METHOD I

GRID PULSE CHARACTERISTICS

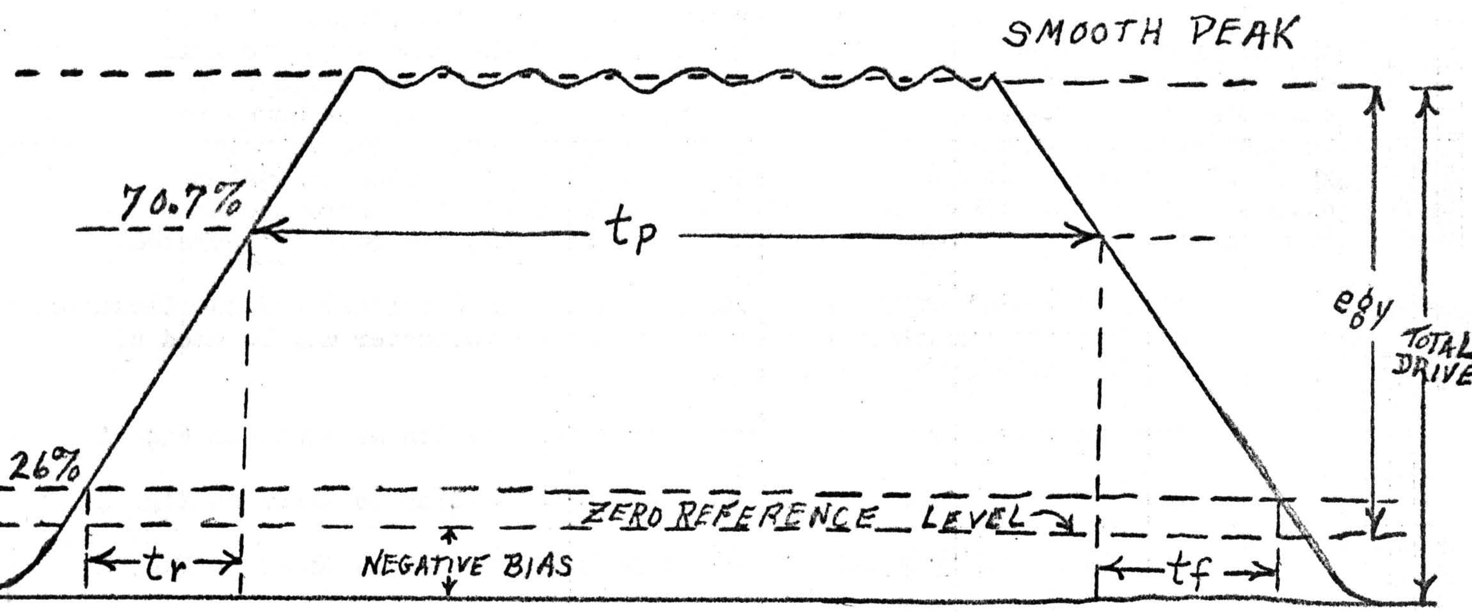
1. Grid pulse characteristics are properties of the output pulse of the trigger circuit, measured at the grid-input of the tube with the grid disconnected. The scope input is secured from a capacitance divider of compensated resistance voltage divider tap, and this voltage is connected to the vertical plates through a matching co-axial cable. The voltage ratio of dividers plus associated cables should be calibrated against a direct oscilloscope measurement. The test circuit shall be arranged to compensate for the removal of measuring equipment when the tube is operated.

egy: Measured with a capacity potentiometer (divider) and oscilloscope. See Fig. I. An electrostatic peak reading voltmeter may be used as an alternate method of measurement.

tr: Measured by examining the scope presentation as shown on Fig. I

tf: Measured by examining the scope presentation as shown on Fig. I

tp: Measured by examining the scope presentation as shown on Fig. I



GRID PULSE

FIG. 1

METHOD 2

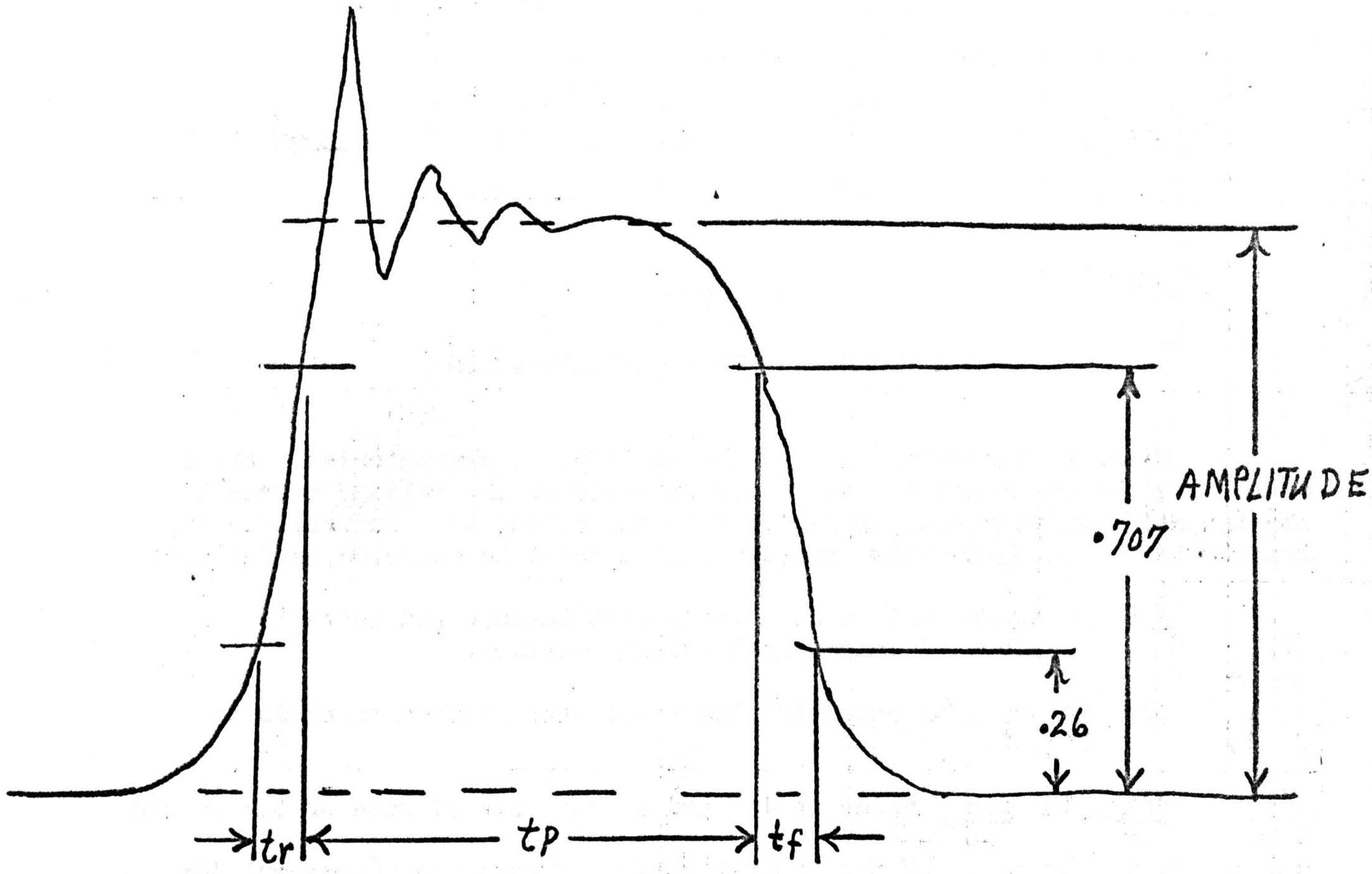
ANODE (CURRENT) PULSE CHARACTERISTIC

1. With the exception of epy, the anode pulse characteristic shall be measured by examining the scope presentation of the voltage across a non-inductive current viewing resistor or the output of a current viewing transformer. The anode pulse characteristic shall be measured as follows:

epy: Measured with a calibrated oscilloscope and suitable calibrated compensated voltage divider.

ib: Measured by examining the scope presentation as shown on Fig. 2.

$\frac{dik}{dt}$: The $\frac{dik}{dt}$ value is defined as the rate of rise of the current pulse. It is the ratio of the current change between the 26-percent and 70.7-percent points of the leading edge to the rise time for that portion of the pulse.



PULSE AMPLITUDE IS THE MAXIMUM VALUE OF A SMOOTH CURVE THROUGH THE AVERAGE OF THE FLUCTUATIONS OF THE TOP PORTION OF THE PULSE, EXCLUSIVE OF SPIKE. THE AMPLITUDE SHALL BE AVERAGED OVER A TIME EQUAL TO AT LEAST 25% OF THE PULSE WIDTH. A SPIKE IS A TRANSIENT OF DURATION LESS THAN 10% OF PULSE WIDTH DURING WHICH THE AMPLITUDE APPRECIABLY EXCEEDS THE AVERAGE AMPLITUDE OF THE PULSE.

ANODE PULSE CURRENT

FIG. 2

METHOD 3

TRIGGER SOURCE IMPEDANCE

1. The impedance of trigger sources employing a line-type modulator (gas tube circuit) shall be measured by the short-circuit current method or the matching-resistor method indicated below. The impedance of trigger sources employing a high vacuum tube, cathode follower (or similar circuit) shall be measured by the short-circuit current method only.

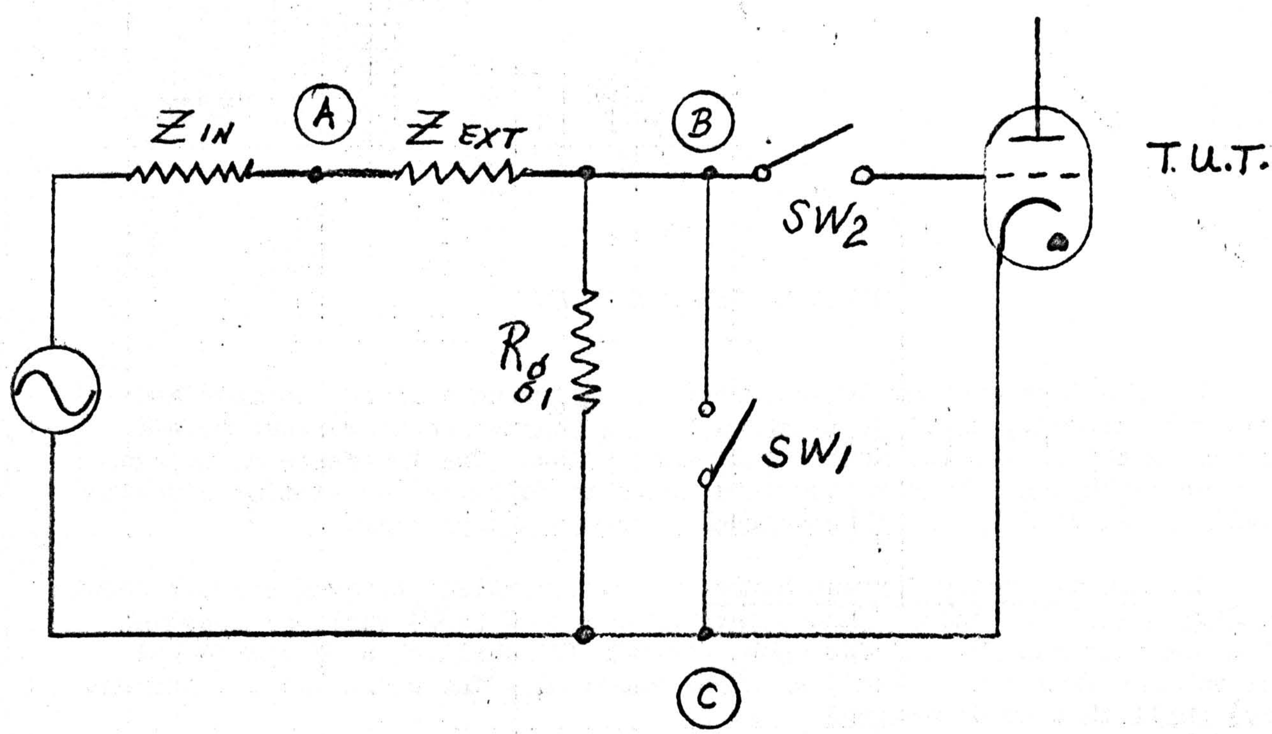
2. Short-Circuit Current Method - The equivalent trigger circuit shown on Fig. 3 shall be used. The voltage from B to C (eBC) shall be measured with the switches SW1 and SW2 open. Switch SW1 shall then be closed and the voltage from A to C (eAC) shall be measured. The short-circuit current (is) shall then be determined from:

$$is = \frac{eAC}{Zext}$$

The trigger-source impedance (Zs) is then:

$$Zs = \frac{eBC}{is} = \frac{eBC}{eAC} Zext$$

3. Matching-Resistor Method - The equivalent trigger circuit shown on Fig. 3 shall be used. The open-circuit voltage from B to C (eBC) shall be measured. A noninductive resistor shall be inserted between B and C, and the value of resistance shall be adjusted until the voltage across the resistance is equal to onehalf the open-circuit voltage. The trigger-source impedance is then equal to the value of the resistance inserted.



Z_{IN} - INTERNAL IMPEDANCE OF TRIGGER CIRCUIT

Z_{EXT} - EXTERNAL RESISTANCE ADDED SO THAT $Z_{IN} + Z_{EXT}$ EQUALS DESIRED SOURCE IMPEDANCE (Z_S)

R_{g1} - THYRATRON GRID RETURN RESISTOR

SW_1 - SWITCH

SW_2 - SWITCH

TRIGGER CIRCUIT

FIG. 3

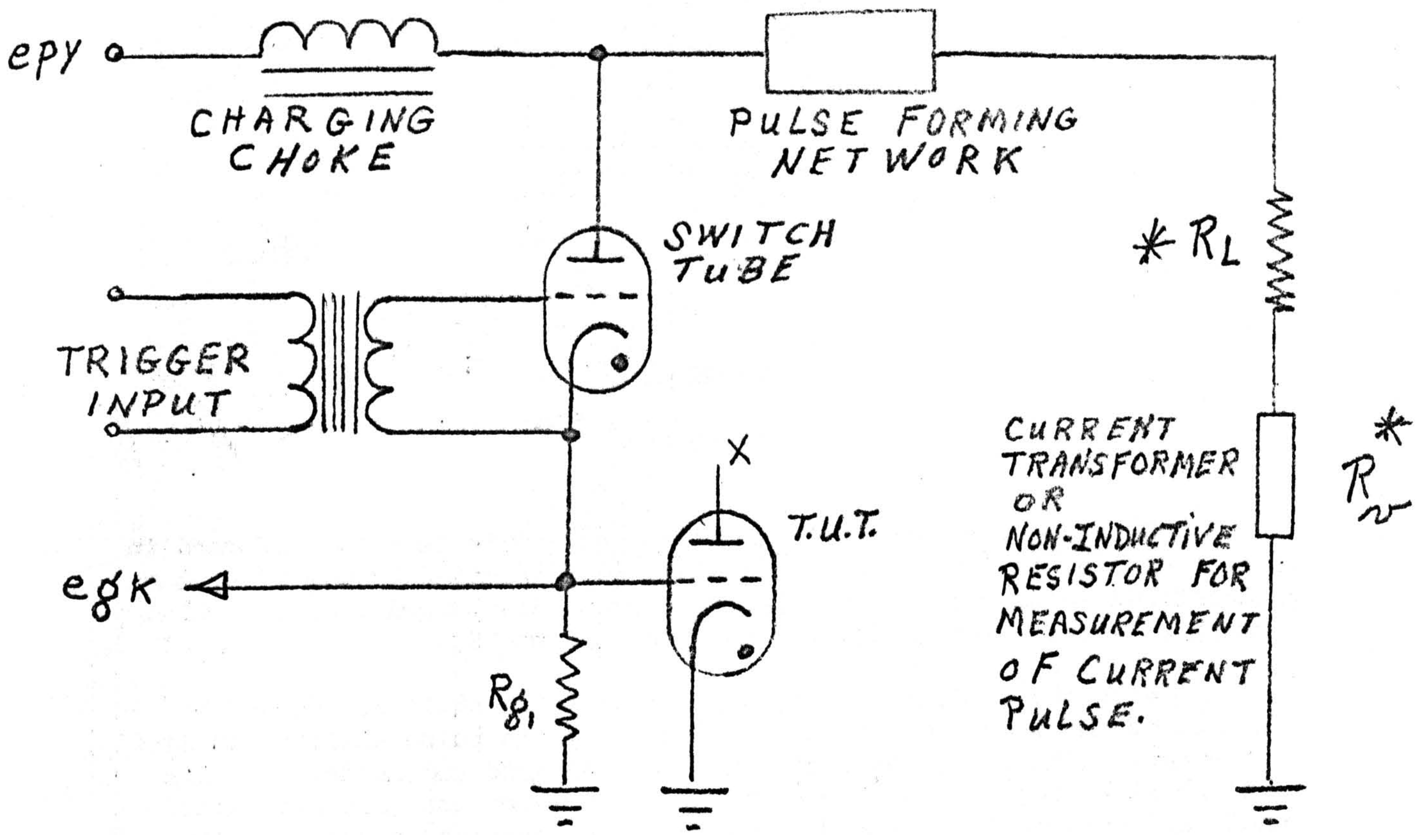
METHOD 4

EMISSION

1. Emission (Adjustable Voltage Source) - This test is performed in circuit on Fig. 4A. The emission quality is determined by measuring the grid-cathode voltage during a pulse of current discharged from the pulse forming network. Test conditions as specified on TSS.

With the anode floating, a positive pulse shall be applied to the grid of the tube under test or alternately the pulse shall be applied to the anode with a one ohm resistance between grid and anode. Voltage (egk) shall be measured as shown on Fig. 4B between the grid and cathode (anode and cathode in case of the alternate connection) a point in time not later than the value specified on the TSS after beginning of current pulse. The voltage shall be within the limits specified on the TSS and the voltage shall not rise during the conduction time following the point of measurement.

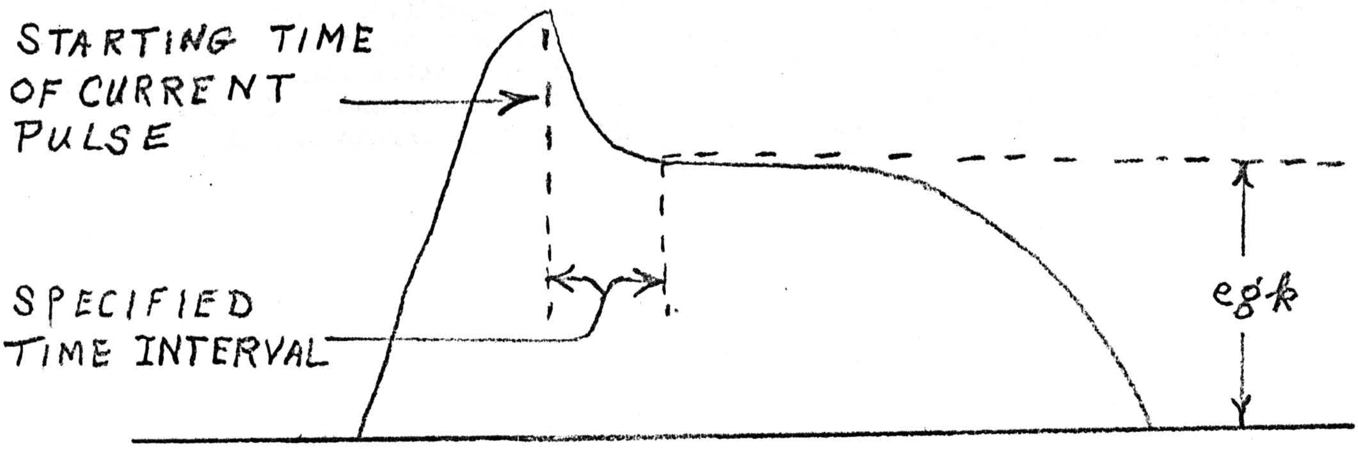
2. Emission (Fixed Voltage Source) - The tube shall be tested for pulse emission in the circuit shown on Fig. 4C. A resistor shall be substituted for the tube under test for calibration purposes. The calibrated pulse voltage amplitude shall be within the value specified over 80 percent of the top portion of the pulse and shall not vary from this value by more than 5 percent. The pulse voltage characteristics shall be $tp = 5.0 \pm 0.25\,\mu s$; $tr = 0.5\,\mu s$ maximum; $tf = 1.0\,\mu s$ maximum. The peak voltage drop between anode and cathode (etd) shall be within the limits specified on the tube specification sheet.



BASIC EMISSION TEST CIRCUIT

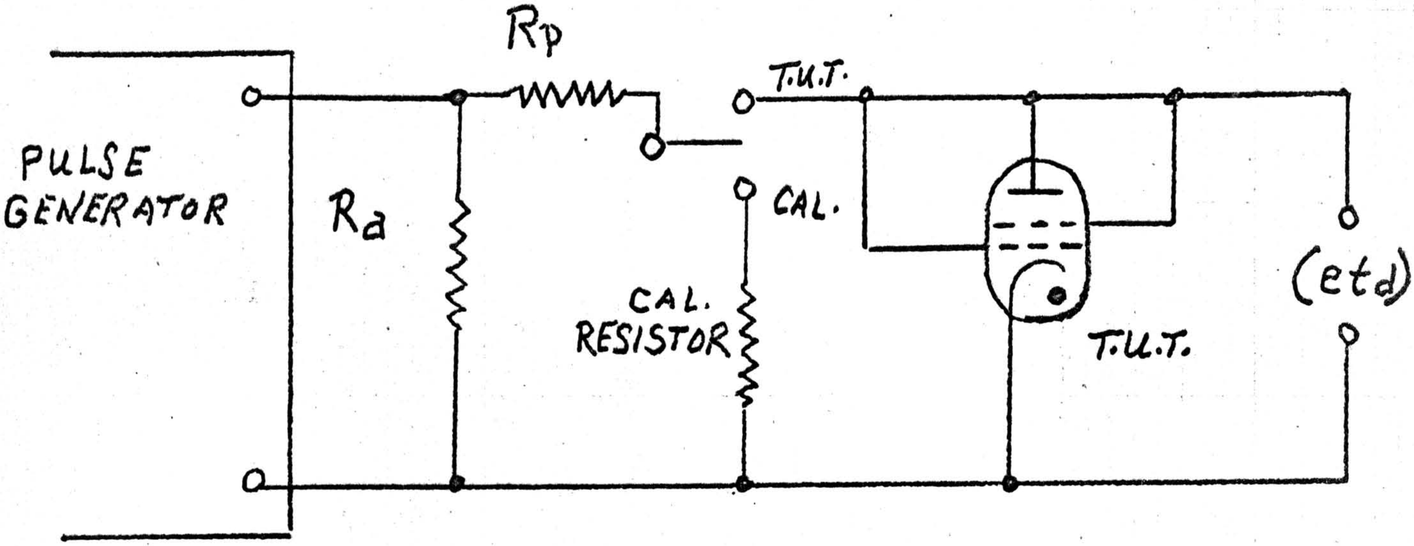
FIG. 4A

* INCLUDE R_v AS PART OF R_L



POSITIVE GRID PULSE (EMISSION TEST).

FIG. 4B



RESISTORS SHALL BE NON-INDUCTIVE, TOLERANCE $^{+5}_{-0}$ %

$Z_{gen.}$, R_a, R_p, $R_{cal.}$ AS SPECIFIED ON TSS

BASIC EMISSION TEST CIRCUIT
(FIXED VOLTAGE SOURCE)

FIG. 4C

METHOD 5

ANODE DELAY TIME TESTS

1. Anode Delay Time Tests - These tests are measurements of the time interval (tad) between the 26-percent point on the rising portion of the unloaded grid pulse and the point where anode conduction takes place as shown on Fig. 5. In multigrid tubes, the reference grid shall be that which receives the last pulse.

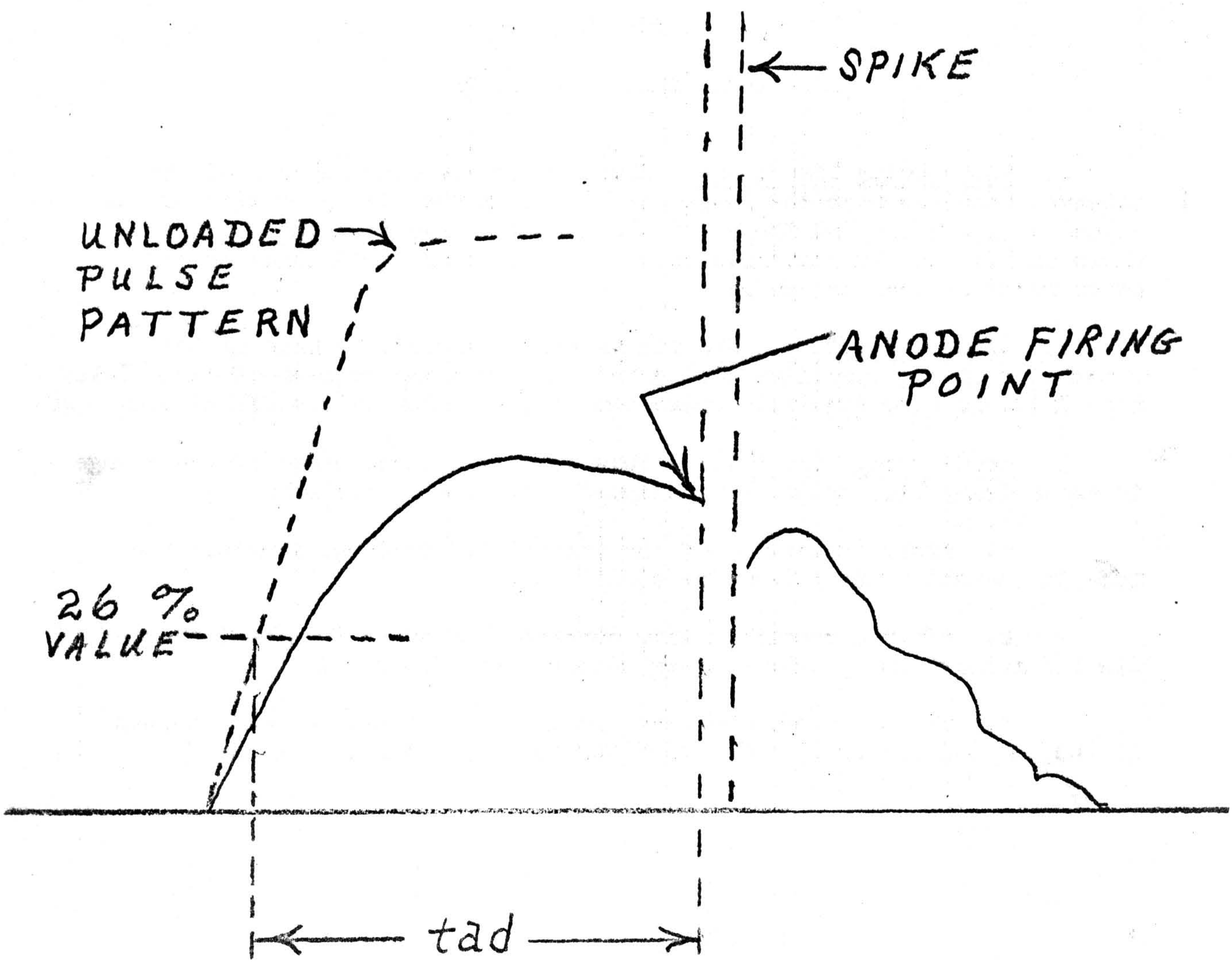
2. Anode Delay Time - The tad measurement shall be made at the conclusion of the specified test duration. If a measurement of anode delay time drift is also required, operation of tube under test shall be continued.

3. Anode Delay Time Drift - This test is a measurement of the change in anode delay time caused by continued operation of the tube.

a. After completion of the initial tad reading, continue the tube in operation under the same conditions.

b. After a specified time duration (measured from beginning of the tad measurement), make another measurement of the tad.

c. The difference between the initial and second tad readings is the Δ tad and shall not exceed the specified maximum value.



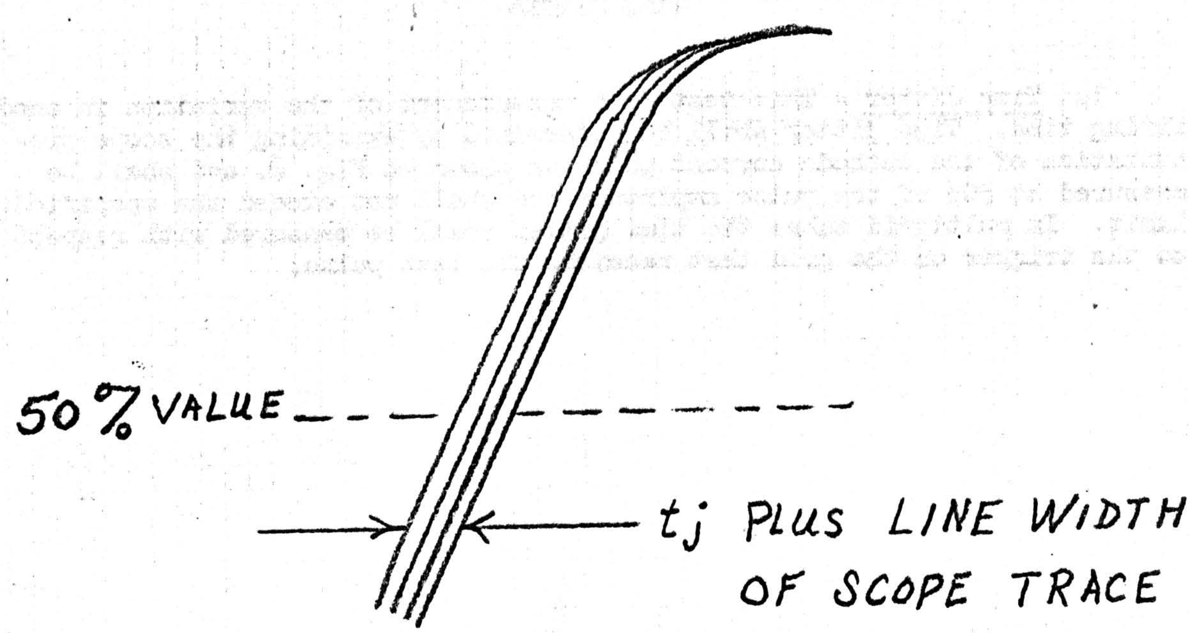
GRID PULSE (ANODE CONDUCTING)

FIG. 5

METHOD 6

TIME JITTER

1. Time Jitter - This test is a measurement of the variation in anode firing time. Time jitter shall be determined by examining the scope presentation of the cathode current pulse as shown on Fig. 6, and shall be measured at 50% of the pulse amplitude and shall not exceed the specified limit. In multigrid tubes the time jitter shall be measured with respect to the trigger on the grid that receives the last pulse.



CATHODE CURRENT PULSE
(LEADING EDGE) - TIME JITTER

FIG. 6

METHOD 7

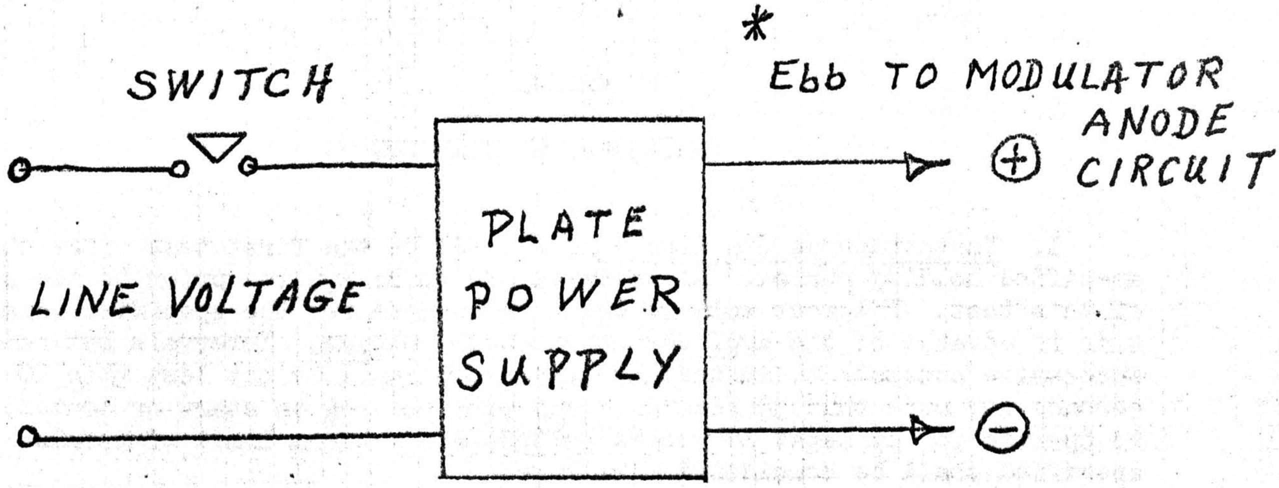
INSTANTANEOUS STARTING

1. Instantaneous Starting - This shall be the first test after the specified holding period. No voltages are to be applied prior to the start of this test. Filament voltage shall be applied for the specified warmup time in advance of the application of anode voltage. Intervals between successive attempts to instantaneously start shall be not less than 10 seconds nor more than 30 seconds. Any tube failing to start or continue to operate for at least 10 seconds within the maximum limit of trials specified shall be considered a failure.

a. AC Instantaneous Starting - The thyratron shall operate on AC instantaneous starting as shown on Fig. 7 with the time of rise of anode voltage as required in the tube specification sheet.

b. DC Instantaneous Starting - The thyratron shall operate when the DC anode voltage is applied instantaneously, as shown on Fig. 7A.

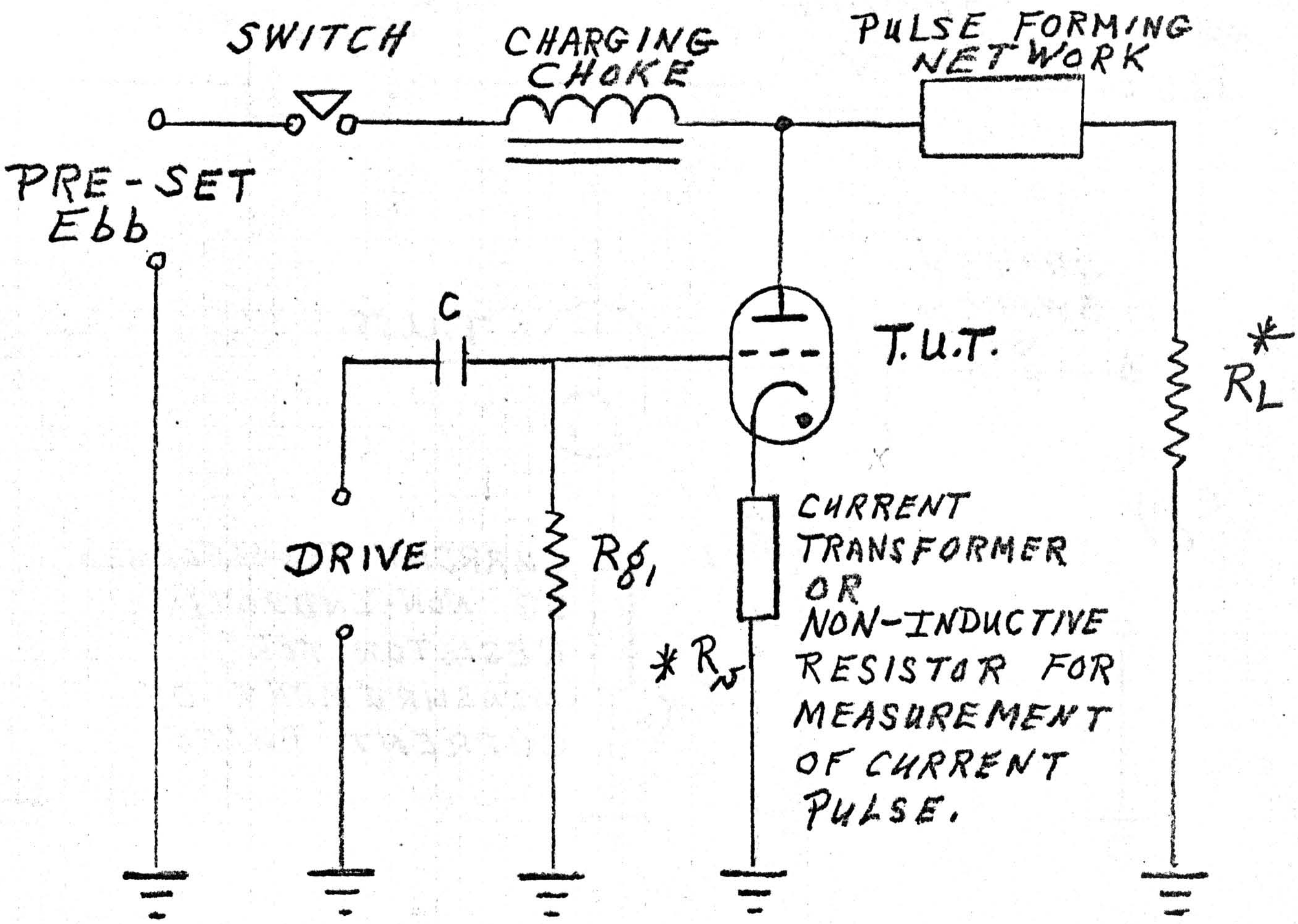
c. Control Grid Instantaneous Starting - The anode voltage shall be applied simultaneously with the heater voltage. The tube shall operate continuously for at least 60 seconds after the first application of grid drive as shown on Fig. 7B.



BASIC CIRCUIT FOR AC INSTANTANEOUS STARTING.

* PRE-SET Ebb TO VOLTAGE PRESCRIBED IN TSS.

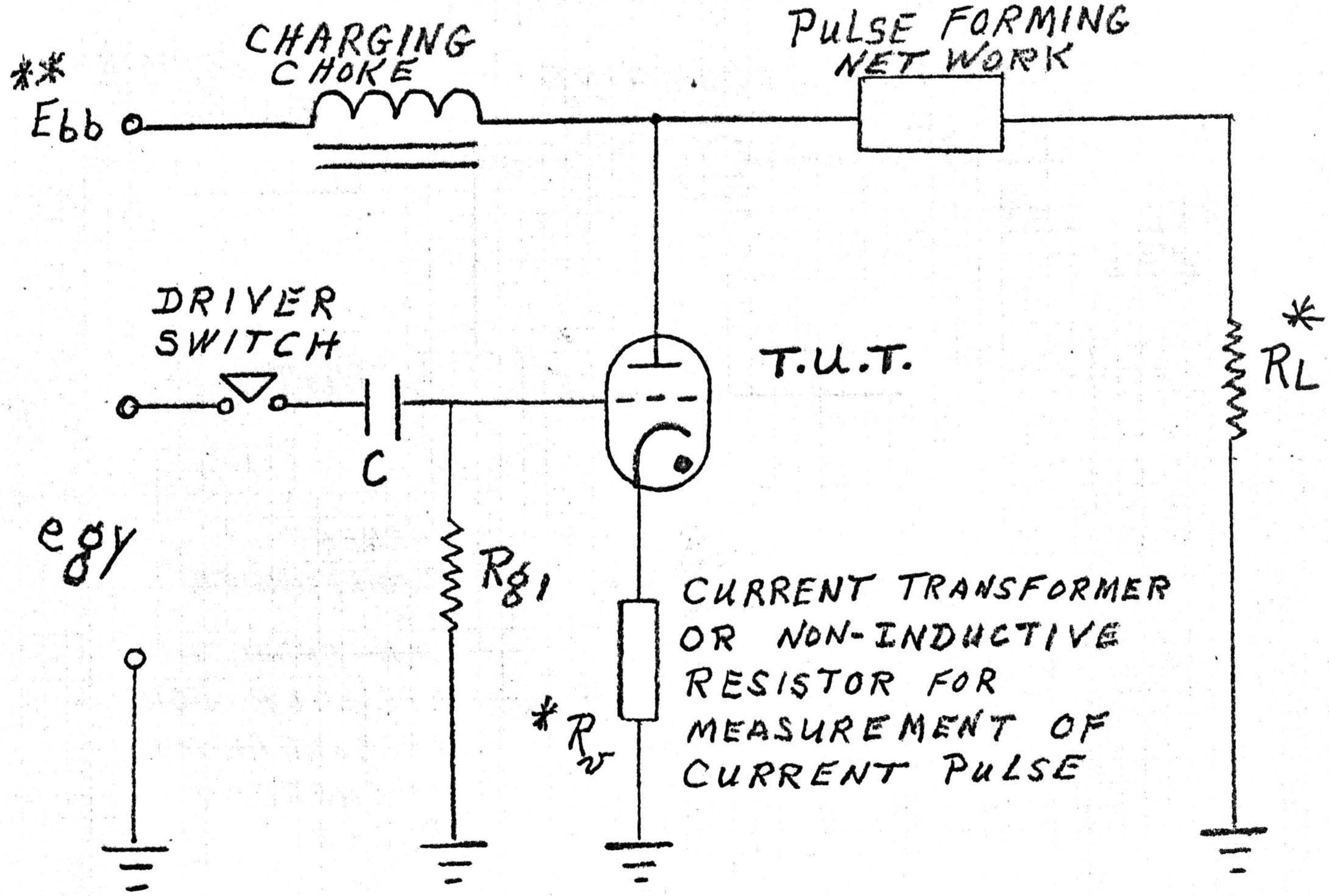
FIG. 7



* INCLUDE R_v AS PART OF R_L

BASIC CIRCUIT FOR DC INSTANTANEOUS STARTING

FIG. 7A



* INCLUDE R_v AS PART OF R_L

** PRESET E_{bb} TO VOLTAGE PRESCRIBED IN TSS

BASIC CIRCUIT FOR CONTROL GRID INSTANTANEOUS STARTING.

FIG. 7B

METHOD 8

OPERATIONAL TESTS

1. Operation for Modulators, Gas-Filled - During operation tests, the specified number of breakdowns will not be exceeded and there shall be no evidence of detrimental anode heating.

2. Reservoir Tubes with Adjustable Reservoir Heater Voltage - Such tubes shall be operated at the specified reservoir heater voltage value as marked on the tube.

3. Reservoir Tubes (Reservoir connected internally) - Such tubes shall be operated at the specified heater voltage.

4. Critical Anode Voltage for Conduction - This test shall be performed in the same circuit as the correspondingly numbered operation test and within 60 seconds following the conclusion of the operation test. Under the conditions specified, the anode voltage shall be increased until the tube starts to conduct current. The DC anode voltage required shall be within the limits specified on the tube specification sheet.

5. Elevated Ambient Temperature Tests - Elevated ambient temperature tests shall be made at the specified operating conditions and ambient temperatures. No more than three breakdowns are permitted during the entire operating period.

(a) Tubes without reservoirs shall be operated at the Bogie Filament Voltage for the entire operating period.
(b) Tubes with reservoirs tied directly across the heater shall be operated at the upper limit for heater voltage for the entire operating period.
(c) Tubes with a separate reservoir lead shall be operated at the high end of the reservoir range.

6. Optimum Reservoir Voltage - This test is performed to determine compliance with the reservoir voltage when marked. The procedure for the test shall be as follows:

(a) Set up the trigger and anode circuits for operation under operation test conditions.
(b) Set the reservoir voltage at the marked value minus 5 percent.
(c) After the specified warmup period, apply the trigger voltage to the grid of the tube. Start the plate at the minimum position of the voltage control and raise the voltage until the specified epy has been reached.

(d) The tube shall operate continuously for 30 minutes without evidence of arc-back or anode heating.

(e) Turn-off trigger voltage and plate voltage and readjust reservoir voltage to marked value plus 5 percent. Allow tube to stand under these conditions for the specified warmup period.

(f) Repeat (c) and (d) as above.

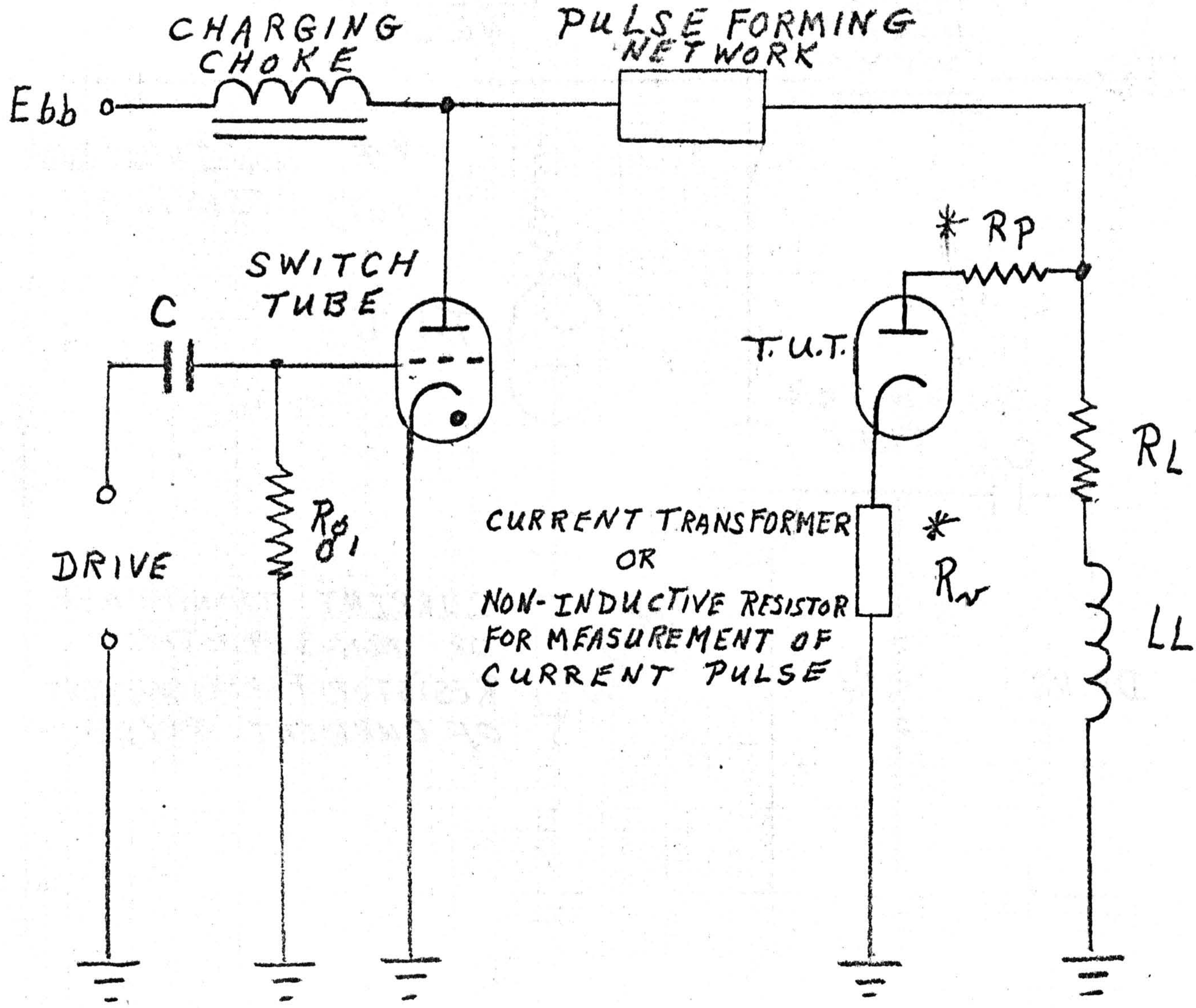
The value marked on the base shall be within the limits specified on the TSS.

7. Operation Tests for Pulse Transformer Backswing Diodes, High Vacuum and Gas-Filled - Pulse transformer backswing diodes shall be tested in a thyratron modulator circuit, as shown on Fig. 8 under the specified circuit conditions.

8. Operation Tests for Line Clipper Diodes, High Vacuum and Gas-Filled - Clipper tubes shall be tested in a thyratron modulator circuit as shown on Fig. 8A under the specified circuit conditions.

9. Operation Tests for Pulse Transformer Backswing Triodes, Gas-Filled - Gas-filled pulse transformer backswing triodes shall be tested in a thyratron modulator circuit as shown on Fig. 8B under the specified circuit conditions.

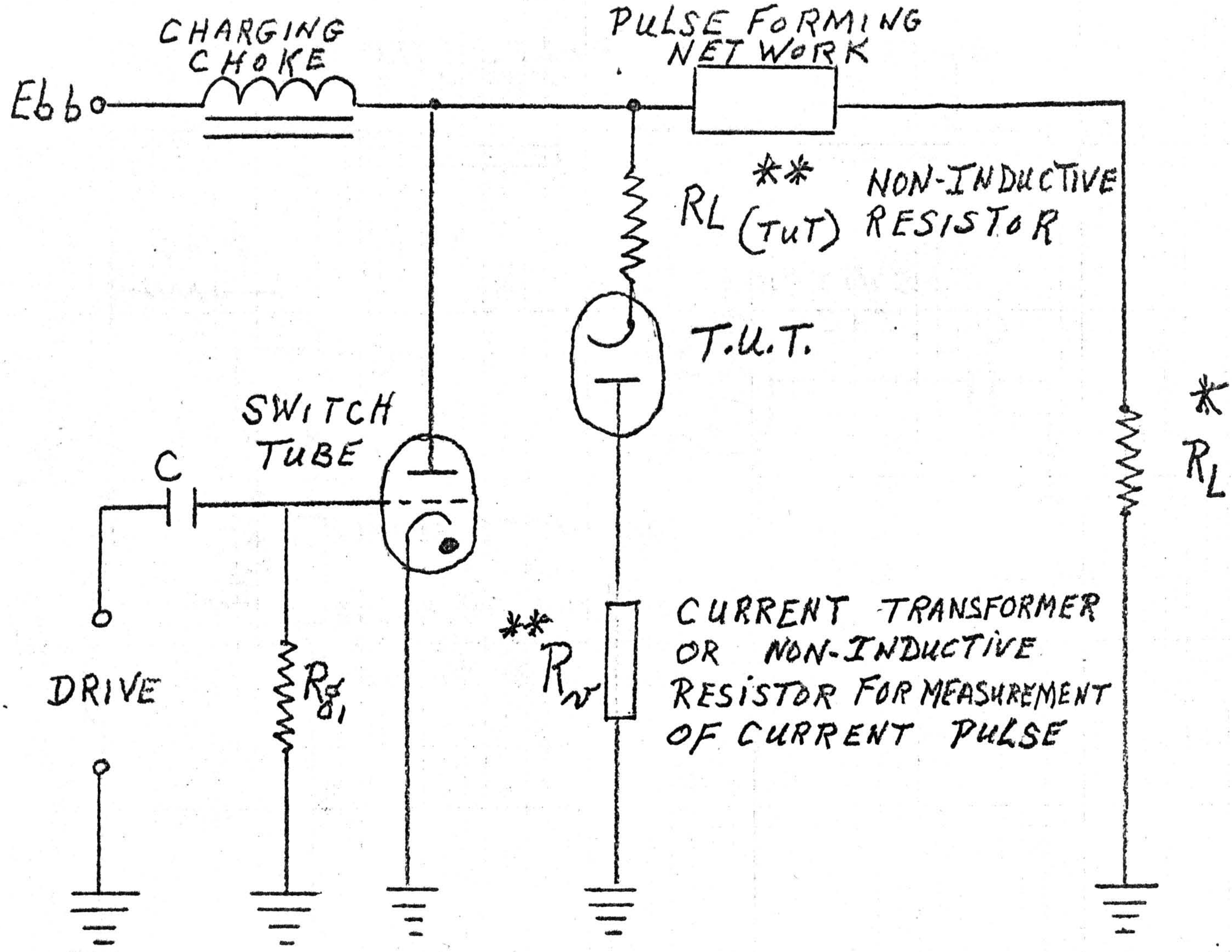
10. Operation Tests for Clipper Triodes, Gas-Filled - The modulator anode circuit parameters on Fig. 8C shall be as specified and shall be obtained without a clipper tube. The ratio of clipped to unclipped spike voltage shall not exceed 0.3.



BASIC PULSE TRANSFORMER BACKSWING DIODE, TEST CIRCUIT.

* INCLUDE R_v AS PART OF R_p

FIG. 8

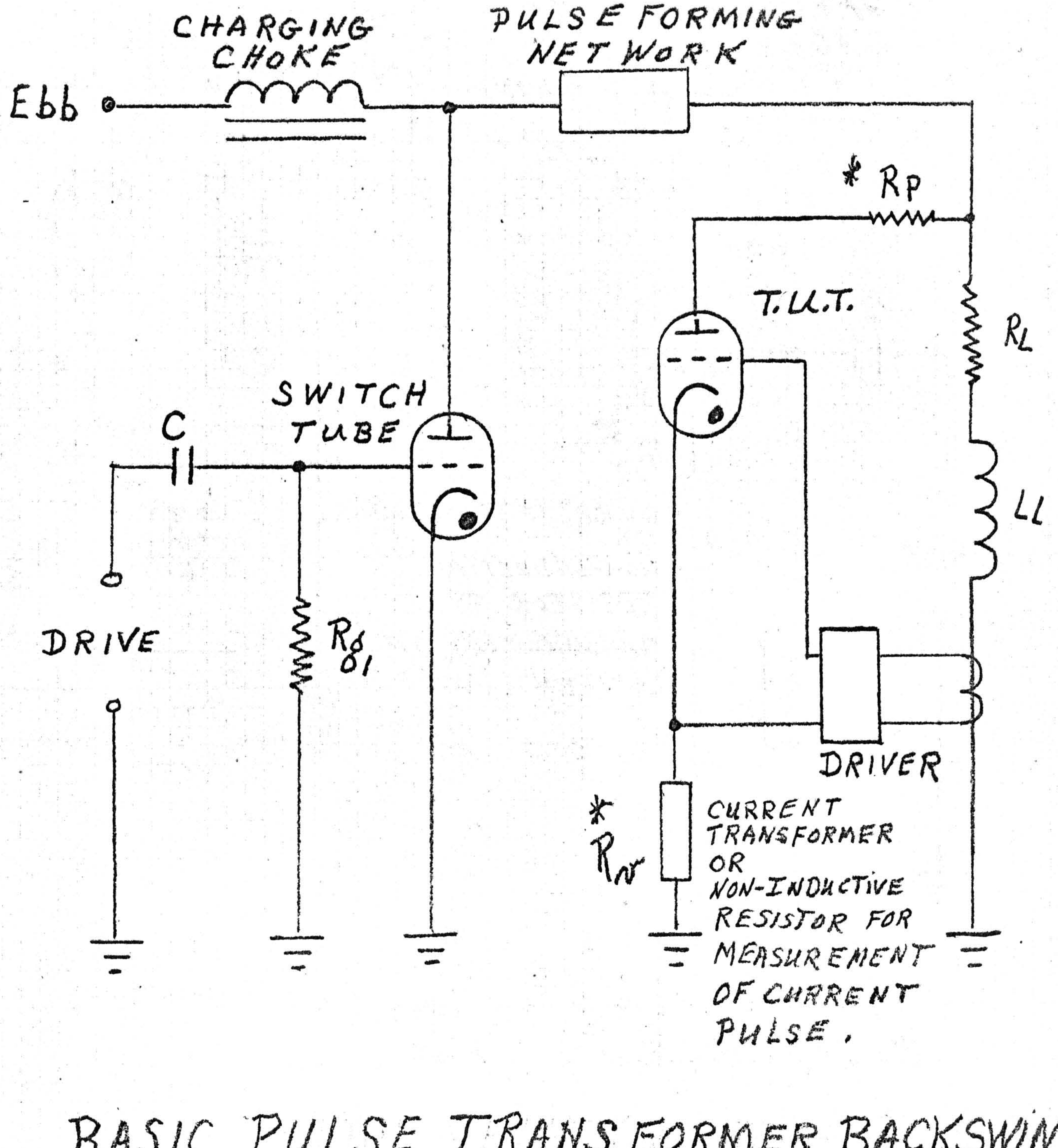


BASIC CIRCUIT FOR LINE CLIPPER DIODES.

* SEE TSS FOR DEGREE OF MISMATCH

** INCLUDE R_v AS PART OF R_L (TUT)

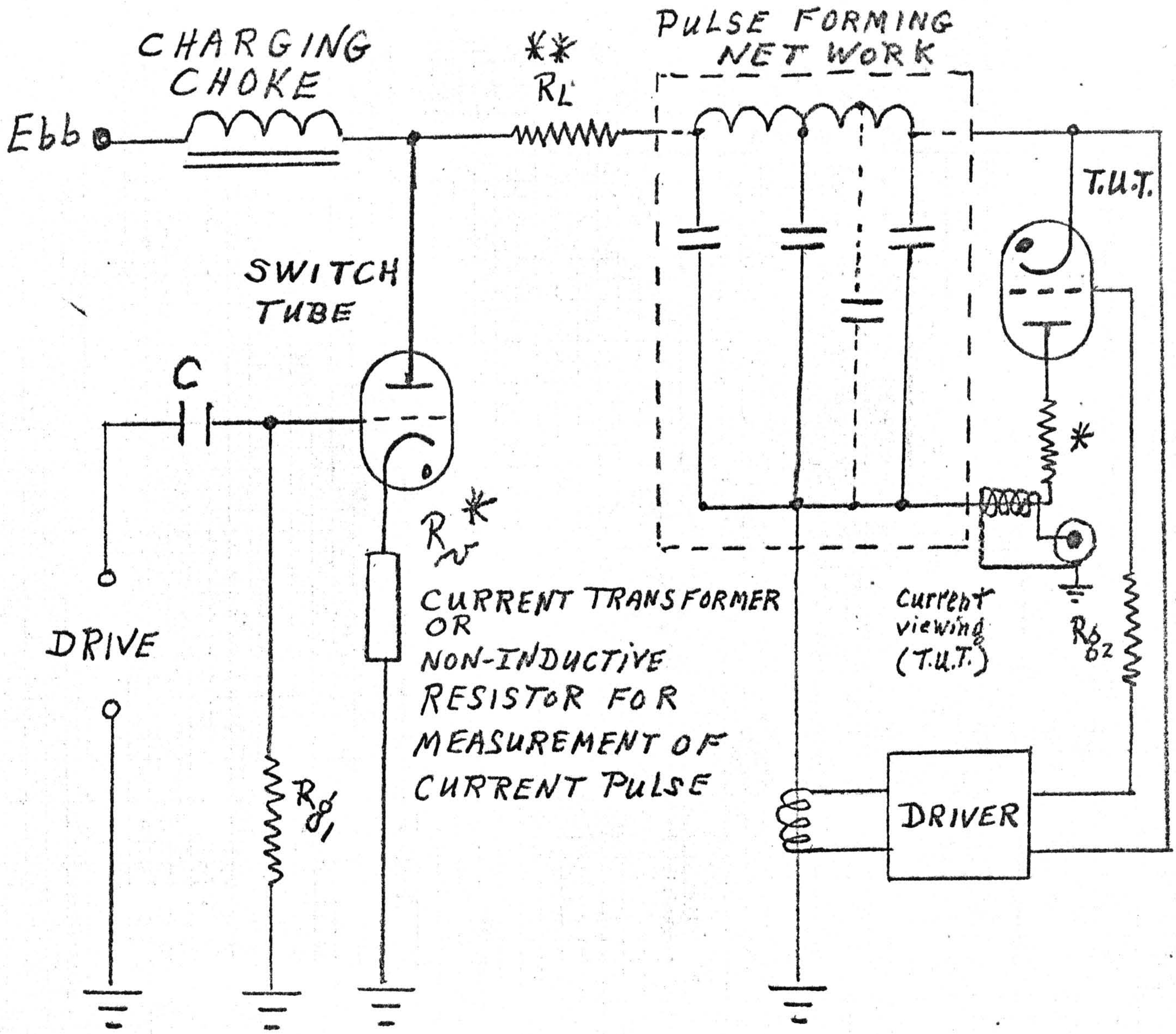
FIG. 8A



BASIC PULSE TRANSFORMER BACKSWING TRIODES, GAS FILLED, TEST CIRCUIT

* INCLUDE Rn AS PART OF Rp

FIG. 8B



* CLIPPER LOAD ≈ Z_{NET} (NON-INDUCTIVE).

** INCUDE R_v AS PART OF R_L

BASIC CIRCUIT FOR END OF LINE TRIODE CLIPPER, GAS FILLED.

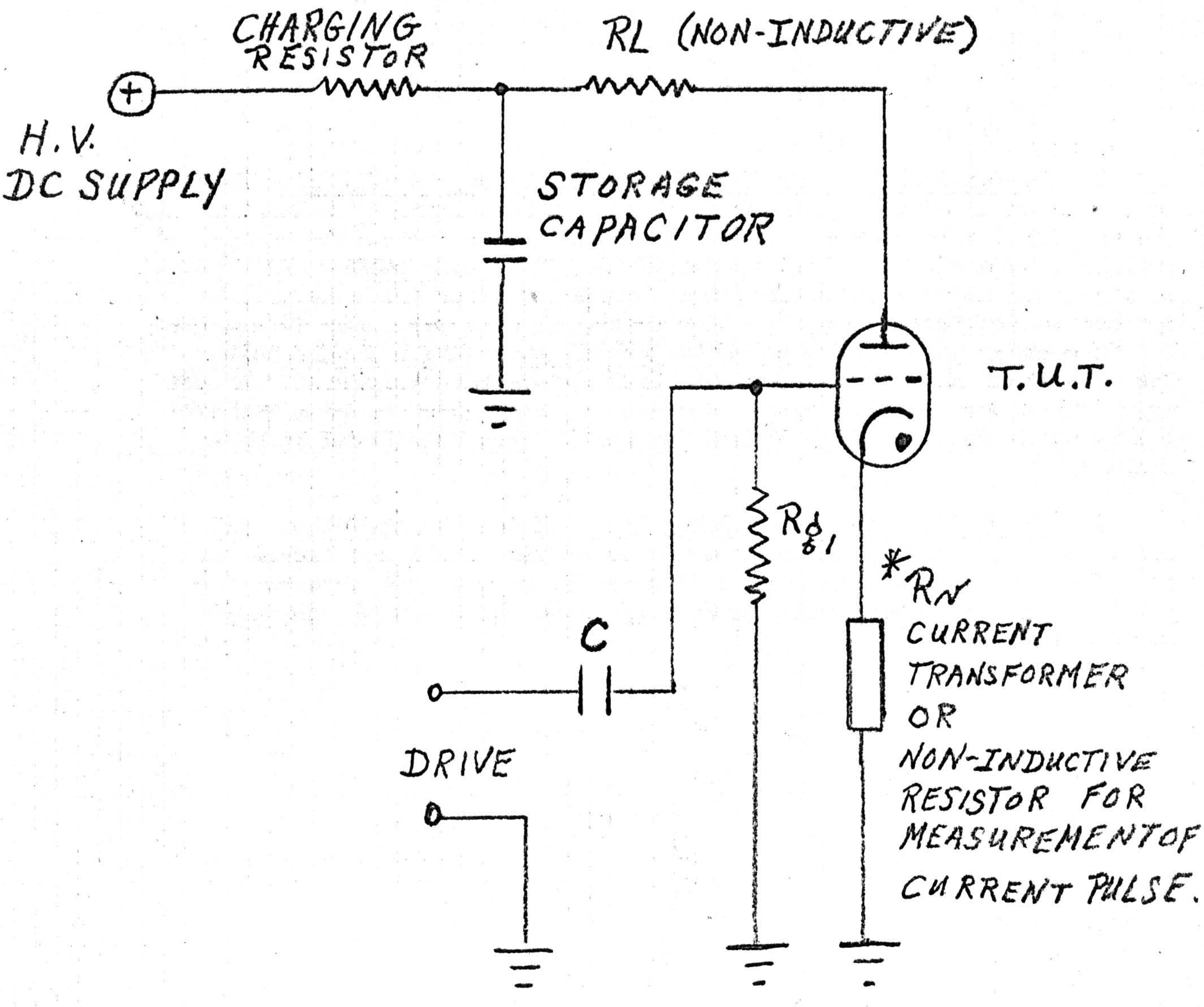
FIG. 8C

METHOD 9

ENERGY DIVERTER OPERATION TESTS

1. Operation Tests for Energy Diverter Tubes, Gas-Filled - In the test circuit as shown on Fig. 9 the anode voltage shall be maintained at the specified value for 2 minutes. The tube under test will then be triggered by a single pulse, as specified. The anode voltage will then be increased 20% and maintained for 30 seconds after which it will be reduced to its former value and maintained at this value for 30 minutes. The tube under test will then be triggered again with a single pulse. The tube shall not fire during this test except when triggered. A tube which fires once without being triggered is considered to be a failure. A tube which does not fire when triggered is also considered to be a failure.

2. Energy Diverter Anode Delay Time - Under the operation test conditions, the energy diverter anode delay time shall not exceed the specified value. The anode delay time shall be measured from the 26% point of the unloaded single pulse trigger to the start of the anode current pulse.



BASIC ENERGY DIVERTER THYRATRON OPERATION TEST CIRCUIT.

* INCLUDE R_N AS PART OF R_L

FIG. 9

METHOD 10

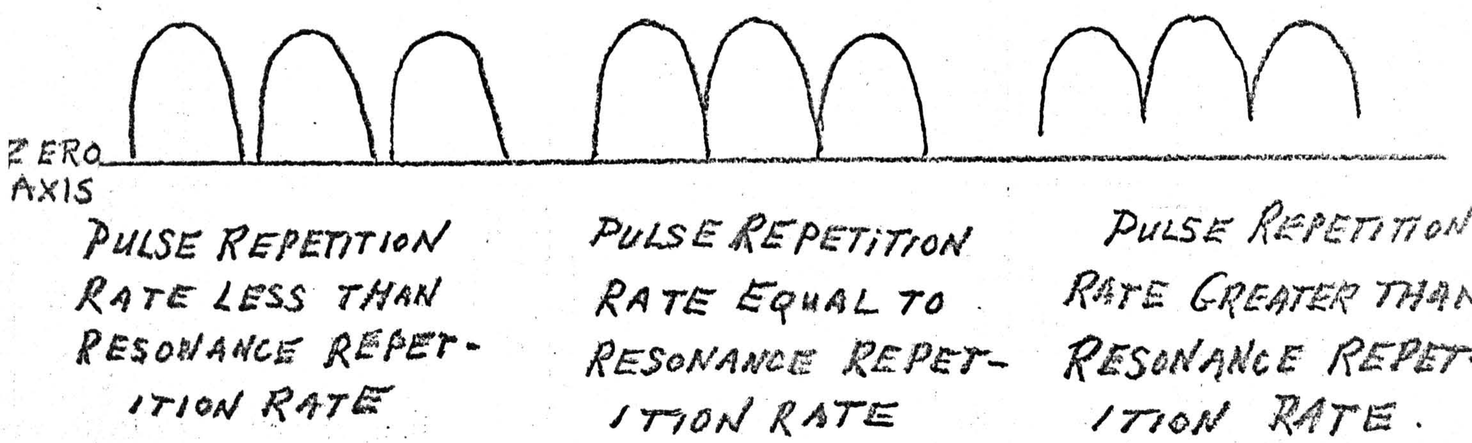
OPERATION TEST FOR HIGH VACUUM MODULATORS

1. Operation Test for Modulators, High Vacuum - The electrical potentials specified on the tube specification sheet shall be applied to the tube. Sufficient negative grid voltage shall be applied to cut off the plate current. The cathode shall be preheated for the specified warmup time before grid pulse is applied. The duration of the test, excluding preheating, shall be as specified. The grid pulse (in time duration, excluding time of rise and time of fall) shall be as specified. There shall be no evidence of arcing during the last half of this test.

METHOD 11

RESONANT prr

1. Resonant prr shall be measured by examining the charging-current waveforms on an oscilloscope. Tests performed at repetition rates less than the resonant rate shall be made with a hold-off diode in the charging circuit. The resonant pulse recurrence rate is determined as the repetition frequency at which the falling edge of one charging cycle and the leading edge of the next charging cycle just meet at the zero current axis, forming a sharp cusp. The conditions of the charging circuit for pulse recurrence rates less than, equal to, and greater than, the resonant pulse recurrence rate are shown on Fig. 11. (Caution: The plate circuit conditions are specified only for the purpose of determining circuit constants).



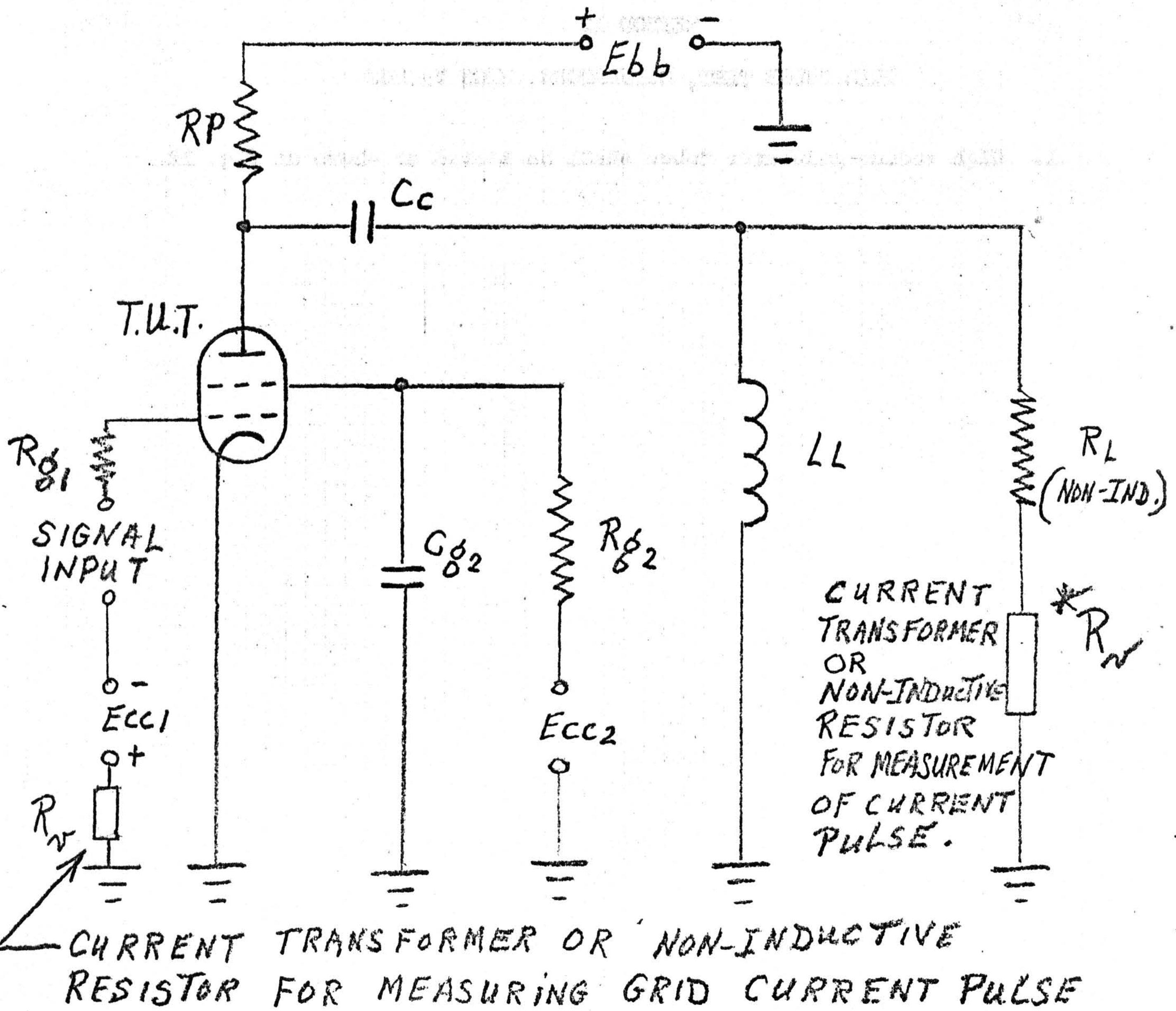
PULSE RECURRENCE RATES

FIG. 11

METHOD 12

GRID PULSE TEST, MODULATORS, HIGH VACUUM

1. High vacuum modulator tubes shall be tested as shown on Fig. 12.



GRID PULSE TEST, MODULATOR TUBES, HIGH VACUUM.

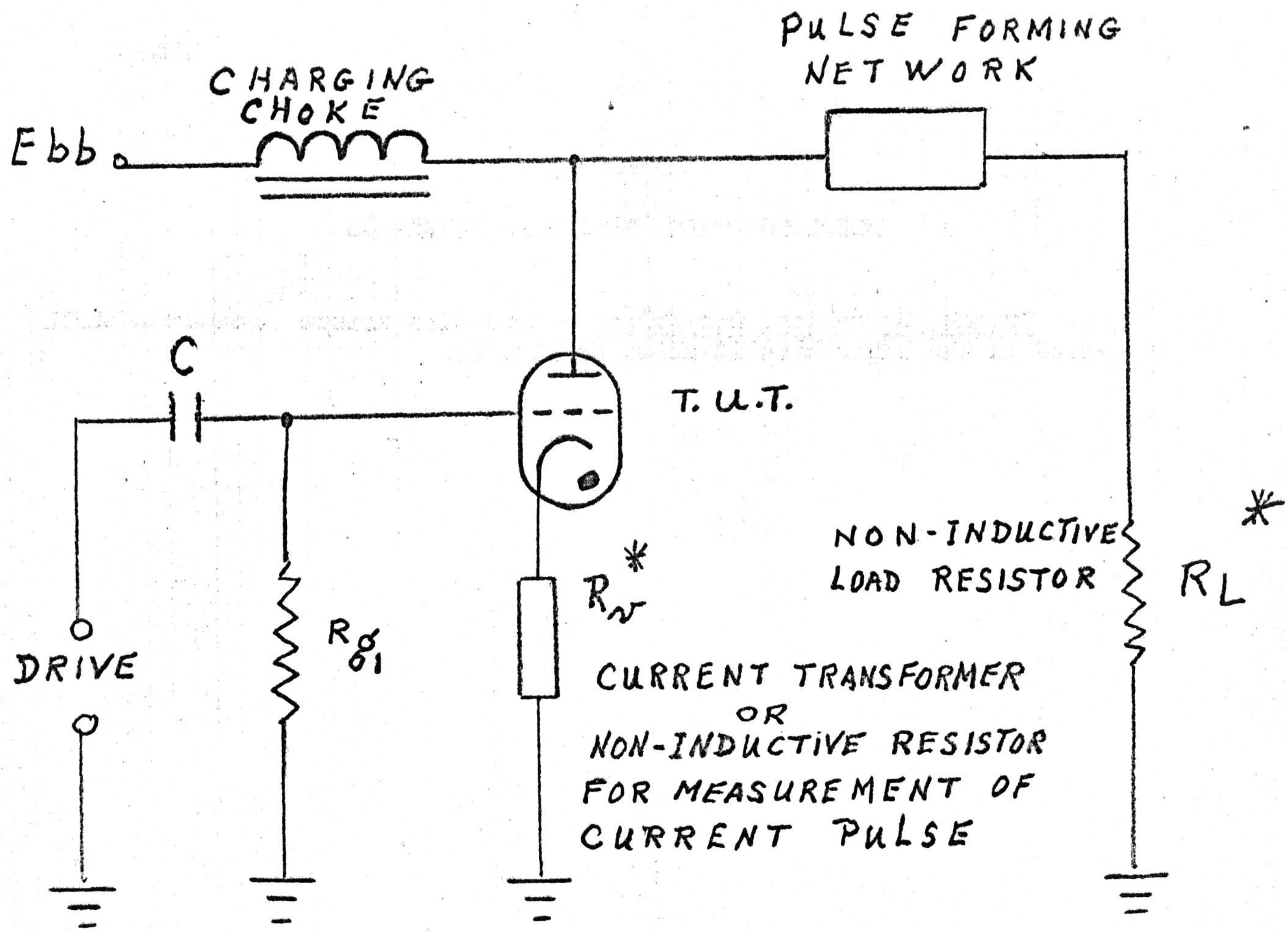
* INCLUDE R_v AS PART OF R_L

FIG. 12

METHOD 13

MODULATOR TEST, ZERO BIAS THYRATRON

1. Triode, Zero-Bias, Gas-Filled - Zero-Bias triode thyratrons shall be tested in the basic circuit shown on Fig. 13.



* INCLUDE R_v AS PART OF R_L

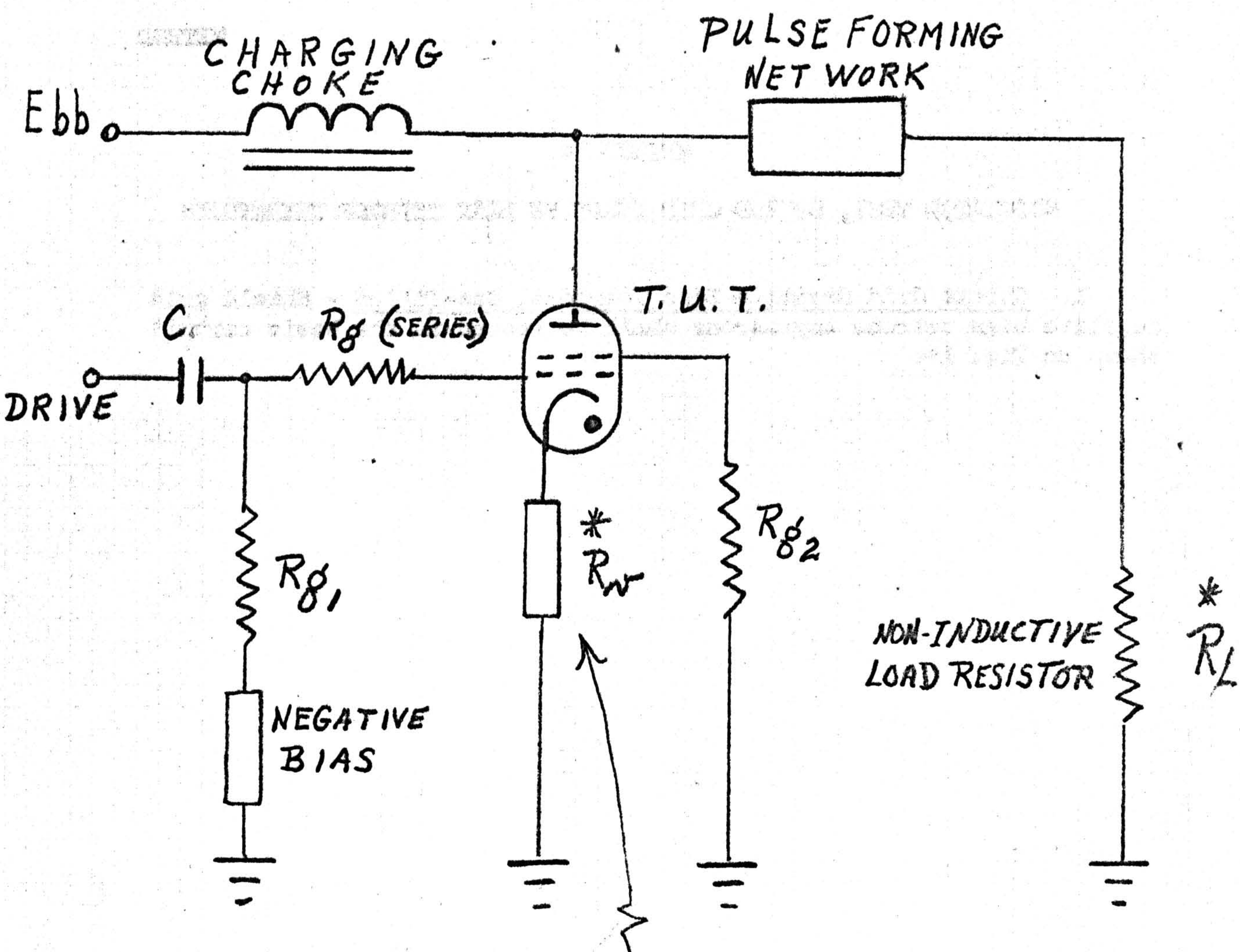
BASIC MODULATOR TEST CIRCUIT FOR ZERO BIAS THYRATRONS

FIG. 13

METHOD 14

MODULATOR TEST, SHIELD GRID NEGATIVE BIAS TETRODE THYRATRONS

1. Shield Grid Negative Bias Tetrodes, Gas-Filled - Shield grid negative bias tetrode thyratrons shall be tested in the basic circuit shown on Fig. 14.



* INCLUDE R_w as PART OF R_L

CURRENT TRANSFORMER
OR
NON-INDUCTIVE RESISTOR FOR MEASUREMENT OF CURRENT PULSE

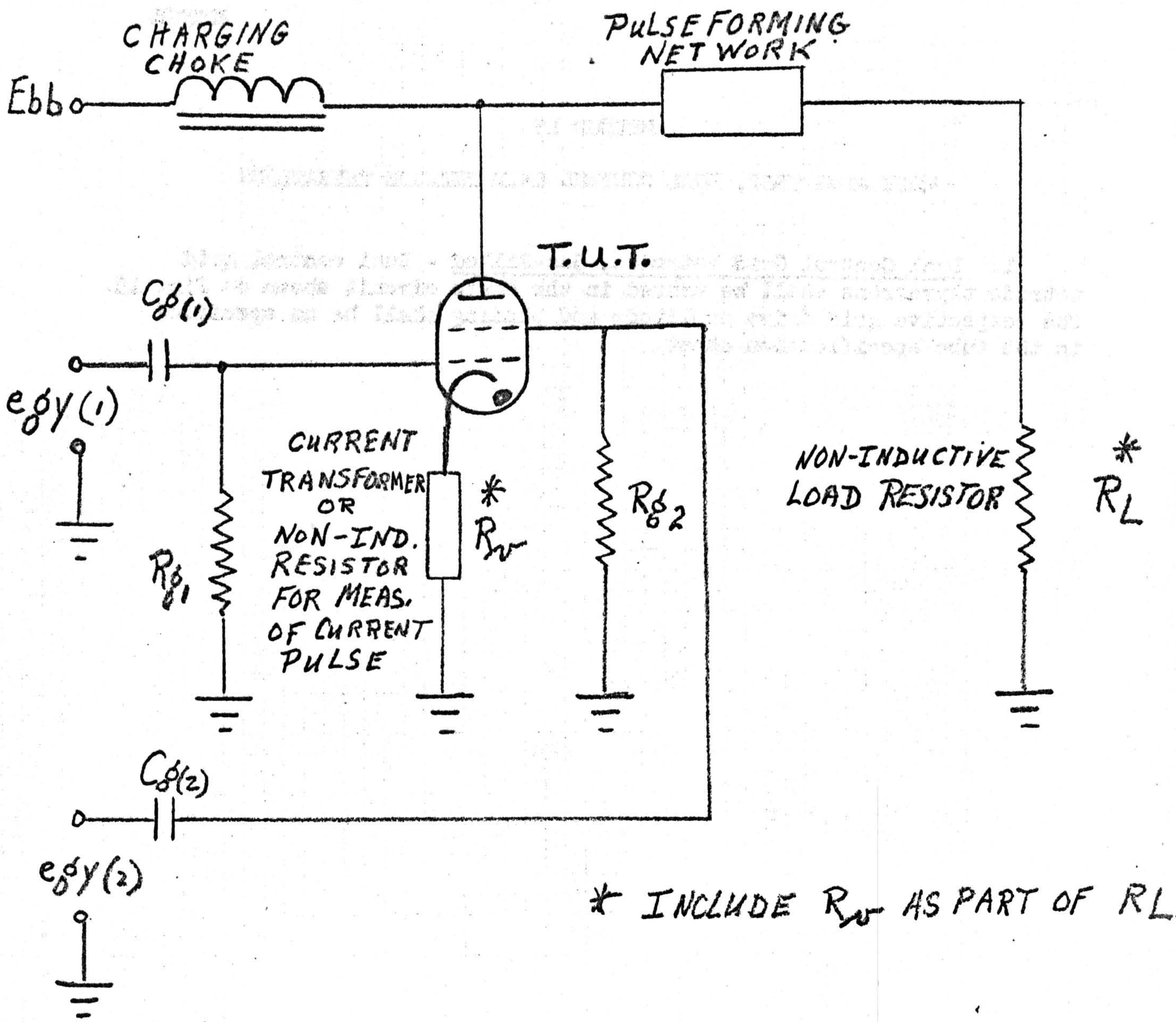
BASIC MODULATOR CIRCUIT FOR SHIELD GRID NEGATIVE BIAS TETRODE THYRATRONS.

FIG. 14

METHOD 15

MODULATOR TEST, DUAL CONTROL GRID TETRODE THYRATRONS

1. Dual Control Grid Tetrodes, Gas-Filled - Dual control grid tetrode thyratrons shall be tested in the basic circuit shown on Fig. 15. The respective grid drive amplitude and phasing shall be as specified in the tube specification sheet.



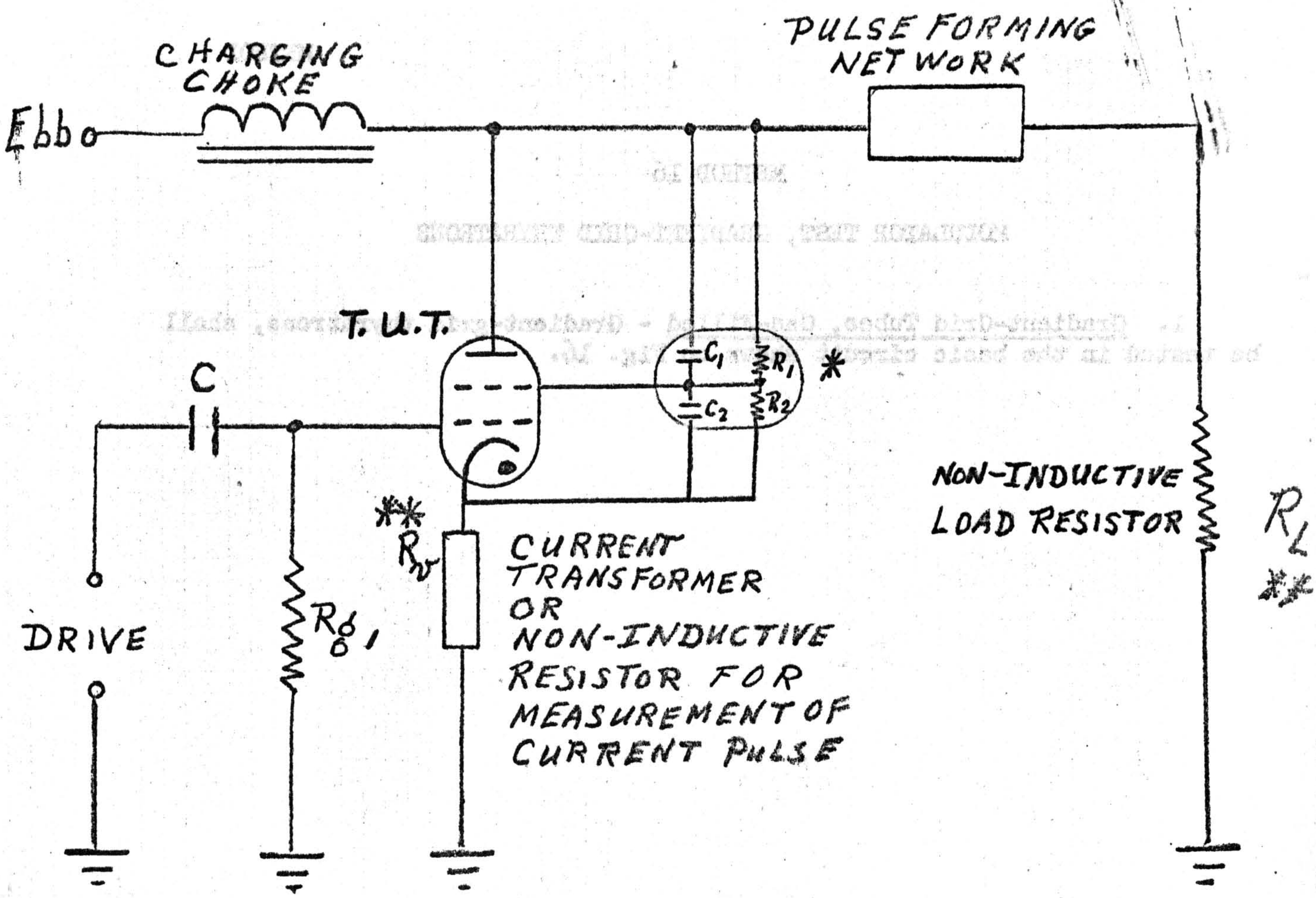
BASIC MODULATOR CIRCUIT FOR DUAL CONTROL GRID SWITCH TUBES

FIG. 15

METHOD 16

MODULATOR TEST, GRADIENT-GRID THYRATRONS

1. Gradient-Grid Tubes, Gas-Filled - Gradient-grid thyratrons, shall be tested in the basic circuit shown on Fig. 16.



* THE VALUES OF R_1, R_2, C_1, C_2, IF REQUIRED, SHALL BE AS INDICATED IN THE TUBE SPECIFICATION SHEET (TSS).

** INCLUDE R_v AS PART OF R_L

BASIC MODULATOR CIRCUIT FOR GRADIENT GRID SWITCH TUBES.

FIG. 16