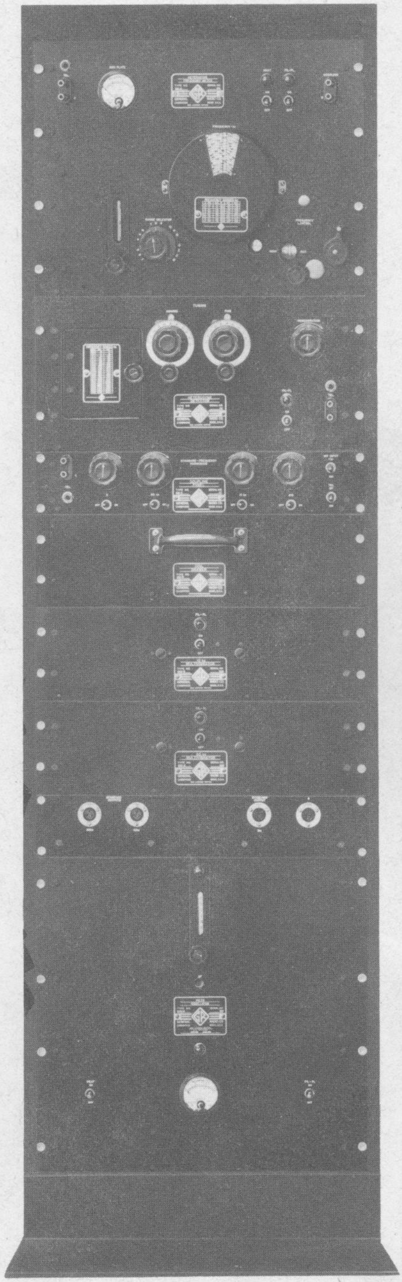
OPERATING INSTRUCTIONS
FOR
CLASS C-10-H SECONDARY FREQUENCY STANDARD

FORM 527-C

GENERAL RADIO COMPANY
CAMBRIDGE A, MASSACHUSETTS



Type 616-D Heterodyne Frequency Meter

Type 619-F Heterodyne Detector

Type 612-K Coupling Panel

Type 619-P1 Coil Drawer

Type 692-B Multivibrators

Terminal Strip and Cable

Type 675-P Piezo-Electric Oscillator
with Type 676-B Quartz Bar

Type 480-B Relay Rack

FIGURE 1. Class C-10-H Secondary Frequency Standard and Frequency-Measuring Equipment. The Class C-10-H Secondary Frequency Standard consists of the four lowest panels in the photograph and, when supplied without the measuring equipment, is mounted on a bench-type rack (Type 480-B)

GENERAL RADIO COMPANY

OPERATING INSTRUCTIONS
FOR
CLASS C-10-H
SECONDARY FREQUENCY STANDARD

1.0 DESCRIPTION

1.1 Instruments

The Class C-10-H Secondary Frequency Standard consists of:

1 - Type 675-P Piezo-Electric Oscillator
1 - Type 676-B Quartz Bar (50 kc)
1 - Type 692-B Multivibrator (50 kc)
1 - Type 692-B Multivibrator (10 kc)
1 - Type 480-B Relay Rack
1 - Set of shielded signal cables
1 - Set of power cables

1.11 Piezo-Electric Oscillator

The Type 675-P Piezo-Electric Oscillator, with the Type 676-B Quartz Bar, is the standard-frequency source. This oscillator includes (1) a piezo-electric oscillator, (2) a control output amplifier for supplying a voltage of the oscillator fundamental frequency to control multivibrators, (3) a harmonic output amplifier, and (4) an a-c power supply, capable of furnishing cathode and plate power to a maximum of three multivibrators. For a complete description, see "Operating Instructions for Type 675-P Piezo-Electric Oscillator", Form 384-E.

1.12 Multivibrators

Two multivibrators are used, one operating at 50 kc, the other at 10 kc. Both are controlled from the "control" output amplifier in the oscillator unit. Owing to its highly distorted waveform, the 50-kc multivibrator supplies usable harmonics for frequency-measurement purposes at frequencies much higher than can be obtained from the harmonic output amplifier in the oscillator unit. The 10-kc multivibrator furnishes harmonics spaced at 10-kc intervals for convenient interpolation in frequency measurement.

1.13 Terminal Plate

A terminal plate carrying shielded output plugs provides for connections from the various outputs of the frequency standard to the working circuits. This plate is supplied as part of the cable assembly, which includes shielded low-impedance cables for all radio frequency circuits, shielded cable for audio-frequency circuits and power cables for all units.

As supplied, the equipment is complete and ready to operate upon connection to the power mains.

1.2 Other Assemblies

Other combinations of equipment can be assembled to meet specific requirements. A third multivibrator can be added to supply audio-frequency harmonics, usually of 1 kilocycle. Another possible assembly uses two multivibrators, operating at 10 kc and 1 kc, and a Type 693-B Syncronometer for timing the oscillator. Still more units can be added, if an external power supply, such as Type 696-C, is used. The method of operation and use is, in general, the same as that for the stock assembly described here. Details of instruments and their operation will always be found in the instruction books for the individual instruments.

2.0 OPERATION

2.1

These instructions apply to the operation of the assembly as a whole. Details of the operation of any given instrument will be found in the instruction book for that instrument.

2.2 Type 675-P Piezo-Electric Oscillator

2.21 After the temperature control has been operating for about four hours the secondary standard is ready for use. It is recommended that the temperature control be operated continuously unless the assembly is to be shut down for an extended period of time.

2.22 When the power supply ON-OFF switch is thrown to the ON position, plate and cathode power to the piezo-electric oscillator and all multivibrators is turned on. When a multivibrator is not being used, it can be turned off by throwing its FILAMENT-PLATE switch to OFF.

2.23 Oscillation in the crystal oscillator is indicated by a reading of the PLATE current meter of 75-110 microamperes.

2.3 Type 692-B Multivibrators

See also "Operating Instructions for Type 692-B Multivibrators", Form 383-D.

2.31 Either multivibrator, or both, may be used. To start them, simply throw the FILAMENT-PLATE switches to ON. It is recommended that the multivibrators be operated at all times that the piezo-electric oscillator is operated.

2.32 The 50-kc multivibrator supplies two output amplifiers, for "control" and "harmonic" outputs. In the normal use in this assembly, the "control" output is not used, and the control amplifier tube may simply be omitted. (If desired, the user may make his own connections to this output at the multipoint plug; see wiring diagram in the multivibrator instruction book.) The "harmonic" output is connected, by the shielded cables supplied, to the "50 kc" standard frequency shielded output plug on the terminal strip.

2.33 The 10-kc multivibrator also supplies two output amplifiers for "control" and "harmonic" outputs. In this assembly the "control" output is not utilized; the amplifier tube for the "control" output may, therefore, be omitted. (If a user desires to obtain a standard 1-kc output, a 1-kc Type 692-B Multivibrator may be added and controlled from the "control" output of the 10-kc multivibrator.) The "harmonic" output is connected, by the shielded cables supplied, to the "10 kc" standard frequency shielded output plug on the terminal strip.

2.4 Output Circuit Connections

2.41 Output connections from the harmonic circuits of the multivibrators are made through shielded plugs on the terminal strips. These output circuits are low-impedance - approximately 65 ohms. Three connections are made through the plugs: (1) "high" wire, (2) "low" wire, and (3) shield. These numbers appear on the plug for identification.

2.42 In using the low-impedance output, it must be remembered that the voltages are not high and that suitable terminating or coupling arrangements must be used to develop maximum output. If connected to a low-impedance input circuit of a receiver, such as one intended for use with a half-wave doublet, very effective coupling is obtained and the higher harmonics can be used easily.

2.43 The Type 619-E Heterodyne Detector is designed with a suitable low-impedance input for use with this Frequency standard.

2.44 If the output of the standard is fed into a suitable tuned circuit, with low-impedance coupling, a substantial increase in output voltage is available across the tuned circuit for the band of frequencies covered by the resonance curve of the circuit.

2.45 Other arrangements are, of course, possible to meet special requirements. The above are brief suggestions. In the following section it is evident how the standard frequency outputs are utilized for measuring purposes.

3.0 MEASURING EQUIPMENT

3.1 General

The measuring equipment discussed here consists of a Type 616-D Heterodyne Frequency Meter, Type 619-E Heterodyne Detector and Type 612-K Coupling Panel, with all necessary power and signal cables.

The measuring equipment provides for the measurement of radio frequencies, by interpolation between standard frequencies, up to 25 megacycles. This is the upper limit of the Type 619-E Heterodyne Detector. By means of a suitable external receiver, the upper limit may be extended to higher frequencies.

These instructions will deal entirely with the operation of the Type 612-K Coupling Panel and of the measuring equipment as a whole. Detailed instructions for the Type 616-D Heterodyne Frequency Meter and Type 619-E Heterodyne Detector are given in the instruction books for these instruments.

3.2 Operating Instructions

3.21 Type 612-K Coupling Panel

3.221 The Type 612-K Coupling Panel is a centralized switching and control panel for conveniently utilizing the output of the Class C-10-H Secondary Frequency Standard and the frequency measuring equipment in making frequency measurements.

3.222 A wiring diagram of the coupling panel is given in Figure 3. A block diagram, illustrating the functions of the controls, is given in Figure 2.

3.223 Four radio-frequency volume controls are provided, each with an ON-OFF switch for control of the voltage fed to the Type 619-E Heterodyne Detector from any one, or any combination, of four sources:

1. "X" or source the frequency of which is to be measured.
2. 50-kc harmonic output of frequency standard.
3. 10-kc harmonic output of frequency standard.
4. Type 616 Heterodyne Frequency Meter

The ON-OFF switches are a convenience in removing any source from the detector without the necessity of returning the volume control to zero.

3.224 Provision is also made in the control panel for utilizing additional units in the frequency standard and measuring equipment - a 1-kc multivibrator and a Type 617 Interpolation Oscillator. The use of these units is described below. They are additional to, and are not furnished as a part of, the stock assembly of instruments. Switching is provided for connecting the input of the Type 617 Interpolation Oscillator to the output of the Type 619-E Heterodyne Detector for matching, or to the 1-kc multivibrator for checking calibration. The telephones may be switched to the output of the Type 619-E Heterodyne Detector or the output of the Type 617 Interpolation Oscillator.

3.3 Making Frequency Measurements

In making frequency measurements with the equipment described, there are several steps which are, in general, as follows:

Step 1 - Picking up and identifying the signal whose frequency is to be measured.

Step 2 - Transferring this frequency for comparison against the frequency standard.

Step 3 - Evaluating the frequency difference between the transferred frequency and the nearest standard frequency.

Step 4 - Identifying the frequency of the standard frequency harmonic utilized in (3) above.

Dependent upon circumstances, and whether or not the harmonics involved are known from other considerations, there are two further steps, either or both of which may not be necessary in any given measurement:

Step 5 - Determination of the harmonic of the heterodyne frequency meter used in the measurement.

Step 6 - Determination of the harmonic of the unknown frequency used in the measurement.

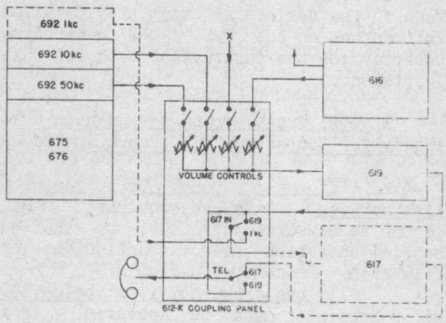


FIGURE 2. Functional diagram of the frequency-measuring assembly. All switching and amplitude adjustment is accomplished by means of the Type 612-K Coupling Panel.

The unknown and standard frequencies are applied through attenuators to the heterodyne detector. The unknown is then measured by linear interpolation, using the heterodyne frequency meter.

The interpolation oscillator (shown by broken lines) is not included with this assembly. It can be ordered separately or added later, if desired. Provision for using it is made in the Type 612-K Coupling Panel as shown.

The various steps will now be considered in detail.

Step 1. Picking up the Frequency to be Measured.

The frequency to be measured is introduced through the "X" cable (Figure 2) which is provided at the rear of the equipment. If the source is a local oscillator, the "X" cable can be connected to suitable coupling points in the oscillator circuit, or, a coupling coil of a few turns can be connected to the cable and coupled to the oscillator. If a local transmitter is to be measured, an antenna wire can be connected to the cable.

There are three cable connections: (1) "high" wire (marked), (2) "low" wire and (3) shield. Whether or not the shield should be grounded at the source (it is grounded in the measuring equipment) is best determined by trial.

The voltage transferred to the heterodyne detector is controlled by the "X" switch and volume control on the coupling panel.

Throw the "X" switch to ON; advance the "X" volume control. (The other three radio-frequency switches should be thrown to OFF.) Insert the proper coil in the heterodyne detector. Plug in the telephone receivers at the jack or binding posts marked TEL. Throw the TEL switch to the 619 (heterodyne detector) position. Tune in the desired signal. (For detailed information on the Type 619-E Heterodyne Detector see the instruction book for that instrument.)

Step 2. Transferring the Unknown Frequency for Comparison with the Standard

If the frequency to be measured lies between 100 kc and, roughly, 10 Mc, it can be measured directly, so that no special operation need be carried out for this step. Proceed with Step 3.

If the frequency lies below 100 kc, a harmonic must be measured. If a large voltage is available, sufficiently strong harmonics may be present to be heard in the heterodyne detector. If not, either distortion must be introduced, as by passing the frequency to be measured through a rectifier, or an auxiliary oscillator must be used.

If the frequency is higher than about 10 Mc, it can be measured by setting a harmonic of the heterodyne frequency meter into agreement with it, then measuring the fundamental frequency of the heterodyne frequency meter.

By the use of harmonics, either of the source frequency or of the heterodyne frequency meter, the frequency to be measured is effectively transferred into a range convenient for measurement.

Alternatively, the frequency can be measured by interpolating by means of the heterodyne frequency meter, using a harmonic of the frequency meter. This avoids the necessity of changing the tuning of the heterodyne detector from the signal frequency to the fundamental frequency of the heterodyne frequency meter during the course of a measurement.

Step 3. Evaluating the Frequency Difference between the Transferred Frequency and the Frequency Standard

This step covers the operation of interpolating on the scale of the heterodyne frequency meter to find the frequency difference between the transferred frequency and the nearest standard frequency.

A. For frequencies between 100 kc and, roughly, 10 Mc, proceed as follows:

Having tuned in the signal, the frequency of which is to be measured, introduce the standard frequency into the detector and tune the detector to zero beat against the standard frequency next below (lower dial reading) the unknown frequency. This is done by throwing the "10 kc" switch on the coupling panel to ON and advancing the "10 kc" volume control; then tuning the heterodyne detector toward lower frequencies and setting for zero beat against the first standard frequency harmonic below the unknown frequency. The unknown frequency may be cut off by throwing the "X" switch on the coupling panel to OFF during this operation.

Next introduce the heterodyne frequency meter output to the detector by throwing the 616 switch on the coupling panel to ON; advance the 616 volume control. Adjust the Type 616-D Heterodyne Frequency Meter to the frequency of the standard or to one-half the frequency if it is over 5000 kc, by the three-oscillator method (see section on Special Instructions following). Set the auxiliary dial of the heterodyne frequency meter to zero. Note the frequency of the standard harmonic indicated by the "finder dial" of the frequency meter.

Next, throw the "X" switch to ON and retune the Type 619-E Heterodyne Detector to the unknown frequency. Set the heterodyne frequency meter to zero beat with the unknown by the three-oscillator method. The standard frequency may be cut off during this operation by throwing the "10 kc" switch on the coupling panel to OFF. Note auxiliary dial reading; call this reading A_1.

Next, cut off the unknown frequency and introduce the standard frequency. Adjust the heterodyne detector to the standard harmonic next above the unknown. Set the heterodyne frequency meter to zero beat with this standard frequency by the three-oscillator method. Note the auxiliary dial reading; call this reading A_2.

The unknown frequency is then:

$$f_x = f_1 + \frac{A_1}{A_2}(f_2 - f_1) \text{ kc}$$

where f_1 = frequency of standard harmonic next below unknown

f_2 = frequency of standard harmonic next above unknown

A_1 = frequency meter scale interval between f_1 and f_x

A_2 = frequency meter scale interval between f_1 and f_2

(For further details concerning the use of the auxiliary dial of the Type 616-D Heterodyne Frequency Meter, see the instruction book for that instrument.)

B. For frequencies below 100 kc:

While the lower limit of the Type 619-E Heterodyne Detector is 25 kc, that of the Type 616-D Heterodyne Frequency Meter is 100 kc.

Tune in a harmonic of the unknown frequency which lies above 100 kc. Then proceed exactly as though the frequency being measured lay above 100 kc as described above. The measured frequency is then divided by the harmonic number to obtain the fundamental frequency of the unknown.

C. For frequencies above about 10 Mc:

Two methods of procedure are open. First, because at these high frequencies the 10-kc standard harmonics not only are weak, but come so close together as to be difficult to identify, make use of the 50-kc harmonics. Proceed exactly as described in (A) above, interpolating by means of a harmonic of the heterodyne frequency meter. (See Step 4 concerning identification of standard frequency harmonics.)

Second, a harmonic of the heterodyne frequency meter may be set to zero beat against the unknown, using the heterodyne detector at this frequency. The heterodyne detector is then changed to the fundamental frequency of the heterodyne frequency meter and the fundamental is measured. This value is then multiplied by the number of the harmonic to obtain the unknown frequency.

Step 4. Identifying the Frequency of the Standard Frequency Harmonic used in the Measurement

The standard frequencies may be identified directly from the "finder dial" of the Type 616-D Heterodyne Frequency Meter throughout the range from 100-5000 kc.

For frequencies below 100 kc, the calibration of the Type 619-E Heterodyne Detector will identify all the standard frequency harmonics without ambiguity.

For frequencies above 5000 kc, the Type 616-D Heterodyne Frequency Meter finder dial may still be used if the readings are kept corrected, or the amount of error is noted, if 10-kc harmonics are being identified directly.

A method of overcoming any ambiguity due to small errors in calibration is to check the value of the 50-kc harmonic next above or below the frequency being measured. This can be done by the finder dial without difficulty. Then, using the heterodyne detector and the 10-kc harmonic output of the standard, count the number of 10-kc harmonics between the identified 50-kc harmonic and the frequency being measured. For example, if a frequency of 8733 kc is being measured, the next lower 50-kc harmonic would be identified as 8700 kc. The 10-kc harmonics passed over would be 8710, 8720 and 8730 kc. The final figures would be obtained by interpolation between 8730 and 8740. The ratio A_1/A_2 would be 0.3, giving 3 kc.

Another method which is sometimes useful is to set the heterodyne frequency meter to some frequency such as 500 kc. Harmonics of this frequency will identify either 10-kc or 50-kc harmonics of the standard as being multiples of 500 kc; the calibration of the heterodyne detector will identify which multiple is observed. All standard harmonics in between may then be identified by stepping off by 50-kc intervals and then by 10-kc intervals.

Step 5. Determination of the Harmonic of the Heterodyne Frequency Meter used in the Measurement

If a harmonic of the heterodyne frequency meter has been set to agree with the frequency being measured and the fundamental frequency has then been measured, it is necessary to multiply this value by the number of the harmonic for the final result.

Generally it is sufficient to note the approximate value of the frequency being measured, either from other considerations, or by the calibration of the heterodyne detector. This, divided by the fundamental frequency of the heterodyne frequency meter, gives the harmonic used in the measurement. The harmonic number is, of course, integral. If the check above does not give an integral number, it will give a number very nearly integral and the nearest integral value should, of course, be used.

Another method is to complete the measurement as directed. Then reduce the heterodyne frequency meter frequency until the next higher harmonic is brought into agreement with the frequency being measured. If f_1 is the heterodyne frequency meter fundamental in the first case, with the nth harmonic agreeing with the unknown, and f_2 is the fundamental in the second case, with the (n + 1) th harmonic agreeing with the unknown, we have:

$$nf_1 = f_x = (n+1)f_2$$

and

$$n = \frac{f_2}{f_1 - f_2} \text{ (Use nearest integral value)}$$

The necessary values of f_1 and f_2 may be read with sufficient accuracy directly from the finder dial of the heterodyne frequency meter.

Step 6. Determination of the Harmonic of the Unknown Frequency Used in the Measurement

In measuring low frequencies, below 100 kc, the fundamental (if over 25 kc) may be estimated with sufficient accuracy directly from the calibration of the heterodyne detector. The actual measurement would be carried out at some harmonic, over 100 kc, as previously described. The measured frequency divided by the estimated frequency gives the harmonic number by which the measured frequency should be divided for the final result. This ratio may not be exactly integral, but will lie very near an integral value. The integral value should, of course, be used.

3.4 Instructions for use of Added Interpolation Oscillator and 1-kc Multivibrator

The purpose of the Type 617 Interpolation Oscillator is to provide means for rapidly measuring the difference in frequency between the unknown and the nearest 10-kc standard harmonic frequency. The 1-kc multivibrator is provided for checking the calibration of the interpolation oscillator.

The procedure in making measurements is as follows:

Step 1 - As before.

Step 2 - As before.

Step 3A - Obtaining audio beat frequency difference between standard and unknown.

Step 4A - Determining value of beat frequency.

Step 5A - Determining sign of beat difference.

Step 3A. Obtaining Audio Beat Frequency Difference between Standard and Unknown

Having picked up the frequency to be measured, introduce the standard 10-kc harmonics. Throw 10 KC switch on coupling panel to ON; advance 10 KC volume control. Adjust tuning of Type 619-E Heterodyne Detector and regeneration so as to obtain the strongest audio frequency tone. The heterodyne detector should not be in the oscillating condition. This beat tone should be obtainable for frequencies between 25 kc and, roughly, 10,000 kc. If the standard frequency harmonics are too weak, or if using frequencies above 10,000 kc, set a harmonic of the heterodyne frequency meter to the unknown frequency and then obtain the audio beat difference between the fundamental of the heterodyne frequency meter and the standard, as above.

Step 4A. Determining Value of Beat Frequency

This is done by matching the audio beat frequency with the Type 617 Interpolation Oscillator and reading the value directly from the dial.

Throw 617 switch on coupling panel to 619 position; throw TEL switch to 617 position. (See Figure 1.)

(See instruction book for Type 617 Interpolation Oscillator for details on operation of that instrument.)

Step 5A. Determination of Sign of Beat Frequency Difference

Throw TEL switch on coupling panel to 619 position; throw 617 switch to 1 kc position.

Cut off X by throwing X switch to OFF.

Advance regeneration control on type 619-E Heterodyne Detector until oscillation is obtained. A beat note should be heard; bring this note to zero.

Throw 10 KC switch to OFF; throw X switch to ON.

A beat tone will now be heard which is approximately the difference between the unknown and standard frequencies. Change tuning of Type 616-D Heterodyne Detector to bring this tone to zero. Note direction in which the dial of the heterodyne detector is moved to do this. If the dial is moved up scale, the unknown is above the standard frequency and the sign of the beat frequency is plus. If the dial is moved down scale, the unknown is below the standard frequency and the sign of the beat frequency is minus.

Identify the standard frequency harmonic as previously described.

The unknown frequency is then

$$f_x = f_1 \pm f_b$$

where f_1 is the frequency of the standard harmonic

f_b is the beat frequency difference.

If the heterodyne frequency meter is used,

$$f_x = n(f_1 \pm f_b)$$

where n is the number of the frequency meter harmonic, determined as outlined previously.

3.5 General Notes and Special Instructions

3.51 To Interpolate more rapidly on Type 616-D Heterodyne Frequency Meter

In making measurements of frequency, particularly where routine checks are made from day to day, in many cases time may be saved by tabulating the number of divisions on the scale of the heterodyne frequency meter for the standard frequency interval $f_2 - f_1$, in the regions where many measurements are made. In spite of slight variations in calibration of the heterodyne frequency meter, this interval remains quite constant over long periods of time. The tabulated values can readily be checked at any time. If the difference in scale readings for the frequency interval $f_x - f_1$ is observed, then the frequency interval can be obtained at once, as

$$f_x - f_1 = \frac{\text{number of observed divisions}}{\text{number of tabulated divisions}} \times 10 \text{ kc}$$

3.52 Checking Calibration of Type 617 Interpolation Oscillator

When an interpolation oscillator and 1-kc multivibrator are added to the equipment, the interpolation oscillator frequency is easily checked at a number of points in its range.

Throw TEL switch on coupling panel to 617 position.

Throw 617 switch on coupling panel to 1-kc position.

(See instruction book for Type 617 Interpolation Oscillator for details in handling of this instrument.)

The frequency of the interpolation oscillator may then be checked at all multiples of 1 kc. It may also be checked at multiples of 1000/2, 1000/3, 1000/4.... or at multiples of 500, 333.3, 250 cycles, etc.

In general, it is more convenient and more accurate to check the frequency at a value near that of the frequency to be measured, correcting the calibration to obtain zero error. For a considerable range on either side of the check frequency, the calibration may then be relied upon and readings taken directly without the need of any correction.

3.53 Adjusting Two Radio Frequency Sources to Zero Beat by the Three-Oscillator Method

In making measurements, it is often required to adjust one radio frequency oscillator to zero beat with an incoming frequency, a frequency from the frequency standard, or that of another oscillator. If the frequencies are stable, this adjustment is easily made to within a cycle, as follows:

Tune in the fixed frequency (or the one which is to be matched) on the heterodyne detector. Adjust for zero beat by ear. Next, vary the adjustable frequency to obtain zero beat again by ear, making no changes in the setting of the heterodyne detector.

Now, detune the heterodyne detector by a kilocycle or two. An audio frequency tone will be heard, with a "flutter" superimposed on it. If the amplitudes of the voltages impressed on the detector from the two oscillators are made nearly equal, the "flutter" will be most pronounced. Now, carefully adjust the variable oscillator until the "flutter" becomes a very slow waxing and waning in the amplitude of the beat tone. This waxing and waning is the frequency difference between the two oscillators.

To be certain that zero beat is obtained between the correct pair of oscillators, vary the tuning of the heterodyne detector so as to vary the beat tone. If the pitch changes, but the rate of waxing and waning does not, the correct pair of oscillators has been brought to zero beat.

3.54 Use of Output of Type 616-D Heterodyne Frequency Meter in External Circuits.

The harmonic output of the Type 616-D Heterodyne Frequency Meter may be utilized in external circuits, such as high frequency receivers (which are not a part of the measuring equipment), through the cable connection provided for the purpose. (See Section 3.0 of instructions for Class C-10-H Secondary Frequency Standard for details on connections.)

The load connected to the cable is thereby placed in parallel with the input to the Type 612-K Coupling Panel. Care must be taken not to decrease the output of the frequency meter to a point where proper operation of the measuring equipment cannot be obtained.

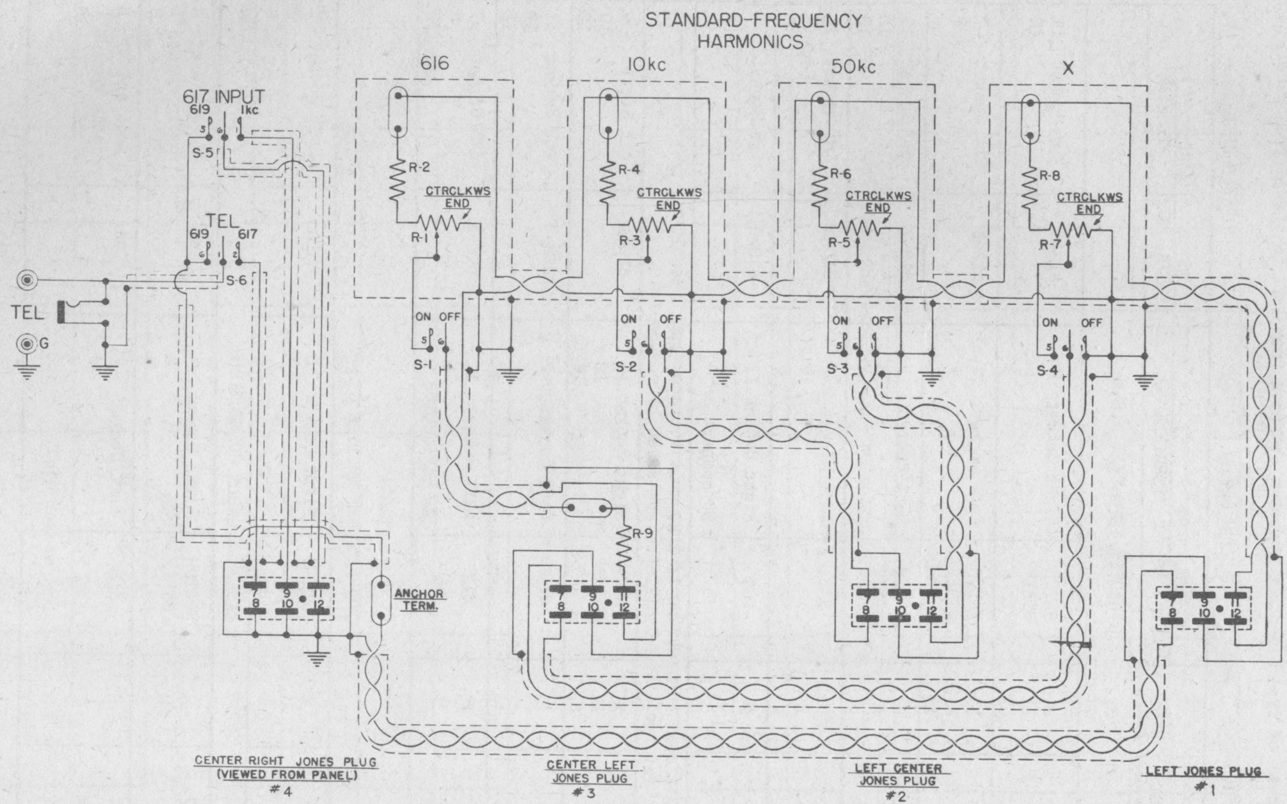


FIGURE 3. Circuit diagram for Type 612-K Coupling Panel

Resistors

R-1 = 200 Ω
R-2 = 200 Ω
R-3 = 200 Ω

R-4 = 200 Ω
R-5 = 200 Ω
R-6 = 200 Ω

R-7 = 200 Ω
R-8 = 200 Ω
R-9 = 500 Ω

Switches

S-1 = S.P.S.T. 139-323
S-2 = S.P.D.T. 139-320
S-3 = S.P.D.T. 139-320

S-4 = S.P.D.T. 139-320
S-5 = S.P.D.T. 139-320
S-6 = S.P.D.T. 139-320

TYPE 697-21A SIGNAL CABLE

Measuring Equipment Signal Cable for Use with Secondary Standard
NOTE: Sockets of Type 612-K are numbered starting from left as viewed from panel.

"H" = High "L" = Low "S" = Shield

ITEM	CODE	WIRE	START		FINISH	
			INSTR. NO.	TERMINAL NO.	INSTR. NO.	TERMINAL NO.
CIRCUITS INTO TYPE 612-K						
"X"	C	H L S	PATCH STRIP	Right Socket 7 8 9	612-K	3rd Socket 11 12 10
10 kc Harmonics	B	H L S	PATCH STRIP	Left Socket 7 8 9	612-K	2nd Socket 7 8 9
50 kc Harmonics	A	H L S	PATCH STRIP	Left Socket 11 12 10	612-K	2nd Socket 11 12 10
616 Output	E	H L S	616	Left Socket 7 8 9	612-K	3rd Socket 11 12 10
619 Output	G	H L S	619	Right Socket 11 12 No connection -	612-K	1st Socket 7 8 9
Additional connections if 1 kc multivibrator and Type 617 Interpolation Oscillator are added by customer.						
1 kc Harmonics		H L S	PATCH STRIP	Right Socket 11 12 10	612-K	4th Socket 9 10 12
617		H L S	617	Left Socket 7 8 12	612-K	4th Socket 11 12 12
617		H L S	617	Left Socket 11 12 No connection -	612-K	4th Socket 7 8 12
CIRCUITS OUT OF TYPE 612-K						
619 Output	F	H L S	612-K	First Socket 11 12 10	619	Left Socket 7 8 9
EXTERNAL CABLE CONNECTIONS						
"X"	D	H L S	PATCH STRIP	Right Socket 7 8 9	End	Free end of cable marked "X" H L S
"616"	H	H L S	616	Left Socket 7 8 9	End	Free end of cable marked "616" H L S

ITEM	COLOR CODE	WIRE	START INSTR. NO.	START TERMINAL NO.	FINISH INSTR. NO.	FINISH TERMINAL NO.
TYPE 697-312-C POWER CABLE						
Fil.(692-B 50 kc)	ORANGE TWISTED		675	Right Socket 1 2	692-B 50 kc	Right Socket 7 8
Fil.(692-B 10 kc)	BROWN TWISTED		675	Right Socket 3 4	692-B 10 kc	Right Socket 7 8
B+	SLATE		675	Right Socket 11	692-B 50 kc Then to 692-B 10 kc	Right Socket 11 Right Socket 11
B-,G	YELLOW		675	Right Socket 12	692-B 50 kc Then to 692-B 10 kc	Right Socket 12 Right Socket 12
Additional connections if 1 kc multivibrator is added by customer.						
Fil.(692-B 1 kc)			675	Right Socket 5 6	692-B 1 kc	Right Socket 7 8
B+	SLATE		675	Right Socket 10	692-B 1 kc	Right Socket 11
B-	YELLOW		692-B 10 kc	Right Socket 12	692-B 1 kc	Right Socket 12
TYPE 697-322-C SIGNAL CABLE Secondary Frequency Standard Signal Cable						
50 kc Control	A	H L S	675-P	Left Socket 10 12 12	692-B 50 kc	Left Socket 7 12 No connection-
50 kc Control	B	H L S	692-B 50 kc	Left Socket 7 12 12	692-B 10 kc	Left Socket 7 12 No connection-
50 kc Harmonics	D	H L S	692-B 50 kc	Left Socket 11 9 12	PATCH STRIP	Left Plug 11 12 10
10 kc Harmonics	C	H L S	692-B 10 kc	Left Socket 11 9 12	PATCH STRIP	Left Plug 7 8 9
Additional connections if 1 kc multivibrator is added by customer.						
10 kc Control		H L S	692-B 10 kc	Left Socket 10 12 12	692-B 1 kc	Left Socket 7 12 No connection -
1 kc Harmonics		H L S	692-B 1 kc	Left Socket 11 9 12	PATCH STRIP	Right Plug 11 12 10

TEST DATA
ON
CLASS C-10-H
SECONDARY FREQUENCY STANDARD

FOR

____

TYPE 675-P PIEZO OSCILLATOR

Serial No.__________________
Plate Current_______________µa
Temperature_________________^{o}C.
Frequency Adjustment (Inside)______________div.

TYPE 676-B QUARTZ BAR

Serial No.__________________
Frequency___________________kc

TYPE 692-B MULTIVIBRATOR

Serial No.__________________
Frequency___________________kc
Control Switch (Inside)__________________

TYPE 692-B MULTIVIBRATOR

Serial No.__________________
Frequency___________________kc
Control Switch (Inside)__________________

TYPE 692-B MULTIVIBRATOR

Serial No.__________________
Frequency___________________kc
Control Switch (Inside)__________________

TYPE 612-K CONTROL PANEL

Serial No.__________________

TYPE 619-E HETERODYNE DETECTOR

Serial No.__________________

TYPE 616-D HETERODYNE FREQUENCY METER

Serial No.__________________

TYPE 617-C INTERPOLATION OSCILLATOR

Serial No.__________________

Date:____________________ No. _______________ Observer:_______________

PATENT NOTICE

This equipment is manufactured under the following U. S. Patents and license agreements:

Patents of the American Telephone and Telegraph Company, solely for utilization in research, investigation, measurement, testing, instruction and development work in pure and applied science.

1,542,995	1,943,302
1,713,146	1,955,739
1,744,675	1,967,184
1,931,530	1,967,185

All patents and patent applications of Dr. G. W. Pierce pertaining to piezo-electric crystals and their associated circuits.

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BOSTON, MASSACHUSETTS, U. S. A.