No. 90662-A GRID DIP METER

I. GENERAL

The Millen No. 90662-A Grid Dip Meter may be used in any of the following manners:

1. **A Grid Dip Oscillator** for use as an oscillating frequency meter to determine the resonant frequency of de-energized r-f circuits.

With the function selector set to "OSC," the grid dip meter becomes an r-f oscillator. A transistorized electronic voltmeter built into the unit measures the relative power output of the oscillator. When an external circuit, resonant at the oscillator frequency, is coupled to the "Probe" inductance, power is absorbed from the oscillator and is indicated by a dip (decrease) in the voltmeter reading. The grid dip meter used in this manner may then be used to check the resonant frequency **of a circuit without the application of power to the circuit in question.** This results in a considerable saving of time; and a definite assurance of correct frequency adjustment of a circuit is obtained without the danger of working in the presence of high voltage d-c or f-f. Circuits may be checked or pre-tuned before completion of the unit in which they are to be used. Only minor trimming is generally required under actual operating conditions. Guesswork or "cut and try" methods are eliminated, while, at the same time, possible damage to components during initial tune-up and adjustment is eliminated.

2. **An Oscillating Detector** for determining the fundamental or harmonic frequencies of energized r-f circuits.

With the function selector set to "OSC" and a pair of headphones plugged into the 'phone jack, an audible beat note may be heard when the instrument is tuned to the fundamental or harmonic frequency of a source of r-f. The frequency in question, or its harmonics (and sub-harmonics) may be read directly from the calibrated dial to an accuracy ± 0.5%. Plugging the headphones into the jack provided will generally cause the meter reading to drop to approximately 0.2 ma or less, but this is normal and should be ignored.

3. **A Signal Generator** for use as a modulated or non-modulated source of accurately known (± 0.5%) r-f frequencies between 220 KC and 300 MC. The Grid Dip Meter may also be used as a source of a-f either separately or simultaneously with the modulated r-f.

When the function selector is set to "OSC" or "MOD. OSC," the instrument may be employed in place of a standard signal generator, except in those cases where special shielding or a known r-f voltage is required. Either modulated or unmodulated r-f is available depending on the setting of the function selector. The audio modulating signal of approximately 800 cps is available separately at the 'phone jack at any time that the function selector is set to "MOD. OSC."

4. **A Tuned R-F Diode Detector** for use as an absorption type frequency meter.

To use the grid dip meter as an absorption frequency meter, set the function selector to "DIODE," and advance the sensitivity control so that, with no r-f being picked up, the meter reads approximately 0.6 ma. The meter reading will now increase when the probe is brought into the presence of an r-f field of the same frequency as that to which the dial is tuned. The frequency may be read directly from the dial if between 1.7 Mc and 300 Mc or from the logging scale and calibration curve if between 220 KC and 2.0 Mc.

The sensitivity of the 90662-A is considerably greater than conventional Grid Dip Meters when used as an absorption frequency meter because of the improved indicator circuit using a transistorized electronic voltmeter.

II. MEASUREMENT TECHNIQUES

Correct methods of coupling the grid dip meter to circuits under test are shown in Fig. 1. Because of the improved indicating circuit, the coupling need not be as close as with conventional Grid Dip Meters, particularly at the higher frequencies.

When used as a Grid Dip oscillator, harmonics of lumped-constant resonant circuits will not be indicated; however, other resonant frequencies are sometimes indicated. These will be due to other resonant circuits formed by circuit wiring, stray capacitances, etc. In most cases these will occur at a higher frequency. On the other hand, harmonics of antennas, transmission lines, etc. will be indicated as will be explained under the heading "Antennas." It will be noted that the meter reading slowly varies as the dial is rotated; however, correct resonance of the unknown is indicated when the meter makes a sharp or pronounced "dip" or "peak." Care must be taken that the circuit under test is not coupled too tightly to the probe, for this will cause the oscillator frequency to change in proportion to the degree of coupling. The least coupling with which it is possible to obtain a recognizable indication is the proper way to use a grid dip meter.

In general, for most measurements the sensitivity control should be adjusted so that a meter reading of about 0.8 ma. is indicated when the grid dip meter is not coupled to any external circuitry either passive or active.

However, for those cases where the resonant frequency is not known within wide limits, it is best to set the "no coupling" meter reading to approximately 0.5 ma. and couple as tightly as possible to the circuit under test while varying the frequency slowly. Should no indication be noted on the first pass through the frequency range expected, the sensitivity should be increased progressively with each successive pass. When an indication is obtained, the coupling should be decreased in steps while the sensitivity is simultaneously increased until the meter reads about 0.9 ma. No further increase of the sensitivity control should be made, this being about optimum, but the coupling should be decreased until, as above, the indication is just barely recognizable. This will insure maximum accuracy of frequency calibration.

It is suggested that the user of the Grid Dip Meter at first set up test L/C combinations, short test antennas, etc. The resonant frequency of these test circuits should be measured with the grid dip meter in order to become familiar with the coupling methods suggested and with the general behavior and operation of the instrument.

III. APPLICATIONS

Receiver tuned circuits. Use the instrument as a grid dip oscillator. Remove power from the receiver and resonate each tuned circuit to the desired frequency as indicated by the meter dip. Gang tuned circuits should be aligned for tracking by checking at each end of the ganged range. A check at one or two points in between will also be helpful. Methods of electrically obtaining the desired bandspread or tracking will not be explained here. Reference may be made to any good radio text book.

Following the above procedure, power may be applied to the receiver and the grid dip meter employed as a signal generator for checking final alignment. A very short antenna should be connected to the receiver input terminals and the "Grid Dipper" should be placed on the bench removed from nearby conductors, and where body movements are least apt to affect the r.f. signal from the instrument. Some sort of indicating device such as an "S" meter or v.t.v.m. at the receiver detector must be used. If the r.f. signal is too strong, the receiver antenna may be shortened, or the instrument may be removed to a more remote or partially shielded location.

Where a superheterodyne type of receiver is involved and, if the receiver fails to function, it is quite possible that the receiver local oscillator is not working. This may be checked by employing the "Grid Dipper" as an r.f. diode detector or absorption type wave meter. Couple it to the oscillator coil and, if the meter does not go up-scale when the instrument is tuned to the resonant frequency of the oscillator tank, the oscillator is not functioning. An alternative method having greater sensitivity and capable of more accurate frequency measurement is to use the instrument as an oscillating detector and listen for the local oscillator beat in the headphones.

Transmitter tuned circuits. Use the instrument as a grid dip oscillator with plate power removed from transmitter and proceed to adjust tanks to desired frequency as with receiver circuits. Tubes should be in place, and where capacitive coupling is used between stages, the grid circuit associated with following tube should be completed.

After the above procedure, plate power may be applied and final alignment made according to grid and plate meter indications. R.f. power at correct frequency in each tank may be checked by employing the "Grid Dipper" as a diode absorption frequency meter or it may be utilized as an oscillating detector. Due to its greater sensitivity in the latter state, care must be taken not to mistake audible beats from some other energized r.f. circuit. This may be checked by moving the instrument closer to the circuit under test and noting whether or not the beat increases in volume. If it does, the beat heard is from the desired circuit. Harmonics also may be heard, so it is wise to check for the beat heard at the lowest frequency.

Neutralization. Employ the instrument as a grid dip oscillator. Remove all plate power from the transmitter. Couple the "Grid Dipper" to grid tank of stage to be neutralized, or in the case of capacitive coupling to the preceding plate tank (it is assumed that the tank has already been tuned to correct frequency). Couple fairly close and leave instrument set in position with its meter deflected at bottom of the resonant dip, being sure to increase the sensitivity control so that meter reads about 0.9 ma. Neutralization is then indicated when rotation of amplifier plate tank capacitor has no reaction on the deflected meter reading. Another method is to use the instrument as a diode absorption-type meter and proceed to neutralize in the manner normally employed when using absorption-type wavemeter, or as with similar indicating device, i.e.:

> Remove plate power from amplifier stage to be neutralized, and apply power to stage driving the grid. Couple the "Grid Dipper" to the amplifier tank, tune the instrument to the driving frequency and check for the presence of r.f. in the tank as indicated by a rise in the "Grid Dipper" meter current. Adjust neutralizing capacitor until no reading is seen on the meter.

Parasitic Oscillations. Apply power to transmitter and use instrument as an oscillating detector while listening on headphones for beat of parasitic oscillation. As an alternative, the parasitic frequency may be determined by using the instrument as a tuned r.f. diode or absorption type frequency meter. When parasitic frequency has thus been determined, as read from the "Grid Dipper" scale, remove power from transmitter and use instrument as a grid dip oscillator to locate circuits or components, such as r.f. chokes, circuit wiring, etc., resonant at parasitic frequency.

Parallel resonant traps. Use as a grid dip oscillator. Trap may be tuned or checked either before or after connecting it in desired circuit. If tuned before installation, adjustment will remain correct upon installation if its inductance is physically removed from other conductive components which may alter the inductance value. This is not usually the case, so further minor adjustment will probably be required after installation. When in the circuit, it is possible that its resonant frequency may be quite a bit off as indicated by the "Grid Dipper." Actually the trap itself will still be tuned to approximately correct frequency but the grid dip oscillator reading may be found at some other frequency (usually lower) due to circuit "strays" across the trap.

Final precise adjustment may be made by applying power to circuit and by tuning trap under actual operation for desired effect.

Series resonant traps. Follow same general procedure as with parallel resonant trap. To check or tune prior to installation, trap may be first connected as a parallel trap. At high frequencies or where the trap inductance is low, the lead completing the parallel circuit should be of large wire or wide copper ribbon to keep its inductance low, and care should be taken not to permit this lead to be positioned so as to add stray capacitance. Leads to be used upon final installation must also be included when external measurements are being made.

R. F. Chokes. To determine self resonance of r.f. chokes, use "Grid Dipper" as a grid dip oscillator.

Circuit Q. Use the "Grid Dipper" as signal generator. Connect a v.t.v.m. across the circuit to be measured. Couple instrument to circuit (Fig. 1A) and resonate for maximum, or peak reading, on v.t.v.m. Note frequency at which this occurs. Then shift the instrument each side of resonance to the frequency where the voltmeter reading drops to approximately 70.7% of that at resonance. Note the frequency of these two points and calculate the circuit Q from equation "A," Appendix 1, where Fr is the resonant frequency and delta f is the difference between the "off resonance" frequencies just found. The original coupling should be adjusted for a convenient maximum reading of the v.t.v.m. and then should be left fixed at this position for the remainder of the procedure.

Relative circuit Q at a given frequency. Use as a grid dip oscillator and observe character of the dip whether broad or sharp for a fixed setting of sensitivity control. The sharper the dip, the higher the Q.

Measurement of capacitance. Several methods may be employed. All involve the use of the "Grid Dipper" as an oscillator.

A small jig (Fig. 2) must be made, into which may be plugged any one of the "Grid Dipper" coils.

To check an unknown capacitor, it is then only necessary to clip the jig, with a coil inserted, across the unknown capacitance. Find the resonant frequency and refer to the calibration chart for value of capacitor with the coil employed. For over-all accuracy, it is best to employ one of the coils from the medium frequency range.

Due to the distributed capacitance of the coils, a slight error will be encountered at very low capacitance measurements. Likewise, due to self inductance of large capacitors, a small error will be found when measuring these. Errors will be negligible for most practical purposes.

Measurements of capacity of below 50 mmf are generally not obtainable because resonance at these values usually falls out of range of the coils left available for frequency checking. For measurements below 50 mmf an additional calibrated coil is required.

For these measurements, in a great number of cases, the capacitor need not be removed from the circuit in which it is wired unless the capacitor is heavily loaded.

Another method, similar to that above, is to employ a known inductance and find the resonant frequency with the unknown connected across it. See equation "B," Appendix 1 where f is the resonant frequency in cycles and L is the inductance in henries. Cx will be in farads.

A third method, for capacitors up to about 1000 mmf, requires an inductance which is shunted by a calibrated variable capacitor. The capacitor is set at maximum and the resonant frequency of the circuit is found. The unknown capacitor is then connected across the variable and the capacitance of the latter decreased to a point where the circuit resonates at the original frequency. The difference between the first and last settings of the calibrated variable capacitor is the value of the unknown.

Measurement of inductance of R-f Coils. Connect a capacitor of known value across the coil and use the "Grid Dipper" as a grid dip oscillator to find the resonant frequency of the resulting L/C combination. The inductance of the coil may be calculated from equation "C," Appendix 1 where Lx is in henries, C is known capacitor in farads; or reference may be made to an L/C-resonance chart.

In measuring small values of inductance, be sure to employ a low inductance standard condenser, connected to the unknown coil by wide ribbon, in order to obtain most accurate results. Due to the distributed capacitance, especially in large coils, some slight error will result; however, if the value of the low inductance known capacitor is fairly high, the error will be negligible.

Relative Q of capacitors or inductances at a given frequency may be noted by observing the character of the dip, as previously described.

Antennas. Use instrument as grid dip oscillator. Coupling should be made at a low impedance or high current point as shown in Fig. 1E. This point, for a half wave antenna, is at the center, and for longer wires is at points odd quarter wavelengths measured from either end. It will be observed that a full-wave antenna will not be a half-wave at exactly half its resonant frequency. This is because the end effects are found only at the antenna ends and will be absent at other points when the antenna is a full wave or more long. It is therefore always necessary to measure an antenna under the conditions desired (relating to physical and electrical length). Measurement should be made with the antenna placed as near as possible to its ultimate operating position. Checks on a given antenna at different heights or positions will show an amazing difference in antenna resonance.

If it is physically impossible to reach a low impedance point, a check may be made at a high-impedance or high-voltage point. Capacitive coupling should be used as shown at Fig. 1F. If the high impedance point involved is one of the ends, the end effect will be altered due to the presence of the instrument and the resonant frequency of the antenna will slightly decrease. This must be taken into consideration when making measurement, i.e., the reading indicated will be slightly lower than true antenna resonance (with "Grid Dipper" away from end). This difference will be about 1 to 3% and will be encountered only when checking at the ends.

In all cases it is helpful to keep in mind the physical length in feet vs. electrical length (half-wave, full-wave, etc.) as calculated approximately by formula. Unlike lumped resonant circuits, antenna harmonics are detected when using the "Grid Dipper." As previously mentioned, these harmonics will not occur at exact multiples of a half-wave.

When measurement is made, the feeders should be disconnected from the antennas. Unless the feeders happen to be perfectly matched or terminated, true antenna resonance will not be indicated because unmatched feeders or incorrectly terminated feeders will present either a positive or negative reactance and will, therefore, alter the electrical length of the antenna.

When the antenna element is of very large diameter, such as is often found in rotating beams, sufficient coupling to the "Grid Dipper" may not be obtained and some difficulty will be encountered in finding a reading. This condition may sometimes be relieved by jumping a foot or so of the antenna at the center with a small diameter wire and coupling to this wire.

If the antenna is to be normally used with its center open, close it with the shortest possible wire during measurement. This must be done also with the folded dipole. The short may later be removed, if required, when feeders are conncted.

Tuned or resonant feeders, such as used in the Zepp antenna. Use instrument as grid dip oscillator and check for desired resonance at the series or parallel tuned circuit on the transmitter end of the feeder. If resonance at the desired frequency is not obtainable, alterations may be made in the tuned circuit or the feeder length according to the actual resonant frequency found. Care must be exercised not to become confused by other resonance indications. It must be remembered that a Zepp is actually a long wire antenna partially doubled back on itself and resonances can therefore be noted at frequencies both higher and lower than the desired one.

Untuned or non-resonant feeders. After the antenna has been adjusted to the correct length, an untuned feed line may be connected employing some system of matching. Correct match may be obtained by making adjustment while employing an impedance bridge such as the Millen 90672 Antenna Bridge or a standing-wave-ratio bridge such as the Millen 90671 Standing Wave Ratio Bridge and using the "Grid Dipper" (set at antenna resonant frequency) as the signal generator.

The transmission bridge or the s-w-r meter should employ a meter of full scale sensitivity of 200 ua or less, for most accurate readings. Coupling to the "Grid Dipper" should be as loose as possible consistent with obtaining sufficient reading. If the coupling is too tight, the instrument frequency calibration may be slightly shifted.

The matching device should then be adjusted for as near unity standing-wave-ratio as possible. If a satisfactorily low standing-wave-ratio is unobtainable, it is due to either a fault in the matching system or due to a shift in antenna resonance. The latter may be checked by slightly varying the "Grid Dipper" frequency until a lower s-w-r is found or until a better s-w-r meter null is indicated. The frequency at this point will be that of antenna resonance. If necessary, the antenna length may then be changed until the correct standing-wave-ratio is realized at the desired frequency. It may also be necessary to trim up the adjustment of the matching system.

Tuning the parasitic beam. Use the instrument as grid dip oscillator and adjust driven element for resonance. The feeder should be disconnected and the parasitic elements should be set at their calculated correct length. If the driven element is open at the center, close it. After this element has been properly set, connect and match feeder as described in the foregoing paragraph (open antenna center if matching system so requires). The parasitic elements may then be adjusted using the "Grid Dipper" as the signal generator coupled to the feed line and by observing readings on a receiver (with an "S" meter) connected to a short antenna some distance away. Relative field readings in actual "S" units then may be obtained after each adjustment. As when matching feeder, coupling to the "Grid Dipper" should be as loose as possible. It is a good idea to occasionally check the actual frequency of the instrument on the receiver.

Following the tuning of the parasitic elements, the standing-wave-ratio should again be checked. It will, undoubtedly, increase, because tuning of the other elements will cause a change in antenna resonance. This will have to be altered accordingly, as described under "matching of non-resonant lines." Repetition of the preceding steps is advisable for putting on the finishing touches.

If the beam is located so that surrounding objects are likely to cause detuning as the beam is rotated (this may be checked during antenna and parasitic element tuning), it may be advisable to do the final retuning with the beam positioned either towards the direction in which it will be mostly used, or where the greatest degree of rotation has the least effect.

Needless to say, the transmitter may be used as the signal generator in place of the "Grid Dipper" during the above adjustments; however, the employment of the "Grid Dipper" for this purpose is more convenient, because the entire operation may be handled right on the roof by one person, or wherever the beam is located The use of the instrument also keeps the channel free from unnecessary QRM.

Quarter-wave shorted lines. Use as a grid dip oscillator and couple for open wire lines as at Fig. 1G, and for coaxial lines as at Fig. 1H. When trimming lines for correct length, fittings to be used eventually for connections should be installed on the end of the line. The approximate frequency of the line may be determined by rough calculation. Other resonant points can be found, however. These will be at three times the fundamental quarter-wave, where the line is then three-quarter waves long, or five times the fundamental quarter-wave, etc.

Quarter-wave open lines. For open-wire lines, connect a short at one end and measure as for quarter-wave shorted line. Due to the length of the short, the actual electrical length of the line (used as an open line) will be slightly in error depending on the line spacing. The closer the spacing, the smaller the error.

For coax lines, place short on line and measure as quarter-wave shorted line. The short should be as direct and short as possible from inner conductor to shield in order to avoid errors. Fittings should also be included. Remove the short after measurements are completed.

Half-wave shorted lines. For open-wire lines, couple at center as shown at Fig. II. For coax line, measure for quarter-wave shorted line at half the calculated or desired frequency.

Resonant frequency thus found must be then multiplied by 2 for a resulting half-wave shorted line.

Half-wave open lines. For open-wire lines, couple at center as shown at Fig. II. For coax line, short one end and measure for quarter-wave shorted line at half the calculated frequency. Resonant frequency thus found must be multiplied by 2 for the correct length of the line after short is removed; provided the short is made direct as mentioned above.

Check standing waves. Aside from employing the "Grid Dipper" as the signal generator in conjunction with a standing wave ratio meter, open-wire feed lines may be checked for the existence of standing waves by using the instrument as a diode detector. A flat line is indicated when the meter reading remains constant as the "probe" coil is moved along the line. Care must be used to maintain uniform distance or coupling between coil and line. Since the "Grid Dipper" coil is protected by an insulated sleeve, the coil form may be held against the line for maintaining uniform coupling.

This method is the same as that using a neon bulb, crystal detector or other similar device, but is much more sensitive because of improved electronic voltmeter indicating circuit.

Relative field-strength meter. Use the "Grid Dipper" as diode detector. Connect a short antenna to one of the coil posts through a 5-30 mmf capacitor. The instrument's frequency calibration will shift some, so the dial will have to be rotated for maximum reading of the received signal. Actual frequency calibration is unimportant for this purpose. Sensitivity of the "Grid Dipper" as a field-strength meter is not as great as that of some other devices, but it will, nevertheless, be helpful in many cases.

The "Grid Dipper" may be employed for a number of other measurements, principally when utilized as a signal generator. Its use as a grid dip oscillator will be quite obvious and self suggestive for measurement of many other types of equipment and circuits. The applications herein described are those which will be generally most useful.

IV. POWER SUPPLY

The 90662-A is supplied complete with its own internal power supply. The unit will operate on 105 to 125 volts at 50 to 60 cps. If it should become necessary to use the instrument where 115 volts 60 cps power is not readily available, it may be operated from an external d-c power supply capable of supplying 100 vd-c @ 2 ma d-c and 6.3 v @ 150 ma. a-c or d-c.

External power should be connected to the row of terminal posts located on the printed circuit board on the left hand side of the unit just in back of the plug button on the cover. The jumpers between the first and second posts and the fourth and fifth posts (counting from the coil socket end towards the meter) must be removed and the external supply put in their place. The "B" supply should be connected with the (+) terminal wired to post no. 5, and the (—) terminal wired to post no. 3. The "A" supply should be connected between posts no. 1 and no. 3. The "A" supply may be either a-c or d-c but the "B" supply must be d-c.

It is not necessary to disconnect batteries while not in use, though the practice is encouraged, as the function selector on the panel will switch the external power on and off in the same way in which it handled the internal power supply.

V. GROUND

The power cable on the 90662-A Industrial Grid Dip Meter is a three wire cable with a ground lead terminating in a third pin on the a-c plug. This is to insure that the chassis remains at ground potential to avoid the danger of serious shocks while working with the unit in the vicinity of high voltage.

VI. MAINTENANCE

The entire unit is built on a single frame, therefore the cover on three sides may be removed by simply removing the four screws on the bottom, and removing the plug button from the hole on the side.

Symptom:

1. Unit does not operate:

   — check that unit is connected to source of 117V ac or proper battery connections are made.

   — check that a coil is, in fact, plugged into the unit.

   — check for blown fuse. If open, do not replace until unit has been adequately checked for shorts in B+, heater or low voltage d-c supply circuits. Do not use fuse larger than 1½ amps.

2. Meter reads slightly but sensitivity control will not operate:

   — replace tube with another 9002 (if not available locally, may be obtained from James Millen Mfg. Co., Inc., at a nominal cost).

3. Meter cannot be made to read full-scale on extremes of "G" range:

   — normal condition, no cause for concern, if full scale can be obtained over only a small portion of "G" range, however, the trouble may very likely be due to a more serious problem, the solution of which may require re-calibration. If this type of trouble arises, the unit should be returned to the factory for repair and re-calibration.

4. Tone modulator not operating:

   — trouble is most likely due to difficulties in the low-voltage d-c supply. Check for supply voltage of less than —9 volts due to open filter condenser (C8) or defective rectifier. Also check that a-c voltage to rectifier is approximately 6V a-c rms.

5. Spurious dips:

   — With the exception of the "G" range, no dips should be present throughout the tuning range of the oscillator when the probe is not coupled to any external tuned circuit. Any trouble in this direction that cannot be cured by removing the dust from the variable condenser plates with a blast or two of air should result in the unit being returned to the factory for repair.

6. Meter does not indicate but tube lights and oscillations may be detected by ext. wavemeter or receiver:

   — a special case of no. 3. The cure is the same as that of no. 4.

7. Calibration incorrect:

   — Unit should be returned to factory for re-calibration with complete set of original coils if possible.

Factory Repair Work:

No equipment will be accepted for repair if permission to return equipment and/or a proper shipping label has not been obtained from the factory prior to shipment. Care should be taken to insure proper packing of unit when shipping to factory.

VII. LOW FREQUENCY USE

It will be noted that no calibration exists on the dial for frequencies below 1.7 Mc although coils are provided for use down to 220 Kc. In order to use these coils, a hand plotted calibration curve has been provided for the specific coils boxed with this grid dip meter. These coils and curves are intended for use with this unit only and should not be expected to hold their calibration when used with another unit. The numbers along the lower edge of the calibration curve refer to the logging scale on the bottom edge of the dial. The range of 220 Kc to 2.0 Mc has been broken up into 4 parts with large overlaps between parts.

VIII. TECHNICAL SUMMARY

Frequency Range:

RF: 220Kc—300Mc

AF: 800 cps (approximately)

Size:

7″ x 3$\frac{3}{16}$″ x 3⅜″

Power Requirements:

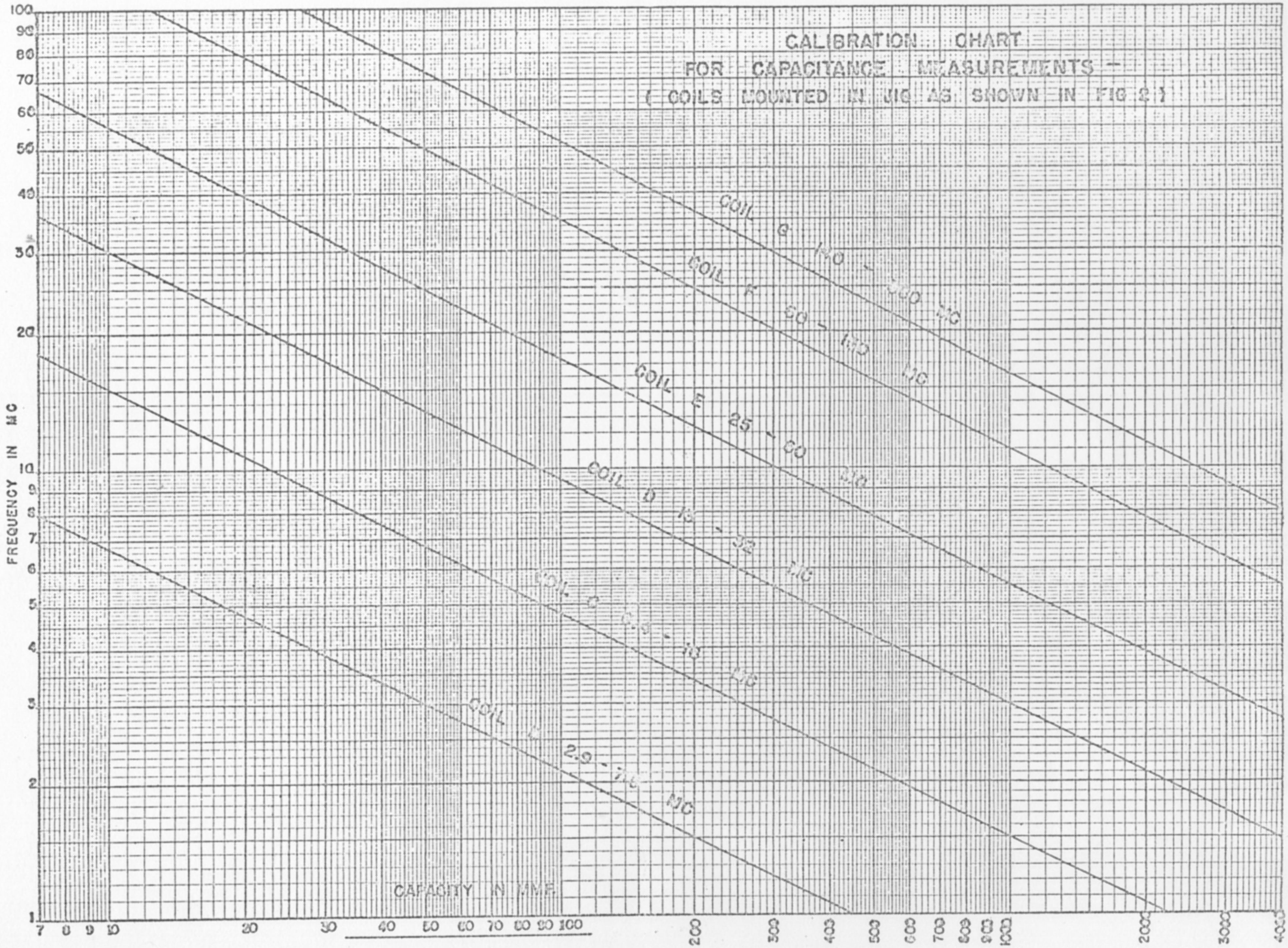
115V a-c rms ±10%, 60 cps

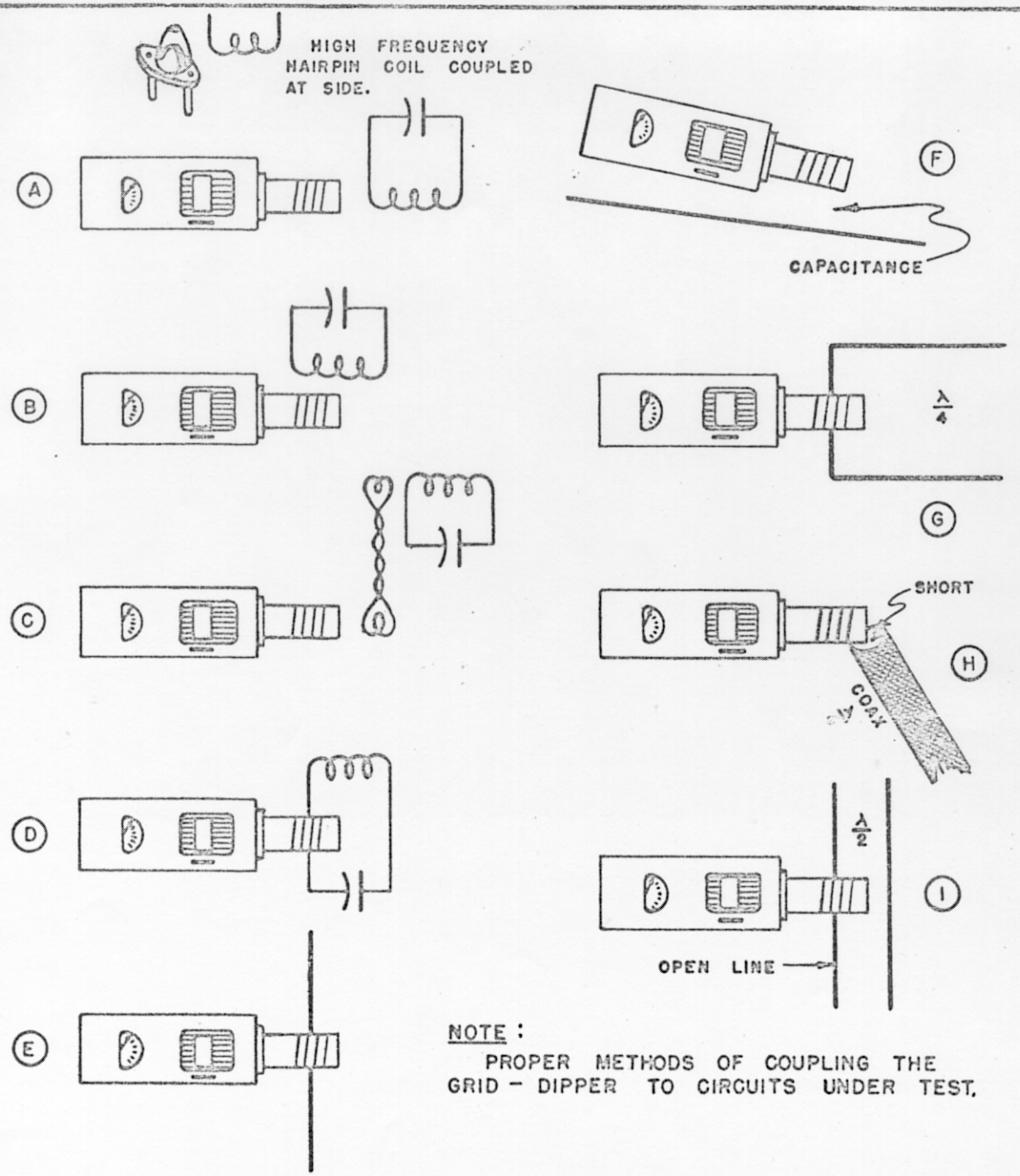
2½ watts

Weight:

3½ pounds

F. L. — 9 Feb. 62


CALIBRATION CHART
FOR CAPACITANCE MEASUREMENTS -
(COILS MOUNTED IN JIG AS SHOWN IN FIG 2)
COIL G
COIL F
COIL E 25 - 60 MC
COIL D 13 - 32 MC
COIL C
COIL B 2.9 -
FREQUENCY IN MC
CAPACITY IN MMF
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
7 8 9 10 20 30 40 50 60 70 80 90 100 200 300 400 500 600 700 800 900 1000 2000 3000 4000



NOTE :

PROPER METHODS OF COUPLING THE GRID - DIPPER TO CIRCUITS UNDER TEST.

ALL DIMENSIONS UNLESS OTHERWISE NOTED MUST BE HELD TO A TOLERANCE OF

FIG. (1)

FIRST MADE FOR

DESIGNED BY

DRAWN BY H. COTTERLY

CHECKED BY R.W.C.

APPROVED.

JAMES MILLEN MFG. CO., INC.
MALDEN, MASS., U.S.A.

K

DATE
5 - 3 - 49

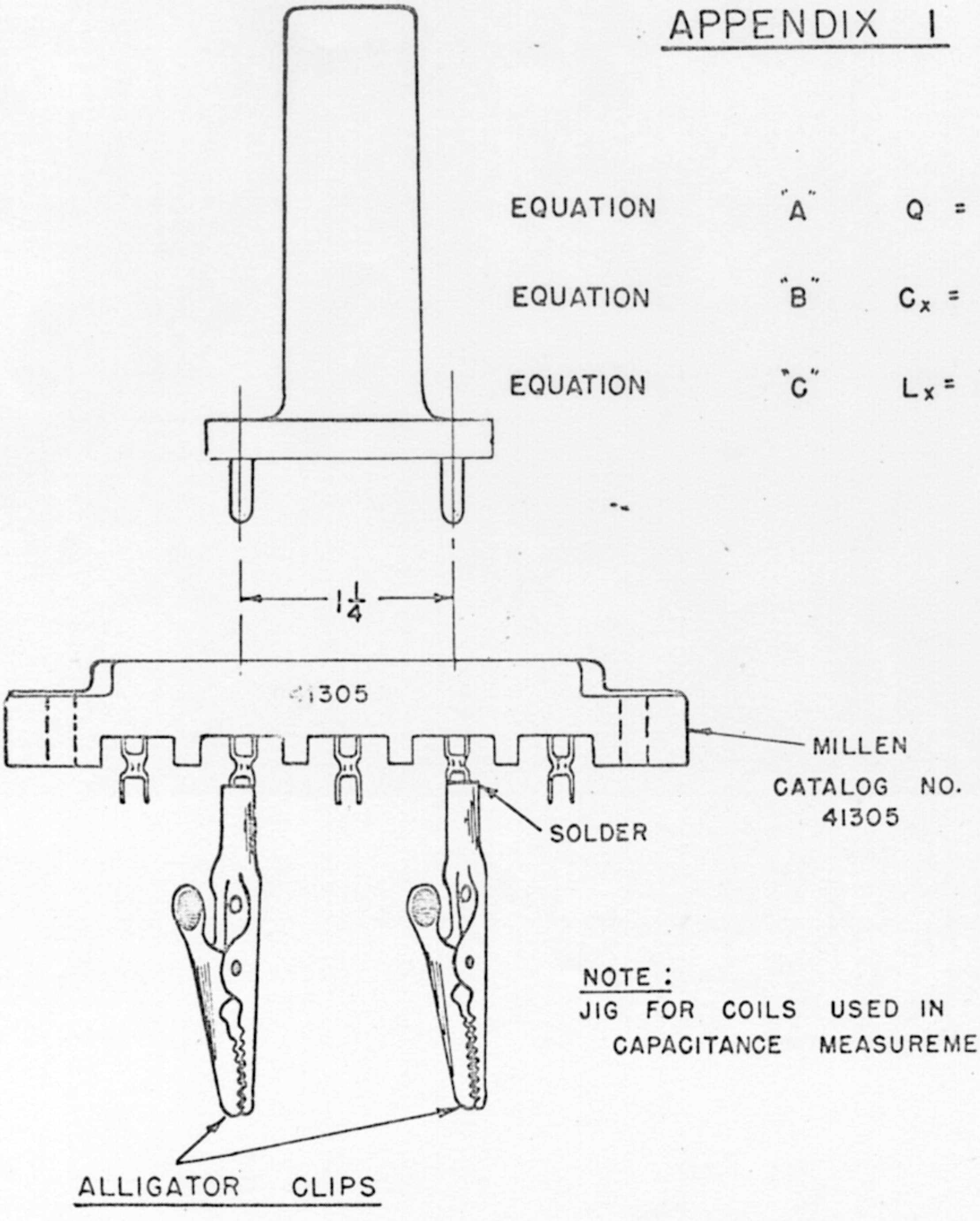
THIRD ANGLE PROJECTION

APPENDIX I

EQUATION "A" $Q = \frac{Fr}{\Delta F}$

EQUATION "B" $C_x = \frac{1}{4 \pi^2 F^2 L}$

EQUATION "C" $L_x = \frac{1}{4 \pi^2 F^2 C}$

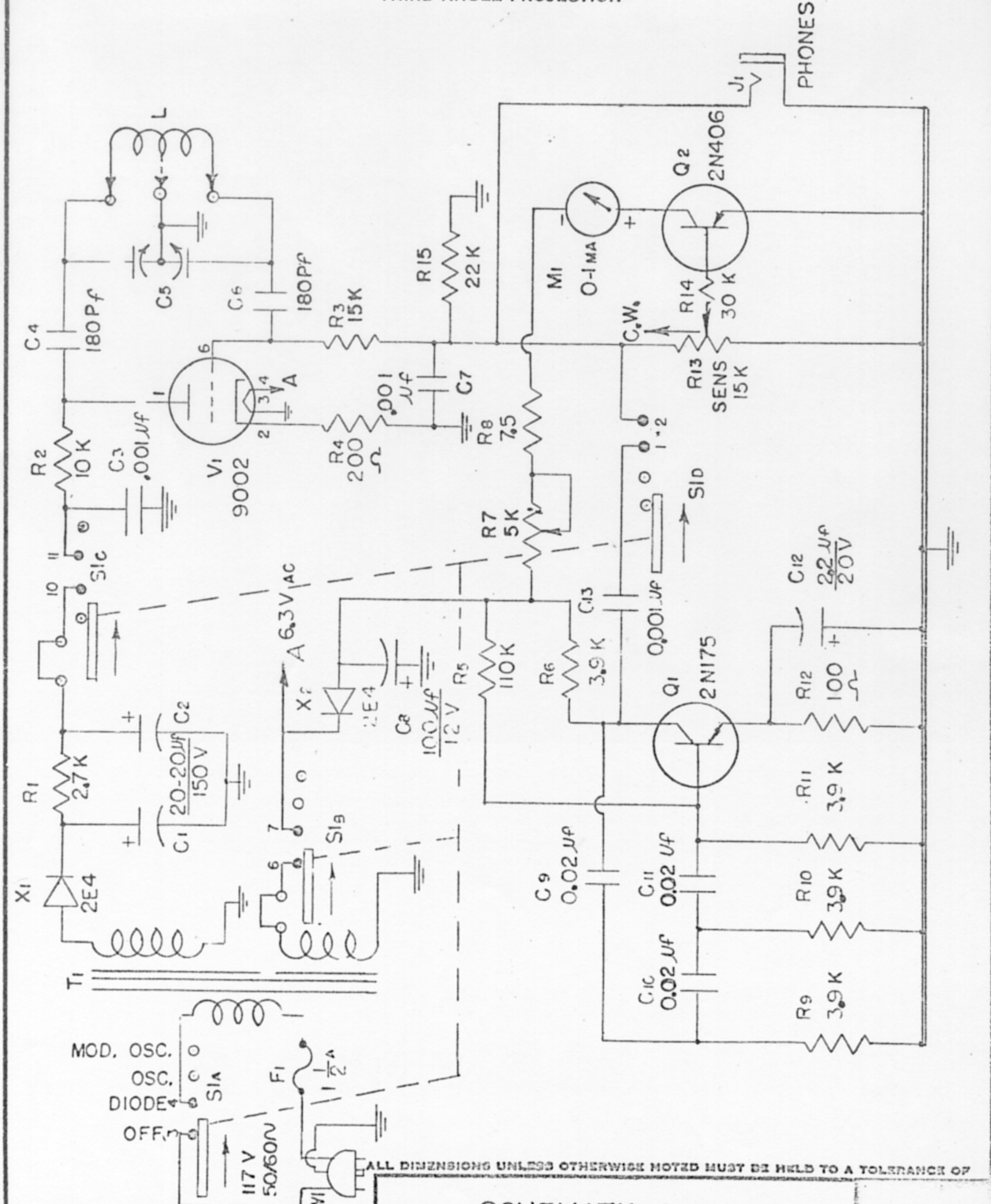


NOTE :
JIG FOR COILS USED IN CAPACITANCE MEASUREMENTS

ALL DIMENSIONS UNLESS OTHERWISE NOTED MUST BE HELD TO A TOLERANCE OF

FIG. (2) FIRST MADE FOR		
DESIGNED BY ____ DRAWN BY H. COTTERLY	CHECKED BY R.W.C. APPROVED ____	
JAMES MILLEN MFG. CO., INC. MALDEN, MASS., U.S.A.	K	DATE 5 - 3 - 49

THIRD ANGLE PROJECTION



ALL DIMENSIONS UNLESS OTHERWISE NOTED MUST BE HELD TO A TOLERANCE OF

SCHEMATIO DIAGRAM

FIRST MADE FOR

DESIGNED BY R. L.

CHECKED BY R. L.

DRAWN BY D. NICOLL

APPROVED R.W.C.

JAMES MILLEN MFG. CO., INC.
MALDEN, MASS., U.S.A.

K90662-A

DATE 10-4-61