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TELETYPE

PRINTING TELEGRAPH SYSTEMS

R. J. Reek

BULLETIN 230B

TEST SET, TELETYPEWRITER, TS-799()/UGM-I (SIGNAL GENERATOR)

OPERATION, INSTALLATION AND
MAINTENANCE INFORMATION
CONTRACT NO. DA36-039-SC-63215

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CORPORATION
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TABLE OF CONTENTS

SECTION 1 - GENERAL DESCRIPTION

SECTION 2 - DETAILED DESCRIPTION AND THEORY OF OPERATION

SECTION 3 - INSTALLATION AND ADJUSTMENTS

SECTION 4 - OPERATING INSTRUCTIONS

SECTION 5 - MAINTENANCE

SECTION I
GENERAL DESCRIPTION

1. SCOPE OF THE MANUAL

This manual describes the Test Set Teletypewriter TS-799( )/UGM-1 hereinafter referred to as the Signal Generator. This manual contains information concerning the purpose, description, theory of operation, operation, maintenance, and parts list for this equipment.

2. PURPOSE OF THE SIGNAL GENERATOR

a. The Signal Generator provides conventional teletypewriter signals for the testing and adjustment of teletypewriter terminal equipment. It also provides pulses for the testing of connecting facilities.

b. In the adjustment of teleprinter equipment it has been found that the modification of a standard teletypewriter signal under controlled conditions will facilitate the adjustments of receiving equipment. Measurement of a receiving equipment's capabilities for receiving distorted signals is another use for such modified signals.

c. The Signals Generator provides four types of controlled signal modifications for use as noted above.

d. The Signal Generator may be attached to and used in conjunction with the TS-800( )/UGM-1 Distortion Indicator unit if desired.

e. The appearance of the unit is shown in Figure 1-1

3. PERFORMANCE CAPABILITIES

a. Types of Signal

(1) The Signal Generator produces teletypewriter signals in the start-stop or Baudot form. Figure 1-2 shows a widely used character coding arrangement. Start-stop signals available include the following.

(a) A "Quick Brown Fox" test message
(b) Selected characters
(c) Alternate "R-Y"

(2) At the 65 word per minute rate of start-stop signal transmission the "Stop" pulse which is generated has the same length as each of the other pulses in the character. This results in a 7 unit code. For the remaining rates of start-stop signal transmission the stop pulse is generated 42 percent longer than the other pulses. This 7.42 unit code which results is a standard in the industry.

(3) Alternate marking and spacing pulses (current-no current) referred to as "dot-cycles" are also available. These pulses have widths identical to pulse widths for standard as well as higher speeds of operation but they are not identifiable as any particular character shown on Figure 1-2. The dot cycle output is intended for testing of transmission or connecting facilities between teleprinters.

b. Operating Speeds

The following operating speeds and corresponding nominal word per minute rates which are available are tabulated below:

(1) 7.42 unit code transmission

Characters per minute	Words per minute class
368	60
404	68 (British compliment of 60)
460	75
600	100

(2) 7 Unit code transmission

390	65

(3) Dot cycle transmission

Frequency (cycles per sec.)	Pulse Duration (Milliseconds)	W.P.M. Compliment
23	21.96	60
28	17.5	75
37	13.5	100
75	7.	200
100	5.	270

c. Distortion

The start-stop signal output can be produced with zero distortion (perfect signal) or it can be supplied with known amounts of distortion.

(1) Distortion is produced by advancing or delaying the transitions of a start-stop character from their normal points of occurrence relative to the start transition. The following four types of these "start-stop displacements" are provided in the Signal Generator.

(a) Marking Bias (marking beginning displacement) is produced by advancing the instant of space (No current flow) to mark transition but not changing the instant of the mark to space transition. This results in an effective lengthening of the duration of a "marking" (current flow condition) pulse.

(b) Spacing Bias (spacing beginning displacement) is produced by delaying the instant of the space to mark transition but not affecting the mark to space transition. This resulting in an effective lengthening of a marking pulse.

(c) Marking End Distortion (marking end displacement) is produced by delaying the instant of the mark to space transition but not affecting the space to mark transition. This results in an effective lengthening of the duration of a marking pulse.

(d) Spacing End Distortion (spacing end displacement is produced by advancing the instant of the mark to space transition. This results in an effective shortening of a marking pulse.

(2) Each of the types of distorted signals can be generated in amounts up to 50 percent of a unit pulse period.

(3) Overall accuracy of the Signal Generator is such that actual pulse widths measured at the output terminal will be within 2 percent of the distortion dial setting.

(4) The distortion circuitry is so arranged that a fixed amount of distortion as determined by the setting of the distortion dial may be generated in any of the 4 types of signal distortion by the manipulation of two distortion selector switches.

d. Output Circuit Characteristics

All outputs consist of undirectional current signals, called neutral signals. Two output options are provided.

(1) Internal power supply

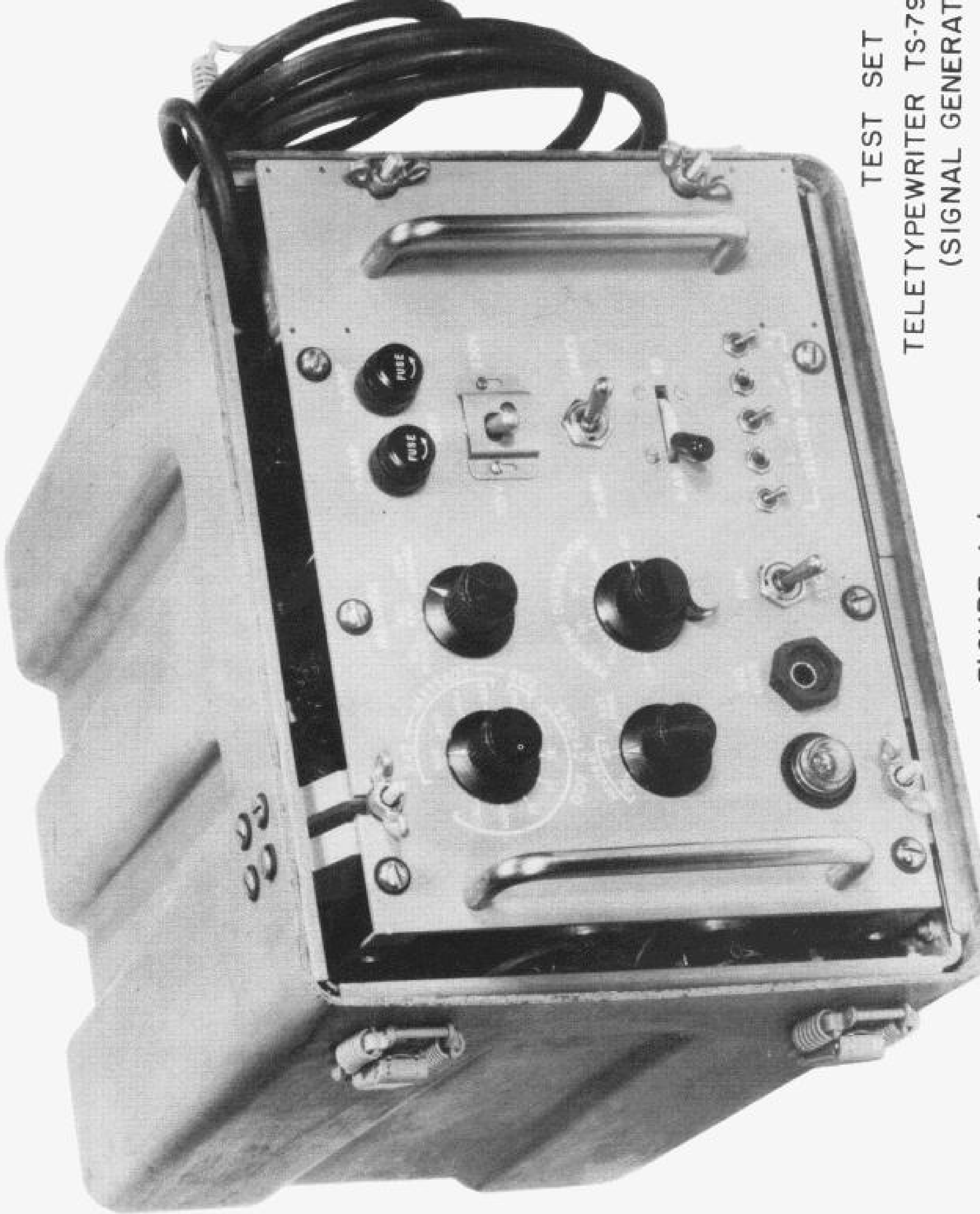
Internal power of 120 volts is used to supply either 20 or 60 milliamperes current to the output loop.

(2) External power supply

A line relay included in the unit provides for low impedance keying of a circuit by insertion in place of existing transmitters.

f. Input Power Requirements

The Signal Generator can be operated from 230 or 115 volt 50-60 cycle power. At 115 volts the unit requires approximately 0.65 amperes of current or 60 watts of power.



TEST SET
TELETYPEWRITER TS-799()/UGM-1
(SIGNAL GENERATOR)

FIGURE 1-1

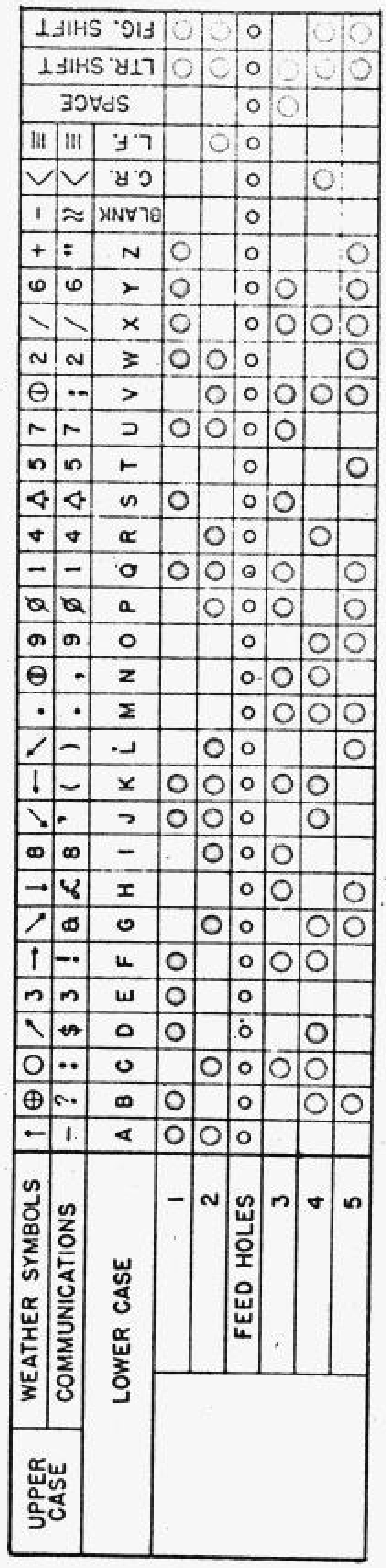

UPPER CASE
WEATHER SYMBOLS
COMMUNICATIONS
LOWER CASE
FEED HOLES
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
BLANK
C.R.
L.F.
SPACE
LTR. SHIFT
FIG. SHIFT

FIGURE 1-2

SECTION II

DETAILED DESCRIPTION AND THEORY OF OPERATION

1. DETAILED DESCRIPTION

a. INTRODUCTION:

Section II presents the physical description and theory of operation of the Signal Generator designed for generating teletypewriter test signals.

b. PHYSICAL DESCRIPTION

(1) TRANSIT CASE

(a) The transit case housing the Distortion Generator has overall dimensions of 11-1/4 x 11-1/2 x 9 inches and has a detachable cover which allows the unit to be operated within the case after removal of the cover.

(b) The transit case cover is equipped with a gasket lining around the edge which acts as a moisture seal. Pressure equalization is also allowed by the gasket lining during high altitude transportation.

(c) A webbed canvas carrying handle is mounted on the detachable cover of the transit case.

(d) The transit case cover is secured to the case by spring fastener latch assemblies.

(e) Weight of the unit mounted in the transit case is 28 pounds.

(2) FRONT PANEL

(a) Overall dimensions of the front panel are 9-1/2 x 7 inches, the material being of 1/8 inch aluminum stock. The unit is designed to mount in a standard 19 inch relay rack, or on the mounting brackets of the transit case.

(b) For relay rack mounting, the Signal Generator must first be secured to the TS-800 Teletypewriter Test Set (Distortion Indicator). Total panel area for the two units is then 7 x 19 inches.

(c) On the front panel are mounted the operator's controls, indicator lamp, fuses, input jacks and the power switch.

(3) CHASSIS

(a) The chassis is constructed of aluminum in the form of a box by the use of aluminum angles. The approximate overall dimensions of the chassis are 8-1/2 x 7 x 10 inches.

(b) The power supply circuits occupy the area at one side of the chassis while the etched circuit board which contains the control circuitry is mounted directly across from the power supply.

(c) The Quick Brown Fox message generator is an etched circuit board and forms a vertical partition near the center of the chassis.

(4) CONTROL CIRCUIT BOARD

The control circuit board contains the timer, distributor, delay and amplification stages required in the Signal Generator. Tube sockets, resistors, capacitors and diodes are mounted to this board.

c. SIMPLIFIED CIRCUIT DESCRIPTION OF ENTIRE SIGNAL GENERATOR (Refer to Fig. 2-1)

Description of Function or Operation	Name of Circuit Performing Function
(1) A train of pips having a controlled frequency as selected by the front panel speed control is generated.	TIMER
(a) When dot-cycles are generated, this train of pulses controls the output binary directly.	
(2) These timer pips drive a circuit which produces a sequential signal on a multi-wire output. Each of the outputs corresponds to its respective element of the start-stop code, including the start and stop pulse.	RING DISTRIBUTOR
(3) The above multiple outputs are combined onto a single lead under the control of	"B" NET
(a) Manual switches which can be set for any character	
(b) "Quick Brown Fox" test message matrix for test message	
(c) "R-Y" binary, for alternate R-Y signals	
(4) The above signals are amplified and shaped to the proper level.	"B" AMPLIFIER
(a) Auxiliary circuits used for the generation of distorted signals sense the condition of the pulse following the one which is being transmitted.	"A" NET

(b) These pulses are amplified and shaped to the proper level.	"A" AMPLIFIER
(c) A variable timer is controlled by the above pulses.	DELAY TIMER
(5) The "A" amplifier and the Delay Timer signals are combined to generate distorted signals of type and amount determined by front panel controls.	OUTPUT BINARY
(6) The distorted signals are amplified to the proper power level for directly driving the output line (internal battery) or for driving an output relay for subsequent connection to the output line (external battery).	OUTPUT AMPLIFIER

d. SIMPLIFIED CIRCUIT DESCRIPTION OF QUICK BROWN FOX MATRIX (Refer to Fig. 2-2)

Description of Function or Operation	Name of Circuit Performing Function
(1) At the end of each start-stop distributor cycle, a drive pulse is generated for application to one of the cold cathode tubes which control the matrix.	STOP AMPLIFIER
(2) The above mentioned cold cathode tube forms one part of a cross point switch. One of the cathodes will always be fired and will partially raise a vertical column of eight connections to a positive level.	UNITS TUBE
(3) One of eight cathodes will always be fired in the tens tube. One row of 10 connections will be partially raised to a positive level.	TENS TUBE
(4) One element associated with the particular column and row mentioned above will be raised to a higher positive level than can be found at any other point in the matrix.	MATRIX
(5) This positive voltage is connected by means of diodes to the proper signal pulse leads in accordance with the character which is wired into the matrix at the point of coincidence.	MATRIX
(6) The 5 wire signal is then applied to the "B" and "A" net, which is also under the control of the ring distributor as previously described.	
(7) At the completion of a cycle of operation of the "Units" tube a drive pulse is generated for stepping the "tens" tube to its next position.	TENS DRIVER

2. THEORY OF OPERATION

a. Introduction

The Signal Generator Operating Block diagram is shown for zero, bias, and end distortion in Figures 2-3, 2-4, 2-5 respectively.

(1) Zero Distortion (Perfect Signal)-Figure 2-3

(a) Figure 2-3 shows the elemental control system consisting of a timer oscillator which determines the pulse boundaries; a seven stage distributor ring which distributes the pulses to be transmitted so that each pulse occurs at its position in the pulse train; a sensing net which gates the preselected pulse for transmission; an amplifier which drives the output Binary which in turn drives the output amplifier stage.

(b) The timer is a free running phantastron which generates a train of positive pulses for driving the seven stage thyratron counting ring. Each thyratron in turn gates a sensing circuit associated with its position in the ring (character). The sensing circuit thus contributes when its gate is operated and a positive voltage condition appears at the input to the "B" amplifier if the switch associated with the pulse position is closed. If the switch is open, a lower positive voltage is fed to the "B" amplifier for the pulse period. The start pulse of the teletypewriter code is invariably generated as a low voltage at the "B" amplifier by the absence of any connection from the start thyratron tube.

(c) Amplified signal transitions drive an output binary circuit and a following amplifier stage. A positive transition results in a current (marking) output and a negative transition results in a no current (spacing) output.

(2) Bias Distortion (Beginning Displacement)-Figure 2-4

(a) To change the instant of the space to mark transition the controls of Figure 2-4 are used. A second sensing net "A" is added. This "A" net senses the pulses one stage early so that a transition which is to be varied in time is sensed one pulse early to trigger a delay timer. This is necessary since the distorted signal transition may be required to occur before the normal transition point. (Marking beginning displacement). Thus, in the "A" sensing, the start tube gates #1 pulse; #1 tube gates #2 pulse, etc.

(b) Diode blocking at the output of the delay permits the delay to drive the output binary for space to mark transition on front ends of pulses. The "B" amplifier is permitted to drive the binary for only the mark to space transition on ends of the pulses. The step by step sequence is taken up under a later section.

(3) <u>End Distortion (End Displacement)-Figure 2-5</u>

(a) To change the instant of the mark to space transition the operation is similar to the above except that the "B" function controls the time of the space to mark transition at the beginning of a pulse while the delay controls the output for the mark to space transition at the end of the pulse.

(b) As the mark to space transition of the start pulse is the point from which all measurements are made the <u>stop pulse is not affected by "end distortion"</u>.

b. <u>Detailed Description of Individual Circuits</u>

(1) <u>Basic Phantastron Timer - Figure 2-6</u>

(a) The basic Phantastron circuit is shown in Figure 2-6. Note the plate to grid capacitor Cg which forms the Miller integrator part of the circuit. The screen is coupled to the suppressor by resistance and capacitance to provide the self gating which is required. Thus if the grid is positive, the screen is conducting heavily and is at its lowest voltage. Due to the connection of the suppressor to a voltage divider between the screen and the negative supply, the suppressor is normally at about-25 volts and the plate current is cut off.

(b) When a positive pulse is applied to the suppressor, plate current flows, dropping the plate voltage. Cg couples this drop in plate voltage to the control Grid which greatly reduces the screen current. As a result, the screen voltage rises rapidly, driving the suppressor positive to ground potential where it is held by the diode CR-1.. The plate drops rapidly until the negative voltage fed to the grid thru Cg is sufficient for the grid to control the plate current which then stops its initial rapid change and begins its linear run down characteristic until the plate reaches a low voltage limit determined by the space charge in the tube.

(c) At the point where the plate "bottoms" shown as point "B", the plate can no longer hold the grid negative, and since the grid return resistor is connected to a positive source, the grid voltage begins its rise, and the screen begins to draw more current. Consequently, the screen voltage drops, carrying the suppressor with it and cutting off the plate current.

(d) The plate voltage now rises as a function of the R_p C_g time constant as the grid is driven positive and grid current flows. The positive grid excursion is limited by the grid-cathode drop under the grid current condition.

(e) If the plate is prevented from reaching full voltage, the run down starts at a lower voltage and since the slope remains the same, the run down period is reduced, as the plate bottoms at the same point as before. As seen in Figure 2-6, diode CR-2 conducts when the plate reaches a maximum voltage determined by the setting of Potentiometer R-1. This gives a simple means of accurate control of the delay, as shown in the dotted waveforms, since the run down of the plate voltage is linear within 1/10%. The period of the delay is determined by the tube characteristics, circuit parameters and the voltage applied to the various leads.

(f) It is characteristic of this circuit that if the supply voltage is varied, all the circuit elements see the same percentage change and the delay period does not change. But if one of the voltages is varied, the period of the run down is changed. Advantage of this characteristic is taken in the Signal Generator to lower the control grid voltage during the stop pulse period to produce the 1.42 stop pulse period.

(g) The logarithmic run up of plate voltage can be made a small part of the total cycle by using a cathode follower to charge up the capacitor Cg. This is shown in Figure 2-7. Here V2 grid rises with the plate voltage and the tube grid cathode current and grid to ground diode is used to charge Cg.

(h) Outputs from the timer circuit may be taken from the plate circuit using the cathode follower as a low impedance source. The screen may also be used as an output point if desired.

(3) <u>Free Running Phantastron Timer - Figure 2-8</u>

(a) If the negative bias on the suppressor is removed, the plate current is cut off only momentarily following a run down. The plate immediately starts its next run down as shown in Figure 2-8. As before, the plate continues its run down until bottoming where the grid is no longer held negative and the fast fall of the screen couples a negative spike to the suppressor to cut off the plate current for the plate run up period. A short time later the suppressor voltage returns to ground potential and plate current again flows to re-start the cycle. Diode CR is used to prevent excessive positive voltage on the suppressor, protecting it from excessive current.

(b) This free running curcuit is used as the timer in the Signal Generator where it is required as a time base. This timer generates six equal periods and one period which can be made 1.42 times the duration of the others by changing an operating voltage during the stop time.

(c) The biased phantastron (Figure 2-7) is used as a delay timer for the generation of distorted pulses.

(4) Start Stop Distributor

(a) Need for Distributor

In order to generate teletypewriter start-stop signals, two conditions must be met:

1. Control is required over the voltages associated with each of the 5 code pulses.

2. A means of time-modulating these voltages is required.

(b) In the Signal Generator, one of the signal inputs is derived from five switches which can be set in accordance with the marking or spacing pulses as required for a given character. The start-stop distributor provides a means of time modulating these potentials so that the generated signal consists of a series of marking and spacing pulses for transmission over a single wire line rather than over a six wire cable. This time modulation is accomplished in the Signal Generator by using a thyratron ring of seven; each tube controls the pulse during which it is conducting.

(c) Operation of the Distributor - Figure 5-6

Tube VI thru V7 are so connected so that as each tube fires or conducts its cathode primes the grid of the following tube so that the next incoming drive pulse is able to bring that one grid to the firing voltage. All thyratron plates in the ring have a common anode load resistor.

1. When the power is first applied to the circuit none of the ring tubes is conducting, and since none of the grids are primed by the previous tubes, auxiliary means are used to initiate operation.

2. R9 is connected from the common anode line to the grid of V6. As no plate current is flowing this anode line is at +185V and Grid V6 is thereby conditioned. After the timer begins operation, a positive pulse from the timer fires V6. The anode line now drops to about +45 volts. The cathode capacitor charges up to 30 volts and the grid of V7 is conditioned by R4-7 for firing by the next positive pulse from the timer.

   The cycle is repeated for each of the tubes V1, V2, V3, V4, V5. With the fall of potential of the anode line the grid of V6 is no longer conditioned by the anode to grid resistor and waits for priming by the cathode voltage of V5 before being fired by the drive pulse.

3. The characteristics of a thyratron are such that the grid may prevent firing of a tube, but once conducting the conduction is not under control of that grid. To cut off conduction in a thyratron the plate to cathode voltage must be made less than the minimum arc drop within tube. This is accomplished by the cathode capacitors. When a new tube is fired, the anode to ground voltage at firing instant is the arc drop of about 12 volts. Since the cathode of the proceeding tube is held at +30V by its capacitor, its anode is momentarily some 18 volts negative with respect to its cathode and the arc extinguishes.

4. The common grid bias must be such as to prevent firing of the tubes except under influence of the conditioning voltage from the proceeding tube combined with the drive pulse. The drive pulses must be of short duration to be dissapated before conditioning of the next succeeding tube as all tubes are driven simultaneously.

(5) Drive Amplifier

The drive pulses are derived from the timer phantastron and supplied to a zero biased amplifier which amplifies only the negative transitions of the screen. The positive going plate pulses are coupled to the distributor ring trigger line feeding all the thyratron grids.

(6) 1.42 Stop Pulse

The cathode of the V6 tube is DC coupled to the "Stop Amplifier" which is normally cut off. When the V6 cathode rises to +30 volts, the amplifier tube grid is made slightly positive and the tube is saturated. The low voltage at the anode is used to lower the grid supply voltage of the timer phantastron to lengthen its period during the time that No. 6 tube is conducting. Adjustment of the period to 1.42 as compared to the other pulses is accomplished by potentiometer R15 in the divider used as the plate load of the amplifier.

(7) Stop Switch

The stop switch biases V7 grid to prevent its conduction and thus holds the distributor on V6. Operation of the stop switch thus ends or begins a character following the stop pulse.

(8) Signal Generation Network - Figure 2-9

The thyratron cathode load resistors act as "shunt gates" for the diode sensing nets. A cathode which is not fired is effectively at ground potential due to its low load resistor.

(a) "B" Junction Gates

The cathode resistor values of 10K are small compared to 3.3 megohms and there is effectively no voltage at B1 when switch No. 1 is closed if V1 is not conducting. However, when the cathode of V1 rises to +30 volts, diode CR1-1 is blocked and "B" rises to a voltage of approximately 23 volts. If the switch "1" is open, CR1-1 prevents the cathode voltage from appearing at the B net so the resultant net voltage is less positive.

Thus, if switches 1, 3 and 5 are closed and 2 and 4 are open, the output at "B" junction will be 1 marking, 2 spacing, 3 marking, 4 spacing, and 5 marking. In addition since the net is permanently biased to +30V for the stop position, the stop period is always marking. No connection is made to the start tube, so that its period is always spacing.

(b) "B" Amplifier - Figure 5-6

The output at "B" is fed to the grid of DC amplifier consisting of a high gain first stage and a low impedance second stage so biased that over drive on the second stage produces a clean square wave output of the signal desired.

(c) Output Binary - Figure 5-6

For undistorted signals it would only be necessary to provide power amplification to this output. But as it is required to operate on this signal, the output is fed to a Bistable Multivibrator of the Eccles Jordan type. In "zero" distortion the "B" amplifier output pulses drive this output driver for both positive and negative transitions.

(d) The output binary drives the output amplifier from below cutoff to a positive voltage which is clamped by the current control in the grid circuit of the amplifier. The change from 20 to 60 milliamperes is accomplished by changing the resistance in the cathode of the amplifier. This method of current control offers the advantage of degenerative feed back for current stability. An alternate output may be taken from a line relay which is driven by the output amplifier. This relay output is desirable where low voltage circuits must be keyed. No contact protection is provided for the relay contacts so this must be done externally.

(9) Distortion Generation Circuits - Figure 2-10

(a) Introduction - Figure 2-11

Perfect (0 distortion) teletypewriter signals are shown on line A of Figure 2-11. Lines B, C, D, and E show the extremes of distortion which are required to be generated. The reference for these pulses is the train of timing pulses shown at the bottom of the Figure.

(b) Bias Distortion Circuits - Figure 2-11

1. Lines B & C show the modification of the signal for the extremes of 50% distortion involved in Bias Distortion as generated in the Signal Generator. To generate such a signal it is necessary to have the ends of the marking pulses under control of the "timer" while the front ends are under the control of the distortion dial.

2. Line B shows the marking pulse actually starting in the preceding pulse period. In Line C the pulse is delayed until the center of its own period. This beginning displacement is under the control of a delay timer which is triggered at the start of the preceeding pulse boundary and has a range of delay of 50% to 150% of a pulse period. The dial range is restricted to 50% of a pulse period to comply with existing practice in previous generators. Thus the dial may be set at a fixed percentage and changed from marking to spacing distortion by operation of another switch.

3. "A" Function gates - figure 5-6, figure 2-12

To accomplish triggering of the delay timer one pulse early, another network, "A" is provided. Its operation is similar to that of the "B" function described earlier except that the sensing is done one pulse early by the distributor ring. Thus number 1 pulse is sensed during the start tube period; number 2 pulse is sensed during No. 1 period etc.

4. During the stop time, the "A" net voltage is spacing (low). When the next character begins, the start tube fires and sensing of the number 1 pulse is accomplished by the "A" net as the voltage rises to marking if number 1 pulse is marking.

This positive pulse is supplied to a two stage "A" amplifier identical to the "B" amplifier previously described. For the bias condition, the output of the second stage is used to trigger the delay.

5. The delay phantastron is a stable, normally cut-off, circuit which was described previously. With the delay in its stable state, the suppressor is negative, keeping the plate current cutoff. A negative pulse on the suppressor is thus ineffective when the circuit is at rest. While the delay phantastron may only be triggered in the suppressor by a positive pulse, it is necessary provide the diode CR9 in the suppressor lead to prevent negative pulses from the "A" net cutting off the plate of the phantastron and interfering with its normal cycle.

   The period of the delay cycle is determined by the percent distortion required. This delay is proportional to the limiting voltage on the plate of V13 as determined by the setting of the potentiometer R100A and the speed of operation voltage divider comprised of R108 through R113 and R104 and R105. This voltage source supplies the limiting voltage to the timer as well as the delay so that when R100A is set to 0 on the distortion dial, both timers are clamped to the same voltage and a distortionless output signal results.

6. When marking bias is to be generated, the delay is varied from 0 to 50 percent of a pulse width. If spacing bias is to be generated, the delay must cover the range of 100 to 150 percent of a pulse width. This is accomplished by the Mark-space switch which inverts the position of R100A and R100B in the divider network. Since these two resistors have the same value, the midpoint voltage does not change.

7. The plate waveform of the delay phantastron is taken from the cathode follower V12 and differentiated so that only the fast positive rise appears at the grid pin 7 of V12. Grid 7 of V12 is normally biased below cutoff. The positive pulse saturates the tube momentarily, discharging capacitor C7 and placing a negative pulse on grid 7 of V14 which drives the output binary to marking. (Distortion Switch in bias position).

8. Output Control

   The output binary performs the function of a memory circuit in that it holds a condition until instructe to change. The delay circuit drives the output to marking. This condition continues until the "B" net senses a spacing pulse resulting in a negative transition at anode pin 1 of V18. This pulse coupled to grid pin 2 of V14 drives the output to spacing. As positive transitions of the "B" output are not to affect the binary, they are blocked by a silicon diode CR6.

(b) <u>End Distortion Circuitry - Figure 2-13</u>

1. The principles involved in the generation of End Distortion (End displacement) differ from that of Bias (Beginning displacement) only in the following:

   a. The variation in the duration of the marking pulse is by change in the instant of the mark to space transition, at the ends of the pulses.

   b. The instant of the mark to space transition of the start pulse is the reference point and therefore cannot change. Therefore there is no end distortion of the stop pulse.

   c. The "B" amplifier drives the signal to marking (instead of spacing as in bias).

   d. The delay phantastron drives the signal to spacing, (instead of marking as in Bias).

   e. The stop amplifier generates the start pulse.

2. Since in end distortion, it may be required that a pulse end earlier than normal, (spacing E.D.) it is required that the character be sensed one pulse ahead as was done for Bias. As the delay phantastron is now to control the mark to space transitions, it must be triggered by a negative going transition from the "A" net. The first stage of the "A" amplifier is used as a phase inverter to supply a suitable positive pulse to trigger the delay when the A net voltage drops, denoting the end of a pulse.

3. The pulse generation sequence is as follows: Start at left hand end of line of Figure 2-11. During the previous stop pulse with switch ED Figure 2-9 closed the "A" net is marking as the net is sensing the closed ED switch. When the start tube conducts "A" remains marking as the marking number 1 is sensed. On the next pulse from the timer Number 1 tube conducts, and the "B" output drives the output binary to marking. Simultaneously the "A" net goes to spacing as number 2 pulse sensed spacing. The inverted output from the "A" amplifier triggers the delay which times out the required period and triggers the output binary from mark to space to end the No. 1 pulse.

4. Start pulse generation - Figure 5-6

Note that the "B" net sensing causes the signals to shift from space to mark and the delay controls the shift from mark to space. At the first transition of a character (start pulse,) there was no preceeding mark to space transition to trigger the delay in advance of the start pulse. An auxillary circuit for triggering the output binary for the start pulse is provided. This circuit consists of the amplifier V19 which is coupled to the cathode of the stop distributor tube. When the distributor stop tube extinguishes, V19 returns to its normal cutoff state, resulting in a rise in voltage at its plate. This rise is coupled to one grid of the output binary to drive it spacing to begin the start pulse.

(10) Test Message Generation - Figure 2-14

(a) Introduction

A "Quick Brown Fox" test message is generated by use of a diode matrix driven by a cross point switch consisting of ten unit steps and eight tens steps to provide an eighty character message. Each of the junctions is tied through appropriate diode connections to the proper combination of the 5 code connections which are then applied to the B and A sensing nets in combination with the start-stop distributor. Figure 2-14 shows each character as it is wired into the matrix in its approximate location on the card.

(b) A typical cross point switch consists of vertical and horizontal bars so constructed that if a horizontal and a vertical bar are operated, a switch at the intersection of the two bars is closed. Thus a ten by eight configuration results in a 80 point output. In the matrix this function is accomplished by 2 cold cathode tubes, each of which has 10 ouput cathodes. On the tens tube, however only 8 output connections are utilized.

(c) "AND" gates and the cross point matrix - Figure 2-15

Refer to the cross point matrix at the left of Figure 5-6 and also to the basic sensing net as drawn on Figure 2-15. A two resistor sensing net provides a three step output as shown in 2-15a, b, c. If neither cathodes sources is energized, the output is 0. If only one cathode is energized the output is 1/2 of the cathode voltage (15V). If both cathodes are energized, the output is nearly equal to the cathode voltage (30V). Since the spacing level is represented by two voltages (0 and +15V) and the marking level is represented by +30 volts, only the range between 15 and 30 volts is usable for sensing purposes. Due to the interaction between the multiple circuits the space to mark differential is less than 10 Volts as measured at the grids of the "A" or "B" amplifiers.

(d) Character Formation - Figure 2-16(a)

To generate "T" (5 marking) as shown in the lower left of Figure 2-14, the cathode 0 (10) of the units and 20 (2) of the tens are both energized. A single diode to the No. 5 pulse lead would result in the transmission of the character "T". The character "H" would require two diodes, one to No. 3 and one to No. 5 leads.

(e) To conserve diodes, the build up of pulse combinations is done in steps as shown in Figure 2-16a. Starting at the top, No. 3 (space) and No. 5 (T) are combined to form 3, 5 (H). No. 1 (E) is added to form 1, 3, 5, (Y). Then No. 2 (line feed) and No. 4 (carriage return) are added to form 12345 (letters). Using such combinations, the 80 character message is built up using 125 diodes. The units tube is stepped each time by the stop amplifier V19 is energized at the end of a character. The No. 10 cathode of the "units" tube feeds a pulse to the amplifier which steps the "ten" tube. As only eightly characters are to be transmitted it is necessary to double step in the tens tube. This is done by the amplifier which is energized from the No. 10 cathode to directly fire No. 2 cathode, overriding the internal stepping action.

(f) Message Start - Figure 2-16(b)

To provide for starting at the beginning of the sentence each time the unit is switched from stop to run the cathode capacitors of cathodes 90 and 6 are switched from a positive charging resistor to ground which causes the arc to transfer to these cathodes to start the sentence at "carriage return", "carriage return", "line feed", "letters", "space", before beginning the sentence.

(g) <u>Operation of the 6167 Tube</u>

1. Counting in the 6167 tube, is done by the shifting of the arc discharge between the anode and successive cathodes. The main counting ring consists of twenty cathodes. Alternate cathodes are the output cathodes, the others being transfer cathodes. The transfer cathodes, as the name implies, serve to transfer the arc from a conducting cathode to the next succeeding cathode.

2. The W.E. type 6167 provides directional characteristics to the transfer cathode by so shaping the electrode that the back lead is in the arc and the forward end is close to the next succeeding cathode. Characteristics of multiple electrodes in a low pressure atmosphere (gaseous conduction) are that an arc will be established between electrodes across which the greatest potential exists. Thus if the arc is between the anode and No. 3 cathode and the transfer electrode nearest is made negative to No. 3 cathode, the arc will shift to the most negative electrode (transfer cathode). If now the transfer electrode is made positive, the arc will pass on to the next succeeding output cathode. In this manner the arc is passed step by step around the tube.

3. If another cathode not adjacent to the one carrying current is made some 80 volts negative to the conducting cathode, the arc will transfer to it. Use is made of this characteristic in stepping the tube from K10 to K2 in the tens tube and in resetting the message to character 97 for start.

4. As the arc drop in the tube is some 50% of the supply voltage, 50% of the supply voltage variations would appear across the cathode resistor. A regulated supply is used to eliminate this excessive variation of level.

(11) R-Y Binary - Figure 5-6

(a) V8 and V9 are thyratrons connected in a ring circuit with a common anode load resistor. One tube is always fired and the application of drive pips to the grids occurs each time the stop tube V6 fires. Thus each tube is on for every other character.

(b) The cathode of V8 raises a line to which diodes connect to the sensing nets for pulses 2 and 4. When the start stop distributor scans this combination, the letter "R" is generated.

(c) In a similar manner, the letter "Y" is generated for the following character since three diodes connect pulses 1, 2 and 3 to the cathode of V9 which now is fired.

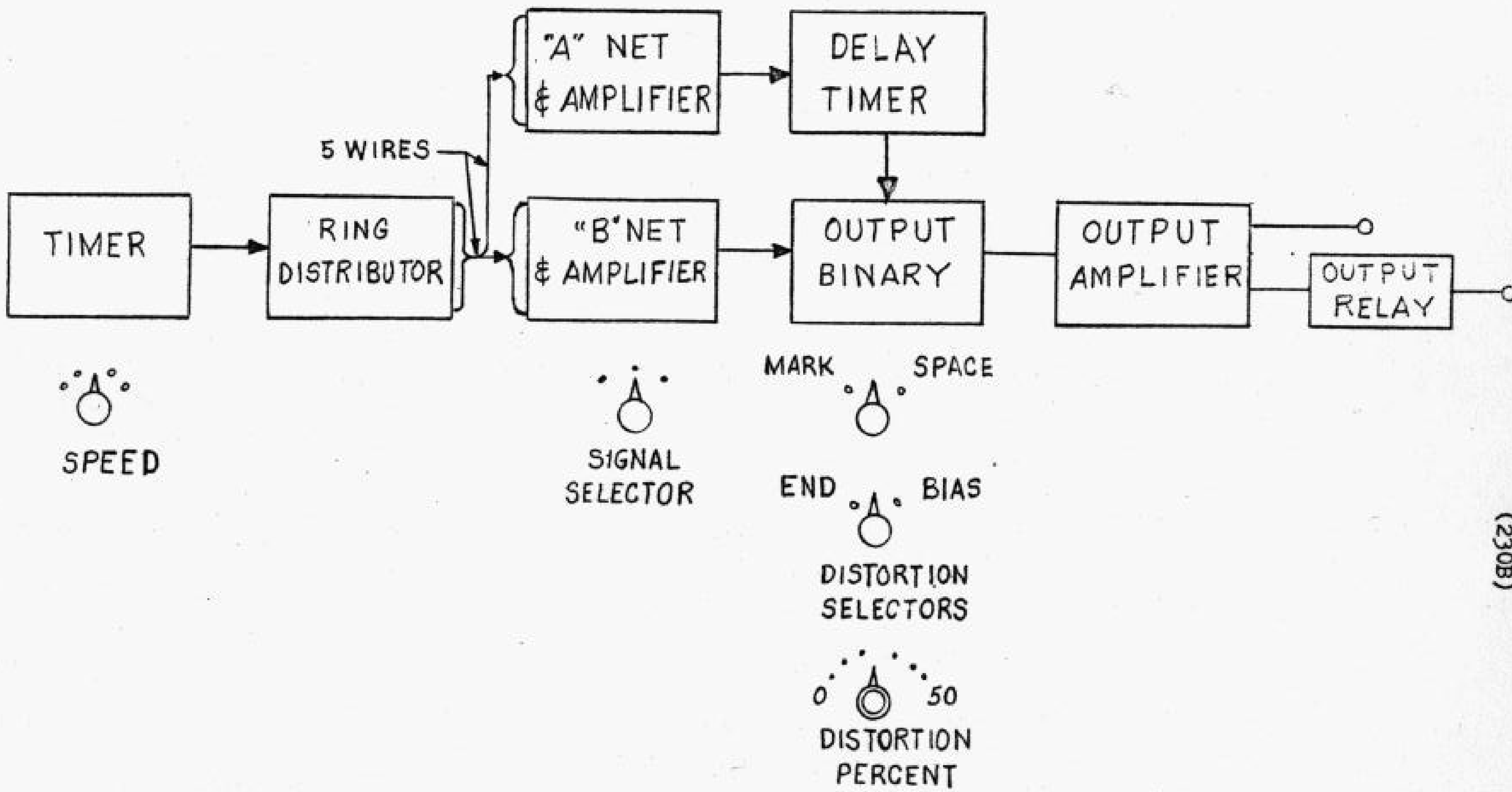
(12) Power Supply - Figure 5-6

(a) The transformer has a 2 winding 115/230 volt 50-60 cycle primary. Each winding is protected by a 3/8 ampere fuse. The series parallel switch is a double pole, double throw switch with a center off position. A locking plate restricts operation to the Off-115 or Off-230V position.

(b) High Voltage rectifiers are of the full wave centertapped type. Rectifiers are Silicon diffused junction diodes, Transitron Electronics Type SJ 31. The diodes are low forward resistance, and are presently rated for 250 volts peak inverse. Series resistors are used to limit the peak forward current to a safe value.

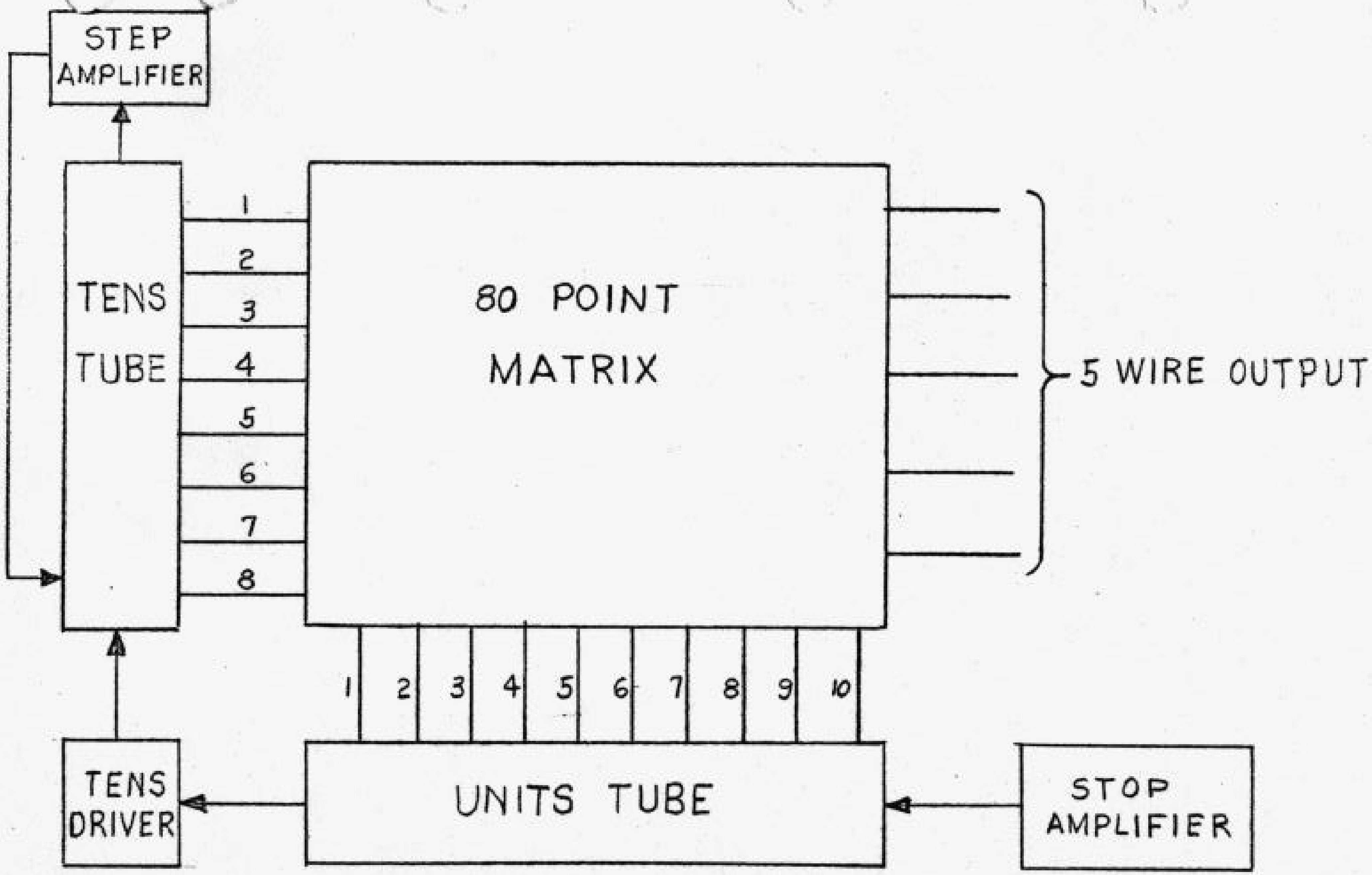
(c) The output tubes require 120V DC supply so that standard signalling conditions are provided. V202 and V203 form a series tube regulator which is referenced to +108V. This circuit holds the output voltage at 120V under the varying load conditions imposed by V15.

(d) A separate power supply is provided for the control circuits.



SIMPLIFIED BLOCK DIAGRAM
OF SIGNAL GENERATOR

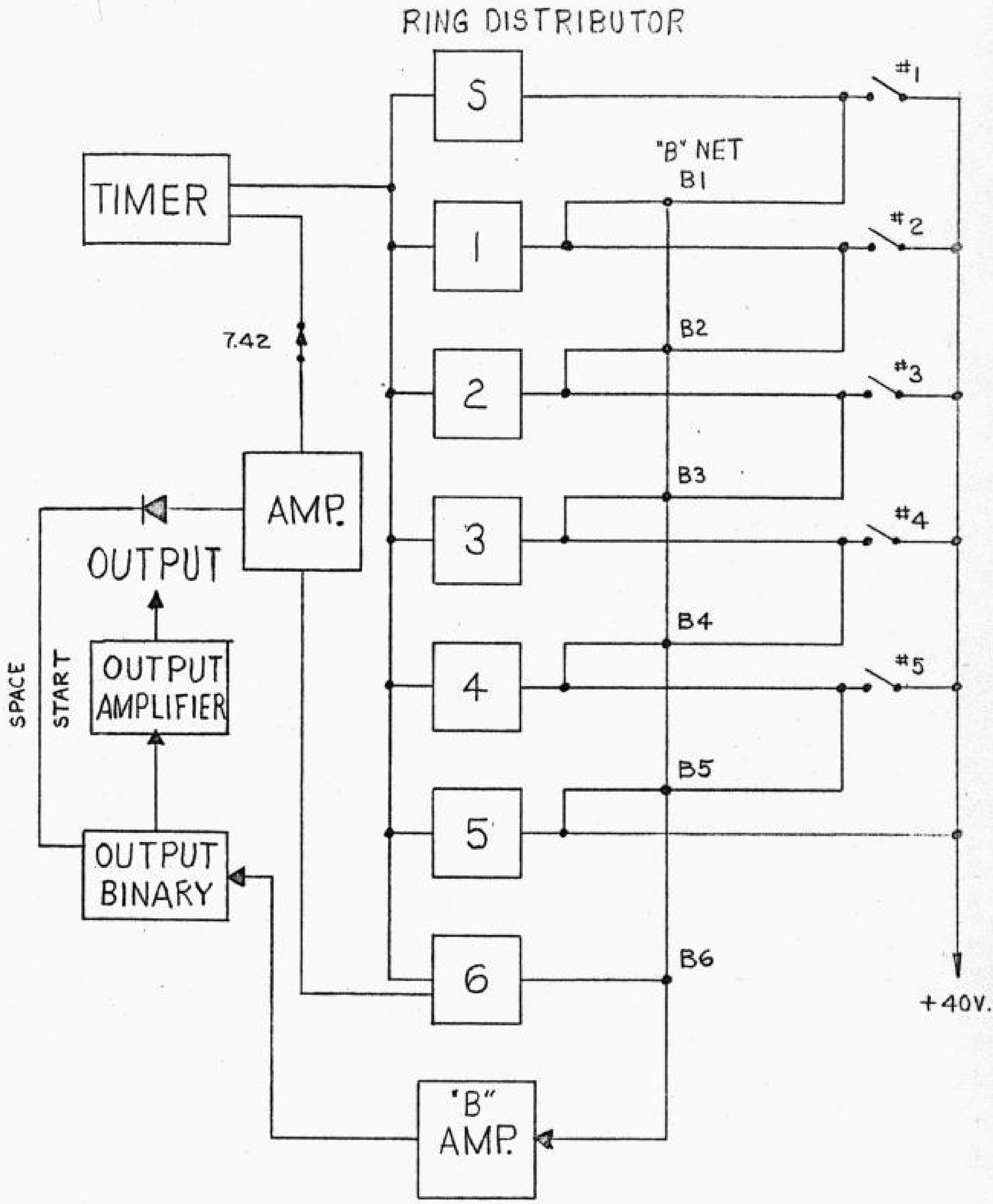
FIGURE 2-1



SIMPLIFIED BLOCK DIAGRAM

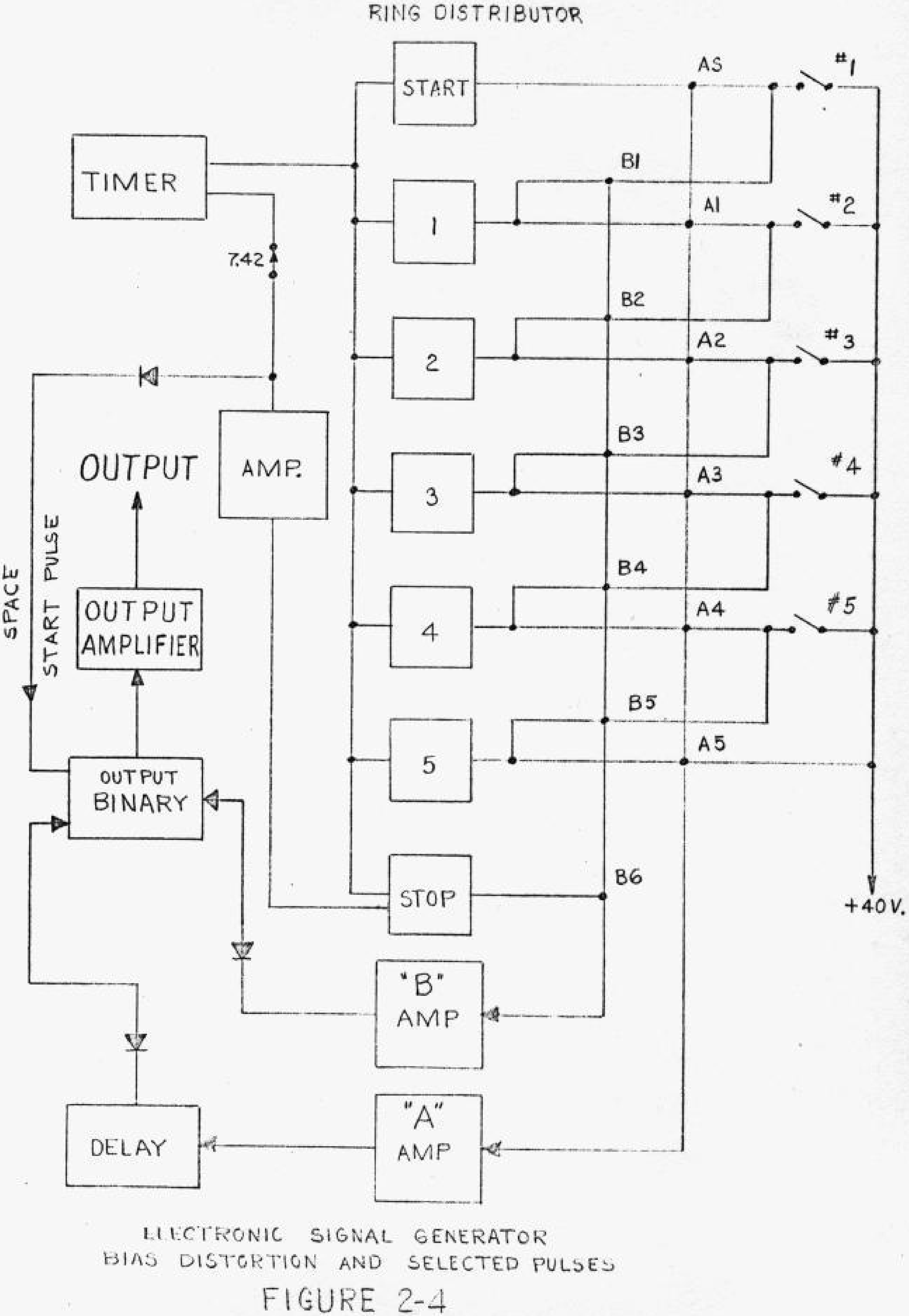
QUICK BROWN FOX TEST MESSAGE
USED IN SIGNAL GENERATOR

FIGURE 2-2



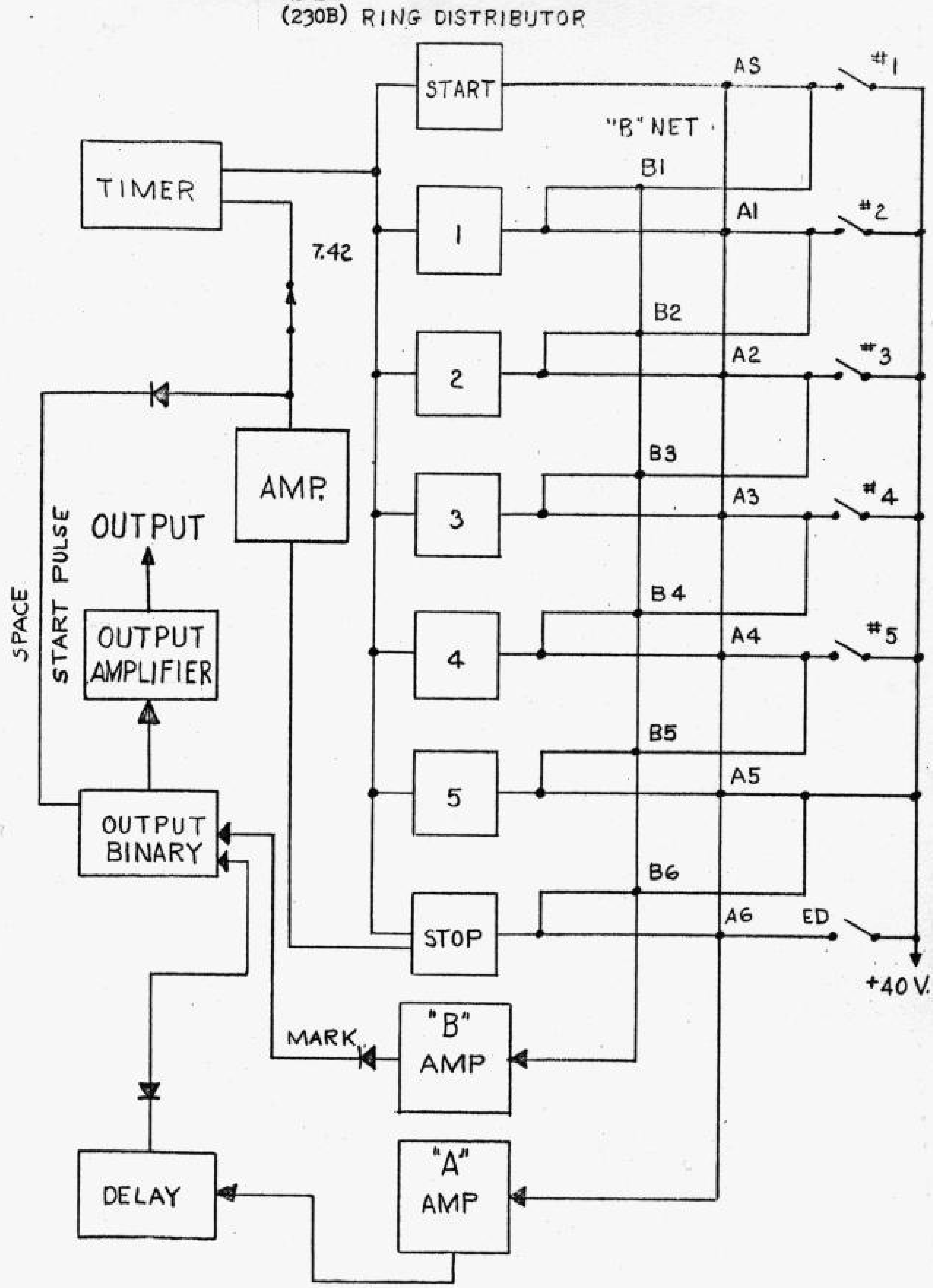
ELECTRONIC SIGNAL GENERATOR
ZERO DISTORTION & SELECTED PULSES

FIGURE 2-3



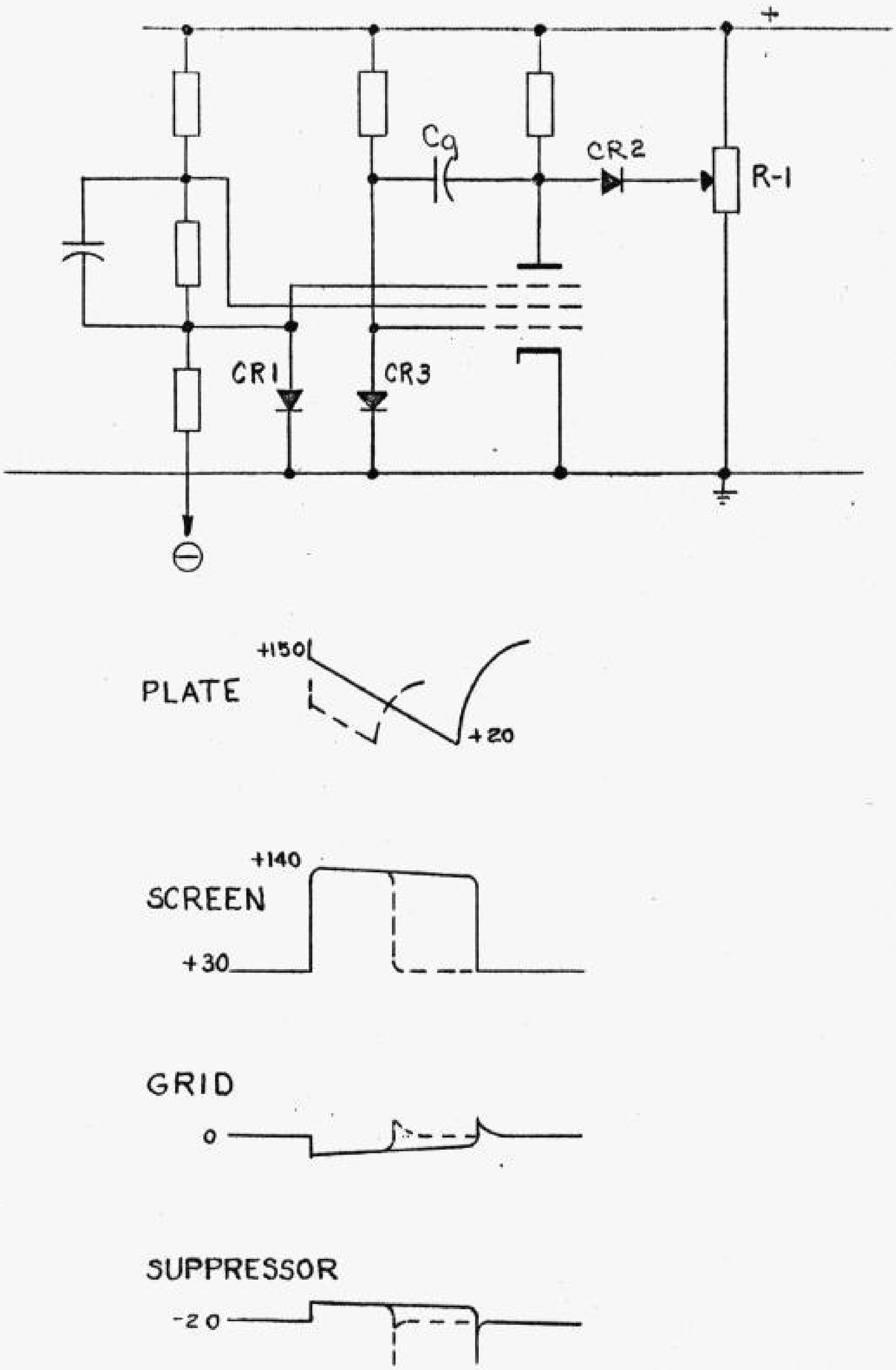
ELECTRONIC SIGNAL GENERATOR
BIAS DISTORTION AND SELECTED PULSES

FIGURE 2-4



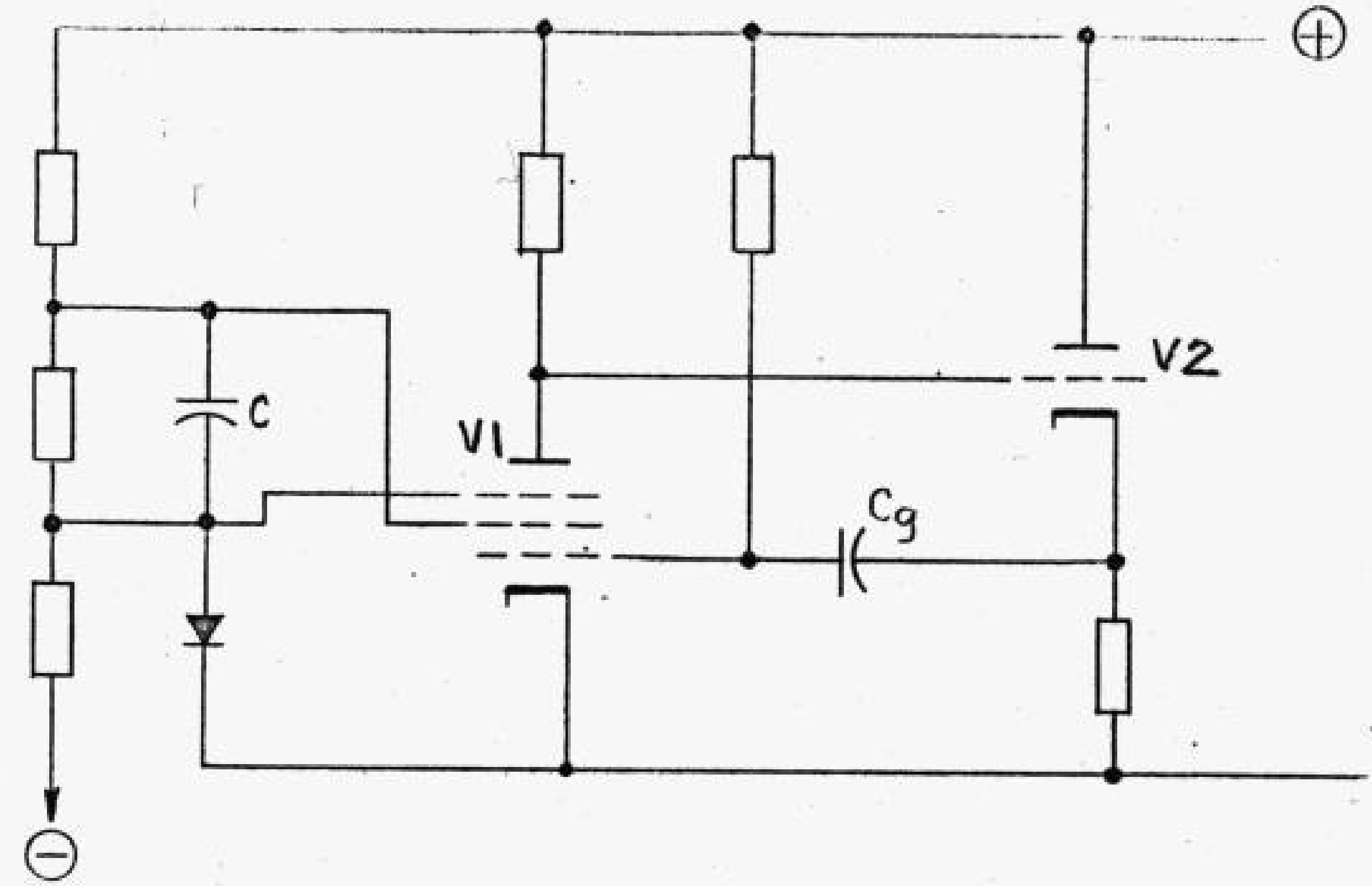
ELECTRONIC SIGNAL GENERATOR
END DISTORTION & SELECTED PULSES

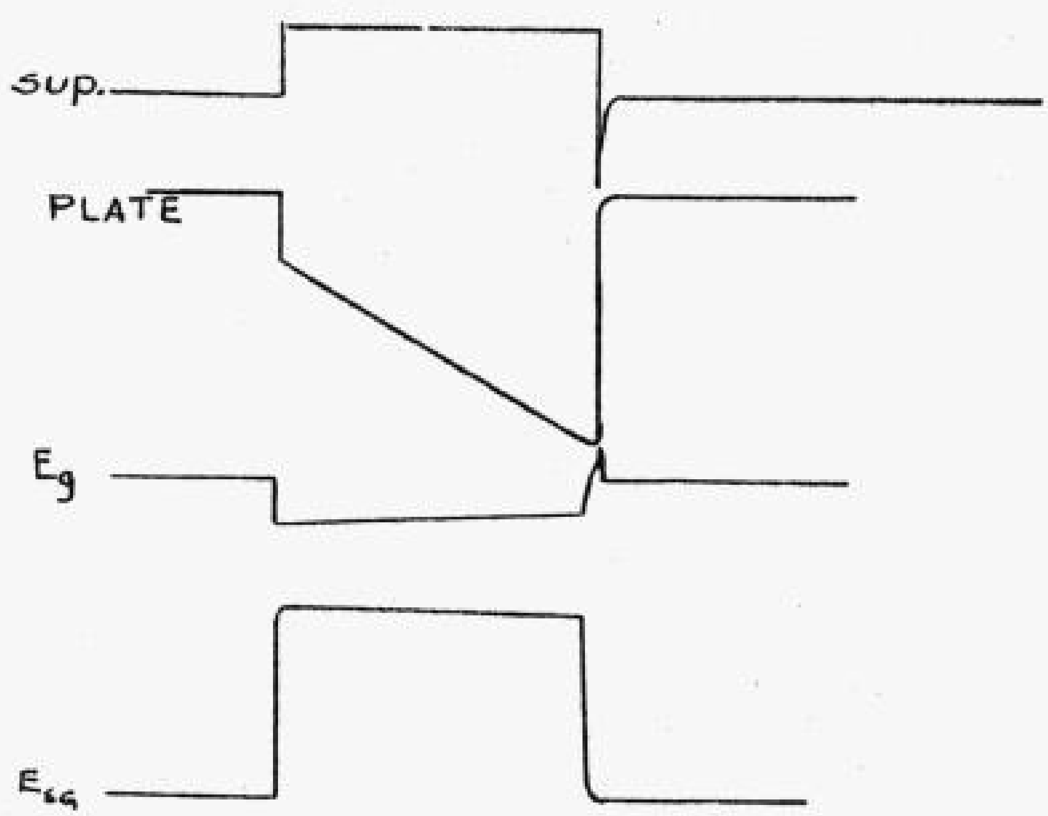
FIGURE 2-5



BASIC PHANTASTRON TIMER

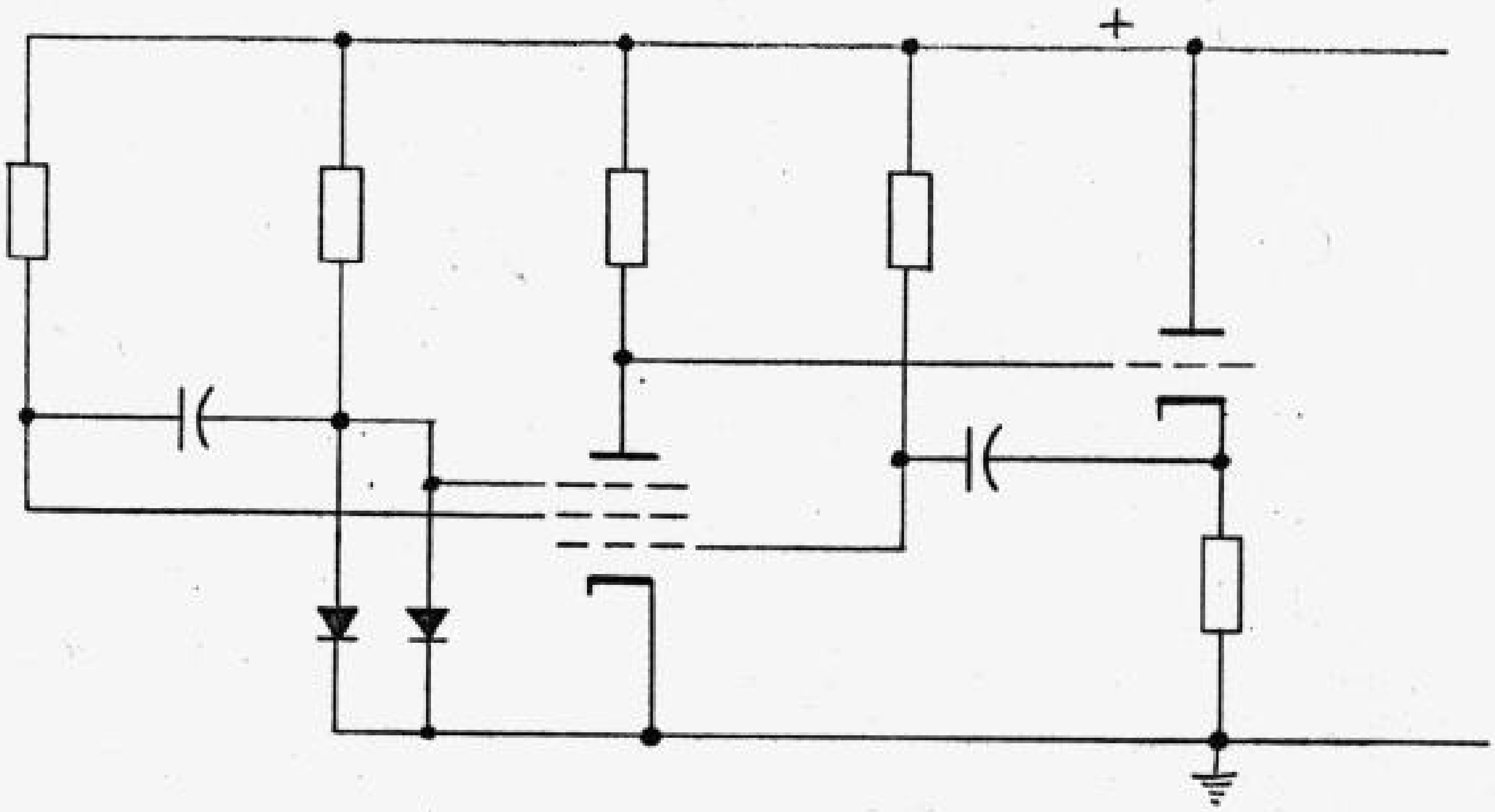
FIGURE 2-6

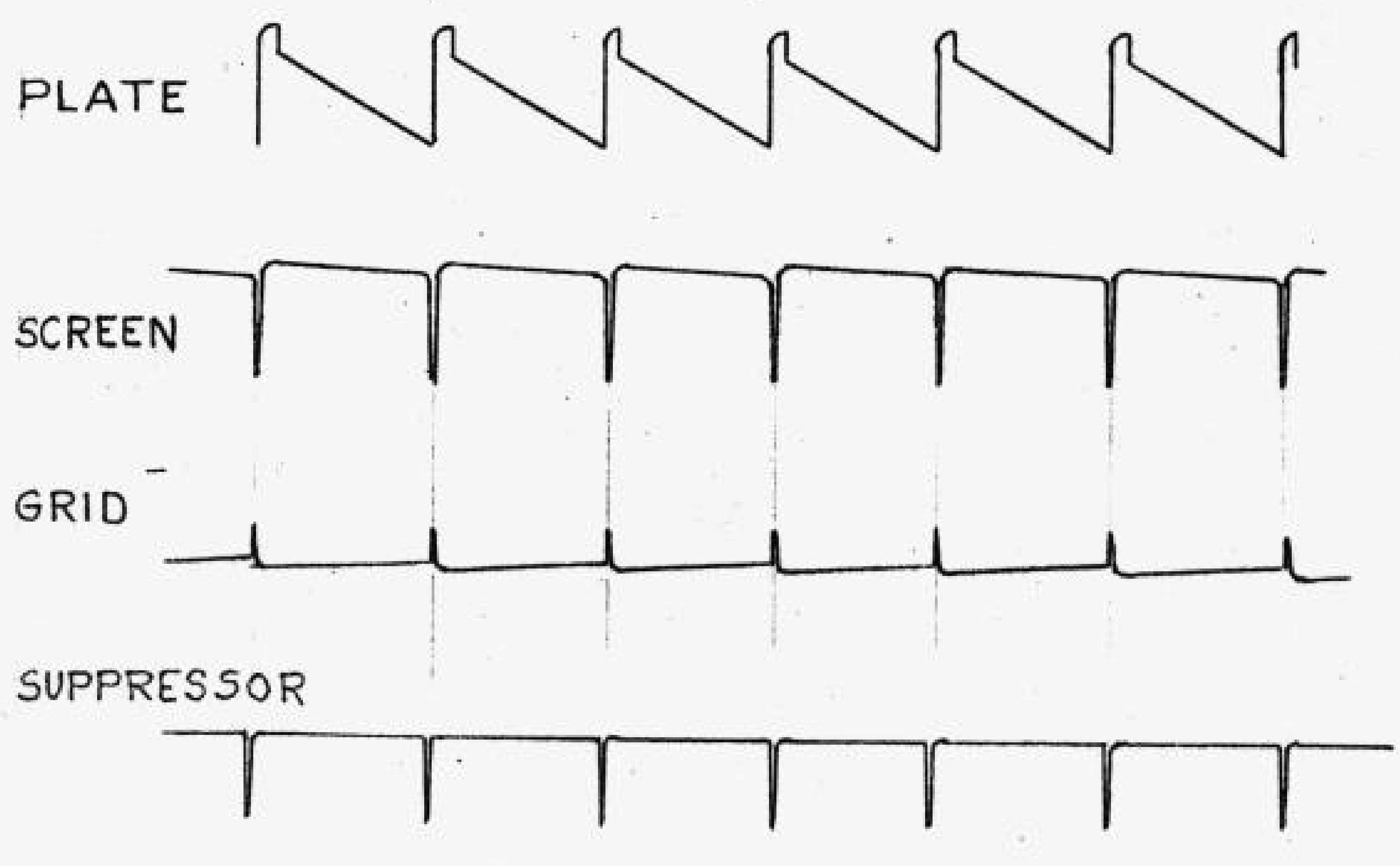




BASIC PHANTASTRON TIMER WITH
CATHODE FOLLOWER AMPLIFIER

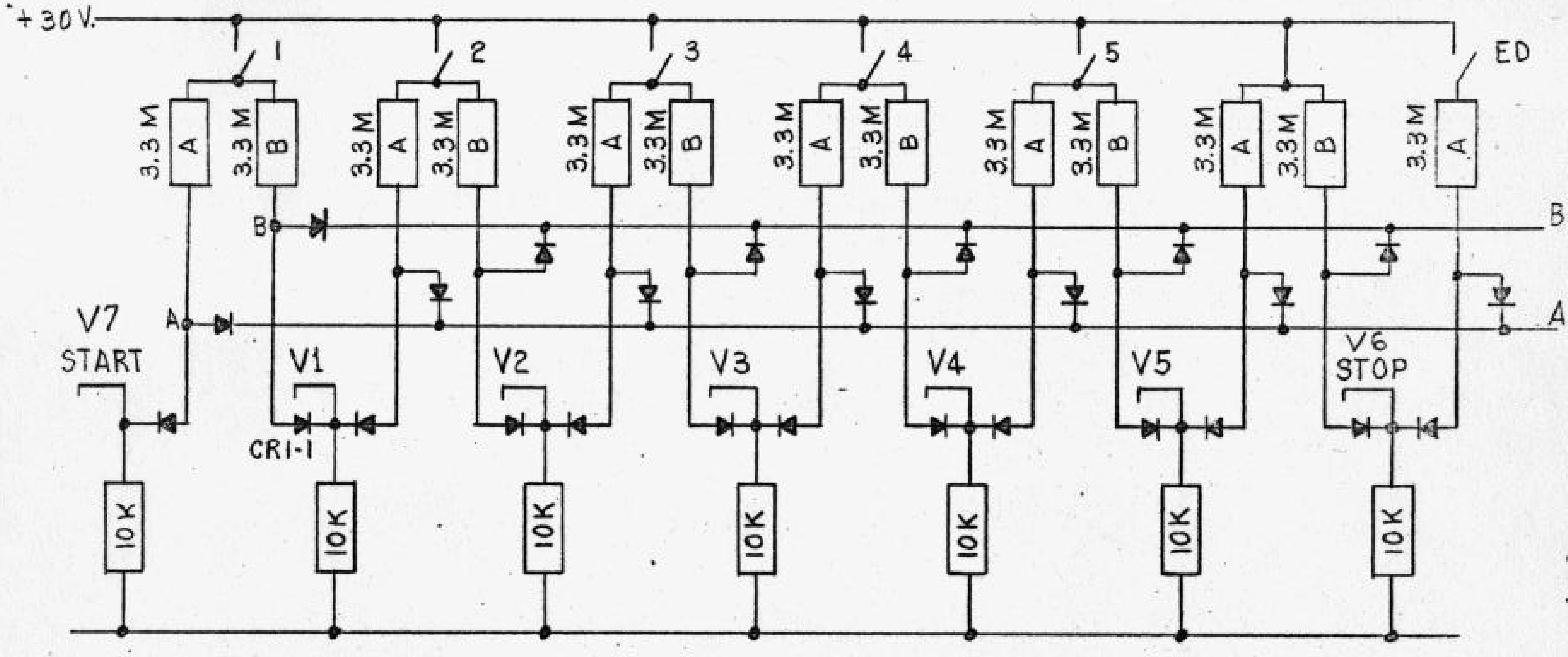
FIGURE 2-7





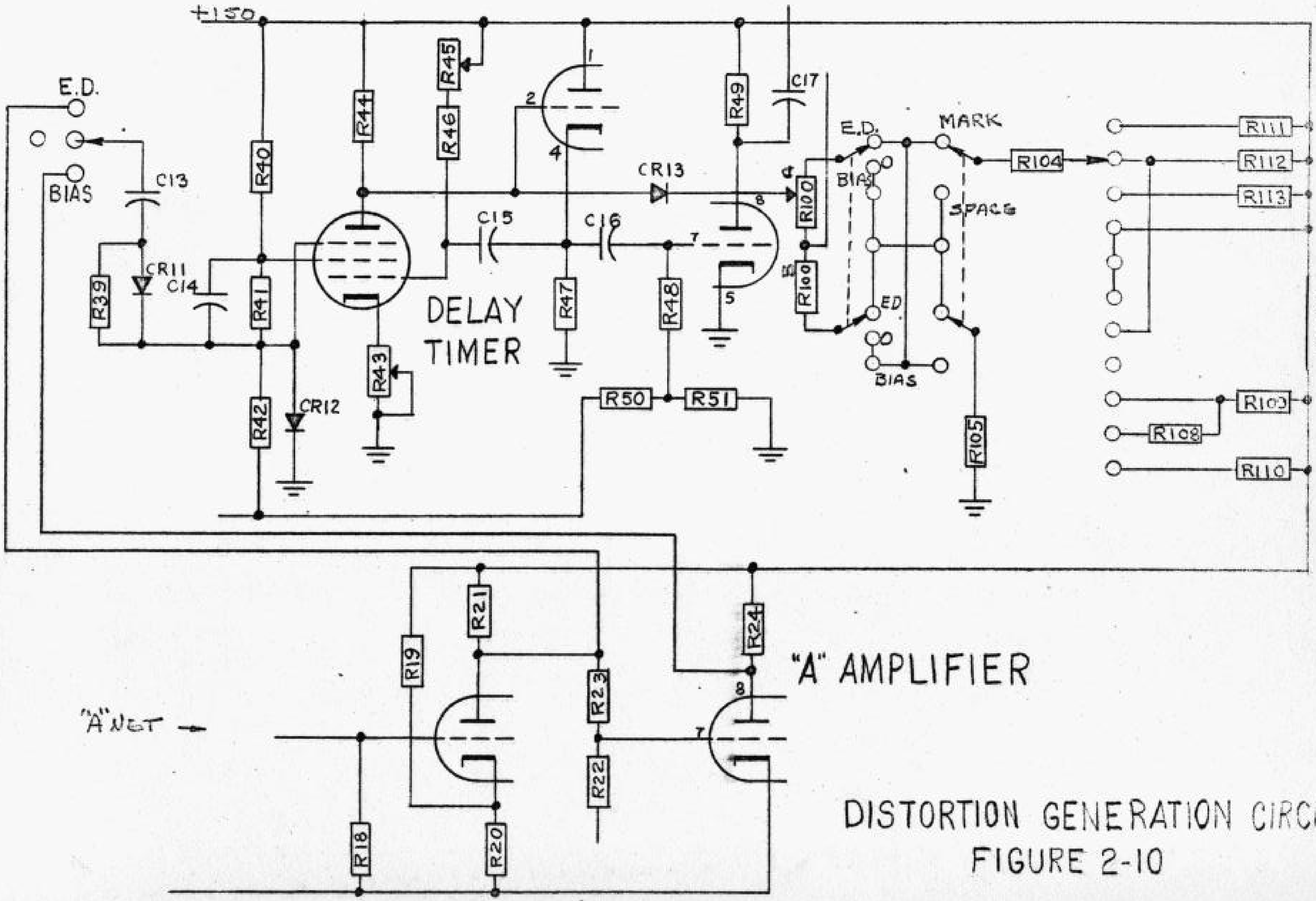
FREE RUNNING PHANTASTRON TIMER

FIGURE 2-8

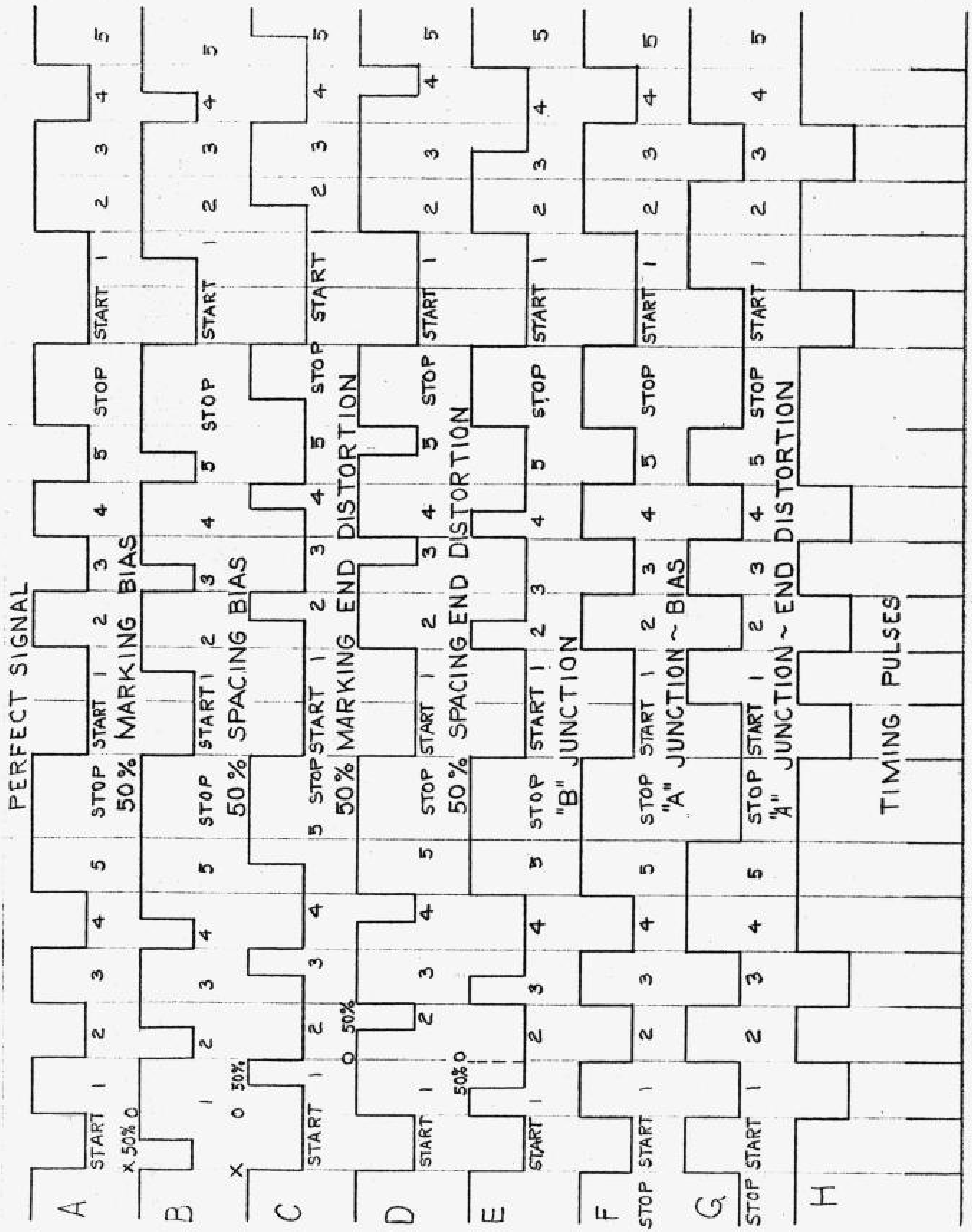


SIGNAL GENERATION NETWORK

FIGURE 2-9

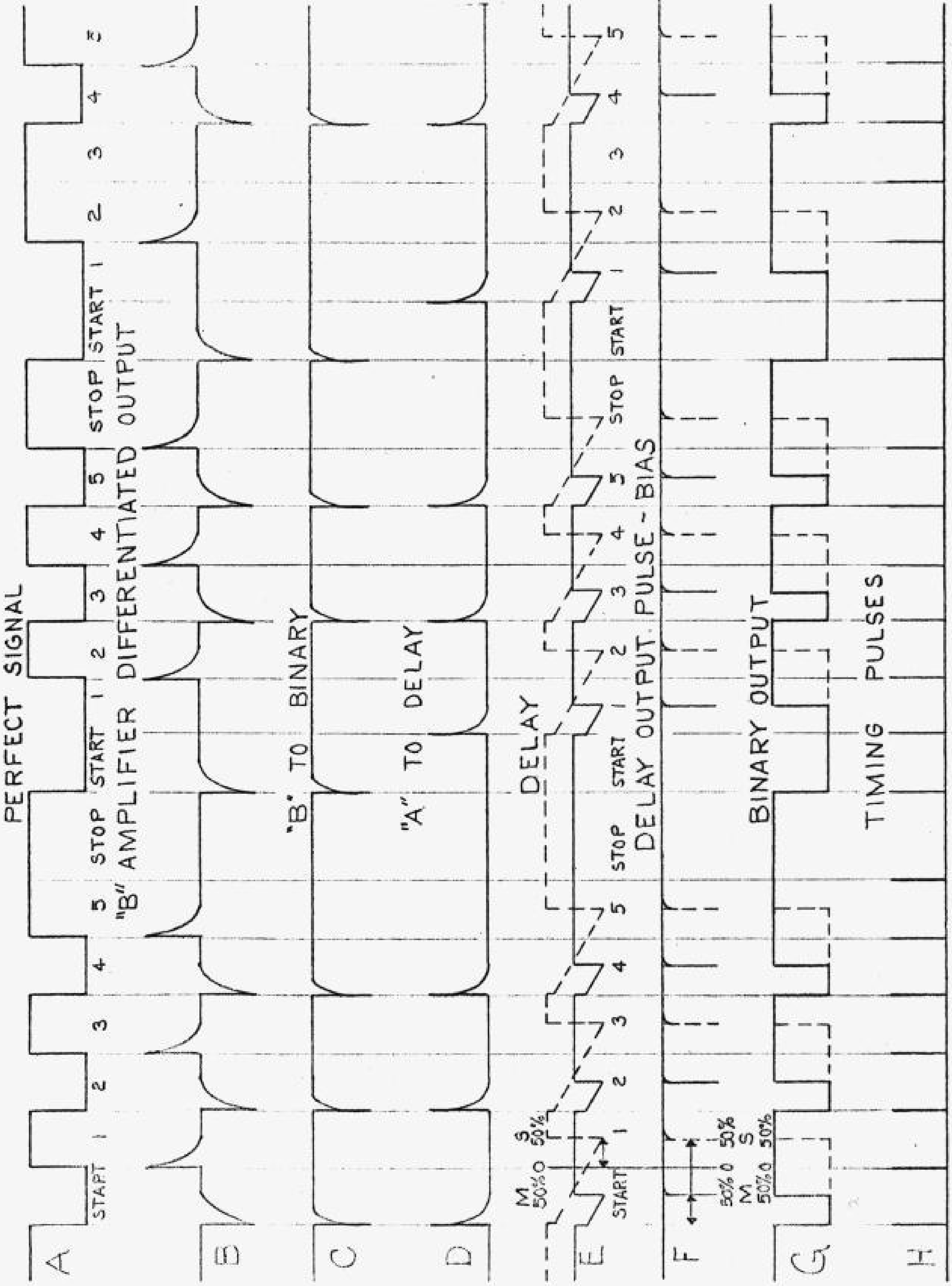


DISTORTION GENERATION CIRCUITS
FIGURE 2-10

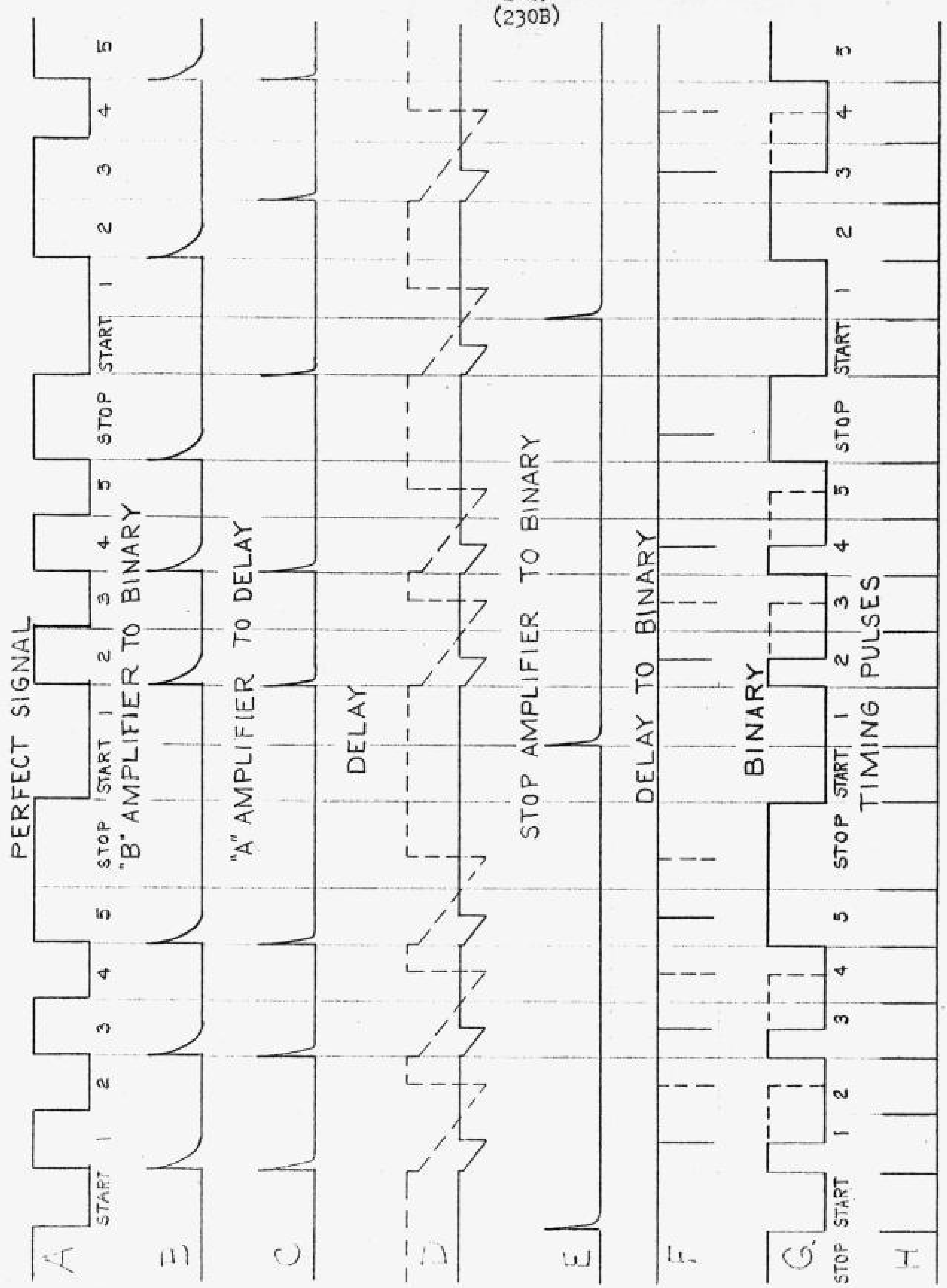


BASIC TIMING DIAGRAM

FIGURE 2-11



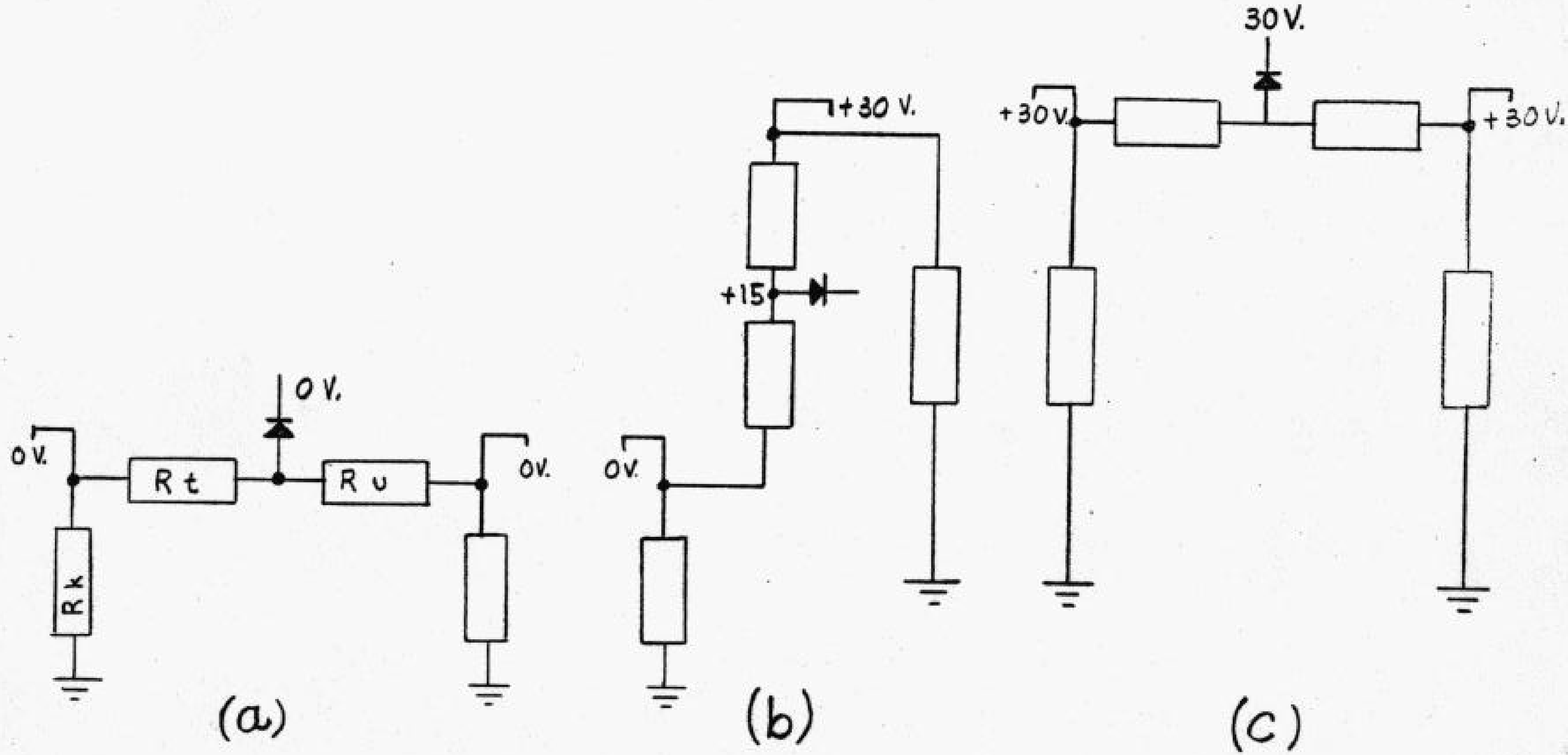
BIASED SIGNAL DISTORTION
TIMING DIAGRAM
FIGURE 2-12



END DISTORTION
TIMING DIAGRAM
FIGURE 2-13

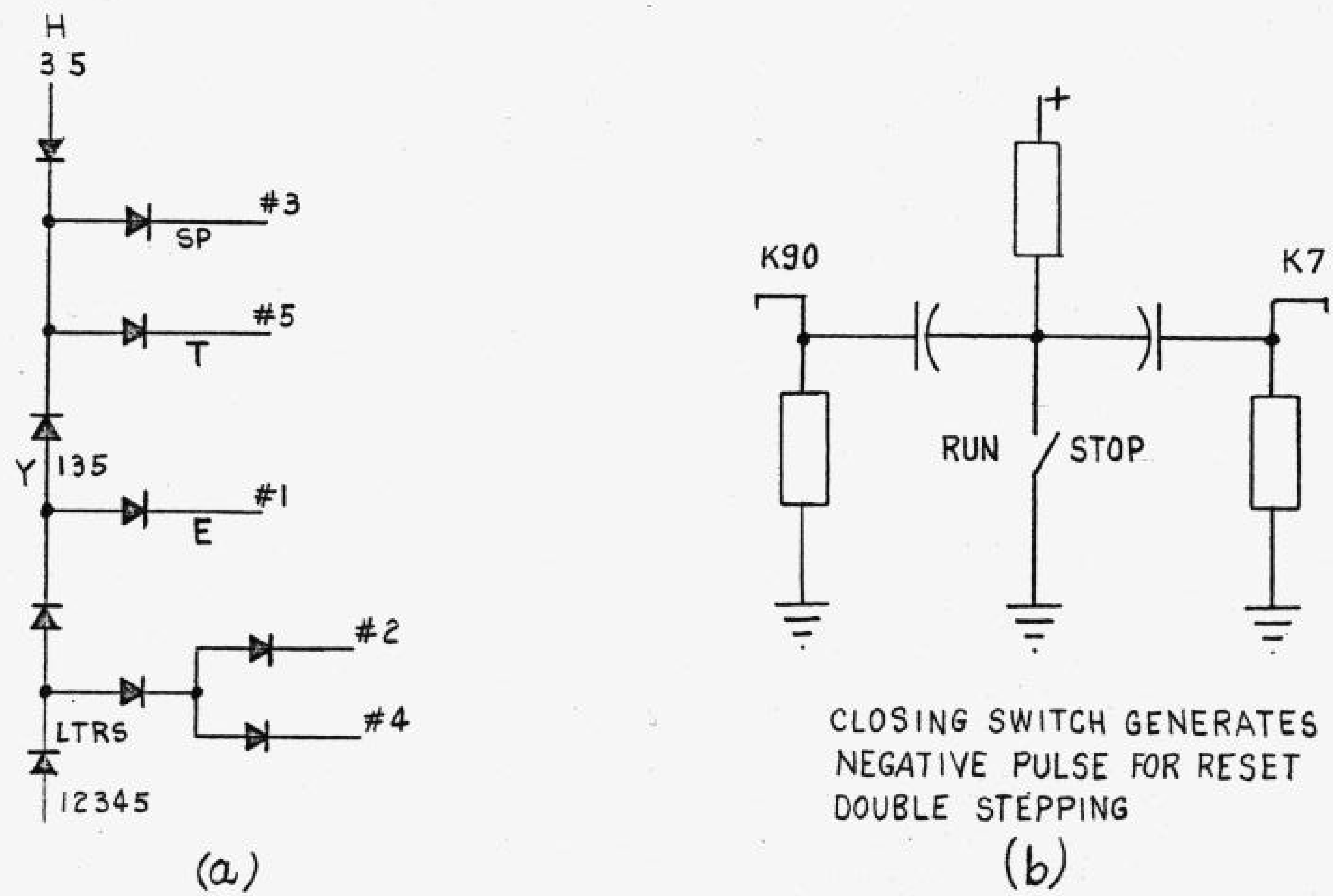
UNITS → / TENS ↓ (PIN)	10 [4]	1 [3]	2 [2]	3 [1]	4 [13]	5 [12]	6 [10]	7 [9]	8 [8]	9 [7]
9 [7]	3 4 N	2 4 5 G	1 2 3 4 5 LTRS.	1 2 3 4 5 LTRS.	1 2 3 4 5 LTRS.	1 2 3 4 5 LTRS.	4 C.R.	4 C. R.	2 L.F.	1 2 3 4 5 LTRS.
8 [8]	2 3 8	4 5 9	2 3 5 Ø	3 SP.	1 2 3 4 5 LTRS.	5 T	1 E	1 3 S	5 T	2 3 I
7 [9]	1 2 3 4 K	3 SP.	1 2 4 5 FIG.	1 2 3 5 1	1 2 5 2	1 3	2 4 4	5 5	1 3 5 6	1 2 3 7
6 [10]	4 5 O	2 4 5 G	1 2 4 5 FIG.	1 2 4 APOST.	1 2 3 4 5 LTRS.	1 3 S	3 SP.	1 4 5 B	1 2 A	2 3 4 C
5 [12]	2 4 R	3 SP.	1 2 A	3 SP.	2 5 L	1 2 A	1 5 Z	1 3 5 Y	3 SP.	1 4 D
4 [13]	1 2 4 J	1 2 3 U	3 4 5 M	2 3 5 P	1 E	1 4 D	3 SP.	4 5 O	2 3 4 5 V	1 E
3 [1]	1 4 5 B	2 4 R	4 5 O	1 2 5 W	3 4 N	3 SP.	1 3 4 F	4 5 O	1 3 4 5 X	3 SP.
2 [2]	5 T	3 5 H	1 E	3 SP	1 2 3 5 Q	1 2 3 U	2 3 I	2 3 4 C	1 2 3 4 K	3 SP

TEST MESSAGE MATRIX
FIGURE 2-14



CROSS POINT SWITCHING VOLTAGES
NO LOAD AT JUNCTION
R_k SMALL COMPARED TO R_t & R_u
$R_t = R_u$

FIGURE 2-15



BASIC MESSAGE MATRIX CIRCUITS

FIGURE 2-16

SECTION III

INSTALLATION AND ADJUSTMENTS

1. INSTALLATION OF EQUIPMENT

a. The Signal Generator requires no special installation procedure when it is to be operated within its transit case. The unit is designed to operate from an AC source of 115 or 230 volts, 50-60 cycles per second.

b. When the unit is in its transit case, it may be used with the front panel facing upward, or the unit may be placed on its side so that the front panel is vertical.

c. If the unit is to be rack-mounted, it must be removed from its transit case and secured to a TS-800 ( )/UGM-1 Distortion Indicator unit. Screws for this purpose are included in the mounting holes on the Signal Generator unit.

d. Table 3-1 lists equipment needed for adjustment of the Signal Generator.

2. ADJUSTMENTS

a. Speed Calibration

(1) Timer Adjustment

NOTE: The model 5500 and similar counters are low impedance (50,000 phms) input and will load all but the output stage. Berkley Model 5510 and possibly the new 5500 models are arranged for 10 megohms input impedance, but the coax cable must be removed or decoupled by a one megohm resistor before connecting to the pulse circuits.

(a) The speed control is a voltage divider which is common to both the delay and pulse timer phantastrons. Resistors R108 through R113 control the center voltage between R100A and R100B to fix the start of the run down of the timer phantastron and the zero distortion calibration of the delay phantastron.

(b) Attach the electronic interval timer to pin 3 of V15 and to ground. There should be no loads connected to the signal line jack. Set the timer to start on minus and stop on plus

(c) Set the Signal Generator controls to the following position.

Control	Position
Message Switch	Selected Pulses
Speed Switch	368
Output Selector Switch	60
Pulse Selector Switches	All Down (Spacing)
Bias-End Distortion Switch	Center (Zero)
Distortion Dial	-
Mark-Space Switch	-
Run-Stop Switch	Run

(d) Turn on the equipment and allow a 10 minute warmup period. Adjust the purple potentiometer R32 on the control circuit board for a reading of 131.77 milliseconds. This interval corresponds to 6 pulse widths at 60 speed. (Start pulse 5 code pulses.)

(e) Change the speed switch to 600 opm and after 3 minutes adjust the green potentiometer R114A mounted on the message switch at the rear of the front panel to obtain a reading of 80.86 milliseconds.

(f) Return the speed switch to 368 to check for drift, and if necessary, repeat the operation.

(g) In areas in which the 60 cycle supply is known to be accurate the TS-383A/GG Distortion Transmitter may be used to observe the Signal Generator output. The time frequency adjustments are then made to stop the strobe rotation observed. Absolute stopping is difficult as the frequency adjust resistor, in spite of its narrow range, becomes critical and even a .01% difference in frequency will rotate the strobed signal.

(2) Stop Pulse Adjustment

(a) Set the electronic interval timer to start on plus and stop on minus and adjust the yellow potentiometer R15 on the control circuit board until the reading of 31.17 milliseconds is obtained at the 368 opm speed. Change the speed to 600 opm speed and check for 19.137 milliseconds. This adjustment sets the 1.42 stop time required in the standard start stop signal. This is not included in the 390 speed position as the 390 speed uses the same timer period but has unity instead of 1.42 stop time.

(b) An alternate less accurate procedure for the stop pulse adjustment can be used if desired. Connect a milliammeter in the Signal Line Jack and set speed switch at 390. Set the message switch on selected pulses selected pulse switches down. Set the Bias-E.D. switch in the center positon. Observe reading meter. Turn speed switch to 368 and adjust yellow potentiometer R15 to give a reading 1.42 times the 390 reading.

(3) Delay Adjustment

(a) Due to lock-in between the delay timer and pulse timer near the zero distortion position it is best to calibrate the delay timer phantastron with a linear dual sweep oscilloscope such as a Tektronix 531. Such a scope can be adjusted to display only one pulse per total sweep and be readable within 1 percent.

(b) Set the Signal Generator controls to the following positions:

Control	Position
Message Switch	Sel. Pulses
Speed Switch	368
Output Selector Switch	60
Pulse Selector Switches	2 and 4 up (marking)
Bias-End Distortion Switch	Bias
Distortion Dial	50 percent
Mark-Space Switch	Mark-Space
Run-Stop Switch	Run

(c) Turn on the equipment and allow a 10 minute warmup period.

(d) Connect one of the oscilloscope probes to the anode pin 1 of V11 and the other probe to the cathode pin 3 of V15.

(e) Adjust the brown potentiometer R45 on the control circuit panel so that changing the mark space switch from mark to space moves the pulse transition from midpoint to midpoint on successive pulses. Thus in marking bias the pulse transition is midway between the beginning of the previous pulse and the pulse observed. In spacing bias the pulse transition is midway in the pulse observed.

If this adjustment provides an equal change in each direction but not exactly 50% then proceed with (f) for range adjust.

The linearity of the delay is not checked as the characteristics of the phantastron make this better than required by this instrument.

(f) Delay Range

NOTE: The following adjustment is a factory adjustment and should not require readjustment. Its purpose is to adjust the range of the delay so that the plus 50% and minus 50% pulse lengths are in calibration. Any adjustment in this section affects all other timing calibrations.

Set the distortion dial to 50% and check pulse length for 50% marking and 50% spacing bias. If the pulse is too long and too short respectively the distortion control range is too great. Adjust blue variable resistor R115 to reduce the value of R100, R100A. Reset timer period with purple R32 and recheck range. This is a repetitive process until the desired accuracy is obtained.

Electronic timer intervals or linear sweep oscilloscope may be used.

(4) Output Current Adjustment

(a) Meter Method

Set the Message switch to 75 dot cycles and the Current Switch to 20 milliamperes. Insert a line milliammeter in the signal line jack and adjust the red potentiometer R78 until a reading of 10 milliamperes is obtained. Change current switch to 60 milliamperes and check for a reading of 30 milliamperes.

(b) Oscilloscope Method

Attach a calibrated oscilloscope to cathode pin 3 of V15 and ground.

Set the speed switch to dot cycles, the Current switch to 20 milliamperes. Adjust R78 for a 30 volt mark pulse. Change current switch to 60 milliamperes and check for a 30 volt marking pulses.

TABLE 3-1

EQUIPMENT NEEDED FOR ADJUSTMENTS AND MAINTENANCE

1. Vacuum Tube voltmeter such as ME-25A/U

2. Cathode Ray Oscilloscope with a high impedance probe or other non-loading device such as Tektronix 531 with 53C input.

3. Electronic decimal counter such as the Berkley Model 5500, with an added cathode follower stage for use with the counter or Model 5510 which has the cathode follower included.

4. 0-100 milliammeter.

SECTION IV

OPERATING INSTRUCTIONS

1. The Signal Generator will operate on 115/230 Volt 50-60 cycles Ac line supply. The upper frequency limit has not been determined but operation at below 50 cycles will cause excessive heating and damage in a short time.

   a. Line Voltage

   Ascertain the line voltage for the supply and set the line voltage plate. DO NOT LEAVE THIS PLATE OFF.

   b. Output

   Set output current selector sw to 20, 60 or EXT for operation desired.

   WARNING: If external operation is selected for keying of an existing circuit with its own power supply, RELAY CONTACT PROTECTION MUST BE PROVIDED EXTERNALLY. Operation at 20 or 60 ma DC without such protection will damage the relay in a few minutes. No contact protection was incorporated within the unit due to the variety of circuits the relay may be required to key.

   c. Speed

   (1) Set speed switch to correspond to that of printer or facility which is to be tested. Note that the 390 speed is the straight seven unit code.compliment of 368 (60 wpm) OPM. All other teletypewriter speeds, marked "message" are 7.42 unit code.

   (2) The 404 speed is the British 20 millisecond pulse standard transmission.

   d. Dot Cycles

   This output is normally used for checking the transmission characteristics of lines, radio channels and relays. Testing should be done at the dot cycle speed corresponding to the speed of the teletype transmission to be used.

   e. Distortion switches

   (1) Mark-Space switch

   (a) In mark position the pulse duration is increased from 0% to 50%.

   (b) In space position the pulse duration is decreased. 0% to 50%.

(2) Bias-Zero-End Distortion switch

(a) In the center "zero" position signals are not modified.

(b) Bias position causes the changes in the duration of the pulses by moving the front end of the marking pulses in respect to the mark to space transition of the start pulse.

(c) End distortion position causes the changes in the duration of the pulses by moving the trailing edges of the marking pulses in respect to the mark to space transition of the start pulse.

f. Stop Run Switch

This switch starts and stops the transmisstion. When in the stop position the output is left in the current flow, "Marking" condition. The last character is completed before stopping when the switch is changed from run to stop.

g. Message Switch

(1) Selected Pulses

In this position the message output consists of the continuous repetition of a single character set up by five subminiature toggle switches. Any switch in the up (Mark) position will cause the output to be marking for that pulse period.

(2) Alternate R & Y

As the name implies the position provides a continuous flow of alternate R & Y character transmissions.

(3) Test Message

In this position an 80 character message is available for transmission. The characters which are sent include the following. THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING "letters" "letters" "letters" "letters" Carriage Return, Carriage Return, line feed, "letters". This message requires a 68 space typing width. At each operation of the Run-Stop switch to the "Run" position the message starts at the carriage return signal to bring the carriage to the left margin. A line feed and "letters" follow before starting the message proper.

2. Operating Procedure

a. Turn power switch on.

b. Plug printer signal line cord into Line Jack in the front panel.

c. If a printer is to be tested, turn printer motor "on". Printer should indicate steady marking. If not, flip Stop Run Switch up and back down.

d. Put Stop Run Switch to Run position. Printer should copy selected operations.

e. If Dot cycles output was selected, the line or relay will receive such a signal.

SECTION V

MAINTENANCE

1. General

The Signal Generator has been designed to provide maximum accessibility to facilitate maintenance.

a. All major assemblies plug together and may be separated if desired

b. Eyelets in the etched circuit boards permit replacing components with no damage to the circuitry.

c. The control circuits board is hinged to permit tube replacement and point checking without disassembly. The control board may be removed by pushing up to withdraw the bottom hinge pin from the frame and tilting.

d. The power supply is hinged but requires hinge unscrewing for removal.

e. The message matrix card may be removed by removing its supporting bar and tilting.

f. While most maintenance can be performed without removal it will be found expedient to disassemble into major units and layout on a bench for work on the front panel.

2. Test Equipment Required

The equipment required is listed in Section 3 in Table 3-1.

a. Servicing is greatly simplified if a dual trace oscilloscope with calibrated DC vertical deflection is available.

Tektronix 531 with 53C input.
Dumont 323 or 324 with electronic switch.

b. Use 10 megohm or cathode follower probes. Lower impedance probes will load down the circuits under test. Any probe will affect the timer to some extent.

c. Best scope operation is obtained if the sweep is externally triggered by the cathode pin 5 of the stop tube V6.

3. Maintenance Procedures

a. Trouble shooting in the Signal Generator as in any set involves first, the localizing of the fault. In order to facilitate localizing of the trouble, several typical symptoms of failure and their corrective measures are tabulated below. Failure of the unit to operate falls in the following main categories.

(1) Improper pulse distribution - distributor
Failure - either stopped or double stepping
Control binary not triggering.
Speed off- calibration.

(2) Failure on QBF only
Improper stepping of cold cathode tubes
Diode failure
Joints at etched circuit
Improper level sensing.

b. Start-Stop Distributor Testing

(1) The cold cathode tubes should step if the distributor is operating.

(2) Distributor operation requires the timer pulses and proper bias. It is possible for improper bias to result in.

Bias	
<u>too high</u>	Total failure of 5643's to fire or one tube will remain fired.
<u>too low</u>	Skip positions or several positions remain fired.

(3) With proper bias the distributor is insensitive to line voltage changes.

(4) Using the high impedance probe with the oscilloscope to a grid pin 7 of the thyratron ring will give a display that will show the intermediate pulses, the conditioning pulse and the fired pulse as the grid rises positive with respect to its cathode. Total pulses should count to seven.

CAUTION: A ten megohm probe will change the voltages at the grids some ten percent. This load may stop operation if the voltages have been made too critical.

(5) The waveform is as shown on Figure 5-6. These voltage levels shown provide stable operation. If a string of pulses riding at -50 or more volts is observed, the stop switch is holding the distributor ring off. If only noise at a slightly positive voltage is observed, several tubes are fired due to insufficient bias voltage.

(6) If no pulses appear at the grids of the distributor, check pin 5 of V11 for the plate rundown of the phantastron. Then trace for drive pulses at anode pin 1 of V11.

(7) Eratic operation as in failure to count four pips between conditioning levels is usually a function of bias. If the voltage levels are maintained and count is off, step probe from tube to tube until a tube is found which has only a spike instead of the second positive step. This indicates that the next tube is firing at the beginning of the conditioning pulse which is usually due to too wide a drive pulse or lack of sufficient bias. The grid drive pulse at the beginning of the conditioning step should not appear above the level of the step.

c. Sensing Net and Output Signal Testing

(1) With message switch on "Selected Pulses" and probe at grid pin 7 of V17 at the upper right hand corner of the control board, observe the character output under control of the pulse selector switches.

(2) If a pulse fails to appear, check the "A" or "B" junction to assure that the voltage is appearing at the sensing net. This is a 10 meg point and is loaded by any probe.

(3) If this voltage is correct and the distributor is operating properly, then check the diode connecting the particular net to the "B" or "A" junction involved.

(4) Thus if No. 2 pulse is not being transmitted in the zero distortion position and No. 2 switch is up, check junction R2-2, R1-3 for +30V. If this is correct, then diode CR4-3 is open.

(5) If No. 2 pulse comes through whether the switch is up or down then diode CR1-3 is open as this diode permits the cathode resistor to effectively short junction CR3-3, CR2-3 to ground.

(6) If pulse level on the "A" or "B" net is low but the distributor cathode and switched junction voltages are normal, remove the input amplifier tube V17. If pulses return to normal then grid current was loading down the net. Replace the tube.

(7) Check bias on V17 which is partly stabilized by a 60k resistor to regulated +250V. It should be the level shown in the waveform on Figure 5-6.

(8) If correct pulses are generated at the anode pin 1 of V18 but there is no output at the signal line, check anode pin 6 of V14. If signal appears here check for voltage at cathodes pins 3,6 V15. This voltage should be +30V marking, zero on spacing. (Voltage on the order of 60 or more indicates lack of clamping of the grid).

(9) Control Binary.

This bistable multivibrator under dot cycles acts as a frequency divider. Observe the output at cathodes pin 3 of V15. Alternate mark and space pulses of equal duration should be seen.

Improper triggering of Binary under dot cycles comes under two easily recognized types.

(a) Insufficient Drive
Sharp pulses of amplitude less than the normal pulse amplitude..

(b) Excessive Drive
Sharp pulses whose amplitude is equal to that of the normal pulse with brightening of the tops to indicate that the trace reaches and maintains a maximum amplitude for a moment.

(c) Insufficent drive may be corrected by increasing the drive capacitors C101 and C102.

(d) Excessive drive may be corrected by lowering the capacity of C101 and C102 or by a load resistor from anode pin 1 V18 to ground.

(e) Any change in this drive may affect the drive pips in the distributor.

d. Operation under zero distortion but fails on bias or E.D.

Check suppressor pin 4 V13 for proper drive. Actual pulse heights are clipped by diode CR8 but drive must assure that the suppressor goes sufficiently positive to permit anode current flow.

If the delay is operating check output for delay drive.

(1) Bias Distortion

Delay causes output to go to marking. Stop amplifier causes spacing (no current) transition. Failure of delay causes steady spacing output.

(2) End Distortion

Delay causes output to go to spacing. Failure of delay results in letters transmission (12345) as stop amplifier generates start pulse and "B" drives No. 1 marking but no other pulse to cut off the marking current.

e. Message sensing is done under same 30% of the voltage swing available under Selected Pulses or Alternate R & Y. A high gain stabilized bias input stage clips the pulse at top and bottom. The stabilized bias should make this operation independent of tube changes.

Observe the output at anodes pin 1 and 8 of V18, Wave shapes should be clean rectangles, essentially free of extraneous pulses. Improper sensing level shows up as clipped marking or spacing conditions at the output anode of either the "A" or "B" amplifiers.

f. Printed copy error.

Greatest difficulty has been found in
failure of soldered joints
open silicon diodes
Trouble shooting is best done by evaluating the errors in the copy for missing pulses.
Added pulses are caused by open resistors or improper sensing levels.

g. Typical trouble shooting from printed copy (printer has automatic carriage return).

Cold Cathode Tube and Printer Failures

Many of the following faults can be found by observing the arc transfer in the cold cathode tubes.

```
THE QUICK BROWN FOX JUMPED.OVER A LAZY DOG'S BACK 1234567890 TESTIIOP TEST
NG         I
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTIIOP TEST
NG         I
```

Tens tube fails to steop from No. 8 to No. 9 cathode on alternate drive pips. Check tens tube drive amplifier and coupling capacitor.

```
THE QUICK1234567890 TESTINGOVER A LAZYD
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING
```

Half spacing at "D" indicated printer in trouble. No. 4 pulse(carriage return) being falsely recognized.

```
THE QUICK THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TES
```

Failure of tens tube to transfer from No. 2 to No. 3.

Transfer failures have been eliminated by increasing the drive pulse or by additional capacity in the cathode circuits.

```
THE QUICK BVBQUKV JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING
```

Caused by simultaneous firing of K3 and the transfer electrodes. Eliminated by increasing the positive bias on the transfer electrode to assure full transfer to succeeding output cathode.

Failures such as overlay printing (one character over another) which are impractical for the generator to cause must be recognized as printer failures to save trouble shooting time.

---

h. Matrix Failures

```
THE QUICK BROWN FOX JUMPED OVER A TAZY DOG'S BACK 1234567890 TESTING
THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING
```

Failure to pick up No. 2 pulse indicated No. 2 diode failing. Intermittent failure. This diode is located by looking for a junction of No. 2 and No. 5 diodes to form 2,5 which is located at 54 on the Matrix board Figure 5-2.

Thus a series of errors can be caused by a single component failure. Check the printed copy and list the missing pulses for each error. A pattern will be formed which will lead to the defect.

The work thus far has indicated open diodes-no shorts. Where a single character is failing, the message may be stepped to the position desired by removing the drive lead pin 17 on the control board which is the matrix drive pulse. Now connect intermittently until stepped to failing position and observe output.

A change in level of a units cathode causes a failure every tenth character. Similarly a tens cathode level change causes a ten character group failure.

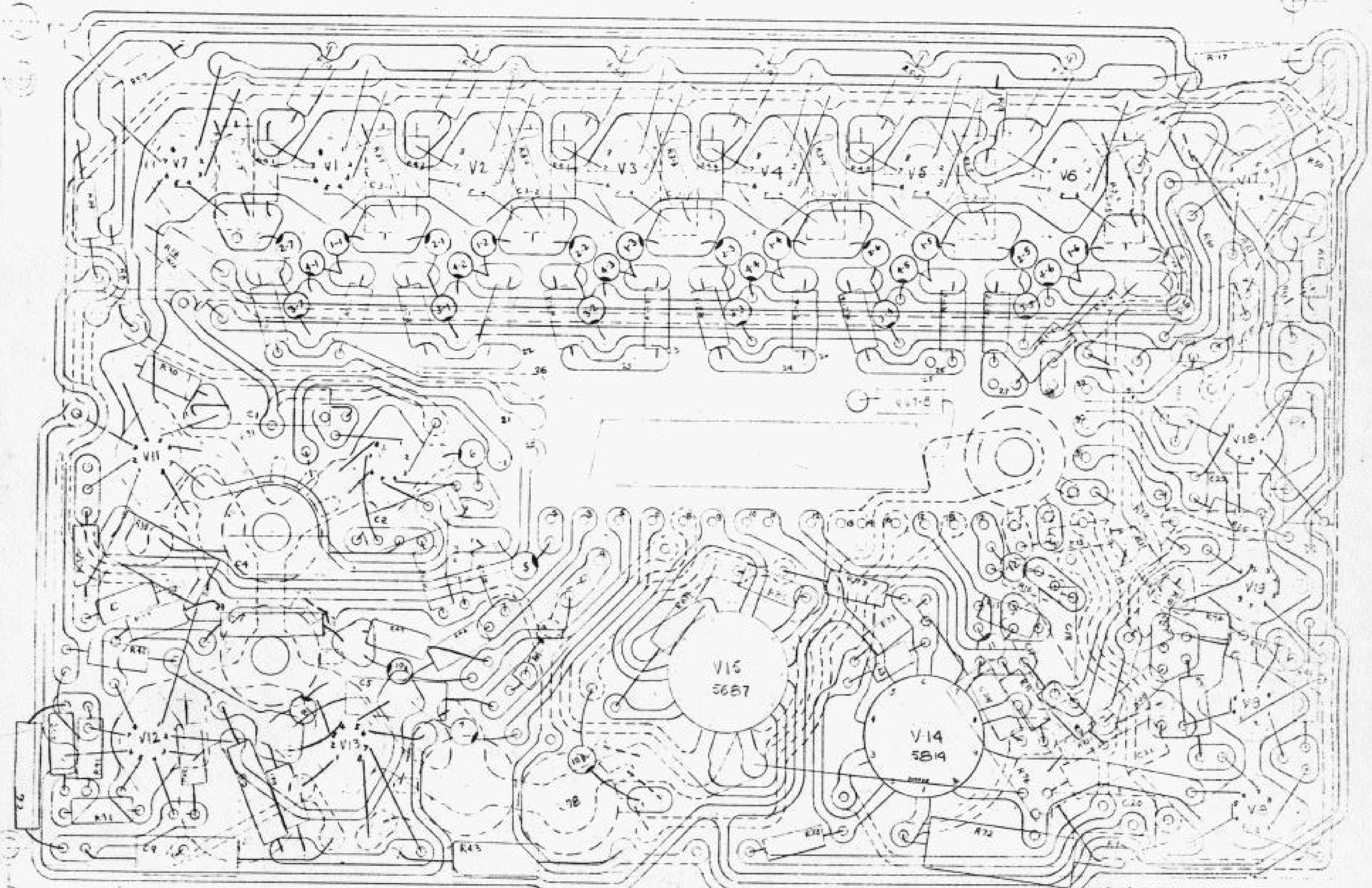
An open sensing element caused by an open resistor or failure of the solder joint causes the other cathode associated with this junction to add the pulses controlled by the junction as long as the other cathode is conducting.

ZYESQUVVKKSBROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING

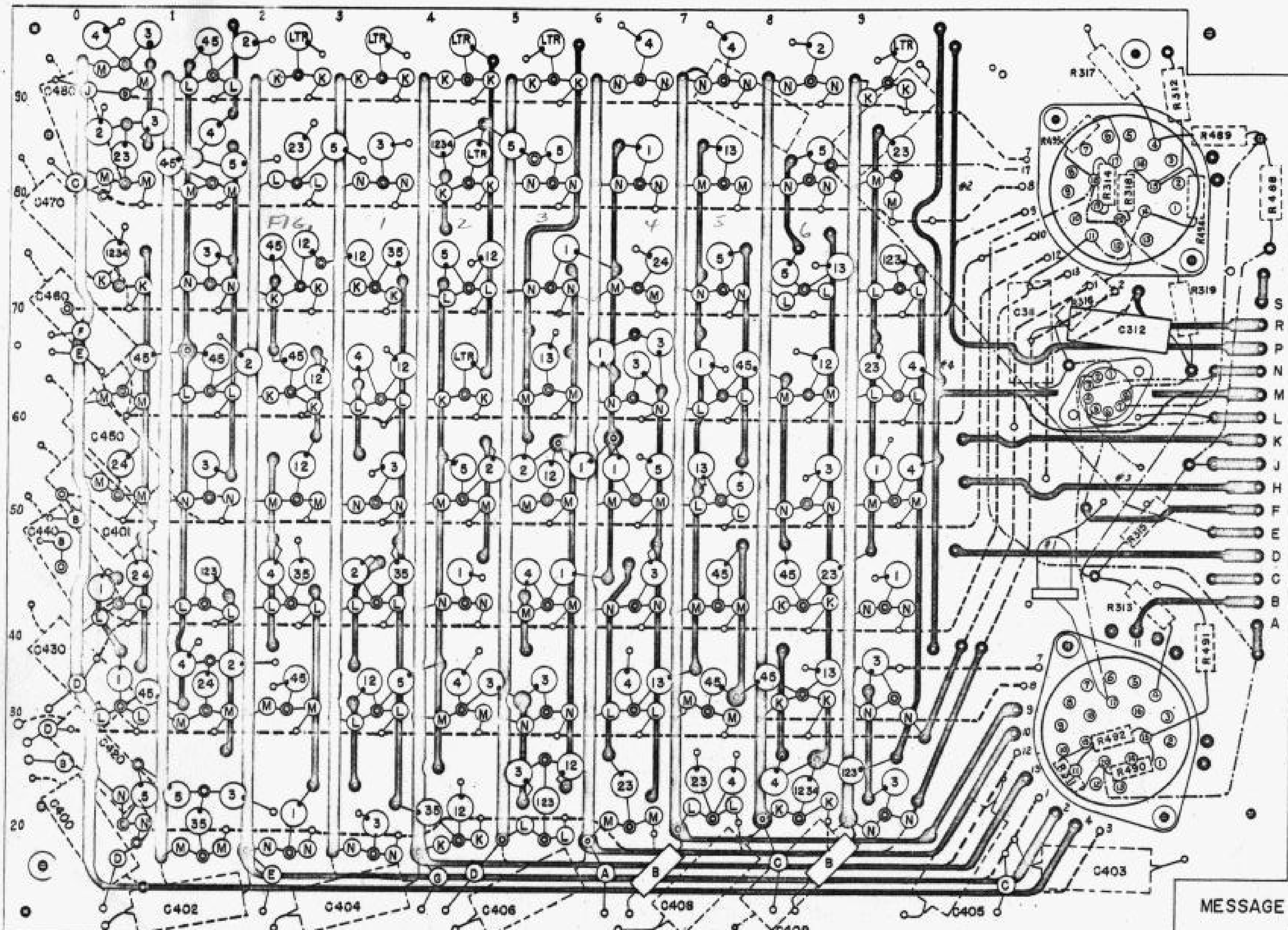
The above sample illustrates the gain of a number 1 pulse each time cathode 20 conducts which is the result of an open connection of R325 at junction 22.

THE QUICK BR[illegible]VN FCX JU[illegible]PED OVER A LAZY DOG,S BACK 123456789[illegible] TESTING

The above sample illustrates the gain of the number 1 pulse each time cathode 2 conducts which is a result of an open connection at R326 at junction 22.



CONTROL BOARD
FIGURE 5-1



LEGEND: RESISTORS:

A - 33K
B - 47K
C - 47K
D - 47K
E - 56K
F - 62K
G - 75K
H - 100K
J - 120K
K - 100K
L - 150K
M - 220K
N - 470K

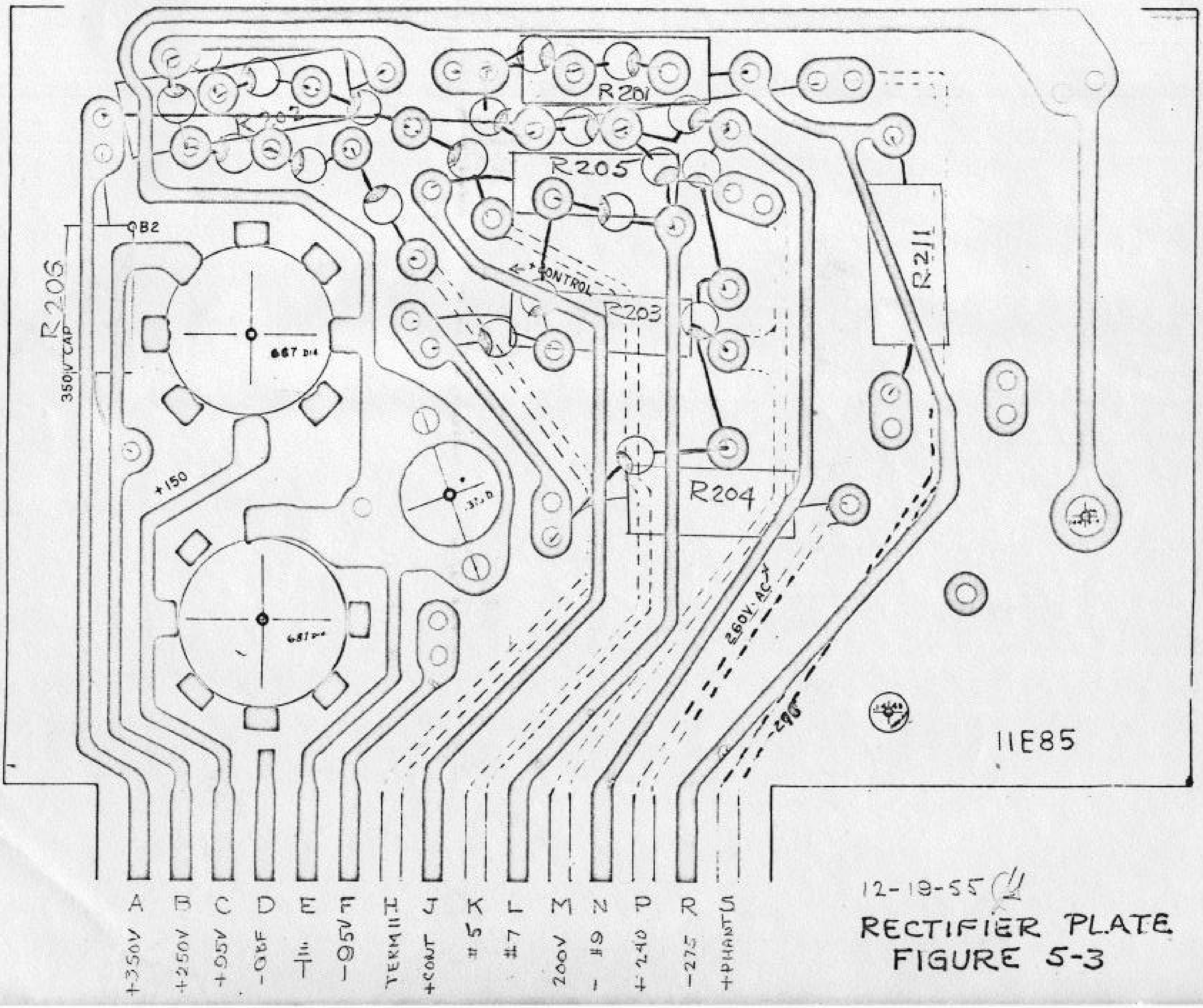
DIODES:

LTR - 12345

ACTUAL WIRES ON OTHER SIDE SHOWN AS: —·—·—·—

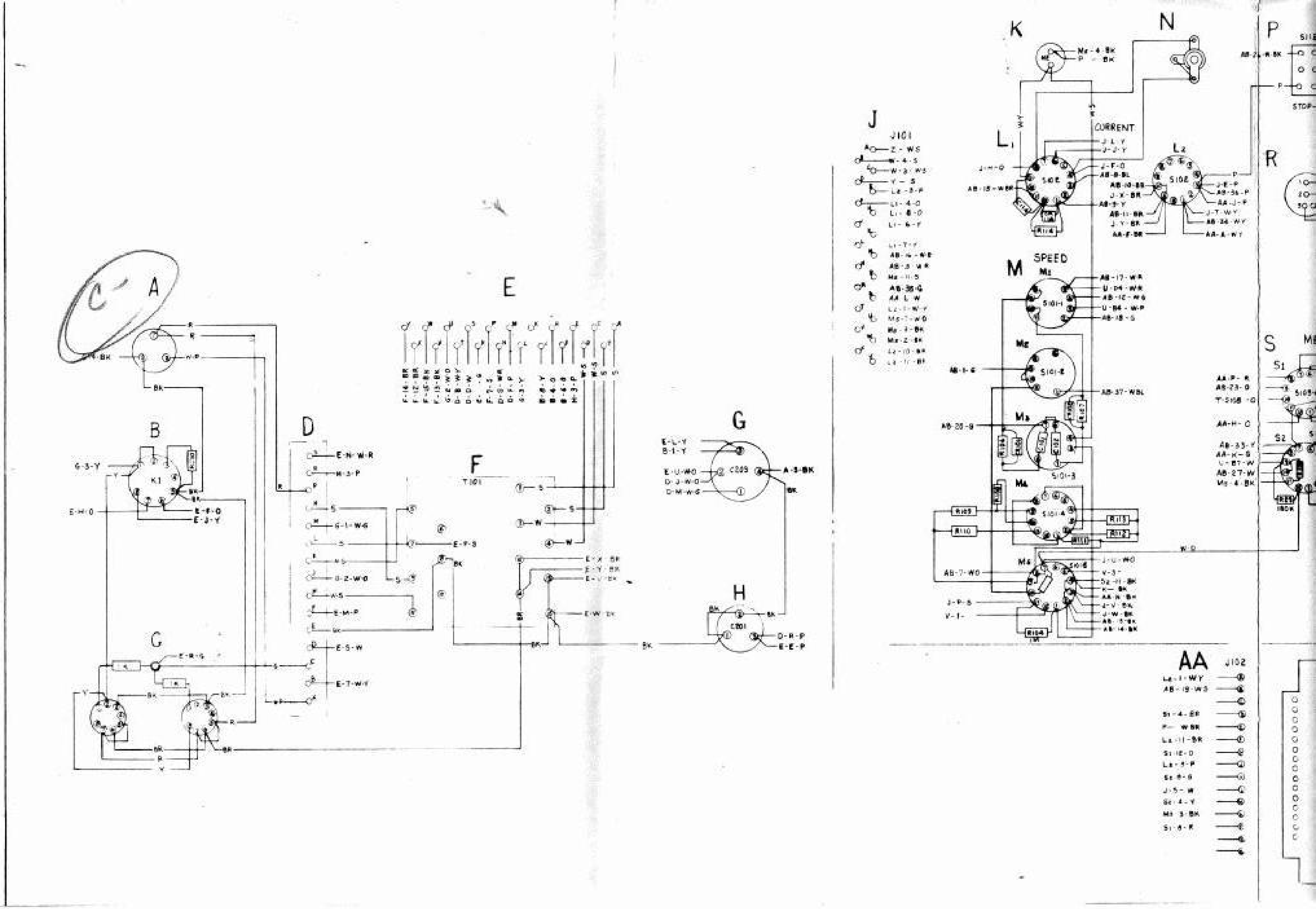
MESSAGE MATRIX ASSEMBLY

FIGURE 5-2



12-19-55

RECTIFIER PLATE
FIGURE 5-3


A
B
K1
C
D
E
F
T101
G
C209
H
C201
J
J101
K
N
L1
S102
CURRENT
L2
M
SPEED
M1
S101-1
M2
S101-2
M3
S101-3
M4
S101-4
M5
S101-5
P
STOP
R
S
S1
S2
AA
J102

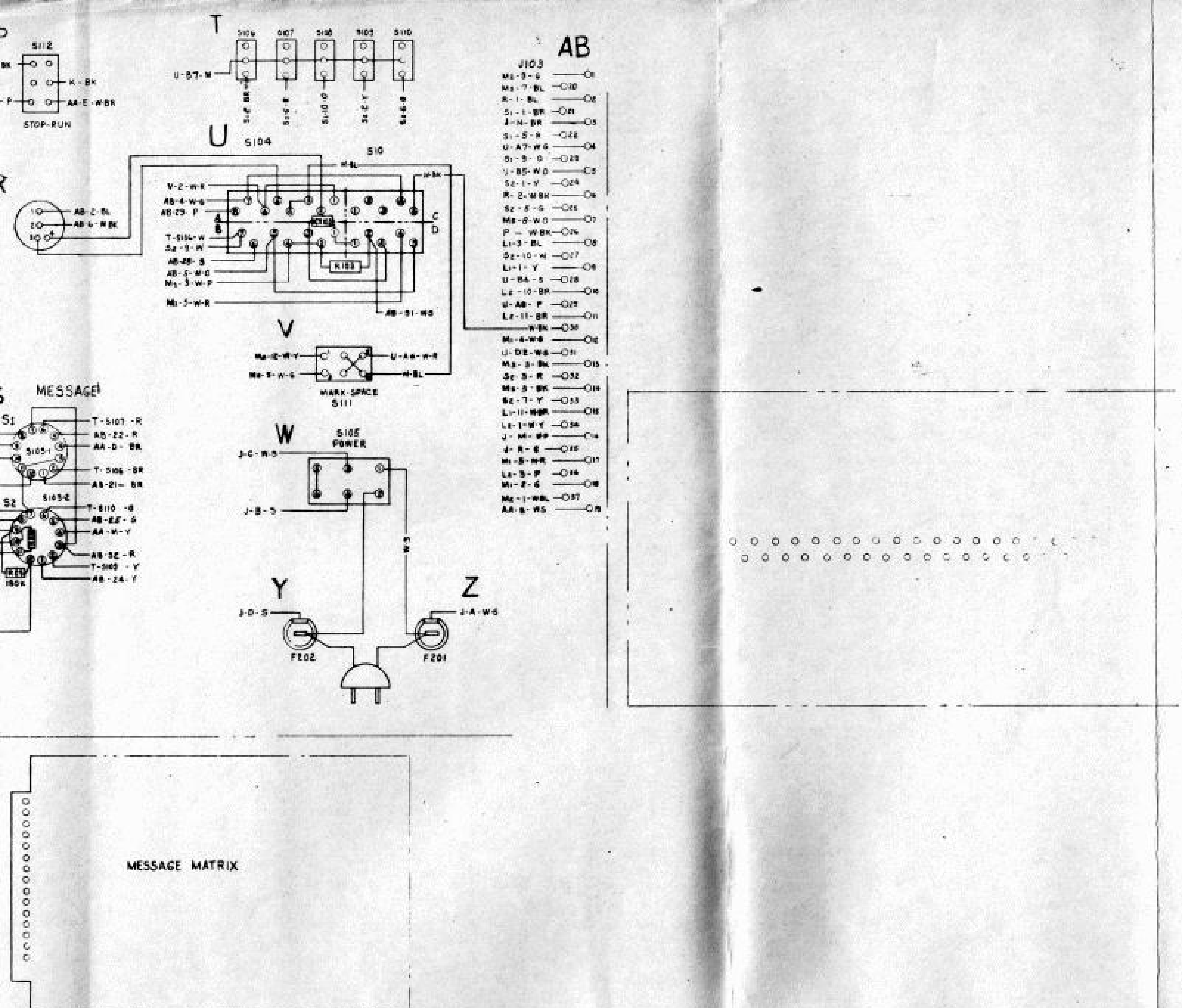


FIGURE 5-5

11E97WD

REVISIONS

ISSUE	DATE	AUTH

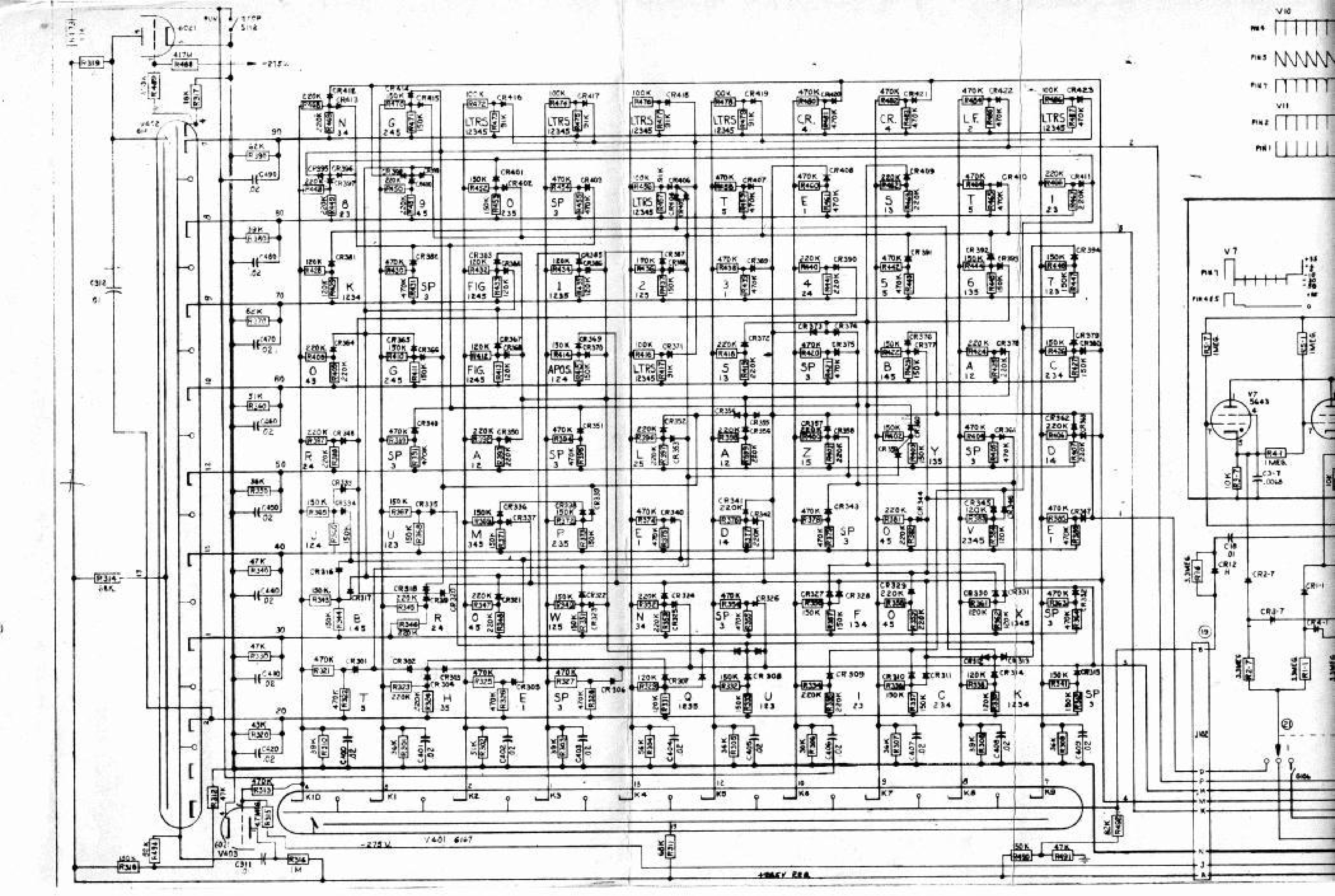
ACTUAL WIRING DIAGRAM

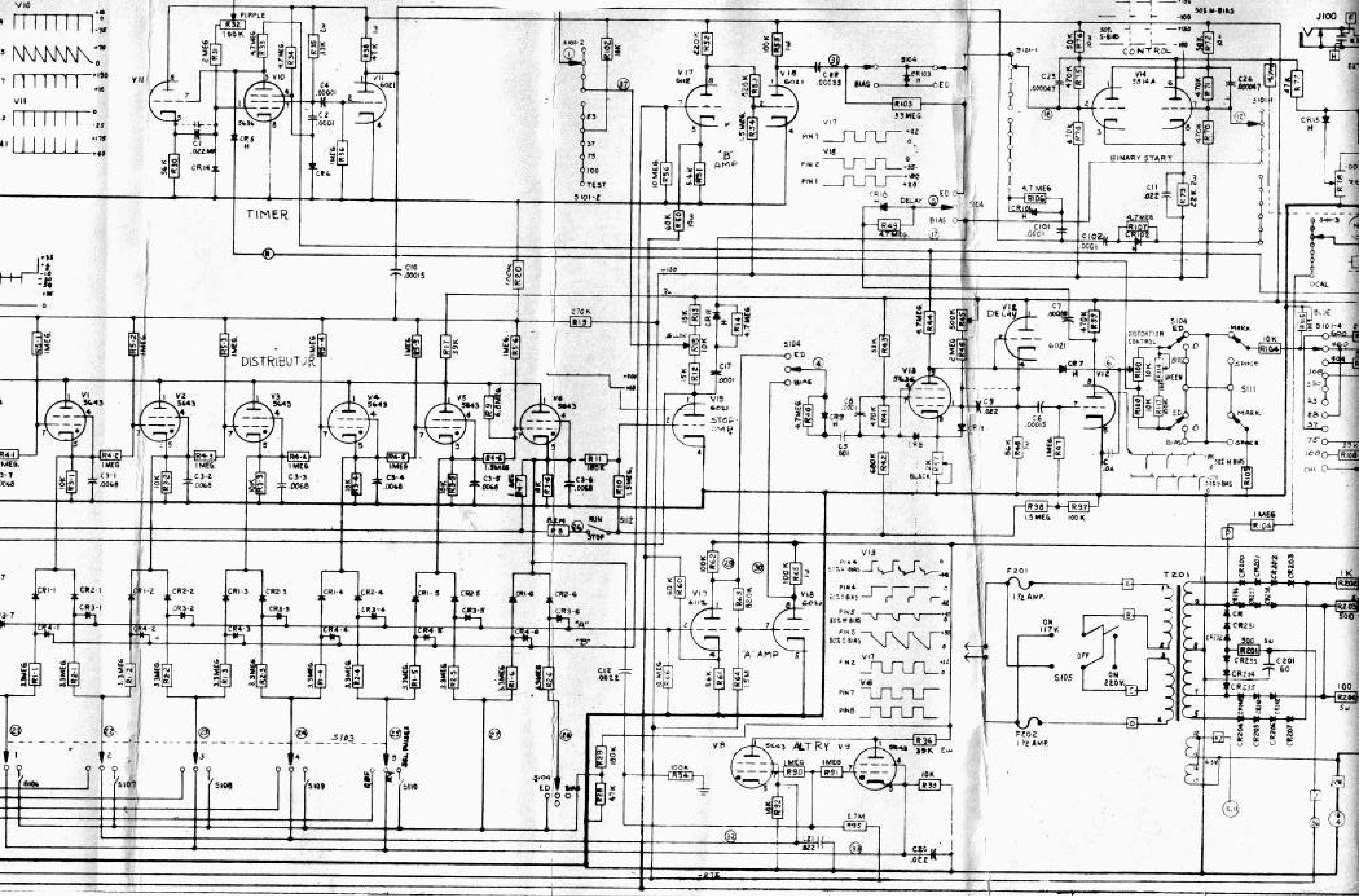
SIGNAL GENERATOR DISTRIBUTOR

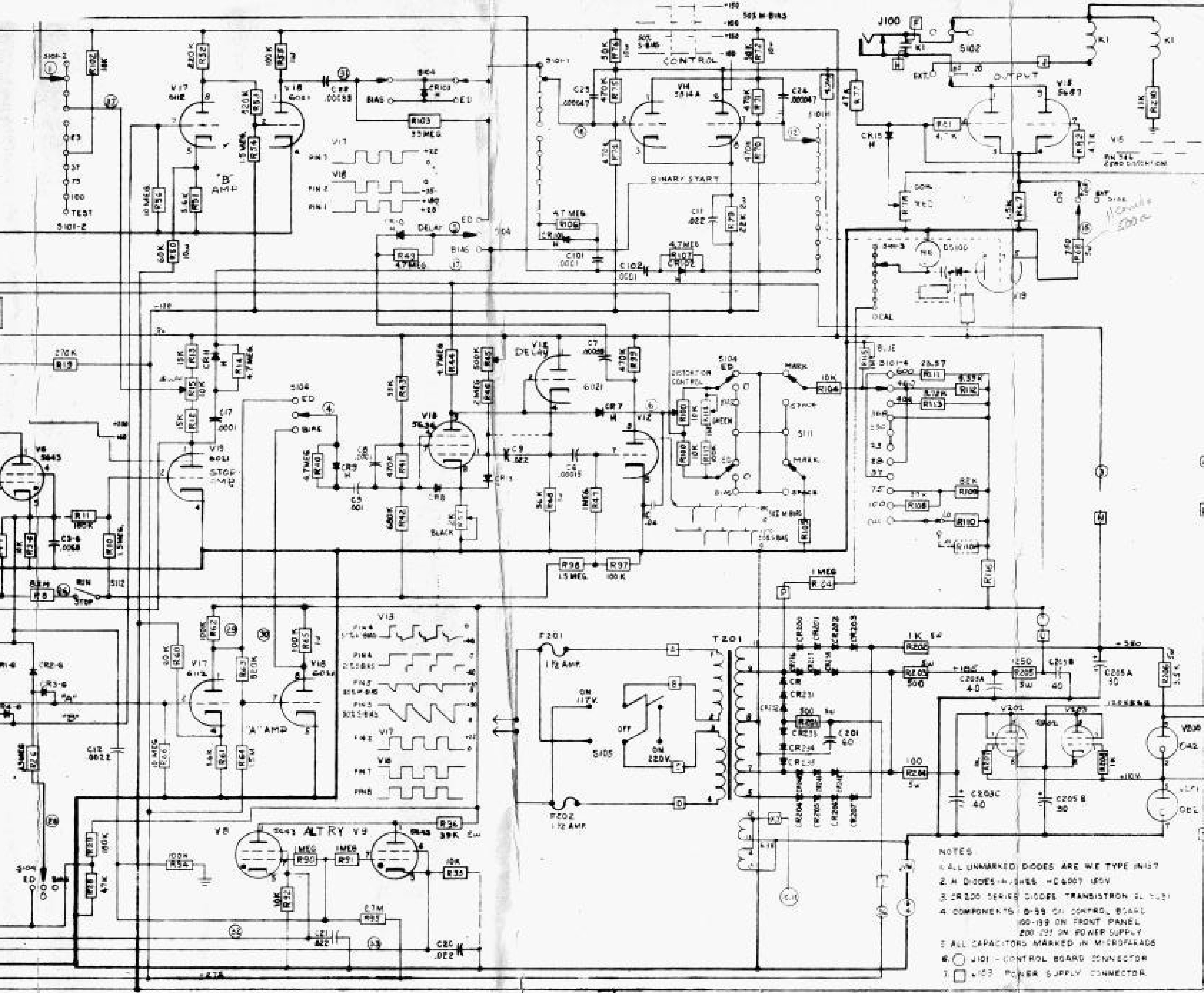
DATE: 4-10-55
F.D. FILE NO:
DRAWN: G.W. CHKD:
ENGD: J.G. APPD:

TELETYPE CORPORATION

11E97WD


RUN
STOP
-275 V
V401 6147
V403
V7
5643
K10
K1
K2
K3
K4
K5
K6
K7
K8
K9
J100
LTRS 12345
FIG. 1245
APOS. 124


TIMER
DISTRIBUTOR
BINARY START
CONTROL
DELAY
'A' AMP
'B' AMP
STOP AMP
ALTRY



NOTES

1. ALL UNMARKED DIODES ARE W.E. TYPE IN197
2. H DIODES-HUGHES HD6007 180V
3. CR200 SERIES DIODES TRANSISTRON SL TU31
4. COMPONENTS 0-99 ON CONTROL BOARD
 100-199 ON FRONT PANEL
 200-299 ON POWER SUPPLY
5. ALL CAPACITORS MARKED IN MICROFARADS
6. ◯ J101 - CONTROL BOARD CONNECTOR
7. ☐ J103 - POWER SUPPLY CONNECTOR

FIGURE 5-6

11E81WD

REVISIONS		
ISSUE	DATE	AUTH. NO.

ELECTRONIC SIGNAL GENERATOR TS-799 SCHEMATIC DIAGRAM

DATE: 4-19-55	
P.D. FILE NO. 23-87AAA	
DRAWN: G.W.	CHKD.
ENGRD: J.G.	APPD.

TELETYPE CORPORATION

11E81WD

SECTION
VI
PARTS LIST

Symbol Desig.	Description				
C1	Capacitor	.022MFD	Paper	300V	CP09A3ED223M
C2	Capacitor	100MMFD	Mica	500V	CM20B101J
C3-1 to C3-7	Capacitor	.0068MFD	Paper	100V	CP16A1H682M
C4	Capacitor	10MMFD	Mica	300V	CM15B100J
C5	Capacitor	.001MFD	Mica	500V	CM20B102J
C6	Capacitor	150MMFD	Mica	500V	CM20B151J
C7	Capacitor	390MMFD	Mica	500V	CM20B391J
C8	Capacitor	100MMFD	Mica	500V	CM20B101J
C9	Capacitor	.022MFD	Paper	300V	CP09A3ED223M
C10	Capacitor	470MMFD	Mica	500V	CM20B471J
C11	Capacitor	.022MFD	Paper	100V	CP16A1H223M
C12	Capacitor	.0022MFD	Paper	100V	CP16A1H222M
C17	Capacitor	100MMFD	Mica	500V	CM20V101J
C18	Capacitor	.01MFD	Paper	400V	CP09A3EE103M
C20	Capacitor	.022MFD	Paper	100V	CP16A1H223M
C21	Capacitor	.022MFD	Paper	100V	CP16A1H223M
C22	Capacitor	330MMD	Mica	500V	CM20B331J
C23	Capacitor	47MMFD	Mica	300V	CM15B470J
C24	Capacitor	47MMFD	Mica	300V	CM15B470J
C101	Capacitor	150MMFD	Mica	500V	CM20B151J
C102	Capacitor	150MMFD	Mica	500V	CM20B151J
C201	Capacitor	60MFD	Electrolytic	350V	Mallory
C203	Capacitor	40,40,40MFD	Electrolytic	250V	Mallory
C205	Capacitor	30,30	Electrolytic	350V	Mallory
C311	Capacitor	.01	Paper	300V	CP09A3ED103M
C312	Capacitor	.01	Paper	300V	CP09A3ED103M
C400 to C409	Capacitor	.022	Paper	100V	CP09A3EB223M
C420	Capacitor	.022	Paper	100V	CP09A3EB223M
C430	Capacitor	.022	Paper	100V	CP09A3EB223M
C440	Capacitor	.022	Paper	100V	CP09A3EB223M
C450	Capacitor	.022	Paper	100V	CP09A3EB223M
C460	Capacitor	.022	Paper	100V	CP09A3EB223M
C470	Capacitor	.022	Paper	100V	CP09A3EB223M
C480	Capacitor	.022	Paper	100V	CP09A3EB223M
C490	Capacitor	.022	Paper	100V	CP09A3EB223M
CR1-1 to CR1-6	Diode	IN137		30V	W.E.
CR2-1 to CR2-7	Diode	IN137		30V	W.E.
CR3-1 to CR3-7	Diode	IN137		30V	W.E.

Symbol Desig.	Description				
CR4-1 to CR4-6	Diode	IN137		30V	W.E.
CR5	Diode	HD6007		150VZ	Hughes
CR6	Diode	IN137			W.E.
CR7	Diode	HD6007		150VZ	Hughes
CR8	Diode	IN137			W.E.
CR9	Diode	HD6007		150VZ	Hughes
CR10	Diode	HD6007		150VZ	Hughes
CR11	Diode	HD6007		150VZ	Hughes
CR12	Diode	HD6007		150VZ	Hughes
CR13	Diode	IN137			W.E.
CR14	Diode	IN137			W.E.
CR15	Diode	HD6007		150V	Hughes
CR101	Diode	HD6007		150V	Hughes
CR102	Diode	HD6007		150V	Hughes
CR103	Diode	HD6007		150V	Hughes
CR200 to CR207	Diode	SJ31		200P.I.V.	Transitron
CR230 to CR242	Diode	SJ31		200V	Transitron
CR301 to CR423	Diode	IN137		30V	W.E.
DS100	Lamp	NE51	Neon		G.E.
F201	Fuse	½a	3AG	250V	Littelfuse
F202	Fuse	½a	3AG	250V	Littelfuse
J100	Jack	41-031			Allied Radio
J101	Connector	DB37P			Cannon
J102	Connector	HHB3369			Buggie
J103	Connector	MRE21P			Winchester
J200	Connector	K15P			Winchester
K1	Relay	72			Sigma
P101	Plug	DB37's			Cannon
P102	Plug	HHB3372			Buggie
P103	Plug	K15S			Winchester
R1-1 to R1-6	Resistor	3.3 Meg.	½ watt	5% Tol.	A.B.
R2-1 to R2-7	Resistor	3.3 Meg.	½ watt	5% tol.	A.B.

Symbol Desig.	Description				
R3-1 to R3-7	Resistor	10k	½ watt	5% tol.	A.B.
R4-1 to R4-5	Resistor	11 Meg.	½ watt	5% Tol.	A.B.
R4-6	Resistor	1.2 Meg.	½ watt	5% Tol.	A.B.
R4-7	Resistor	1 Meg.	½ watt	5% Tol.	A.B.
R5-1 to R5-7	Resistor	1 Meg.	½ watt	5% Tol.	A.B.
R8	Resistor	8.2 Meg.	½ watt	5% Tol.	A.B.
R9	Resistor	6.8 Meg.	½ watt	5% Tol.	A.B.
R10	Resistor	1.5 Meg.	½ watt	5% Tol.	A.B.
R11	Resistor	180k	½ watt	5% Tol.	A.B.
R12	Resistor	15k	½ watt	5% Tol.	A.B.
R13	Resistor	15k	½ watt	5% Tol.	A.B.
R14	Resistor	4.7 Meg.	½ watt	5% Tol.	A.B.
R15	Resistor	10k (pot)			
R16	Resistor	3.3 Meg.	½ watt	5% Tol.	A.B.
R17	Resistor	39k	2 watt	5% Tol.	A.B.
R19	Resistor	270k	½ watt	5% Tol.	A.B.
R28	Resistor	47k	½ watt	5% Tol.	RC20GF4735
R29	Resistor	180k	½ watt	5% Tol.	RC20GF184
R30	Resistor	56k	½ watt	5% Tol.	RC20GF563
R31	Resistor	2 Meg.	1 watt	1% Tol.	Blackburn
R32	Resistor	100k (pot)	¼watt		Centralab Mod 3
R33	Resistor	4.7 Meg.	½ watt	5% Tol.	A.B.
R34	Resistor	4.7 Meg.	½ watt	5% Tol.	A.B.
R35	Resistor	33k	2 watt	5% Tol.	A.B.
R36	Resistor	1 Meg.	½ watt	5% Tol.	RC20GF105J
R37	Resistor	6.8 Meg.	½ watt	5% Tol.	RC20GF685J
R38	Resistor	47k	1 watt	5% Tol.	RC30GF473J
R40	Resistor	4.7 Meg.	½ watt	5% Tol.	RC20GF475J
R41	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R42	Resistor	680k	½ watt	5% Tol.	RC20GF684J
R43	Resistor	33k	2 watt	5% Tol.	RC42GF333J
R44	Resistor	4.7 Meg.	½ watt	5% Tol.	RC20GF475J
R45	Resistor	500k (pot)			Centralab Model 3
R46	Resistor	2 Meg. wirewound	1 watt	1% Tol.	Blackburn Electronics
R47	Resistor	1 Meg.	½ watt	5% Tol.	RC20GF105T
R48	Resistor	56k	1 watt	5% Tol.	RC30GF563J
R49	Resistor	4.7 Meg.	½ watt	5% Tol.	RC20GF475J
R50	Resistor	60k wirewound	10 watt	5% Tol.	Ohmite
R51	Resistor	5.6k	½ watt	5% Tol.	RC20GF562J
R52	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R53	Resistor	820k	½ watt	5% Tol.	RC20GF824J
R54	Resistor	1.5 Meg.	½ watt	5% Tol.	RC20GF155J
R55	Resistor	100k	1 watt	5% Tol.	RC30GF104J
R56	Resistor	10 Meg.	½ watt	5% Tol.	RC20G5106J
R57	Resistor	2k pot	¼ watt		Centralab Model 3
R60	Resistor	60k wirewound	½ watt	5% Tol.	Ohmite
R61	Resistor	5.6k	½ watt	5% Tol.	RC20GF562J
R62	Resistor	100k	1 watt	5% Tol.	RC30GF104J

Symbol Desig.	Description				
R63	Resistor	820k	1 watt	5% Tol.	RC30GF824J
R64	Resistor	1.5Meg.	½ watt	5% Tol.	RC20GF155J
R65	Resistor	100k	1 watt	5% Tol.	RC30GF104J
R66	Resistor	10 Meg.	½ watt	5% Tol.	RC20GF106J
R67	Resistor	1.5k	½ watt	5% Tol.	RC20GF155J
R68	Resistor	750	½ watt	5% Tol.	RC20GF751J
R70	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R71	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R72	Resistor	50K wirewound	10 watt	5% ohmite	Ohmite
R74	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R75	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R76	Resistor	50k wirewound	10 watt	5% ohmite	Ohmite
R77	Resistor	47k	½ watt	5% Tol.	RC20GF473J
R78	Resistor	100k pot	¼ watt		Centralab Model 3
R79	Resistor	22k	2 watt	5% Tol.	RC42GF223J
R81	Resistor	4.7k	½ watt	5% Tol.	RC20GF472J
R82	Resistor	4.7k	½ watt	5% Tol.	RC20GF472J
R90	Resistor	1 Meg.	½ watt	5% Tol.	RC20GF105J
R91	Resistor	1 Meg.	½ watt	5% Tol.	RC20GF105J
R92	Resistor	10k	½ watt	5% Tol.	RC20GF103J
R93	Resistor	10k	½ watt	5% Tol.	RC20GF103J
R94	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R95	Resistor	2.7 Meg.	½ watt	5% Tol.	RC20GF275J
R96	Resistor	39k	2 watt	5% Tol.	RC42GF393J
R97	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R98	Resistor	1.5 Meg.	½ watt	5% Tol.	RC20GF155J
R99	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R100	Resistor	10k pot	¼ watt		Centralab
R102	Resistor	18k	½ watt	5% Tol.	RC20GF183J
R103	Resistor	3.3 Meg.	½ watt	5% Tol.	RC20GF335J
R104	Resistor	10k wirewound	1 watt	.5% Tol.	Blackburn
R105	Resistor	10k wirewound	1 watt	.5% Tol.	Blackburn
R106	Resistor	4.7 Meg.	½ watt	5% Tol.	RC20GF475J
R107	Resistor	4.7 Meg.	½ watt	5% Tol.	RC20GF475J
R108	Resistor	39k	½ watt	5% Tol.	RC20GF393J
R109	Resistor	82k	½ watt	5% Tol.	RC20GF823J
R111	Resistor	23.57k	1 watt	0.5% Tol.	Blackburn
R112	Resistor	9.39k	1 watt	0.5% Tol.	Blackburn
R113	Resistor	3.72k	1 watt	0.5% Tol.	Blackburn
R114	Resistor	1 Meg. pot	¼ watt		Centralab Model 3
R115	Resistor	1 Meg Pot	¼ watt		Centralab Model 3
R116	Resistor	2k wirewound		1% Tol.	Ohmite
R117	Resistor	100	½ watt	5% Tol.	Ohmite
R201	Resistor	500	5 watt	5% Tol.	Ohmite
R202	Resistor	1k	5 watt	5% Tol.	Ohmite
R203	Resistor	500	5 watt	5% Tol.	Ohmite
R204	Resistor	100	5 watt	5% Tol.	Ohmite
R205	Resistor	1250	5 watt	5% Tol.	Ohmite
R206	Resistor	3.5k	5 watt	5% Tol.	Ohmite
R207	Resistor	1k	½ watt	5% Tol.	Ohmite
R208	Resistor	1k	½ watt	5% Tol.	RC20GF102J
R210	Resistor	11k wirewound	5 watt		Ohmite

Symbol Desig.	Description				
R301	Resistor	36k	½ watt	5% Tol.	RC20GF363J
R302	Resistor	51k	½ watt	5% Tol.	RC20GF513J
R303	Resistor	39k	½ watt	5% Tol.	RC20GF393J
R304	Resistor	56k	½ watt	5% Tol.	RC20GF563J
R305	Resistor	36k	½ watt	5% Tol.	RC20GF363J
R306	Resistor	30k	½ watt	5% Tol.	RC20GF303J
R307	Resistor	36k	½ watt	5% Tol.	RC20GF363J
R308	Resistor	39k	½ watt	5% Tol.	RC20GF393J
R309	Resistor	36k	½ watt	5% Tol.	RC20GF363J
R310	Resistor	39k	½ watt	5% Tol.	RC20GF393J
R311	Resistor	68k	½ watt	5% Tol.	RC20GF683J
R312	Resistor	47k	½ watt	5% Tol.	RC20GF473J
R313	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R314	Resistor	68k	½ watt	5% Tol.	RC20GF683J
R315	Resistor	4.7 Meg.	½ watt	5% Tol.	RC20GF475J
R316	Resistor	1 Meg.	½ watt	5% Tol.	Rc20GF105J
R317	Resistor	18k	½ watt	5% Tol.	RC20GF183J
R318	Resistor	150k	½ watt	5% Tol.	RC20GF153J
R319	Resistor	1 Meg.	½ watt	5% Tol.	RC20GF105J
R320	Resistor	43k	½ watt	5% Tol.	RC20GF433J
R321	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R322	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R323	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R324	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R325	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R326	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R327	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R328	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R329	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R330	Resistor	47k	½ watt	5% Tol.	RC20GF473J
R331	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R332	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R333	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R334	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R335	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R336	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R337	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R338	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R339	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R340	Resistor	47k	½ watt	5% Tol.	RC20GF473J
R341	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R342	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R343	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R344	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R345	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R346	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R347	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R348	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R349	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R350	Resistor	36k	½ watt	5% Tol.	RC20GF363J
R351	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R352	Resistor	220k	½ watt	5% Tol.	RC20GF224J

Symbol Desig.	Description				
R353	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R354	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R355	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R356	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R357	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R358	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R359	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R360	Resistor	51k	½ watt	5% Tol.	RC20GF513J
R361	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R362	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R363	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R364	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R365	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R366	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R367	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R368	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R369	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R370	Resistor	62k	½ watt	5% Tol.	RC20GF623J
R371	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R372	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R373	Resistor	150k	½ watt.	5% Tol.	RC20GF154J
R374	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R375	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R376	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R378	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R379	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R380	Resistor	39k	½ watt	5% Tol.	RC20GF393J
R381	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R382	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R383	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R384	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R385	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R386	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R387	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R388	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R389	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R390	Resistor	62k	½ watt	5% Tol.	RC20GF623J
R391	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R392	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R393	Resistor	200k	½ watt	5% Tol.	RC20GF224J
R394	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R395	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R396	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R397	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R398	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R399	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R400	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R401	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R402	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R403	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R404	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R405	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R406	Resistor	220k	½ watt	5% Tol.	RC20GF224J

Symbol Desig.	Description				
R407	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R408	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R409	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R410	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R411	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R412	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R413	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R414	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R415	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R416	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R417	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R418	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R419	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R420	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R421	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R422	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R423	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R424	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R425	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R426	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R427	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R428	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R429	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R430	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R431	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R432	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R433	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R434	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R435	Resistor	120k	½ watt	5% Tol.	RC20GF124J
R436	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R437	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R438	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R439	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R440	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R441	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R442	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R443	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R444	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R445	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R446	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R447	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R448	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R449	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R450	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R451	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R452	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R453	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R454	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R455	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R456	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R457	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R458	Resistor	470k	½ watt	5% Tol.	RC20GF474J

Symbol Desig.		Description			
R459	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R460	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R461	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R462	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R463	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R464	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R465	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R466	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R467	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R468	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R469	Resistor	220k	½ watt	5% Tol.	RC20GF224J
R470	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R471	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R472	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R473	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R474	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R475	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R476	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R477	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R478	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R479	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R480	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R481	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R482	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R483	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R484	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R485	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R486	Resistor	100k	½ watt	5% Tol.	RC20GF104J
R487	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R488	Resistor	4.7 Meg.	½ watt	5% Tol.	RC20GF475J
R489	Resistor	470k	½ watt	5% Tol.	RC20GF474J
R490	Resistor	150k	½ watt	5% Tol.	RC20GF154J
R491	Resistor	47k	½ watt	5% Tol.	RC20GF473J
R492	Resistor	82k	½ watt	5% Tol.	RC20GF823J
R493	Resistor	1 Meg.	½ watt	5% Tol.	RC20GF105J
R494	Resistor	82k	½ watt	5% Tol.	RC20GF823J
S101	Switch, Rotary				Dwg.#
S102	Switch, Rotary				Dwg.#
S103	Switch, Rotary				Dwg.#
S104	Switch, Keylever		MCT4		Dwg.#
S105	Switch, Toggle		ST52P		Micro switch
S106 to S111	Switch, Min. Toggle		6AT2		Micro switch
T201	Transformer, Power		5676		Electran Mfg. Co.
V1 to V9	Tube, Electron		5643		Sylvania
V10	Tube, Electron		5636		Sylvania
V11	Tube, Electron		6021		Sylvania
V12	Tube, Electron		6021		Sylvania
V13	Tube, Electron		5636		Sylvania
V14	Tube, Electron		5814A		Sylvania
V15	Tube, Electron		5687		Sylvania

Symbol Desig.	Description		
V17	Tube, Electron	6112	Sylvania
V18	Tube, Electron	6021	
V19	Tube, Electron	0A2	
V200	Tube, Electron	0B2	
V201	Tube, Electron	5902	
V202	Tube, Electron	5902	Sylvania
V203	Tube, Electron	5902	Sylvania
V401	Tube, Electron	6167	W.E.
V402	Tube, Electron	6167	W.E.
V403	Tube, Electron	6021	W.E.
XKI	Socket, Octal		Cinch
XV1 to XV3	Socket, Subminiature		Cinch 46B22373
XV4 to XV15	Socket, Noval		Elco 623BC
XV17 to XV19	Socket, Subminiature		Cinch 46B22373
XV200 to XV201	Socket, Septal		Elco 622-BC
XV202 to XV203	Socket, Subminiature		Cinch 46B22373
XV401 to XV402	Socket, 20 pin		Cinch 54A17686

Chatham Electronics SIMULATION OF DISTORTED SIGNALS FILE 23-87/AAA

SIGNAL CORPS
TECHNICAL REQUIREMENTS

SCL-1488
4 January 1954

TEST SET TELETYPEWRITER TS-799( )/UGM-1

1. SCOPE

1.1 This specification covers requirements for the development, engineering and construction of models of a teletypewriter test set which will generate undistorted reversals or miscellaneous or recurring teletypewriter signals with a controlled amount of distortion.

2. APPLICABLE SPECIFICATIONS, STANDARDS AND DRAWINGS

2.1 The following specifications, standards, and drawings, of the issue in effect on the date of invitation for bids, form a part of this specification.

SPECIFICATIONS

Military

MIL-V-95	Vibrators, interrupter and self-rectifying
MIL-P-11268 ✓	Parts, Materials, and Processes Used in Signal Corps Equipment
MIL-S-11748 ✓	Suppression requirements for electrical and electronic equipment (except internal combustion engine-driven equipment)
MIL-W-12410 ✓	Wire, Cable, and Cord (electrical, hook-up insulated, radio and apparatus
MIL-C-3884 ✓	Cord, Electrical (short lay)

U.S. Army

71-4945	Rubber Substitutes for use in Cords, Cordages and Cables

STANDARDS

Military

MIL-STD-15	Electrical and Electronic Symbols
MIL-STD-16 ✓	Reference Designations for Electrical and Electronic Symbols
MIL-STD-122 ✓	Color Code for Chassis Wiring for Electronic Equipment
MIL-STD-200	Electronic Tubes
MIL-STD-202 ✓	Test Methods for Electronic and Electric Components parts

PUBLICATIONS

Signal Corps

SCL-2101	Technical Reports

2.2 Drawings. The following drawings, of the issue in effect on the date of invitation for bids, form a part of these requirements:

RL-A-825	Identification Tag for Cords
SC-A-4894	Arctic Rubber Compound, Mechanical Grade, Non-Oil Resistant, 40-Durometer
SC-D-9823	Binding Post TM-216
SC-D-15914	Humidity Test Cycle for Ground Signal Equipment, 48-hour
SC-D-17269	Caution Plates
SC-DL-69167	Connector Plug, U-120/U
SC-DL-72398	Binding Post, U-106/U
SC-D-20648	Catch, Small, Assembly and Details
SC-D-20649	Catch, Large, Assembly and Detail
SC-D-20650	Catch Tops
SC-B-20651	Catch Retainers

11 dwgs

(Copies of specifications, standards, and drawings required by contractors in connection with specific procurement functions may be obtained from or as directed by the contracting officer. Both the title and identifying number or symbol should be stipulated when requesting copies.)

3. REQUIREMENTS

3.1 Design. Lightweight miniature parts and construction techniques shall be used to the fullest possible extent consistent with dependability, ease of maintenance and simplicity of operation. The design, layout and assembly shall be such as to permit quantity production. Electrical parts shall not be required to operate under conditions of current, voltage, power or temperature beyond those specified by the manufacturer of the part, or by the applicable MIL or other subsidiary specifications, without specific written approval by the contracting officer or his representative. All samples submitted for approval shall be accompanied by test data showing compliance with requirements and tests of this specification.

3.1.1 Design evaluation. During the initial design and the "breadboard" stage, the contractor shall study the various design factors in order to affect a compromise among performance, reliability, life, power drain, weight, size and complexity. Prior to "freezing" the design of the equipment, this study shall be submitted to the contracting officer or his designated representative in the form of an evaluation of two or more designs showing the improvement in equipment characteristics such as size, weight, power drain and the possible decrease in life or reliability which might result from a minor deviation from specification requirements or commercial practice. This evaluation will be considered by the contracting officer, or his representative, and will be used as a basis for selection by mutual agreement with the contractor of the most desirable design. Further study of these factors shall continue during the course of the contract and be described in a separate section of the progress reports. Acceptance of any design described in these studies shall not be construed as authorizing deviation from any requirements of this specification except those specifically authorized in writing by the contracting officer.

3.1.2 Reliability. The equipment covered by this specification will not be considered fully developed until its functioning under all Service Conditions is reliable. If it can be demonstrated that fulfillment of the other requirements of this specification is likely to compromise reliability this shall be brought to the attention of the Contracting Officer and consideration will be given to adjustment of the other requirements accordingly. The requirements shall be considered in the order of importance sequence as follows and in making adjustments. Factors higher on the list may not be compromised to gain advantages for lower listed factors:

(a) Reliability
(b) Performance
(c) Ease of operation and maintenance
(d) Size and weight

3.1.3 Changes in Specifications. As the work progresses, it may appear desirable to modify these technical requirements within the general scope of the contract. The contractor is encouraged to submit proposals for modification if based on evidence that the current approach may be unproductive or otherwise undesirable. Detailed procedures for making changes are described in the contract. In general, specification changes which do not involve change in cost or delivery will be authorized by letter, and those which change the cost or delivery will be accomplished by contract modification.

3.2 Electrical Functions.

3.2.1 Generated Signals.

3.2.1.1 Teletypewriter Signals. The equipment shall be capable of generating 7.42-unit code signals at speeds of 368.1, 404, 460, and 600 operations per minute and 7.0-unit code signals at a speed of 390 operations per minute. It shall be possible to generate the standard test message "THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING followed by four successive "letters" impulses, two "carriage return" impulses, one "line feed" impulse, and one "letters" impulse in that order with 30 percent fixed marking or spacing bias or marking or spacing end distortion. It shall also be possible to generate any one of the following test signals "R," "Y", "T," "O," "M," "V," "letters," "Blank," "space," "RY," or standard test message with a controlled amount of marking or spacing bias or marking or spacing end distortion continuously variable from 0 to 50 percent.

3.2.1.2 Reversals. The equipment shall be capable of generating reversals at frequencies of 20, 30, 35, 75, and 100 cycles per second.

3.2.2 Keying. Keying shall be either 20 or 60 ma. neutral or 30 ma. polar. When polar keying is desired, line current shall be furnished internally and means shall be provided for adjusting line current from 20 to 30 ma. when keying a 100 ohm circuit. When neutral 20 or 60 ma. keying is desired, the resistance offered by the test equipment to the line shall not exceed 100 ohms.

3.2.3 Accuracy. The generated signals, when the distortion control is positioned for zero distortion, shall be such that no transitions shall be displaced by more than 2 percent from their correct positions.

3.2.4 Cords.

3.2.4.1 A six-foot cord shall be provided to connect the test set to an a.c. power source.

3.2.4.2 A six-foot cord, terminated with a block plug type 347 as manufactured by Western Electric Co. or equal, shall be provided to connect the output of the test set to a local loop.

3.2.5 Controls. The test set shall be furnished with the following controls:

a. A separate ON/OFF switch
b. A switch to short out the keying functions so that keyed loop will be shorted out. For polar operation, this switch, while in the shorted condition, shall furnish steady marking condition.
c. A switch to select either teletypewriter signals or reversals.
d. A five-position switch to select any of the following frequencies of reversals 22.5, 30, 35, 75, and 100 cycles per second.
e. A knob to control the amount of distortion on generated teletypewriter signals from 0 to 50 percent.
f. A three-position switch to select either standard test message, repeated RY, or manual setting up of any of the 32 baudot codes using the switches described in par. g below.
g. A group of five toggle switches that may be used to set up any of the 32 baudot codes.
h. A switch to introduce either bias or end distortion on teletypewriter signals.
i. A switch to introduce either marking or spacing bias on teletypewriter signals.
j. ~~Means for providing fixed distortion~~ of 30 percent either by a simple mechanical adjustment or by a ~~two-position switch~~. cut

no.

3.3 Construction. The equipment is intended for both tactical and fixed plant applications. The equipment shall be designed such as to permit removal from the equipment transit case and installed on the standard 19" racks. Transit cases used to house the equipment will be decided on at the time the breadboard stage is achieved. The contractor should make every endeavor to restrict the weight of the equipment including the transit case to 35 pounds.

3.3.1 Controls and jacks. All operating controls and input and output jacks shall be located on or be operable from the front panel; be clearly identified and shall be arranged in such a way as to be of maximum convenience and utility to the user of the test equipment.

3.3.2 Sub-units. Any sub-unit may be used by itself or in conjunction with other sub-units of the equipment.

3.3.3 Caution notice. Each component which bears an identification nameplate shall also bear in a conspicuous location a notice per Drawing SC-D-17269.

3.3.4 Adjustment and Repair. The equipment shall be so constructed that parts, terminals, wiring, etc. are accessible for circuit checking, adjustment, maintenance, repair, and replacement with minimum disturbance to other parts and wiring and with use of the minimum number and variety of special tools, particularly those needed for tuning and adjustment.

3.3.5 Ruggedness and Reliability. All parts and details of construction shall have the maximum of ruggedness and reliability under all operating conditions. The equipment all be so constructed that it can withstand long periods of service and repeated rough handling in transportation with a minimum of damage and readjustment.

3.3.6 Interchangeability. All components, subassemblies and parts shall be mechanically and electrically interchangeable with all corresponding components, subassemblies, and parts of the equipment or equipments on order.

3.3.7 Tools and/or Running Spare Parts. Tools and running spare parts shall be furnished as specified in the bid request and contract. Running spare parts shall be identical to corresponding integral parts in the equipment furnished on order.

3.4 Parts, materials and processes. All parts, materials and processes not specifically mentioned herein shall be in accordance with specifications and drawings listed in Section 2 of this specification covering such parts, materials and processes. The selection of class, grade or type shall be such that when mounted in the equipment, the part or material will perform its intended function under the Service Conditions specified in 3.5.

3.4.1 Wire, Hook-up. Hook-up wire shall be nylon jacketed LW type wire in accordance with MIL-W-12410. The wire shall be stranded and shall be of sufficient conductor size to avoid deterioration in electrical properties of the wire from overheating.

3.4.2 Samples of component parts. Prior to, or at the time of delivery of the development model of the equipment, six samples of any type of capacitor, resistor, transformer, or other electrical parts which have not previously received Signal Corps or MIL approval shall be submitted for test. The particular electrical values of the samples to be delivered under each type, selected from the values employed in the equipment, will be specified by the contracting officer or his representative. If, in the construction of the equipment, hermetic sealing of subassemblies is employed, two each of a typical subassembly shall also be furnished. One shall be complete; the other shall be complete except for final covering and sealing.

3.4.2.1 Approval of sample components. If any sample components, required to be submitted by this or by subsidiary specifications, are disapproved, the contractor may be required to submit additional sample until satisfactory samples have been submitted. Such additional samples shall be accompanied by a description of the changes made in the new samples in order to correct the faults of the rejected samples. Approval of the samples shall not be construed as authorizing any deviations from specified requirements.

3.5 Service Conditions.

3.5.1 Vibration. Except for internal resonance of parts and subassemblies specified herein, the equipment shall have no mechanical resonance below 55 cycles per second when the shock mounts (if any) are blocked.

3.5.2 Bounce and Shock.

3.5.2.1 The equipment shall meet the requirements of Table I below:

Table I - Bounce and Shock Tests

Test	Test Paragraph	Requirements after Test
Bounce, 3 hour	4.5.5	Full specification performance. No physical damage except surface abrasions.
Bench-handling	4.5.7	Full specification performance. No physical damage.
Shock test (drop)	4.5.6	Equipment shall be operable. Minor mechanical damage is permissible.

3.5.3 The equipment shall be constructed to withstand, without damage, transportation and storage and operation under any probable combination of the service conditions listed in the appropriate column below:

	TRANSPORTATION AND STORAGE	OPERATION
a. Temperature	-80 to + 160 F	-25 to + 131 F
b. Relative Humidity	0 to 95%	0 to 95%
c. Altitude	Sea Level to 25,000 ft.	Sea Level to 10,000 ft.

*The equipment shall operate within these temperature limits meeting all requirements of this specification.

3.6 Service Literature. The contractor shall provide instruction books, drawings and final reports as specified in the bid request and contract.

3.6.1 Manufacturer's Drawings. The contractor shall supply a complete set of manufacturers shop drawings prepared in accordance with the contractors practices.

3.6.2 Instruction Books. Instruction books shall be furnished as stipulated in the bid request and contract. The books shall contain sufficient operating and maintenance information for Laboratory use. The instruction books shall follow Specification MIL-M-10953 in arrangement but need not contain all information specified therein. The books shall be furnished in manuscript form and need not be printed, but may be typed, dittoed or mimeographed.

3.7 Reports. The contractor shall prepare and submit reports of the type and in the quantities required in the bid request and contract. These reports shall be in accordance with Specification SCL-2101 and shall contain pertinent explanations of points of theoretical interest, descriptions of design procedure and reasons for selecting the particular design and the rejecting of others. The tests, design and construction of the equipment shall be described in sufficient detail to enable any competent technician to duplicate the results.

3.7.1 Conferences. The contractor shall meet with the representatives of the contracting officer once each month, or at any interval determined by the contracting officer or his representative. The time and place for such meetings shall be arranged by mutual agreement between the contractor and the contracting officer. At these conferences, progress on design and development problems and the difficulties encountered therein, will be discussed. Requests for information, approvals and other commitments to or from the contractor will not be considered binding unless made or confirmed in writing.

3.8 Workmanship. The workmanship shall be first class in every respect. All components and the finished equipment shall be free from any defects which might affect their serviceability or appearance.

4. METHODS OF INSPECTION AND TESTS

4.1 It is the desire of these Laboratories to obtain the fullest cooperation from one manufacturers of this equipment. The test procedure shall be submitted by the contractor to the contracting officer for his approval and shall be sufficiently comprehensive to insure compliance with all requirements listed in this specification. The tests may be performed either at the plant of the manufacturer and under the supervision of representatives of the contracting officer, prior to submission of the equipment to these Laboratories for final tests and acceptance, or at these Laboratories. The contracting officer reserves the right to make other tests not specifically described herein, when such tests are deemed necessary to determine full compliance with the specification requirements.

4.1.1 All material and processes entering into the fabrication of the equipment covered by this specification shall be subject to inspection by the authorized Government inspector. The contractor shall furnish all necessary facilities and equipment for making the tests and inspection required by this specification (except the tests of 4.5 to 4.5.9, inclusive). The contracting officer reserves the right to make other tests not specifically described herein, when such tests are deemed necessary to determine full compliance with the specification requirements. The contractor shall correct all deviations from this specification pointed out by the inspector.

4.2 Parts. All parts shall be inspected and tested by the contractor to ascertain that they meet the requirements of this specification prior to assembling in the equipment. Tests of parts may be repeated by the inspector. All parts covered by subsidiary specifications shall be inspected in accordance with their respective specifications by a representative of the contracting officer, before their assembly into the equipment. Inspection of parts may be made either at the contractor's plant or at the place of manufacture, whichever is deemed preferable by the contracting officer.

4.3 Mechanical inspection. Each equipment shall be given a thorough inspection for mechanical faults and poor workmanship. All controls and moving parts shall operate smoothly without excessive binding, scraping, or cutting. Wiring, soldering, switch contacts, finish and all other mechanical details shall be checked on each unit.

4.4 Electrical tests.

4.4.1 Continuity. Each equipment shall be given a continuity test to verify that the wiring is correct and that good electrical contact is obtained.

4.5 Service conditions tests. The following tests will be performed at a Government laboratory. For all of these tests (except the bench handling test 4.5.7) the equipment shall be in its field transit case.

4.5.1 Low temperature test. The equipment shall be exposed to storage at an ambient temperature of -80 F for three days. The temperature of the test chamber shall then be raised to -25 F and permitted to stabilize at that temperature for a continuous period of 24 hours. At -25 F there shall be no degradation in performance from that obtained prior to this test.

4.5.2 High temperature test. The equipment shall be exposed to storage at an ambient temperature of +160 F for three days. The temperature of the test chamber shall then be lowered to +131 F and permitted to stabilize at that temperature for a continuous period of 24 hours. At +131 F, there shall be no degradation in performance from that obtained prior to this test.

4.5.3 <u>Moisture Resistance Test for Equipment</u>.

4.5.3.1 <u>Test Conditions</u>.

(a) Do not remove the sample from the humidity chamber for measurements.

(b) Start measurements not more than 5 minutes after power is applied to the sample. Complete measurements as rapidly as possible. Do not leave power on after measurements have been completed.

4.5.3.2 <u>Test Procedure</u>. The sample will be tested as follows:

(a) Dry at 130 F ± 5 F for 24 hours.

(b) Condition at 77 F ± 5 F and 40 to 50 percent relative humidity for 24 hours.

(c) Measure the performance as specified in 4.2 and readjust or realine as necessary to meet specification requirements.

(d) Subject to continuous cycling for five 48-hour cycles. Temperature, relative humidity, and period of time for each portion of the cycle shall conform to Drawing SC-D-15914.

(e) After cycling has been completed, condition the sample for 24 hours at 77 F ± 5 F and 40 to 60 percent relative humidity. Then adjust for optimum performance, using only those means provided by the equipment. No repair or replacement of parts shall be made. After adjustment, the sample shall meet full specification requirements.

4.5.3.3 <u>Performance</u>. The equipment shall meet the requirements of this specification. There shall be no mechanical deterioration, as evidenced by corrosion of metal parts or the binding of rotating parts.

4.5.4 <u>Vibration Test</u>. The equipment shall be tested to determine if any resonant frequencies below 55 cycles per second are present as follows:

4.5.4.1 The equipment shall be fastened in its normal mounting position (Shock mounts any shall be blocked) on a vibration table that can be controlled within 10% of the specified amplitude.

4.5.4.2 The vibration table shall provide approximate sinusoidal vibration. The equipment shall be vibrated successively in three mutual perpendicular directions that are respectively parallel to the edges of the equipment. The frequency range from 10 to 55 shall be traversed at 1 cycle per second increments with a constant total excursion of .0156".

4.5.4.3 Resonances of components, structure, and sub-assemblies may be detected visually, by means of a Strobotac, as made by the General Radio Corporation, Cambridge, Massachusetts, and by energizing the equipment and detecting mechanical vibration through e trical output indications.

4.5.5 Bounce test. The equipment, in its case, shall be placed on the table of the Package Tester, as made by the L.A.B. Corporation, Summit, N.J., or equal. The equipment may be loosely constrained by wood cleats. The Package Tester, shafts in phase, shall be run at a speed of 285 rpm $\pm$ 1% for 3 hours. The equipment shall be placed on each of its 6 faces in turn and shall be subjected to this test for 1/2 hour on each face. At the conclusion of this test, the equipment shall evidence no mechanical degradation and shall meet the require- ts of this specification. Superficial surface abrasion is permissible.

4.5.6 Shock test (drop). The equipment, in its case, shall be dropped a distance of 4 feet on each corner, edge and face. Drops may be made from a quick release hook, by an Acme Drop Tester, by a 10 degree Inclined Plane (Conbur) Tester or by a Basket Type Pendulum Tester. The barrier or floor receiving the impact shall be 2 inch fir backed by concrete or by a rigid steel frame. The equipment shall be operable, with no serious degradation in performance at the end of this test. Local mechanical damage consistent with the preceding is permissible.

4.5.7 Bench handling test. The chassis and front panel assembly shall be removed from the equipment case required for maintenance. The equipment shall be tilted on each face at an approximate angle of 30 degrees and the raised edge dropped on a 2 inch thick fir surface. At the conclusion of this test, the equipment shall evidence no mechanical degradation and shall meet the requirements of this specification.

4.5.8 Altitude test. The equipment shall be placed in an altitude chamber at normal conditions of temperature, pressure and humidity, and the performance measured. The pressure shall then be reduced to 20 inches of mercury and stabilized for two hours. The performance of the equipment shall again be measured. The pressure shall then be lowered to 7 inches of mercury and stabilized for another 2 hour period. The pressure shall then be increased to 29.9 inches of mercury and the performance measured again. The equipment shall meet the requirements of this specification.

4.5.9 Rain Test. The transit case, with the equipment or an equivalent weight in it, shall be tested step by step, as follows:

4.5.9.1 Dry at 150 $\pm$ 5 F for 48 hours.

4.5.9.2 Condition for 4 hours at 77 $\pm$ 5 F and 40 to 60 percent relative humidity.

4.5.9.3 Place the case, in its normal operating position, in a test chamber maintained at 77 $\pm$ 5 F. Allow simulated rainfall to fall on exposed surfaces of the component. The water shall be at a temperature of 65 $\pm$ 5 F and shall fall freely at a rate of 2 inches per h r. Maintain this condition for one hour.

4.5.9.4 With the rainfall continuing at the 2-inch rate, introduce a simulated wind blowing horizontally at 20 ± 5 miles per hour against one side of the case. The water shall ...ll on exposed surfaces and shall be blown by the wind against one side of the case. Main-...n this condition for one hour.

4.5.9.5 Rotate the case 90 degrees horizontally, to expose a second side of the case to the wind and rain. Maintain this condition for one hour.

4.5.9.6 Continue as in 4.5.9.5 until all four sides of the case have been exposed to the wind and rain, each side for one hour.

4.5.9.7 Open the case. There shall be no visible evidence of leakage.

5. PREPARATION FOR DELIVERY

5.1 Packaging, packing and marking. The equipment shall be packaged, packed and marked as specified in the bid request and contract.

6. NOTES

6.1 Expenses. It is to be understood that the contractor will bear all expenses in connection with shipping of samples to and from the point where they are tested, and any damage to the samples resulting from shipment, disassembly, reassembly, or testing.

Patent Notice: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture use or sell any patented invention that may in any way be related thereto.

Strike
87.6
120.0
60 cycle line