17A AND 17B OSCILLATORS

CONTENTS

1. GENERAL

1.01 This section, consisting of notes prepared by the Bell Telephone Laboratories, describes the 17A and the 17B oscillators and their operation.

1.02 These oscillators are heterodyne type vacuum tube generators of alternating current and are capable of delivering any single frequency from about 50 cycles to 150 kilocycles per second. The output is substantially constant with frequency except in the range below about 1000 cycles where it falls off as the frequency is reduced. One control serves to vary the frequency continuously over the full range, with frequency scale divisions 50 cycles apart throughout. Another control serves to vary the frequency in a 50-cycle range plus and minus from any setting of the first control.

1.03 After a small number of 17A oscillators were manufactured the 17A was superseded by the 17B oscillator. The principal difference between the two is that the 17B has a greater maximum output. The increased output was obtained through the use of two 311A vacuum tubes in place of two 310A tubes in the output stage; this required changes in the heater circuit, different output and power transformers, a new filter and a new output control potentiometer and a redesign of the ventilating features. Except for the difference in output the 17A and 17B oscillators are substantially the same in performance and operation.

1.04 Both oscillators operate from 105-125-volt 50-60 cycle supply and their output is adjustable to any value between 1 milliwatt and their maximum: +18 db (with respect to 1 milliwatt) for the 17A and +30 db for the 17B.

1.05 Output impedances of either 135 or 600 ohms may be used under control of a lever type key.

1.06 Each oscillator is contained on a panel for relay rack mounting 19 inches wide by 28 inches high, and is complete with the exception of the vacuum tubes and power supply cord. For portable use it may be mounted on a self-supporting rack and provided with a shipping trunk which has been made available for this purpose as described in Part 3.

2. DESCRIPTION OF CIRCUIT AND EQUIPMENT

2.01 The circuit for the 17B oscillator is shown in detail on Drawing ESO-624450 and for the 17A on ESO-621346 (not attached). Each oscillator is provided with a copy of the circuit drawing mounted on the inside of the rear cover and a wiring diagram. A schematic diagram of the principal circuit features of the oscillator is shown in Fig. 1.

2.02 As shown in Fig. 1, the circuit consists of two oscillator circuits, one of which is variable, supplying two frequencies to a modulator circuit in which the difference frequency is separated from the other modulation products by means of a low-pass filter. The output of the filter is then amplified to supply the oscillator output. All required filament, grid and plate power for the vacuum tubes is obtained from the a-c power mains. Additional details of these component circuits are shown in later figures.

2.03 The power supply arrangement provides heater current, grid potentials and plate potentials for all its own tubes and those in the oscillators and modulator-amplifier. The fixed oscillator generates a frequency of about 650 kilocycles. The variable oscillator generates a frequency which may be varied continuously from 500 to 650 kilocycles. The output of the fixed oscillator feeds into the modulator-amplifier through an input transformer. The modulator is of the balanced tube type, and the output of the variable oscillator is applied to the common grid lead. The output of this balanced tube circuit is fed through a filter and output control potentiometer to a push-pull amplifier. The output of this amplifier has a frequency equal to the difference in frequency of the two oscillators and appears at jacks on the panel and at terminals on the rear of the panel so that permanent connection may be made to jacks at other locations.

2.04 The apparatus is, in general, arranged on the panel in accordance with the circuit functions, the controls appearing on the face of the panel. The upper portion of the panel comprises the power supply equipment, the middle portion the modulator-amplifier, and the lower portion the variable oscillator and fixed oscillator. The controls associated with the operation of the oscillator consequently appear in the same arrangement on the front of the panel. The principal features are shown in Fig. 2.

2.05 The rear of the panel is protected by one large cover which is arranged to operate cutoff switches in the a-c power supply when the cover is removed. A shallow cover fastened with screws is provided for the portion of the front of the panel occupied by the terminals of the power supply apparatus, and also controls the protective switch.

2.06 The adverse effects of temperature variations on the output frequency have been minimized in various ways. The power supply apparatus is located at the top of the panel in order to reduce the effect of its heat dissipation. The modulator-amplifier unit which employs four tubes is also located above the oscillators in order to reduce heating effects. The layout of apparatus in the fixed and variable oscillators is, in so far as possible, similar in order that the effect of temperature changes of the components in the two units would tend to cancel and therefore reduce the effect on the output frequency. In addition to these precautions, perforations are provided in the rear cover to assist in dissipating the heat generated.

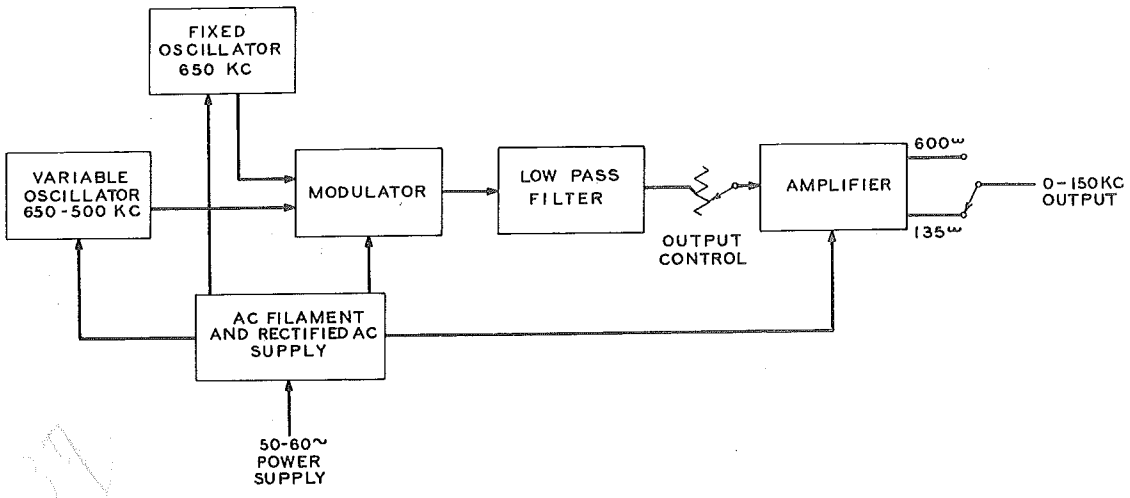

Fig. 1 - Principal Circuit Features.

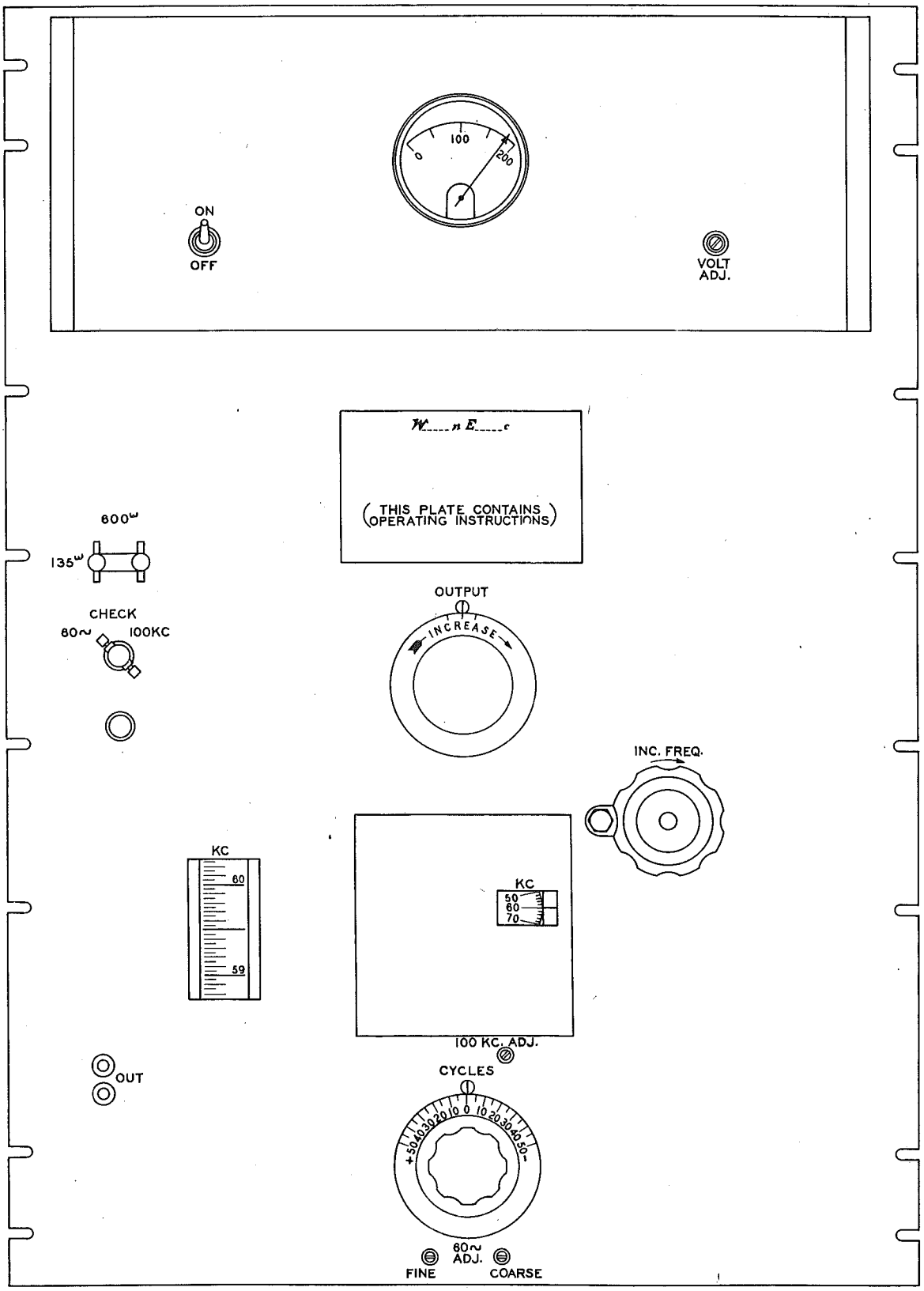

Fig. 2 - Principal Features.

(A) Power Supply Arrangements

2.07 A schematic of the power supply circuit is shown in Fig. 3. An important feature of this circuit is the very close regulation of plate potential which it provides.

2.08 The power transformer is provided with three taps on the primary side (105, 115 and 125 volts); by connecting to the proper tap it may be operated on any line voltage from 100 to 130 volts. In addition to the automatic cover switches in this primary circuit, another automatic switch is supplied which opens the primary circuit when the shallow power supply cover is removed from the front of the panel. This provides protection against shock from accidental contact with the high voltage terminals in the rectifier circuit which might otherwise occur should the rear cover be in place and the power supply cover removed. The highest voltage to ground is approximately 475 r.m.s. volts and occurs on the high voltage terminals on the transformer secondary and on the rectifier tube terminals. At these two points the voltage from terminal to terminal is approximately 950 r.m.s. volts. In addition to these points, a number of other terminals including the 180-volt plate voltage terminals under both front and rear covers are at a sufficient voltage above ground to be considered a possible source of hazard. The terminals under the front cover with which contact is more likely have been provided with supplementary protection in the form of insulating cover plates or insulating tape. Even with these precautions, however, it is important to observe the procedures given in Part 5 - Maintenance, during any trouble location tests.

2.09 The power transformer has three low voltage secondary windings for supplying the heaters and filaments of the various tubes in the complete oscillator circuit. It is also provided with a high voltage winding for supplying the plates of the rectifier tube. The low voltage leads, supplying the heaters of the 310A tubes in the oscillator and the 311A tubes are provided with a common 122A ballast lamp (E1) for reducing variations in heater current. The 310A tubes in the power supply circuit and the modulator circuit are not ballasted.

2.10 A 200-volt scale meter across the plate supply leads provides a means

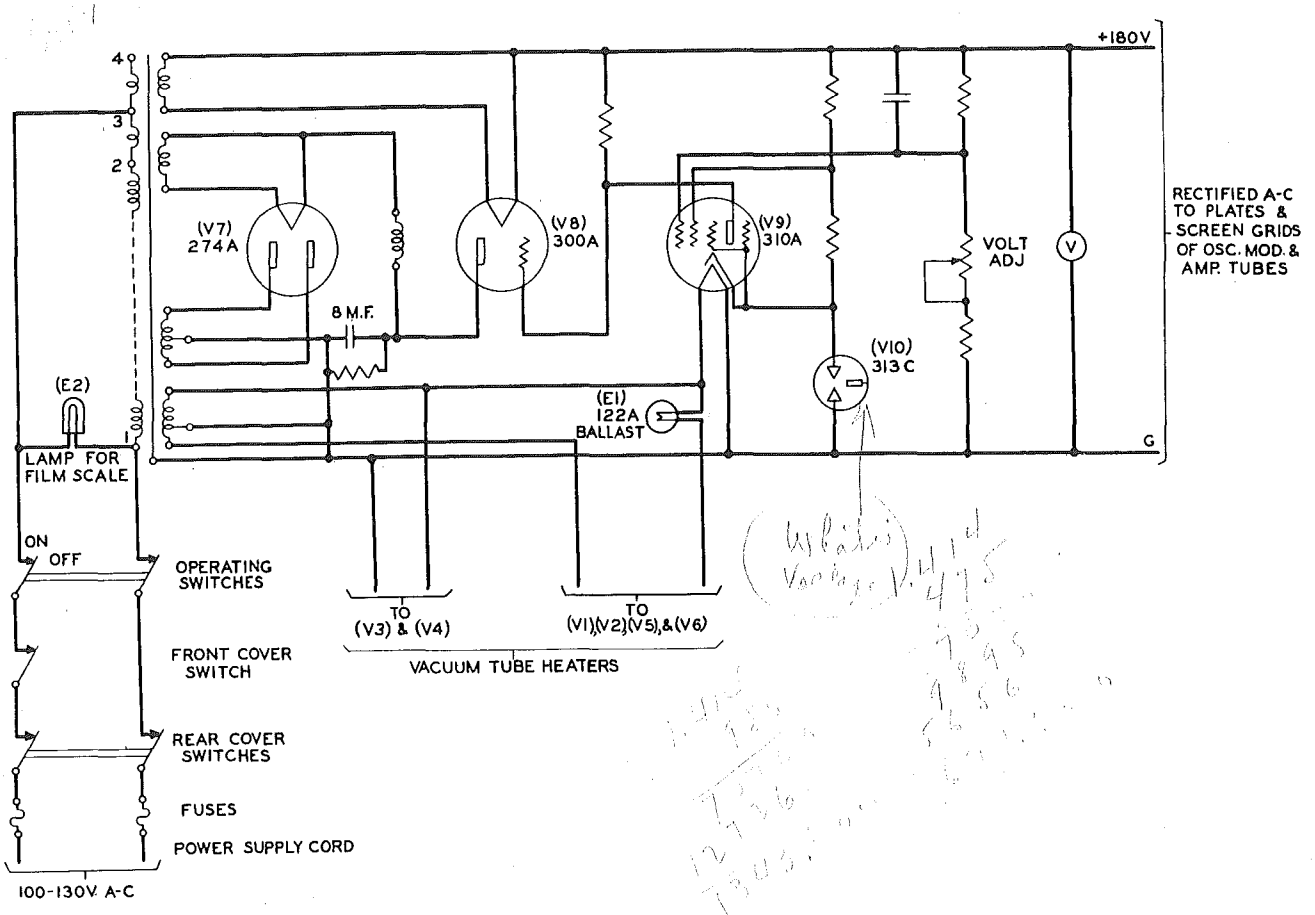

Fig. 3 - Schematic of Power Supply.

for measuring the plate voltage. A potentiometer provided with a screwdriver adjustment operated from the front of the panel permits the adjustment of the plate voltage to 180 volts. A red index line is provided on the meter at this point. The voltmeter, power control switch and potentiometer adjustment shaft (designated "VOLT ADJ") appear near the top of the panel.

2.11 After rectification the current is filtered by means of a retardation coil connected in series and a condenser bridged to the negative lead. The regulation of the 180-volt potential is accomplished by vacuum tubes V8 and V9 with the anode-cathode impedance of V8 acting as a variable resistance in series in the positive lead under control of V9. V10 is a 313C gas tube and operates to supply to the cathode of V9 a substantially constant positive voltage with respect to ground. The action is described as follows: When the line voltage drops or an increase in the load occurs, the output voltage is momentarily reduced. Portions of this voltage are supplied to both the control and screen grids of V9 through two shunt potentiometer arrangements. The reduction in voltage makes the grid of V9 more negative with respect to its cathode because of the action of V10. This results in a decreased plate current and a corresponding decrease in voltage drop across the resistance connected to the grid of V8. This decreased drop makes the grid of V8 less negative with respect to its cathode, thereby decreasing the tube resistance in series in the +180-volt lead and increasing the output of the rectifier. The circuit characteristics are such that the magnitude of this voltage change offsets the initial change and thus effectively stabilizes the output voltage. In the same manner an increase in the line voltage or a reduction in the load current will be reflected through the regulating circuit and cause the output voltage to be immediately restored to its normal value. The regulating action is practically instantaneous so that no sudden variations are apparent on the meter. One of the benefits of this rapid action is that noise voltages due to ripples from the rectifier or from other sources are greatly reduced and consequently a smaller amount of filtering is needed. It will be noted that this type of regulation is independent of variations in the frequency of the a-c power supply.

2.12 Since the cathodes of tubes V7 and V8 are of the filamentary type, and tube V9 has a heater type cathode, it will be seen that full regulation is not obtained until the cathode of tube V9 reaches normal temperature; also, in case of failure in the heater of tube V9 a condition of no regulation will result.

(B) Fixed Oscillator Circuit

2.13 A schematic circuit of the fixed oscillator is shown in Fig. 4. This oscillator employs plate circuit tuning and generates 650 kilocycles. It operates in the usual manner by feeding a certain portion of the output back to the input.

2.14 Most of the tuning capacity is provided by a fixed condenser C3. This is supplemented by several variable condensers whose functions are described as follows: Condensers C1, C24, and C6 are arranged for screwdriver adjustments for calibration purposes and are accessible from the front of the panel near the bottom. Condenser C24 is the coarse adjustment and condenser C1 is the fine adjustment for the 50 or 60-cycle calibration. Condenser C6 is to balance out changes caused by a similar condenser C2 in the variable oscillator when making the 100-kc. adjustment. Condenser C6 in the fixed oscillator and condenser C2 in the variable

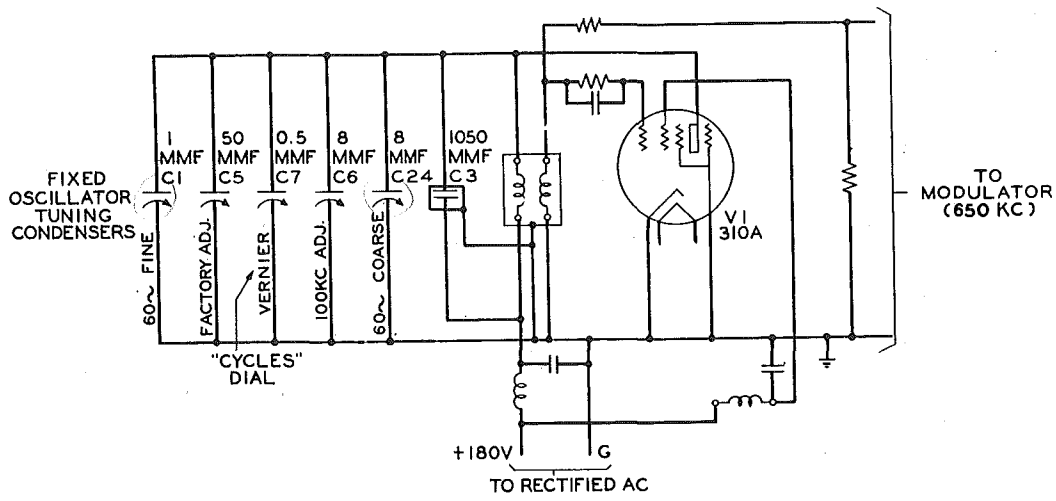

Fig. 4 - Schematic of Fixed Oscillator.

oscillator are geared together and operate by means of a common pinion on whose shaft a screwdriver slot is provided. This provides simultaneous vernier control on both condensers. The inter-linkage of these two condensers is explained under "Calibration." Condenser C5 is also provided with a screwdriver control reached from the front of the panel. This condenser is for initial factory adjustments and occasional field adjustments should they prove to be necessary; in order to avoid accidental changes or tampering, a protective plate, fastened by two screws, is provided over the opening. Condenser C7 is provided with a dial located in the lower middle part of the panel. This dial has a scale extending from -50 through 0 to +50 and provides means for varying the oscillator frequency over a 100-cycle range independently of the main frequency setting.

2.15 In order to minimize the adverse effects of temperature variations, coils and condensers with low temperature coefficients have been used in the tuned circuits of both local oscillators. The stator and rotor plates of the main control condenser C8 shown in Fig. 5 are alternatively invar and aluminum in order to reduce temperature effects on the output frequency. In addition, the fixed condenser C3 which constitutes the bulk of the tuning capacity is so designed that it has a negative temperature coefficient and thus tends to compensate for the positive coefficient of the air core oscillator coil.

(C) Variable Oscillator Circuit

2.16 The schematic circuit of the variable oscillator is shown in Fig. 5. As will be noted, the general circuit arrangement is similar to that of the fixed oscillator.

2.17 This oscillator is equipped with an 8-mmf. variable condenser C2 which is geared to the C6 condenser in the fixed oscillator and will be treated under "(E) Calibration." Condenser C25 is provided for factory adjustments and its control is located under the cover of the main condenser dial.

2.18 A comparatively large variable air condenser, C8, of 820-m-mf. maximum capacity, whose range is such that the frequency of the oscillator can be varied from 650 to 500 kilocycles, is provided in this circuit. This condenser is the main frequency control and is operated by a knob, equipped with a crank, on the front of the panel. This control, through a pair of 1:1 ratio bevel gears on the rear of the panel, drives a countershaft on the condenser which in turn drives the condenser rotor through a 100:1 ratio worm and worm gear. This countershaft also carries a sprocket which meshes with the perforations on the film scale and drives the film. This scale consists of about 30 feet of 35 milliameter safety base moving picture film which is stored on two spools and passes over the sprocket and a guide roller to provide a linear section behind a window in the panel; this window is 3" long and 1" wide. The storage spools are geared together through an idler gear. The lower spool is connected to the gearing through a spiral spring which maintains a tension on the film and compensates for the changing diameters of the film rolls on the two spools. The portion of the film behind the panel window is illuminated by a 3-watt lamp through a diffusing glass.

2.19 Each division on the film scale represents a change of 50 cycles and each kilocycle division is numbered. Between 70 and 129 kilocycles, there is an inverse scale reading from 60 to 1 kilocycle. The numbers of this scale are en-

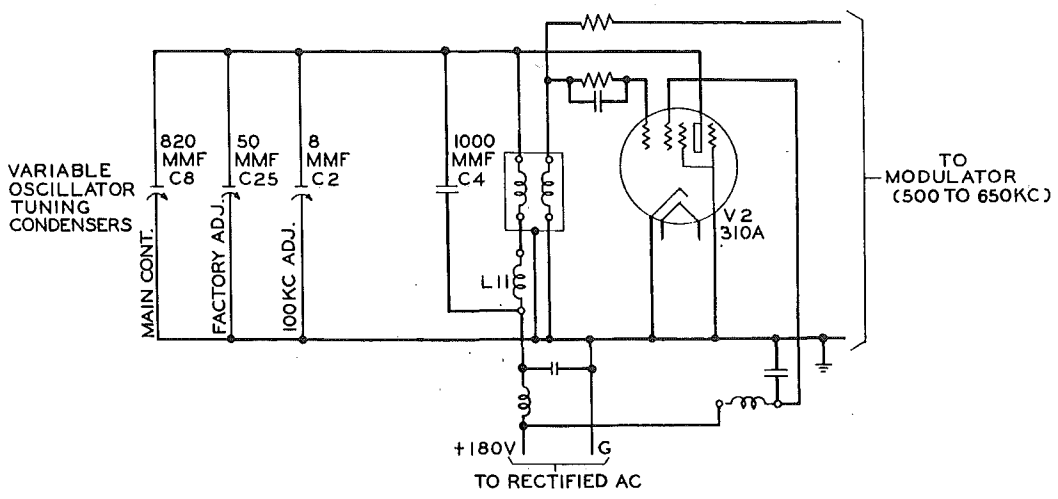

Fig. 5 - Schematic of Variable Oscillator.

closed in parentheses and indicate the difference between 130 and the output frequency of the oscillator. This scale has been provided for use with the 42A (J64042A) transmission measuring system for K carrier telephone in which the oscillator furnishes the carrier supply for a modulator circuit whose output frequency must always be 130 kilocycles. The numbers in parentheses thus represent the frequency that is being measured by the pilot level measuring circuit.

2.20 In addition to the regular and inverse scale on the film, two 60-cycle calibration points, two 50-cycle calibration points, a zero reference point and a calibration point in the vicinity of 100 kilocycles are provided. Their use is discussed under "(E) Calibration."

2.21 A coarse frequency scale is marked on a dial mounted directly on the condenser shaft with a section of the scale near the index appearing behind a rectangular window 1-1/8" long by 3/4" wide. These scale divisions are 2 kilocycles apart. This scale is legible when the film scale is moving too fast to be read; this will be the case when large changes are being rapidly made in the output frequency.

2.22 A positive stop is provided shortly after either end of the scale is reached for preventing further turning of the crank and thus protecting the film scale from damage.

(D) Modulator-Amplifier Circuit

2.23 A general schematic of the modulator-amplifier is shown in Fig. 6.

2.24 The 650-kc. output of the fixed oscillator is impressed on the grids of a pair of modulator tubes (V3 & V4) in a balanced circuit. The output of the variable oscillator is applied across a resistance common to the cathode-grid circuit of both modulator tubes. The desired frequency is the difference between these two frequencies. The output of the modulator is made up of two applied frequencies and new frequencies represented by the sums and differences of these frequencies and their harmonics. Since both of the applied frequencies are in a band substantially higher than that of the desired output frequency all main modulation products except the difference between the two applied frequencies are suppressed by the low-pass filter at the modulator output. The output of the low-pass filter is fed through a tapered potentiometer, which serves as an output control, to a pair of push-pull amplifier tubes, V5 and V6. These are 311A tubes in the 17B oscillator and 310A tubes in the 17A oscillator. This amplifier circuit substantially balances out any even harmonics generated in the modulator and amplifier.

2.25 The output control dial is located at the center of the panel and is arranged with a scale subdivided into divisions of approximately 1 db each. An ar-

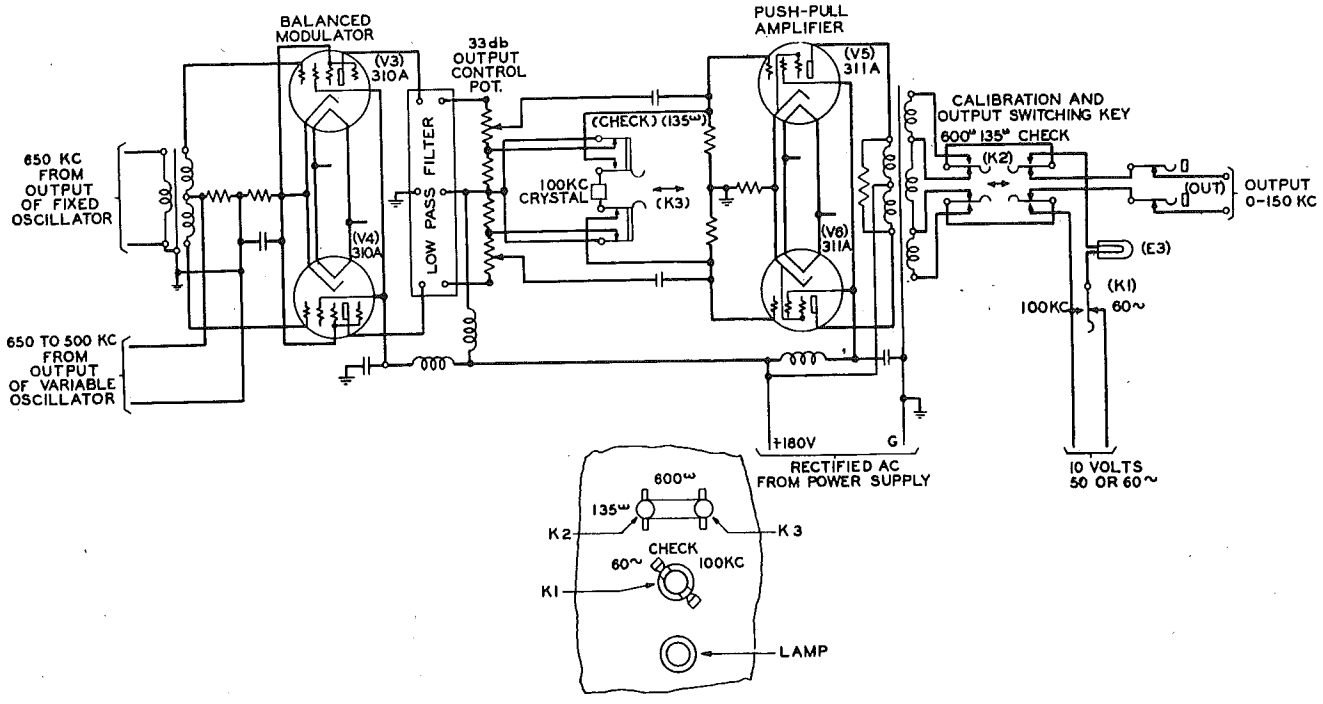

Fig. 6 - Schematic of Modulator-Amplifier.

rangement is provided for automatically increasing the oscillator output to approximately its maximum value when the lever keys are operated to the "CHECK" position for calibration purposes.

2.26 The output transformer is provided with a tapped secondary so that an output impedance of either 135 or 600 ohms may be obtained. A key is provided for changing from one value to the other. The output leads are terminated in a pair of jacks on the oscillator panel and may also be picked up at a terminal strip at the rear of the panel.

(E) Calibration

2.27 Circuit arrangements are provided for calibrating the oscillator at the 50 or 60-cycle point (power supply frequency) and at the 100-kc. point. With these two points calibrated the scale is substantially correct over its full range.

2.28 The 50 or 60-cycle calibration is effected by beating the power supply frequency against the output frequency with the film scale set at 60 (or 50) cycles. This is accomplished by lighting the calibration lamp with a small amount of the power supply current in series with the output of the oscillator. The resultant current through the calibration lamp causes it to vary in brightness at a rate equal to the difference in the two frequencies. Synchronism between the output and the power supply will occur when the variable oscillator is generating a voltage either above or below the frequency of the fixed oscillator by the amount of the power frequency. Both 60 (and 50) cycle points are therefore marked on the film scale in order that a check can be made at each point to insure that calibration is not made on the wrong sideband which would result in the output being in error by 120 (or 100) cycles. These markings are shown in Fig. 7.

2.29 The 100-kc. calibration is accomplished by matching the output frequency against the resonant frequency of a fixed crystal. A mark on the film scale is made at the measured resonant point of the individual crystal which is approximately 100 kilocycles. When the film scale is set at this point and the crystal is connected across the grids of the amplifier tubes, condensers C2 and C6 may be adjusted until the modulator output resonates the crystal; when this occurs the voltage on the grids of the amplifier tubes is considerably reduced and this extinguishes the calibration lamp which, in this case, is bridged directly across the 135-ohm windings of the output transformer.

2.30 Since the 60 (or 50) cycle calibration is made by adjusting condensers C1 and C24 in the fixed oscillator and the 100-kc. calibration is made by adjusting condenser C6 in the fixed oscillator, it is

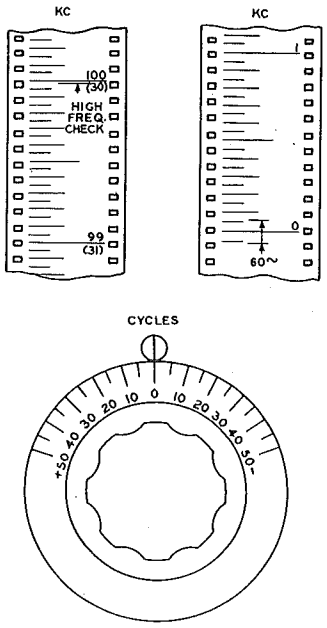

Fig. 7 - Frequency Scale Markings.

necessary to provide means for making these calibrations independent. This is done by gearing condenser C6 in the fixed oscillator to condenser C2 in the variable oscillator. Thus at the 60-cycle point these condensers have equal effects on both local oscillators and hence the output frequency is unaffected by an adjustment. However, at the 100-kc. point, the network capacity of the variable oscillator is higher than that of the fixed oscillator and hence the frequency change of the variable oscillator is less than that of the fixed oscillator thus producing a change in the output frequency.

2.31 The calibration lamp is located at the left center of the panel and is recessed in the panel in order to provide sufficient shading to make the illumination more pronounced. The calibration control keys are also located at the left center of the panel.

3. OPERATING FEATURES

3.01 The principal operating procedures of the oscillator consist in turning on the power supply, waiting until temperature stability is reached, checking the frequency calibration and making the desired output settings.

3.02 External connections to the oscillator include an a-c supply cord, an output lead and a ground connection. The output is obtained from the OUT jacks in the oscillator panel and patched directly to the circuits under test or from output jacks provided in a test bay and wired to the oscillator terminal block. The sleeves of the OUT jacks in the panel are connected

to the panel. When portable or mobile arrangements are provided for the oscillator, either a ground connection should be made from the panel terminal by means of a separate lead or by means of a shielded patching cord connected to a circuit having a grounded jack sleeve. When the rack mounted arrangements are provided the connection to ground is permanently wired from a panel terminal to the frame ground bus at the top of the bay. P-3-P cords equipped with 305A plugs are shielded and are suitable for patching the oscillator output. When the oscillator is to be connected to a circuit having d-c voltages on the tip and ring leads, it should be protected by using series blocking condensers as shown on Drawing SD-64381-01 (not attached).

3.03 The power supply to the oscillator is turned on by operating the ON switch near the top of the panel. When first applied the power supply will cause the plate voltage meter to go off-scale for approximately one-half minute until the cathode of the tube V9 approaches its normal operating temperature. At the end of the warming up period the plate voltage should be adjusted if necessary to the red mark at 180 volts. The plate voltage is adjusted to this value by means of the screwdriver adjustment designated VOLT ADJ near the top of the panel.

Note: The oscillator may be operated satisfactorily at voltages as high as 200 volts if an increased output is desired, or as low as 150 volts if a decreased output is preferable.

3.04 A warming up period of from 10 to 30 minutes is necessary to obtain optimum stability of output and frequency.

(A) Calibration

3.05 The calibration of the oscillator for maximum frequency accuracy is accomplished in the following manner after the initial warming up period has elapsed.

Note 1: In the portable or mobile arrangements, it is necessary to provide a ground connection to the panel when calibrating the oscillator. This can be done by using a P-3-P cord equipped with 305A plugs and connecting the output to a suitable jack having a grounded sleeve connection, or by means of a separate connection from the panel ground terminal to the best available ground.

Note 2: For optimum accuracy of frequency settings backlash effects in the film mechanism should be minimized by approaching all scale settings from the same direction, both in calibrating and in operating the oscillator.

(a) With the CYCLES dial set at zero and the KC dial turned to zero by means of the INC FREQ dial, operate the keys to CHECK and 100 KC. The oscillator output is then supplied to the lamp.

(b) Adjust the COARSE 60 ADJ screw until the lamp is extinguished. This indicates that the frequency and hence the output is approximately zero.

(c) Operate the 60~ key and set film scale to the power frequency (60 or 50 cycles) mark above zero mark.

(d) The flashing of the lamp should be adjusted to four per second or less by means of the FINE 60 ADJ condenser screw at the bottom of the panel.

Note 1: Theoretically, perfect resonance would be indicated by the unvarying brilliance of the calibration lamp; this condition is rarely obtainable, however, and the frequency of variations in brilliance is an indication of the number of cycles per second discrepancy which exists between the a-c power source and the oscillator output.

Note 2: When the film scale is changed to the lower power frequency scale division (60 or 50) cycles) a condition of near synchronization should also be observed.

Note 3: During the process of adjusting the FINE condenser it may sometimes be noted that the condenser will pass through one of its points of either maximum or minimum capacity and a satisfactory adjustment cannot be obtained without first making a slight change in the COARSE adjustment.

(e) Operate the 100 KC key and set the film scale to the HIGH FREQ CHECK calibration mark near 100 KC.

(f) Adjust the 100 KC ADJ screw until the lamp brilliancy is at minimum.

(g) Operate the key to 135 ohms or 600 ohms to disconnect the calibrating circuit and supply the oscillator output at the OUT jacks.

(B) Output

3.06 With the oscillator calibrated as described above, it is ready to supply output power of any frequency up to 150 kilocycles to turning the frequency dial to the desired setting. This usually is done by means of the INC FREQ dial only. When frequency deviations of less than 50 cycles

are to be measured from any film scale setting the CYCLES dial can be turned as desired and the increment can be noted with good accuracy on the CYCLES dial. The use of this dial for obtaining precise frequency settings between 50-cycle divisions does not materially improve the accuracy of the frequency setting over that obtained directly on the film scale.

3.07 The output is increased when the OUTPUT dial is turned clockwise. The divisions are approximately 1 db apart and serve as a rough guide to the amount of output power. For frequencies above 1 kilocycle an output of the order of one milliwatt is supplied when the OUTPUT dial is set at minimum.

3.08 The output impedance of the oscillator may be made either 135 ohms or 600 ohms by operating the key to the appropriate position.

(C) Portable Arrangements

3.09 When the oscillator is to be used on a portable or semi-portable basis it should be mounted on either a self-supporting rack such as is shown on Drawing ED-90523-01 (not attached), or on a mobile rack as shown on Drawing ED-69591-01 (not attached). In these applications the oscillator should preferably be mounted at such a height that the film scale window, which is about 9" from the bottom of the panel, appears a few inches below eye level. The position of the panel on the self-supporting rack and the height of the support for the rack can be determined locally. It is important from the standpoint of frequency stability that the oscillator panel be rigidly mounted.

3.10 For shipping, the oscillator mounted on the portable rack may be placed in a trunk per KS-5328. The oscillator panel assembly weighs approximately 80 pounds. With the rack and the trunk the weight for shipping purposes is approximately 200 pounds. The rack alone weighs about 48 pounds.

3.11 When the oscillator is to be shipped in the trunk all of the tubes and lamps should be removed from the panel and carefully packed.

3.12 When setting the oscillator up at a new location the mean voltage of the a-c supply should be determined and a tap on the power transformer should be connected in accordance with the following table:

Mean Voltage	Power Supply Connected to Transformer Terminals
105	1 and 2
115	1 and 3
125	1 and 4

4. PERFORMANCE DATA

4.01 The operating characteristics of the 17A and 17B oscillators are given in the following paragraphs for both the carrier and message frequency ranges. These oscillators were designed primarily for frequencies above about 3 kilocycles, and in the message frequency range are, in general, less suitable than oscillators designed specifically for use in this range.

4.02 The performance data given in the following paragraphs assume that good vacuum tubes are used and that the frequency calibration has been made as described in Part 3.

(A) Frequency Range Accuracy and Stability

4.03 The 17A and 17B oscillators will supply testing frequencies between about 50 cycles and 150 kilocycles. The film scale is calibrated at 50-cycle intervals throughout the range in a manner that assures a high degree of accuracy. Considering errors in calibration, backlash in the condenser drive, observational and other errors, it is expected that at room temperatures of from 65 to 85°F. shortly after calibration, an accuracy of ± 25 cycles will be obtained at any scale setting.

4.04 In order to provide for a small amount of shrinkage of the film with time, it is necessary to allow a small initial backlash between the film perforations and the sprocket teeth. The error introduced in this way is small and may be minimized as described in Part 3. The shrinkage of the film does not seriously affect the accuracy of the oscillator since, regardless of its length, the film perforations return to the same tooth on the sprocket for any given setting. The shrinkage which may occur in the distance between the hair line and the sprocket is equivalent to displacing the hair line by approximately 1/32-inch and is cancelled out during the low frequency adjustment of the oscillator.

4.05 Due to changes in temperature and other causes, such as aging, the oscillator requires calibration adjustments to make its output frequency correspond precisely with the frequency scale indication at two points. These adjustments tend to bring the output frequency into agreement with the frequency scale divisions throughout the range and are essential to proper performance of the oscillator. They are described in Part 3.

4.06 After a warming-up period of about 30 minutes, the change in frequency of the oscillator over a long period of time should be less than ± 20 cycles at any frequency scale setting. This includes the effect of a variation in the a-c line voltage of ± 5 per cent. and a variation in office temperature of ± 15°F. from a normal value of 75°F.

(B) Frequency Settings

4.07 The film is scaled at 50 cycles per division with numerical designations at each kilocycle point throughout the range from zero to 150 kilocycles. 60-cycle calibration points are marked and designated on the film at both 60 cycles above and below the zero point. A high frequency check calibration point is also marked near the 100-kc. division based on the actual resonant frequency of the crystal used in a particular oscillator. The coarse scale divisions and designations on the main condenser dial are 2 kilocycles apart, and because of its slower rotation provides an indication of the frequency during a rapid changing of the film scale. The CYCLES dial scale provides an adjustable range from -50 cycles through zero to +50 cycles referred to any film scale frequency setting and is accurate for making small frequency changes. The divisions are 5 cycles apart and the numerical designations are 10 cycles apart. With these scale indications, the oscillator dials can be set quickly and precisely to any desired frequency setting in the full range.

(C) Output Control Stability and Impedance

4.08 Any output power between about zero and +30 db (+18 db for 17A oscillator) referred to one milliwatt can be supplied to either a 135 or a 600-ohm circuit, at frequencies between 1 and 150 kilocycles. Below 3 kilocycles the output falls off in such a manner that at 1000 cycles the output may be reduced by as much as 1.5 db and at 200 cycles it may be reduced as much as 7 db from the output at 3 kilocycles. This characteristic will vary widely for different oscillators. At a particular setting the stability of the output is $\pm$.5 db or less provided the a-c supply voltage is stable to within +5 volts.

4.09 A representative output frequency characteristic is shown in Fig. 8 for both the carrier and the message frequency range. The variation in output is approximately the same for either the maximum or minimum settings of the output control.

4.10 The oscillator output impedance is substantially 135 ohms (or 600 ohms) throughout the frequency range from 3 to 150 kilocycles, the deviations being greater at the extremes than at intermediate frequencies. When normal vacuum tubes are used in the output stage, the reflection coefficient is better than 10 per cent. in this frequency range.

4.11 The output control provides means for adjusting the output continuously over the full range, i.e., to obtain any output power from one milliwatt to full output in steps smaller than 0.1 db. The scale divisions in the scale are approximately 1 db apart and are provided to facilitate making rough changes in the output. Where an exact value of output or where an exact change in output obtained by adjustment of the output control is required it must be measured by means of a 30A (J64030A) transmission measuring set or its equivalent.

(D) Harmonic Content

4.12 The total power of any spurious frequencies, including harmonics and power supply interference, is at least 37 db below the fundamental when the oscillator output is one milliwatt at the fundamental frequency and when the latter is 3 kilocycles or higher. The proportion of harmonics increases with the amount of output and also as the frequency is reduced below 3 kilocycles about as shown in the following table:

Frequency (Kc.)	Probable Maximum Total Harmonic Content Referred to the Output of the Fundamental: At 1 MW Output (db)	At +20 db Output (db)	At +30 db Output (db)
75	40	40	30
3	37	37	27
1	50	30	20
200 cycles	20	20	10

5. MAINTENANCE

5.01 The maintenance of the oscillator consists essentially in checking for defective vacuum tubes or other features affecting the performance of the oscilla-

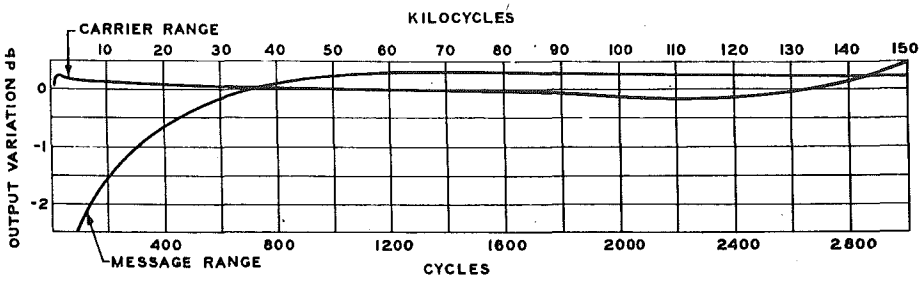

Fig. 8 - Representative Output - Frequency Characteristics.

tor, clearing specific troubles, cleaning of the film scale and occasional lubrication of certain parts.

> Caution: On account of the high voltages between certain apparatus terminals, the power supply cord should be removed from its receptacle before proceeding with any tests or maintenance requiring removal of the front or rear protective covers. This is desirable even though cover switches are provided and the OFF switch is operated.

5.02 Unsatisfactory performance will usually appear as either low or unstable output or an increase in harmonic content or by difficulty in making the frequency calibration.

5.03 Lubrication of the bearings on the worm shaft of the main tuning condenser is occasionally required using materials as specified below.

(A) Performance Checks

5.04 The output of the oscillator at frequencies of 1, 3, 60 and 150 kilocycles should be measured occasionally with the output control set at maximum. This requires a 30A (J64030A) transmission measuring set or its equivalent. At 60 kilocycles the output with respect to one milliwatt should be within 30 ± 3 db for the 17B oscillator (18 ± 3 db for the 17A oscillator) and at frequencies of 1, 3 and 150 kilocycles it should be within 1.5 db of the 60-kc. output. Deviations greater than these are usually indications of one or more defective vacuum tubes. A tube of the proper type which meets the requirements for use in repeaters or other circuits is suitable for use in the oscillator. An instability of output at any one frequency greater than .5 db during short intervals of time, such as one-half hour, is an indication of trouble and should be investigated.

5.05 An increase in the harmonic content of the output is usually an indication of trouble in the modulator-amplifier circuit such as unbalanced modulator or amplifier vacuum tubes. It is expected, however, that new vacuum tubes will be satisfactory without selection for balance. Excessive harmonic content sometimes results in inaccurate measurements of circuits having a non-uniform frequency response characteristic.

5.06 Errors in frequency of more than 25 cycles when compared with known frequencies after observing the anti-backlash precautions described in Part 3 are an indication of improper calibrating procedure, mechanical damage resulting from improper handling, a defective 100-kc. crystal or of circuit trouble. If after a calibration as given in Part 3 the frequency error still exists, the circuit should be investigated. A defective crystal will usually result in broadening the calibration adjustment and an error of several hundred cycles in the frequency at this point.

5.07 Difficulty in obtaining satisfactory adjustment of the output control potentiometer is an indication of either defective contact or broken wires in the circuit associated with the output control potentiometer. The potentiometer contacts should be cleaned and lubricated as described in a section in the A500 series of Practices.

> Note: The contact portion of the front potentiometer may be reached by removing the output dial. Care should be taken to replace it in the same position.

(B) Trouble Indications

5.08 The following trouble indications are given as a guide in determining the source of the more common troubles.

(a) Failure of film scale illumination usually indicates defective lamp, loss of power, or burned out fuse on the rear of the panel.

(b) Failure to obtain 180-volt meter reading usually indicates a defective vacuum tube in the power supply circuit or loss of power.

(c) Failure of oscillator output at all frequencies is usually due to a defective vacuum tube in either the fixed or variable oscillator circuits or to one of the causes given above in (a) or (b).

(d) Difficulty in obtaining the frequency calibration is usually due to improper calibration procedure. When the calibration adjustments given in Part 3 do not bring about the desired result, the cause is probably a defective circuit condition and should be investigated.

5.09 The investigation of circuit troubles, in general, should be limited to an inspection of the wiring and switching conditions with the expectation of finding a broken wire on defective contact. Defective conditions which cannot be readily discovered will usually necessitate returning the oscillator to the manufacturer for repairs and adjustments.

(C) Cleaning and Adjusting the Film Scale

5.10 The film scale will, in the course of time, pick up a certain amount of dust and dirt. Most of this can be removed

without taking the scale out of the oscillator by cleaning as described below.

(a) Remove the rear cover and turn the frequency control until the positive stop at the low frequency end of the scale is encountered.

(b) Roll a 6" x 6" piece of KS-2423 cloth into a tube and fold it in the middle to form a "U" shaped pad. Insert the ends of this pad over the film between the upper storage spool and the upper roller guide and with the fingers press the pad lightly against the film.

(c) Crank the scale to the stop at the other end of the scale. Remove and refold the cloth to expose a fresh surface, and insert it in the same manner between the lower storage spool and the lower roller guide and again crank to the other end of the scale.

(d) Repeat if necessary to obtain a clean surface.

5.11 If for any reason the film scale must be readjusted or replaced, the following procedure must be followed to charge the take-up spring associated with the lower storage spool properly and to locate the scale correctly with respect to the teeth on the sprocket.

(a) Attach high frequency end of scale to upper storage spool, as shown on Fig. 9, with the spring clip furnished, and roll the entire scale on the spool except for the last few feet.

(b) Loosen slightly the two screws which determine the position of the guide roller arm and swing the roller away from the sprocket.

(c) A reference arrow will be found on the film scale in the neighborhood of 3 KC pointing toward one of the perforations at the right-hand edge of the film. Note the exact frequency 4" below the arrow (about 1.5 kilocycles) and set the main frequency dial to this frequency. The film should then be engaged with the sprocket so that the reference arrow comes opposite the sprocket tooth which is marked with a V notch on the edge of the sprocket.

(d) With the film in this position, and the film drawn down against the sprocket, adjust the position of the roller to bring the ribs on the roller as close to the film as is practical without binding (approximately .005" clearance) against the sprocket in any position.

(e) Attach the low frequency end of the film to the lower storage spool with the clip furnished.

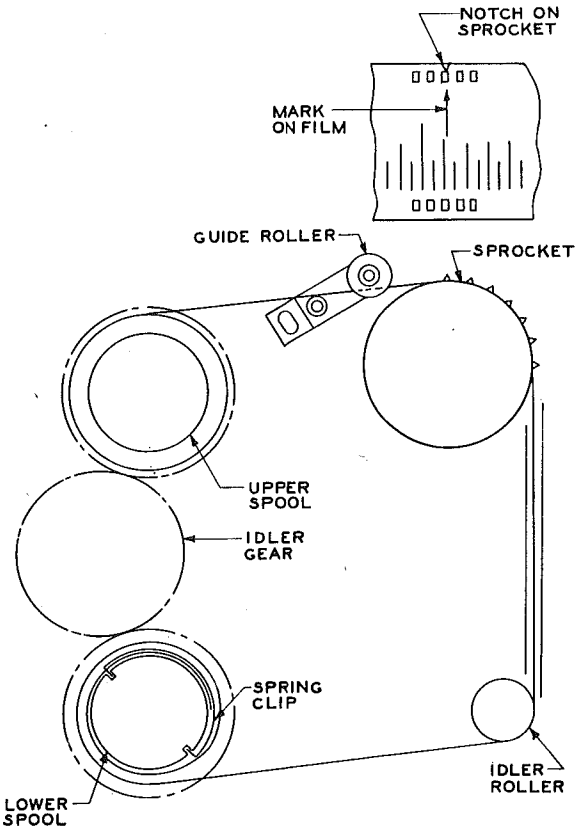

Fig. 9 - Diagram Showing Film Assembly.

(f) Turn the frequency control crank clockwise until the positive stop is reached. Loosen the screw holding the upper spool on the spindle and slide the spool sideways until the gears disengage. Rotate the upper and lower storage spools counter-clockwise and clockwise, respectively, to take up all the slack film.

(g) With the film reasonably taut on both spools, turn the idler gear counter-clockwise 11 complete revolutions. This charges a clock spring which maintains a tension on the film and compensates for the varying diameters of the rolls of film on the two spools.

(h) Reengage gear on upper spool and tighten screw on spindle.

(D) Lubrication

5.12 KS-7470 oil should be used for all of the points listed below. This oil should be applied as indicated, preferably with the small oiler designated the 486A tool. This oiler with the oil recommended will be found to work best when kept at least three-quarters full.

	Quantity	Normal Interval in Months
Film Scale Mechanism		
Storage spool spindles (each end)	2 drops	3
Idler roller spindles (each end)	2 drops	3
Idler gear stud	2 drops	3
Main Tuning Condenser		
Worm shaft sleeve bearings	4 drops	3
Worm - worm wheel	8 drops	3
Ball bearings	4 drops	6
Bevel Gear Shaft Bearings	4 drops	3

(E) Replacements and Supplies

5.13 The following vacuum tubes and lamps and other accessories are required for each oscillator:

Note: Vacuum tubes and the power supply cord are not supplied with the oscillator and must be ordered separately.

Circuit Designation	Quantity Used for 17B	Quantity Used for 17A	Name
E2	1*	1*	3-watt 120-volt S6 Mazda lamp candelabra base
V7	1	1	274A vacuum tube
V8	1	1	300A vacuum tube
V1, V2, V3, V4 and V9	5	7	310A vacuum tubes
V5 and V6	2	0	311A vacuum tubes
V10	1	1	313C vacuum tube
E1	1*	1*	122A ballast lamp
E3	0	1*	E1 lamp
E3	1*	0	A1 lamp
F1, F2	2*	2*	Bryant 3-ampere plug fuses
-	1*	1*	2BN lamp cap

* Supplied with the oscillator; listed for reference only.

5.14 If the film scale should be injured or should break, a replacement scale can be obtained from the Western Electric Company by specifying as follows:

Film scale per ESO-621931, Detail 2, for 17B oscillator, Serial No. - - -.

5.15 Lubricating oil for the bearings and mechanisms should be specified as follows:

KS-7470 Oil.

5.16 A power cord required for the oscillator should be specified as follows:

(length) Cord and Radial-Polarized Plug Cap Assembly KS-7585 or
(length) Cord and Parallel-Polarized Plug Cap Assembly KS-7993

5.17 Patching cords equipped with shields required for connecting the oscillator output should be specified as follows:

P-3-P Cord - (length 4, 6 or 8 ft.) equipped with two 305A Plugs.