

INSTRUCTION BOOK
for
STANDARD SIGNAL GENERATOR

Model 78 B

MEASUREMENTS CORPORATION



BOONTON

NEW JERSEY

MADE IN U.S.A.

Model 78B Standard Signal Generator

The Model 78B covers two frequency ranges: 15-25 mc. and 195-225 mc. The instrument has been designed primarily for field use. Many precautions have been taken in the choice of component parts and in the design of circuits to assure continued operation under adverse conditions of vibration, humidity, temperature, etc.

SPECIFICATIONS:

Frequency Range: 15 to 25 megacycles and 195 to 225 megacycles.

Modulation: Choice of 400 or 8200 cycle amplitude modulation fixed at approximately 30%. The modulation may also be turned off.

Output Voltage: Continuously variable from 1 microvolt to 100,000 microvolts.

Output Impedance: Fixed at 34 ohms.

Dimensions: 10" x 13" x 7".

Weight: Approximately 25 lbs.

Fuses: Two type 3 AG 1 ampere.

Power Supply: 117 volts, 25 to 60 cycle AC.

Tubes: One type 9002 r. f. oscillator
One type 7Y4 rectifier tube.
One type VR-150-30 voltage regulator tube
One type 7L7 amplifier tube
One type 7C5 modulator tube

Audio Jack: About 30 volts of modulation frequency voltage is available through the jack on the front panel for synchronizing oscilloscope sweeps. Any external impedance connected to this jack should be greater than 50,000 ohms.

OPERATING INSTRUCTIONS:

1. Plug the power cord into a 117 volt line having a frequency of 25 to 60 cycles.
2. Throw the power switch to the "ON" position and allow about 30 seconds for the tubes to warm up. The reading on the output meter should be adjusted to the red mark by the knob marked "output." If no reading is obtained see that the button marked "range switch" is either all of the way in or out and inspect the fuses immediately adjacent to the power cord. These are removable from the front of the instrument by unscrewing them from their holders.
3. There are two frequency bands: 15 to 25 mc and 195 to 225 mc. Select the desired band by means of a two position push-pull range switch on the panel.
4. Adjust the frequency dial by means of the knob located at the left side of the panel to the correct frequency as determined from the frequency calibration chart located directly under the instrument. This chart can be pulled out for use drawer-wise.
5. The output is controlled by the sliding tube at the righthand side of the instrument to which there is attached the output cable and output terminals. The output is indicated on the scale engraved on the sliding tube. Pulling the tube out decreases the output down to 1 microvolt — the lowest obtainable output. Pushing the tube in increases the output to 100,000 microvolts — the maximum output.
6. Very short leads must be used to connect the output terminals of the model 78B to the receiver under test. Leads longer than two inches at 200 megacycles will cause serious errors in output voltage because of resonant step-up.
7. Insert in series with the output leads the correct dummy antenna resistance determined by subtracting 34 from the desired value: for example, if the receiver operates from a 100 ohm cable, the dummy antenna resistor should be 100 minus 35 or 65 ohms. If the receiver is designed for operation from a balanced input line, this dummy antenna resistor should be half (33 ohms each for a 100 ohm input) as much inserted in each lead.
8. See that the output meter is adjusted to the red line; otherwise the output voltage indicated on the engraved scale will not be correct.
9. Also check tuning of the generator for maximum output from the receiver at each test frequency.
10. The modulation is controlled by the dial located near the output knob under the output meter. When the dial is turned to "8200" the output is amplitude modulated approximately 30% at 8200 cycles. When the dial is set at 400 cycles the generator is also modulated approximately 30%. When the dial is set at "OFF" the carrier is unmodulated.

DESCRIPTION OF MODEL 78B:

R. F. Oscillator: The r. f. oscillator uses a 9002 tube operating in a Colpitts circuit. A splitstator tuning condenser simplifies operation of the circuit and eliminates moving contacts which might give rise to noise as the frequency is varied. A two position range switch selects either of the frequency ranges desired. The oscillator is shielded by means of a silver plated copper box. All leads into the box are carefully filtered to eliminate leakage and stray fields. The frequency scale is carried on a drum which rotates with the tuning condenser shaft. The tuning condenser is driven by means of a combined planetary and cord drive which produce a reduction ratio of approximately 20:1.

The Attenuator: The mutual inductance type attenuator gives a logarithmic variation of output voltage with linear displacement of the movable tube. This attenuator consists of a grounded metallic tube placed so that one end is near the oscillator coil. A second coil is attached to the movable inner tube which can be moved linearly inside of the grounded outer tube to change the coupling and thus vary the output voltage. The system is designed so that a variation of 10 to 1 in output voltage is secured by a 9/16" linear travel of the movable inner coil and tube. The movable coil is connected to the output terminals by a transmission line which is terminated in its characteristic impedance to eliminate standing wave errors. The output meter indicates the oscillator grid current so that a standard, fixed input to the attenuator can be maintained. As the instrument, is tuned thru its frequency range, it will be necessary to re-adjust the output meter to the red mark by means of the output knob. This knob controls the plate voltage applied to the r. f. oscillator. The range switch has a set of contacts which insert the correct shunt on the output meter, so that it can be set to the same red mark on both tuning ranges. The attenuator is calibrated between 1 and 100,000 microvolts. Considerable care has been exercised in the filtering of the power supply leads and the shielding of the instrument to reduce the leakage and stray fields to a minimum.

The Modulator: The audio oscillator used in the modulator operates on the resistance tuned principle as described by Professor Terman in the Proceedings of The Institute of Radio Engineers for October, 1939, page 654. This oscillator has the advantage of low distortion, stable frequency, constant output voltage, etc. The oscillator consists of a two stage resistance coupled audio amplifier which has its output tied back to its input thru a frequency selective network, such that oscillation occurs at one frequency. The amplitude of this oscillation is controlled by a degenerative network in the cathode of the first amplifier tube. This degenerative network includes a small lamp filament in such a manner, that an increase in oscillation amplitude causes an increase in the resistance of the lamp filament which increases the amount of degenerative or negative feedback, thus maintaining a constant amplitude of oscillation. In most oscillating circuits the non-linearity of a vacuum tube characteristic is utilized to limit the amplitude of oscillation and this results in some distortion. But in the resistance tuned oscillator the vacuum tubes are kept on linear or class "A" portions of their characteristics, and the control of amplitude left to the non-linear lamp characteristic, which by virtue of its thermal lag does not introduce distortion.

This resistance tuned oscillator does have a characteristic variation in output voltage of about 1% when properly adjusted. This variation takes the form of a small, slow, periodic shift in audio output amplitude. This effect results because of the fact that the lamp requires a small change in output before correction can be made, just as an a.f.c. circuit requires a small change in frequency to affect any frequency correction. The correction is a slow one because of the thermal lag characteristic of the regulation lamp filament. If the degenerative feedback control rheostat is improperly set so that insufficient power is applied to the lamp, it will not operate far enough up its characteristic, and a "bouncing effect" or severe variation in audio output will result — particularly when the modulation is turned off or on. If too much voltage is fed back to the lamp by reducing the rheostat too far, the power output tube will be overloaded and distortion of the waveshape will result. A dull red glow of the lamp indicates sufficient negative feedback, and under normal conditions the 7C5 tube should have no difficulty in supplying this small amount of power without distortion.

The audio output amplitude has been adjusted by the manufacturer to produce 30% modulation. Since a VR-150/30 regulator tube is used to hold the plate supply to the constant value of 150 volts d.c., the audio is adjusted to deliver 45 peak volts (32 volts r.m.s.) by means of the feedback control at the top of the modulation and power unit as viewed from the rear. Due to the large amount of negative feedback and automatic control effected by the lamp filament, the modulator will continue to deliver 45 peak volts over a wide range of power supply voltages.

The modulation frequency is determined by the time constants of the regenerative resistance capacitance network. The modulation switch in the model 78B adjusts the resistance to the correct value to produce 8200 cycles and 400 cycles; however it is possible to obtain other modulating frequencies by inserting different values of resistance and capacitance in accordance with the following formula:

Frequency = $\frac{1}{2\pi RC}$, where R is the value of the series and shunt resistor and C the value of the series and shunt condenser. If very low modulation frequencies are desired, it may be necessary to employ larger blocking condensers in the resistance coupled amplifier than those used on the standard model 78B.

The modulation is turned off by shorting the grid of the 7C5 tube to ground.

The Power Supply: The power supply employs a power transformer having an unusually large core cross section capable of operating on frequencies as low as 25 cycles. It is possible to operate the instrument on 60 cycles or higher frequencies without any change in power supply. The high voltage is rectified by a type 7Y4 tube and filtered to eliminate a.c. ripple. No electrolytic condensers are used in the instrument.

A type VR-150-30 gaseous regulator tube is used to maintain constant plate voltage on the r.f. oscillator in order that the output and frequency of the generated carrier will be substantially independent of power supply variations.

One ampere panel mounting fuses have been inserted in each side of the power line to protect the instrument against damage if attempts are made to operate the instrument on direct current or 220 volts. It is important that these be replaced with fuses of the correct type, otherwise the instrument may be seriously damaged.

MAINTENANCE AND REPAIR:

Every effort has been made to select and inspect all component parts to insure uninterrupted trouble-free service. However, in any instrument as complex as the model 78B, some troubles may occur, and this section is devoted to suggestions for locating and correcting the troubles.

If no reading is obtained on the output meter, the fuses should be inspected. They are located near the power cord and are readily accessible from the front of the panel. In the event one is blown it should be replaced with a standard one ampere type 3AG fuse. In the event that the fuses continue to blow, the power supply should be checked for correct voltage and frequency. If this is not the trouble, it may be due to a short somewhere in the heater or B supply, or possibly in the power transformer itself or the line filter. If the fuses are not blown, but the instrument refuses to operate and the correct reading cannot be obtained on the output meter, an inspection of the VR-150/30 voltage regulator tube visible thru the louvers on the righthand side of the case will disclose whether or not the B supply is functioning. The absence of a purple glow in this tube indicates a likelihood of trouble in the rectifier tube, power transformer, filter condensers, or the line filter.

If the VR-150/30 glows, but the proper indication cannot be obtained on the output meter, the trouble may be in the r. f. oscillator unit or its supply leads.

To repair any troubles inside the instrument, the generator should be removed from the case in the following manner: Place the instrument on its back on a bench and remove the 12 screws around the edge of the panel. The front panel to which are attached all of the components may then be lifted from the case. To inspect the r.f. unit, place the panel face down on the bench and remove the screw which holds the black r.f. shield cover in place. After this cover is removed the various supply voltages to the oscillator can be checked and the 9002 tube removed and tested. It may be well to insert a new 9002, since some tube tests will not adequately indicate usefulness of the tube as a high frequency oscillator. It should have a mutual conductance of at least 1800 microhms as measured on a dynamic mutual conductance tester. The voltage on the oscillator varies with the range switch and with the setting of the output knob —

If the trouble is localized in the power unit, this can be removed from the front panel in the following manner: unsolder the wires leading from the terminal strip located just above the drum dial; then unsolder the twisted red and black leads from the power line by-pass condensers located on the front panel directly under the power transformer; remove the knobs marked "output" and "modulation" and remove the $\frac{1}{2}$ " nuts underneath them; then the six screws that hold the power unit in place may be removed and the entire unit lifted from the front panel. Care should be taken to remove only the right screws in doing this, as other loose screws may cause trouble.

After the trouble has been located and the repair effected, the instrument can be reassembled by reversing the order of the above operations. Care should be exercised not to disturb the adjustment of the three variable rheostats, unless re-calibration is necessary.

Per Cent Modulation re-calibration: The rheostat marked "audio oscillator" controls the percentage modulation. To adjust the modulation percentage, a vacuum tube voltmeter arranged to block off d.c. should be connected from the B+ lead to the oscillator to ground. The output control knob should be turned all of the way up (Maximum) and the rheostat turned until a peak reading of 45 volts or 32 volts r.m.s. of audio is indicated on the v.t.v.m. It is necessary that the "modulation switch" be set either on 400 or 8200 in order to do this, of course. Since the VR-150/30 tube holds the applied plate voltage constant at 150 volts, the carrier will be modulated 30% by the 45 peak volts of modulation.

Attenuator Output Calibration: The relative calibration of the mutual inductance attenuator is fixed, but the absolute reference level of 100,000 microvolts or 1/10 volt can be adjusted in the following manner; a sensitive vacuum tube voltmeter having low input capacity and very short leads to produce a self resonant frequency well above 300 megacycles should be connected across the output terminals, and the attenuator adjusted to read 100,000 microvolts with the range switch set for the 195 to 225 megacycle range. The modulation must be turned "OFF." The output control should be set at approximately 3/4 of its full rotation clock-wise, then the rheostat marked "output meter calibration" located on the side of the power unit chassis should be adjusted until the output meter reads on the red mark with the frequency dial set at about 210 megacycles. The set screw located in the hole in the knurled knob on the attenuator slider should be loosened, and the position of the output pick-up coil adjusted until the v.t.v.m. reads 1/10 volt. This can be accomplished by moving the 1/4" chrome plated tube which projects from the attenuator slider. When properly adjusted the output coil should be about 1/16" to 1/8" away from the high frequency oscillator coil, and should be oriented in the same direction as the oscillator coil for maximum pick-up. The set-screw in the knurled knob should then be tightened securely.

The switch should now be changed to the low frequency range and the frequency dial adjusted to about 20 megacycles. With the attenuator still adjusted to read 100,000 microvolts, the output knob should be adjusted until the v.t.v.m. reads 1/10 volt. The rheostat inside the r.f. oscillator shield can should then be adjusted until the meter reads opposite the red mark. This rheostat is accessible from the top of the r.f. oscillator just to the right of the frequency scale drum.

WARNING: The adjustment outlined above is critical and should not be attempted unless absolutely necessary. Care should be exercised in ordinary repair work not to change the position or adjustment of the output or r.f. oscillator coils.

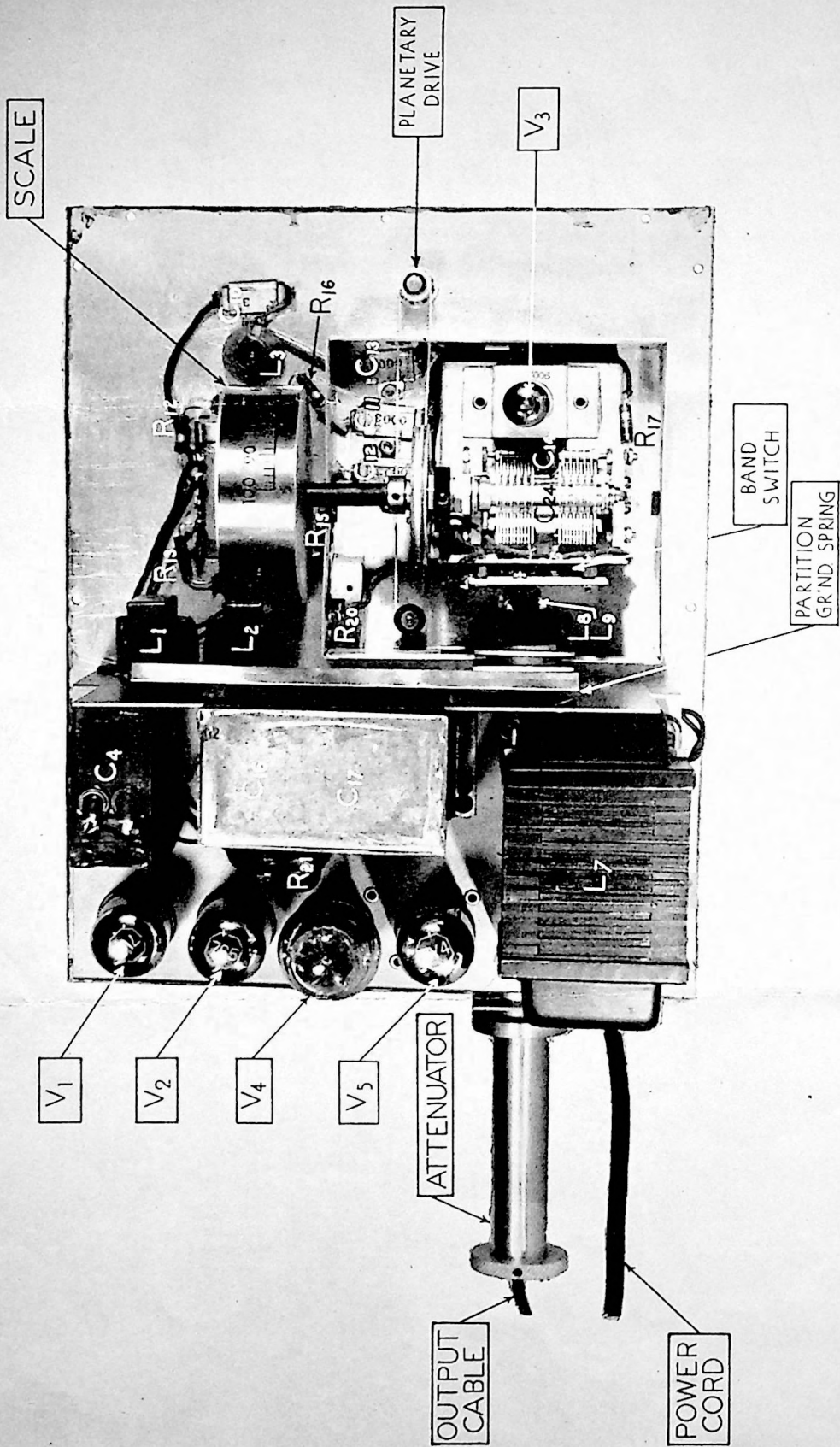
Any further information not contained in this instruction book may be obtained from the Measurements Corporation at Boonton, New Jersey.

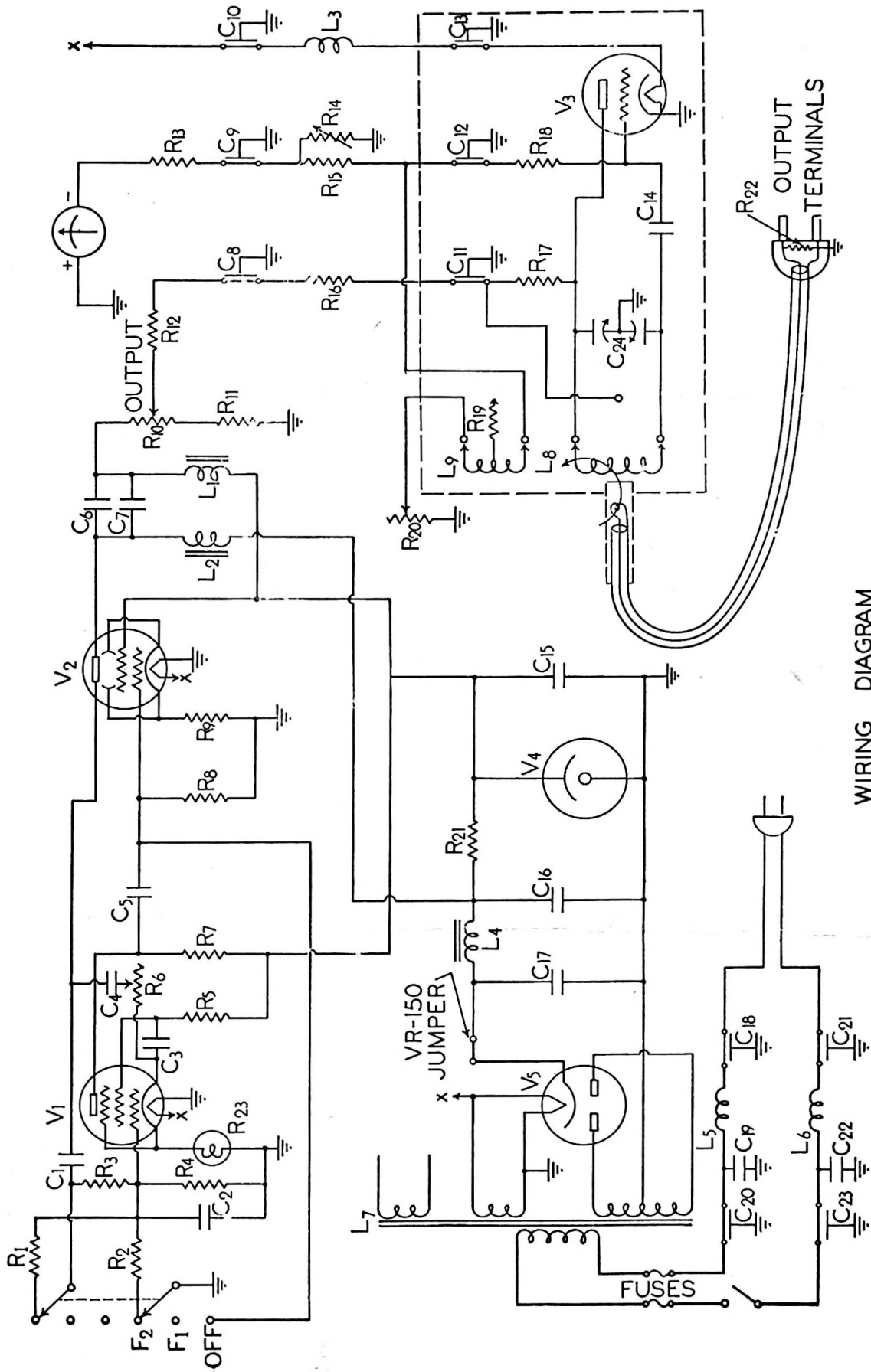
PARTS LIST — MODEL 78-B

78C
 .980 M44 } ?
 .980

C 1	Condenser	.001 mfd. 400 V	
C 2	"	" " "	
C 3	"	.1 " 300 V	
C 4	"	4 mfd. (Dwg. No. 78-K1)	
C 5	"	.003 mfd. 400 V	
C 6	"	.1 " 300 V	
C 7	"	.5 " 200 V	
C 8	"	.0003 "	
C 9	"	.0003 "	
C 10	"	.0003 "	
C 11	"	.0003 "	
C 12	"	.0003 "	
C 13	"	.0003 "	
C 14	"	.0001 "	
C 15	"	.1 " 400 V	
C 16	"	8-8- " (Dwg. 78-K2)	
C 17	"	in common case	
C 18	"	.0003 mfd.	
C 19	"	.003 " 400 V	
C 20	"	.0003 "	
C 21	"	.0003 "	
C 22	"	.003 " 400 V	
C 23	"	.0003 " ?	
C 24	"	Tuning Condenser	
F 1		400 cycles	
F 2		625 cycles	
L 1	Choke	Stancor No. C-1706	
L 2	"	" "	
L 3	"	Dwg. No. C 8	
L 4	"	Thordarson T13C28	
L 5	"	Dwg. C-8	
L 6	"	Dwg. C-8	
L 7	Transformer	Dwg. 78-A15	
L 8	Coil	Dwg. 78-R15-3	
L 9	"	Dwg. 78-R17	
R 1	Resistor	20,400 ohms, 2%, 1/2 Watt	710000
R 2	"	20,400 " " " "	710000
R 3	"	400,000 " " " "	
R 4	"	400,000 " " " "	
R 5	"	250,000 " 10% " "	
R 6	Rheostat	10,000 " 1 Watt	
R 7	Resistor	100,000 " 10% 1/2 Watt	
R 8	"	500,000 " " " "	
R 9	"	500 " " " "	
R 10	Potentiometer	20,000 " 4 Watt	
R 11	Resistor	20,000 " 10% 2 Watt	
R 12	"	1,000 " " 1/2 "	
R 13	"	1,000 " " " "	
R 14	Rheostat	15,000 " 1 Watt	10000
R 15	Resistor	1,000 " 10% 1/2 Watt	
R 16	"	2,000 " " " "	
R 17	"	10,000 " " " "	
R 18	"	25,000 " " " "	
R 19	"	1,000 " " " "	out
R 20	Rheostat	15,000 " 1 Watt	10000
R 21	Resistor	2,500 " 20 Watt	
R 22	"	34 " 2% 1/2 Watt	
R.23		Lamp, 3 watt 110 volt.	
V 1		Tube, 7L7	
V 2		" 7C5	
V 3		" 9002	
V 4		" VR 150	
V 5		" 7Y4	

REAR VIEW OF PANEL





WIRING DIAGRAM

