OPERATING INSTRUCTIONS
FOR
TYPE 713-B
BEAT-FREQUENCY OSCILLATOR
FORM 487-C

GENERAL RADIO COMPANY
CAMBRIDGE A, MASSACHUSETTS

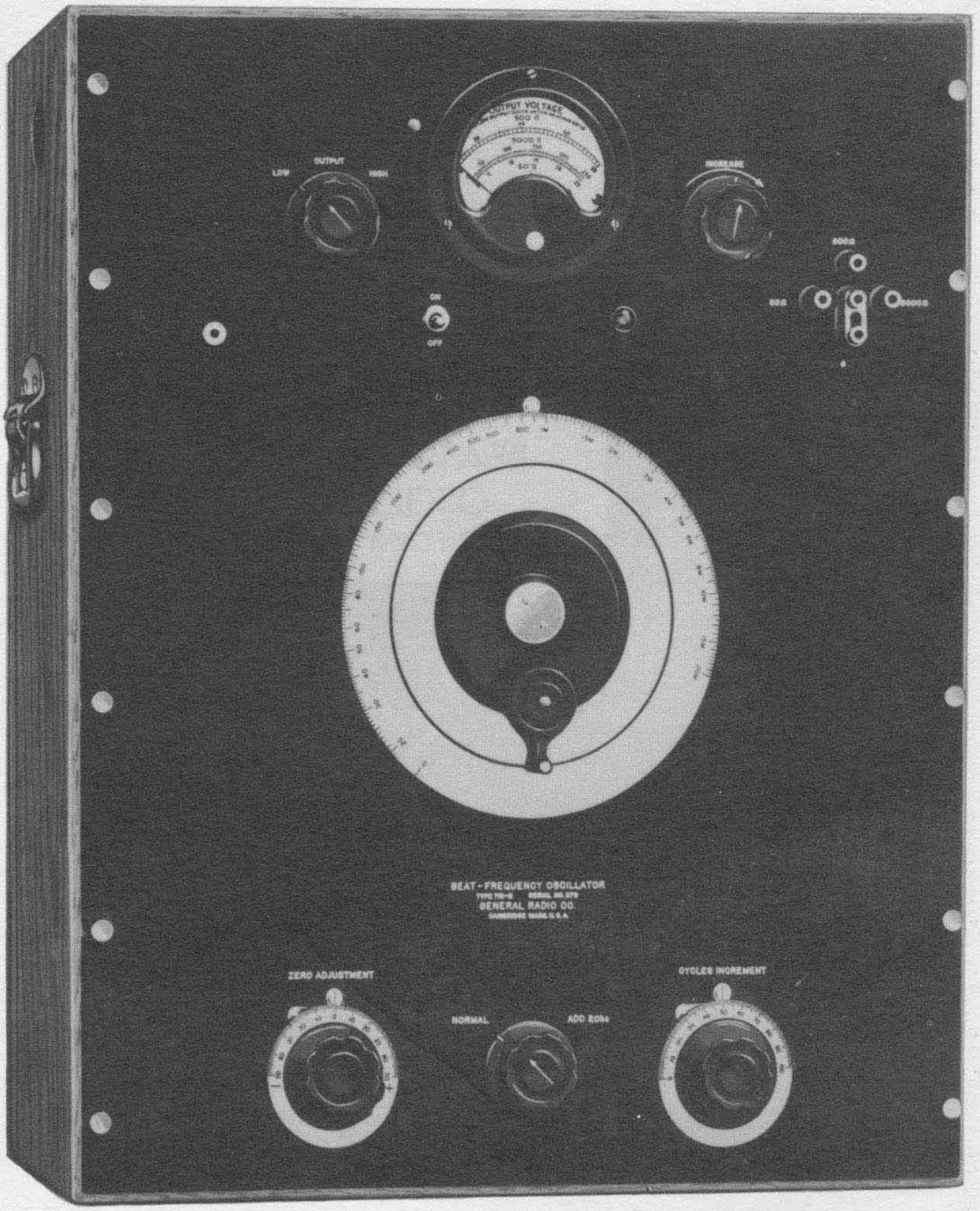

FIGURE 1. Photograph of Type 713-B Beat-Frequency Oscillator

PATENT NOTICE

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Patent 1,542,995.
Patent 1,525,778.

GENERAL RADIO COMPANY

OPERATING INSTRUCTIONS
FOR
TYPE 713-B
BEAT-FREQUENCY OSCILLATOR

PART 1
DESCRIPTION

The Type 713-B Beat-Frequency Oscillator is an a-c operated device intended for use as a source of alternating current for making tests in the audio-frequency and lower supersonic-frequency ranges. The frequency range of the oscillator is from 10 to 40,000 cycles per second with a logarithmic calibration from 20 to 20,000 cycles per second. Throughout the greater portion of this range the available power is slightly over one watt into a matched load while the open circuit voltage is approximately 150 volts. The instrument is provided with a tapped output transformer providing impedances of 50, 500 and 5000 ohms. These output impedances remain constant regardless of the setting of the volume control. The output circuit is so designed that it will work into a grounded or an ungrounded load. The 50- and 500-ohm output circuits are satisfactory for working into the average low-impedance audio-frequency transmission lines.

Throughout the important part of the audio-frequency spectrum the oscillator maintains a practically constant open circuit output voltage or a practically constant voltage across a resistive load of the rated impedance. Accordingly, for most practical audio-frequency tests, it is merely necessary to connect the oscillator directly to the line or equipment, making sure that a reasonable impedance match is secured, and then turn the main frequency control over the audio-frequency range and note the reading of an output meter on the equipment under test.

When loaded with the rated impedance, the oscillator will provide high output with low harmonic distortion.

PART 2
INSTALLATION

The instrument is shipped with all tubes removed from their sockets excepting the vacuum-tube voltmeter tubes T-8 and T-10 which are both Type 6H6.

The other tubes are stamped for their proper location, which is as shown in Figure 2. The various tube types are as follows:

T1 = 41	T4 = 6C6	T7 = 6L6
T2 = 41	T5 = 6C6	T8 = 6H6
T3 = 6D6	T6 = 6L6	T9 = 5T4
		T10 = 6H6

The instrument is not critical in regard to the selection of tubes, but it has been adjusted in the manufacturer's laboratory for a minimum harmonic content with the tubes installed in accordance with the numbers stamped on them. It is, accordingly, advisable to use care in placing the tubes in the correct sockets. The proper procedure when installing a new set of tubes is described in a later section of this instruction book.

PART 3
OPERATION

Instruments are normally connected for 110- to 120-volt operation. Under these conditions, terminal 2 is strapped to terminal 4 on the power transformer and terminal 1 is strapped to terminal 3. These connections are shown in the wiring diagram.

The instruments are also supplied on

special order for operation from 220 to 240 volts. Under these conditions, terminals 1 and 3 and 2 and 4 are no longer connected together and terminals 3 and 2 are strapped together instead. In making this change the name plate near the power jack is also changed.

For the convenience of customers who may wish to change the oscillator from one voltage range to the other, two name plates are supplied, one mounted on top of the other. If the power transformer connections are changed, the name plates should also be changed to eliminate any possibility of damage to the instrument from connecting it to a line of the wrong voltage.

Ground Connection

The instrument should always be operated grounded in order to avoid hum. A terminal is provided on the panel for this purpose.

Vacuum-Tube Voltmeter Adjustment

After the instrument has been turned on, allow it to warm up for a few minutes. Then, turn the volume control as far as it will go in a counterclockwise direction and set the zero-adjustment screw on the meter so that it reads zero.

Frequency Calibration

To set the frequency calibration, turn the output switch to the LOW position, the volume control (marked INCREASE) fully on, the main frequency dial to zero, the CYCLES INCREMENT dial to zero and the frequency range switch to NORMAL. Then, adjust the dial marked ZERO ADJUSTMENT until the meter on the panel reads zero. This adjustment is quite sharp and should be made carefully. It is advisable to check this adjustment occasionally during the first few minutes of operation if maximum accuracy of calibration is desired.

Frequency Adjustment

After the calibration has been adjusted, as described above, the output frequency at any time is determined by the setting of the frequency range switch, the main frequency dial and the CYCLES INCREMENT dial. These controls are all calibrated directly. With the frequency range switch in the NORMAL position the algebraic sum of the main frequency dial and the CYCLES INCREMENT dial gives the actual output frequency. When the frequency range switch is turned to the ADD 20 KC position, 20 kilocycles should be added to the sum of the readings of the other two frequency dials.

Output Switch

The function of this switch is to reduce the level at which the detector and amplifier circuits are operating, thus reducing harmonic distortion.

Load Impedance

Whenever possible, the oscillator should be operated into its rated load impedance, that is, a load of 5000 ohms should be connected to the 5000-ohm terminals or a load of 500 ohms should be connected to the 500-ohm terminals, etc. Under no circumstances should loads be connected to two sets of terminals at once. If the oscillator is operated into an open circuit, the harmonic content will increase slightly when the output switch is in the high position. When the output switch is in the low position the harmonics are practically no greater when operating into an open circuit than when operating into the rated load impedance.

Because of the design of the output circuit, it is possible to connect any load to the 5000-ohm terminals without introducing excessive distortion. When a very low impedance is connected across the 5000-ohm terminals, the total harmonic content is only about twice as great as when the oscillator is operated into its rated impedance. It is not recommended, however, that loads lower than 1/2 the rated value be connected to the 50- or the 500-ohm terminals, if best waveform is to be secured.

PART 4
SUGGESTIONS FOR USE

Frequency Setting

The main frequency control is calibrated logarithmically from 20 to 20,000 cps. Accordingly, this dial may be set to the same percentage accuracy at any portion of this range, which is a distinct advantage when recording data on logarithmic paper.

The CYCLES INCREMENT dial is useful

for obtaining accurate settings at very low frequencies and for obtaining frequencies in the range between 10 and 20 cycles which are not indicated on the main dial. The CYCLES INCREMENT dial is also useful when measuring resonance curves and for psychological acoustic measurements. This dial operates on both the NORMAL and ADD 20 KC positions of the frequency range switch.

The range from 20 kilocycles to 40 kilocycles is obtained by turning the FREQUENCY RANGE SWITCH to the ADD 20 KC position. Under these conditions 20,000 cycles should be added to the readings of the main frequency-control dial.

Internal Output Impedance

As previously mentioned, the oscillator is equipped with output terminals for 50-, 500- and 5000-ohm loads, and any impedance ranging from 1/2 of the rated value up to a complete open circuit can be connected to any of these terminals without seriously affecting the waveform or, in fact, without affecting the waveform at all when the output switch is on the LOW position. So far as the 5000-ohm terminals are concerned, practically any impedance ranging from a short circuit up to an open circuit can be connected to these terminals without introducing excessive harmonics.

When the ground strap is disconnected from the common output terminal, the 50- and 500-ohm output circuits are sufficiently well balanced for operation into the average audio-frequency equipment for frequencies up to 15 kilocycles. It is not recommended that the 5000-ohm terminals be operated into circuits where close balance is important.

Because of the design of the output circuit, best accuracy of the voltmeter readings at high frequencies in the neighborhood of 40 kilocycles is obtained when the 500-ohm output terminals are used.

PART 5
MAINTENANCE

The Tubes used in the Type 713-B Oscillator are not especially selected, and average tubes will usually be found satisfactory. During the first few minutes of operation with new tubes it may be found that the vacuum-tube voltmeter will have to be reset to zero several times, since the voltmeter tubes may shift their characteristics appreciably.

Waveform Adjustment

The detector and amplifier circuits in the oscillator are of the balanced push-pull type in order to reduce distortion to a minimum. The potentiometer provided with the screw-driver slot in the shaft, which will be found on the top shelf assembly, is R-28 on the diagram and controls the balance of the detector so that it can be set accurately for a minimum of second harmonic. Ordinarily, this adjustment need not be touched since the harmonic content of the oscillator will be so small as to be negligible. In cases where a distortion factor meter or wave analyzer is to be used, however, it is possible to readjust this control for minimum harmonic distortion.

PART 6
SPECIFICATIONS

Frequency Range:

10-40,000 cycles per second.

Frequency Control:

The main frequency control provides a true logarithmic increase in frequency with angular rotation over the range from 20 to 20,000 cps, the total scale length being approximately 17.5 inches. The INCREMENTAL FREQUENCY control provides a band extending 50 cycles on either side of the frequency determined by the setting of the main dial. The frequency range switch extends the range to 40 kilocycles.

Frequency Calibration:

The calibration may be readjusted at any time by merely setting the instrument to zero beat. This adjustment can easily

be made with an error of less than one cycle.

The calibration of the main frequency control dial can be relied upon to within 2% ± 1 cycle after the oscillator has been correctly set to zero beat, and for one year from date of purchase. The incremental frequency dial is marked with one division for every 1-cycle interval over a range of from -50 cycles, through 0 to +50 cycles. Its calibration is correct to within ±2 cycles per second.

Frequency Stability:

Care has been taken in the design of the oscillator to provide adequate thermal insulation and ventilation, thereby greatly minimizing frequency drifts due to temperature changes. During normal operation the frequency may drift 5 to 10 cycles in the first two hours of operation, and thereafter the drift will be practically negligible in the absence of any marked change in room temperature. Of course, the oscillator may be accurately reset to zero beat at any time, thereby eliminating the effects of even these small frequency drifts.

Output Impedance:

The output circuit includes a tapped autotransformer providing output impedances to 50, 500 and 5000 ohms. The output circuit is electrostatically shielded and isolated from ground, thus making it practical to operate into an ungrounded load such as a transmission line. The output circuit is sufficiently well balanced for operating into the average audio-frequency transmission lines throughout the entire frequency range of the oscillator when using the 50-ohm output terminals. When using the 500-ohm output terminals, the balance is satisfactory up to 15 kilocycles. When using the 5000-ohm output terminals, the balance is satisfactory up to 3 kilocycles. Obviously, the output circuit may be operated ungrounded at higher frequencies than those specified, providing a close balance to ground is not necessary. When it is desired to ground definitely one side of the load, this may be accomplished by means of the grounding strap provided on the oscillator panel.

Output Power:

The open circuit output voltage of the oscillator is approximately 150 volts. The maximum power delivered to a matched load is slightly over one watt when the output control is in the HIGH position. When the output control is in the LOW position, the maximum power is approximately 0.02 watts.

For a matched resistive load the output voltage varies by less than ±0.5 db between 30 and 12,000 cycles, and by less than 1 db between 15 and 16,000 cycles and zero.

Waveform:

With the output switch on the HIGH position, and with the oscillator operating into a matched load, the maximum amplitude of the harmonics is less than 2% of the output voltage in the audio-frequency range above 70 cycles, regardless of the setting of the volume control. Below 70 cycles the harmonics increase to about 8% at 20 cycles. Operation of the oscillator into an open circuit causes a small increase in the harmonic content which is, however, negligible for frequencies above 40 cycles. Operation of the 5000-ohm terminals into an extremely low impedance, so that they are practically short-circuited, causes the harmonic content to be doubled approximately.

When the output switch is on the LOW position, the total harmonic content is less than 0.2% throughout the frequency range from 250 to 2000 cycles and less than 1% between 70 and 10,000 cycles. At 20 cycles the harmonic content is approximately 3%. When operating on the low output position, the harmonic content is practically unaffected by any load impedance between one-half of the rated value and an open circuit.

The power supply ripple is less than 0.1% of the output voltage for either position of the output switch and for any value of output voltage which can be read on the panel voltmeter.

Voltmeter:

A voltmeter is provided on the panel for indicating the output voltage of the oscillator. The voltmeter is of the vacuum-tube type employing a balanced circuit so that no appreciable harmonics are introduced into the output voltage. The voltmeter is provided with three scales, one for each set of output terminals.

Mounting:

This instrument is available in either cabinet or relay-rack mounting. The cabinet is a heavy oak case fitted with carrying handles. For relay-rack mounting, the cabinet is replaced with a metal dust cover and shield.

Power Supply:

110-120 volts or 220-240 volts, 40-60 cycles alternating current. The total consumption is about 95 watts.

Tubes:

The following tubes are required:

2 - Type 41	2 - Type 6L6
1 - Type 6D6	2 - Type 6H6
2 - Type 6C6	1 - Type 5T4

A complete set of tubes is supplied with each instrument.

Accessories:

A seven-foot connecting cord is supplied.

Dimensions:

Panel, (width) 19 x (height) 24-1/4 inches, over-all. Cabinet size, including handles, (width) 20-1/2 x (height) 25 x (depth) 11 inches.

Screw holes in the panel are the standard spacing for mounting the instrument in a Type 480 (standard) 19-inch relay rack.

Net Weight:

93 pounds.

PARTS LIST

Resistors

R-1	= 20 kΩ	R-29A	= 5200-0-2800Ω
R-2	= 3500Ω	R-33	= 300 kΩ
R-3	=	R-34	= 3 kΩ
R-4	= 2 MΩ	R-35	= 25 kΩ
R-5	= 10 kΩ	R-36	= 25 kΩ
R-6	= 500Ω	R-37	= 10 kΩ
R-7	= 100 kΩ	R-38	= 10 kΩ
R-8	= 100 kΩ	R-39	= 56 kΩ
R-9	= 100 kΩ	A	= 30 kΩ
R-10	= 50 kΩ	B	= 200 kΩ
R-11	= 250 kΩ	C	= 200 kΩ
R-12	= 250 kΩ	D	= 30 kΩ
R-13	= 100 kΩ	E	= 100 kΩ
R-14	= 100 kΩ	F	= 150 kΩ
R-15	= 500 kΩ	G	= 40 kΩ
R-16	= 500 kΩ	R-40	= 6300Ω
R-17	= 250Ω	R-41	= 25 kΩ
R-27	= 90 kΩ	R-42	= 25 kΩ
R-28	= 20 kΩ	R-43	= 25 kΩ
R-29	= 17500Ω	R-44	= 25 kΩ

Condensers

C-1	= 0.003 mf	C-23	= 0.000025 mf
C-2	= 3-25 mmf	C-24	= 0.25 mf
C-3	= 1435-1465 mmf	C-25	= 0.25 mf
C-4	= 0.5 mmf	C-26	= 0.02 mf
C-5	= 440 mmf	C-29	= 1.0 mf
C-6	= 100 mmf	C-30	= 4.0 mf
C-7	= 0.005 mf	C-31	= 4.0 mf
C-8	= 2255-2305 mmf	C-32	= 0.02 mf
C-9	= 0.5 mf	C-33	= 1.0 mf
C-10	= G.R.Co. 713-360	C-35	= 0.0001 mf
C-11	= 15 mmf	C-37	= 0.0001 mf
C-12	= 1.0 mf	C-38	= 50 mmf
C-13	= 0.1 mf	C-39	= 100 mmf
C-14	= 0.02 mf	C-40	= 512-532 mmf
C-15	= 0.02 mf	C-41	= 0.0001 mf
C-16	= 0.1 mf	C-42	= 0.0006 mf
C-17	= 0.1 mf	C-43	= 1.0 mf
C-18	= 1.0 mf	C-44	= 0.000035 mf
C-19	= 10-70 mmf	C-45	= 0.05 mf
C-22	= 0.000025 mf		

Inductors

L-1	= 713-373
L-2	= 713-374
L-3	= 713-356
L-4	= 379-400
L-5	= 379-400
L-6	= 379-400
L-7	= 379-400
L-8	= 713-354
L-9	= 713-332
L-10	= 713-350
L-11	= 672-32
L-12	= 672-34

Tubes

T-1	= RCA Type 41
T-2	= RCA Type 41
T-3	= RCA Type 6D6
T-4	= TCA Type 6C6
T-5	= RCA Type 6C6
T-6	= RCA Type 6L6
T-7	= RCA Type 6L6
T-8	= RCA Type 6H6
T-9	= RCA Type 5T4
T-10	= RCA Type 6H6

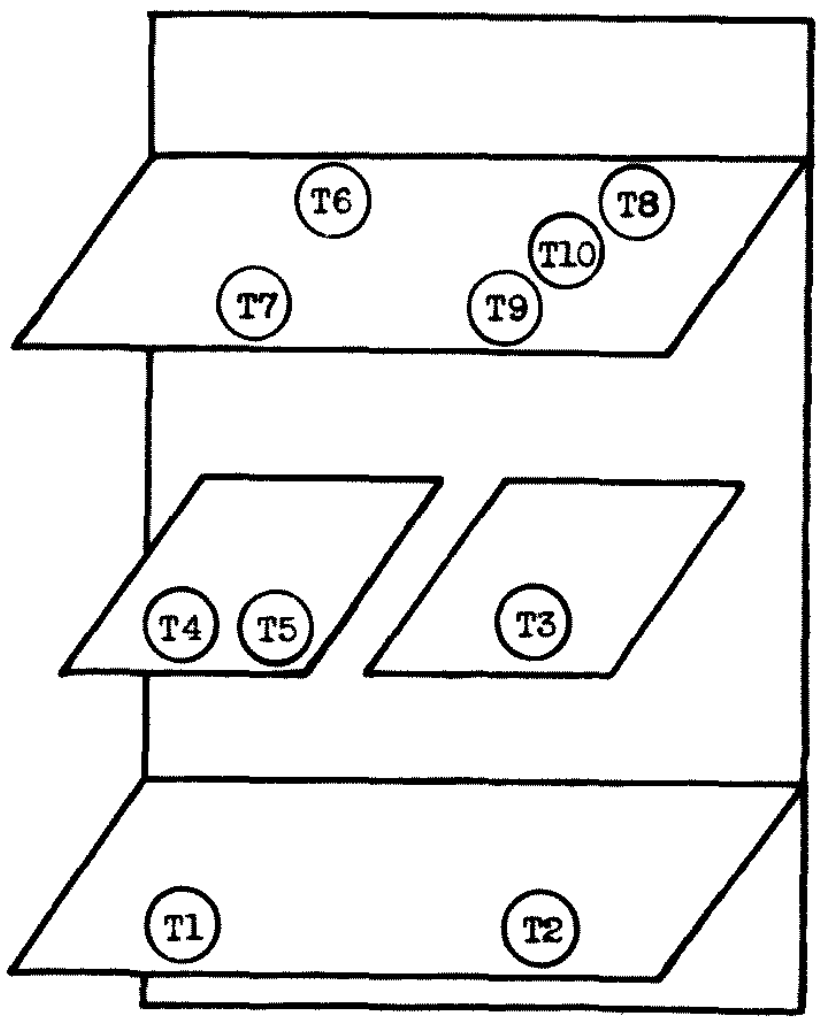

FIGURE 2. Location of Tubes

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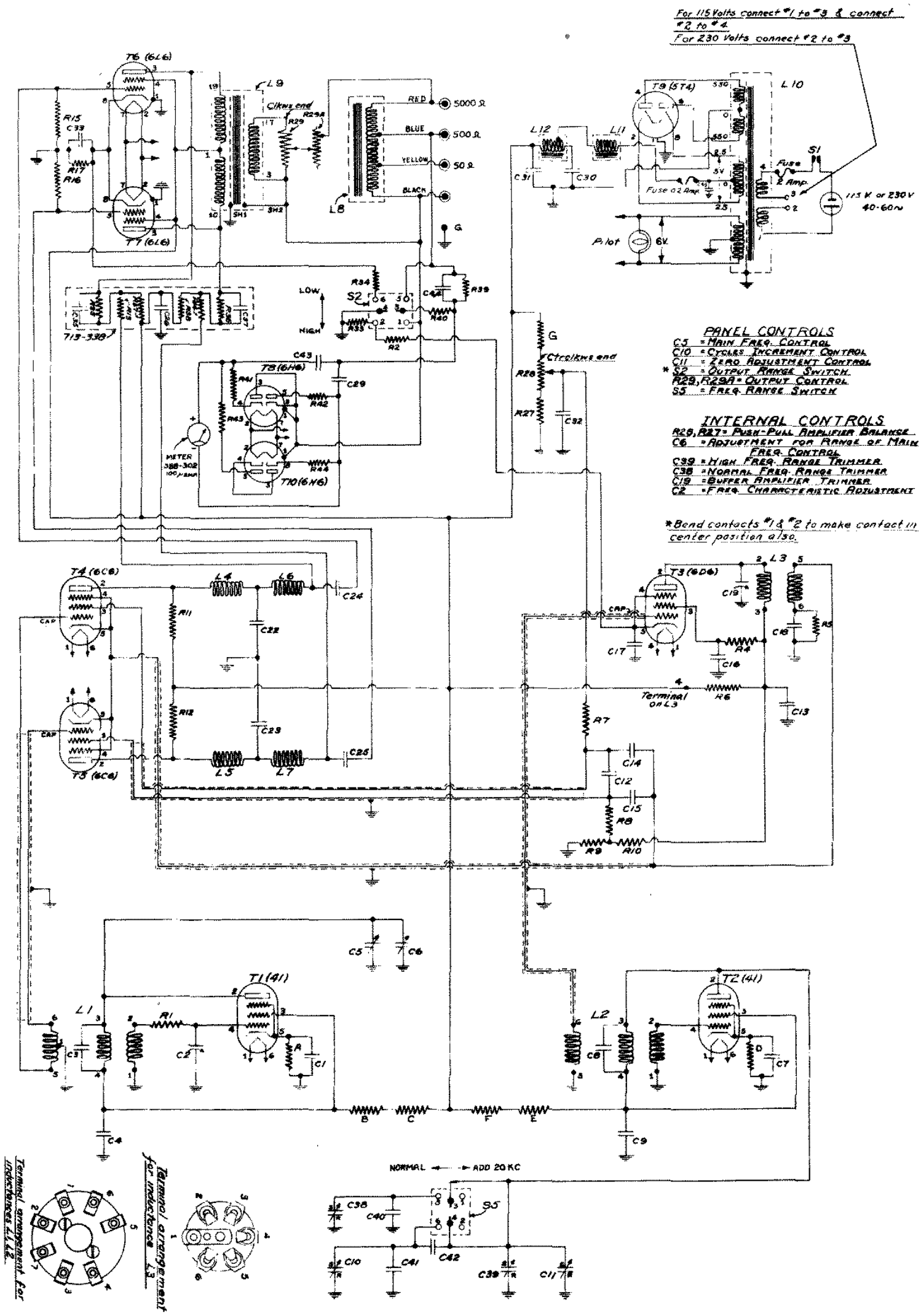

PANEL CONTROLS

C5 = Main Freq. Control
C10 = Cycles Increment Control
C11 = Zero Adjustment Control
* S2 = Output Range Switch.
R29, R29A = Output Control.
S5 = Freq. Range Switch

INTERNAL CONTROLS

R26, R27 = Push-Pull Amplifier Balance
C6 = Adjustment for Range of Main Freq. Control
C39 = High Freq. Range Trimmer
C38 = Normal Freq. Range Trimmer
C19 = Buffer Amplifier Trimmer
C2 = Freq. Characteristic Adjustment

*Bend contacts #1 & #2 to make contact in center position also.

FIGURE 3. Wiring Diagram for Type 713-B Beat-Frequency Oscillator

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