 600 volts	K-8856404-1	52983
C6	Capacitor, 1.0 mf, 600 volts	K-895406-3	56124
C7	Capacitor, 68 mmf, 500 volts	P-722001-569	51338
C8	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C9	Capacitor, 470 mmf, 500 volts	P-722001-589	39644
C10, C11	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C12	Capacitor, 120 mmf ±5%, 500 volts	P-722002-525	39630
C13 to C15	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C16	Capacitor, 0.25 mf, 400 volts	P-72061-518	54145
C17	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C18	Capacitor, 1.0 mf, 600 volts	K-895406-3	56124
C19	Capacitor, 390 mmf, 500 volts	P-722001-587	39642
C20	Capacitor, 10 mmf, 500 volts	P-722001-552	39604
C21	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C22	Capacitor, 0.5-0.5 mf, 600 volts	K-895406-1	51916
C23	Capacitor, 27 mmf, 500 volts	P-722001-559	39614
C24	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C25	Capacitor, 1000 mmf, 500 volts	P-722008-597	68954
C26	Capacitor, 0.05 mf, 400 volts	P-72061-544	52974
C27	Capacitor, 1.0 mf, 600 volts	K-895406-3	56124
C28	Capacitor, 27 mmf, 500 volts	P-722001-559	39614
C29	Capacitor, 0.02 mf, 400 volts	P-72061-545	53114
C30	Capacitor, 1000 mmf, 500 volts	P-722008-597	68954
C31	Capacitor, 0.05 mf, 400 volts	P-72061-544	52974
C32	Capacitor, 1.0 mf, 600 volts	K-895406-3	56124
C33	Capacitor, 27 mmf, 500 volts	P-722001-559	39614
C34	Capacitor, 0.02 mf, 400 volts	P-72061-545	53114
C35	Capacitor, 1000 mmf, 500 volts	P-722008-597	68954
C36	Capacitor, 0.05 mf, 400 volts	P-72061-544	52974
C37	Capacitor, 1.0 mf, 600 volts	K-895406-3	56124
C38	Capacitor, 270 mmf, 500 volts	P-722001-583	39638
C39	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C40	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C41	Capacitor, 0.05 mf, 400 volts	P-72061-544	52974
C42	Capacitor, 1.0 mf, 600 volts	K-895406-3	56124
C43, C44	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C45	Capacitor, 150 mmf, 500 volts	P-722001-577	39632
C46	Capacitor, 27 mmf, 500 volts	P-722001-559	39614
C47	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C48	Capacitor, 1000 mmf, 500 volts	P-722008-597	68954
C49	Capacitor, 0.05 mf, 400 volts	P-72061-544	52974
C50	Capacitor, 100 mmf, 600 volts	K-895406-3	56124
C51	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C52	Capacitor, 20-20 mf, 450 volts	M-95695-39	34889
C53, C54	Capacitor, 1.0 mf, 600 volts	K-895406-3	56124
C55	Capacitor, 50-40 mf, 450 volts	M-442900-59	94280
C56	Capacitor, 0.05 mf, 400 volts	P-72061-544	52974
C57	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C58	Capacitor, 0.05 mf, 400 volts	P-72061-544	52974
C59	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C60	Capacitor, 1800 mmf, 500 volts	P-722018-515	52784
C61, C62	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
F1	Fuse, 10 amperes	K-850339-2	61971
F2, F3	Fuse, 5 amperes	K-850339-3	64203
	Fuse holder	K-99088-1	48551
J1	Connector	P-722805-14	52002
J2	Connector	P-722805-19	52003
J3	Receptacle	K-895389-1	52004
M1	Meter	K-859073-1	44919
R1	Resistor, variable, 100,000 ohms (log taper)	M-433196-25	51934
R2	Resistor, 10,000 ohms, 1 watt	K-90496-74	71914
R3	Resistor, 4.7 megohms, 1 watt	K-99081-106	19480
R4	Resistor, 6800 ohms, 1/2 watt	K-82283-72	14659
R5	Resistor, 82,000 ohms, 1 watt	K-90496-85	512382
R6	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652

FOR ORDERING INFORMATION SEE PAGE 4

SYMBOL NO.	DESCRIPTION	DRAWING NO.	STOCK NO.
R7	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R8	Resistor, 3.3 megohms, 1/2 watt	K-82283-104	31417
R9	Resistor, 560 ohms, 1 watt	K-99081-59	38884
R10	Resistor, 6800 ohms, 1 watt	K-99081-72	38887
R11	Resistor, 120 ohms, 1/2 watt	K-82283-51	30189
R12	Resistor, 10,000 ohms, 1 watt	K-90496-74	71914
R13	Resistor, 820 ohms ±5%, 1/2 watt	K-99080-157	30158
R14	Resistor, 56,000 ohms ±5%, 1 watt	K-99081-201	17440
R15	Resistor, 47,000 ohms ±5%, 1 watt	K-99081-199	71988
R16	Resistor, 15,000 ohms, 1 watt	K-90496-76	70723
R17	Resistor, 470,000 ohms, 1/2 watt	K-82283-94	30648
R18	Resistor, 6800 ohms, 1/2 watt	K-82283-72	14659
R19	Resistor, 470,000 ohms, 1/2 watt	K-82283-94	30648
R20	Resistor, 39,000 ohms, 1 watt	K-99081-81	71084
R21	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R22	Resistor, 15,000 ohms, 2 watts	K-99126-76	68935
R23	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R24	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R25	Resistor, 15,000 ohms, 2 watts	K-99126-76	68935
R26	Resistor, 10,000 ohms, 1 watt	K-90496-74	71914
R27	Resistor, 2200 ohms, 1 watt	K-90496-66	71991
R28	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R29	Resistor, 2.2 megohms, 1/2 watt	K-82283-102	30649
R30	Resistor, 1.0 megohm, 1 watt	K-99081-98	71993
R31	Resistor, 100 ohms, 1 watt	K-90496-50	31215
R32	Resistor, 470 ohms, 1/2 watt	K-82283-58	30499
R33	Resistor, 100,000 ohms, 1 watt	K-90496-86	72635
R34	Resistor, 6800 ohms, 1 watt	K-99081-72	38887
R35	Resistor, 1.5 megohms, 1 watt	K-99081-100	47967
R36	Resistor, 5600 ohms ±5%, 1/2 watt	K-99080-177	30734
R37	Resistor, variable, 5000 ohms	M-433196-7	51923
R38	Resistor, 150,000 ohms ±5%, 1 watt	K-99081-211	31895
R39	Resistor, 47,000 ohms, 1 watt	K-99081-82	71988
R40	Resistor, 1.5 megohms, 1 watt	K-99081-100	47967
R41	Resistor, 4700 ohms ±5%, 1/2 watt	K-99080-175	30494
R42	Resistor, variable, 5000 ohms	M-433196-7	51923
R43	Resistor, 56,000 ohms ±5%, 2 watts	K-99083-201	28741
R44	Resistor, 47,000 ohms, 1 watt	K-99081-82	71988
R45	Resistor, 1.5 megohms, 1 watt	K-99081-100	47967
R46	Resistor, 8200 ohms ±5%, 1/2 watt	K-99080-181	502282
R47	Resistor, variable, 5000 ohms	M-433196-7	51923
R48	Resistor, 68,000 ohms ±5%, 1 watt	K-99081-203	38897
R49	Resistor, 47,000 ohms, 1 watt	K-99081-82	71988
R50	Resistor, 1.5 megohms, 1 watt	K-99081-100	47967
R51	Resistor, 3900 ohms ±5%, 1/2 watt	K-99080-173	30694
R52	Resistor, variable, 5000 ohms	M-433196-7	51923
R53	Resistor, 68,000 ohms ±5%, 1 watt	K-99081-203	38897
R54	Resistor, 47,000 ohms, 1 watt	K-99081-82	71988
R55	Resistor, 1.0 megohm, 1 watt	K-99081-98	71993
R56	Resistor, 100 ohms, 1 watt	K-90496-50	31215
R57	Resistor, 470 ohms, 1/2 watt	K-82283-58	30499
R58	Resistor, 100,000 ohms, 1 watt	K-90496-86	72635
R59	Resistor, 6800 ohms, 1 watt	K-99081-72	38887
R60	Resistor, 1.5 megohms, 1 watt	K-99081-100	47967
R61	Resistor, 680 ohms ±5%, 1/2 watt	K-99080-155	12262
R62	Resistor, variable, 5000 ohms	M-433196-7	51923
R63	Resistor, 390,000 ohms ±5%, 1 watt	K-99081-221	32725
R64	Resistor, 47,000 ohms, 1 watt	K-99081-82	71988
R65	Resistor, 2700 ohms, 1 watt	K-99081-67	14421
R66	Resistor, 7500 ohms, 5 watts	M-428781-44	51995
R67	Resistor, 10,000 ohms, 5 watts	M-428781-45	45354
R68	Resistor, 56,000 ohms ±5%, 1 watt	K-99081-201	17440
R69	Resistor, 62,000 ohms ±5%, 1 watt	K-99081-202	2724
R70	Resistor, 470,000 ohms, 1 watt	K-90496-94	72521
R71	Resistor, 270 ohms, 1 watt	K-90496-55	30497
R72	Resistor, 470,000 ohms, 1 watt	K-90496-94	72521
R73 to R76	Resistor, 10 ohms, 1 watt	K-99081-38	69640
R77	Resistor, 270 ohms, 1 watt	K-90496-55	30497
R78	Resistor, 47,000 ohms, 1 watt	K-99081-82	71988
R79	Resistor, variable, 100,000 ohms	M-433196-4	51924

FOR ORDERING INFORMATION SEE PAGE 4

SYMBOL NO.	DESCRIPTION	DRAWING NO.	STOCK NO.
R80	Resistor, variable, 50,000 ohms	M-433196-5	51944
R81	Resistor, 330,000 ohms, 1 watt	K-90496-92	38892
R82, R83	Resistor, 5.6 megohms, 1 watt	K-99081-107	513556
R84	Resistor, 470,000 ohms, 1 watt	K-90496-94	72521
R85	Resistor, 27,000 ohms, 1 watt	K-90496-79	71990
R86	Resistor, 68,000 ohms, 1 watt	K-99081-84	38897
R87	Resistor, 3.3 megohms, 1/2 watt	K-82283-104	31417
R88	Resistor, 6800 ohms, 1 watt	K-99081-72	38887
R89	Not Used		
R90	Resistor, 560,000 ohms, 1 watt	K-99081-95	32726
R91	Resistor, 470 ohms, 1/2 watt	K-82283-58	30499
R92	Resistor, 1.0 megohm, 1 watt	K-99081-98	71993
R93	Resistor, 3.9 megohms, 1 watt	K-99081-105	44046
R94	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R95	Resistor, 4700 ohms, 1 watt	K-90496-70	71987
R96	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R97	Resistor, variable, 10,000 ohms	M-427471-41	94573
R98 to R101	Resistor, 10 ohms, 2 watts	K-99126-38	43008
S1	Switch, frequency control	K-834682-5	19627
S2	Switch, power	M-441684-1	52001
S3	Switch, interlock	K-99119-1 & 2	48337
S4	Switch, AFC time constant	K-834682-6	51941
S5	Switch, counter indicator	K-8857197-2	52997
T1	Transformer, filament, for phasing, 60 cycle only	K-895313-1	51997
T1	Transformer, filament, 50/60 cycle	K-895313-2	94550
T2	Transformer, vertical pulse	K-895314-1	51936
T3	Transformer, 31.5 kc, oscillator	M-441504-501	51937
T4	Transformer, 94.5 kc, oscillator	M-441504-502	51938
T5 to T9	Transformer, blocking oscillator	K-895315-1	51939
T10	Reactor	M-441509-1	52000
T11	Transformer, power	M-441508-1	51999
X0	Socket, for crystal	K-834496-1	17340
X1 to X26	Socket, octal, saddle type	K-99390-1	54414
X27	Socket, for V27	M-426755 (Parts 1, 3, and 6)	54143
Y1	Crystal, 94.5 kc	K-895300-501	
	MISCELLANEOUS		
	Cap, dust, for J1	M-441522-2	52005
	Cap, dust, for J2	M-441522-6	52006
	Knob, for S2	P-712336-505	17268
	Knob, (small)	P-712336-507	30075
	Plate, capacitor mounting, steel, for C52	K-85559-2	
	Plate, capacitor mounting, steel, for C55	K-85559-3	
	FIELD PULSE SHAPER, MI-26115		
C1	Capacitor, 100 mmf, 500 volts	P-722001-573	39628
C2 to C32	Capacitor, 200 mmf, 500 volts	P-722002-530	39635
C33, C34	Capacitor, 100 mmf, 500 volts	P-722001-573	39628
C35 to C65	Capacitor, 200 mmf, 500 volts	P-722002-530	39635
C66	Capacitor, 100 mmf, 500 volts	P-722001-573	39628
C67	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C68	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C69	Capacitor, 390 mmf, 500 volts	P-722001-587	39642
C70	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C71	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C72	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C73	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C74A, B, C, and D	Capacitor, 10-10-10-20 mf, 450 volts	M-442900-30	59759
C75	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C76, C77	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C78A and B	Capacitor, 0.5-0.5 mf, 600 volts	K-984681-471	56861
C79	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C80, C81	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C82	Capacitor, 68 mmf, 500 volts	P-722001-569	51338
C83A, B, C, and D	Capacitor, 10-10-10-20 mf, 450 volts	M-442900-30	59759

FOR ORDERING INFORMATION SEE PAGE 4

SYMBOL NO.	DESCRIPTION	DRAWING NO.	STOCK NO.
C84	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C85	Capacitor, 680 mmf, 500 volts	P-722008-593	51919
C86	Capacitor, 0.25 mf, 400 volts	P-72061-518	54145
C87	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C88	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C89, C90	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C91	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C92	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C93, C94	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C95	Capacitor, 68 mmf, 500 volts	P-722001-569	51338
C96	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C97A, B, C, and D	Capacitor, 10-10-10-20 mf, 450 volts	M-442900-30	59759
C98	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C99 to C101	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C102, C103	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C104	Capacitor, 56 mmf, 500 volts	P-722001-567	39622
C105	Capacitor, 0.05 mf, 400 volts	P-72061-512	69565
C106	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C107	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C108	Capacitor, 0.005 mf, 500 volts	P-72061-543	51917
C109	Capacitor, 560 mmf, 500 volts	P-722008-591	51918
C110	Capacitor, 0.25 mf, 400 volts	P-72061-518	54145
C111	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C112	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C113	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C114	Capacitor, 220 mmf, 500 volts	P-722001-581	67562
C115	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C116	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C117 to C121	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C122	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C123	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C124A, B, C, and D	Capacitor, 10-10-10-20 mf, 450 volts	M-442900-30	59759
C125	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C126	Capacitor, 680 mmf, 500 volts	P-722008-593	51919
C127	Capacitor, 0.25 mf, 400 volts	P-72061-518	54145
C128	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C129A and B	Capacitor, 20-20 mf, 450 volts	M-95695-39	34889
C130	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C131	Capacitor, 1000 mmf, 500 volts	P-722008-597	68954
C132	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C133	Capacitor, 680 mmf, 500 volts	P-722008-593	51919
C134	Capacitor, 0.25 mf, 400 volts	P-72061-518	54145
C135	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C136	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C137	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C138	Capacitor, 150 mmf, 500 volts	P-722001-577	39632
C139	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C140	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C141	Capacitor, 0.01 mf, 600 volts	P-72061-538	51628
C142	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C143	Capacitor, 0.25 mf, 400 volts	P-72061-518	54145
C144 to C146	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C147	Capacitor, 1000 mf, 25 volts	M-442900-31	59891
C148	Capacitor, 20 mf, 450 volts	M-442901-136	52008
C149	Capacitor, 20-20 mf, 450 volts	M-95695-39	34889
C150A and B	Capacitor, 1000-1000 mf, 15 volts	M-442900-40	59757
C151	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C152	Capacitor, 0.02 mf, 400 volts	P-72061-510	69564
C153	Capacitor, 20 mf, 450 volts	M-442901-136	52008
C154	Capacitor, 1.0 mf, 600 volts	K-984680-8	56124
C155	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C156	Capacitor, 2200 mmf, 500 volts	P-722017-567	39660
C157	Capacitor, 560 mmf, 500 volts	P-722008-591	51918
C158	Capacitor, 0.25 mf, 400 volts	P-72061-518	54145
C159	Capacitor, 0.10 mf, 400 volts	P-72061-514	67910
C160	Capacitor, 470 mmf, 500 volts	P-722001-589	39644
J1	Connector	P-722805-13	52013
J2	Connector	P-255223-1	51800

FOR ORDERING INFORMATION SEE PAGE 4

SYMBOL NO	DESCRIPTION	DRAWING NO.	STOCK NO.
J3	Connector	P-722805-14	52002
L1 to L64	Coil Assembly	K-889979-501	51920
L65	Coil Assembly, 400 turns, 1.18 mh	K-895311-501	51921
L66, L67	Coil Assembly, 500 turns, 2.0 mh	K-895311-502	51922
R1, R2	Resistor, 1000 ohms, 1 watt	K-90496-62	71916
R3	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R4	Resistor, 82,000 ohms, 1 watt	K-90496-85	512382
R5, R6	Resistor, 270,000 ohms, 1 watt	K-90496-91	19232
R7, R8	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R9	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R10	Resistor, 1000 ohms, 1 watt	K-90496-62	71916
R11	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R12	Resistor, 10,000 ohms, 1 watt	K-90496-74	71914
R13	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R14	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R15	Resistor, 1.0 megohm, 1 watt	K-99081-98	71993
R16	Resistor, 22,000 ohms, 2 watts	K-99126-78	72629
R17	Resistor, 10,000 ohms, 1 watt	K-90496-74	71914
R18 to R20	Resistor, 1800 ohms, 1 watt	K-99081-65	38875
R21	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R22, R23	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R24	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R25	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R26	Resistor, 6800 ohms, 1 watt	K-99081-72	38887
R27	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R28	Resistor, 56,000 ohms, 1/2 watt	K-82283-83	30650
R29	Resistor, 820 ohms, 1 watt	K-99081-61	68025
R30	Resistor, 1200 ohms, 1 watt	K-99081-63	38896
R31	Resistor, 100,000 ohms, 1 watt	K-90496-86	72635
R32	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R33	Resistor, 100,000 ohms ±5%, 1 watt	K-99081-207	72635
R34	Resistor, variable, 5000 ohms	M-433196-18	52009
R35	Resistor, 18,000 ohms, 1 watt	K-99081-77	18757
R36	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R37, R38	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R39	Resistor, 2.2 megohms, 1 watt	K-99081-102	38898
R40	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R41	Resistor, 680,000 ohms ±5%, 1 watt	K-99081-227	52012
R42	Resistor, variable, 100,000 ohms	M-433196-19	52010
R43	Resistor, 56,000 ohms ±5%, 1/2 watt	K-99080-201	30650
R44	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R45	Resistor, 2.2 megohms, 1/2 watt	K-82283-102	30649
R46	Resistor, 22,000 ohms, 1 watt	K-90496-78	71986
R47	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R48	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R49	Resistor, 3900 ohms, 1 watt	K-90496-69	38894
R50	Resistor, 100,000 ohms, 1/2 watt	K-82283-86	502410
R51	Resistor, 4700 ohms, 1/2 watt	K-82283-70	30494
R52	Resistor, 2700 ohms, 1 watt	K-99081-67	14421
R53	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R54	Resistor, 1000 ohms, 1 watt	K-90496-62	71916
R55	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R56	Resistor, 22,000 ohms, 1/2 watt	K-82283-78	30492
R57	Resistor, 3300 ohms, 1 watt	K-90496-68	71986
R58	Resistor, 4700 ohms, 1 watt	K-90496-70	71987
R59	Resistor, 100,000 ohms, 1 watt	K-90496-86	72635
R60	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R61	Resistor, 220,000 ohms ±5%, 1 watt	K-99081-215	54449
R62	Resistor, variable, 5000 ohms	M-433196-18	52009
R63	Resistor, 33,000 ohms, 1 watt	K-90496-80	38895
R64	Resistor, 1.0 megohm, 1 watt	K-99081-98	71993
R65	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R66	Resistor, 330,000 ohms, 1 watt	K-90496-92	38892
R67	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R68	Resistor, 10,000 ohms, 1 watt	K-90496-74	71914
R69	Resistor, 1800 ohms, 1 watt	K-99081-65	38875
R70	Resistor, 100,000 ohms, 1/2 watt	K-82283-86	502410
R71	Resistor, 4700 ohms, 1/2 watt	K-82283-70	30494
R72	Resistor, 3900 ohms, 1 watt	K-90496-69	38894
R73	Resistor, 100,000 ohms, 1 watt	K-90496-86	72635

FOR ORDERING INFORMATION SEE PAGE 4

SYMBOL NO.	DESCRIPTION	DRAWING NO.	STOCK NO.
R74	Resistor, 1000 ohms, 1 watt	K-90496-62	71916
R75	Resistor, 1000 ohms, 1/2 watt	K-82283-62	34766
R76	Resistor, 3900 ohms, 1 watt	K-90496-69	38894
R77	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R78	Resistor, 4700 ohms, 1 watt	K-90496-70	71987
R79	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R80	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R81	Resistor, 5600 ohms, 1/2 watt	K-82283-71	30734
R82	Resistor, 820 ohms, 1 watt	K-99081-61	68025
R83	Resistor, 1200 ohms, 1 watt	K-99081-63	38896
R84	Resistor, 82,000 ohms, 1 watt	K-90496-85	512382
R85	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R86	Resistor, 330,000 ohms ±5%, 1 watt	K-99081-219	38892
R87	Resistor, variable, 5000 ohms	M-433196-18	52009
R88	Resistor, 270,000 ohms ±5%, 1 watt	K-99081-217	19232
R89	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R90	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R91	Resistor, 1800 ohms, 1 watt	K-99081-65	38875
R92	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R93	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R94	Resistor, 47,000 ohms, 1 watt	K-99081-82	71988
R95	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R96, R97	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R98	Resistor, 1.0 megohm, 1 watt	K-99081-98	71993
R99	Resistor, 270,000 ohms ±5%, 1 watt	K-99081-217	19232
R100	Resistor, variable, 100,000 ohms	M-433196-19	52010
R101	Resistor, 68,000 ohms ±5%, 1/2 watt	K-99080-203	14138
R102, R103	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R104	Resistor, 2.2 megohm, 1/2 watt	K-82283-102	30649
R105, R106	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R107	Resistor, 330,000 ohms, 1 watt	K-90496-92	38892
R108	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R109	Resistor, 270,000 ohms ±5%, 1 watt	K-99081-217	19232
R110	Resistor, variable, 100,000 ohms	M-433196-19	52010
R111	Resistor, 82,000 ohms ±5%, 1/2 watt	K-99080-205	8064
R112	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R113	Resistor, 39,000 ohms, 1/2 watt	K-82283-81	30147
R114	Resistor, 1500 ohms, 1 watt	K-90496-64	72762
R115	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R116	Resistor, 2700 ohms, 1 watt	K-99081-67	14421
R117	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R118, R119	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R120, R121	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R122	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R123	Resistor, 1800 ohms, 1 watt	K-99081-65	38875
R124	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R125	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R126	Resistor, variable, 2000 ohms	M-433196-17	52011
R127	Resistor, 10,000 ohms, 1 watt	K-90496-74	71914
R128	Resistor, 1800 ohms, 1 watt	K-99081-65	38875
R129	Resistor, 560,000 ohms, 1 watt	K-99081-95	32726
R130	Resistor, 15,000 ohms, 1/2 watt	K-82283-76	36714
R131	Resistor, 56,000 ohms, 1/2 watt	K-82283-83	30650
R132	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R133, R134	Resistor, 10,000 ohms, 1 watt	K-90496-74	71914
R135	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R136, R137	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R138	Resistor, 1.0 megohm, 1 watt	K-99081-98	71993
R139	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R140	Resistor, 120,000 ohms, 1 watt	K-90496-87	72636
R141	Resistor, variable, 250,000 ohms	M-433196-21	51589
R142	Resistor, 100,000 ohms ±5%, 1/2 watt	K-99080-207	502410
R143	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R144	Resistor, 2.2 megohms, 1/2 watt	K-82283-102	30649
R145	Resistor, 10,000 ohms, 1 watt	K-90496-74	71914
R146	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R147	Resistor, 27,000 ohms, 1 watt	K-90496-79	71990
R148	Resistor, 330,000 ohms, 1 watt	K-90496-92	38892
R149	Resistor, 33,000 ohms, 1/2 watt	K-82283-80	502333
R150	Resistor, 470,000 ohms, 1 watt	K-90496-94	72521

FIELD PULSE SHAPER - Continued

FOR ORDERING INFORMATION SEE PAGE 4

SYMBOL NO.	DESCRIPTION	DRAWING NO.	STOCK NO.
R151	Resistor, 100,000 ohms, 1/2 watt	K-82283-86	502410
R152	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R153, R154	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R155	Resistor, 1.0 megohm, 1 watt	K-99081-98	71993
R156	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R157	Resistor, 120,000 ohms, 1 watt	K-90496-87	72636
R158	Resistor, variable, 250,000 ohms	M-433196-21	51589
R159	Resistor, 100,000 ohms, 1/2 watt	K-82283-86	502410
R160	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R161	Resistor, 2.2 megohms, 1/2 watt	K-82283-102	30649
R162	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R163	Resistor, 15,000 ohms, 1 watt	K-99081-76	70723
R164	Resistor, 27,000 ohms, 1 watt	K-90496-79	71990
R165	Resistor, 180,000 ohms ±5%, 1 watt	K-99081-213	12356
R166	Resistor, variable, 100,000 ohms	M-433196-19	52010
R167	Not Used		
R168, R169	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R170	Resistor, 27,000 ohms, 1/2 watt	K-99080-79	502327
R171	Resistor, 4700 ohms, 1 watt	K-90496-70	71987
R172	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R173	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R174	Resistor, 1.0 megohm, 1 watt	K-99081-98	71993
R175	Resistor, 100 ohms, 1 watt	K-90496-50	31215
R176	Resistor, 270 ohms, 1/2 watt	K-82283-55	30929
R177	Resistor, 56 ohms, 1 watt	K-99081-47	71992
R178	Resistor, 2700 ohms, 2 watts	K-99126-67	33855
R179	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R180	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R181	Resistor, 8200 ohms, 2 watts	K-99126-73	43493
R182	Resistor, 2200 ohms, 1 watt	K-90496-66	71991
R183	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R184	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R185	Resistor, 10,000 ohms, 2 watts	K-99126-74	44294
R186	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R187	Resistor, 100 ohms, 1/2 watt	K-82283-50	502110
R188	Resistor, 270 ohms, 1/2 watt	K-82283-55	30929
R189	Resistor, 56 ohms, 1 watt	K-99081-47	71992
R190	Resistor, 2700 ohms, 2 watts	K-99126-67	33855
R191	Resistor, 220 ohms, 1/2 watt	K-82283-54	5201
R192	Resistor, 2700 ohms, 2 watts	K-99126-67	33855
R193	Resistor, 270 ohms, 1/2 watt	K-82283-55	30929
R194	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R195	Resistor, 100 ohms, 1/2 watt	K-82283-50	502110
R196	Resistor, 8200 ohms, 1 watt	K-90496-73	38888
R197	Resistor, 10 megohms, 1/2 watt	K-82283-110	30992
R198, R199	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R200	Resistor, 100 ohms, 1 watt	K-90496-50	31215
R201	Resistor, 10,000 ohms, 2 watts	K-99126-74	44294
R202	Resistor, 3900 ohms, 1 watt	K-90496-69	38894
R203	Resistor, 1500 ohms, 1/2 watt	K-82283-64	30654
R204	Resistor, 1.0 megohm, 1/2 watt	K-82283-98	30652
R205	Resistor, 100 ohms, 1 watt	K-90496-50	31215
R206	Resistor, 47,000 ohms, 1 watt	K-99081-82	71988
R207	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R208, R209	Resistor, 5600 ohms, 1 watt	K-90496-71	38886
R210	Resistor, 1.0 megohm, 1 watt	K-99081-98	71993
R211	Resistor, 150,000 ohms ±5%, 1 watt	K-99081-211	31895
R212	Resistor, variable, 100,000 ohms	M-433196-19	52010
R213	Resistor, 15,000 ohms ±5%, 1/2 watt	K-99080-187	36714
R214, R215	Resistor, 10 ohms, 1/2 watt	K-82283-38	502010
R216	Resistor, 2.2 megohms, 1/2 watt	K-82283-102	30649
R217	Resistor, 1000 ohms, 1 watt	K-90496-62	71916
R218	Resistor, 22,000 ohms, 1 watt	K-90496-78	71989
R219	Resistor, 4700 ohms, 1 watt	K-90496-70	71987
R220	Resistor, 1000 ohms, 1 watt	K-90496-62	71916
T1, T2	Transformer	K-895326-3	58619
X1 to X30	Socket, octal, saddle type	K-99390-1	54414

FOR ORDERING INFORMATION SEE PAGE 4

SYMBOL NO.	DESCRIPTION	DRAWING NO.	STOCK NO.
	FIELD PULSE SHAPER - Continued		
	MISCELLANEOUS		
	Cap, dust, for J1	M-441522-6	52006
	Cap, dust, for J2	K-887140-1	52007
	Cap, dust, for J3	M-441522-2	52005
	Plate, capacitor mounting, steel, for C74, C83, C97, C124, C147, C150	K-85559-3	
	Plate capacitor mounting, steel, for C129	K-85559-2	
	Plate, capacitor mounting, phenolic, for C149	K-85558-2	28452
	INTERCONNECTING CABLES, MI-26735, FOR FIELD PULSE FORMER AND SHAPER		
W103	Power Cable, 2 conductor, complete with connectors and dust cap		
	10 feet long		MI-26759-2
	Connector, female, 2 contacts		54243
	Connector, male, 2 contacts		54244
	Dust Cap, for female connector		52005
W104	Power Cable, complete with lugs and connector - 2 feet long		MI-26759-5
	Connector, female, 4 contacts		54262
W105-A	Transmission Line, complete with connectors and dust caps		
	7 feet long		MI-26759-12
	Adapter		54246
	Connector, coaxial		66344
	Dust Cap		54247
	Power Cable, 4 conductor, complete with connectors:		
W109-A	50 feet long		MI-26759-3
W109-B	100 feet long		MI-26759-4
	Connector, female, 4 contacts		54262
	Connector, male, 4 contacts		54245
W110	Pulse Cable, 7-conductor, complete with connectors and dust caps		
	4 feet long		MI-26759-10
	Connector, female, 7 contacts		54249
	Connector, male, 7 contacts		54248
	Dust Cap, for female connector		52005
	Dust Cap, for male connector		52006
	Pulse Termination Plug:		
	Cap only		56178
	Connector, 7 contacts, contact section only		54250
	Resistor, fixed, composition, 75 ohms $\pm 5\%$, 1/2 watt		34764

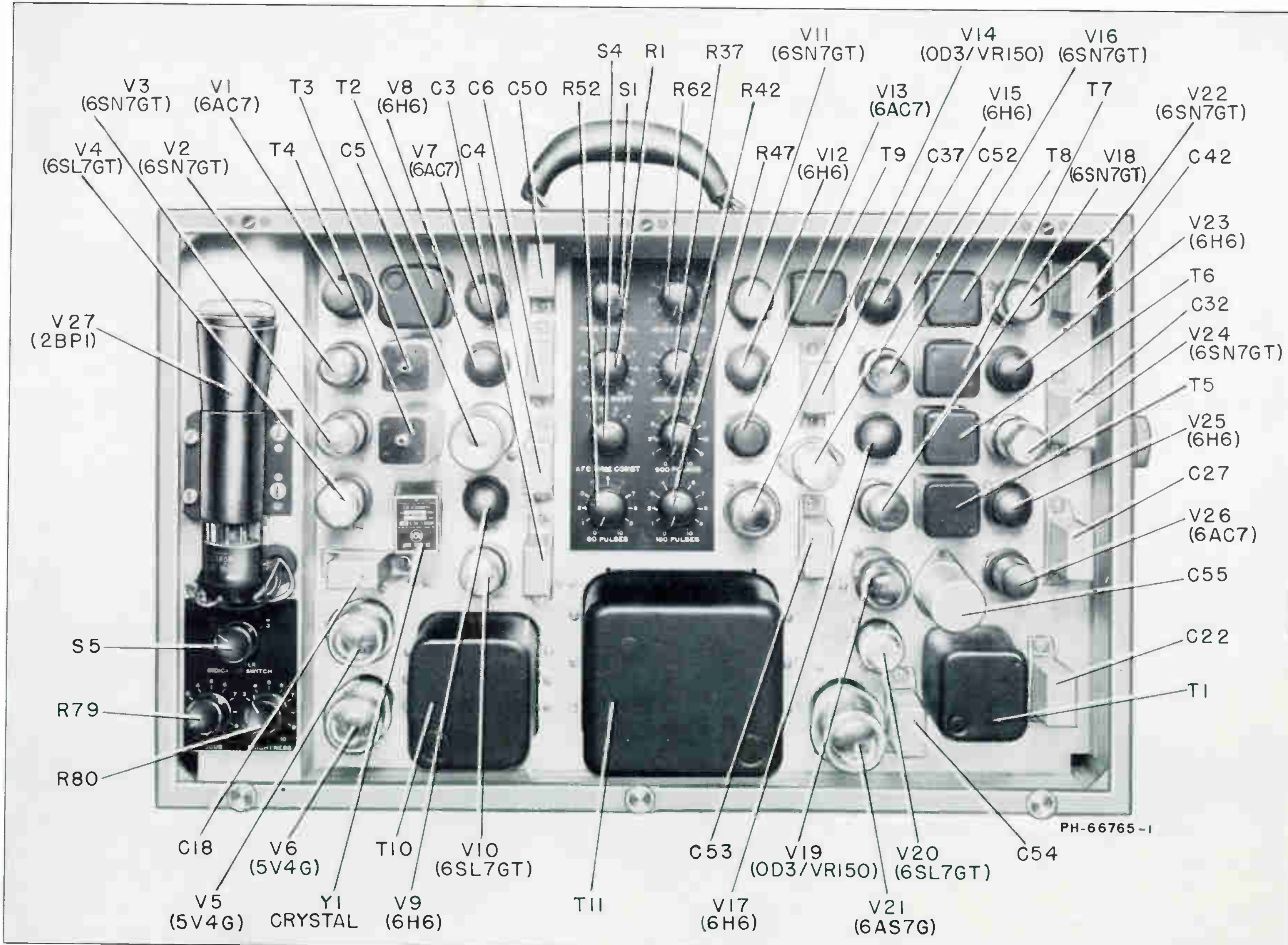
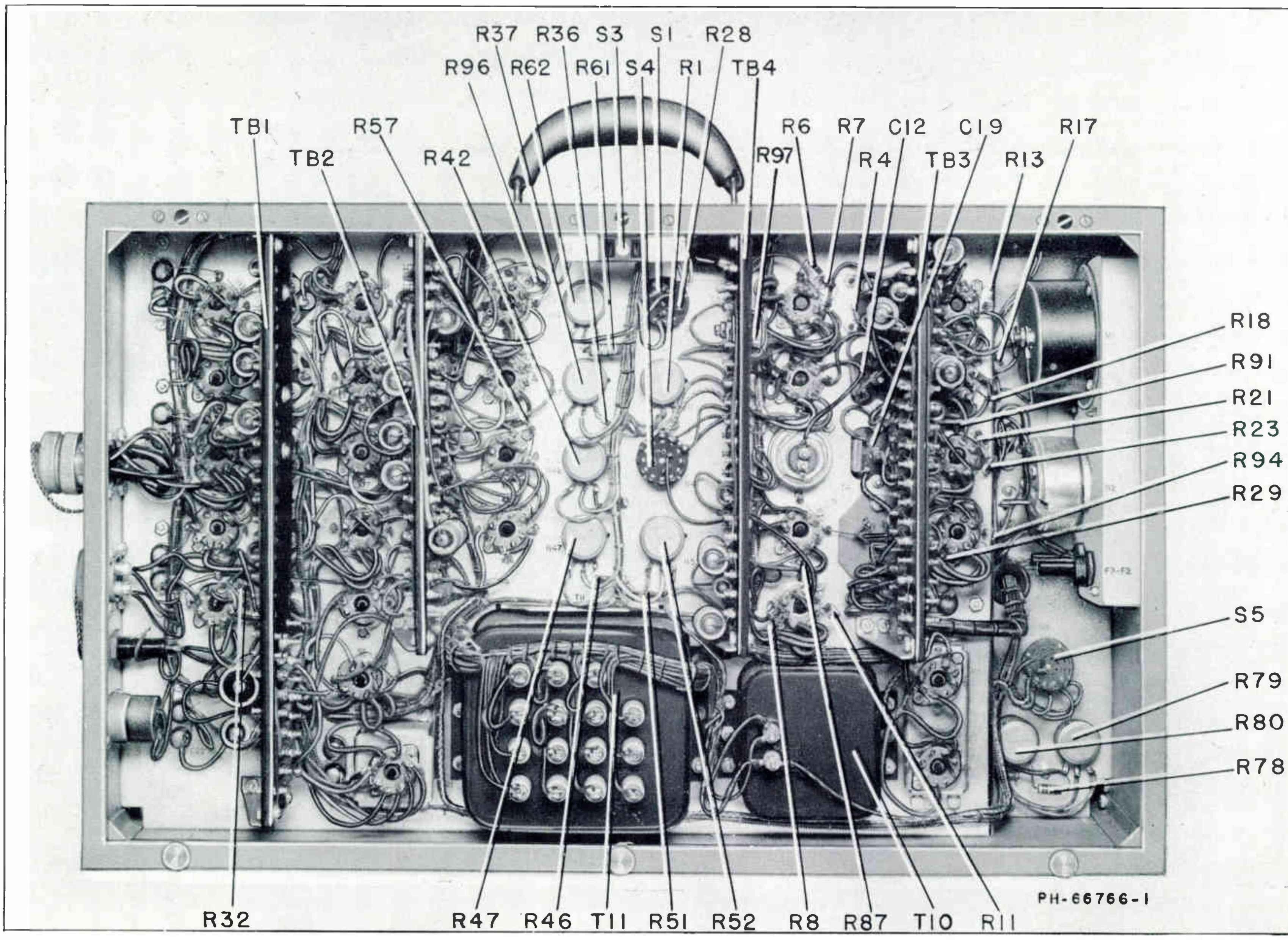


Figure 10 -- Field Pulse Former Tube - Side View, Panel Off



TERM. BOARD TB1
(TOP TO BOTTOM)

LEFT	RIGHT
C43	R73
R54	R74
R50	R72
C41	R71
C33	R75
C34	R76
C35	R77
R44	
C31	
R40	
C23	
C24	
C25	
C21	
R30	
R31	
R33	
R34	
C16	
C1	

TERM. BOARD TB2
(TOP TO BOTTOM)

LEFT	RIGHT
C62	C51
C40	R64
C38	R60
R49	C49
R45	C47
C36	C48
C28	C46
C29	C44
C30	R56
C26	R55
R35	R59
R39	R58
R67	C39
R68	R65
R69	R66
R70	

TERM. BOARD TB3
(TOP TO BOTTOM)

LEFT	RIGHT
C60	C8
C13	R14
C11	R15
R16	R12
R90	C10
C9	R20
R63	C14
R38	R22
R43	R25
R48	C15
R53	C61
R95	C17
R92	R27
R93	R26
R83	
R82	
R81	

TERM. BOARD TB4
(TOP TO BOTTOM)

LEFT	RIGHT
C7	C59
C45	R88
R5	R9
R3	C56
R84	R10
R86	C57
R85	C58
R2	

Figure 11 -- Field Pulse Former,
Wiring - Side View, Panel Off

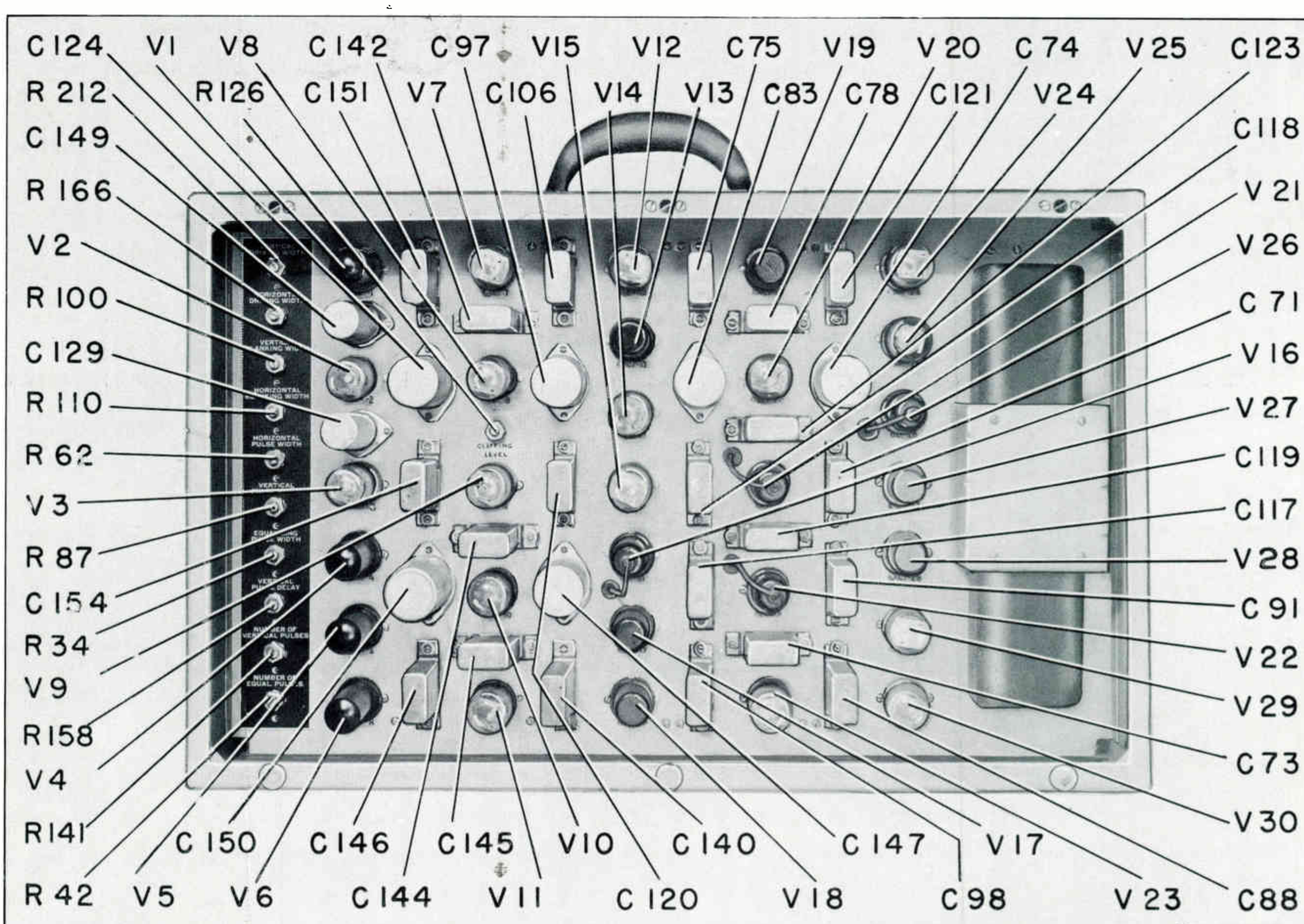
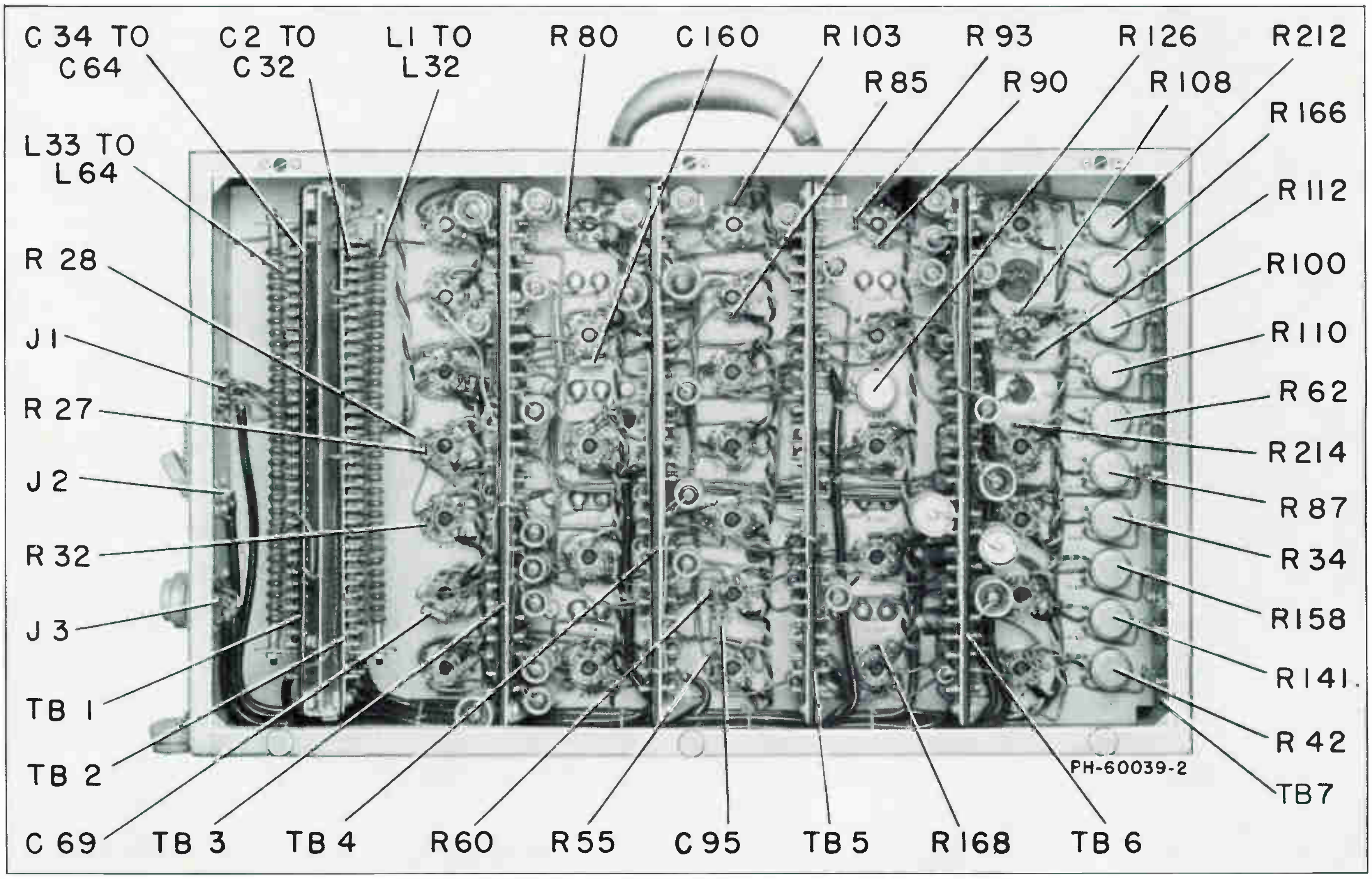


Figure 12 -- Field Pulse Shaper, Tube - Side View, Panel Off



TERM. BOARD TB3 (TOP TO BOTTOM)

LEFT	RIGHT
C134	C135
R154	R162
R153	C133
R152	R155
C132	C125
R74	R138
R73	C126
C131	R137
C148	R145
C99	C128
R26	R147
C82	R146
R35	R150
C79	R31
R30	C80
R29	C81
R25	C68
C70	R5
R10	R4
R6	C87
R46	C84
R39	
C85	
R38	
C86	

TERM. BOARD TB4 (TOP TO BOTTOM)

LEFT	RIGHT
C102	C111
C101	R105
R82	C110
C127	R83
R72	R84
R136	C104
R135	R88
R79	C103
R78	C122
R77	R129
C100	R127
R76	R128
C130	C93
R3	R66
C67	R59
R11	C94
R12	R63
C72	R53
R17	R54
R18	C90
R15	R52
R16	C89
R49	
R36	
R37	

TERM. BOARD TB5 (TOP TO BOTTOM)

LEFT	RIGHT
C107	R94
R98	R96
C109	C113
C108	R107
R97	C114
R95	C112
C77	R106
R19	R220
R20	R123
C76	R217
R68	R181
R69	R182
R64	C137
C96	R164
R57	C138
R58	C136
C92	R163

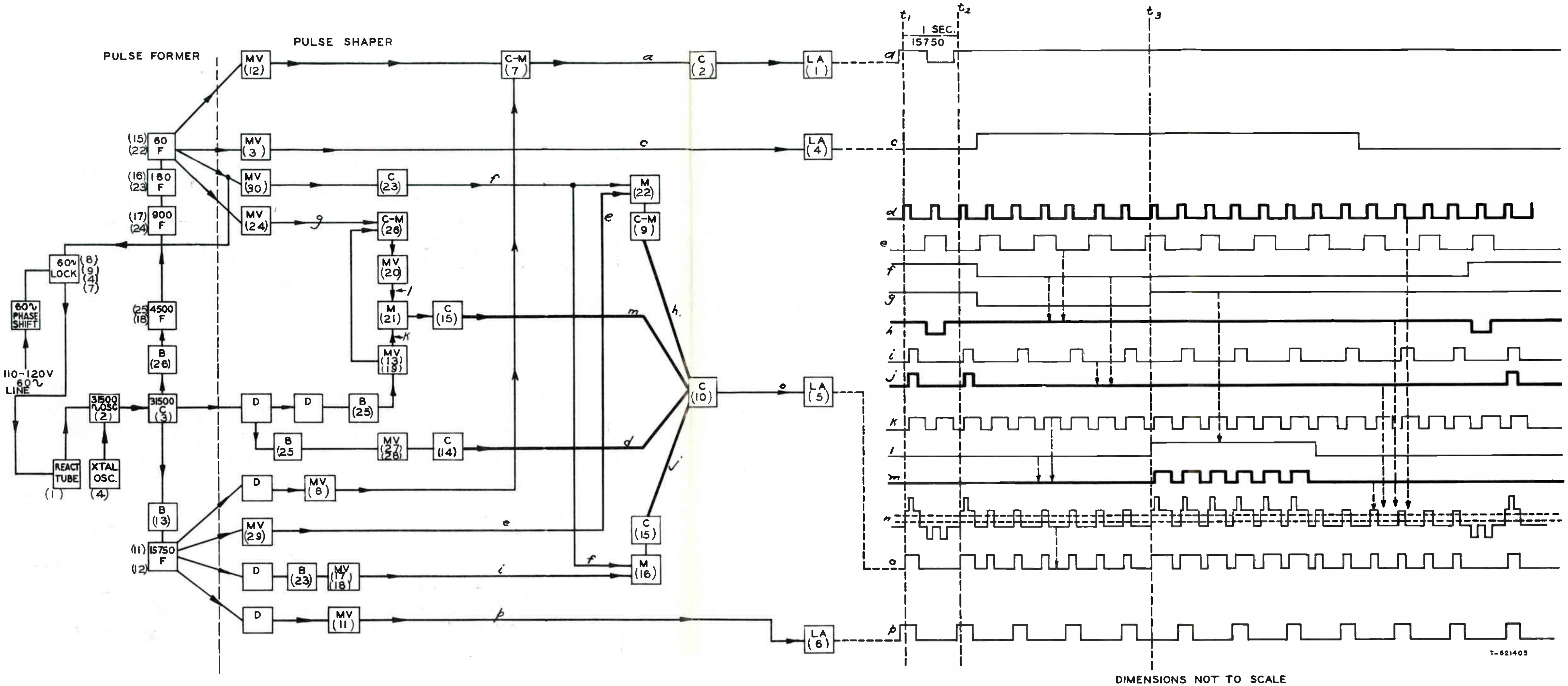
TERM. BOARD TB6 (TOP TO BOTTOM)

LEFT	RIGHT
C152	L67
C105	R196
R91	C155
C116	R210
R115	C157
R114	C156
C115	R209
R116	R208
R192	R207
R202	C159
R206	R218
R190	C158
R201	R205
R178	C148
C153	R189
R200	C143
L66	R177
R185	R175
R172	R174
L65	C141
R219	
R171	
C139	
R173	

TERM. BOARD TB7 (TOP TO BOTTOM)

R211
R165
R99
R109
R61
R86
R33
R157
R140
R41

Figure 13 -- Field Pulse Shaper, Wiring Side View, Panel Off



SYMBOLS

B- BUFFER
F- FREQUENCY DIVIDING CIRCUIT
MV-MULTIVIBRATOR
C - CLIPPER
M - MIXER
LA-LINE AMPLIFIER
OO -NUMBERS IN PARENTHESES INDICATE TUBE DESIGNATION.

D- DELAY NETWORK

NOTES

ARROWS ON SOLID LINES INDICATE DIRECTION OF TRAVEL OF PULSES.
LETTERS a, d 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 14, 9, 15-15, TO PRODUCE WAVE n. WAVE n IS CLIPPED AT LEVELS INDICATED BY DOTTED LINES TO PRODUCE WAVE o.

TUBES NOT SHOWN

POWER SUPPLY - (5)(6)(14)(19)(20) & (21)
INDICATOR AMP. - (10)
INDICATOR TUBE - (27)

CONTROLS

60~ LOCK—"ON"-"OFF" SWITCH (S2) - TIME CONSTANT SWITCH (S4)
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

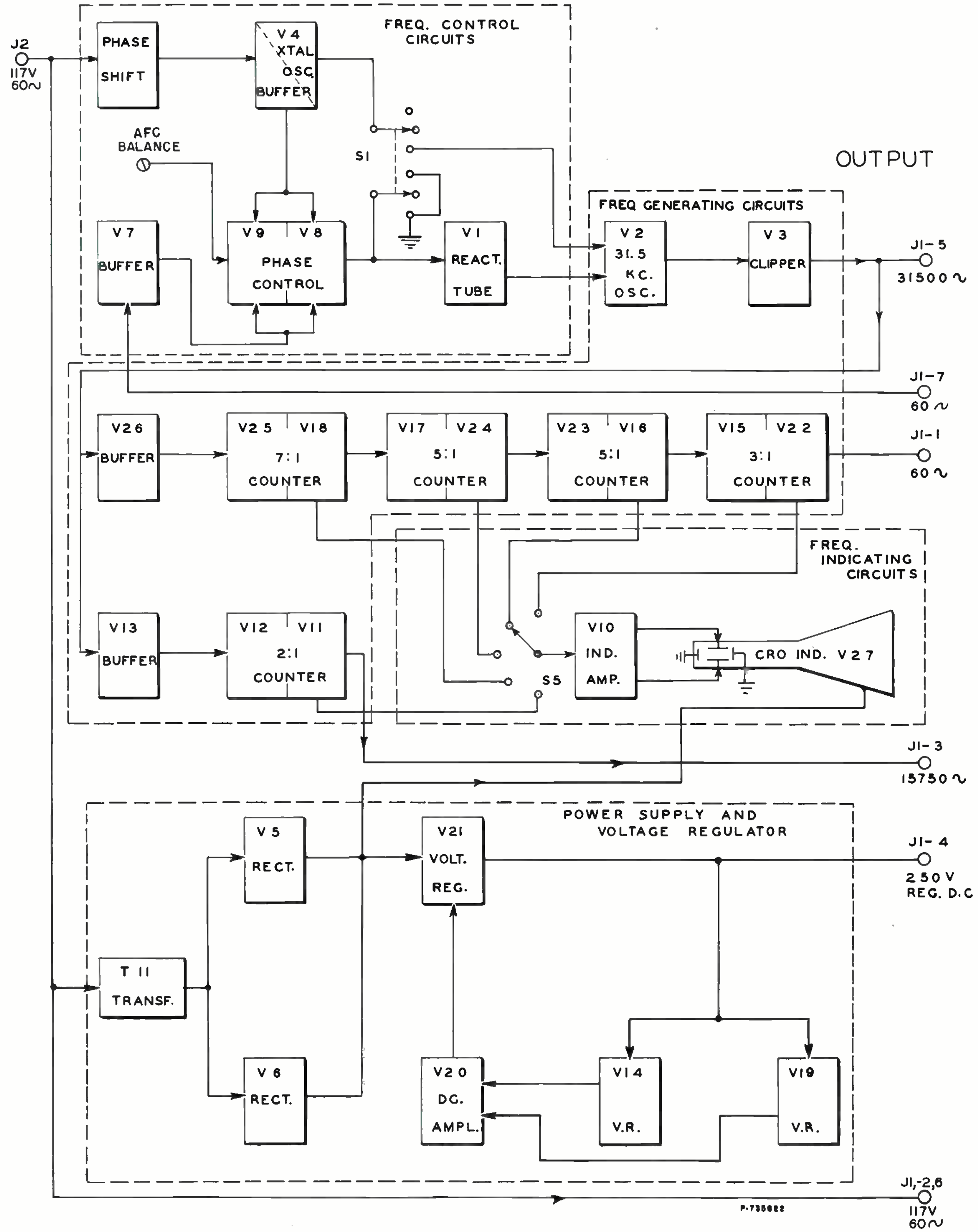
MV 11 —— HORIZ. DRIVING WIDTH
MV 3 —— VERTICAL DRIVING WIDTH
MV 8 —— HORIZ. BLANKING WIDTH
MV 12 —— VERTICAL BLANKING WIDTH
MV 17 — HORIZ. PULSE WIDTH
MV 24 — VERTICAL PULSE DELAY
MV 30 — NUMBER OF EQUALIZING PULSES
MV 28 — EQUALIZING PULSE WIDTH
MV 20 — NUMBER OF VERTICAL PULSES
MV 13 — VERTICAL PULSE WIDTH

OUTPUTS

WAVE a - BLANKING
WAVE c - VERTICAL DRIVING
WAVE p - HORIZ. DRIVING
WAVE o - SYNCHRONIZING (RMA)

NEGATIVE POLARITY
4-VOLTS PEAK TO PEAK 75-OHMS IMPEDANCE

Figure 14 -- Block Diagram and Waveshapes, Field Pulse Former and Pulse Shaper



Block Diagram, Field Pulse Former

D-C VOLTAGE CHART -- FIELD PULSE FORMER

TUBE			PLATE			GRID			CATHODE			SCREEN		
			Pin	Condition		Pin	Condition		Pin	Condition		Pin	Condition	
No.	Type	Function	No.	Normal	No Sig.	No.	Normal	No Sig.	No.	Normal	No Sig.	No.	Normal	No Sig.
1	6AC7	Reactance	8	203	238	4	0.15	0	5	3	2.9	6	125	125
2	6SN7GT	31.5 KC Oscillator	2 5	190* 220*	190§ 220§	1 4	-15* 0*	-23§ 0§	3 6	15* 15*	18§ 18§			
3	6SN7GT	Clipper	2 5	132 180	148 103	1 4	-68 -58	0 -0.35	3 6	4 0.05	3.45 0.12			
4	6SL7GT	Crystal Osc. Clipper	2 5	243 240	212 -	1 4	-69 -2.58	-0.6 -	3 6	0.6 0.02	0.03 -			
5	5V4G	Rectifier	4,6	310**					2,8	365	-			
6	5V4G	Rectifier	4,6	310**					2,8	365	-			
7	6AC7	Buffer	8	252	251	4	0	-0.3	5	0.12	0.13	6	72.5	71.5
8	6H6	AFC Discriminator	3 5	-10 0	0.6 0.05				4 8	0 18.5	0.05 0.65			
9	6H6	AFC Discriminator	3 5	-10 0.2	-0.6 0				4 8	0.2 18.5	0 0.65			
10	6SL7GT	Indicator Amplifier	2 5	232 237	232 237	1 4	-0.4 -0.6	-0.17 -0.19	3 6	0.6 0.6	0.58 0.58			
11	6SN7GT	Blocking Osc. Amplifier	2 5	36 205	150 180	1 4	1.75 -4.45	-4.0 0	3 6	6.75 6.75	7.58 7.58			
12	6H6	Counter	3 5	0 0.88	0 0.52				4 8	0.88 1.72	0.52 1.32			
13	6AC7	Buffer	8	218	228	4	-0.7	0	5	3.72	2.45	6	115	148
14	OD3	Regulator	5	252	-				2	103	-			
15	6H6	Counter	3 5	0 2.8	0 1.33				4 8	2.8 6.4	1.33 1.68			
16	6SN7GT	Blocking Osc. Amplifier	2 5	204 250	160 220	1 4	13.2 13.2	0.05 0.05	3 6	35.6 35.6	42 42			
17	6H6	Counter	3 5	0 3.7	0 1.28				4 8	3.7 15.4	1.28 1.61			
18	6SN7GT	Blocking Osc. Amplifier	2 5	93.5 221	150 200	1 4	8.85 8.85	0.1 0.1	3 6	22.6 22.6	25 25			
19	OD3	Regulator	5	147	-				2	0	-			
20	6SL7GT	D-C Amplifier	2 5	146 225	- -	1 4	77.3 146	- -	3 6	78.5 147	- -			
21	6AS7G	Regulator	2,5	340	-	1,4	227		3,6	253	-			
22	6SN7GT	Blocking Osc. Amplifier	2 5	199 248	218 249	1 4	7 7	-0.03 -0.03	3 6	26.8 26.8	26.1 26.1			
23	6H6	Counter	3 5	0 3.2	0 1.2				4 8	3.2 13.3	1.2 1.25			
24	6SN7GT	Blocking Osc. Amplifier	2 5	167 247	218 250	1 4	15.4 15.4	0 0	3 6	36.4 36.4	40 40			
25	6H6	Counter	3 5	0 4.7	0 1.2				4 8	4.7 8.83	1.2 1.32			
26	6AC7	Buffer	8	213	225	4	1	0	5	3.2	2.53	6	112	142
27	2BP1	CRO Indicator	2ND ANODE 340			1ST ANODE 76			GRID 7.5			CATHODE 19		

*60-cycle lock in. §Crystal lock-in. **A-C.

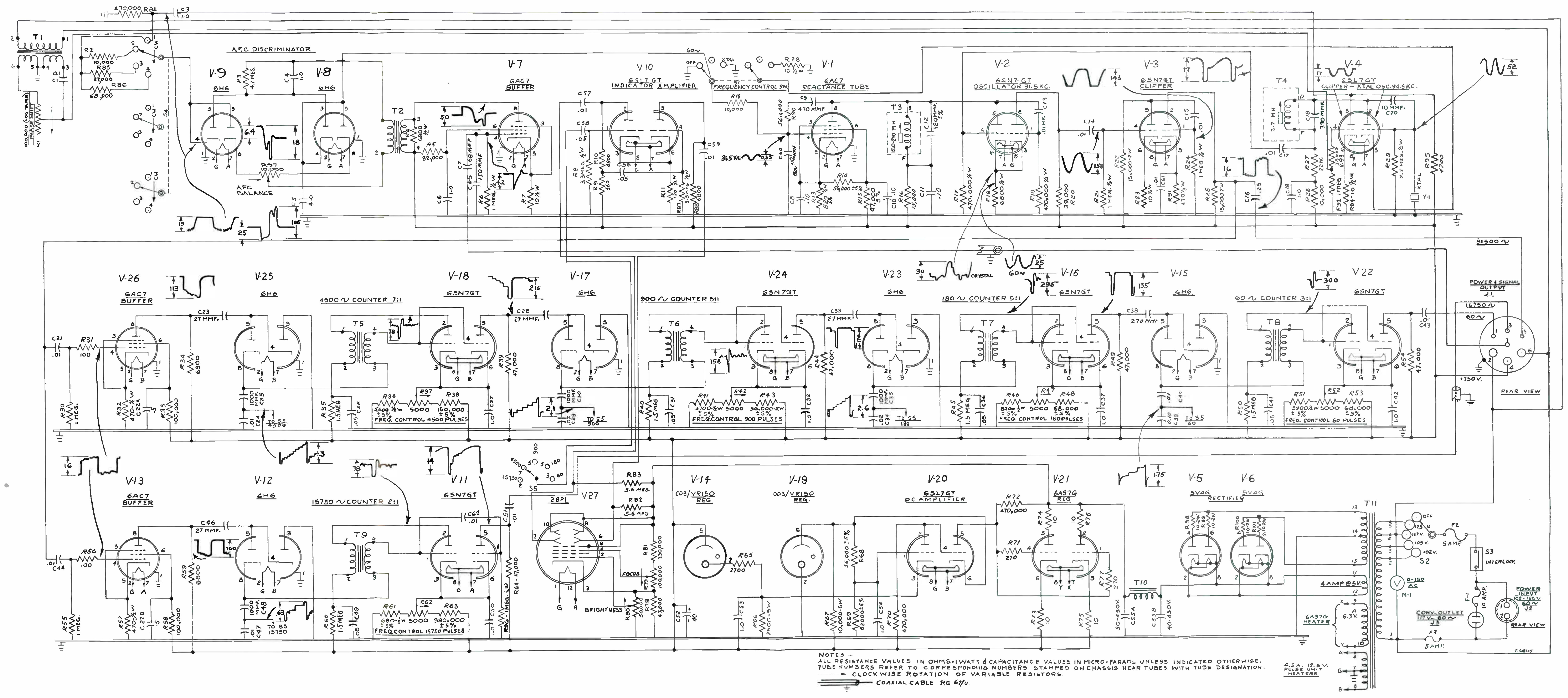
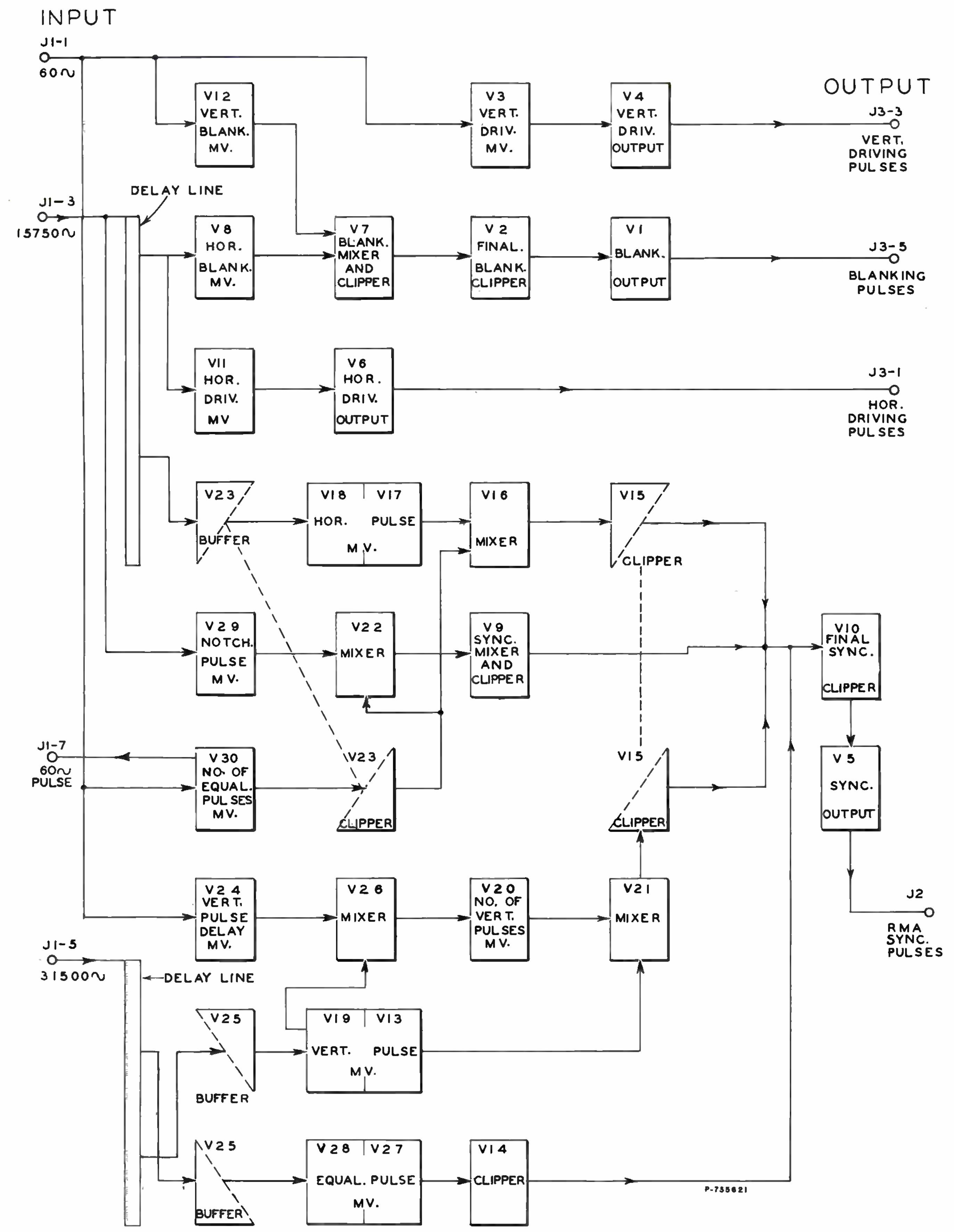


Figure 15 -- Schematic Diagram, Pulse Former



Block Diagram, Field Pulse Shaper

D-C VOLTAGE CHART -- FIELD PULSE SHAPER

TUBE			PLATE			GRID			CATHODE			SCREEN		
			Pin	Condition		Pin	Condition		Pin	Condition		Pin	Condition	
No.	Type	Function	No.	Normal	No Sig.	No.	Normal	No Sig.	No.	Normal	No Sig.	No.	Normal	No Sig.
1	6AG7	Blank. Output	8	207	199	4	-29.5	0	5	6.15	7.4	6	232	226
2	6SL7GT	Final Blank. Clip.	2,5	215	208	1,4	-3.6	0.88	3,6	0.02	0.03			
3	6SL7GT	Vert. Driving MV	2 5	187 171	188 172	1 4	-15.3 -0.3	-6.5 0	3 6	0.01 0.04	0.01 0.03			
4	6AG7	Vert. Drive. Out.	8	205	204	4	-2.0	0.01	5	9.58	9.85	6	252	252
5	6AG7	Sync. Output	8	222	198	4	-97	0	5	4.06	7.73	6	252	252
6	6AG7	Hor. Drive. Out.	8	213	191	4	-21.5	0.1	5	4.55	7.75	6	252	252
7	6SL7GT	Blanking Mixer and Clipper	2 5	248 248	233 233	1 4	-4.38 -8.5	-0.65 -0.66	3 6	0.02 0.02	0.05 0.07			
8	5691	Horizontal Blanking MV	2 5	157 155	158 156	1 4	-2.96 -0.82	-2.6 -0.52	3 6	0.02 0.04	0.01 0.03			
9	6SL7GT	Sync Mixer and Clipper	5 2	248 227	246 225	4 1	-6.18 -4.45	-0.43 -0.5	6 3	0.03 0.02	0.05 0.04			
10	6SN7GT	Final Sync Clipper	2 5	138 233	143 128	1 4	-2.03 -13.8	0 0.32	3 6	0.13 0.02	0.12 0.13			
11	5691	Horizontal Driving MV	2 5	147 115	148 115	1 4	-3.83 -0.35	-3.32 -0.1	3 6	0.02 0.05	0.01 0.04			
12	6SL7GT	Vertical Blanking MV	2 5	170 183	168 185	1 4	-0.54 -14.8	0 -7.5	3 6	0.03 0.01	0.03 0.01			
13	6AC7	1/2 Vert. Pulse MV	8	192	182	4	-11.2	-0.65	5	0.02	0.12	6	43.5	68.3
14	6SL7GT	Sync Mixer and Clipper	2 5	250 227	237 225	1 4	-13.6 -1.5	-0.45 -0.6	3 6	0.02 0.04	0.04 0.03			
15	6SL7GT	Sync Mixer and Clipper	2 5	227 227	225 225	1 4	-0.35 -1.25	-0.25 -0.4	3 6	0.04 0.03	0.04 0.02			
16	6L7	Mixer	3	247	244	cap 5	0 -0.72	0 -0.4	8	0.01	0.01	4	81	25.2
17 18	6AC7 6AC7	Horizontal Pulse MV	8 8	148 200	136 197	4 4	-0.8 -7.1	-0.28 -0.42	5 5	0.1 0.02	0.12 0.1	6 6	53 53	58.6 62.2
19	6AC7	1/2 Vert. Pulse MV	8	100	96	4	-0.58	-0.22	5	0.12	0.13	6	43.5	48.5
20	6SL7GT	No. of Vertical Pulses MV	2 5	178 168	178 168	1 4	-11.2 0.08	-4.7 -0.28	3 6	0.01 0.05	0.01 0.05			
21	6L7	Mixer	3	251	251	cap 5	-7.1 0	0.01 0	8	6.9	6.1	4	81.5	48.9
22	6L7	Mixer	3	218	178	cap 5	-1.32 -7.35	0.01 0	8	0.1	0.14	4	79.5	86.3
23	6SL7GT	Buffer Clipper	2 5	252 251	252 238	1 4	12.2 -12	12.2 -0.54	3 6	14 0.01	14.3 0.04			
24	6SL7GT	Vert. Pulse Delay MV	2 5	159 179	162 182	1 4	0.13 0	0 -7.0	3 6	0.04 0.01	0.04 0.01			
25	6SN7GT	Buffer	2 5	252 252	252 252	1 4	0 0	0 0	3 6	11.4 7.85	10.8 7.85			
26	6L7	Mixer	3	251	251	cap 5	0.17 0	0 0	8	14.1	11.7	4	48.9	78.3
27 28	6AC7 6AC7	Equalizing Pulse MV	8 8	193 185	158 185	4 4	-4.52 -0.13	-0.49 0.25	5 5	0.02 0.12	0.09 0.12	6 6	47.5 47.5	66.5 49.2
29	6SL7GT	Notching Pulse MV	2 5	155 165	168 163	1 4	-3.15 -3.5	-3.48 0.2	3 6	0.02 0.03	0.01 0.05			
30	6SL7GT	No. of Equal. Pulses MV	2 5	172 188	175 192	1 4	-0.85 -13.8	-0.5 -5.5	3 6	0.04 0.01	0.04 0.01			

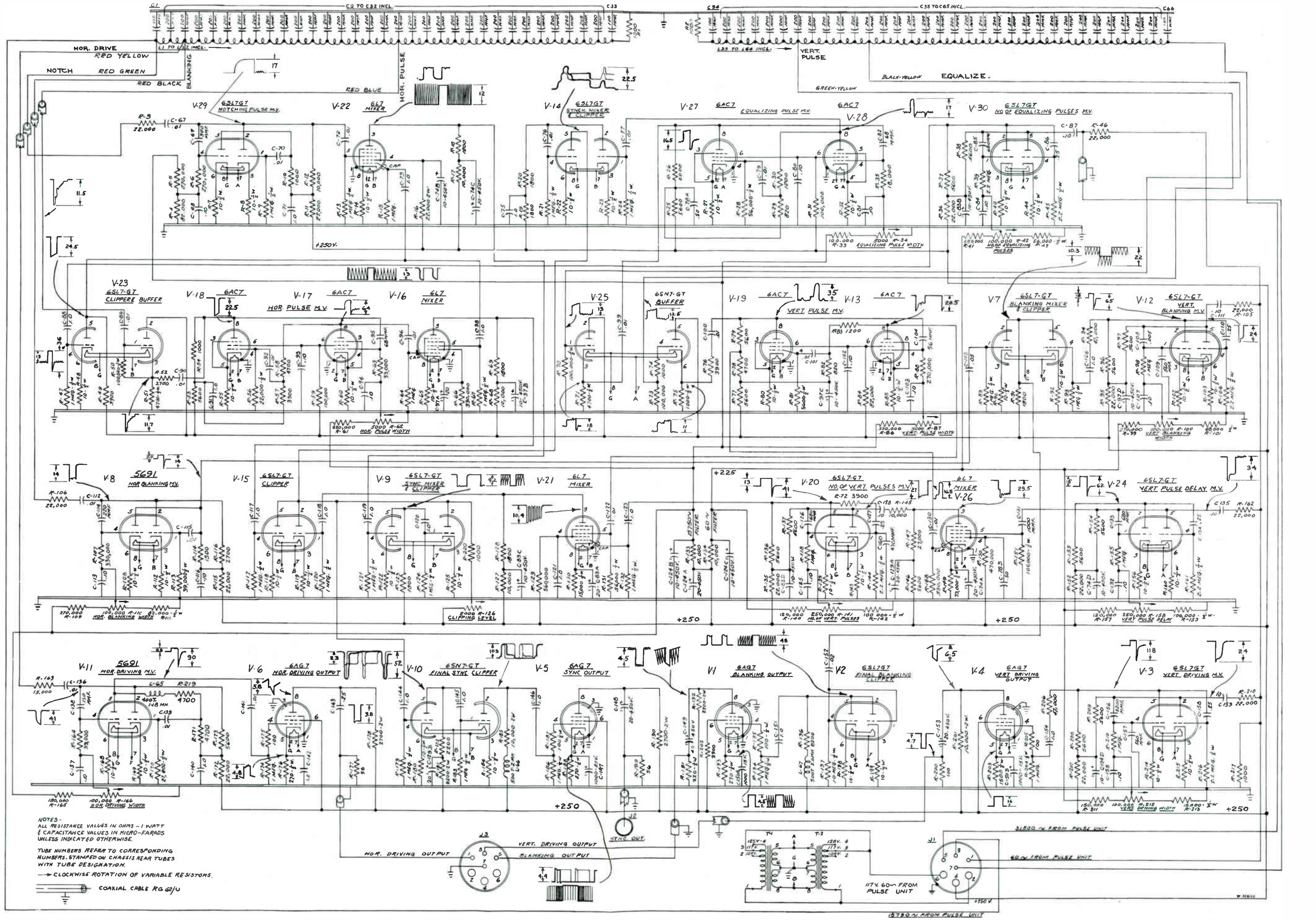


Figure 16 -- Schematic Diagram, Pulse Shaper

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