CHAPTER II

METHOD OF MEASUREMENT AND CALIBRATION

In this chapter the method of measurements, equipments, and the calibration methods are mentioned.

Method for Measuring Bandwidth

A transmitter is a system specifically designed to generate and transmit radio frequency energy. It is desired that the system transmit only those frequencies in a necessary bandwidth.[2] Since most transmitters generate power outside of their necessary bandwidths, it is important to establish the mutual interference capabilities of these out-of-band emissions.

Ordinarily, amplitude modulation is not composed of a single frequency sine wave, but of many complex frequencies of speech and music. So we have not a pair of side frequencies, but two "side bands" of frequencies, each as wide as the band of audio frequencies being transmitted. Such a modulated wave occupies a channel, or band of frequencies, the width of the channel being two times the highest modulating frequency, this is called

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[2] Alfred A. Ghirard, Receiver Circuitry and Operation (Taiwan, 1962) p. 20.

band width.

Aural broadcast stations transmit programs which contain both speech and musical sounds. Since the sounds in orchestral music lie within a frequency band of from approximately 40 to 15,000 cps.[3] It has been frequently stated in both popular and technical literature that "A-M aural broadcast stations are assigned carrier frequencies 10 KC apart, so they are restricted to the use of R-F transmission channels or bandwidth not over 10 KC in order to prevent interference with the signals of adjacent channel transmitters operating within the same service area. Consequently, the highest A-F modulation that can be transmitted by these stations is only 5 KC.[4]

According to the characteristic of tank circuit, method of modulation, and band width mentioned in the above paragraph. We are able to find the bandwidth of the transmitter by injecting an R-F signal modulated with the audio frequency from an audio oscillator, which vary from 1, 2,....... up to 10 KC if possible, at the level that will cause the same per cent modulation used in daily service. It should be noted that the same per cent modulation will be received by a receiver and then waveforms of the carrier and the side bands will be displayed on the screen of a spectrum analyzer.

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[3]Ibid.

[4]Ibid. p. 21.

Measure the amplitudes of carrier and various side bands, and the voltage of radio signal when transmitted R-F carrier. Then change the amplitudes of various side bands into voltages and let it plot a curve of audio frequency spectrum.

The bandwidth is generally understood to be measured between half-power frequencies where the gain and the voltage amplification are 3-db down the reference value. Thus, from the audio frequency spectrum the frequency at which the amplitude of the side band is down 3-db defines the bandwidth of that transmitter.

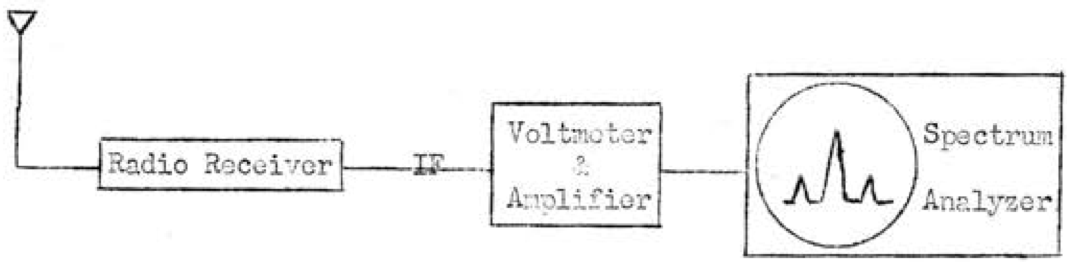

Fig. 5 —— Connection of the equipments used for measuring bandwidth.

Method for Measuring Frequency

It is important to know the output frequency of a radio broadcast transmitter. The allowable tolerance or variation from assigned frequency is also established by International agreement. Observance of the tolerance restrictions is an important factor in permitting the maximum number of transmitter to occupy the frequency spectrum without mutual interference.

From Rules and Regulations by FCC under section 3.59 states that: "The operating frequency of each station shall be maintained within 20 cycles of the assigned frequency."

Electronic Counters are becoming almost universally used for H-F measurements in the laboratory.[5] Some can operate up to 30Mc input, but most have a lower frequency limit such as 10 or 1 Mc or as low as 100 KC. An external frequency converter is used to translate the transmitter carrier-output frequency down into the counter range. The conversion frequency must be accurate, and often the crystal oscillator in the counter is used for this source.

Due to the fact that the frequency in broadcast region is in the range of 535 - 1605 KC, therefore, in measuring the frequency of the transmitter we should measured it in KC with 3 decimal points, for example; a carrier frequency of a 1000 KC transmitter, the range of the frequency of that transmitter is between 999.980 to 1000.020 KC.

As already mentioned in the "Method for measuring bandwidth" that we measured the amplitude of the sidebands which appears on the screen of the spectrum analyzer in order to find the bandwidth. From the waveform on the screen if we inject an R-F signal only, we will get the pip of R-F signal on the screen without any side bands. If we use the CW signal from the signal generator until its waveform on the screen of the spectrum analyzer

[5] Louis C. Cuccia, Harmonics, Sidebands, and Transients in Communication Engineering (New York: McGraw-Hill Book Company, Inc., 1952) p. 374.

is directly in the same place of the waveform received from the radio transmitter, the frequency which injects from the signal generator will be the frequency that the transmitter inject R-F signal broadcasts, and connect the signal generator to the Electronic Counter which we can read out the value, that is three decimal points of KC. The frequency shown by the Electronic Counter is the carrier frequency of that transmitter.

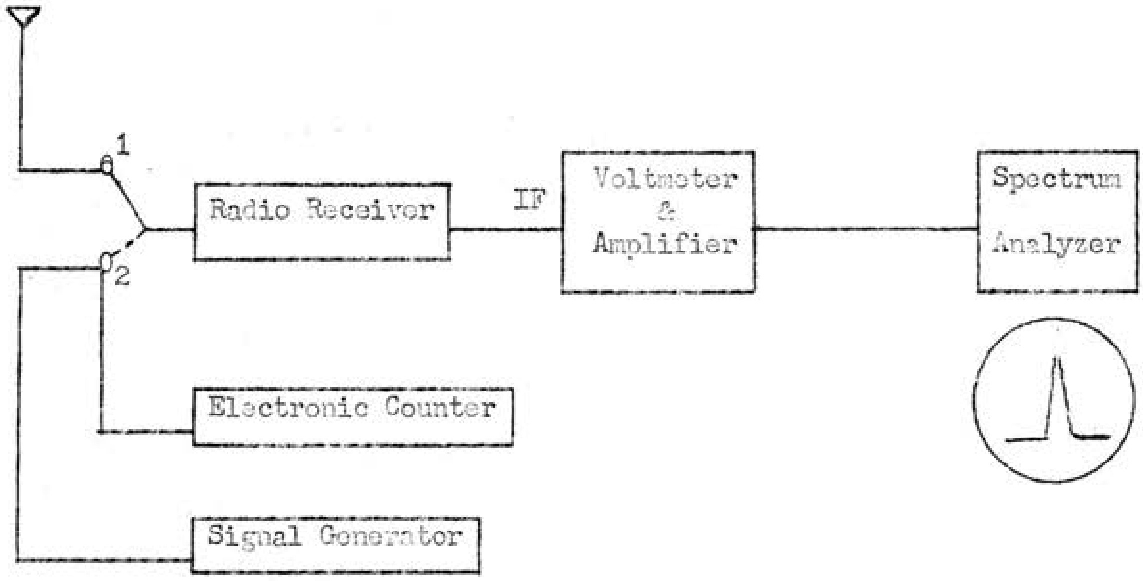

Fig. 6 —— Connection of the equipments used for measuring frequency.

Method for Measuring Per cent Modulation

When a transmitter is delivering the proper power output on the assigned frequency, it is safe to commence modulation. If the modulation is too low, the signal-to-noise ratio at the receiver may be degraded, while if overmodulation occurs, distortion will be introduced at the receiver.

Excessive modulation may also cause interference to other transmitters. The FCC requires that the percentage of modulation of broadcast transmitters be maintained at **not less** than 85 per cent and **not more than 100 per cent on** peaks (FCC Rules and Regulations section 3.55.)

From the method for measuring bandwidth, we are able to know the amplitude of the carrier frequency and of the side bands at difference audio frequencies. Therefore, we may find the per cent modulation of the transmitter by measuring the amplitude of the carrier frequency and amplitude of the side band at 1 KC audio frequency. Generally, when the amplitude of the sideband components related with the amplitude of the carrier, the amplitude of the side band components will be half of the amplitude of the carrier at 100 per cent modulation. (See APPENDIX II). If we set the amplitude of the carrier to be equal to 1 unit, then the per cent modulation is equal to two times the amplitude of the side band at 1 KC audio frequency multiple with 100.

The method mentioned above is not a precise form, there are other methods for checking modulation by using an oscilloscope. Two types of the patterns are in general use -- the trapezoid pattern, and the wave envelope pattern. Percentage of amplitude modulation can be measured on an oscilloscope by either the trapezoid pattern or the wave envelope pattern.

The trapezoid pattern is obtained by connecting the modulating audio frequency signal to the horizontal deflecting plate and the tank circuit output to the vertical deflecting plates. When the modulating voltage is not high enough to produce a useful sweep voltage, it must be amplified first. Most oscilloscopes have well designed amplifiers which introduce very little distortion at audio frequencies. Low level modulating voltages can then be connected through the horizontal amplifier of the oscilloscope. This insures a horizontal deflection which compares favorably with the vertical RF deflection.

The wave envelope pattern is obtained by connecting the modulated RF signal to the vertical deflection plates and using the internal horizontal sweep for horizontal deflection plates.

When the AF voltage represented by the sine wave is inphase with the RF voltage, the AF and RF add, increasing the height of the vertical pattern. As they go out of phase along the horizontal sweep, they cancel, and the vertical amplitude approaches zero. In the case of the wave envelope pattern, the horizontal sweep can be adjusted to obtain any number of similar patterns on the screen.

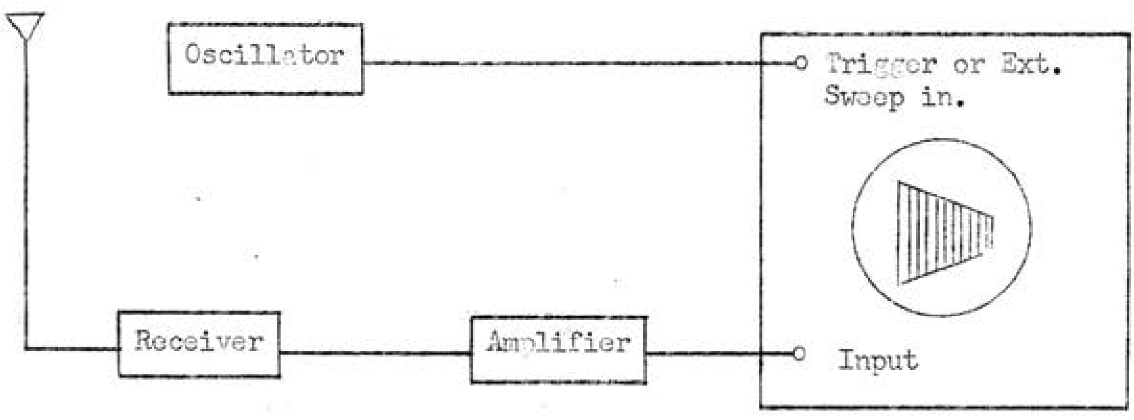

Fig. 7 —— Connection of the equipments use for measuring per cent modulation. (Trapezoid pattern.)

Examine the illustration in Fig. 8 showing the typical waveforms. If pattern similar to the one at C and D is obtained. The percentage of modulation is less than 100 per cent. This indicates that the amount of audio power developed by the modulator is not high enough. Overmodulation is shown at E and F. At E, the short horizontal line at the right hand side of the pattern indicates that the modulation voltage is excessive on the negative peaks.

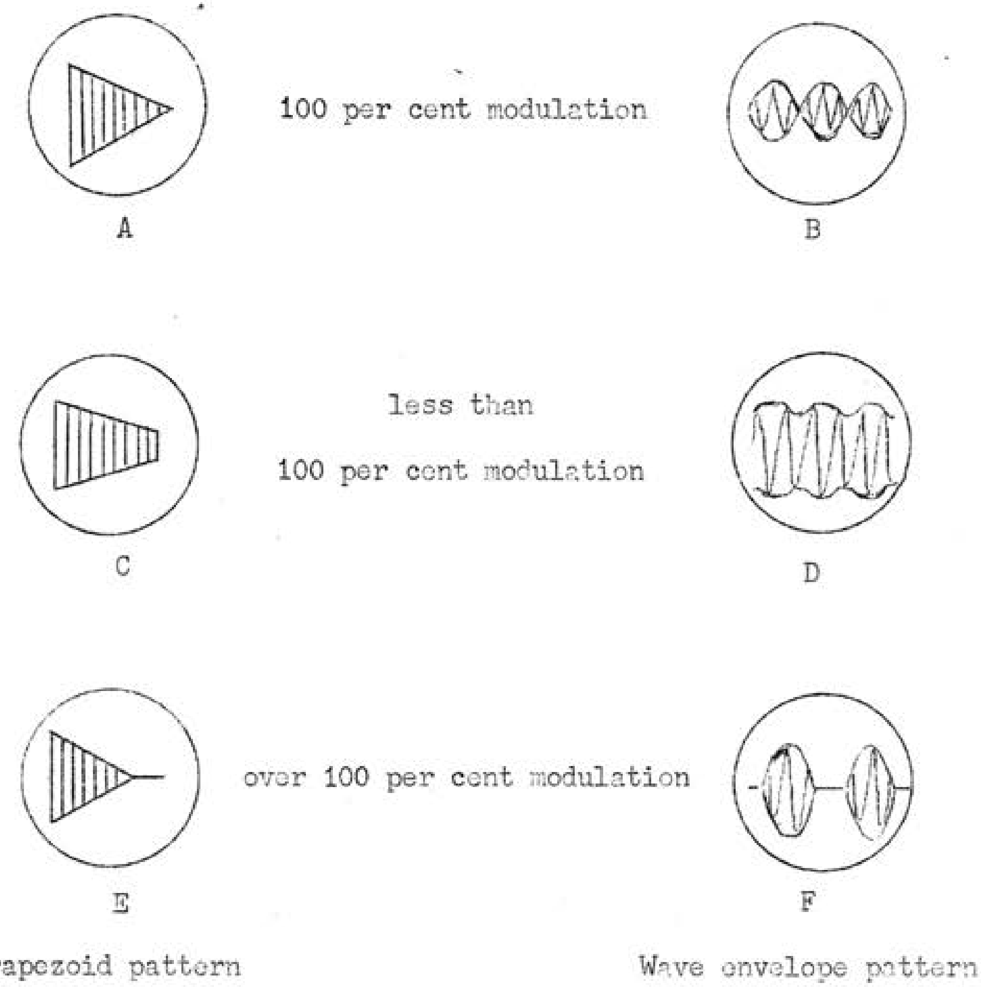

Fig. 8 —— Amplitude Modulation Waveform.

Method for Measuring Spurious Emission

Under FCC Rules and Regulations, a transmitter should radiate energy only on its assigned frequency and within the allocated bandwidth, All of the radiation which lie outside the allocated bandwidth are termed as spurious output. The allowable spurious output from transmitters must continue to be reduced as more and more use is made of the frequency spectrum. The following types of spurious output may be found.

Harmonics. A transmitter may radiate on multiples of the carrier frequency. For the standard A-M broadcast, the FCC Rules require that any emission more than 75 KC away from an A-M carrier shall be attenuated at least 43 + 10 log(power in watts)-db below the level of the unmodulated carrier, or 80-db, which ever is the lesser attenuation.(See APPENDIX IV.)

Subharmonics. Where frequency multipliers are used in a transmitter, there is a possibility of radiation of submultiples of the carrier frequency.

In-band Noise. Spurious outputs within the broadcast bands are referred to as in-band noise.[6] For A-M broadcast transmitters, the FCC requires 25-db attenuation from 15 to 30 KC away from the carrier and 35-db from 30 to 75 KC away from the carrier.

For measuring, only unmodulated carrier frequency will be transmitted

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[6] Laurence Gray, and Richard Graham, Radio Transmitters (New York: McGraw-Hill Book Company,Inc., 1964), p. 405.

from a transmitter. Tune the receiver to receive the unmodulated carrier, measure the voltage of the carrier signal and then tune the receiver to the 15 KC, 30 KC, and 75 KC away from the carrier frequency. Then tune the receiver to the second, third, fourth, and fifth harmonics respectively. Note down the amplitude of the carrier signal at every points mentioned above.

Method for Measuring Harmonic Distortion

Excessive A-F distortion is annoying to the radio listener. In order to ensure acceptable quality of transmission, the FCC has required that no broadcast transmitter shall have more than 10 per cent combined audio-harmonic distortion when operating at a level of 85 per cent modulation.

Total harmonic distortion is measured in terms of the root mean square of all the harmonics present in the output.[7] As an example, assume that the value of the second, third, and fourth harmonics are 3%, 5%, and 2% respectively. The rms value would be found by taking the square root of the sum of the squares or:

$$\text{Total rms harmonic distortion} = \sqrt{3^2 + 5^2 + 2^2} = 6.2\ \%$$

The harmonic produces may be individually determined by means of spectrum analyzer. The per cent of any harmonics would be found from the

[7] George E. Stering and Robert B. Monroe, The Radio Manual (New York: D. Van Nostrand Company, Inc., 4th ed), p. 181.

method for measuring spurious emission in the preceeding paragraph. Then the total rms harmonic distortion can be found as afore-mentioned.

Spectrum Analyzer

Spectrum analyzer is a device used to provide a display of radio frequency signal distribution in a selected portion of the radio frequency spectrum. The display represents a plot of signal amplitude versus frequency, usually on a cathode-ray oscilloscope. Spectrum analyzer used in conjunction with a suitable receiver which provides the required preselection of the desired signal as well as audible indications. Useful information such as the presence, or absence, of signals of interest, their frequencies, frequency differences, relative amplitudes, type of modulation, side band structure, and relative amplitudes may be determined.

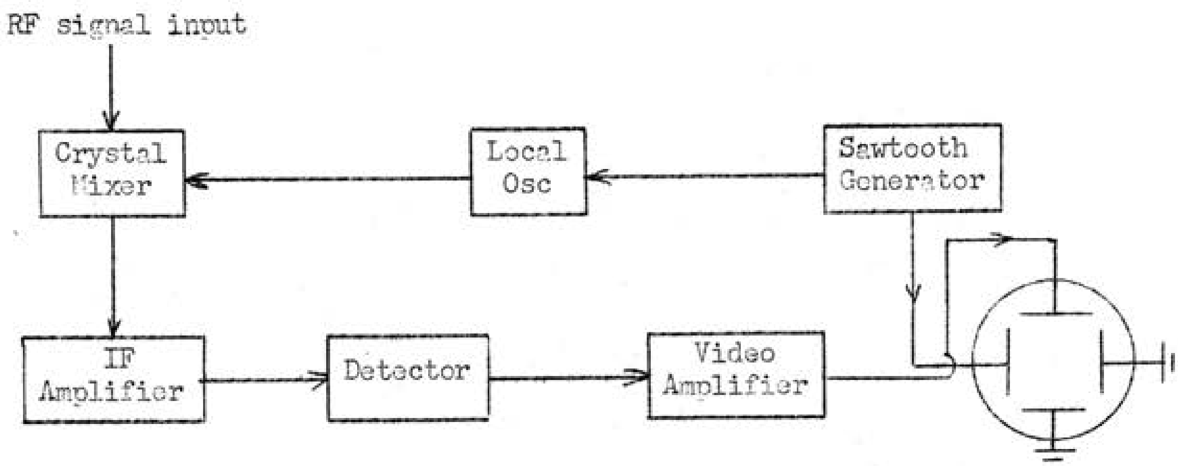

Fig. 9 —— Block diagram of the basic type of spectrum analyzer.

Spectrum analyzer is a narrow-band super heterodyne receiver with a local oscillator whose frequency is made to vary as a function of time.

The local oscillator is a frequency modulated by a sawtooth frequency in synchronism with the sweep frequency of the oscillator tube, allowing one to observe the response of signals within the range covered. As no image rejection is employed ahead of the crystal frequency converter, an indication will appear when the local oscillator is either lower or higher than the received signal by an amount equal to the intermediate frequency amplifier. Most of the analyzers may be adjusted from zero sweep width to a value wide enough to show both responses as the local oscillator is swept.

The bandwidth of the IF amplifier is made narrow enough so that only one frequency component of the signal is passed through the IF amplifier at a time. Thus, as the local oscillator sweeps through the desired frequency range, a succession of beats, each representing a different frequency component of the signal spectrum, is amplified by the IF amplifier. The IF beats are detected and further amplified in a video amplifier in order to produce a vertically deflected line on the cathode-ray tube screen.

By synchronizing the frequency excursion of the local oscillator with the horizontal deflection of the CRT beam, the spectrum analyzer converts the horizontal scale into a frequency scale and thereby presents a plot of spectrum component amplitudes versus a frequency.

In selecting a type of spectrum analyzer for investigation of radio broadcasting interference, it is necessary to consider its various qualifications as follow:-

1) Sweep width: adjustable and more than 10 KC,

2) Sweep rate : adjustable,

3) IF bandwidth : adjustable,

4) Scan rate : adjustable.

The PANORAMIC PANALYZOR Model SB-12b (Panoramic Electronics, Inc., U.S.A.) is a suitable type.

PANORAMIC PANALYZOR Model SB-12b

The PANORAMIC PANALYZOR Model SB-12b is designed for research, design or test application such as:-

Single sideband studies.

Hum level analysis.

RF cross modulation analysis.

Adjacent channel interference investigations.

Band occupancy studies.

Residual carrier and side band level measurements.

Spurious oscillation or modulation detection.

FM deviation measurements.

The PANALYZOR is an automatic scanning superheterodyne receiver which permits analysis and identification of one or many radio frequency signals at one time. Each signal within the band being scanned is displayed on a cathode-ray tube as one of a series of pips. The pip amplitude and position along the calibrated horizontal axis are indicative of signal level and frequency, respectively. A CW signal produces a single pip. Modulated signals (AM) cause a series of pips which indicate side band distribution and levels.

The SB-12b is unique in that it offers all the advantages of automatically scanning spectrum presentations, yet enables examination of signals so closely adjacent in frequency that their corresponding deflections normally tend to merge together.

The main electrical characteristics of SB-12b are :-

SWEEP WIDTHS : 0 - 100 KC for continuously variable.

INPUT CENTER FREQUENCY : 500 KC.

BANDPASS REGION AMPLITUDE CHARACTERISTIC : 450 - 550 KC.

SCAN RATES : 0.1 cps to 30 cps continuously variable.

RESOLUTION : Continuously adjustable with IF BANDWIDTH control.

In Fig. 10 showing the front panel of the PANALYZOR Model SB-12b which the function of the switches are mentioned below.

GAIN : The amplitude of the indication on the cathode-ray tube screen is adjustable with this control. Maximum gain is obtained at maximum clockwise position.

SIGNAL INPUT: This coaxial jack receives R-F signal to be analyzed.

VFO INPUT : VFO is the associated external oscillator or signal generator which is used to heterodyne with the test signal to produce the required frequency to operate the SB-12b. The heterodyne product should be the difference between the two frequencies used. If the sum frequency is used, spurious screen indications may result from heterodyne products of the test signals and the external signal generator output.

SWEEP RATE : The potentiometer controls provide continuously adjustable

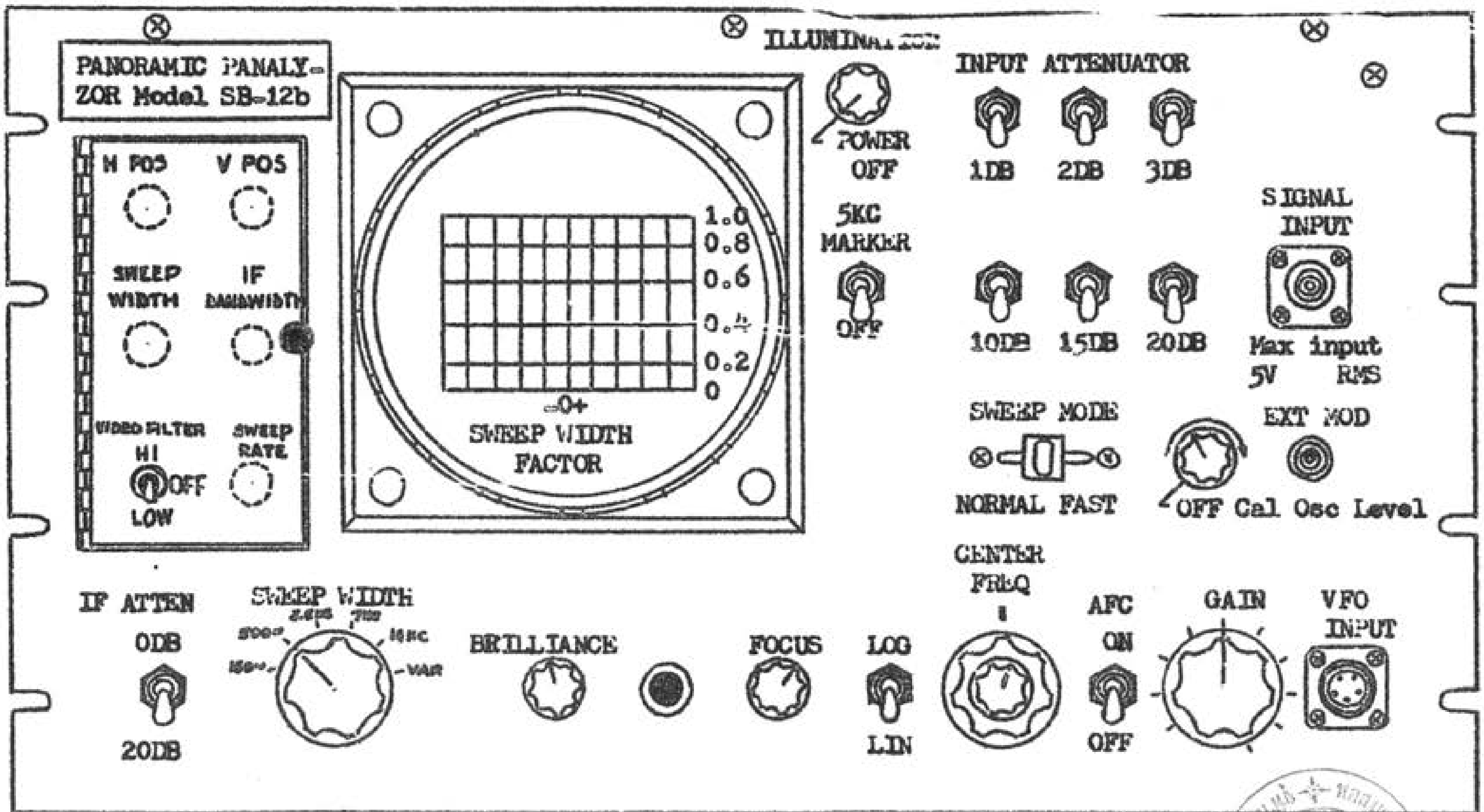

Fig.10 Front Panel, PANALYZOR Model SB-12b Type T-100

scanning rates between 0.1 and 30 cps. Counterclockwise rotation of the controls reduces the sweep rate. The controls are operative only in the VAR position of the SWEEPWIDTH SELECTOR switch.

SWEEP WIDTH SELECTOR : This switch control provides a choice of five preset widths of 150 cps, 500 cps, 3.5 KC, 7 KC, 14 KC, and VAR. In the VAR position, the sweep width may be set to any value from 0 to 100 KC, the I-F BANDWIDTH may be set for any desired resolution within the capability of the instrument, and the SWEEP RATE may be set to any value from 0.1 to 30 cps.

SWEEP WIDTH : The scanning width of the instrument is adjusted with this control. When it is turned completely clockwise, the maximum spectrum width for which the instrument is designed (that is, 100 KC when AFC is off, or 2 KC when AFC is on) can be seen on the screen. As the control is backed off in a counter-clockwise direction, the bandwidth viewed becomes narrower.

CENTER FREQ : Center frequency is the frequency of the signal received on that part of the frequency sweep axis corresponding to zero sweep voltage applied to the reactance modulator.

IF BANDWIDTH: The ability to separate individual signals is dependent upon two factors: the rate of frequency scan and the bandwidth of the IF section of the instrument. Optimum resolution requires a definite relationship between the two. Resolution sharpens as both the frequency scanning rate and IF bandwidth are decreased. This control is used to narrow the IF bandwidth.

Counter clockwise rotation of this control narrows the width of the IF section. It should be noted that as this control is adjusted, there will be some degree of change in the sensitivity of the equipment. The frequency scanning rate is diminished by increasing the scanning period or, conversely, by decreasing the spectrum width scanned within a given time. The AFC and SWEEP WIDTH controls provide the latter method.

Fig. 11 showing the block diagram of the PANALYZOR SB-12b. The circuit description is mentioned followed the block diagram.

Since the output of the first mixer has a pass band of 450 to 550 KC, no external oscillator input frequency is required for incoming signals in the 450-to 550-KC range. An external OSC input frequency 500-KC higher or lower than the signal input frequency is required for incoming signals outside the 450 - to 550-KC range.

The sweep generator section is provided with two sawtooth output circuits. The sawtooth speeds are variable from 0.1 to 30 cps. One sawtooth voltage wave provides the CRT with horizontal sweep. The other sawtooth voltage wave is fed to a reactance modulator. The reactance modulator causes the local sweep oscillator frequency to vary in proportion to the progressively varying magnitude of the sawtooth voltage. With the AFC feedback circuit OFF, the scanning width is ± 50 KC from the 600-KC center frequency, with the AFC feedback circuit ON, $\pm$ 1 KC. The 2nd Mixer stage receives two signals: one, those in the 450- to 550-KC output circuit of first IF amplifier, and two, the scanning voltage 550- to 650-KC of the local sweep osc;

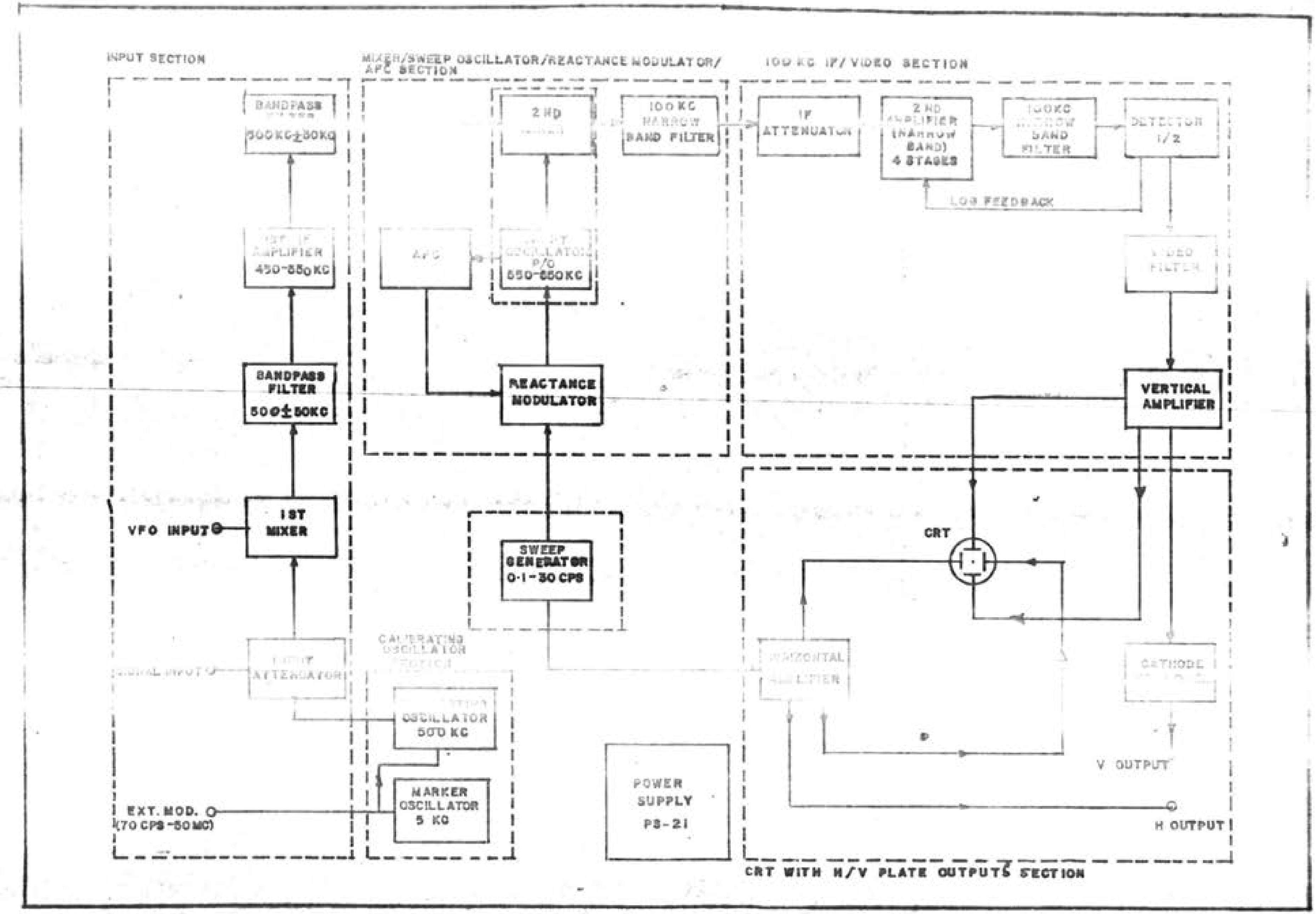

Figure 11. Block diagram, analyzer SB-12B

the scanning voltage progressively translates each voltage component in the 450- to 550-KC signal to a 100-KC difference frequency signal at the output of the mixer's 100-KC center frequency narrow band output filter.

The 100-KC IF and video section receives the 100-KC voltages from the output of the second mixer. These voltages are amplified in a narrow band four-stage amplifier, are detected, and are fed to the CRT vertical plates via a vertical amplifier.

The CRT displays the component signals in the 100-KC R-F bandwidth of the signal under test. The pip amplitude and position along the calibrated horizontal axis are indicative of each component signal level and frequency, respectively. The sawtooth voltage output of the sweep generator progressively shifts the CRT electron beam horizontally across the screen in order to enable the CRT to display the successively demodulated 100-KC signals emerging from the second mixer. These signals represent magnitudes of the successive frequency components in the R-F bandwidth being scanned.

Radio Receiver

ITU and FCC states that bandwidth of A-M radio broadcast transmitter should not exceed 10 KC at the point 3-db down the reference value. Thus, in the measurement, the type of radio receiver used should have the bandwidth of tuned circuit more than 10 KC. Because, in Method for Measuring Bandwidth page 12, we modulate RF signal with the audio frequency which changes from 1 KC up to 10 KC, the signals in the region out-of-band of that transmitter will be filtered by the tuned circuit of the radio receiver if the bandwidth of radio receiver is narrower than 10 KC. Therefore the amplitude of the side-bands which are out-of-band are not the exact value which that transmitter transmit.

The radio receiver R-390A/URR: Stewart-Warner Electronics, U.S.A., is a suitable type for these measurements.

Radio Receiver R-390A/URR

Radio receiver R-390A/URR provides reception of CW, MCW, and amplitude-modulation (A-M) including single-sideband (SSB) signals over a continuous frequency range of 0.5 to 32 Mc. The receiver is a superheterodyne type with multiple conversion. Selected bandwidth: 0.1, 1, 2, 4, 8, and 16 KC.

RF signals are fed into the receiver either by a balanced two-wire antenna such as a doublet, or by an unbalanced antenna such as a whip antenna. The signal from the unbalanced antenna is fed directly to RF amplifier which amplifies the signals before they are fed to first mixer. When the receiver is operated between 0.5 and 8 Mc, the first mixer mixes the RF signals with a 17 Mc signal from first crystal oscillator. The output (sum) frequency is the first variable IF signal; its frequency varies from 17.5 to 25 Mc. When the receiver is tuned between 0.5 and 1.999 Mc, second crystal oscillator feeds a 21 Mc signal into second mixer and mixes with the RF signals. The output frequency of the second mixer varies downward from 3 to 2 Mc and is fed through tuned circuit to third mixer mixes with a continuously variable signal (3.455 to 2.455 KC) from variable-frequency oscillator. The output of third mixer is fed to tuned circuit and is a fixed frequency of 455 KC.

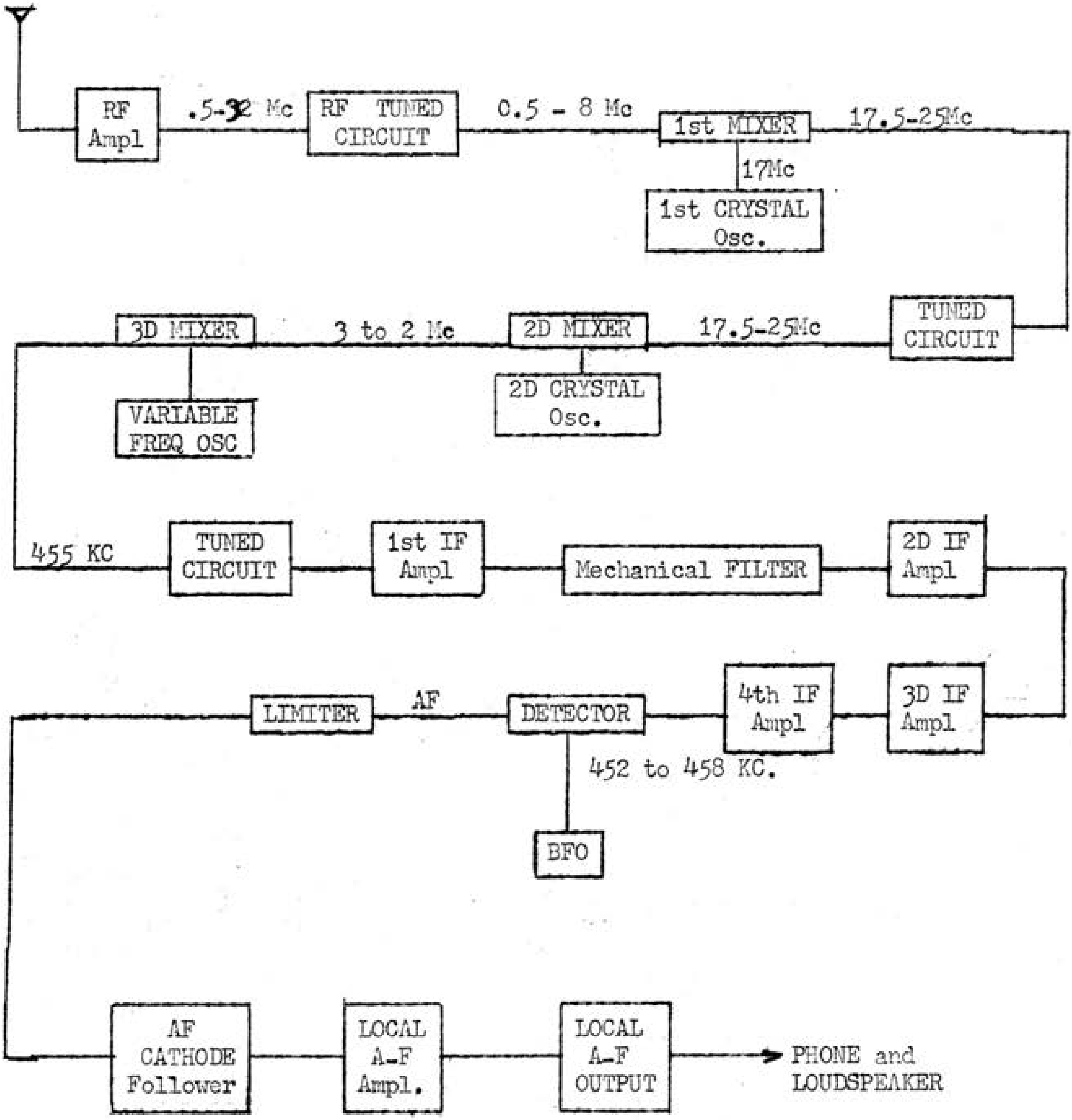

Fig. 12 —— Block diagram of R-390A/URR Radio Receiver when operated in the range 0.5 and 8 Mc.

This is the third IF signal. The 455-KC third IF signal is applied to first IF amplifier. The output of the first IF amplifier is fed into one of four mechanical filters selected by the BANDWIDTH switch. The output from the selected filter is fed successively through the second, third, and fourth IF amplifiers. The output of fourth IF amplifier is fed into detector. Beat-frequency oscillator (BFO) generates and feeds variable-frequency signals (452 to 458 KC) to detector. The detector demodulates the 455-KC IF signal to recover the intelligence from the modulated signals. The AF output from detector is fed to limiter to removes noise pulses that exceed the amplitude of the modulation. The audio output from limiter is fed to first AF amplifier. This stage amplifies the audio signal and then fed to AF cathode follower. This stage feeds the audio signals to the local and line audio channels. The local audio channel consists of local AF amplifier. This audio source is used for 600-ohm headsets and loudspeakers.

Fig. 13 —— Radio receiver R-390A/URR.

Calibration Method

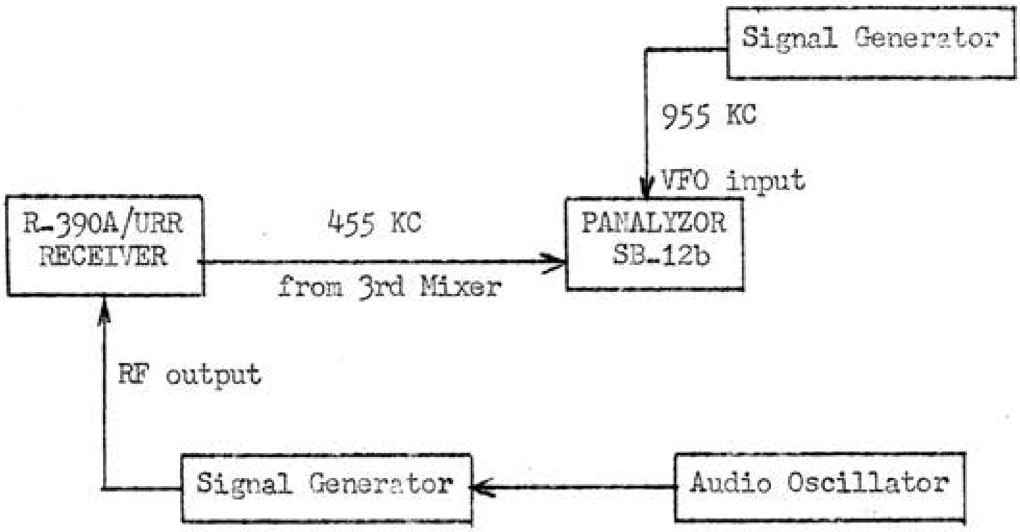

Fig. 14 —— Calibration of the equipments.

From the R-390A/URR radio receiver, the IF out put from 3D MIXER stage is 455 KC, fed this IF signal to the SIGNAL INPUT coaxial jack of the PANALYZOR SB-12b. Because the CENTER FREQUENCY of the PANALYZOR SB-12b is 500 KC, thus, fed the 955 KC frequency from STANDARD SIGNAL GENERATOR Type 1001-A to the VFO input coaxial jack. The VFO 955 KC and IF 455 KC mixes in the 1st MIXER stage of the PANALYZOR SB-12b to give a frequency 500 KC which is the center frequency of the PANALYZOR SB-12b. Feed the output from the 606A SIGNAL GENERATOR which the selected switch at CW and generate the frequency F_o to the UNBALANCED ANTENNA coaxial jack at the back of the R-390A/URR radio receiver. Tune the receiver to receive signal F_o and set the BANDWIDTH SELECTOR switch of the receiver to 16 KC.

Set the front panel controls of the PANALYZOR SB-12b as follows:

INPUT ATTENUATOR.................All switches up.

ILLUMINATION.....................As desired.

CAL OSC LEVEL....................OFF.

AFC ....OFF

5 KC MARKER ....OFF

AMPLITUDE SCALE ....LIN

FOCUS ....For a sharp trace.

BRILLIANCE ....As desired.

SWEEP WIDTH SELECTOR ....VAR.

IF ATTEN ....0 DB.

VIDEO FILTER ....OFF.

V POS ....So that base line trace coincides with the frequency scale.

H POS ....To approximately center the baseline on the CRT screen.

GAIN ....Adjusted.

CENTER FREQ ....Adjusted.

SWEEP RATE ....Adjusted in calibration.

IF BANDWIDTH ....Adjusted in calibration.

SWEEP WIDTH ....Adjusted in calibration.

Adjust the switch GAIN of the PANALYZOR SB-12b until the amplitude of the carrier F_o is full scale on the screen of the CRT, then adjust CENTER FREQ switch for the carrier waveform to display on the center of the screen.

The purpose in calibrating the equipments is to set the horizontal scale which is the scale of frequency, for the PANALYZOR SB-12b when the SWEEP WIDTH SELECTOR set to VAR the maximum sweep widths is 100 KC, thus the scale sweep width factor on the frequency scale is 10 KC per division. For measurement, modulating signal is 1 to 10 KC from 200CD OSCILLATOR, thus the sweep width is 20 KC. For accurate value, the sweep width factor on the frequency scale then must calibrate for 2 KC per division.

At the MOD INPUT of the 606A SIGNAL GENERATOR, feed the A-F signal 6 KC from the 200 CD OSCILLATOR and set the selected switch of the 606A SIGNAL GENERATOR to AC, adjust AMPLITUDE switch of the 200CD OSCILLATOR until the per cent modulation meter of the 606A SIGNAL GENERATOR points at approximately 95 - 100 per cent. The spectrum components of carrier frequency F_o and the two side bands F_o + 6KC and F_o - 6KC will display on the screen of the PANALYZOR SB-12b. Adjust SWEEP WIDTH switch counter-clockwise, and IF BANDWIDTH switch too, until the two side bands on the screen are far from center frequency F_o at the three divisions. Adjust SWEEP RATE switch until the scanning of the spectrum is proper. Then tune the 200CD OSCILLATOR to 1 KC, 2 KC, and so on until 10 KC in order to check that the side bands spectrum are at half division, one division, and so on until five divisions far from center frequency F_o, respectively with the audio frequency changes.

Note that the SWEEP RATE is adjusted for the proper scanning that at 1 KC modulating frequency the spectrum of the carrier F_o and the side bands shown sharply and do not interfere with each other.

Now the PANALYZOR SB-12b is calibrated and appropriate for measurements with a sweep width 2KC per division. For measuring, when the RF signal is received by antenna and fed into the R-390A/URR receiver at UNBALANCED ANTENNA coaxial jack and tune the receiver at desired frequency, the spectrum components will be displayed on the screen of the PANALYZOR SB-12b at sweep width 2 KC per division, and amplitude of the carrier is adjusted by switch GAIN.

All the time of measuring, don't touch the SWEEP WIDTH, and IF BANDWIDTH switches, because it will change the sweep width per division on the frequency scale. If the SWEEP RATE changes, it will cause the IF BANDWIDTH to change too.

The other equipments which are used in cooperation with PANALYZOR SB-12b and the R-390A/URR radio receiver for the measurements are listed in Chapter III. All of those equipments are in general use, therefore, it is unnecessary to describe them in details.