Operating Instructions for Type 720-A Heterodyne Frequency Meter

1.0 DESCRIPTION

The Type 720-A Heterodyne Frequency Meter is designed for measuring frequencies between 10 Mc and 3000 Mc. It contains a calibrated oscillator, a detector, and an audio amplifier. The oscillator frequency can be varied continuously between 100 Mc and 200 Mc. The unknown frequencies are measured by producing beats with the calibrated heterodyne oscillator. Beats may be produced between the fundamentals of the unknown source and the heterodyne oscillator, between harmonies of the unknown frequency and the heterodyne fundamental, between the unknown fundamental and harmonies of the heterodyne oscillator, or between harmonies of both the unknown source and the heterodyne oscillator. The main dial of the frequency meter has essentially a logarithmic calibration, and one small division of the vernier dial corresponds approximately to a frequency change of 0.01percent. A schematic circuit diagram is shown below. A complete wiring diagram is attached to the inside of the cabinet.

2.0 OPERATION

2.1 Battery

One Burgess 6TA60 Battery is used to supply 90 volts to the plates and 1.4 volts to the filaments of the vacuum tubes. This battery is held in place by a cover secured by a thumbscrew. If the battery becomes loose, the sponge rubber in the bottom of the compartment can be adjusted. All necessary connections are made by a battery plug attached to a short cable. Filament and plate loads are well balanced, and the battery will give long service in intermittent use. Since the heating-up time of the tubes is very short, the instrument can be turned off if appreciable time elapses between measurements. The battery should be replaced if the deflection of the panel meter is below one milliampere with the volume control at minimum. Operating currents and voltages are listed in the table below.

2.2 A-C Power Supply

Type 1261-A Power Supply fits the battery compartment and with Type 1261-P3 Selector Plug, supplies the filament and plate voltages for the tubes. To adjust filament voltage to correct value, connect a 1000-ohms-per-volt voltmeter to filament terminals. With filaments turned on, note voltmeter reading; press push-button switch on top of the power supply unit. Turn screwdriver adjustment on the top of power supply until meter reading does not change when button is depressed. ***IMPORTANT*** – When AC power supply is used, leave panel switch ON and use switch in power cord to turn instrument on and off.

2.3 **Tubes** V-1 -- Type 1N5-GT (RCA or equivalent) V-2 -- Type 1D8-GT (RCA or equivalent) V-3 -- Type 958-A (RCA). Select 958-A replacements for low microphone noise. Pick to match frequency calibration as follows: 1. Set an external oscillator (which will beat with 100 and 200 Mc) to obtain beat note with 720-A set at 100.0 Mc. 2. Then set 720-A to get beat note at or near 200.0 Mc. 3. Choose 958-A which gives beat nearest 200.0 Mc. 4. Reset trimmer C-19.

2.4 Detector - 1N21B (Sylvania or equivalent)

A pair of head telephones plugged into the jack marked PHONES is the best means of determining beats. For fairly strong signals the presence of a beat will be indicated by a downward deflection of the panel meter. Exact zero beat will result in no deflection of the meter. The beat note will be heard in the small dynamic speaker on the panel if the telephones are unplugged.

The audio-frequency amplifier has a useful bandwidth of 50 kilocycles, hence indications will be obtained on the panel meter when the beat frequency is above the audible range. This feature is useful when the frequency under measurement is unstable and no steady audible beat can be obtained.

2.5 Coupling

Adequate coupling is usually obtained if the instrument is placed in the vicinity of the oscillator whose frequency is to be measured. For high frequencies the length of the antenna, marked INPUT, on the front panel can be adjusted to improve signal strength. For frequencies below 100 megacycles, it may be necessary to connect a short wire to the antenna.

3.0 MAKING FREQUENCY MEASUREMENTS

3.1 **Frequencies Between 100 and 200 Mc**

When the frequency to be measured lies within the fundamental range of the Type 720- A Heterodyne Frequency Meter, the unknown frequency is read directly from the main dial when a strong beat is obtained. In addition to this beat note other weaker beat notes may be heard. For example, if a fundamental frequency of 150 Mc is measured, a strong beat will be obtained at a dial setting of 150.0 Mc, and weaker beats may be heard at dial settings of 100 and 112.5 Mc. These weaker beats are produced between the 2d and 3d harmonies of the unknown frequency and the 3d and 4th harmonics of the Type 720-A Oscillator, respectively; 2 X 150 Mc = 3 X 100 Mc and 3 X 150 Mc and 3 x 150 Mc = 4 x 112.5 Mc.

3.2 Frequencies above 200 Mc

For frequencies which lie above 200 Mc the procedure is to start at the high end of the frequency range and to note the successive settings of strong harmonic beats as the frequency of the heterodyne oscillator is progressively reduced. If the frequency at which one beat occurs is divided by the frequency difference between it and a successive beat, the result must be an integer and is the harmonic number of the successive beat. *Example*: A high frequency is measured and strong beats are obtained at 200.0 and 160.0 Mc. Subtracting the second beat from the first gives 200.0 - 160.0 - 40.0. Dividing the first beat by this difference gives 200.0/40.0 = 5, which is the harmonic number of the second beat. Hence, the unknown frequency is 5 X 160.0 = 800 Mc.

3.3 Beats Between Harmonics

In many cases it will be possible to produce beats between harmonics of the unknown frequency and harmonies of the heterodyne oscillator. These beats will usually be much weaker than the beats produced between the unknown fundamental and the heterodyne harmonies. The following chart gives the possible beats up to the 3d harmonic of the unknown used in the example above.

In general, if the "unknown" frequency is known approximately, a single beat is sufficient to determine the frequency accurately. On the other hand, if the approximate value is not known, it win be necessary to note successive beats until their pattern can be determined as above. Much time can be saved and possible errors eliminated, however, if the unknown frequency is determined approximately by other means, such as an absorption-type wavemeter.

3.4 Frequencies Below 100 Mc

For frequencies which lie below 100 Mc, the procedure is to start at the low end of the frequency range and to note the successive settings of the beats as the frequency of the heterodyne oscillator is progressively increased. The frequency between two successive beat settings is equal to the unknown frequency. Example: A low frequency is measured and beats are observed at 105.0, 190.0 and 135.0 Mc. The frequency difference between successive beats is 15.0 Mc, which is the frequency being measured.

4.0 MAINTENANCE

4.1 Tubes and Batteries For replacements, see 2.1 and 2.3 above.

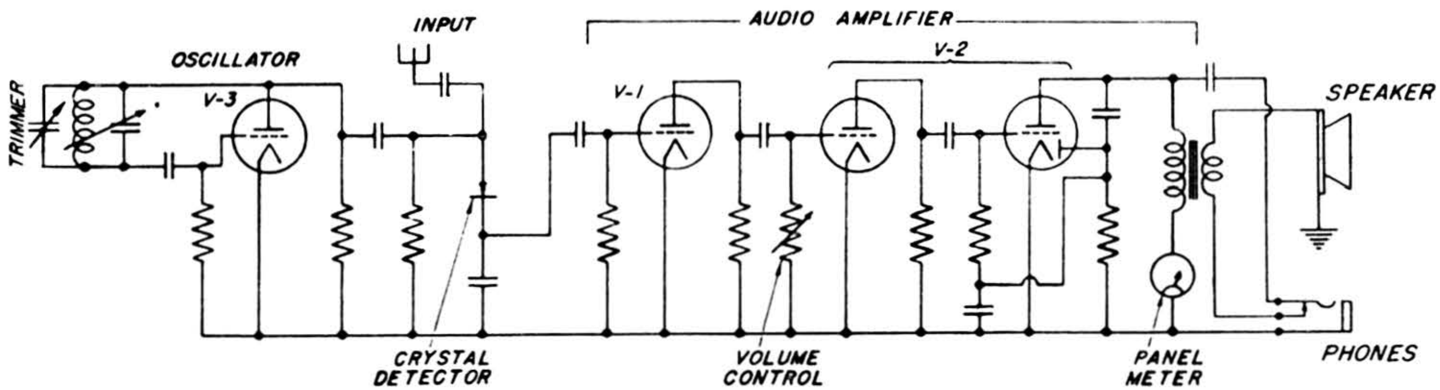
4.2 Detector

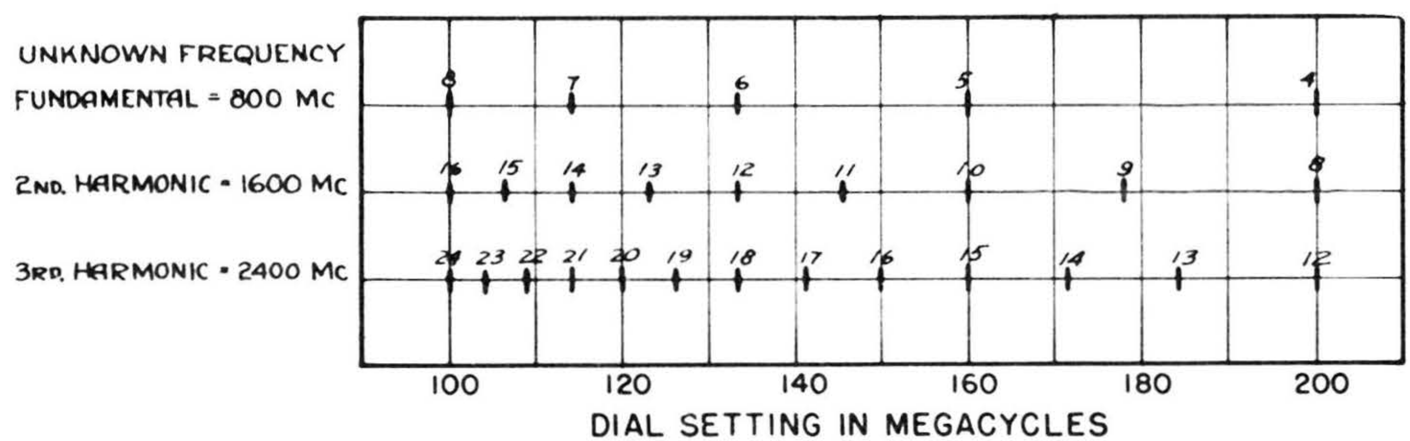
The detector is located near the antenna-input terminal and is held in place by a ring-shaped spring. A spare detector cartridge (clamped to the left rear corner of the top shelf) is supplied with the instrument.

When the dial is rotated rapidly, a drone from the gear train plus some microphonics from the oscillator tube should be heard in the telephones. If these sounds are not heard, either the oscillator is not working or the detector unit is defective.

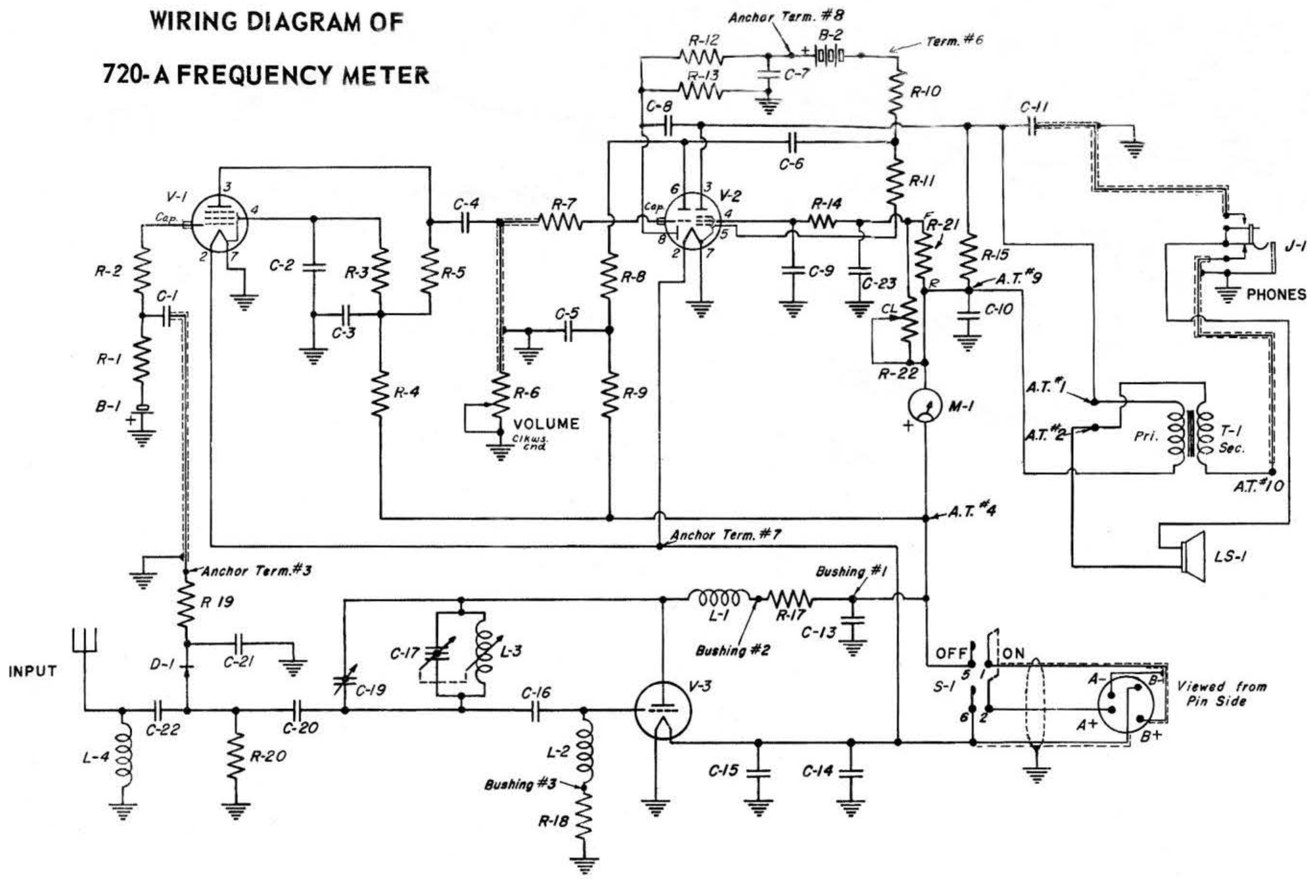
The detector can be tested with an ohmmeter operated from a 1.5-volt battery. The R x 100 range of a Weston Model 663 Ohmmeter is satisfactory for this test. For proper operation, the ratio of back resistance to forward resistance should be 30 to 1 or greater with the back resistance greater than 10,000 ohms and the forward resistance less than 1,000 ohms. The detector will work with ratios of back to forward resistance less than 30, but efficiency of detection is decreased.

	B+	Total B Current	Panel Meter	Filament Voltage	Filament Current	Osc. Grid Current	Osc. Pl. Current
Fresh Battery	90 v	8–9 ma	4–5 ma	1.5 v	270 ma	25–50 μa	3 ma
Average Oper.	75–85 v	4.5–7.5 ma	1.5–3.5 ma	1.2–1.4 v	240–260 ma	20–40 μa	2.3–2.7 ma





WIRING DIAGRAM OF 720-A FREQUENCY METER



RESISTORS

R-1 =	1 MΩ	±10%	IRC	BT-1/2
R-2 =	270 Ω	±10%	IRC	BT-1/2
R-3 =	270 Ω	±10%	IRC	BT-1/2
R-4 =	270 Ω	±10%	IRC	BT-1/2
R-5 =	0.1 MΩ	±10%	IRC	BT-1/2
R-6 =	1 MΩ	±10%		POSC-12
R-7 =	270 Ω	±10%	IRC	BT-1/2
R-8 =	0.1 MΩ	±10%	IRC	BT-1/2
R-9 =	270 Ω	±10%	IRC	BT-1/2
R-10 =	1 MΩ	±10%	IRC	BT-1/2
R-11 =	270 Ω	±10%	IRC	BT-1/2
R-12 =	4.7 MΩ	±10%	IRC	BT-1/2
R-13 =	1 MΩ	±10%	IRC	BT-1/2
R-14 =	270 Ω	±10%	IRC	BT-1/2
R-15 =	12 kΩ	±10%	IRC	BT-1/2
R-17 =	5.6 kΩ	±10%	IRC	BT-1/2
R-18 =	0.1 MΩ	±10%	IRC	BT-1/2
R-19 =	6800 Ω	±10%	IRC	BT-1/2
R-20 =	47 kΩ	±10%	IRC	BT-1/2
R-21 =	100 kΩ	± 5%	IRC	BT-1/2
R-22 =	500 kΩ	±10%		POSC-11

CONDENSERS

C-1 =	0.005 μf	±10%	CD	1W
C-2 =	0.0005 μf	±10%	CD	5W
C-3 =	0.0005 μf	±10%	CD	5W
C-4 =	0.005 μf	±10%	CD	1W
C-5 =	0.0005 μf	±10%	CD	5W
C-6 =	0.005 μf	±10%	CD	1W
C-7 =	0.01 μf	±10%		COM-35B
C-8 =	0.005 μf	±10%	CD	1W
C-9 =	0.0005 μf	±10%	CD	5W
C-10 =	0.0005 μf	±10%	CD	5W
C-11 =	0.1 μf	±10%		COL-11
C-13 =	350 μμf			GR Built-in Condenser
C-14 =	350 μμf			GR Built-in Condenser
C-15 =	250 μμf			GR Built-in Condenser
C-16 =	100 μμf			GR Built-in Condenser
C-17 =	Part of Tuned Circuit			
C-19 =	15 μμf			COA-24
C-20 =	3 μμf			GR Concentric Cond.
C-21 =	500 μμf			GR Built-in Cond.
C-22 =	3 μμf			GR Concentric Cond.
C-23 =	0.25 μf	±10%		COL-12

TUBES

V-1 =	RCA	IN5-GT
V-2 =	RCA	ID8-GT
V-3 =	RCA	958

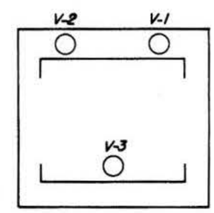
INDUCTORS

L-1 =	ZCHA-9
L-2 =	ZCHA-9
L-3 =	Part of Tuned Circuit
L-4 =	CHA-597

MISCELLANEOUS

Battery	Burgess		6AT60
B-1 = 1, 1-1/2 volt	Mallory	Bias Cell	
B-2 = 4, 1-1/2 volt	Mallory	Bias Cell	
M-1 = 5 ma D-C Meter			MED-8
S-1 = DPST Switch			SWP-4

J-1 =	Jack	CDSJ-3
T-1 =	Output Transformer	720-40
LS-1 =	Loud Speaker	4SP-3
D-1 =	Crystal Det. Assembly	IN21-B



BACK VIEW OF INSTRUMENT

GENERAL RADIO COMPANY, Cambridge, Massachusetts