MODEL
560

VEDOLYZER

OPERATING INSTRUCTIONS

SUPREME
INSTRUMENTS CORPORATION
GREENWOOD, MISS., U.S.A.

STOCK NO.-5286

INDEX

SUPREME INSTRUMENTS CORP.
GREENWOOD, MISS., U.S.A.....

OPERATING INSTRUCTIONS FOR THE SUPREME VEDOLYZER
(STOCK NO. 5286)
(Models 560 and 560-A

ELECTRICAL SPECIFICATIONS

Power Supply Requirements: (unless otherwise specified on plate attached to grill in rear of chassis)

Voltage........................110/120 a.c.
Frequency......................60 cycles
Power Consumption..............75 watts
Fuse Protection................ 2 amperes

MECHANICAL SPECIFICATIONS

Over-all dimensions:

Height.........................$11\frac{1}{2}$ inches
Width..........................$15\frac{1}{2}$ inches
Depth..........................13 inches

Weights:

Net............................35 pounds
Shipping.......................40 pounds

STANDARD EQUIPMENT SUPPLIED WITH THE MODEL 560-A

Quantity Included	Stock No.	Description	Packer's Check
1	5286	Booklet, instruction	
1	6725	Card, registration	✓
1	6288	Chart, sample analysis	✓
1	7682	Screen, calibrated non-linear	✓
1	5198	Probe, coaxial cable (red) R.F. Video	✓
1	4808	Probe, coaxial cable(blue)I.F.	✓
1	5198	Probe, shielded calbe, A.F.	✓
1		Booklet, special application (omitted)	

The above list has been checked by the undersigned who is responsible for the completion of this package.

Model 560-A, SERIAL NUMBER 364 SIGNED L.S.

Mention above numbers in all correspondence

IMPORTANT

SEE ENCLOSED COLORED PAGE FOR INFORMATION CONCERNING REGISTRATION, TRANSPORTATION DAMAGES, GUARANTEE, REPLACEMENT PARTS, ETC.

These instructions must be complied with before the guarantee policy is applicable. The Model and Serial numbers should be mentioned in all correspondence.

SUPREME INSTRUMENTS CORPORATION
GREENWOOD, MISSISSIPPI
U. S. A.

SUPREME MODEL 560-A VEDOLYZER

INTRODUCTION

These instructions cover the description, operation and maintenance of the Supreme Model 560-A Vedolyzer; a complete dynamic analyzer for testing electrical circuits under actual operating conditions. This instrument may be used whenever it is necessary to check the amplitude and condition of the voltage in practically any type of radio or electronic apparatus. It is safe to say that the application of the Vedolyzer is limited only by the knowledge and skill of the operator. In general, the Vedolyzer is a combination cathode ray oscilloscope for checking the quality (hum, distortion, etc.) and a vacuum tube voltmeter for observing thequantity (amplitude, gain, etc.). Provisions are also contained within this instrument for checking static operating conditions (supply potentials, parts, etc.) and also for checking the frequency of voltage between 65 kc. and 6.5 mc.

Since the primary design of the Vedolyzer was for the purpose of facilitating "trouble shooting" in a radio receiver, more space will be given to this particular application. The oscillograph, by its very nature, being an instrument capable of indicating in two dimensions, has almost unlimited applications in a wide variety of commercial fields. Thus, in an instruction book of this type one would hardly expect to do justice to such a versitile instrument as the Vedolyzer.

The Model 560-A is very similar in operation to the Model 560. Notes will be found on the lower parts of the pages at such places where there is a difference in the name of the controls or a change in the operation procedure. Throughout these instructions capitalized quotations such as "POWER," "FUNCTION SELECTOR," etc., refer to controls and terminals. Capitalized underscored indicate the positions of the controls.

OPERATION

Plug the power supply into a suitable a-c outlet (see electrical specifications on preceding pages) and turn "POWER" switch to ON position. The line directly above the tuning knob should illuminate the calibrated frequency dial indicating the power is being supplied to the instrument. Turn the "INTENSITY" knob in an extreme counter clockwise position in order to remove any probability of accidentally burning the cathode ray tube screen while the amplifier tube is heating to operating temperature. Sometimes even the most careful operator will burn the screen slightly, however, if this should occur, it does not in any way effect the operation of the tube.

SETTING UP THE VACUUM TUBE VOLTMETER: As the temperature of the instrument reaches the normal operating point, the "FUNCTION SELECTOR" should be set to DCV position and a short connector placed across the terminals of the V. T. VM. These are pin jack terminals marked "V. T.VM." and "GND." As soon as the meter needle becomes stationary, push the "3AC, 2DC, R. x 100" button on the left hand switch and adjust the "ZERO VOLTS" control until the meter coincides with the "O" marks on the meter scales. Now remove the connector which is shorting the input of the "V. T. VM." and turn the "FUNCTION SELECTOR" to OHMS . Adjust the "ZERO OHMS" until the meter deflects full scale. This completes the adjustment of the a-c volts, d-c volts and ohmmeter functions of the multimeter.

SETTING UP THE OSCILLOSCOPE: To complete the preliminary adjustments on the Vedolyzer we move to the right hand side of the panel and proceed as follows: Push the "65-230" button which places the horizontal sweep in operation. Turn the "INTENSITY" control in a clockwise direction as indicated by the arrows until a florescent line appears on the screen of the cathode ray tube. This line may appear in some position on the screen other than the center and in such cases the positioning controls "HOR. POS." and "VERT. POS." may require adjustment. For vertical movement of the line, adjust "VERT. POS." adjustment and for horizontal movement regulate "HOR. POS." If the line is too long for horizontal positioning it may be reduced by turning "HOR GAIN" in a counter clockwise direction. In order to bring out the definition of the line the "FOCUS CONTROL" may be regulated until a fine line appears on the screen. It may be necessary to readjust the "INTENSITY CONTROL" for proper brilliance and focus.

When using the multimeter section of the Vedolyzer select the proper function by means of the "FUNCTION SELECTOR" and range by means of the "VOLTS OHMS" push button switch. The multimeter functions available on the "V. T. VM." and the "GND." pin jacks terminals and the respective positions of the "FUNCTION SELECTOR" are d-c volts, "DCV;" a-c volts, "ACV;" ohms, "OHMS." The d-c voltage ranges available for selection on the "VOLTS OHMS" push button switch are 2/6/20/60/200/600 and also 2,000 and 6,000 by using the "VOLTS x 10" pin jacks in conjunction with the 200 and 600 push buttons. The a-c voltage ranges are 3/9/30/90/300/900. The resistance measuring functions begins with 1 ohm at center scale on the "R x 10" range and progress in decade multiples to 10 megohms with a deflection of full scale. Resistance can be easily read from 1 ohm to 100 megohms. The voltage at test leads never exceeds 3 volts on the ohmmeter functions. Most of the controls of the oscillograph section of the Vedolyzer are located on the right hand side of the panel. The probes are attached by means of the screw type connectors. The red probe should be connected to the "R. F. VIDEO" and the blue probe to the "I. F." and the black probe to the "A.V.C.-A.F" plugs. In order to connect these probes into the circuits of the Vedolyzer it is necessary to push the respective push buttons directly above the input plugs. With the "FUNCTION SELECTOR" in GAIN position the amplifier is untuned and is a conventional oscillograph with a high gain vertical amplifier. With the "FUNCTION SELECTOR" in the WAVEMETER (A, B, C, D) positions the amplifier is tuned to the frequency as indicated on the dial located between the meter and the cathode ray tube. With the "FUNCTION SELFCTOR" in "A" position the wavemeter band extends from 65 kc. to 205 kc. The "B" band extends from 205 kc. to 650 kc. The "C" band from 650 kc. to 2050 kc. and the "D" band from 2050 kc. to 6.5 mc. The "I.F." and "A.F." sections are similar to the "R.F. VIDEO" with the exception of a slight decrease in the sensitivity and frequency response.

To synchronize or "lock" the image on the screen of the cathode ray tube the horizontal frequency should be adjusted by means of the push button on the right hand side of the panel. A vernier adjustment "FINE FREQ." is provided for frequencies between the points indicated by the push buttons. When the image is almost stationary the "SYNC. CONTROL" should be advanced to such a position which will tend to lock the figure in place. It may be necessary to readjust the "SYNC.

CONTROL" if the "VERT. GAIN" is retarded during the testing procedure. An "EXT. SYNC." pin jack terminal is provided for applying an external synchronization voltage to the input of the sweep oscillator of the Vedolyzer. This is required when viewing modulated voltage with the sweep oscillator set at modulation frequency. In the case of the modulated radio frequency and intermediate frequencies a lead should be connected from the signal generator to the "EXT. SYNC." of the Vedolyzer.

The "MULTIPLIER" controls the input of the Vedolyzer and works in conjunction with the "VERT. GAIN" control. The buttons "1, 10, 100, 1000" are multiplying factors for the "VERT. GAIN" and are used for attenuation and gain measurements.

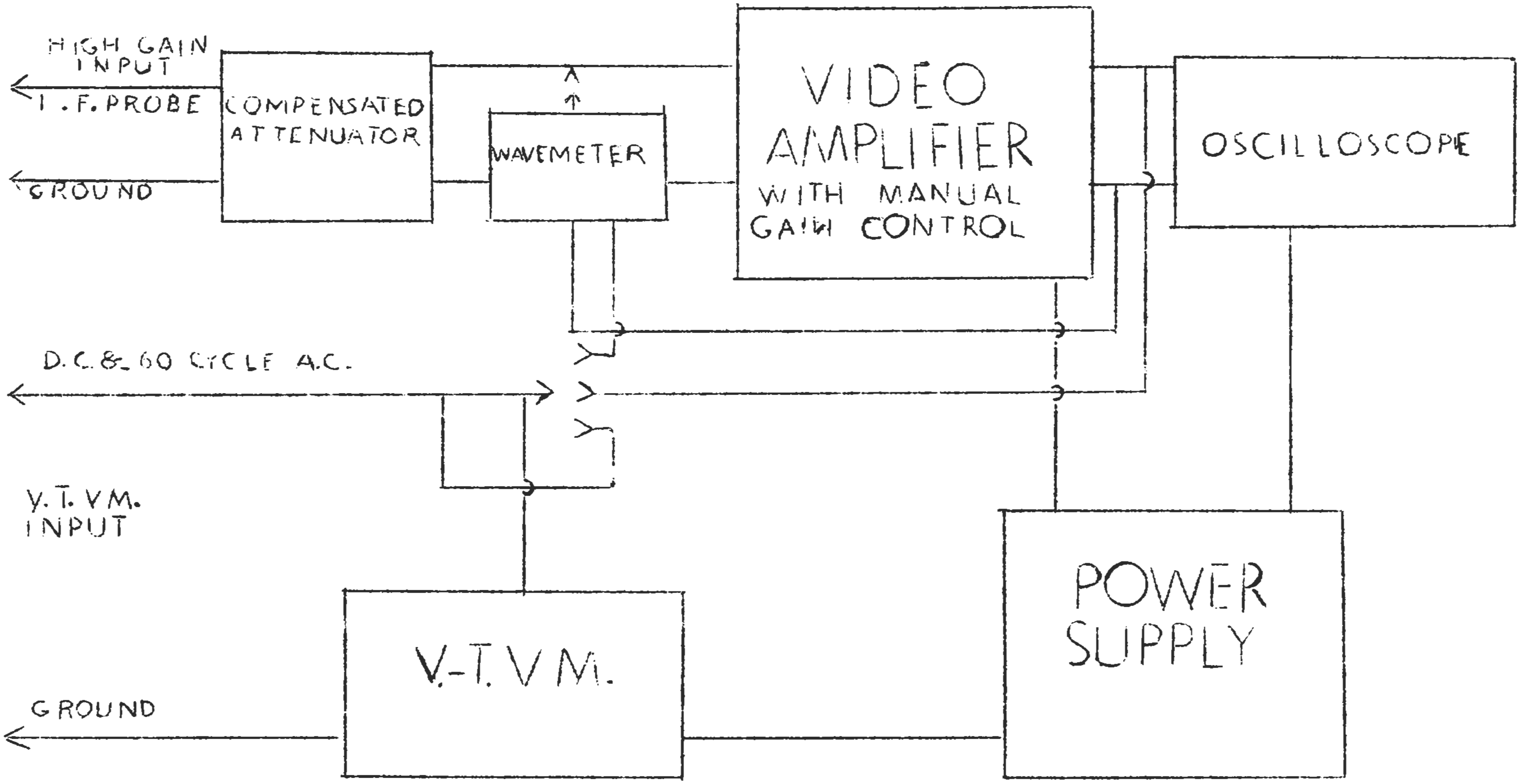


FIG. 1-4. BLOCK DIAGRAM OF VEDOIYZER

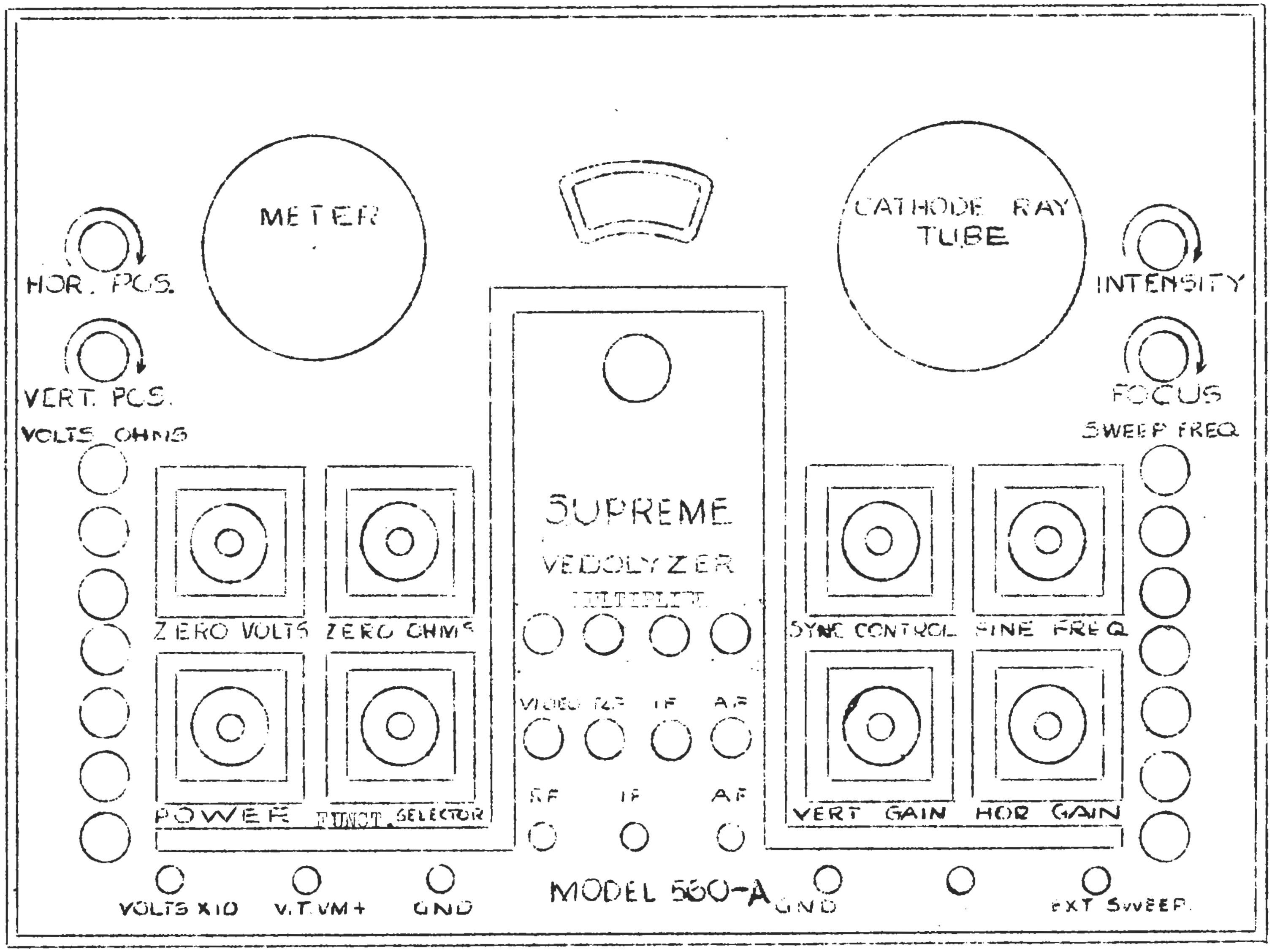

HOR. POS.
VERT. POS.
VOLTS OHMS
METER
CATHODE RAY TUBE
INTENSITY
FOCUS
SWEEP FREQ.
SUPREME
VEDOLYZER
ZERO VOLTS
ZERO OHMS
POWER
FUNCT. SELECTOR
VIDEO
R.F
I.F
A.F
R.F
I.F
A.F
SYNC CONTROL
FINE FREQ
VERT GAIN
HOR GAIN
VOLTS X10
V.T.V.M +
GND
MODEL 560-A
GND
EXT SWEEP

FIG. 1-2

FUNDAMENTAL THEORY AND CIRCUITS

From a circuit standpoint, the VEDOLYZER consists of six parts. They are shown in the block diagram of Fig. 1-4.

A certain percentage of the A. C. voltage picked up by the R. F. probe is transmitted to the grid of the first amplifier tube, the exact percentage depending upon the setting of the attenuator. Due to the unique design of this attenuator, its attenuation is independent of frequency over its entire range.

The "VIDEO AMPLIFIER" is a high gain wide range amplifier that amplifies all sinusoidal voltages within its frequency range the same amount. This amplified voltage is then placed on the vertical deflecting plates of the cathode-ray tube so that its wave form can be seen.

The V. T. VM. reads the output voltage of the video amplifier. This voltage multiplied by the attenuation and divided by the amplification gives the original voltage of the signal. In this instrument the attenuation and amplification are so proportioned that the actual input voltage is either a multiple or sub-multiple of the output of the amplifier.

Great care has been taken in the design of the VEDOLYZER to keep the frequency response absolutely flat. Otherwise, voltage measurements could not be made. The overall frequency response (from probe to meter) of the VEDOLYZER is given in Fig. 2-4.

The compensation in the attenuator is obtained by the use of combination resistive and capacitive voltage dividers.

(II) THE COMPENSATED VOLTAGE DIVIDER

If two series resistors are used to divide an A. C. voltage, as shown in Fig. 3-4, the voltage ratio will generally not equal the resistance ratio and will vary with frequency. That is, $V_1/V_2 = R_1/R_2$ as in D. C. but is affected by the stray capacity of the circuits across R_1 and R_2. These stray capacities form a capacitive divider in shunt with the resistive divider. The reactance of each of these condensers varies inversely with frequency, but their ratio Xc_1/Xc_2 remains constant. We, therefore, have two dividers in parallel each with zero frequency error. At low frequencies $V_1/V_2=R_1/R_2$, since Xc_1 is very much greater than R_1 and Xc_2 is very much greater than R_2; but at high frequencies $V_1/V_2= Xc_1/Xc_2$, since R_1 is very much greater than Xc_1, and R_2 is very much greater than Xc_2. It is seen, therefore, that the overall frequency error may be very large if R_1/R_2 differs very much from Xc_1/Xc_2. On the other hand, the frequency error can be made zero if additional capacity is added to the divider so that $Xc_1/Xc_2 = R_1/R_2$.

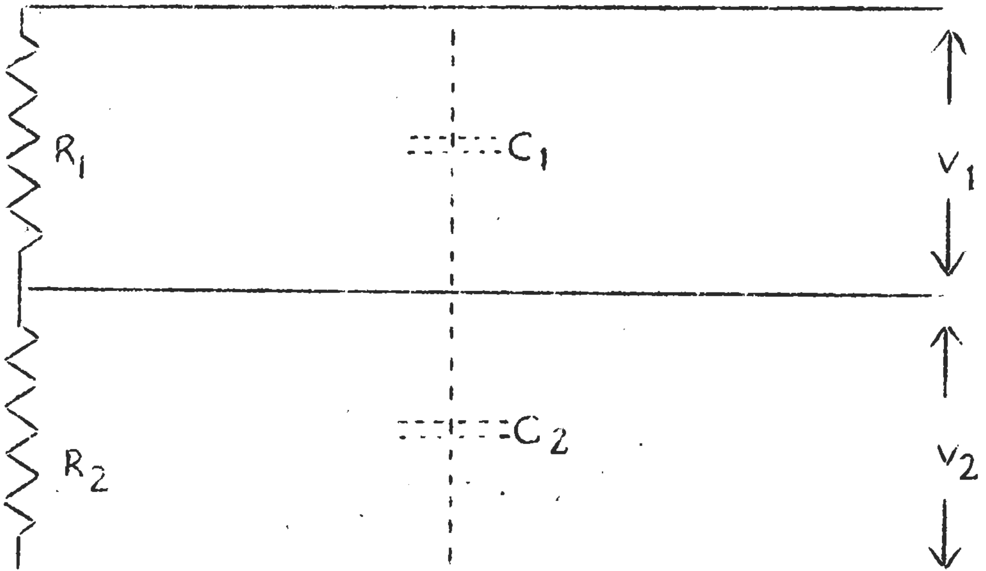


FIG. 3-4

(III) THE WAVEMETER

The wavemeter is of the selective-filter type. That is the high "Q" tuned circuit, controlled by the dial, is used to feed a voltage at its resonant frequency to the Grid of the V.T. VM. The "VIDEO" amplifier with the V.T. VM. serves as an ultra sensitive indicator. (See Fig. 4-4)

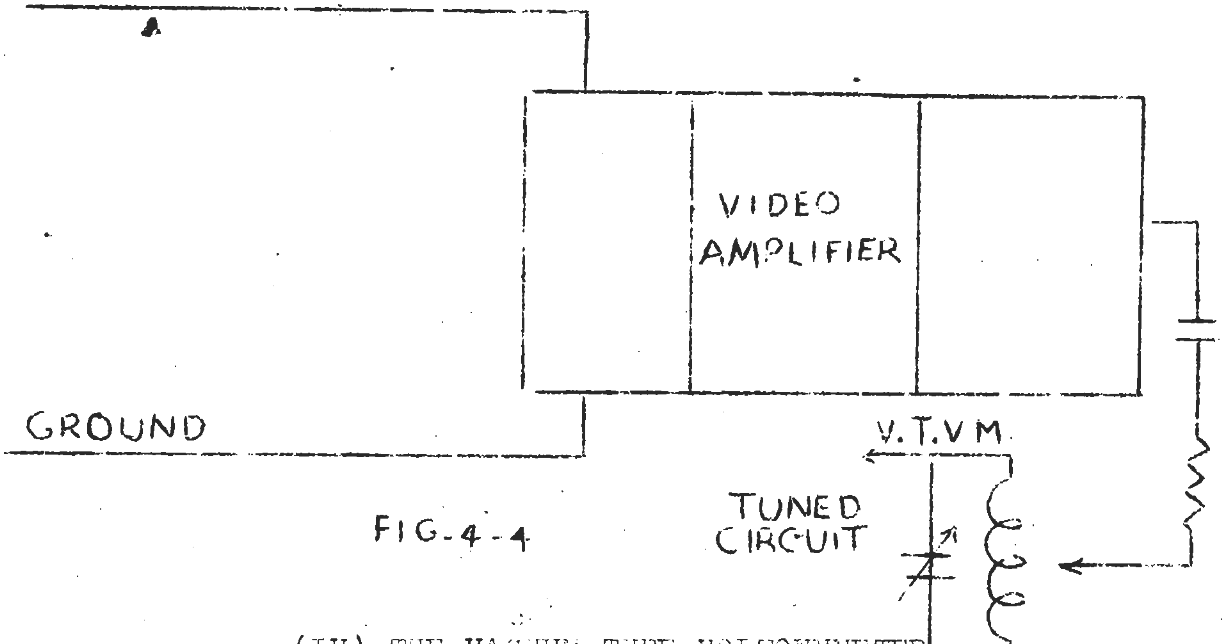


FIG-4-4

(IV) THE VACUUM-TUBE VOLTOHMMETER

The simplified circuits of the bridge type V.T.VM. are given in Fig. 5-4. The bridge has four resistive arms, R_1,

R_2, R_3, R_p, and the meter. The supply voltage is placed across the bridge from "A" to "B" and the unknown voltage from "V. T. VM. +" to "GND." R_3 also supplies the bias for the triode. With no potential on the grid of the tube, the bridge is balanced by adjusting R_1. That is the voltage drop $I_2R_1 = I_1R_p$ and $I_2R_2 = I_1R_3$ so that the potential of "D" equals that of "C". Therefore, no current flows through the meter. However, if a positive voltage is placed on the grid of the tube its plate resistance, R_p, decreases and the bridge is thrown out of balance. The voltage at "D" is now greater than that at "C" because the voltage drop I_1R_p is now less than I_2R_1, since I_2 is greater than I_1. In this way, the meter deflection is caused by the input voltages to the grid, but the current which produces this deflection is not taken from the source. Therefore, no power is taken from the source and the input resistance of the voltmeter is very high. In fact, its input resistance is that of the voltage divider (in this case 15 megohms). The resistance of this divider is limited only by the grid current that the tube draws, since this grid current will cause the potential of the grid to vary as the resistance in the grid circuit is changed. Thus the voltmeter zero is different for each range of the voltmeter when this resistance is too high. A value of 15 megohms is very satisfactory from this standpoint and is quite high enough for the input impedance of the voltmeter.

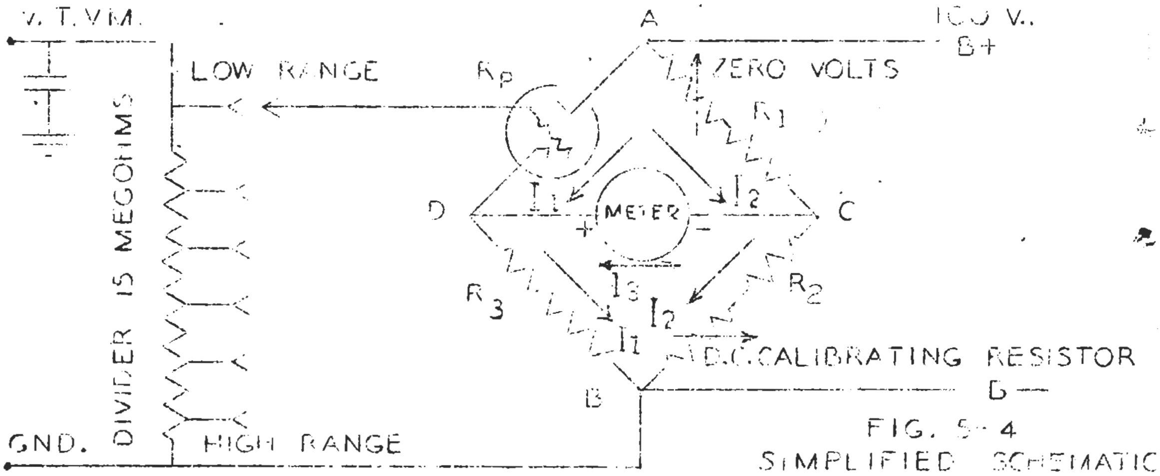


FIG. 5-4
SIMPLIFIED SCHEMATIC
OF V.T.VM.

(V) THE A. C. V. T. VM.

The action of the A. C. V. T. VM. is the same as that of D. C. except that the plate resistance of the vacuum tube is related to the A. C. grid voltage in a different manner than it was to the D. C. grid voltage. The tube must operate on the curved portion of the mutual characteristic curve now, so that rectification will take place. The sensitivity of the A. C. V. T. VM. is, therefore, less than the D. C. Fig. 6-4 is the simplified diagram of the A. C. vacuum-tube voltmeter. Note the addition of C_2 to reduce degeneration and the change of C_1 to isolate the D. C. in the input circuit. See Section IV for further information.

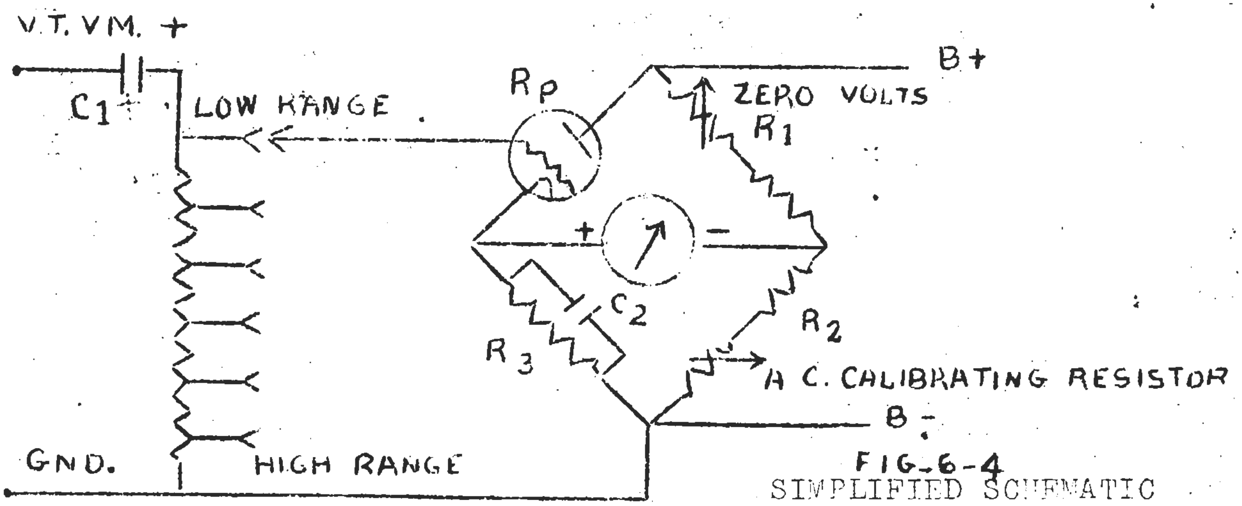


FIG-6-4
SIMPLIFIED SCHEMATIC
OF A.C.V.T. VM.

(VI) THE V.T. OHMMETER

The vacuum-tube ohmmeter is unconventional in that it makes use of the IR drop across, instead of the current through, the unknown resistor in determining its resistance. Referring to Fig.7-4, it is seen that the V.T.VM. measures the IR drop across the unknown resisance. The ohmmeter scale is graduated in percentage of the standard resistance.(R.S,) Since the V.T.VM. does not draw any current, no error is introduced when it is placed across the resistor. In other words, the input resistance of the V.T.VM. is almost infinity (no divider when used as an ohmmeter) so that placing it in parallel with the unknown resistor has negligible effect even at 1,000 megohms.

It will also be noticed that the same precision resistors(R_s) which were used for the V.T.VM. multiplier are now used on the ohmmeter range multipliers. The control "ZERO OHMS" increases the bridge sensitivity as the ohmmeter battery ages. The accuracy of the ohmmeter does not change over the entire life of the battery (i.e. until its voltage drops to below 2 volts). The full "shelf-life" of the battery may be expected if the set-up of the ohmmeter is made each time as explained in Chapter III.

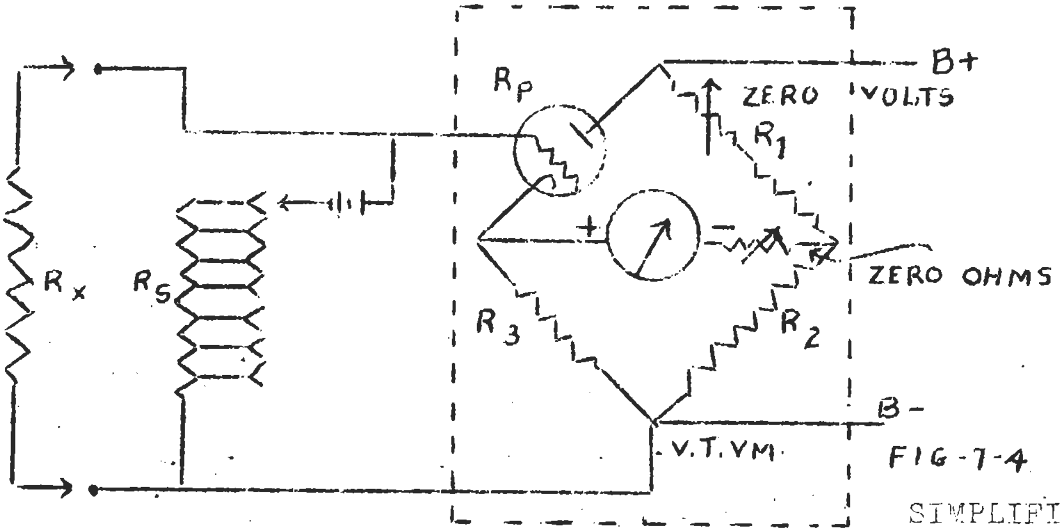


FIG-7-4

SIMPLIFIED SCHEMATIC
OF THE V.T. OHMMETER

(VII) CATHODE-RAY OSCILLOSCOPE

The cathode-ray oscilloscope contained in the "VEDOLYZER is complete in every detail and has an extremely wide-range vertical amplifier which extends its usefulness over intermediate and regular broadcast frequencies. The block diagram of the oscilloscope is given in Fig. 8-4.

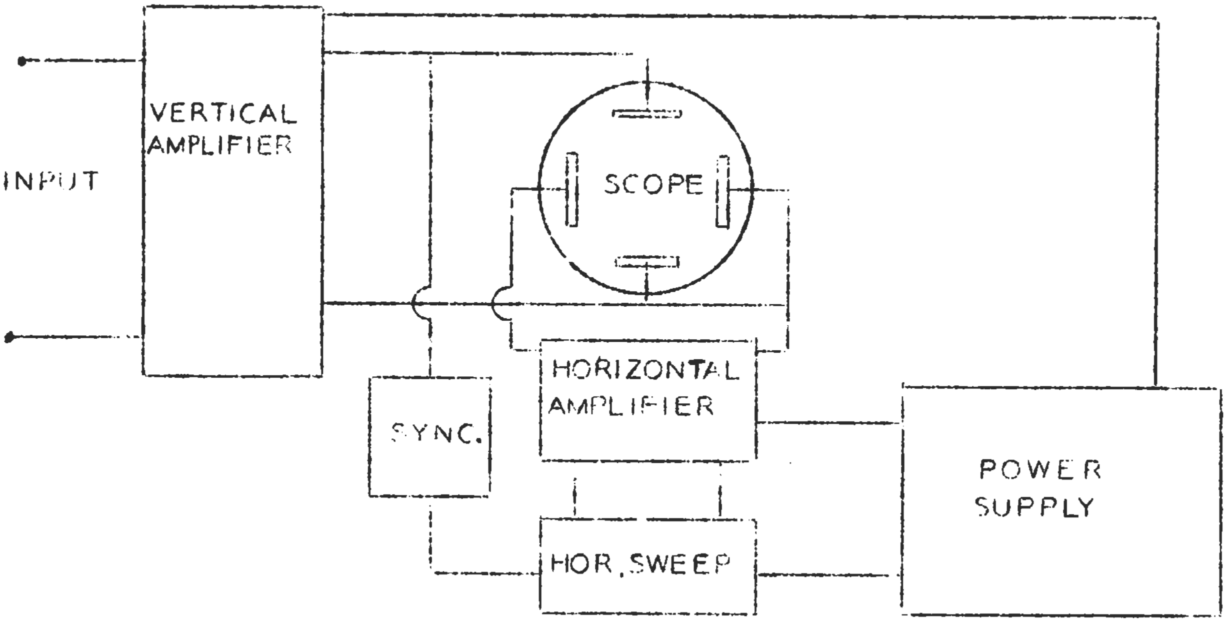


FIG.8-4
BLOCK DIAGRAM OF
CATHODE-RAY OSCILLOSCOPE

The cathode-ray tube is shown diagramatically in Fig. 9-4 and the schematic of a simple cathode-ray oscilloscope in Fig. 10-4. A modern cathode-ray tube consists of six principal parts contained within an evacuated, glass envelope: (1) a cathode for emitting electrons, (2) a grid to control the intensity of this electron stream, (3) a first anode to form the beam of electrons, (4) deflecting plates to deflect the electron beam so that voltage can be observed, (5) a second anode to accelerate this electron beam, and (6) a flourescent screen on which to observe the image.

The cathode is coated only on the end since it is that part alone that is used to furnish the electron beam. The emitting surface is heated indirectly by a heater.

The grid is for controlling the beam intensity. It is a solid metal sleeve with a small disc just in front of the cathode. A small hole in the center of this disc permits the passage of only those electrons which are traveling in the proper direction. This small aperture serves to concentrate the electron beam. The grid is made negative with respect to the cathode. This negative voltage determines the intensity of the beam and is made variable for this reason.

The first anode is very similar to the grid in construction and is placed just in front of it. It is made positive so as to draw the electrons through the grid aperture, thus forming a beam of electrons which then pass through the one or more apertures in this anode. After passing the grid and first anode, the electron stream is a very narrow beam of electrons. This part of the cathode-ray tube is often called the "electron gun."

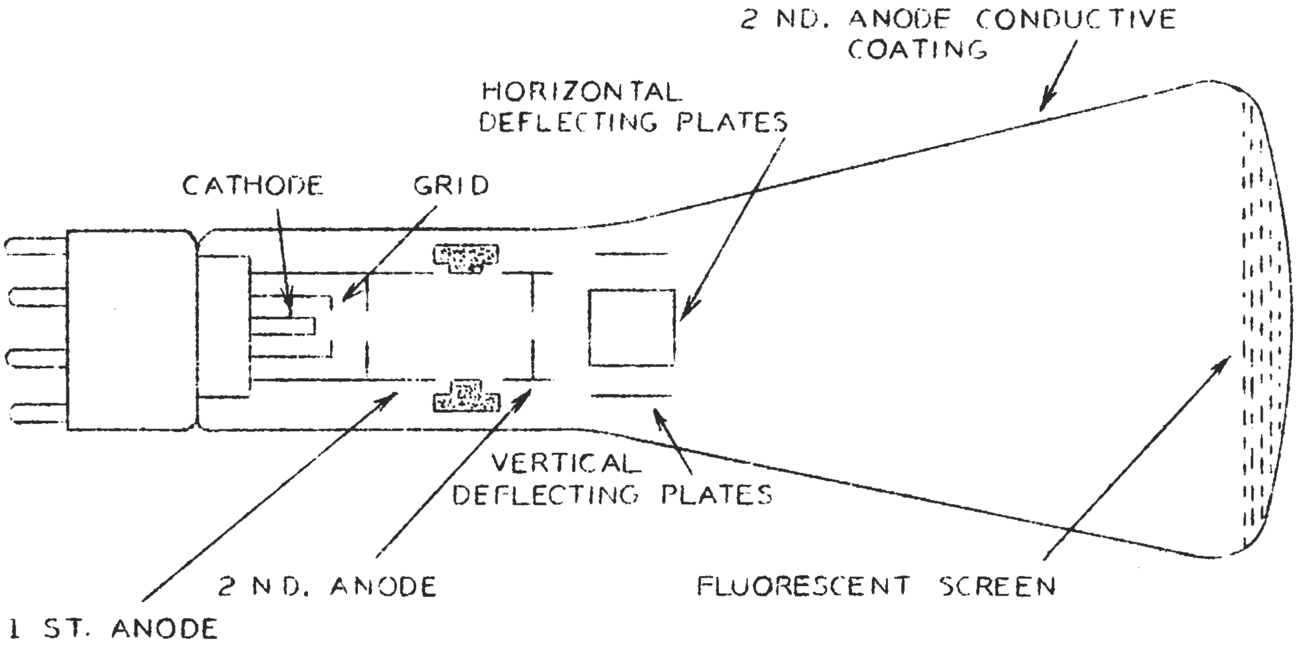


FIG.9-4 —
DIAGRAM OF CATHODE-RAY TUBE

After passing the first anode, the electron beam enters the field of the second anode. The second anode is charged positively and further accelerates the electrons together with a "focusing" action that brings them to a point on the flourescent screen.

On leaving the second anode proper, the beam passes between two pairs of parallel plates, placed at right angles to each other. A voltage across one pair of these deflects the beam horizontally and across the other deflects it vertically.

The moving part in the cathode-ray oscilloscope is the electron beam. Since this beam is extremely light, there is no "inertia effect" at any but the ultra-high radio frequencies. That is, the spot follows faithfully the exact waveform of the impressed voltage.

Fig. 11-4 is a cross section of a cathode ray tube showing the deflecting plates and their electrostatic fields. The arrows indicate the direction of the electrostatic field; the direction that a positive charge would tend to move. The electron being a negative charge is, of course, deflected in the opposite direction.

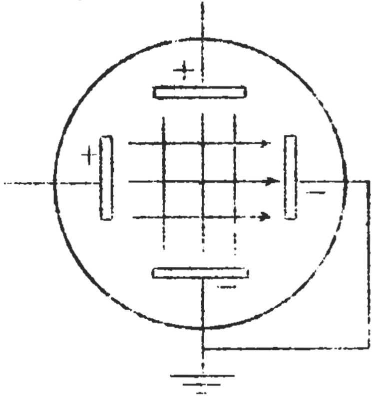


FIG.11- 4- CROSS SECTION OF CATHODE-RAY TUBE, SHOWING DEFLECTION PLATES AND THEIR ELECTROSTATIC FIELDS.

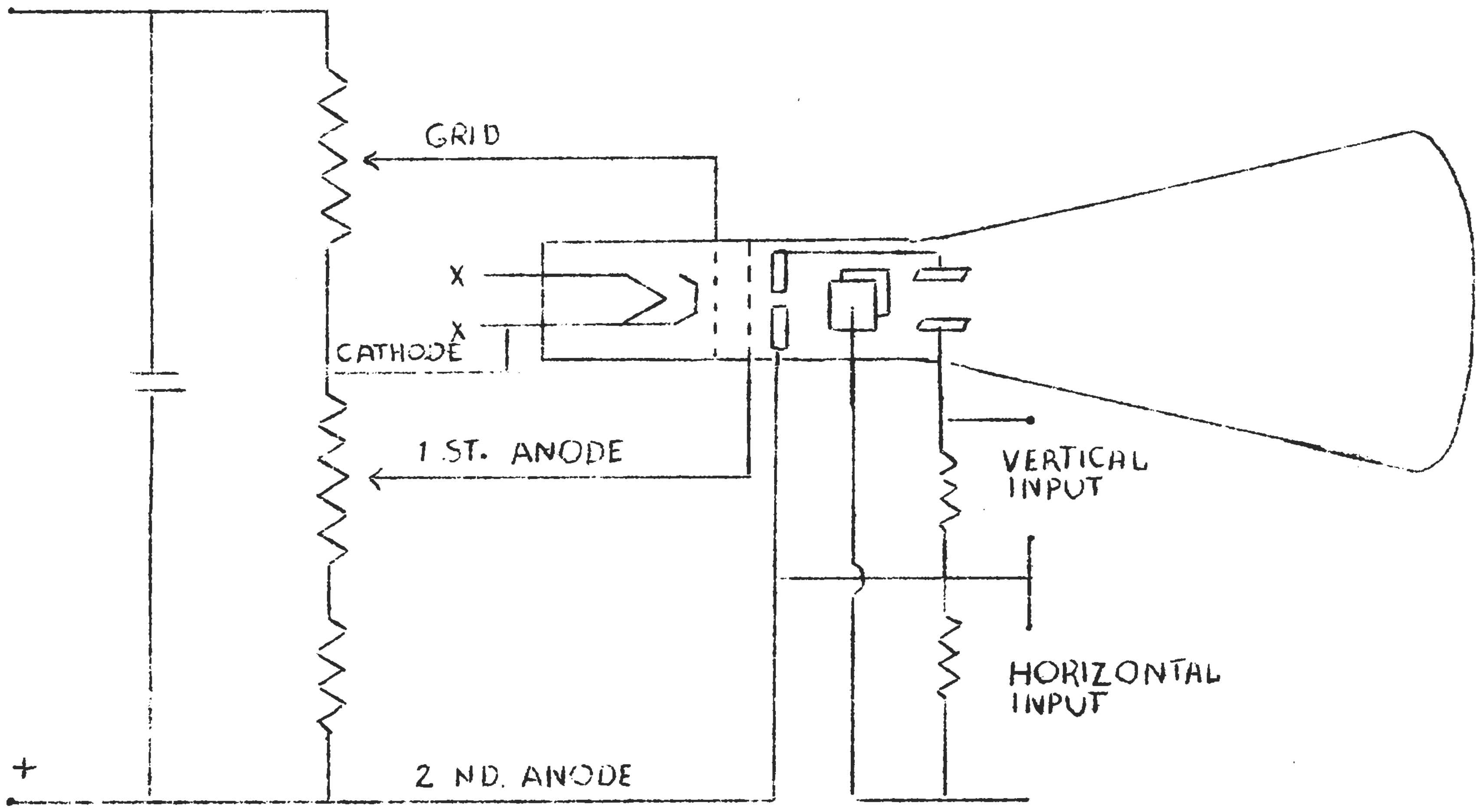


FIG. 10-4—SCHEMATIC OF A SIMPLE CATHODE-RAY OSCILLOSCOPE

If a positive charge is placed on the upper vertical deflecting plates (upper made positive with respect to lower), the electron beam, also the spot on the screen, is deflected upward. The amount of this deflection is directly proportional to the voltage applied. If this voltage changes, the deflection also changes along with it so that we get an instantaneous picture of the amplitude of the impressed voltage. The same is true of the horizontal deflecting plates. When the charge is negative, the deflection is in the opposite direction. If we place voltages on both pairs of plates simultaneously, the spot is deflected vertically and horizontally the same amount as if these voltages were applied separately. That is, there is no reaction between the two pairs of plates.

Figure 12-4 gives several different examples of the deflection produced by different combinations of D. C. voltages.

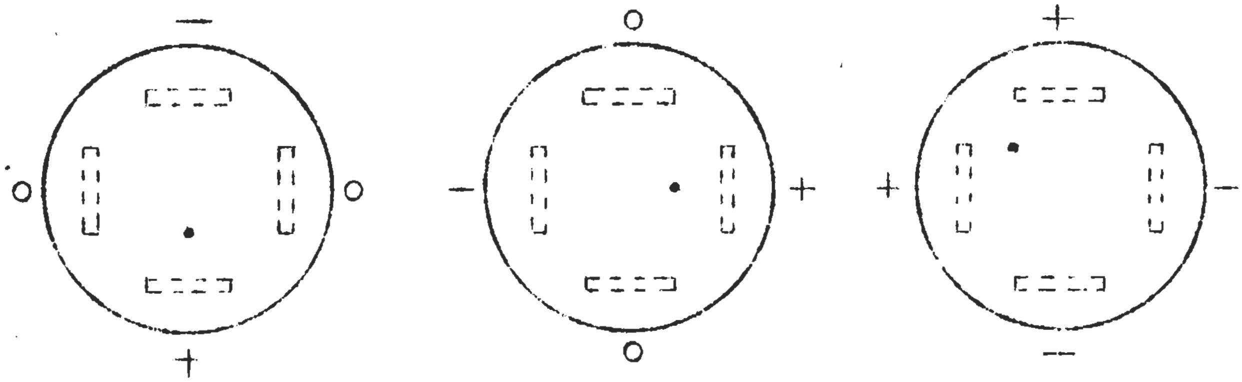


FIGURE 12-4
DEFLECTIONS PRODUCED BY DIFFERENT COMBINATIONS
OF VERT. & HOR. D.C. VOLTAGE—VIEWED FROM FRONT OF TUBE.

If a varying voltage is applied to the plates, the spot is deflected proportionally to the instantaneous voltage. However, due to the persistence of vision and the fact that the spot retraces itself only a line is seen. If we place a varying voltage on the other pair of deflecting plates at the same time, the spot does not retrace itself (unless one of the voltages is a multiple of the other). When two sinusoidal voltages of the same frequency but with various phase difference are placed on the plates of a cathode-ray tube, certain definite patterns are obtained. A few of the most important of these are given in Fig. 13-4.

If the frequency of the voltage applied to the vertical plates is different from that of horizontal plates, we find that various patterns (Lissajous figures) are traced out on the screen by the spot. (See Fig. 14-4). If a little study is given to these figures, it is easy to determine their frequency ratio.

It is often necessary to do this in the measurement of frequency. (See Fig. 15-4). A standard frequency is placed on one set of plates and the unknown frequency on the other set. The shape of the Lissajous figure gives their frequency ratio. The unknown frequency is calculated by the formula: $F_x = N F_s$ where "F_x" is the unknown frequency, "F_s" is the standard frequency and "N" is the ratio gotten from the Lissajous figures. (See Fig. 15-4, $F_s = f_h$, $F_x = f_v$).

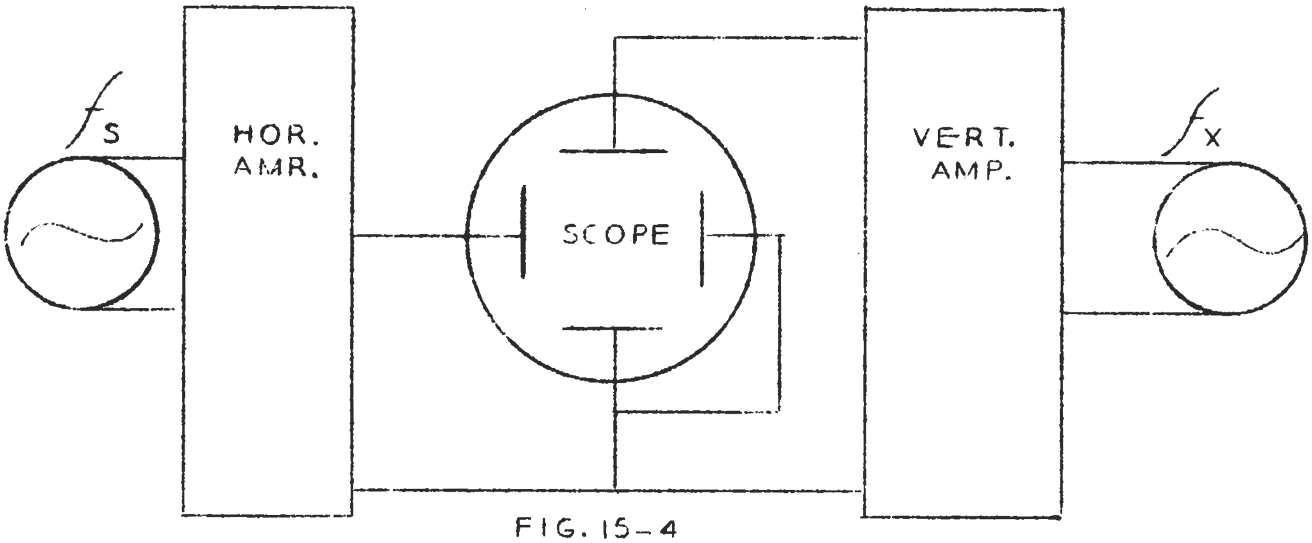


FIG. 15-4
BLOCK DIAGRAM OF SET-UP FOR MEASURING FREQUENCY

f_S = STANDARD FREQ. f_X = UNKNOWN FREQ.

(VIII) THE SWEEP CIRCUIT

This sine voltage on the horizontal plates is called a "sinusoidal sweep." The "sweep" is very much more useful if it is "linear". That is, the spot should travel across the screen from left to right at a constant velocity, so that the wave being examined is "spread out" evenly with respect to time, This is called a "linear sweep."

A "linear sweep" may be generated in a number of ways. The most satisfactory method is that making use of a Thyratron tube to discharge a condenser.

The circuit is that of Fig. 16-4.

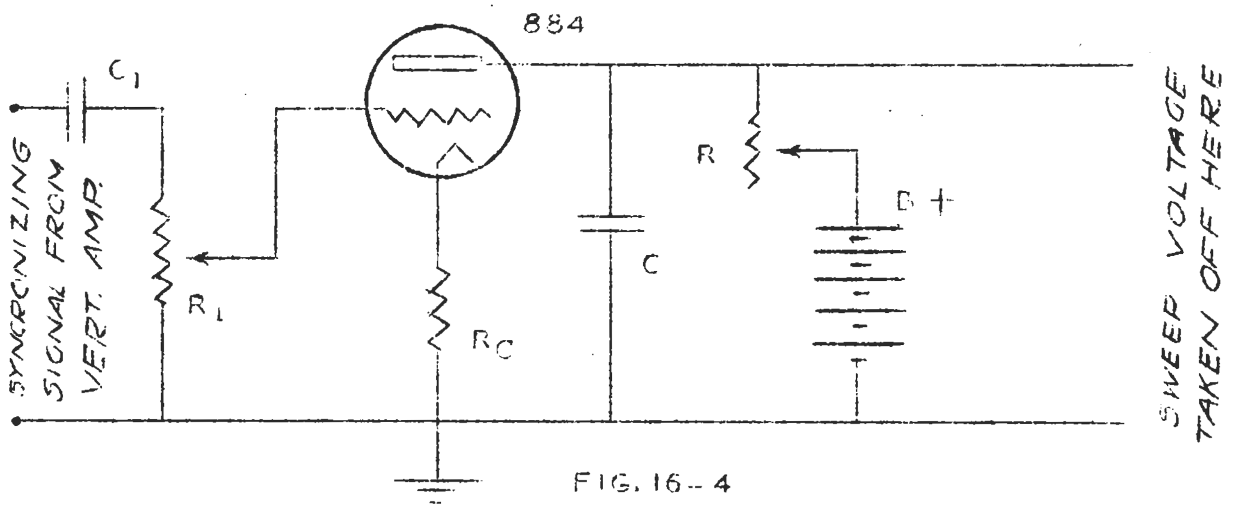
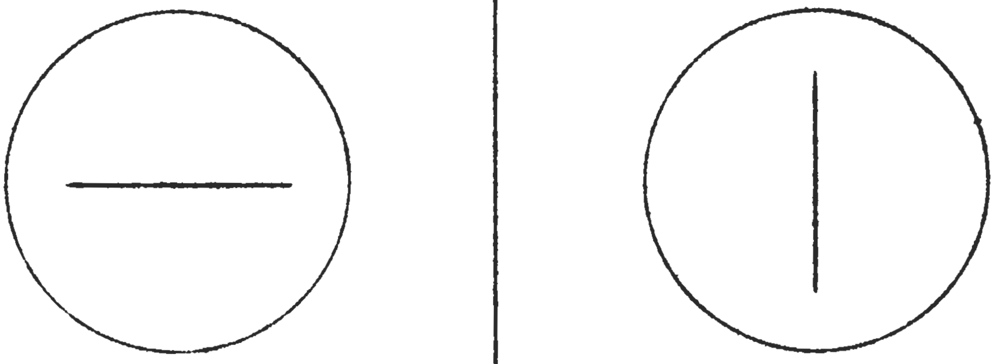


FIG. 16-4
LINEAR SWEEP GENERATOR MAKING USE OF A THYRATRON TUBE

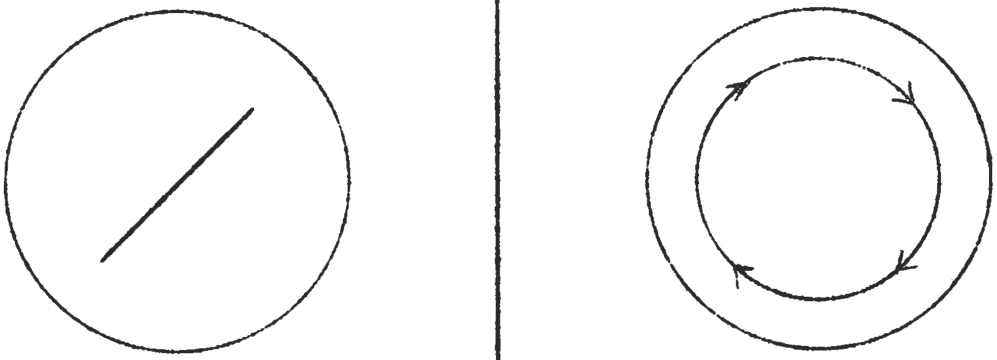


(A)

A.C. VOLTAGE ON HORIZONTAL PLATES

(B)

A.C. VOLTAGE ON VERTICAL PLATES

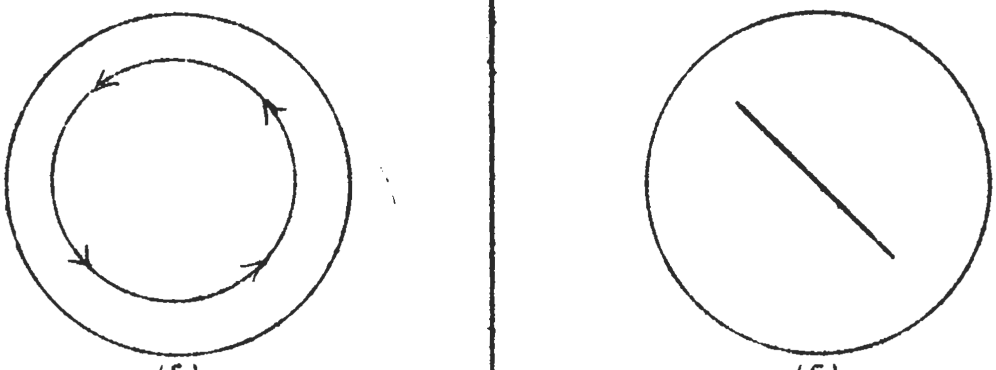


(C)

EQUAL A.C. VOLTAGES ON BOTH PLATES (IN PHASE)

(D)

EQUAL A.C. VOLTAGES. HORIZONTAL LEADING BY 90° OR VERTICAL LAGGING BY 90°



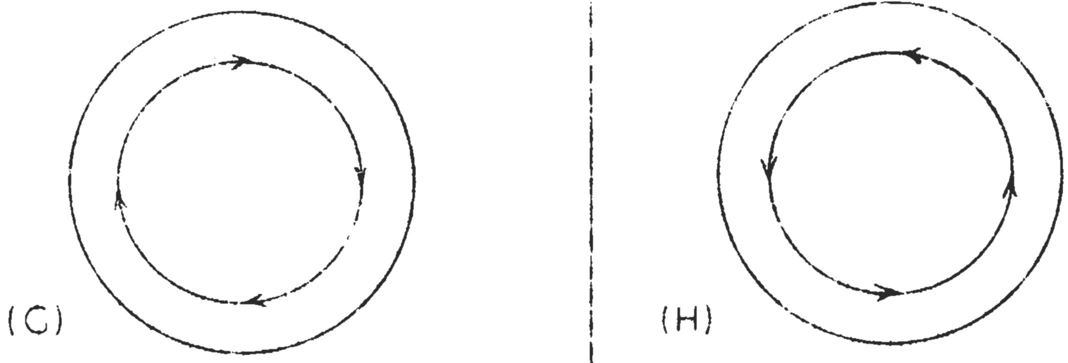
(E)

EQUAL A.C. VOLTAGES. HORIZONTAL LAGGING BY 90° OR VERTICAL LEADING BY 90°

(F)

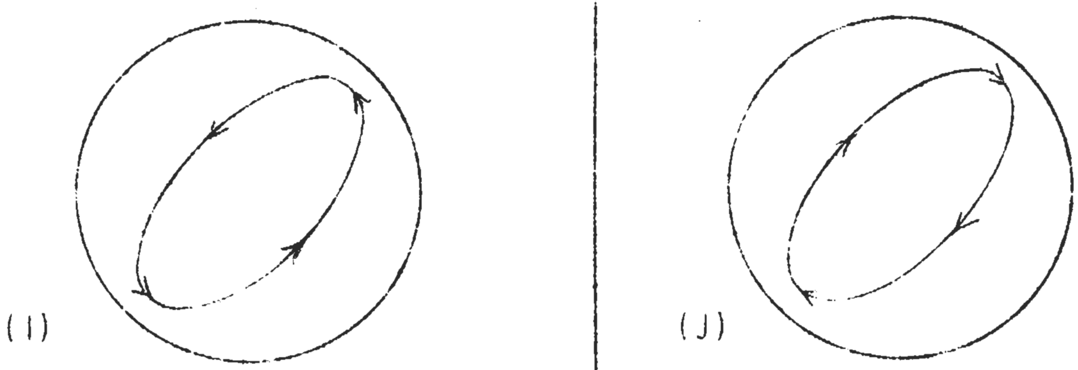
EQUAL A.C. VOLTAGES. HORIZONTAL LEADING BY 180° OR VERTICAL LAGGING BY 180°

FIG. 13-4__ DEFLECTIONS CAUSED BY DIFFERENT COMBINATIONS OF A.C. VOLTAGES (SINE WAVES) OF THE SAME FREQUENCY



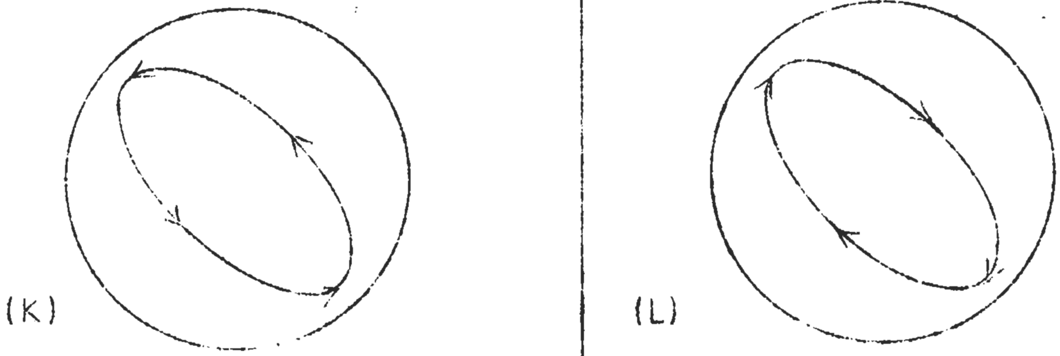
EQUAL A.C. VOLTAGES. HORIZONTAL LEADING BY 270° OR VERTICAL LAGGING BY 270°.

EQUAL A.C. VOLTAGES. HORIZONTAL LAGGING BY 270° OR VERT. LEADING BY 270°



EQUAL A.C. VOLTAGES. HOR. LEADING BY 45°; VERT. LAGGING 45°; VERT. LEADING 315°; OR HOR. LAGGING 315°

EQUAL A.C. VOLTAGES. HOR. LAGGING 45°; VERT. LEADING 45°; VERT. LAGGING 315°; OR HOR. LEADING 315°



EQUAL A.C. VOLTAGES. HOR. LEADING 135°; VERT. LAGGING 135°; VERT. LEADING 225°; OR HOR. LAGGING 225°

EQUAL A.C. VOLTAGES. HOR. LAGGING 135°; VERT. LEADING 135°; VERT. LAGGING 225°; OR HOR. LEADING 225°

FIG. 13-4 (CONT'D.)

The Thyratron is a gas filled triode, and has the unique ability to become conductive whenever a certain ratio of plate voltage to grid voltage is exceeded. That is, if the grid is biased a certain amount negative and the plate voltage is then increased slowly, the Thyratron will act very much like a triode until a certain point is reached where the grid loses control (when the tube becomes ionized). When this occurs, its impedance drops to a very low value and current can flow in either direction. The plate voltage at which ionization starts is determined by the value of grid bias and bears a fixed ratio to it.

Referring now to Fig. 16-4, the condenser C is charged by the battery through the high resistance R at a constant rate. The voltage on the condenser C, therefore, increases at a constant rate (this voltage is used as the sweep) until the point is reached where the grid loses control and the tube becomes ionized (conductive). The condenser then discharges through the tube to ground, the plate voltage falls, the grid regains control and the cycle is repeated. Fig. 17-4 is the graph of this voltage against time.

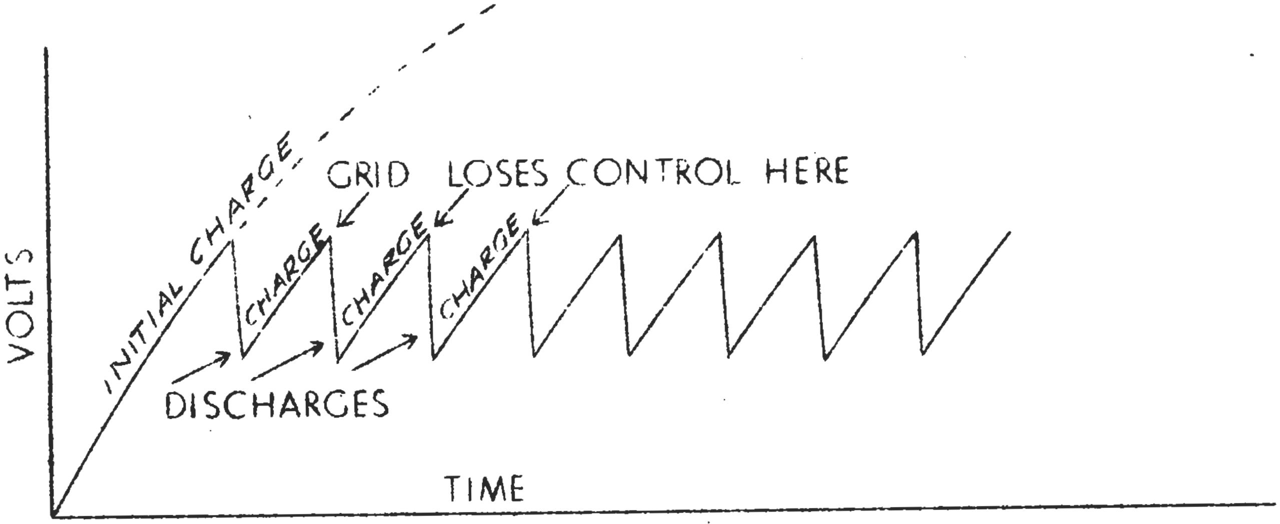


FIG 17-4...VOLTAGE VS. TIME CURVE OF LINEAR SWEEP

This "saw-toothed" sweep voltage is amplified by the horizontal amplifier and placed on the horizontal deflecting plates. The spot when actuated by this voltage moves across the screen at a constant velocity from left to right, then almost instantaneously returns to the left to repeat the sweep. The left-right motion of the spot is called the "sweep" while the right-left is called the "return" or "fly-back."

The frequency of this linear sweep depends upon the time constant of the R C circuit and, therefore, can be changed by varying either R or C. This is easily understood since R determines the rate of charge of the condenser by limiting the current flowing into it and C is the capacity of this condenser and, therefore, determines the amount of charge the condenser will hold at any given voltage. A very satisfactory method is to change the frequency in large steps by large changes in C and then get the fine frequency control by making R variable.

(IX) SYNCHRONIZATION

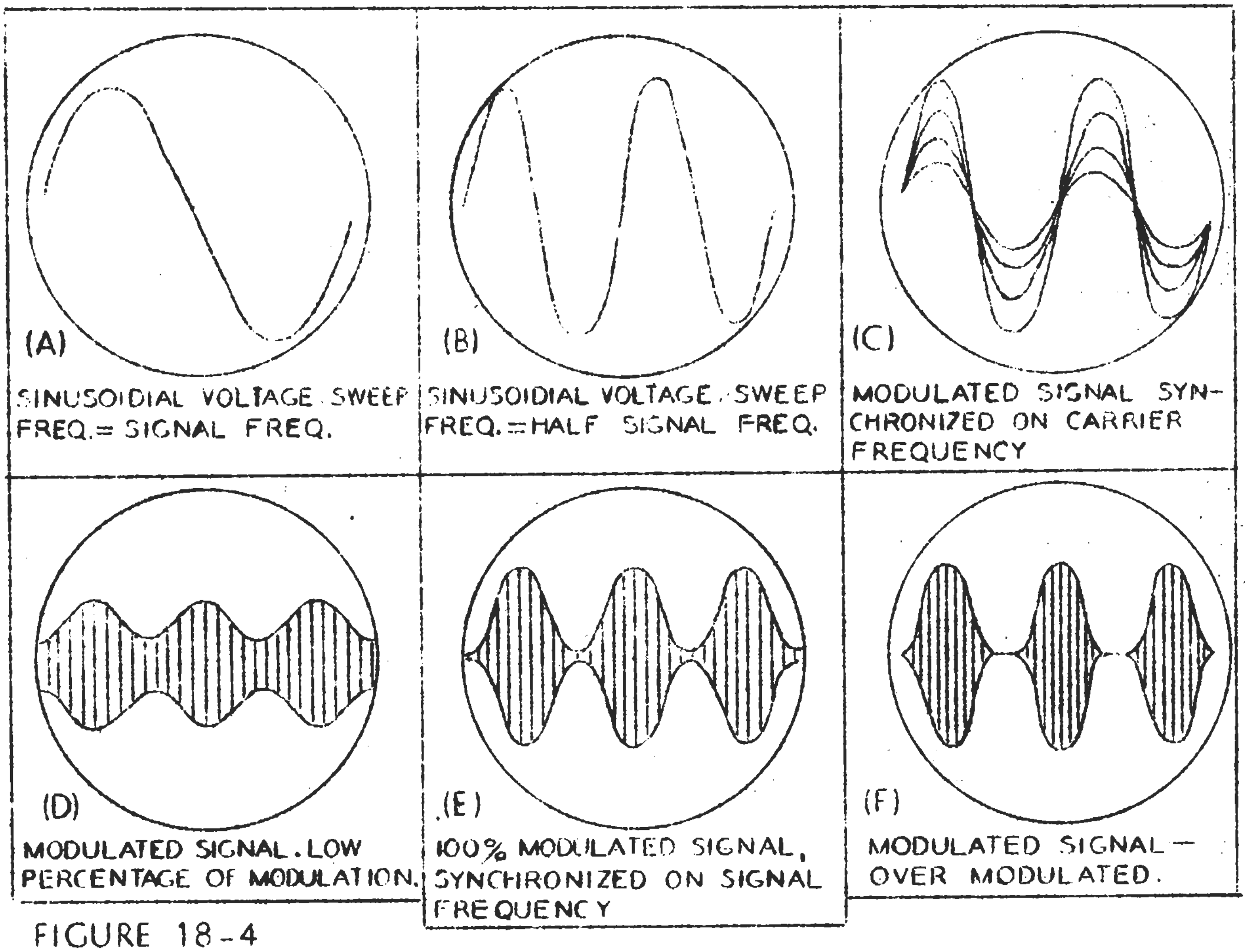
In order to have a stationary image on the screen, the frequency of the "sweep" must be a multiple or sub-multiple of the signal. If this condition is not satisfied, consecutive images do not fall on each other and a stationary pattern cannot be obtained. If the frequency of the "sweep" is made very close to a multiple or sub-multiple of the signal, the image will "crawl." This crawling is in the direction of the sweep (from left to right) if the sweep frequency is too high or in the opposite direction if the sweep is too low.

The adjustment of the fine frequency control to keep the image stationary (synchronization) becomes a task, if some automatic means is not used to control this frequency.

If a small amount of the signal voltage is fed into the grid of the Thyratron, it will "trip" the sweep at the same point on the image each time. The amount of this voltage that must be placed on the Thyratron grid to obtain synchronization depends upon the signal's characteristics and, therefore, should be adjustable. The sweep frequency should be set close to the right value before the synchronizing voltage is applied, otherwise, over synchronization may occur.

For most uses of the oscilloscope the linear sweep is more desirable than any other types, even though it is more complexed and costly. The images produced by a "linear sweep" are more easily interpreted and measured, because a simple time base may be used. This is especially true in measurements of phase angle, time lead or lag, and other relative measurements.

In Fig. 18-4 are given several patterns produced by familiar types of radio signals when a linear sweep is used.



(A) SINUSOIDIAL VOLTAGE SWEEP FREQ.= SIGNAL FREQ.

(B) SINUSOIDIAL VOLTAGE SWEEP FREQ.=HALF SIGNAL FREQ.

(C) MODULATED SIGNAL SYNCHRONIZED ON CARRIER FREQUENCY

(D) MODULATED SIGNAL. LOW PERCENTAGE OF MODULATION.

(E) 100% MODULATED SIGNAL, SYNCHRONIZED ON SIGNAL FREQUENCY

(F) MODULATED SIGNAL— OVER MODULATED.

FIGURE 18-4

(X) VIDEO AMPLIFIER

The high frequency range of the ordinary resistance coupled amplifier is limited because of the "shunt effect" of the tube and circuit capacities in parallel with plate load resistor. (See Fig. 19-4).

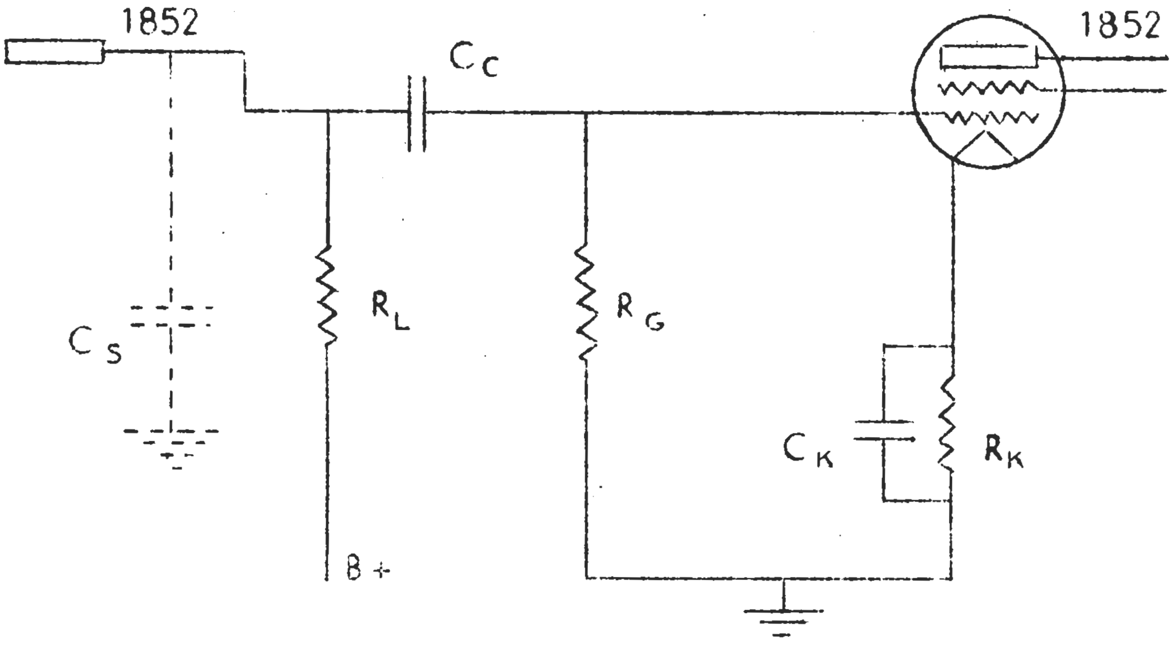


FIG. 19-4—UNCOMPENSATED AMPLIFIER STAGE

At low frequencies the impedance from plate to ground is approximately equal to R_L (Fig. 19-4), since the reactance of C_s is quite high at these frequencies. However, as the frequency increases beyond the audio range, this shunt reactance becomes very small; there is approximately a short from plate to ground. This is shown mathematically as follows:

$$Z_L = \frac{Xc_s\, R_L}{Xc_s + R_L},$$

(rearranging fraction),

$$Z_L \doteq \frac{R_L}{1 + \frac{R_L}{Xc_s}}$$

(at low frequencies, Xc_s is very much greater than R_L)

$$\therefore Z_L = R_L \text{ (which is large)}$$

$$Z_L = \frac{Xc_s\, R_L}{Xc_s + R_L}$$

(rearranging fraction),
$$Z_L = \frac{Xc_s}{1 + \frac{Xc_s}{R_L}}$$

(at high frequencies, R_L is very much greater than Xc_s $\therefore$ $Z_L = Xc_s$ (which is small)

Therefore, the impedance Z_L (and the gain of the stage) becomes zero at frequencies much above the audio stage.

The range of this type of amplifier may be extended at the high frequency by compensating the effect of this shunt capacity. There are several methods of doing this. One which is very satisfactory is known as "series peaking" compensation. (See Fig. 20-4).

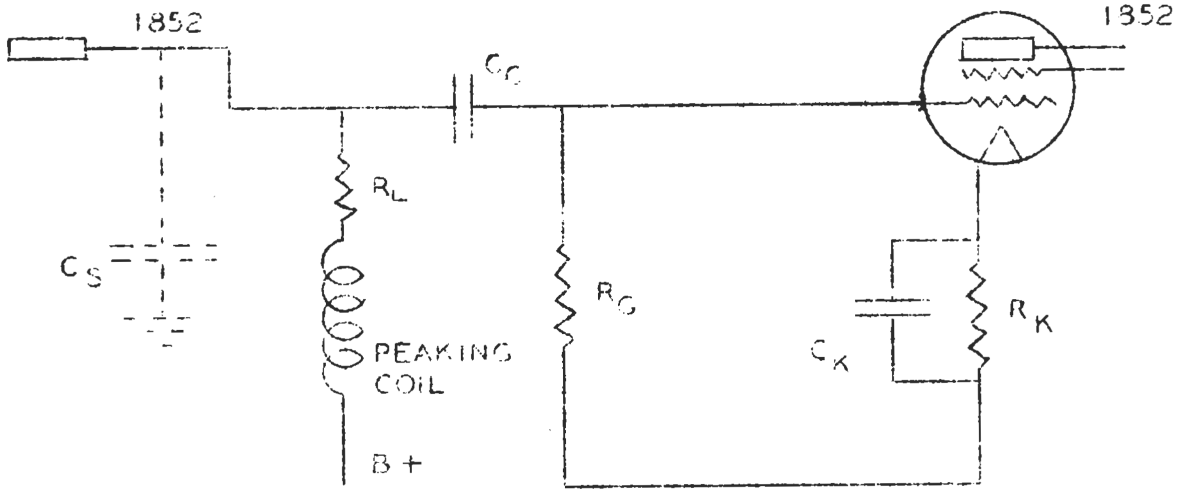


FIG. 20-4
COMPENSATED AMPLIFIER
USING "SERIES PEAKING"

The peaking coil, if properly designed, causes the resistance-inductance arm of the plate load to increase in impedance just enough to counteract the drop in impedance of the capacity arm as the frequency increases. This holds only up to a certain limiting frequency. This frequency limit of compensation is set by the shunt capacity and the value of the plate load resistor, (which is also determined by the shunt capacity). That is, the high frequency range may be extended by reducing the plate resistor "R_2", but the amount of this extension is dependent upon the shunt capacity in the circuit. The gain, therefore, is less the wider the range of the amplifier is made.

The new high transconductance pentodes developed for this purpose in television have made the design of amplifiers with unbelievable frequency characteristic practical. The high frequency limit is now well up in the radio frequency spectrum.

The low frequency response can also be extended in a number of ways. The number is limited, however, if extreme high frequency response is desired at the same time, especially if the overall response is to be uniform. With the above requirement the two most fruitful methods are "bass-boosting" and "degeneration." "Bass-boosting" in its more or less standard form is shown in Fig. 21-4.

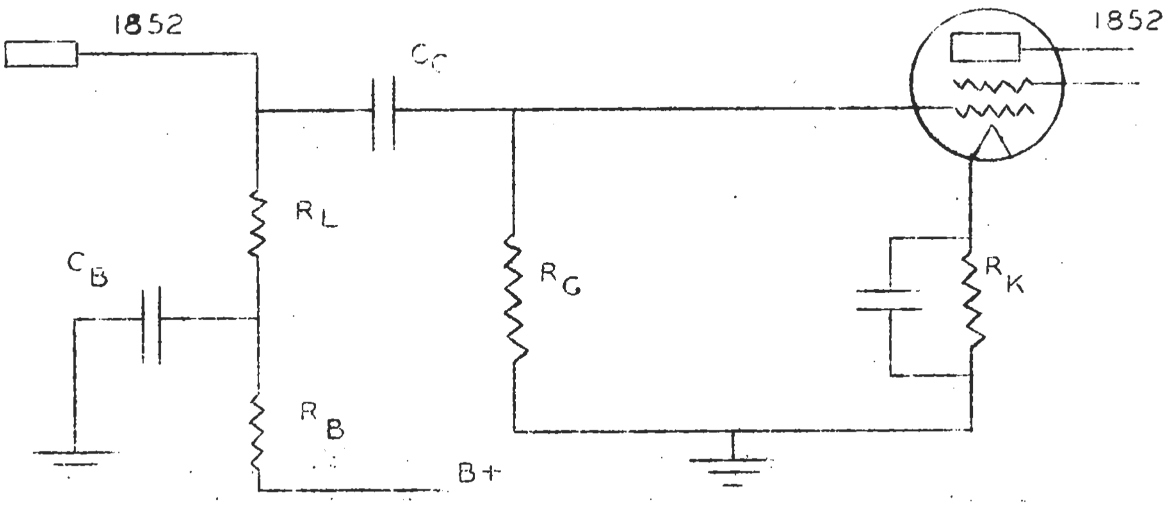


FIG. 21-4
SHOWING BASS-BOOSTING
IN AN AMPLIFIER...

The condenser C_b and R_b constitute the "bass-boost" circuit. The condenser C_b is of such a value that all but the low frequencies are shunted to ground. The result is that the plate load resistor is increased (therefore, the amplification of the stage) at low frequencies. The amount of "boost" is mainly dependent upon size of the resistor R_b while its range is determined by the size of the condenser C_b. The larger the condenser the more nearly the "boost" is confined to the extreme low end of the audio range.

The "degeneration" method of extending the bass response is not a "boosting" method, but rather a distortion-limiting method. In Fig. 21-4 the condenser C_k is used to reduce the impedance (to by-pass R_k) in the cathode circuit. Any impedance in this circuit will develop an out-of-phase voltage on the cathode when the plate current flows through it. The cathode, therefore, has a signal on it which is 180° out of phase with the signal on the grid. This causes degeneration.

If a large condenser is used at C_k, this impedance is reduced to a very small value at all but the very low frequencies. The larger R_k is made the lower frequency C_k will by-pass effectively. For this reason, tubes that require little bias also require larger cathode by-pass condensers. In fact, it is impractical to extend the bass-response by this means. It is even more convincing when phase distortion is considered, for the angle, as well as the magnitude, of the impedance undergoes rapid change as the frequency is reduced in this range.

The simple solution to these difficulties is affected by not by-passing the cathode resistor R_k. Then the impedance of this circuit, although not zero, is constant over the entire range and causes no frequency discrimination. This degeneration also helps to "level off" any other distortion caused by regeneration and variations in amplification.

The uses of the VEDOLYZER are almost without number, and the uses that it will be put to by any one operator are limited only by his knowledge of, and skill in, using it. Anyone who has learned to use an oscilloscope intelligently can see at once how many fold its usefulness is increased simply by the substitution of a high-gain video amplifier for its ordinary vertical amplifier. The vacuum-tube voltohmmeter, the wavemeter, and amplified R.F. vacuum-tube voltmeter all multiply these uses many more times. In fact, we are still finding new uses for this instrument after months of working with it in our own laboratories.

No attempt is made to enumerate the many uses of the VEDOLYZER in this chapter. Due to lack of space, a few typical uses mainly in the radio service field will have to suffice.

USING THE VEDOLYZER TO MEASURE OVERALL GAIN AND FREQUENCY DISTORTION IN AN AUDIO AMPLIFIER

The Vedolyzer makes an ideal output meter because of its extremely flat frequency response, high input impedance, wide frequency range, and extended voltage range.

The set-up for making a "frequency-run" on an audio amplifier is given in Fig. 1-5.

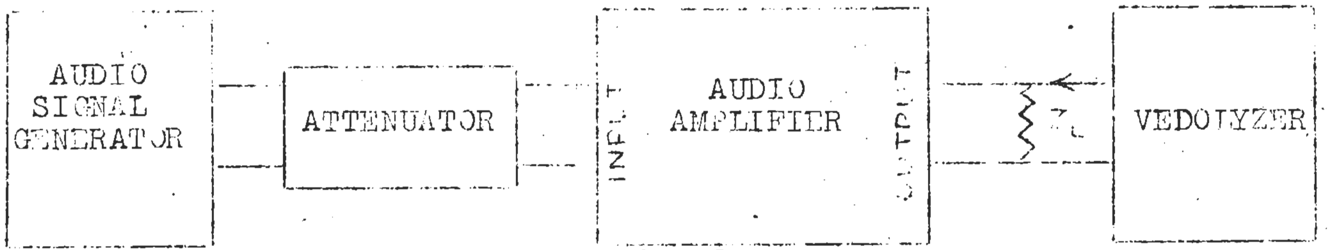


Fig. 1-5
SET-UP FOR FREQUENCY RUN OF AN AUDIO AMPLIFIER

The audio signal generator should have a constant output at all frequencies in the desired range. If the generator is not so equipped, a means of attenuating its output, that is constant with frequency, should be included. The signal should be attenuated to where the input tube is not overloaded.

The amplifier should be adjusted so that it is operating normally as to gain, power output, etc., and should be working into the proper load resistance R_L. The VEDOLYZER is then connected across the load R_L of the amplifier by using a common ground lead and the "R.F." probe (red) (if gain is also to be measured) or the "A.F." probe (black) (if only frequency distortion is to be measured.) The proper "probe selector" and "function selector" buttons should, of course, be down.

The audio signal generator is then set to different frequencies from low to high in the audio range and the voltmeter and frequency readings for each recorded. If this is to be a permanent record that is easily interpreted, the relative voltmeter readings should be plotted against frequency on semi-logarithmic paper to give a gain VS frequency graph.

THE VEDOLYZER FOR ROUTINE TROUBLE-SHOOTING

With the aid of a good signal generator, the VEDOLYZER makes possible a new method of trouble-shooting that has no equal from the standpoint of effectiveness and simplicity. The method of VISUAL DYNAMIC TESTING used in the VEDOLYZER is the only system of testing that reduces trouble shooting to a series of routine measurements that apply to all receivers and all ailments. The simple procedure is given below and the receiver is that of Fig. 5-5.

Hook the signal generator to the antenna and ground posts of the receiver through an artificial antenna. Set the signal generator to some frequency in the middle of the broadcast band and tune the receiver to this frequency. Increase its output to 0.01 volts or more, and modulate the carrier from 50% - 75% at some audio frequency. The waveform of this audio frequency must be good if distortion is to be measured. Connect a lead from the A.F. output of the signal generator to the "EXT. SYNC." of the Vedolyzer.

Tune the signal in on the Vedolyzer by rotating the "FUNCTION SELECTOR" to the proper band and rotating the frequency dial until a peak is received on the meter and the scope. Place the red probe on the antenna post (Position 1). The pattern on the screen should be that given in Fig. 5_1-5 when proper frequency and synchronization adjustments have been made. Synchronize the image on the signal frequency and not the carrier frequency. (See "d" and "f", Fig. 18-4.)

When the correct image is obtained, place the probe on the grid of the first R.F. tube (Position 2). The image should show a definite increase in size, although the shape should be the same as for Pos. 1. (See Fig. 5_2-5). If it does not, there is something wrong with the R.F. transformer. Make sure that the receiver and the Vedolyzer are tuned to the carrier frequency by rocking the respective tuning condensers back and forth. If the signal is OK here, proceed to the plate of this tube (Position 3) with the red probe. The image should be that in Fig. 5_3-5 if this stage is operating correctly. The image will probably be "off screen" by now due to the gain in the transformer and tube. If this is the case, press the next higher button on the attenuator or retard the vertical gain control. Attenuate the signal from the generator if overload is present when the gain is reduced.

The image should keep in synchronization at all times if the gain is held within reason. That is, if the image is anything like the same size each time, it should remain stationary throughout these measurements.

The probe is next placed on the secondary side of the second R.F. transformer (Pos. 4). The image will usually show a little gain here and at the same time, it will be mixed with the oscillator signal enough to change its appearance to Fig. 5_4-5.

Place the probe on the oscillator coil (Pos. 5). The meter should give an indication of the oscillator signal similar to that of Fig. 5_5-5. Tune the signal in by rotating the "FUNCTION SELECTOR" to the proper band and reading the frequency on the dial of the wavemeter.

Place the probe on the input of the first I.F. stage (Pos. 6) and tune in the intermediate frequency signal which is equal to the oscillator frequency minus the signal frequency. There are three signals here, two of which are modulated. They are R.F., Osc., and I.F.: the R.F. and I.F. are modulated. This is the most difficult image in the group to interpret, but when the mixer is operating correctly, this image should look like Fig. 5_6-5. Rock the tuning condenser back and forth to insure that this stage is in tune. The "VALLEY" marked "A" in Fig. 5_6-5 should be deepest when correctly adjusted.

If this stage is not in tune, it shows that the R.F. of the receiver is misaligned. The Vedolyzer should be tuned to the intermediate frequency at this point. Correct this by realigning the R.F. with the probe at Pos. 6. (If the rest of the receiver is operating correctly, any of the positions above Pos. 6 will do equally as well for this purpose.)When the intermediate frequency signal is tuned in on the wavemeter of the Vedolyzer, the waveform on the scope will resemble that at point 7, Fig. 5-5.

Now change the probe to Pos. 7. The image should be that in Fig. 5_7-5. Whether a gain should be experienced at this point depends upon the circuit conditions and the design of the receiver. Usually intermediate frequency transformers have a ratio of 1:1, and since both the primary and secondary are tuned, there is usually no increase in the signal at the output. Most of the amplification is gained from the I.F. amplifier tube.

The input to the receiver should now be cut down to give a medium-size image by means of the multiplier. Next, place the probe on the plate of the I.F. amplifier (Pos. 8). The image will show a very large gain here. If it goes"off screen", press the next multiplier button in order to decrease the size of the image or the deflection upon the meter. Pos. 9 should give Fig. 5_9-5 and Pos. 10 that of Fig. 5_{10}-5. There is usually a loss in gain in both of these positions. The action of the detector is very clearly shown in Fig. 5_{10}-5; the I.F. that has not been filtered out is also easily seen. Now use the audio probe and push the A.F. button.

At Pos. 11 the audio image is very much larger and the R.F. in it is usually less. (See Fig. 5_{11}-5). The signal at Pos. 12 is almost the same as that at Pos. 11, but when the probe is placed on the plate of this tube (Pos. 13), a large gain will be noticed. (See Fig. 5_{13}-5). At Pos. 14 the image will drop down again, due to the step-down in voltage in the output transformer.

In table 1-5 is given the gain to be expected from different stages, tubes, etc., in a receiver. It should be borne in mind, however, that these values are only approximate since they vary widely even in different receivers of the same make. On the other hand, these figures will serve as a guide until the operator learns from experience what to expect. The relative gain can be measured in each case by using the "MULTIPLIER" and "VERT. GAIN" controls and the meter as a reference level indicator. In order to make a gain measurement, place the probe on the input of the amplifier and adjust the input control until the meter gives half scale deflection. Then move to the output of the amplifier, and if there is a gain present, there will be an increase in the meter reading. The "MULTIPLIER"and "VERT. GAIN" controls should be adjusted until the meter again deflects half scale. The gain is equal to the first reading of the "MULTIPLIER" and "VERT. GAIN" controls divided by the second reading.

OTHER USES OF THE VEDOLYZER IN RADIO SERVICING

Along with the routine procedure, certain voltages and resistances should be measured to find the exact source of the trouble. In other words, the routine procedure will quickly show which stage or part is not operating satisfactorily, but from there, the operator will have to make certain measurements on each component of the stage to find the part that is failing.

Aside from these measurements, there are certain "tuning-up" or aligning operations that are often required in servicing a radio. Although this is best done when the VEDOLYZER is complimented with the SUPREME 561 Signal Generator, which has built-in frequency modulator for visual alignment (see operating instructions on Model 561), it can be done very satisfactorily by using the R. F. vacuum-tube voltmeter as an output meter. To do this, place the universal probe (red) on the plate of the mixer tube or the grid of the I. F. amplifier and align the R. F. portion of the receiver. (Make sure the artifical antenna is correct or the first R. F. transformer will be out of alignment when the regular antenna is used). Next, place the probe on the diode (or cathode of the detector tube if it is an "infinite-impedance" type) and proceed to align the I. F. amplifier by watching the wave on the screen of the cathode-ray tube and the V. T. VM. for the peak.

If it is desired to have a "flat-topped" admittance curve, the I. F. transformers can be thrown off resonance a little, (primary in one direction and secondary in the other) and a final check made by making a frequency-run or fidelity curve on the receiver.

This is very easily done with the VEDOLYZER -- 561 Signal Generator combination, as the Model 561 has a built-in beat-note audio oscillator that can be set to modulate the R. F. test signal any desired amount at any frequency in the aduio band. With the same set-up used in alignment, modulate the R. F. carrier about 75% and start the audio oscillator at low end of the band. Take the reading of the V. T. VM. at various frequencies up to 7,500 cycles. Make a graph of these voltmeter readings against frequency as in Fig. 6-5. The graph is not necessary in most cases, simply watching the voltmeter for output and the screen of the cathode-ray tube for distortion at the various aduio frequencies is enough.

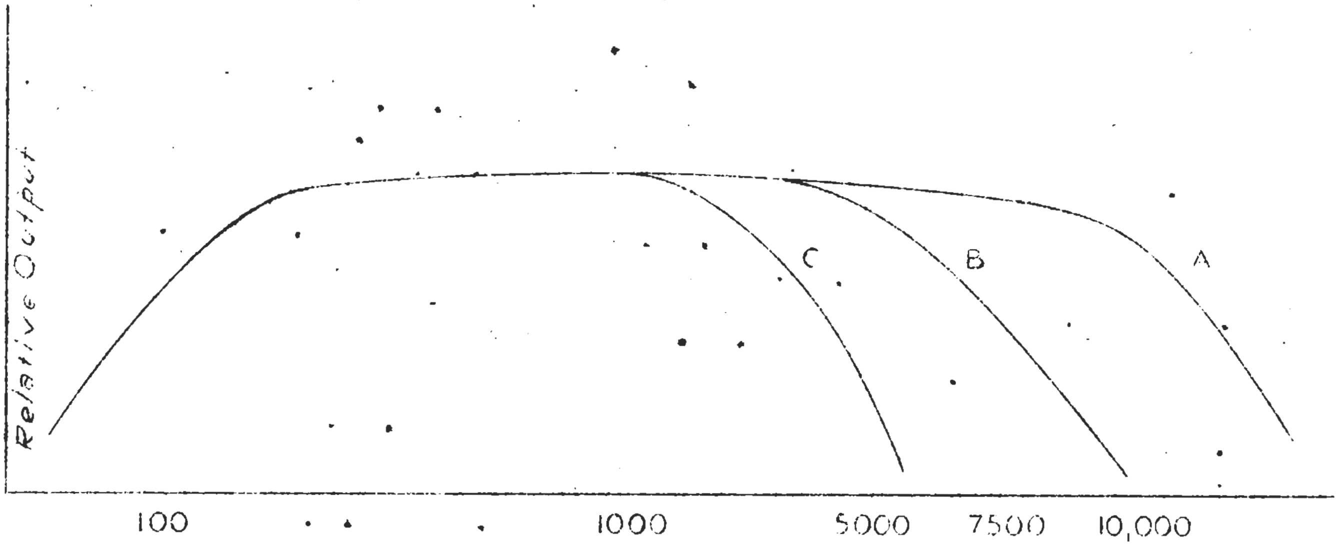


FIG. 6-5
AUDIO FREQUENCY RANGE IN CYCLES

Curve (A) I. F. TRANSFORMERS SET TOO BROAD (inter-channel interference bad for average reception).

Curve (B) I. F. TRANSFORMER SET CORRECTLY (high fidelity reception).

Curve (C) I. F. TRANSFORMERS SET TOO SHARP (frequency response too limited).

D. C. leakage tests up to 1,000 megohms can be made with the V.T. ohmmeter. This extreme sensitivity not only shows up faulty electrolytic but also paper and even mica condensers. Sockets, binding-straps transformer windings, and various other things can be tested very effectively in this way.

R. F. and other A. C. leakage can be located very quickly and effectively by setting the R. F. voltmeter on a sensitive range and using the probe to trace R. F. and A. F. around the chassis. Such things as chokes, filters, by-pass condensers, R. F. chokes, etc., can be tested in this manner. The image on the oscilloscope should be watched closely because it shows the signal that is being measured on the V.T.VM. A V.T.VM. used alone for this kind of work is of little use because of the great error introduced by mistaking one signal for the other. With the VEDOLYZER, there is no excuse for mistaking 60 cycle A. C. for R. F., etc., the cathode-ray tube shows what you are measuring at all times. If the frequency is not determined closely enough by the sweep frequency, the wavemeter can be called in to operation for R. F. (See Chapter III, Section VI) and audio frequency can be measured by Lissajous figures (See Fig. 14-4). The 60-cycle power line frequency can be used for the standard frequency with very satisfactory results.

This 60-cycle standard is placed on the horizontal deflecting plates by simply turning the "FINE FREQ." control to "60 ". This is extremely useful when working with audio and video amplifiers in which different low frequencies are liable to be picked up or generated.

(V) LOCATING INTERMITTENT TROUBLE

To locate the part that is causing intermittent trouble in a radio receiver, connect each of the three probes (using the alligator clips furnished) to different stages in the receiver. When the signal cuts out, press the probe selector buttons, one at a time, to determine where the signal quits in the set.

As an example, (See Fig. 7-5), suppose the R. F. probe (Universal-red) is attached to the plate of the R. F. amplifier, the I. F. probe (blue) is attached to the plate of the I. F. amplifier, and the A. F. probe (black) to the grid of the A. F. power stage. The signal cuts out; the R. F. button was left down so a glance at the screen of the oscilloscope shows the R. F. signal is normal. The I. F. button is then pushed and the I. F. signal is also normal, but on pushing the A. F. button, no signal is seen on the screen. The trouble is definitely between the plate of the I. F. amplifier and the grid of the final audio amplifier.

The first two probes are now attached to intermediate points, the R. F. probe to the secondary of the second I. F. transformer, and the I. F. probe to the grid of the triode section of the 6Q7 detector -- 1st audio. When the set cuts out again and the respective buttons are pushed, the signal is normal at the R.F. and I.F. probes but still zer at the audio amplifier grid. It was a simple matter to trace the trouble to a bad lead on the coupling condenser of the audio stage.

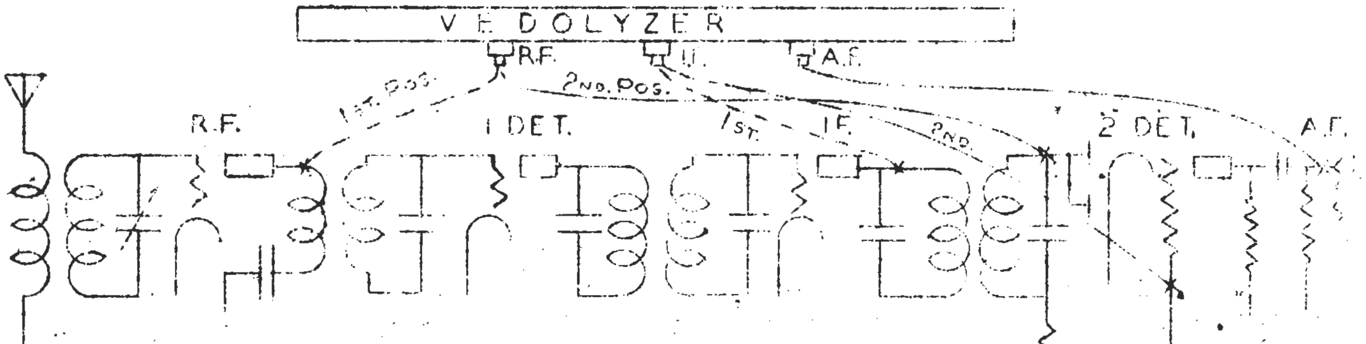


FIG. 7-5
TEST FOR INTERMITTENTS

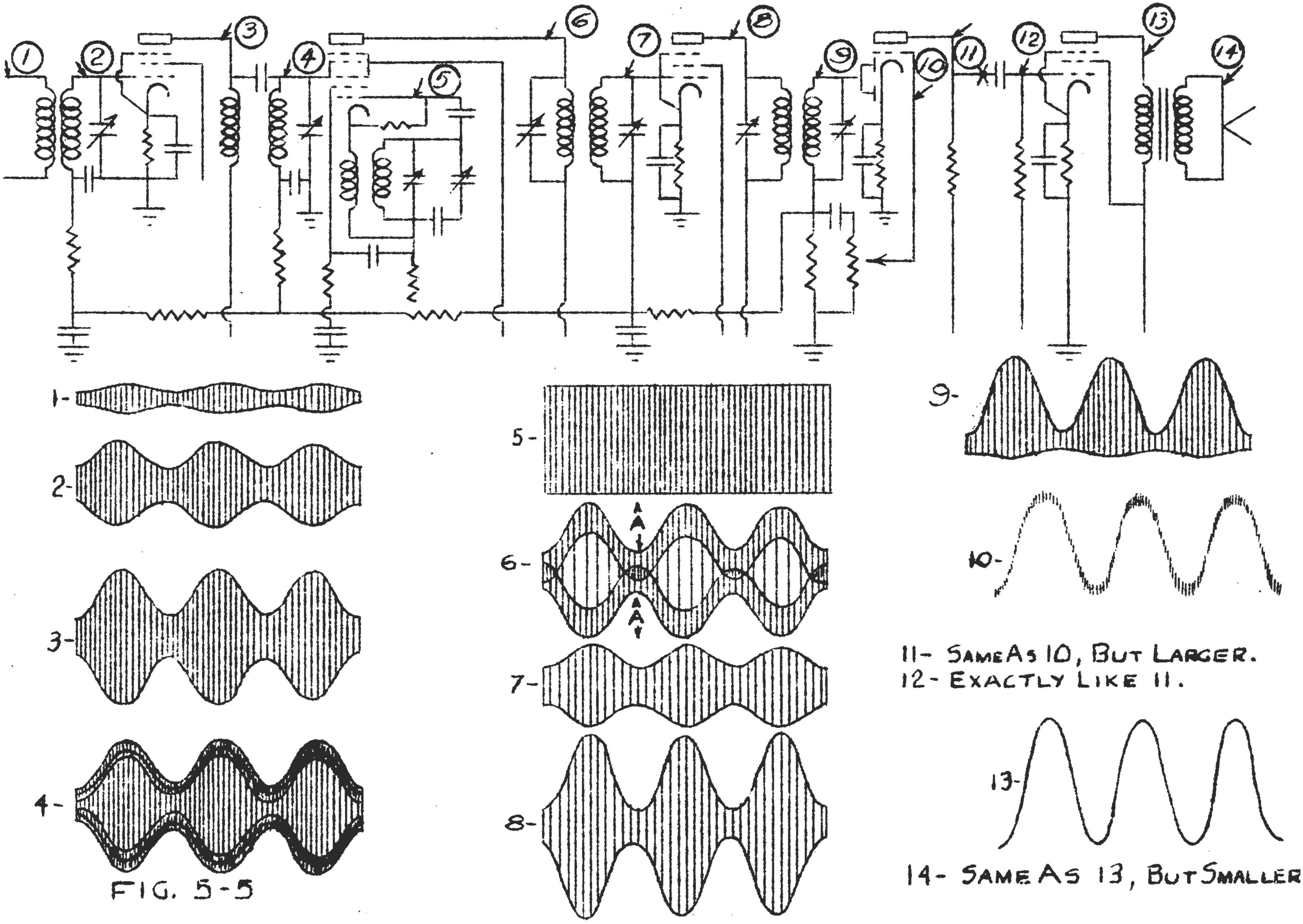


FIG. 5-5

11- Same As 10, But Larger.
12- Exactly Like 11.

14- Same As 13, But Smaller

TABLE 1-5

TUBES

TYPE	GAIN		
	R. F.°	I. F.°	A. F.
01A,26,27,30,37,55*,85*,1E4,1H4,6V7	------	-------	4.5-6
56,76,6C5,6J5,1H6*,6L5,6R7*,6F8,6D5	------	-------	8-14
75,1G4*,1H5*,6F5,6K5,6Q7*,6T7,6SQ7*	------	-------	30-70#
24,57,77,1E5,6C6,6J7,6SJ7	20-100	45-150	100-240#
34,35,58,78,1N5,6D6,6K7,6L7,6SK7,6S7,6U7	25-100	45-150	-------
33,47,41,42,1J5,2A5,6F6,6K6,6L6,6V6	-------	-------	10-20
31,45,50.71,2A3,6B4	-------	--------	2-5

* Triode Section

o No A. V. C.

Resistance coupled

TRANSFORMERS

	Voltage Gain
Antenna Transformer	3-7
Antenna Transformer (Auto Set)	10-50
R. F. Transformer (Interstage)	1-3
I. F. Transformers (Input or Interstage)	1
I. F. Transformers output followed by diode detector	3/1 to 5/1 los
I. F. Transformers output followed by high impedance detector	1-.75
Audio Transformer to class "A" tubes	turns ratio
Audio Transformer to class "B" tubes	75%-85% of turns ratio

NOTE: Gain per stage = gain of transformer X gain of tube