WPAG
WGUN Engineering Dept.
Ann Arbor, Michigan

# INSTRUCTIONS FOR CAT. 600 FM BROADCAST MODULATION AND FREQUENCY MONITOR EQUIPMENT.

RADIO ENGINEERING LABORATORIES, Inc.
LONG ISLAND CITY 1, N. Y., U. S. A.

INDEX

COVERING INSTRUCTIONS

FOR

CAT. 600 FM BROADCAST MODULATION AND FREQUENCY MONITOR EQUIPMENT. Art-9-32

SECTION 1.

INSPECTION OF RECEIVED MATERIAL
RE-ASSEMBLY OF PARTS REMOVED FOR
SHIPMENT - CLAIMS FOR BREAKAGE
IN SHIPMENT.

1. INSPECTION OF RECEIVED MATERIAL

Received material should be carefully inspected at the time of uncrating for evidence of damage or breaking due to careless handling in transit. Care and good sense should be used in the process of unpacking or uncrating the equipment. Hasty use of improper tools such as crowbars, etc., may easily result in damage to the enclosed equipment. Be sure to note and follow externally marked instructions such as, "This End Up" or "Open This End", etc. All equipment is carefully packed at the factory to insure safe delivery with reasonably careful handling. When removing items from packing material check item by item against the enclosed packing list for errors or short shipment.

2. RE-ASSEMBLY OR PARTS REMOVED FOR SHIPMENT

Some items because of their composition, weight or fragility are removed from the equipment for shipment. These items will be found separately packed and should be reinstalled after the equipment has been set-up at its permanent position. Some such items are as follows and should be looked for where applicable.

a. Transformers, reactors where their weights exceed 75 to 100 lbs.

b. Resistors, vitreous or glass stick type sizes over 25 watts where mounting is by means of plug-in ferrule terminals.

c. Vacumn tubes, all types and sizes except some small receiving types held in locking type sockets.

d. Dash pot oil, for timing relays of that type.

e. Plug-in type radio frequency inductors

f. Crystals - radio frequency control type

g. Microphones, telegraph keys, earphones, etc.

h. Portable test equipment and safety devices such as "Dead Man Sticks."

These items where applicable should be reinstalled in their proper position. All items have identifying marks or tags placed on them and similar marked tag at their correct mounting position. When position is not obvious, instructions as to their proper installment and place will be found in Section 2 of this Instruction Manual.

Loose items such as flexible grid and plate leads and armatures of contactors will be found securely tied to stationary members in the equipment. These should obviously be freed prior to installation of vacuum tubes and application of power.

3. CLAIMS FOR BREAKAGE IN SHIPMENT

In cases of damage to equipment due to faulty handling in shipment, notify carrier immediately leaving broken or damaged item or items exactly as found in package. Do not destroy or remove any of the wrappings or protective material involved in the wrapping of the damaged item. Carrier companies will not accept claims for "Damage in Shipment" unless they can inspect the damaged item and its associated packing material. Claims must usually be made within five days of receipt of shipment.

## SECTION II

## GENERAL DESCRIPTION OF EQUIPMENT FOR CAT. #600 FM BROADCAST MODULATION AND FREQUENCY MONITOR EQUIPMENT.

A 1. General Description:-

The REL Cat.600 FM Broadcast Modulation and Frequency monitor provides means of continuous monitoring of both instantaneous percentage of Modulation in either direction and average carrier frequency. The monitor is completely crystal controlled and designed to operate on any one frequency in the band of from 88.1 to 107.9 megacycles. It is furnished completely aligned with crystals for operation on ONE specified frequency in the above band.

Also included is an over-modulation alarm which may be accurately adjusted to flash at some preset modulation level in the range of from 50 to 120% modulation.

2. Assembly and Installation:-

Tubes and crystals removed for shipment should be reinstalled. Particular attention should be paid to insure correct placement of individual tubes. Each tube will be found to have a symbol number marked upon it. TUBES MUST BE REPLACED IN THE SOCKETS HAVING CORRESPONDING SYMBOL DESIGNATIONS. LIKEWISE WITH CRYSTALS.

It is recommended that the equipment be permanently installed near enough to the transmitter so that the connecting coaxial cable will not exceed 50 feet in length.

3. Primary Power Connection:-

115 volt 60 cycle power should be brought into terminals #9 and #10 on the rear of the main chassis. This line should be "ALIVE" 24 hours a day so that the two crystal ovens which connect to the line prior to the "POWER" switch will be energized continuously.

4. Input Connections:-

RF input to monitor is made to jack J-1 located at the rear of the main chassis. A 50 or 70 ohm solid dielectric cable with vinyl jacket is recommended. Standard cable connectors are furnished with equipment.

RF input requirements for satisfactory performance are, Normal 10 volts RMS, minimum 8 volts, maximum 30 volts into 50 ohm termination. Means should be provided at the transmitter end to insure that once set the input level to the monitor is constant.

A 5. Accessory data and connection of same:-

For connection of remote over-modulation alarm indicator, "MAKE" contacts are brought out to terminals #7 and #8 on rear of main chassis.

Audio output for aural monitoring may be obtained by connecting a 600 ohm terminated line between terminals #11 and #12 with #11 being at ground potential. Output level of ODBM for plus or minus 75 kc swing is obtained. This output includes 75 micro-second de-emphasis.

B 1. Circuit Description:-

The monitor consists of a very low sensitivity superhetrodyne receiver. The hetrodyning signal is derived from oven heated crystal Y-1 at approximately 4 mc. and multiplied either 9 or 12 times in second half of V-4 and V-14. Injection is to signal grid of V-1, which junctions as a high level limiting mixer.

The I.F. operates at 10.7 megacycles. V-2 is a limiter driver whose output is controlled by front panel control marked "RF GAIN". This control varies V-2 screen voltage.

Frequency modulation detector comprises transformer assembly Z-2 and duo-diode V-3. The average carrier frequency indicator is a zero center 100 uA instrument in the common diode return. During modulation equal and oppositely poled audio voltages appear across R-7 and R-8. Input from these voltages to the % modulation indicator is selected by switch S-1 which is the front panel control marked "MOD UP" "MOD DOWN".

The % modulation indicator consists of amplifier V-12 rectifier and D.C. amplifier V-13.

V-7 a thyratron, serves as threshold alarm tube having its control grid voltage derived from D.C. amplifier V-13.

The auxilary audio amplifier V-6 is provided for aural monitoring purposes and is preceded by the standard 75 micro-second de-emphasis.

Oven heated crystal Y-2 and oscillator tube V-5 operates at one half the I.F. and serves as a calibrator for the FM detector circuit.

The associated power supply is of conventional full wave type using electronic voltage regulation.

C 1. Operational Adjustments:-

WARNING Before turning on power see that the 100 ohm safety shunt resistor is in place across terminals #13 and #14. Do not remove until instructed to do so in the alignment steps.

C 1. Operational Adjustments:-(Continued)

STEP 1. Connect 115 volt 60 cycles to terminals #9 and #10 with switch marked "POWER" off. Lights on zero center meter will light and will flicker showing operation of oven heaters after several minutes at room ambient.

STEP 2. Set control marked "ALARM SET" at full clockwise, "CAL"-"OPER" at "OPER" and "ALARM CAL" at full counter-clockwise past switch point, turn on "POWER".

STEP 3. using a 0-1 MA milliameter (negative tip) plug in jack located a left hand end of front sub-panel. Slowly increase coupling to transmitter tank until meter reads 0.5 MA. - If any doubt exists check output of cable at monitor end of line with a VTVM loading the cable with 50 ohms capable of dissipating about 5 watts.

STEP 4. Set "CAL OPER" to "CAL 2" and adjust "DET CAL" carefully to make zero center meter read 0.

STEP 5. Set "CAL OPER" to "OPER". Meter should read less than plus or minus 200 cycles if transmitter is within plus or minus 2000 cycles of assigned frequency (due to 100 ohm safety shunt on rear terminals).

STEP 6. If so remove shunt, set "CAL OPER" to "CAL 1" and adjust "RF GAIN" to make zero center meter read ~~2000~~ +1825 cycles.

STEP 7. Repeat procedure outlined in Steps 4 and 5. Do not disturb "RF GAIN" setting unless input to monitor is changed. If it is changed, readjust as in STEP 3 for reading of 0.5 MA tolerance, - 0.1 MA, plus 0.3 MA, repeating STEPS 6, 4 and 5 in that order.

STEP 8. To set over-modulation alarm, set "CAL OPER" to "CAL 2", rotate "ALARM CAL" clockwise until percent modulation meter reads desired alarm valve. Leaving the meter indicating this valve turn "ALARM SET" control counter clockwise until relay buzzes and alarm lamp flashes. "ALARM CAL" should now be returned to extreme counter-clockwise position (past switch) and "CAL OPER" turned to "OPER". Leave "ALARM SET" at position determined above.

STEP 9. Terminals #11 and #12 should be terminated in a resistance or impedance of about 600 ohms. This is the Aux. audio output. Terminal #11 at chassis or ground potential.

C 2. MISCELLANEOUS NOTES AND WARNINGS:-

a. R-52 is zero set for percent modulation meter in case V-13 is changed.

b. R-46 is sensitivity adjustment of percent modulation meter and must be set AFTER R-52 using accurately known transmitter swing (plus or minus 75 kc equal 100%).

(Small black mark near right hand end of % modulation scale is set at)
(133 1/3% modulation or plus or minus 100 kc swing )

PARTS LIST CAT. #600 FM BROADCAST FREQUENCY AND MODULATION MONITOR

| SYMBOL REF. | REL PART NO | DESCRIPTION |
|---|---|---|
| C-1 | C-5047-S1 | Capacitor - fixed, mica, .001 mfd. 500 VDCW, 20% accuracy |
| C-2 | C-5000-M5 | Capacitor - fixed, ceramic, 1200 mmfd. 300 VDCW, 20% accuracy. |
| C-3 | C-5171-S1 | Capacitor - fixed, mica, .006 mfd. 500 VDCW, 20% accuracy |
| C-4 | | Capacitor - Part of Z-1 Assembly |
| C-5 | | Capacitor - Part of Z-1 Assembly |
| C-6 | | Capacitor - Part of Z-1 Assembly |
| C-7 | | Capacitor - Part of Z-1 Assembly |
| C-8 | C-5013-S1 | Capacitor - fixed, mica, 220 mmfd. 500 VDCW, 20% accuracy |
| C-9 | | Capacitor - Same as C-3 |
| C-10 | | Capacitor - Part of Z-2 Assembly |
| C-11 | | Capacitor - Part of Z-2 Assembly |
| C-14 | | Capacitor - Part of Z-2 Assembly |
| C-15 | | Capacitor - Part of Z-2 Assembly |
| C-16 | C-5002-E5 | Capacitor - fixed, ceramic, 4.7 mmfd. 500 VDCW, 10% accuracy, zero coefficient. |
| C-17 | | Capacitor - Same as C-16 |
| C-18 | C-5009-H2 | Capacitor - variable, air, split stator, 5-36 sec. 2.5-18 mmfd. |
| C-19 | C-5175-C8 | Capacitor - fixed, mica, .005 mfd. 500 VDCW, 20% accuracy |
| C-20 | | Capacitor - Same as C-8 |
| C-21 | | Capacitor - Same as C-8 |
| C-22 | | Capacitor - Same as C-7 |
| C-23 | | Capacitor - Same as C-3 |
| C-24 | C-5172-S1 | Capacitor - fixed, silvered mica, .000047 mfd. 500 VDCW, 10% accuracy |

| SYMBOL REF. | REL PART NO. | DESCRIPTION |
|---|---|---|
| C-25 | C-5173-S1 | Capacitor - fixed, silvered mica, .00015 mfd. 500 VDCW, 10% accuracy |
| C-26 | C-5026-S5 | Capacitor - variable, air, trimmer type, 47 mmfd., .016" nominal spacing. |
| C-27 | | Capacitor - ~~Same as C-16~~ fixed, ceramic, 10mmfd. 500 VDC W., 10% accuracy, zero coefficient. |
| C-28 | | Capacitor - Same as C-3 |
| C-29 | | Capacitor - Same as C-26 |
| C-30 | | Capacitor - Same as C-2 |
| C-31 | C-5001-E5 | Capacitor - fixed, ceramic, 100 mmfd. 500 VDCW, 10% accuracy. |
| C-32 | | Capacitor - Same as C-31 |
| C-33 | | Capacitor - Same as C-3 |
| C-34 | | Capacitor - Same as C-26 |
| C-35 | C-5174-S1 | Capacitor - fixed, mica, .001 mfd. 500 VDCW, 5% accuracy |
| C-36 | C-5169-I4 | Capacitor - fixed, paper, oil filled, 0.25 mfd. plus 20%, minus 10%, 600 VDCW |
| C-37 | C-5168-I4 | Capacitor - fixed, paper, oil filled, 1.0 mfd. plus 20% minus 10%, 600 VDCW |
| C-39 | C-5167-I4 | Capacitor - fixed, electrolytic, plug-in, 20 mfd. 450 VDCW, 20% accuracy, metal can |
| C-40 | C-5166-I4 | Capacitor - fixed, electrolytic, plug-in, 40 mfd. 450 VDCW, 20% accuracy, metal can |
| C-41 | | Capacitor - Same as C-37 |
| C-42 | | Capacitor - Same as C-37 |
| C-43 | | Capacitor - Same as C-31 |
| C-44 | | Capacitor - Same as C-37 |
| C-45 | | Capacitor - fixed, paper, oil filled, 0.1 mfd. plus 20% minus 10%, 600 VDCW |

| SYMBOL REF. | REL PART NO | DESCRIPTION |
|---|---|---|
| C-46 | | Capacitor - Part of Z-2 Assembly |
| C-47 | | Capacitor - Same as C-3 |
| C-48 | | Capacitor - Same as C-3 |
| C-49 | | Capacitor - Same as C-31 |
| C-50 | | Capacitor - Same as C-2 |
| C-51 | | Capacitor - Same as ~~Same~~ C-3 |
| C-52 | | Capacitor - Same as C-3 |
| C-53 | | Capacitor - Same as C-2 |
| C-54 | | Capacitor - Same as C-2 |
| C-55 | | Capacitor - Same as C-2 |
| C-56 | | Capacitor - Same as C-2 |
| C-57 | | Capacitor - Same as C-3 |
| C-58 | | Capacitor - fixed, paper, 0.02 mfd. 200 VDCW, plus 20% minus 10% |
| F-1 | F-5000-L3 | Fuse - glass enclosed, 1 ampere, 250 volts |
| F-2 | F-5006-L3 | Fuse - glass enclosed, 2 ampere, 250 volts |
| I1 | I-5004-G2 | Lamp - pilot light, 115 volts, 6 watt, candleabra base |
| J-1 | J-5001-A5 | Jack, female contact, chassis mtg. type |
| J-2 | J-5014-C19 | Jack - phone type, single closed circuit, single hole |
| K-1 | K-5029-C17 | Relay - coil for 100 volts DC with 25 M.A. or less, two form A contact sections per relay |
| L-1 | L-5003-S5 | Coil, R.F. - Choke, 3.5 microhenries, DC resistance 1 ohm, integral type, single layer wound, unshielded. |

| SYMBOL REF. | REL PART NO | DESCRIPTION |
|---|---|---|
| L-2 | L-5028-M3 | Coil, radio - choke, inductance 2.5 millihenries, 15% accuracy, multiple pi, ceramic bobbin, wax impregnated |
| L-3 | L-5002-R7 | Coil, radio - heterodyne oscillator 1st, tripler, integral type, single winding |
| L-4 | L-5051-S5 | Coil, radio - oscillator plate tank |
| L-5 | | Coil, radio - tripler plate |
| L-6 | | Coil, radio - Same as L-4 |
| L-7 | L-5033-C14 | Choke, filter - 20 henries at 75 M.A. maximum DC resistance 1600 ohms, hermatically sealed |
| M-1 | M-5020-W3 | Meter - DC microammeter, zero center 50-0-50 microampere deflection, special scale and pointer, scale has 40 divisions and plus/minus 2000 cycles on the scale to correspond to plus/minus 50 microamps on the meter, 2% accuracy |
| M-2 | M-5027-W3 | Meter - DC microammeter - Movement 0 to 250 microamperes, 1400 ohms, scale as for Model 862 type 30B with 250 microamperes giving full scale (plus 3VU indication and with additional mark at a deflection corresponding to 133-1/3% modulation, damping factor within 16 to 200, time for one complete oscillation of the pointer is from 290 to 350 milliseconds, 2% accuracy |
| P-1 | P-5002-A5 | Plug - connector, coaxial, used with J-1 |
| R-1 | R-5199-S16 | Power measurement lamp - lock-in base, non-linear resistance. |
| R-2 | R-5125-A11 | Resistor - fixed, composition, 1000 ohms, 1/2 watt, 10% |
| R-3 | R-5034-I2 | Resistor - fixed, composition, 82,000 ohms, 1/2 watt, 10% |
| R-4 | R-5224-I2 | Resistor - fixed, composition, 20,000 ohms, 1/2 watt, 10% |
| R-5 | R-5197-I2 | Resistor - fixed, composition, 20,000 ohms, 1 watt, 10% |
| R-6 | R-5219-C6 | Resistor - variable, wire wound, 50,000 ohms, 10% accuracy, 3 watts dissipation at full resistance, linear taper |

| SYMBOL REF. | REL PART NO | DESCRIPTION |
|---|---|---|
| R-7 | R-5225-A11 | Resistor - fixed, composition, 510 ohms, 1/2 watt, 1% |
| R-8 | | Resistor - Same as R-7 |
| R-9 | R-5203-A11 | Resistor - fixed, composition, 6200 ohms, 1/2 watt, 5% |
| R-10 | | Resistor - Same as R-9 |
| R-11 | R-5204-A11 | Resistor - fixed, composition, 1 meg ohm, 1/2 watt, 10% |
| R-12 | R-5226-A11 | Resistor - fixed, composition, 10 ohm, 1/2 watt, 5% |
| R-13 | | Resistor - Same as R-2 |
| R-14 | R-5200-A11 | Resistor - fixed, composition, 100,000 ohm, 1/2 watt, 10% |
| R-15 | | Resistor - Same as R-14 |
| R-16 | R-5035-A11 | Resistor - fixed, composition, 15,000 ohm, 1/2 watt, 10% |
| R-17 | | Resistor - Same as R-3 |
| R-18 | | Resistor - Same as R-16 |
| R-19 | | Resistor - Same as R-3 |
| R-20 | R-5206-A11 | Resistor - fixed, composition, 75,000 ohm, 1/2 watt, 5% accuracy |
| R-21 | | Resistor - Same as R-14 |
| R-22 | R-5207-A11 | Resistor - fixed, composition, 47,000 ohms, 1/2 watt, 10% |
| R-23 | R-5208-I2 | Resistor - fixed, composition, 2000 ohms, 1/2 watt, 10% |
| R-24 | | Resistor - Same as R-11 |
| R-25 | R-5134-A11 | Resistor - fixed, composition, 15,000 ohms, 1 watt, 10% |
| R-26 | R-5217-A11 | Resistor - fixed, composition, 150,000 ohms, 1/2 watt, 10% |
| R-27 | R-5220-C6 | Resistor - variable, composition, 100,000 ohms, 20% accuracy, 1/2 watt at full resistance, linear taper. |
| R-28 | R-5209-I2 | Resistor - fixed, composition, 40,000 ohm, 1/2 watt, 10% |
| R-29 | | Resistor - Same as R-16 |

| SYMBOL REF. | REL PART NO | DESCRIPTION |
|---|---|---|
| R-30 | R-5222-I2 | Resistor - fixed, composition, 300,000 ohm, 1/2 watt, 10% |
| R-31 | R-5112-All | Resistor - fixed, composition, 100,000 ohm, 1 watt, 10% |
| R-32 | R-5032-All | Resistor - fixed, composition, 100 ohms, 1/2 watt, 10% |
| R-33 | R-5101-I2 | Resistor - fixed, composition, 150,000 ohms, 1 watt, 10% |
| R-34 | R-5223-I2 | Resistor - fixed, composition, 30,000 ohm, 1/2 watt, 10% |
| R-35 | | Resistor - Same as R-33 |
| R-36 | R-5221-C6 | Resistor - variable, composition, 100,000 ohms, 1/2 watt at full resistance, linear taper, 20% accuracy |
| R-37 | | Resistor - Same as R-3 |
| R-38 | R-5210-All | Resistor - fixed, composition, 33,000 ohms, 10%, 1 watt |
| R-39 | | Resistor - Same as R-31 |
| R40 | | Resistor - Same as R-16 |
| R-41 | | Resistor - Same as R-2 |
| R-42 | | Resistor - Same as R-2 |
| R-43 | R-5126-All | Resistor - fixed, composition, 250,000 ohm, 1/2 watt, 10% |
| R-44 | R-5212-I2 | Resistor - fixed, composition, 2.7 meg ohm, 1/2 watt, 10% |
| R-45 | | Resistor - Same as R-16 |
| R-46 | | Resistor - Same as R-36 |
| R-47 | | Resistor - Same as R-3 |
| R-48 | R-5213-I2 | Resistor - fixed, composition, 5000 ohms, 1/2 watt, 10% |
| R-49 | | Resistor - Same as R-4 |
| R-50 | | Resistor - Same as R-22 |
| R-51 | R-5215-I2 | Resistor - fixed, composition, 200,000 ohm, 1/2 watt, 10% accuracy |
| R-52 | | Resistor - Same as R-27 |

| SYMBOL REF. | REL PART NO | DESCRIPTION |
|---|---|---|
| R-53 | | Resistor - Same as R-28 |
| R-54 | R-5023-C5 | Resistor - variable, carbon, .5 meg ohms, rotation counter clockwise, tape curve A with switch |
| R-55 | | Resistor - Same as R-28 |
| R-56 | | Resistor - Same as R-3 |
| R-57 | | Resistor - Same as R-2 |
| R-58 | R-5200-A11 | Resistor - fixed, composition, 100,000 ohm, 10% accuracy, 1/2 watt |
| R-59 | | Resistor - Same as R-28 |
| R-60 | | Resistor - Same as R-2 |
| R-61 | R-5086-A11 | Resistor - fixed, composition, 1000 ohm, 1 watt, 10% |
| R-62 | | Resistor - Same as R-2 |
| S-1 | S-5020-A19 | Switch - toggle, SPDT, no center position, contacts 3 amp at 125 volts AC |
| S-2 | S-5019-A19 | Switch - toggle, DPST, no center position, contacts 3 amp at 125 volts AC |
| S-3 | S-5018-M1 | Switch - circuit selector type, 4 circuits, 3 positions, non-shorting |
| T-1 | T-5035-C14 | Transformer - Crystal heater - Primary 115V, 60 cycles - Sec. 6.3 volts rms at 2.0 amps - hermetically sealed |
| T-2 | T-5052-C14 | Transformer - Thyratron plate - Primary 115V, 60 cycles - Sec. 125V rms at 80 M.A. - hermetically sealed |
| T-3 | T-5034-C14 | Transformer - plate - Primary 115V, 60 cycles - Sec. #1, 310-0-310 volts rms at 75 MA - Sec. #2, 5 volts rms at 2.0 amps - Sec. #3, 6.3 volts rms at 1.25 amps - Sec. #4, 6.3 volts rms at 4.0 amps CT - hermetically sealed. |
| V-1 | | Tube - Type 7V7 |
| V-2 | | Tube - Type 6AG7 |

| SYMBOL REF. | REL PART NO. | DESCRIPTION |
|---|---|---|
| V-3 | | Tube - Type 7A6 |
| V-4 | | Tube - Type 7F8 |
| V-5 | | Tube - Same as V-4 |
| V-6 | | Tube - Same as V-4 |
| V-7 | | Tube - Type 2050 |
| V-8 | | Tube - Type 5V4G |
| V-9 | | Tube - Type 6Y6G |
| V-10 | | Tube - Type 7A87 |
| V-11 | | Tube - Type OC3/VR105 |
| V-12 | | Tube - Same as V-4 |
| V-13 | | Tube - Same as V-4 |
| V-14 | | Tube - Same as V-1 |
| X-1 | X-5007-E1 | Socket for V-1, loktal, ceramic |
| X-2 | X-5006-U5 | Socket, for V-2, octal, ceramic |
| X-3 | | Socket for V-3 - Same as X-1 |
| X-4 | | Socket for V-4 - Same as X-1 |
| X-5 | | Socket for V-5 - Same as X-1 |
| X-6 | | Socket for V-6 - Same as X-1 |
| X-7 | X-5060-A5 | Socket for V-7, octal, mica-filled bakelite |
| X-8 | | Socket - Same as X-7 |
| X-9 | | Socket - Same as X-7 |
| X-10 | | Socket for V-10 - Same as X-1 |
| X-11 | | Socket for V-11 - Same as X-7 |

| SYMBOL REF. | REL PART NO | DESCRIPTION |
|---|---|---|
| X-12 | | Socket for V-12 - Same as X-1 |
| X-13 | | Socket for V-13 - Same as X-1 |
| X-14 | | Socket for V-14 - Same as X-1 |
| X-15 | | Socket for R-1 - Same as X-1 |
| X-16 | X-5010-A5 | Socket for Y-1 - 5 prong, ceramic |
| X-17 | | Socket for Y-2 - Same as X-16 |
| X-18 | X-5013-G7 | Socket for I-1 - Pilot light assembly, candleabra base with amber indicator |
| X-19 | X-5027-L3 | Fuse holder - for F-1 |
| X-20 | | Fuse holder for F-2 - Same as X-19 |
| X-21 | X-5051-A5 | Socket for C-39 - 4 prong, mica-filled bakelite |
| X-22 | | Socket for C-40 - Same as X-21 |
| Y-1 | Y-5013-B4 | Crystal Unit - quartz, frequency specified within range 3.75/5.100 mc. accuracy plus/minus .0002% of specified frequency at oven temperature of 75°C in model oscillator. Unit stability plus/minus .0001% for ambient range of 25°C to 60°C - Heater unit operates at 6.3 volts, 1 amp |
| Y-2 | Y-5014-B4 | Crystal Unit - quartz - Frequency 5.350 mc. accuracy plus/minus .0005% of specified frequency at oven temperature of 75°C in model oscillator - Unit stability plus/minus .0001% for ambient range of 25°C to 60°C. Heater unit operates at 6.3 volts, 1 amp |
| Z-1 | | Interstage Tuning Assembly |
| Z-2 | | Discriminator Tuning Assembly |

SECTION 7.

## MAINTENANCE OF EQUIPMENT - ORDERING SPARE OR REPLACEMENT PARTS - PROCEDURE FOR RETURN OF MATERIAL.

### 1. MAINTENANCE OF EQUIPMENT

Normal maintenance requires periodic inspection of equipment with careful scrutinizing of the various components to detect signs of overload or imminant failure.

Components which require periodic maintenance are tabulated below. Where applicable to this equipment , instructions given should be followed.

MOTORS, PUMPS AND BLOWERS - rotating machinery of this type may require periodic lubrication if not of the sealed roller bearing type. Follow lubrication instructions attached to machine.

MECHANICAL DRIVE SYSTEMS - Panel bearings, shafting, belt pully and chain drive arrangements require occasional lubrication with a few drops of light machine oil. Do not apply oil to sliding contacts found in Radio Frequency "Line" assemblies.

MECHANICAL CONNECTIONS - Terminal strips should be inspected occasionally for loose lugs, broken or badly frayed wires. Chuck or clamp type plate and grid lead connectors should be tried for secure fit. Coaxial cables may break loose from plug assemblies if subject to repeated handling or flexing.

RELAYS-CONTACTORS - Relays and contactors with enclosed contacts do not require servicing for the life of equipment. Telephone type relays and other exposed contact relays may require occasional cleansing or burnishing of contact surfaces. Bond paper strips saturated in pure ethyl alcohol may be drawn between contacts while holding relay closed normally.

Electro-pneumatic and oil-dashpot type timing relays should be checked for maintenance of correct timing interval. Adjustment instructions for these items are found in Section IV of this manual.

RESISTORS - Low voltage resistors should be examined for discoloration of paint indicating overloaded operating conditions. Large size plug-in sticks should be checked for loose ferrules and clean contact surfaces.

CLEANSING - The necessity for maintaining equipment in clean condition should be obvious. Dust and dirt will definitely have a deleterous effect on the operation of most electronic components. The necessity and frequency of cleaning operations will vary with the type and location of equipment. Equipment in pressurized cabinets with air filters on intake and exhaust ducts will require less service than a rack mounted receiver.

Air filters may be cleaned by immersing in gasoline to wash out dust and old oil. When clean stand up to drain then reimmerse in SAE 30 motor oil. Again stand to drain. Wipe off excess and reinstall.

Special attention should be paid to wiping dust off of insulators in high voltage circuits and also glass envelopes on vacuum tubes having plate and grid caps.

When cleaning vacuum tube envelopes an excellent opportunity presents itself for an examination and check for loose or corroded tube or tube socket pins.

The more carefully "Preventive Maintenance" is performed, the less service and trouble shooting will be encountered.

## 2. ORDERING SPARE OR REPLACEMENT PARTS

All components used in R.E.L. equipment have been assigned REL Stock Numbers, and are designated as such either on the component itself, or if impracticable, on the Tabular List of Parts, Section 6 of this Instruction manual. When ordering spare or replacement parts please state quantity and REL Stock Number to insure exact duplication.

Another method of ordering components when the above is impracticable is as follows: All components used in R.E.L. equipment are designated on the Tabular List of Parts and Wiring Diagrams as a circuit symbol i.e. R100, C500, C300, etc. This symbol may be used in ordering spare or replacement parts, however, the catalogue number of the equipment must be stated.

## 3. PROCEDURE FOR RETURN OR MATERIAL

Attached here, ~~PAGES~~ are copies of forms used by REL in dealing with return of defective materials used in our catalogued articles.

If for any reason you have a reject which is due to faulty manufacture or a direct fault of manufacture, please forward this information in the "NOTIFICATION" form letter. Within 10 days we will notify you of what disposition is to be made. NOTE: Do not forward the rejects to us before being notified by our acceptance letter. This will save you cost of shipping in certain cases where a return is not required, and also permits us to keep our records in order.

When you receive our deposition notice requesting that the subject material may be returned, the "RETURN MATERIAL REPORT" is to be forwarded us, packed with material itself, along with your regular packing slip via either Parcel Post or Railway Express prepaid. In certain cases additional information may be required in order for us to complete our examination. Forms will be forwarded for compliance. Page 3 shows "Notification" Form; Page 4 shows "RETURN MATERIAL REPORT". These forms may be duplicated or additional copies will be furnished you on request.

"NOTIFICATION FORM"

Radio Engineering Laboratories, Inc.
35-54 Thirty-sixth Street
Long Island City 1, New York

ATT: Return Material Clerk

SUBJECT: Rejected Material originally received on our Purchase Order No._____

Gentlemen:

The following is a list of material you shipped us on our Purchase Order mentioned above, which we have found necessary to reject for reasons herein:

REASON FOR REJECTION:

Return for Replacement: Yes No
Return for Credit: Yes No

Please let us know promptly what disposition you desire us to make of this material. Notify us within 10 days what action you are taking. If notification is not received within 10 days, this material will be return to your address of above for replacement.

Yours very truly,

Reply directly to:

_____

"RETURN MATERIAL REPORT"

Date _____

PURCHASED FROM: Radio Engineering Laboratories, Inc.
35-54 Thirty-sixth Street
Long Island City 1, N.Y.

Against our Purchase Order No. _____

This material was originally received on _____ 1946

Repair or replacement of this material should be charged to _____

_____

| QUANTITY | DESCRIPTION | REASON FOR RETURN |
|---|---|---|
| | | |

R.E.L. Cat. # _____ Part(s) _____ Art. # _____

Returned _____ 194___ Via _____

Name of person claiming defect _____

Final Deposition: Received Replacement _____ Credit _____

Art-9-23
Page No. 4 (1)

SECTION XX VI - ADDENDA - GENERAL SERVICE AND MAINTENANCE NOTES (CAT. #600, 600R, 600T)

WARNING

Several of the operations detailed below are relatively critical, and are so noted, in that improper execution may result in the deterioration of the Monitor's performance beyond the limits allowed. Unless adequate test equipment is at hand, and unless personnel has a working familiarity with the type of procedure indicated, it is strongly urged that the entire instrument be returned to REL for readjustment (Refer to Section IV "Procedure for Return of Material")

Before performing any service work on the Monitor, be sure to read all the service notes below.

TUBE SOCKET VOLTAGE CHECK

The tables below detail the D.C. voltages prevailing at the pins of the tube sockets. Table I is for the OPER condition of the Monitor, but without RF signal from the transmitter. Table II is for the CAL 2 condition, and again without RF signal. As a general rule good operation is secured with variations of as much as plus/minus 25% from the values given. The values shown are to be taken with an electronic DC voltmeter, such as the RCA "Voltohmyst", and in all cases a 100,000 ohm, 1/2 watt resistor is affixed to the probe, and the free end of the resistor used as the actual probe point. A 20,000 ohm per volt meter may be used (also with the 100,000 ohm probe isolator) but the readings will be lower according to the meter scale used. A 1000 ohm per volt meter is of limited usefulness and should be used with caution.

All voltages are measured to the metallic chassis.

TABLE I

CAL Switch AT OPER. NO RF

| TUBE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| V-1 | +38 | +250 | +155 | 0 | 0 | 0 | +5 | +38 |
| V-2 | 0 | +38 | 0 | -.3 | 0 | +75 | +38 | +230 |
| V-3 | +38 | 0 | 0 | 0 | 0 | 0 | 0 | +38 |
| V-4 | -16 | +38 | +105 | 0 | +48 | +180 | +38 | -.9 |
| V-5 | 0 | +38 | +250 | +130 | +130 | +250 | +38 | 0 |
| V-6 | 0 | +38 | +100 | +2.5 | +8.5 | +245 | +38 | 0 |
| V-7 | 0 | +38 | +50 | +18 | +21 | +50 | +38 | +50 |
| V-8 | +86 | +375 | 0 | 0 | +250 | 0 | +120 | +375 |
| V-9 | 0 | +250 | +375 | +375 | +235 | +235 | +250 | +250 |
| V-10 | +38 | +235 | +230 | +105 | +105 | +105 | +105 | +38 |
| V-11 | 0 | 0 | - | +250 | +105 | +38 | - | +375 |
| V-12 | 0 | +38 | +125 | +2.3 | +2.3 | +125 | +38 | 0 |
| V-13 | +14.5 | +38 | +14.5 | +15 | +21 | +250 | +38 | +15 |
| V-14 | +38 | +240 | +95 | 0 | 0 | -4.5 | +4.2 | +38 |

TABLE II

CAL Switch in CAL 2 NO RF

PIN

| TUBE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| V-1 | +38 | +250 | +250 | 0 | 0 | 0 | +30 | +38 |
| V-2 | 0 | +38 | 0 | -9 | 0 | +110 | +38 | +235 |
| V-3 | +38 | -.5 | +25 | 0 | 0 | -.5 | +25 | +38 |
| V-4 | -15 | +38 | +105 | 0 | +48 | +180 | +35 | 0 |
| V-5 | -33 | +38 | +205 | 0 | +38 | +250 | +38 | +.6 |
| V-6 | 0 | +38 | +105 | +2.6 | 98.8 | +180 | +38 | 0 |
| V-12 | 0 | +38 | +125 | +2.3 | +2.3 | +125 | +38 | 0 |
| V-13 | +15 | +38 | +15 | +15 | +21 | +250 | +38 | +15 |
| V-14 | +38 | +248 | +93 | 0 | 0 | -4 | +4 | +38 |

Tube socket voltages differing materially from the tabulated values indicate a defective or altered component. Inspection and the use of an ohmmeter (with all power off the monitor) will generally disclose the defective part. If a resistor, capacitor, or inductor is not found to be at fault, the trouble lies with a tube, in all likelihood the one at whose socket the variant voltage was observed. When replacing a tube consult the table below. The lettered procedures indicated for each tube are those necessary to recover the original calibration, and correspond to the lettered procedures of the second half of these service notes.

V-1 - Procedure C
V-2 - Procedure C and D
V-3 - Procedure D
V-4 - Procedure A
V-5 - Procedure B
V-6 - No recalibrate procedure necessary
V-7 - No recalibrate procedure necessary
V-8 - No recalibrate procedure necessary
V-9 - No recalibrate procedure necessary
V-10 - No recalibrate procedure necessary
V-11 - No recalibrate procedure necessary
V-12 - Procedure E
V-13 - Procedure E
V-14 - Procedure A

READJUSTMENT AND RECALIBRATION

GENERAL - Servicing this equipment can be divided as follows; adjustments in both crystal oscillator circuits; adjustments involving the discriminator and associated tubes and components; and adjustments in the modulation monitor circuits. These are further sub-divided according to the lettered headings below.

NOTE WARNING ON PAGE NO. 4 OF SECTIONS II

PROCEDURE A - Adjustment of Crystal Y-1 and Associated Circuit. Failure of any part including tube and crystal associated directly with Y-1 may necessitate re-adjustment of the variable elements. It is our experience that replacement of V-4 does not affect the frequency of oscillation of Y-1 by more than about 200 cycles referred to 100 megacycles. However, the basic accuracy of the carrier frequency measuring function depends on this crystal oscillator circuit, and recalibration is indicated if any gross component failure occurs.

The crystal unit Y-1 operates at either 1/18th. or 1/24th. of the transmitter frequency less the inter-mediate frequency stated on page 2 of section II (usually 10.7 megacycles). To adjust the frequency of the crystal oscillator requires a good receiver capable of receiving the crystal frequency or a low order harmonic of it, a secondary frequency standard with multivibrators, an audio oscillator to serve for interpolation, and an oscilloscope. Of course, the secondary standard should be set against the transmissions of the National Bureau of Standards (WWV) or some other primary standard. If this equipment is at hand or conveniently available it goes without saying that the calibration process is familiar, and the details are omitted here.

The correct condition for L-4, which controls the "strength" of oscillation is about 3/4 turn back from the point where oscillations suddenly cease, i.e., where the tank becomes capacitive. With L-4 correctly adjusted, C-26 is the fine frequency control. If C-26 will not bring the frequency to its correct value, the crystal or its holder have been damaged, and should be returned for examination.

The tank circuit containing L-3 is resonated at either the 3rd. or the 4th. harmonic of Y-1 and is adjusted to peak the drive on V-14. This peak may be observed by noting the variations in the D.C. cathode voltage of V-14. V-14 always triples the output of V-4, and the resonating element is C-29. This circuit can always be adjusted by loosely coupling the monitor to the transmitter so that not more than 0.1 M.A. is obtained at J-2. This low RF drive is usually most conveniently secured by loose coupling to the transmitter PA grid circuit and should be done with the PA plate voltage off. C-29 is then adjusted for a peak in the meter reading at J-2. Be careful not to pick the wrong harmonic of Y-1.

PROCEDURE B - Adjustment of Crystal Y-2 and Associated Circuits. Substantially the same as Procedure A, except that here the requirements on exactness of oscillation frequency are no so severe (by about 10 to 1) and in that L-6 is adjusted so that the drive measured at J-2 is 0.5 M.A. in the CAL 2 condition.

PROCEDURE C - Adjustment of Z-1. This intermediate frequency transformer is overcoupled and is originally adjusted to be flat within plus/minus 1 db for plus/minus 100 kc. deviation from the intermediate frequency value. Replacement of V-1 or V-2 may require slight readjustment of C-5 or C-7 respectively. The correct setting is that which secures the least change in reading at J-2 when about 100% tone modulation is keyed on and off. This change should not exceed 0.03 ma. when the whole reading is about 0.5 ma. Incidently if a check at J-2 during programming shows changes on program peaks it is a pretty sure sign that Z-1 is out of adjustment. This should not occur except for change of tubes or mechanical damage to Z-1. Be sure first, however, that the transmitter is free of amplitude modulation when programmed.

PROCEDURE D - Adjustment of Z-2 and Associated Circuits. The replacement of either V-2 or V-3 will require at the least an inspection to verify whether or not a change in tuning has been made. The primary is in resonance if, with the secondary tuned for zero frequency deviation, the frequency meter exhibits less than plus/minus 200 cycles average shift with 100% tone modulation from the transmitter. As stated elsewhere M-1 is a delicate meter and should always be shunted down (terminals 13 and 14 at rear) when making preliminary adjustments. All final adjustments, however, must be made without the shunt to secure a correct calibration. If it is not otherwise known that there is less than 1/2% distortion in the transmitter then the very soft peak in the reading of the % Modulation meter must be used as an indication of primary resonance. Do not use more than 50% modulation for this adjustment.

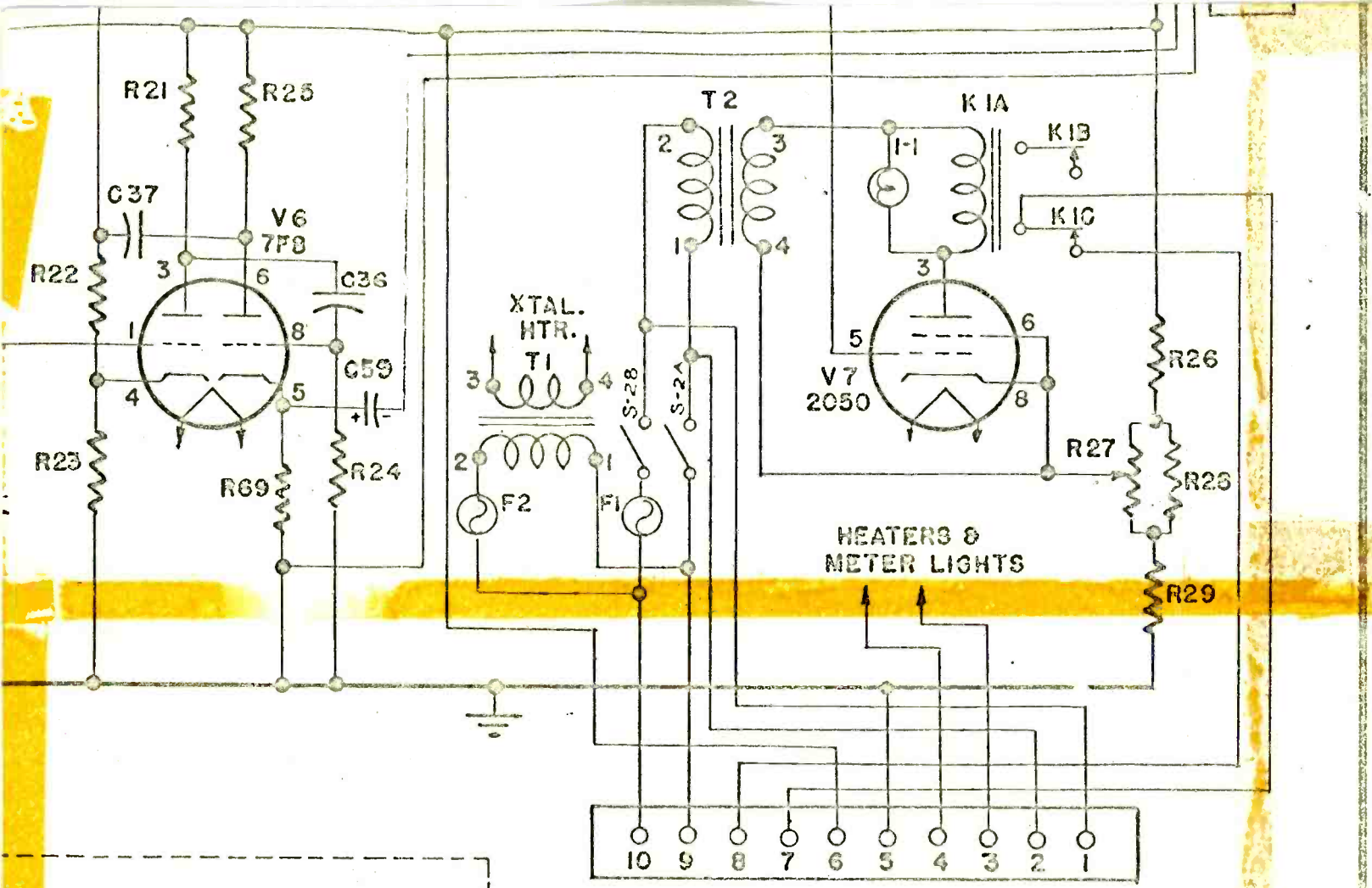
After an adjustment of the primary, the secondary will have to be retuned slightly. If it is necessary to retune C-15, the frequency meter should be protected, and it should be done in the CAL 2 condition, and with an insulated tuning tool. The discriminator transformer is slightly overcoupled, and it will be necessary alternately to repeat primary and secondary adjustments.

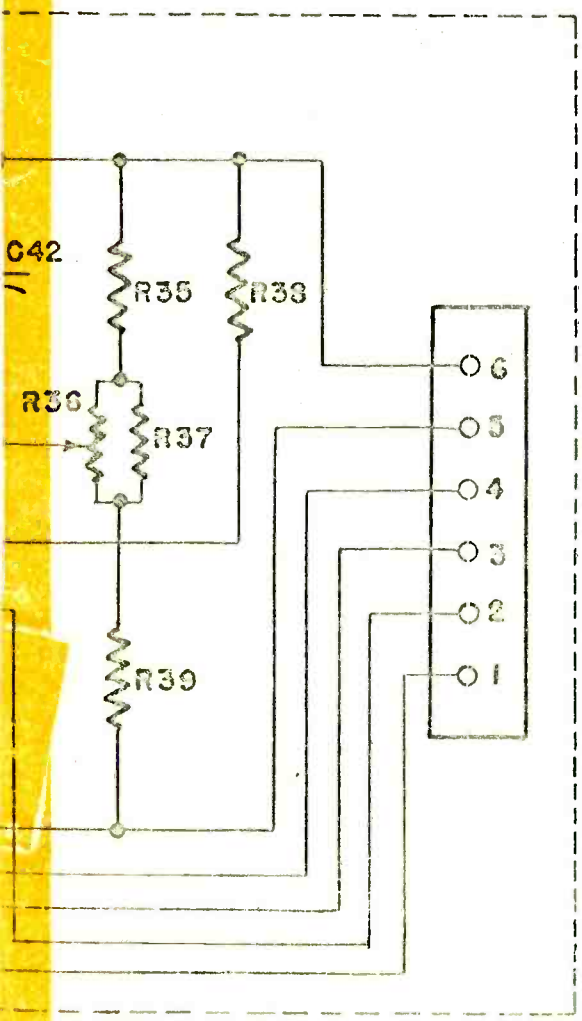
With Z-2 properly tuned, the CAL 1 condition should be met; that is control of R-6 (panel) should yield the frequency meter reading inscribed on the serial number card for the monitor (stapled to front cover of the instruction book) This adjustment establishes the gradient of the detection circuit at 25 microamperes per kilocycle. Hence, with 100% tone modulation (plus/minus 75 kc. peak deviation), an audio voltage of .676 volts rms will appear across both R-7 and R-8. Provided the discriminator has not suffered mechanical damage (such as altered coupling), and provided all associated components are of rated value, this provides a basic check of the percent modulation of the transmitter.

PROCEDURE E - Adjustment of Percent Modulation Meter Circuit. Replacement of either V-12 or V-13 will ordinarily not require readjustments. However such readjustment, if necessary, is straight forward provided the transmitter deviation is accurately known. If the discriminator is correctly tuned and the monitor in correct operating adjustment, the voltage on R-7 or R-8 may be used as a measure of 100% modulation, as mentioned above in Procedure D. The audio frequency meter used for this purpose should be a good one and should not have an impedance of less than 5000 ohms. For accurate results this will have to be done with no shunt on the frequency meter. Since all the audio output current flows in this meter's moving coil, 100% tone modulation should never be continuously applied for more than 1/2 minute; nor should an audio frequency tone lying between 350 and 700 cycles ever be used at greater than 50% modulation, because of mechanical resonance in the meter.

As an entirely independent measurement of deviation the method that follows may be used. It is an adaptation of the so-called "Bessel Function" method, but is in our experience more accurate and requires less accurate equipment. The items necessary are: a communications type receiver of good stability, capable of tuning to the I.F. frequency of the monitor, and having a BFO; an audio oscillator of reasonably accurate frequency calibration; an oscillography. With the transmitter unmodulated

and with the receiver loosely coupled to the IF of the monitor, tune in the intermediate frequency. Using the BFO adjust to as near zero beat as convenient. Modulate approximately 100% at 15000 cycles. Slowly tune the receiver away from the IF to the 5th. zero beat, which will be the 5th. sideband of the modulation, and will be accurately 75 kilocycles ffom the IF. Change the modulative frequency to a low value, such as 100 cycles. Slowly raise the modulation until one burst of beat note per audio cycle is seen on the scope. It will be observed that for less than 75 kc. deviation, the burst on the scope will have no zero beat center. At 75 kc. deviation a zero beat center will appear in the burst, and for more than 75 kc. deviation there will be signs of the frequency modulated signal swinging twice per audio cycle through zero beat with the receiver. At the single zero beat point the deviation will be plus/minus 75 kilocycles, plus/minus a few hundred cycles, plus 5 times the inaccuracy of the 15000 cycle setting of the audio oscillator.




RADIO ENGINEERING LABORATORIES, INC.

CONSULTING AND DESIGNING

35-54 36TH ST. LONG ISLAND CITY, N. Y.

SCHEMATIC OF F.M. MONITOR

MODEL 600A

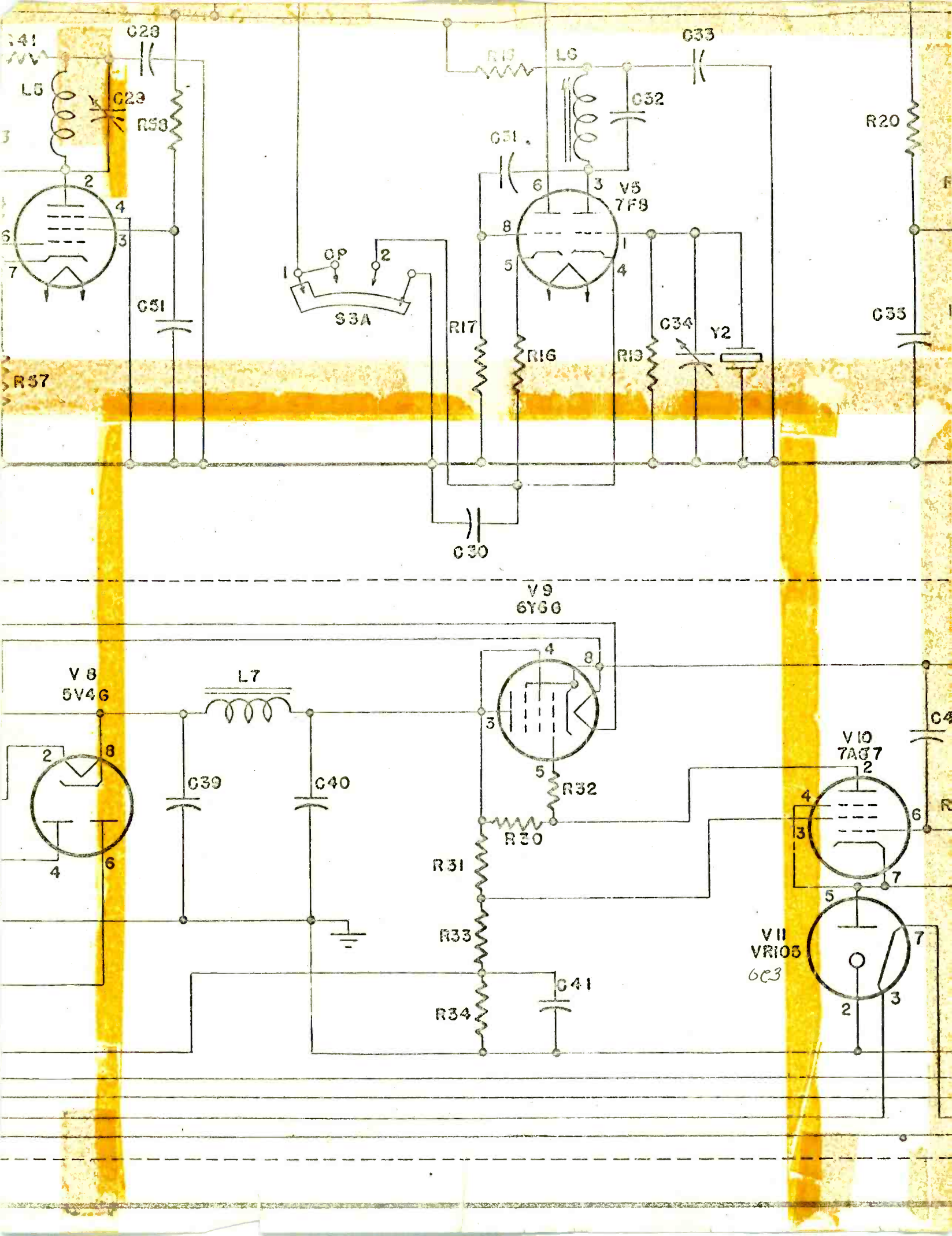
DATE- 5-4-49

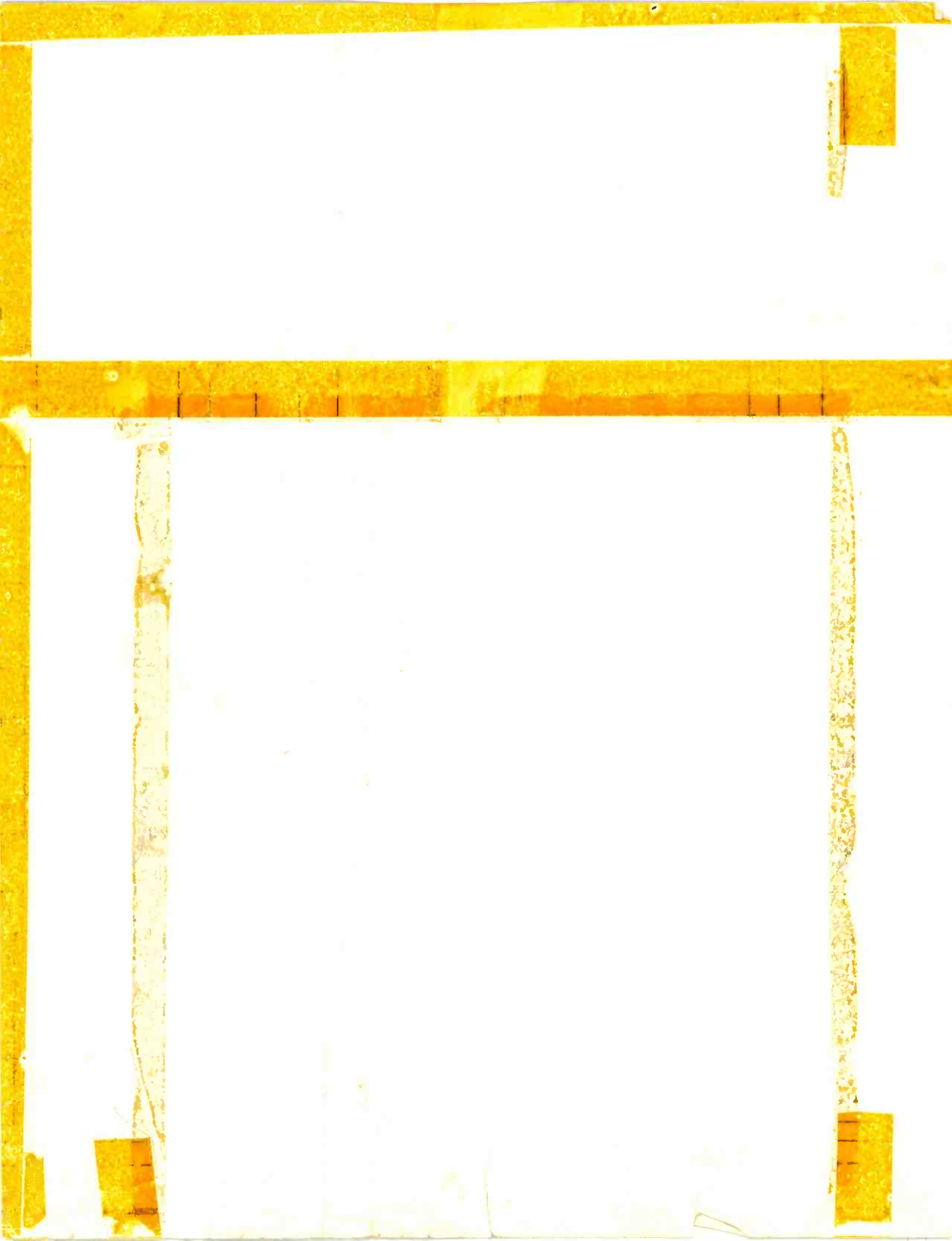
SCALE-

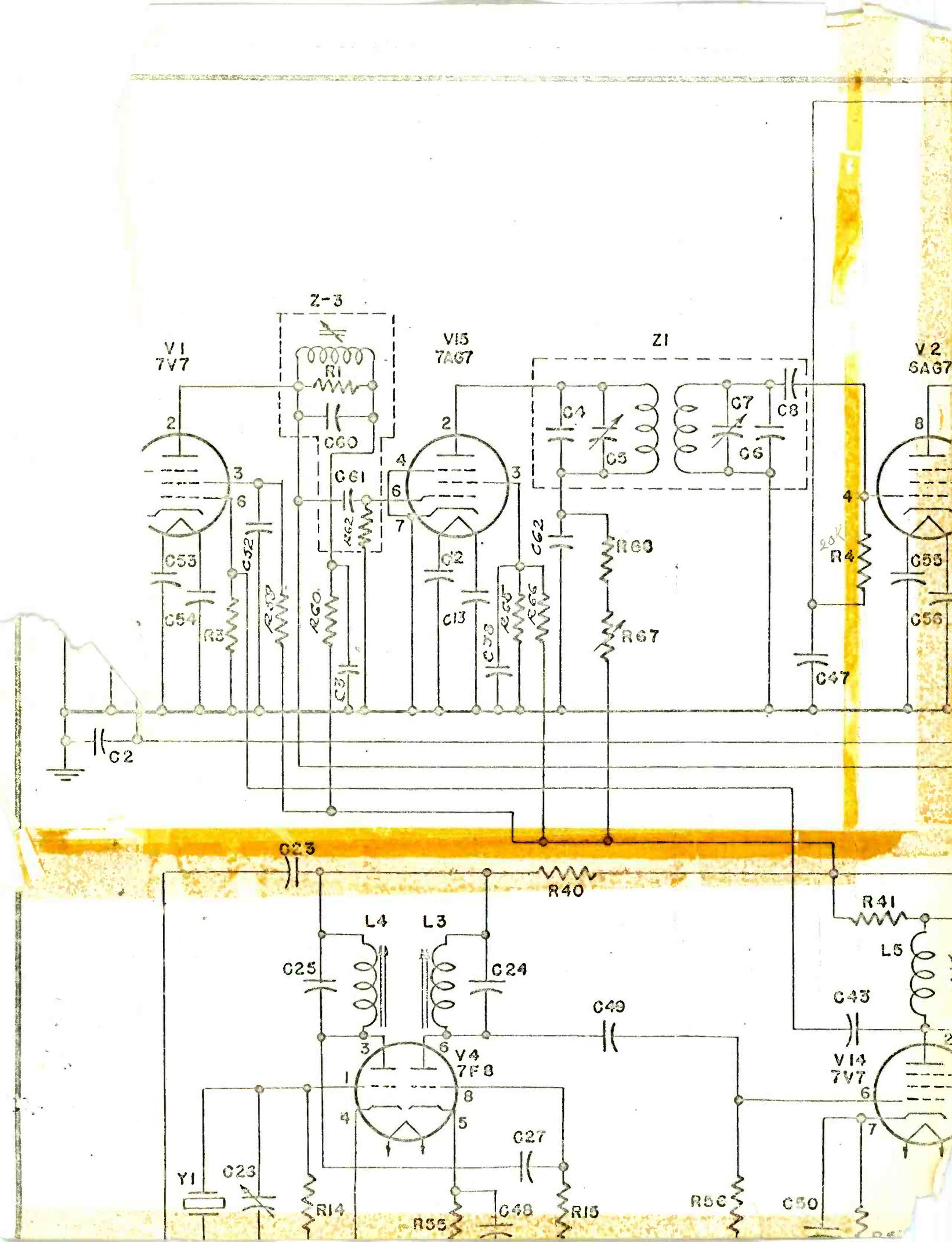
DR. BY- [illegible]

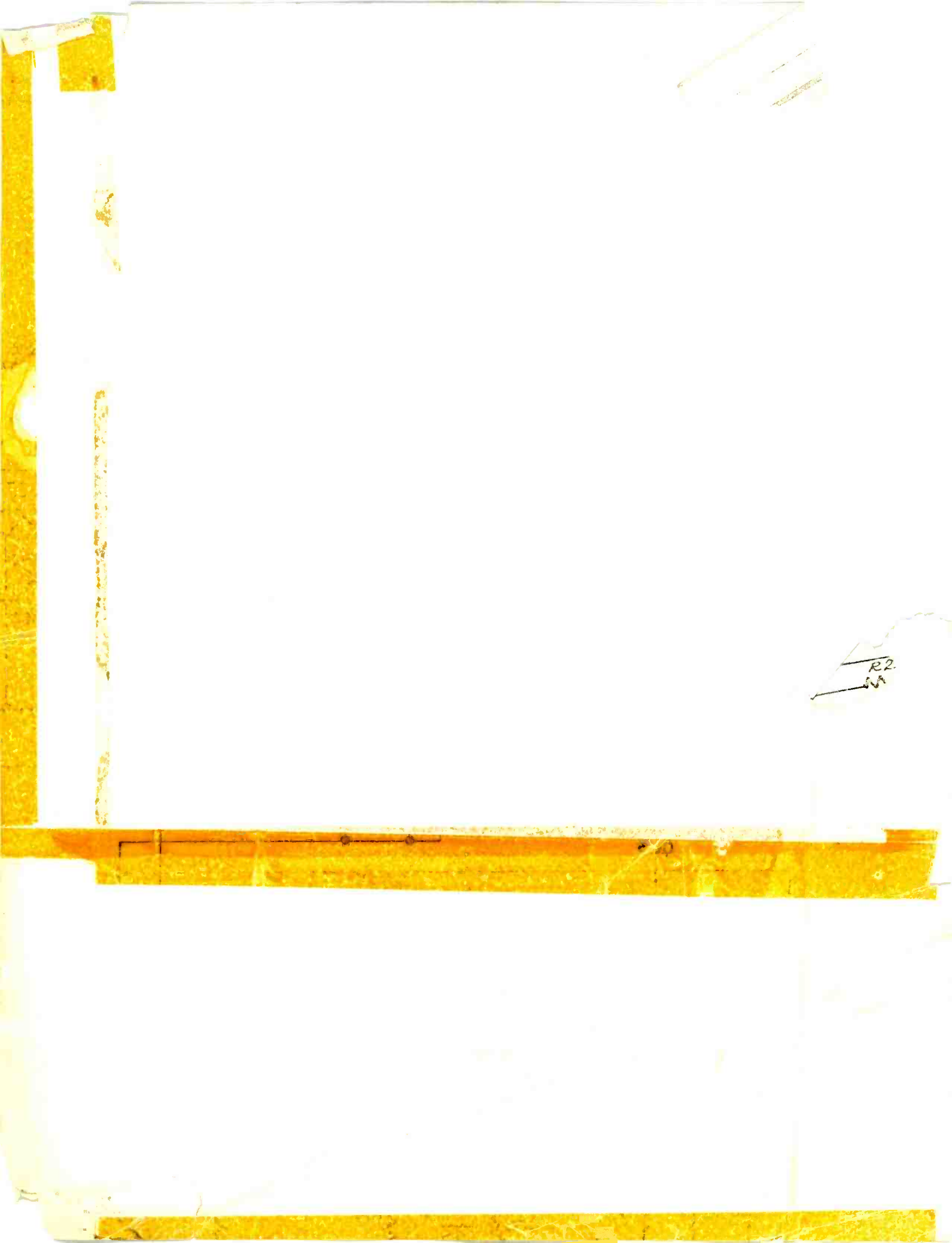
APP. BY - [illegible]

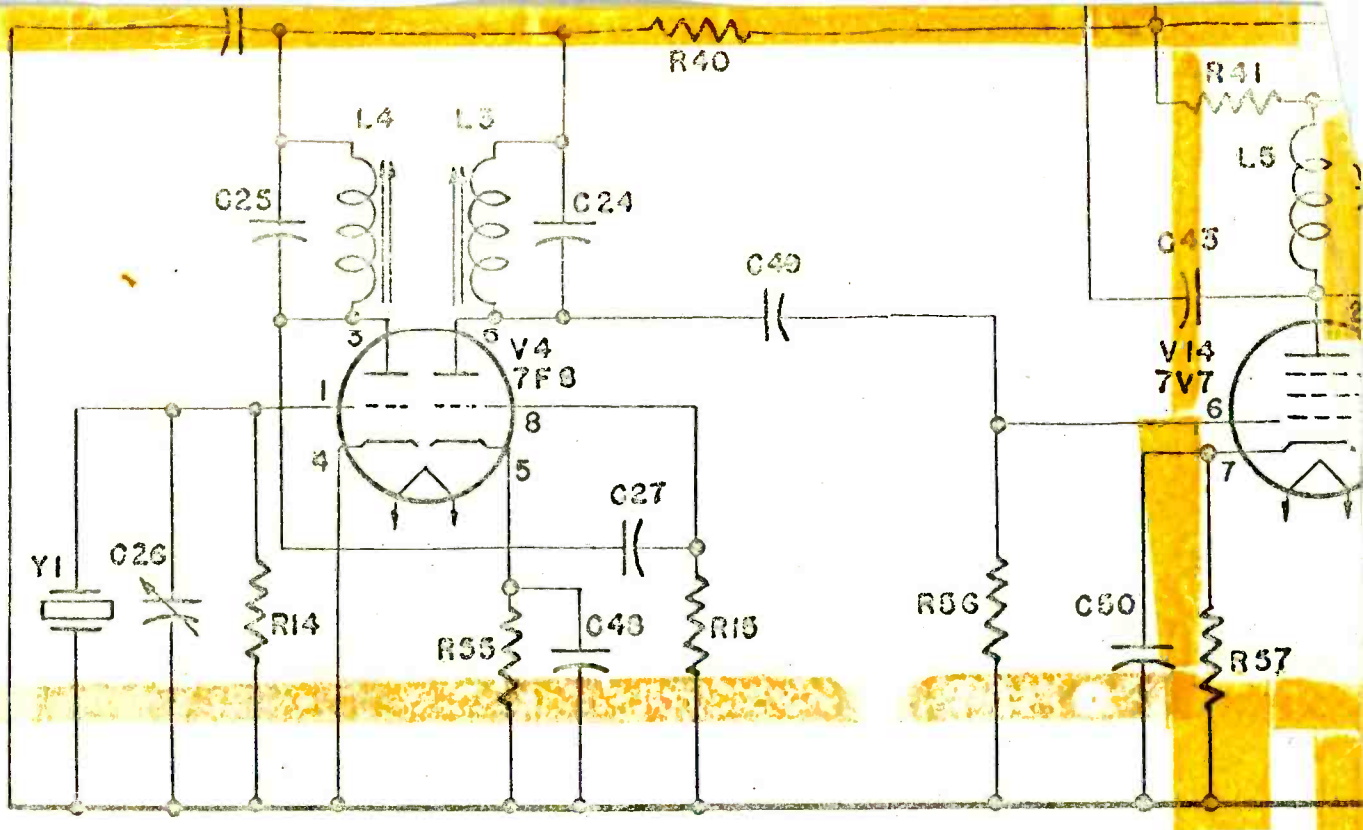
S-663

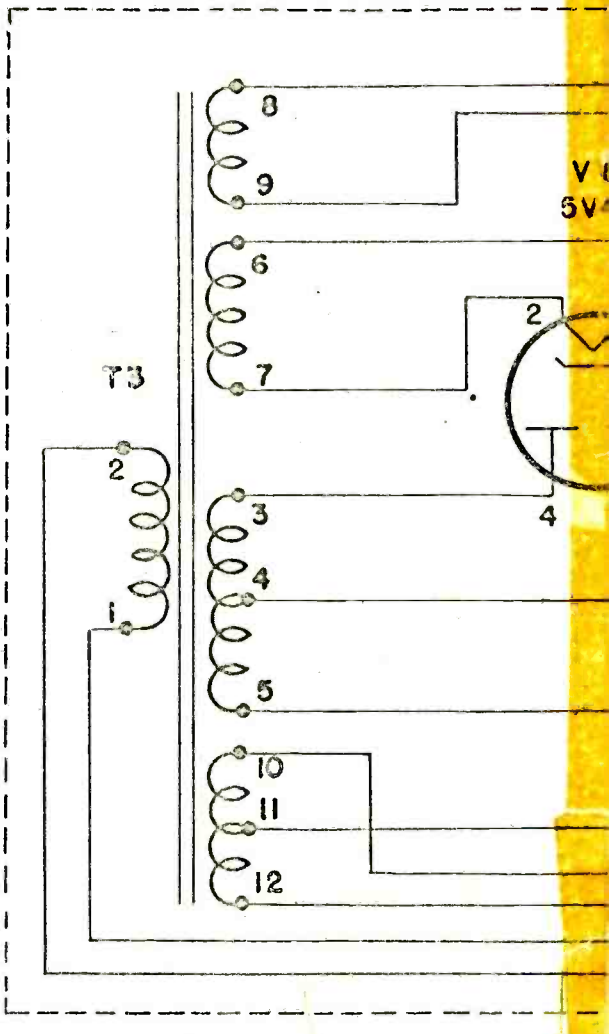

C28
L5
C29
R58
C51
R57
C33
R19
L6
C32
C31
V5
7F8
R20
C35
OP
S3A
R17
R16
R18
C34
Y2
C30
V9
6Y6G
V8
5V4G
L7
C39
C40
R32
R30
R31
R33
R34
C41
V10
7AG7
V11
VR105
6C3



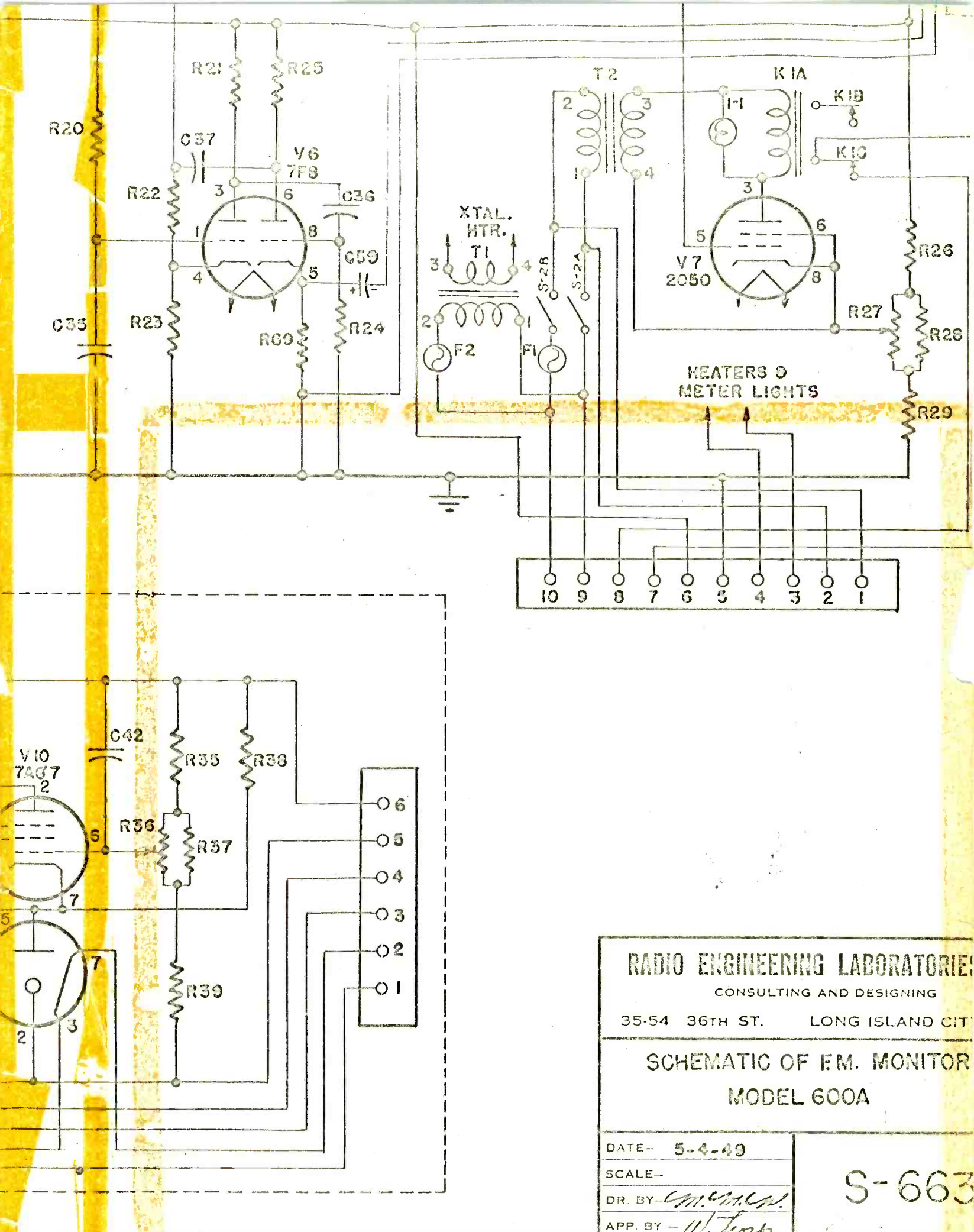

Z-3
R1
C60
V1
7V7
C61
R62
C53
C54
C52
R3
R59
R60
C51
V15
7AG7
Z1
C4
C5
C7
C8
C6
C2
C62
R63
R67
C13
C58
R65
R66
C47
V2
6AG7
20K
R4
C55
C56
C2
C23
R40
R41
L4
L3
L5
C25
C24
C49
C43
V4
7F8
V14
7V7
C27
Y1
C23
R14
R55
C48
R15
R56
C50






SEPARATE POWER
SUPPLY CHASSIS




RADIO ENGINEERING LABORATORIES

CONSULTING AND DESIGNING

35-54 36TH ST. LONG ISLAND CITY

SCHEMATIC OF F.M. MONITOR

MODEL 600A

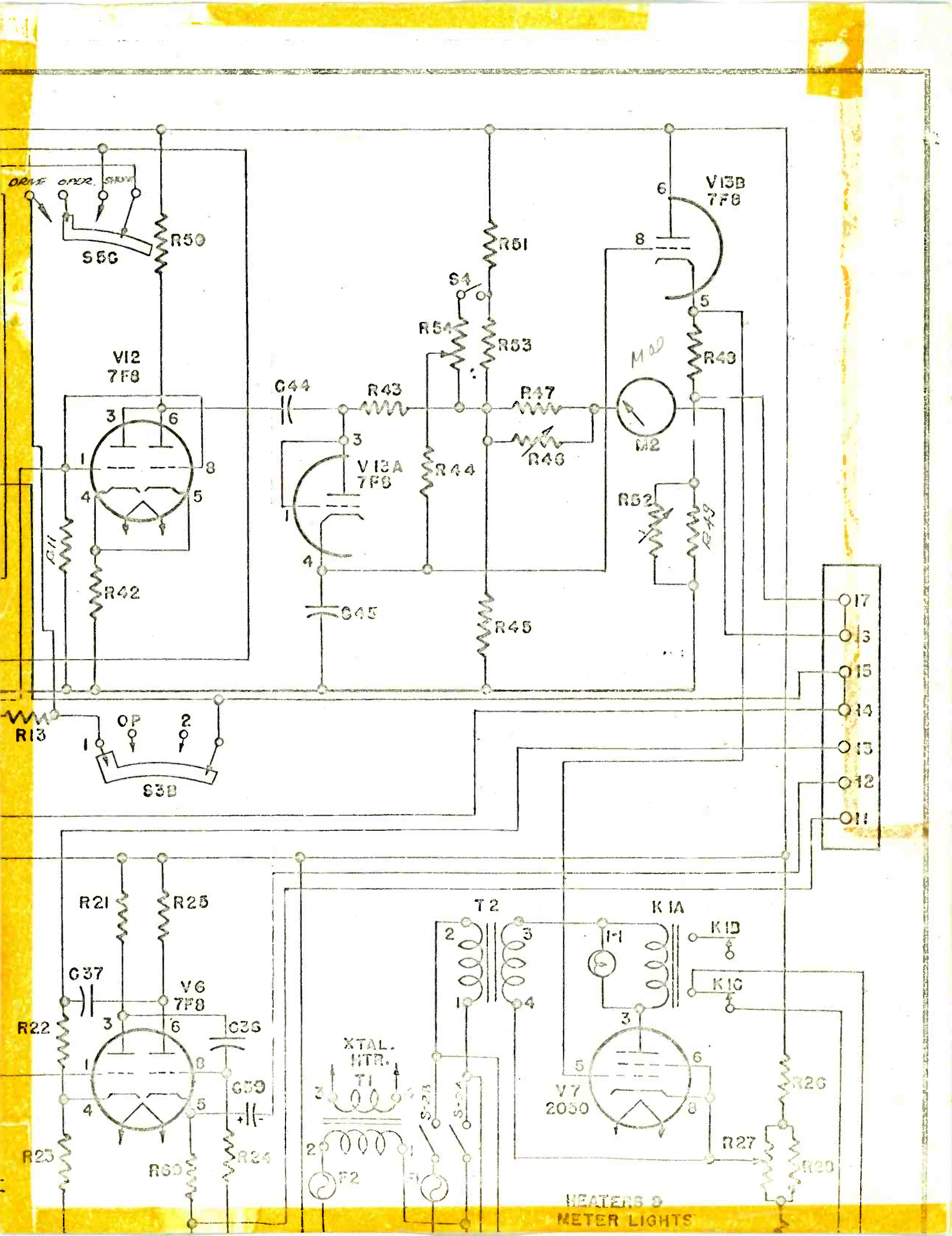
DATE– 5-4-49

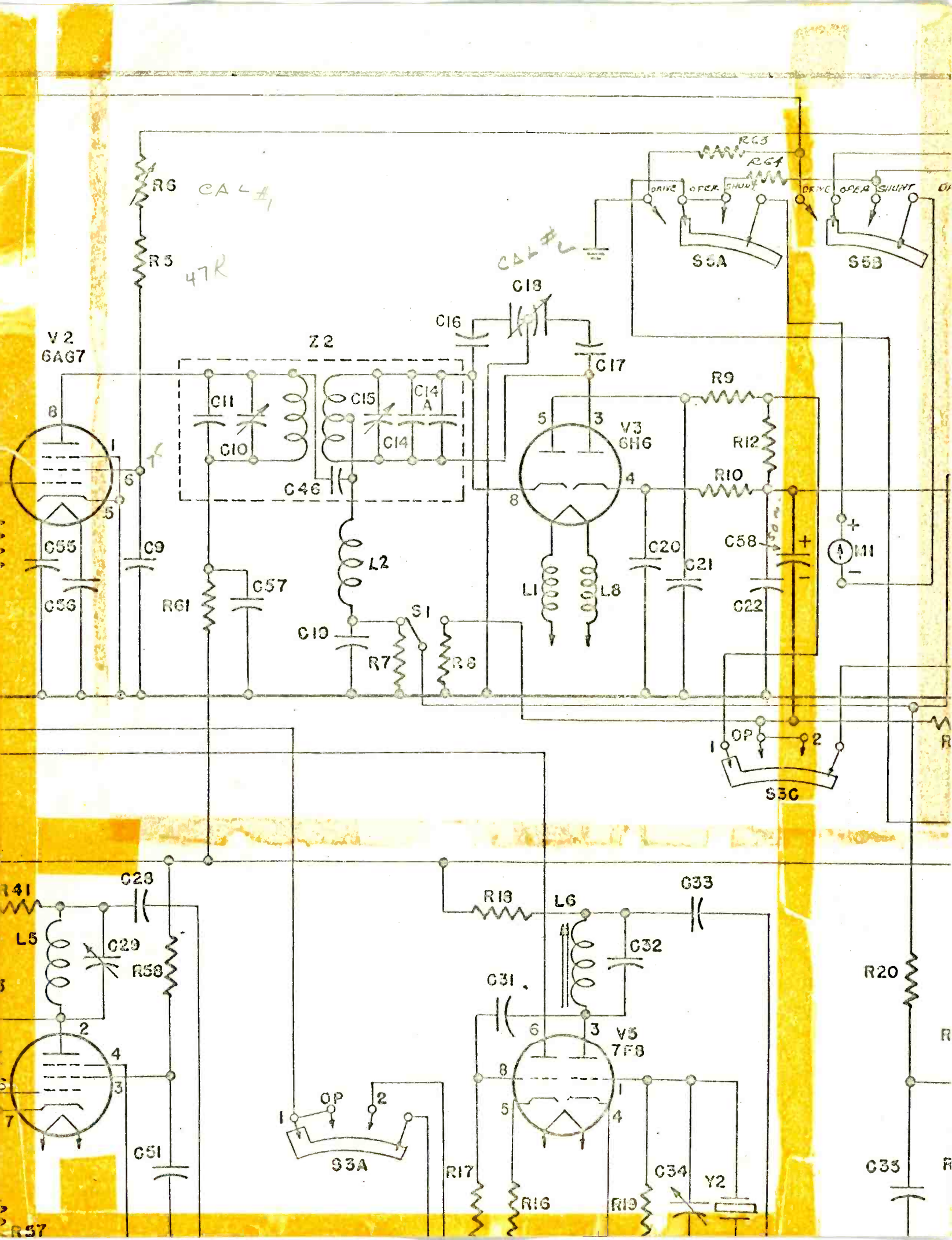
SCALE–

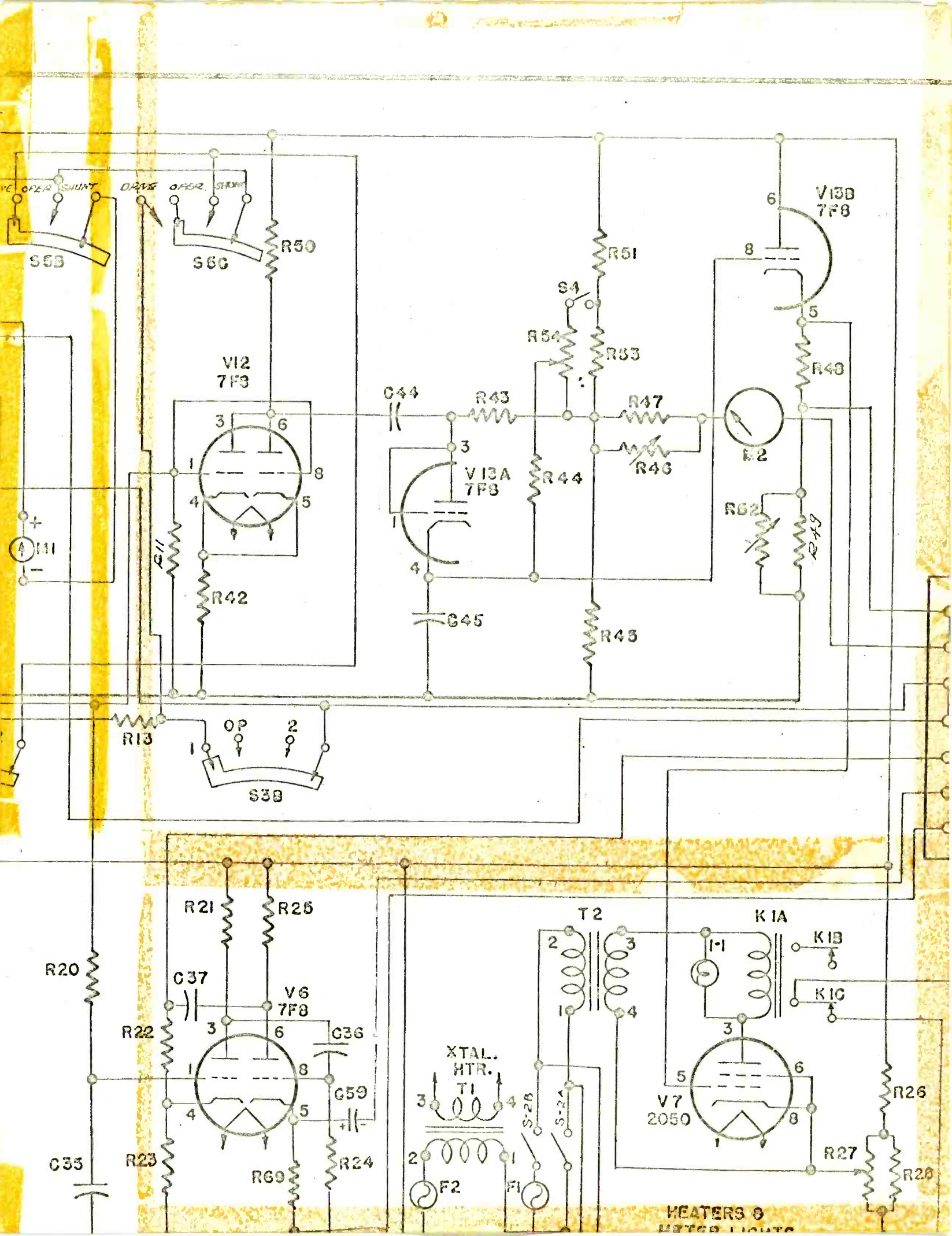
DR. BY– C.M. Cox Jr.

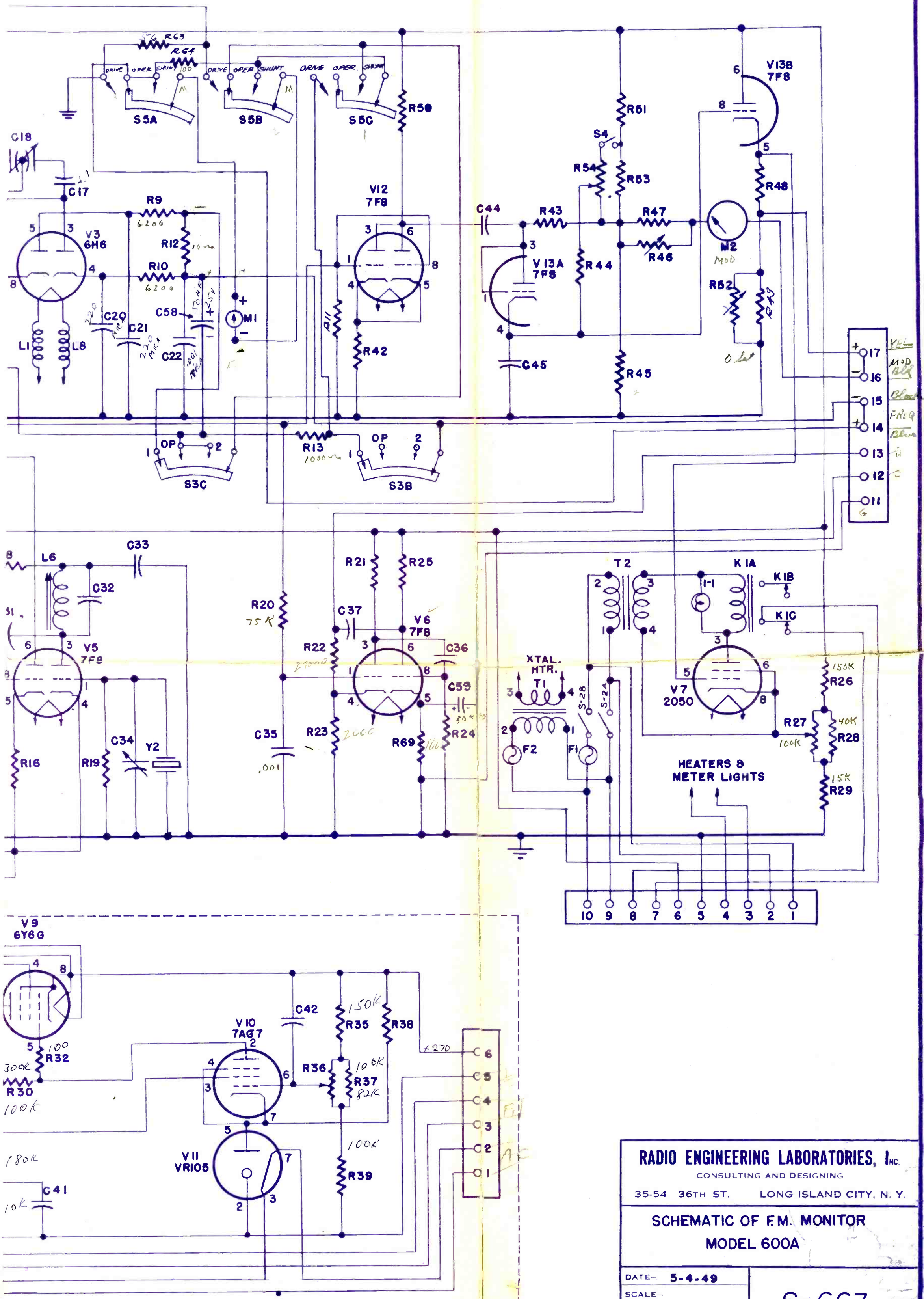
APP. BY – W. Fonda

S-663


ORMF
ONDR.
SHUN
S5C
R50
V12
7F8
C44
R43
R51
S4
R54
R53
R47
R46
V13A
7F8
R44
V13B
7F8
M2
R49
R52
R42
C45
R45
17
16
15
14
13
12
11
R13
OP
2
1
S3B
R21
R25
T2
K1A
K1B
K1C
C37
V6
7F8
R22
C38
C39
XTAL.
HTR.
T1
S-2A
S-2B
V7
2050
R26
R27
R28
R23
R24
F2
F1
HEATERS &
METER LIGHTS


R6
CAL #1
R5
47K
CAL #2
R65
R64
DRIVE
OPER.
SHUNT
S5A
S5B
C18
C16
C17
V2
6AG7
Z2
C11
C10
C15
C14A
C14
C46
R9
R12
R10
V3
6H6
C20
C21
C58
C22
M1
C55
C56
C9
L2
R61
C57
C10
S1
R7
R8
L1
L8
OP
S3C
R41
C28
L5
C29
R58
C51
R13
L6
C33
C32
C31
V5
7F8
S3A
R17
R16
R19
C34
Y2
R20
C33
R37


S5B
S5C
R50
V12
7F8
C44
R43
R51
S4
R54
R53
V13B
7F8
R49
R47
R46
V13A
7F8
R44
M2
R52
R48
M1
R42
C45
R45
R13
OP
2
S3B
R21
R25
R20
C37
V6
7F8
R22
C36
C59
C35
R23
R69
R24
XTAL.
HTR.
T1
T2
S-2B
S-2A
F2
F1
K1A
K1B
K1C
I-1
V7
2050
R26
R27
R28
HEATERS &




RADIO ENGINEERING LABORATORIES, INC.

CONSULTING AND DESIGNING

35-54 36TH ST. LONG ISLAND CITY, N. Y.

# SCHEMATIC OF F.M. MONITOR MODEL 600A

DATE– 5-4-49

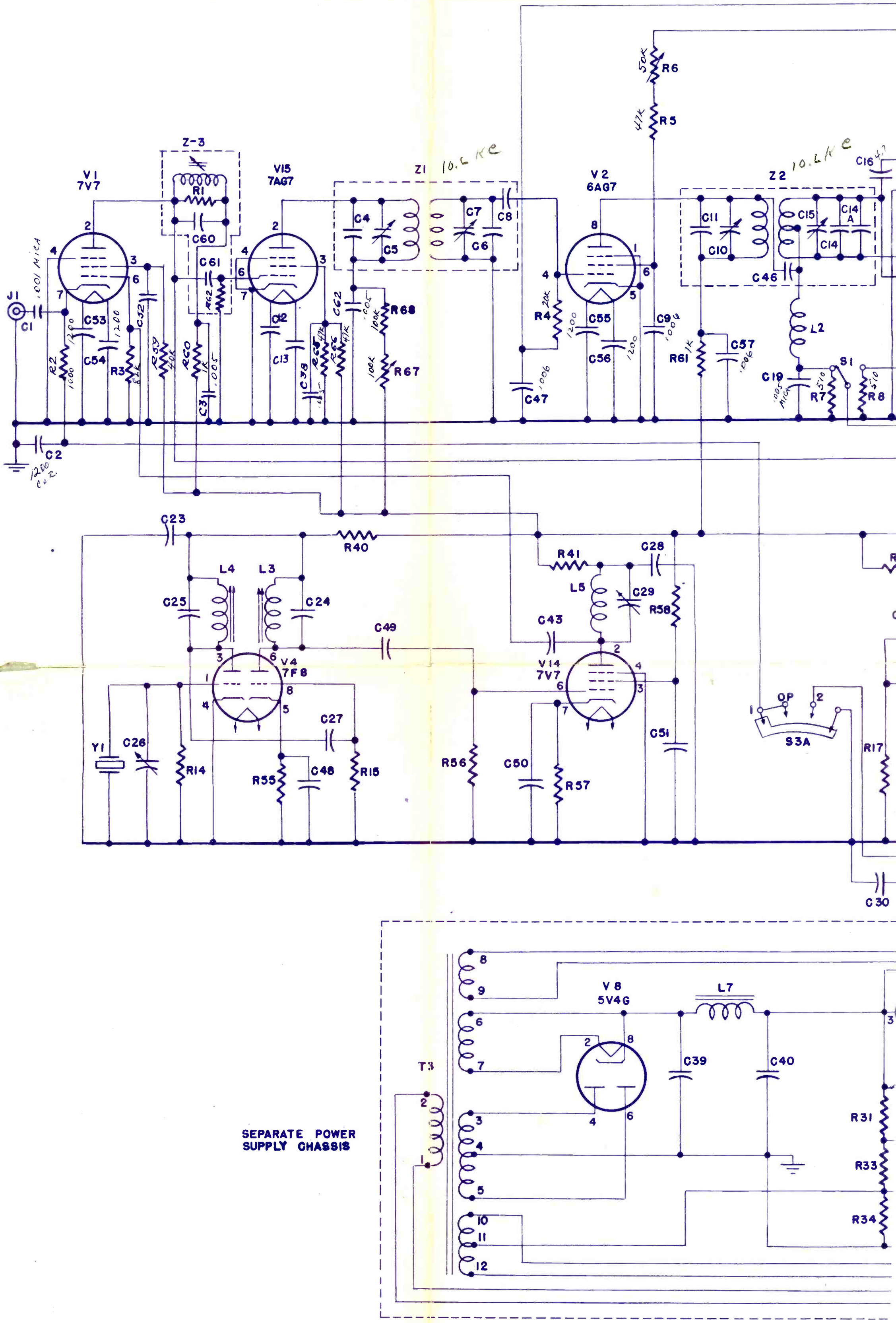
SCALE–

DR. BY– M.M.C.

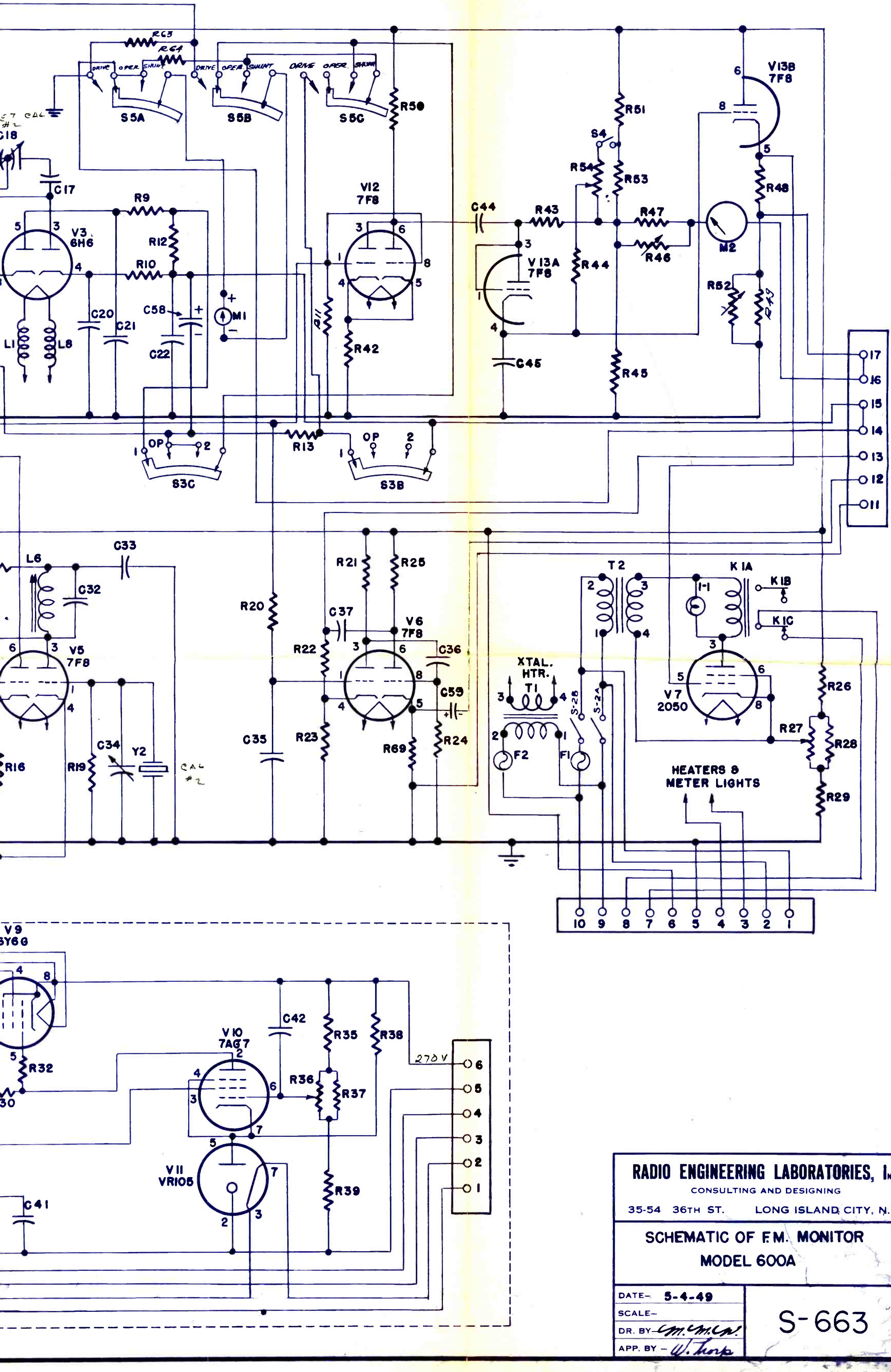
APP. BY – W. Thorp

S-663

Mar 7 Long




SEPARATE POWER
SUPPLY CHASSIS




**RADIO ENGINEERING LABORATORIES, INC.**

CONSULTING AND DESIGNING

35-54 36TH ST. LONG ISLAND CITY, N. Y.

# SCHEMATIC OF F.M. MONITOR MODEL 600A

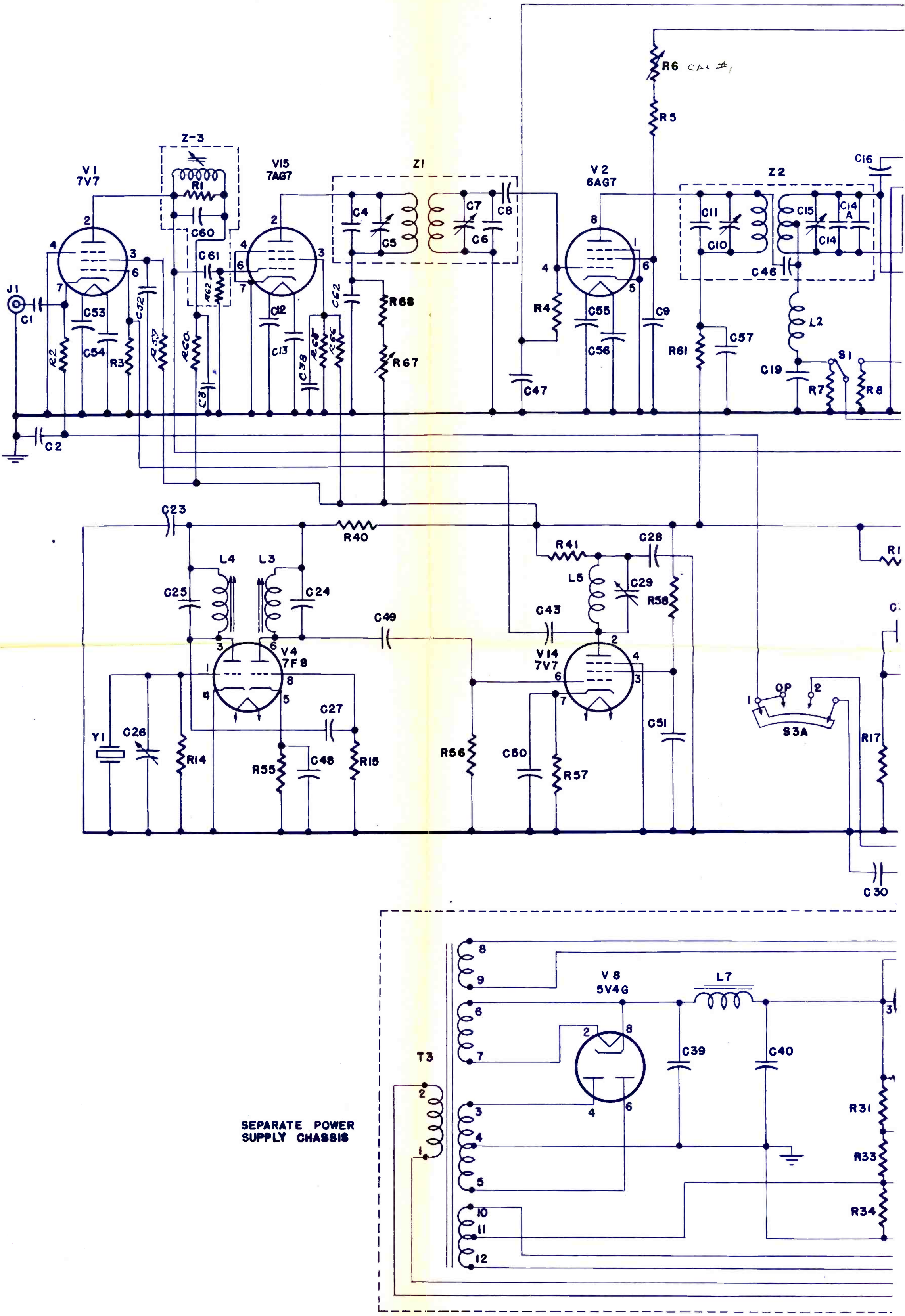
DATE– 5-4-49

SCALE–

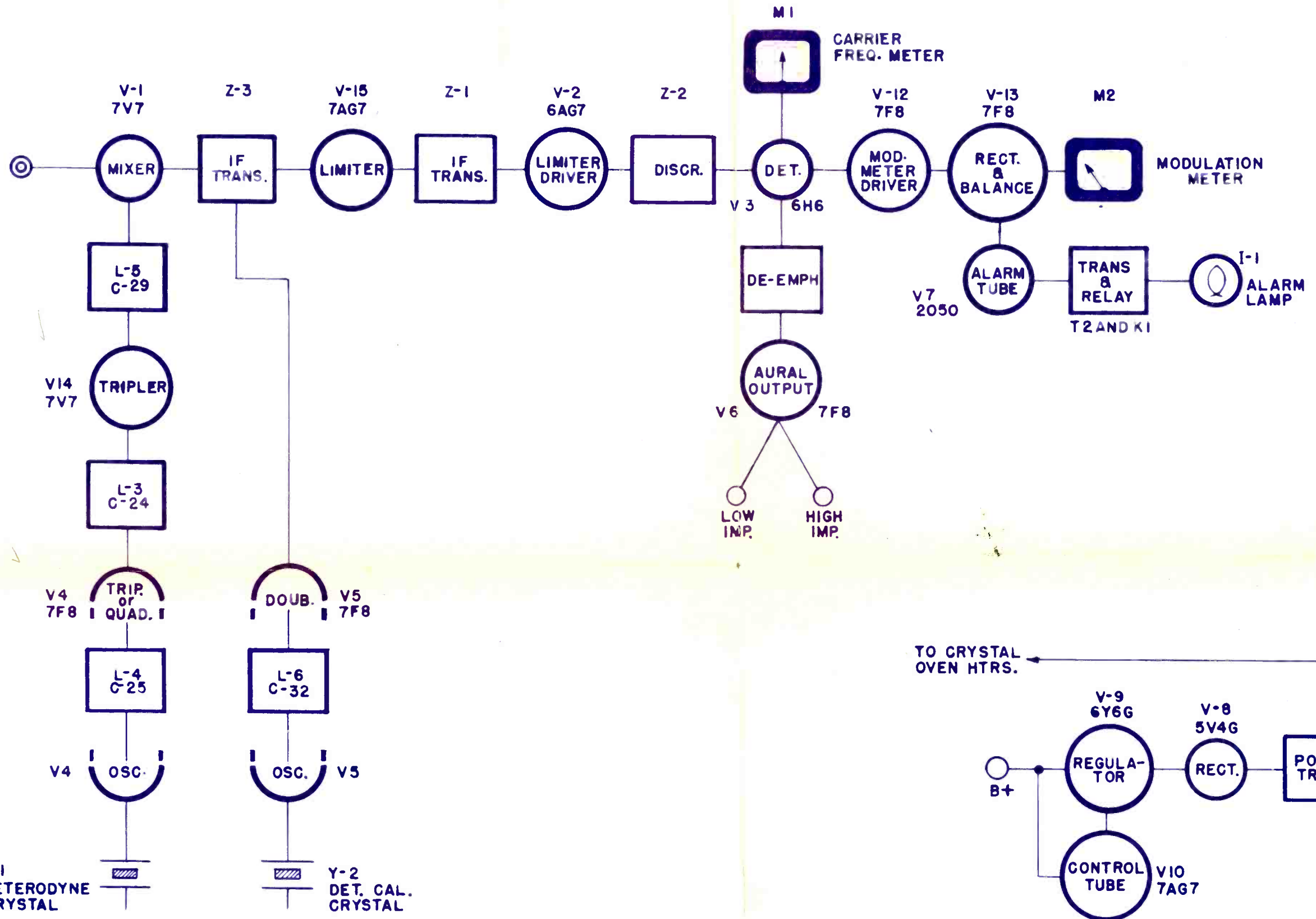
DR. BY– M. M. C.

APP. BY – W. Thorp

S-663




SEPARATE POWER SUPPLY CHASSIS




**RADIO ENGINEERING LABORATORIES, INC.**

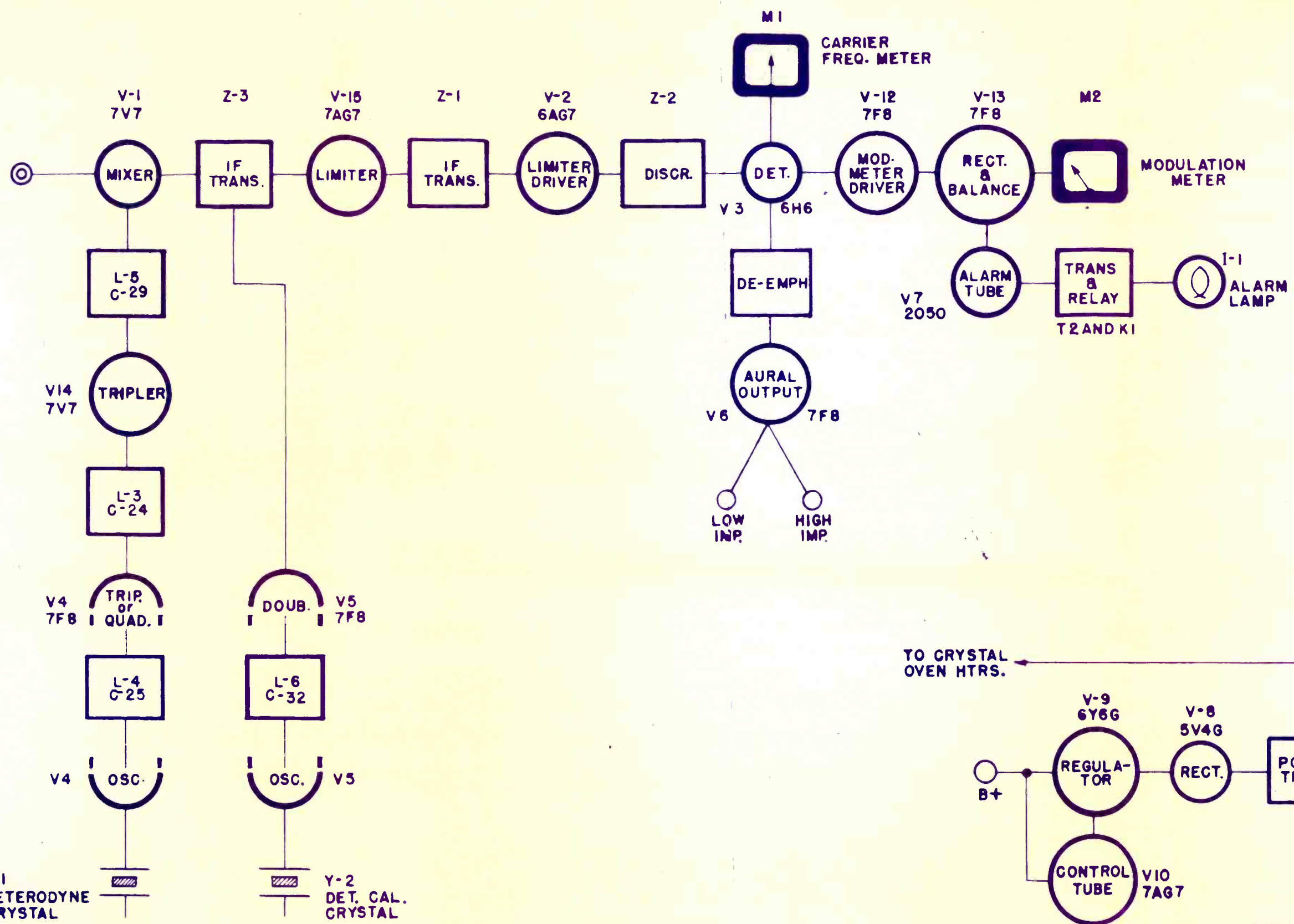
CONSULTING AND DESIGNING

35-54 36TH ST. LONG ISLAND CITY, N. Y.

MODEL 600A
BLOCK DIAGRAM

DATE– MAY 5, 1949
SCALE–
DR. BY– M.M.W.
APP. BY– W. Thorp

B-753




**RADIO ENGINEERING LABORATORIES, Inc.**

CONSULTING AND DESIGNING

35-54 36TH ST. LONG ISLAND CITY, N. Y.

MODEL 600A
BLOCK DIAGRAM

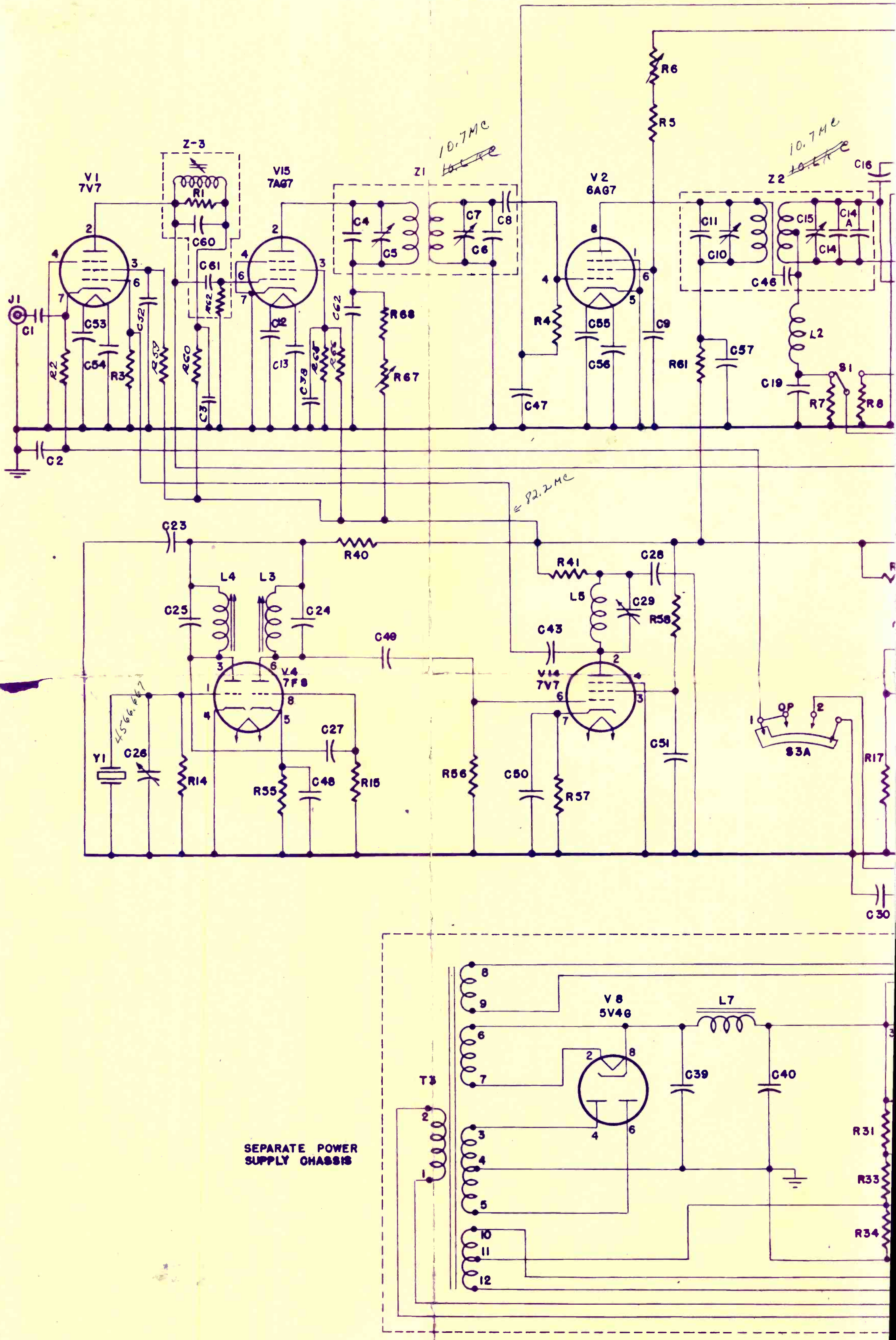
DATE- MAY 5, 1949
SCALE-
DR. BY- M.M.W.
APP. BY- W. Thorp

B-753

R63 R64 S5A S5B S5C R50 C18 C17 R9 6200 V3 6H6 R12 R10 6200 C20 C21 C58 C22 L1 L8 M1 V12 7F8 R11 R42 C44 R43 R54 R53 R51 S4 R47 R46 R44 V13A 7F8 C45 R45 V13B 7F8 R48 M2 R52 R49 OP 1 2 S3C R13 1050Ω OP 1 2 S3B R21 R25 R20 75K C37 V6 7F8 R22 C36 C59 C35 .001 R23 R69 R24 C33 L6 C32 C31 V5 7F8 R16 R19 C34 Y2 5.350Mc 10.7Mc CAL. T2 K1A K1B K1C 1-1 XTAL. HTR. T1 3-26 3-27 F2 F1 V7 2050 150K R26 R27 100K 40K R28 15K R29 HEATERS & METER LIGHTS 10 9 8 7 6 5 4 3 2 1 17 16 15 14 13 12 11 YEL MOD BLU BLACK FREQ BLUE

V9 6Y6G C42 V10 7AG7 R35 R38 R36 R37 R32 R30 V11 VR105 R39 C41 +270 6 5 4 3 2 1

| | |
|---|---|
| RADIO ENGINEERING LABORATORIES, INC. | |
| CONSULTING AND DESIGNING | |
| 35-54 36TH ST. LONG ISLAND CITY, N. Y. | |
| SCHEMATIC OF F.M. MONITOR MODEL 600A | |
| DATE– 5-4-49 | S-663 |
| SCALE– | |
| DR. BY– | |
| APP. BY – | |




SEPARATE POWER SUPPLY CHASSIS