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Some VHF Bridge Applications

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Recognizing the gap that inevitably exists between the basic information offered in the instruction manual and the inherent potentialities of the instrument involved, this article is written with the intent of sharing our knowledge of the RX Meter Type 250-A and offering the benefit of our field experience.

For those not having a speaking acquaintance with the RX meter, we might briefly mention that it consists of a V.H.F. Schering bridge, signal generator, and a detector - indicator completely self - contained in one unit which measures impedances from 500 KC to 250 MC in terms of equivalent parallel resistance and parallel capacitance (or inductance). It will be shown that with these basic elements and some understanding of the principles involved, the bridge lends itself to many applications not immediately obvious.

Measurement of Transistors, Vacuum Tubes, Diodes and Biased Circuits

The RX Type 250-A Meter by virtue of its design lends itself very conveniently to the measurement of circuits under conditions of normal bias and operating voltages. Since there is a d.c. path between the bridge terminals with a d.c. resistance in the order of 66 ohms, biasing currents up to 50 ma can be introduced through the bridge and the component in the manner shown in Figure 1. In using this particular circuit the capacitor C should be made large enough so as to have negligible reactance at the operating frequency. It is desirable to use a d.c. source having a much higher voltage than required, and reducing the voltage through resistor R. By keeping R high the effect of the D.C. supply source is minimized.

For measurements requiring biasing currents in excess of 50 ma the circuit shown as Figure 2 is suggested. In this arrangement the biasing current circumvents the bridge and therefore there are no restrictions imposed upon its magnitude. Here again it is desirable to keep C large enough to have negligible reactance. Since the purpose of the R.F. choke is to isolate the d.c. voltage source its inductance should be high. To preclude the possibility of any error due to the power supply, certain precautionary steps can be taken. Before attaching the test specimen, balance the instrument with the D.C. supply circuit connected. If the range of the balance controls is insufficient, balance the instrument by itself and measure the Cp and Rp of the D.C. supply circuit alone. The subsequent readings of the test specimen can then be corrected (for the effect of the D.C. supply circuit) as follows:

The Author off on an engineering field problem with the bridge.

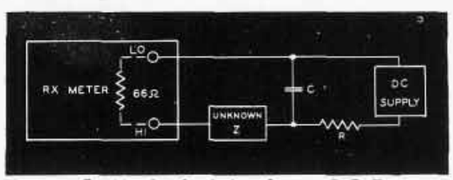

Figure 1. Method of Applying DC Biasing Current Less Than 50 ma.

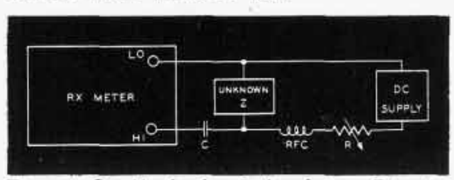

Figure 2. Method of Applying Biasing Current Greater Than 50 ma.

$$C_{px} = C_{xo} - C_o$$

where

$C_{px} = C_p$ of specimen

$C_{xo} = C_p$ of specimen & dc supply

$C_o = C_p$ of dc supply alone

$$R_{px} = \frac{R_o \times R_{ox}}{R_o - R_{ox}}$$

where

$R_{px} = R_p$ of specimen

$R_o = R_p$ of dc supply alone

$R_{ox} = R_p$ of dc supply & specimen

The basic circuits shown in Figures 1 & 2 can be modified or expanded as required to allow measurements to be made of the desired parameters in many types of circuits. Some typical arrangements are given in Figures 3 to 9. In Figures 3 (tube input impedance) and 4 (crystal diode impedance) it should be noted the ground shown by dotted line is the circuit ground and is not connected to the instrument ground. Figures 5 to 9, for which the author is indebted to the "Radio Development & Research Company" of Jersey City, New Jersey, are examples of some typical circuits employed in the measurement of transistors.

One factor that bears consideration in the measurement of vacuum tubes, transistors, and diodes is the level of the r.f. voltage applied to the component under test. With the RX Meter this is in the order of from 0.1 to 0.5 volts r.m.s. Should

YOU WILL FIND . . .

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the constants of the circuit be such that this level cannot be tolerated, the addition of a 2 watt, 50,000 ohm potentiometer, mounted in a louvre hole in the rear of the instrument and wired according to Figure 10 to reduce the oscillator B+ voltage, makes it possible to lower the applied r.f. voltage down to 0.02 volts with satisfactory sensitivity during the measurement.

Measurement of the Self-Resonant Frequency of a Coil

This procedure consists of finding the frequency at which the inductive and capacitive reactances of the coil are equal (and opposite), and the coil itself looks like a pure resistance. The logical way to do this would be to set the Cp dial equal to zero and vary the frequency to obtain a null on the indicating meter. However, since it is necessary on the RX Meter 250-A to peak the "detector tuning" when operating the instrument at the higher frequencies, the self-resonant frequency is found by making two or three rapid preliminary measurements, balancing the instrument, and obtaining the final value.

The actual modus operandi is as follows:

1. Set up the bridge in accordance with the preliminary instructions given in the instruction manual. For the first approximation select a frequency higher than the estimated self-resonant frequency.
2. Mount the coil on the instrument and measure it in a normal manner. If the Cp dial reads in the capacitive range, the frequency is too high and should be lowered for the next approximation. Conversely, if the Cp dial indicates an inductance the frequency should be increased. The frequency change necessitated can be sensed from the effect on the Cp dial reading of the previous change.
3. When the Cp dial reads within 1 or 2 mmfds of the zero line, remove the coil and balance the bridge before making the final reading.

It should be noted that while some manipulation of the Rp dial and some adjustment of the "detector tuning" knob might be needed in making the rough approximations, it is necessary to adjust the initial balance of the bridge *only* for the final measurement.

With those coils having multiple resonances, the alternate parallel and series

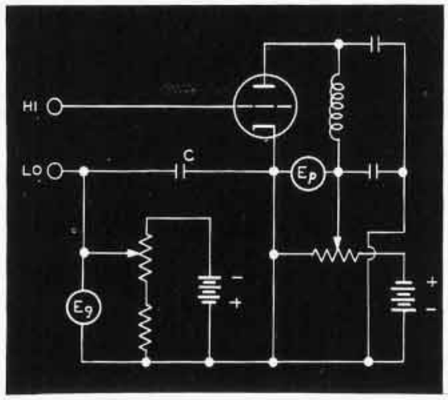

Figure 3. Typical Circuit for Measuring Vacuum Tube Input Impedance on RX Meter.

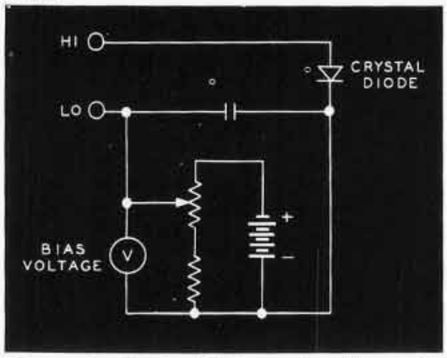

Figure 4. Typical Circut for Measuring Crystal Diodes on RX Meter.

points can be identified by the accompanying respective high or low values of parallel resistance indicated on the Rp dial. The lowest parallel self-resonant frequency is the one used in the determination of distributed capacity discussed below.

Measurement of the Distributed Capacitance (Cd) of a Coil

To consider an old friend very briefly, the expression for the resonant frequency of a series tuned circuit is:

$$f = \frac{1}{2\pi\sqrt{LC}} . \quad (1)$$

This same relationship obtains with a parallel tuned circuit, for all practical purposes, if the Q is ten or greater. For the purpose of our discussion we shall consider coils falling in this category.

Referring to (1) above, if the inductance is held constant but the capacitance changed to a new value, C_2, then:

$$\frac{f_1}{f_2} = \frac{\frac{1}{2\pi\sqrt{LC_1}}}{\frac{1}{2\pi\sqrt{LC_2}}} ,$$

or

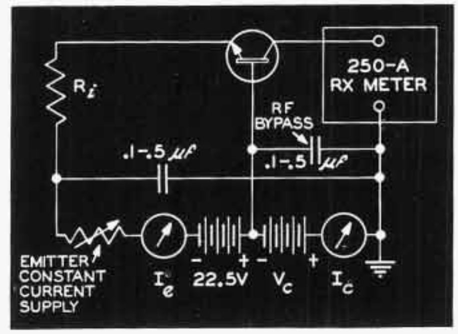

Figure 5. Collector Characteristics -- Grounded Base Tetrode.

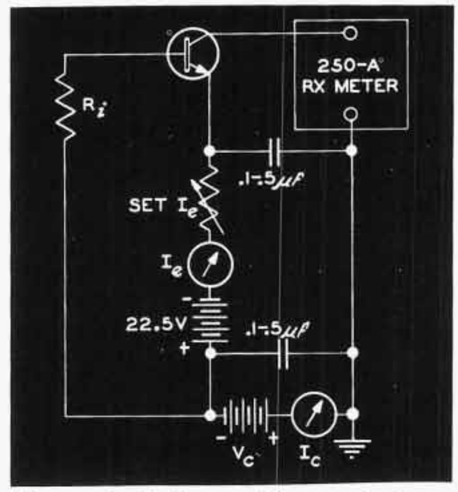

Figure 6. Collector Characteristics - - Grounded Emitter Triode.

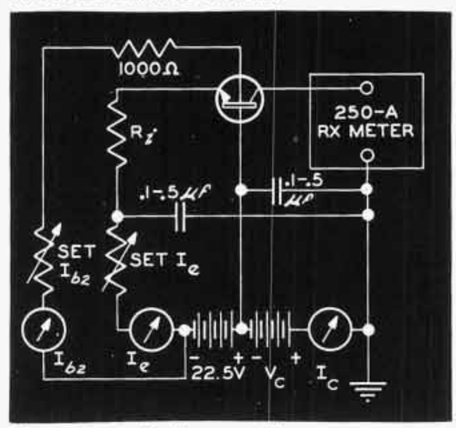

Figure 7. Collector Characteristics - - Grounded Base Tetrode.

$$\frac{f_1}{f_2} = \frac{\sqrt{C_2}}{\sqrt{C_1}} \quad \text{and}$$

$$\frac{C_2}{C_1} = \left(\frac{f_1}{f_2}\right)^2 \quad (2)$$

If, in the case of a coil, f_1 is the self-resonant frequency of f_o, and C_1 is the distributed capacity of the coil, C_d, the relationship then becomes,

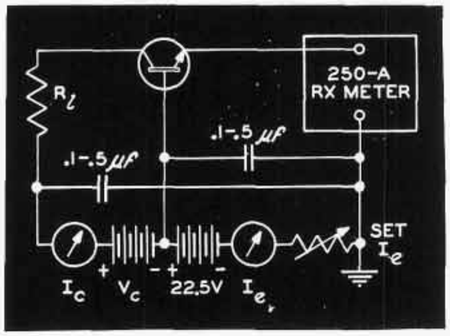

Figure 8. Emitter Characteristics Grounded Base Triode.

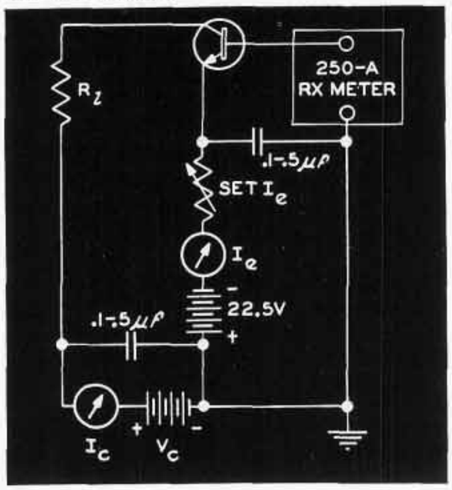

Figure 9. Emitter Characteristics -- Grounded Emitter Triode.

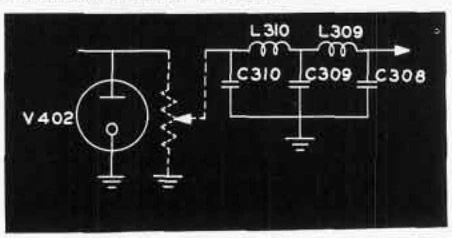

Figure 10A. Terminal Voltage Reduction-Circuit Alteration.

$$\frac{C_2}{C_d} = \left(\frac{f_o}{f_2}\right)^2, \qquad (3)$$

and if frequency f_2 is made equal to 70.7% of f_o,

$$\frac{C_2}{C_d} = \left(\frac{f_o}{.707\,f_o}\right)^2 = 2\,. \qquad (4)$$

For the purpose of our discussion this can be written

$$\frac{C_d + C_p}{C_d} = 2 \text{ and} \qquad (5)$$

$$C_d = C_p\,. \qquad (6)$$

Where Cp is the amount of capacity needed in addition to the C_d of the coil to resonate the coil at a frequency equal to 0.707 times its self-resonant frequency. This value is equal to the C_d of the coil and is read directly off the silver portion of the C_p dial on the RX meter when the bridge is balanced.

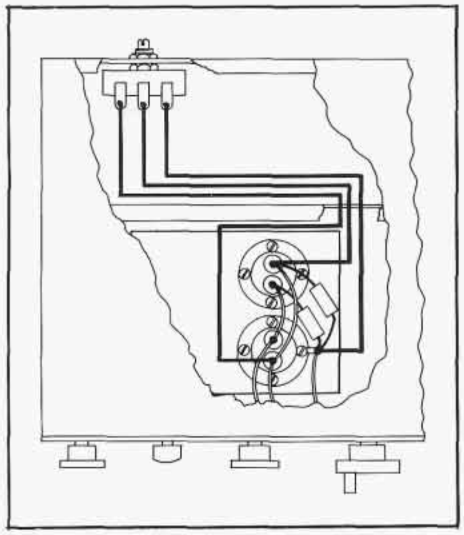

Figure. 10B. Diagram of Circuit Alteration.

Thus to measure the C_d of a coil on the RX Meter it is only necessary to determine its self-resonant frequency, set the bridge at 0.707 times this frequency, and measure the C_d directly on the C_p dial.

Measurement of Tuned Circuits

Very often it is necessary to measure the R_p or Q of a tuned circuit at its resonant frequency. Since under these conditions the circuit is essentially resistive, it merely necessitates operating the RX Meter at the resonant frequency, verifying the resonant condition by insuring the C_p dial reads zero, and reading the dynamic resistance directly off the R_p dial. Conversely, the RX Meter can be set at the desired frequency and the tuned circuit adjusted for resonance as evidenced by a null on the indicating meter. Having the R_p and being able to measure or compute either reactance, the Q of the tuned circuit can be determined from the relationship, $Q = R_p/X_p$.

By setting the RX Meter 250-A to the desired frequency, and the R_p and C_p dials to the required values, the instrument adapts itself to the tuning of pi-coupled matching networks used on transmitters and to the adjustment of line terminations, equalizers, and filters.

Extension of Ranges

The RX Meter 250-A has a parallel resistance range of 15 to 100,000 ohms and a parallel capacitance range from +20 mmfd to —100 mmfd. The negative symbol denotes an inductance and the quantity is the amount of capacitance required to resonate it. These ranges can be extended by the following means which are described for the particular extension desired.

A. Manner of Extending Capacitance Range

Referring to Figure 11, which is a graphical representation of the Cp dial on the RX Meter 250-A, it can be seen that when the dial is set at the zero point, for the purpose of obtaining the initial balance, there actually is a net capacity of 40 mmfd across the terminals. Regardless of what measurement is being made, it is always necessary to have this net capacity of 40 mmfd for the bridge to balance; whether it is obtained by setting the Cp dial to zero, or setting it at +20 mmfd as would be done when actually measuring a capacity in this order, or measuring an L/C combination exhibiting a net capacity of 40 mmfd is of no consequence. As long as this net amount is present, the bridge will balance.

Therefore, to extend the range of capacitance measurement—say to something greater than 20 mmfd but not over 120—it is only necessary to add a coil during the initial balance that will cause the bridge to balance with the C_p dial at —100 mmfd instead of at zero. For a balance point at —100 mmfd, this coil would have the amount of inductance necessary to resonate with 100 mmfd at the chosen frequency. Using the —100 mmfd value as the reference point in this manner, and leaving the coil intact during the measurement, the capacity range now is from —100 to +20 mmfd—or a total of 120 mmfd. The inductance of the coil does not have to be known and the reference balance can be established at any desired point from zero to —100. This allows quite a latitude in the selection of the coil. There are no restrictions imposed upon the coil with respect to Q, since if the latter is not sufficiently high the equivalent R_p of the coil itself can be read in the initial balance, and proper allowances made for it. From experience it has been found that in most cases any reasonable hand-formed coil will suffice without requiring corrections.

Referring once again to Figure 11, it can be seen that by using a smaller coil B and adding a 100 mmfd. capacitor externally across the bridge binding posts to be used in conjunction with the 100 mmfds on the Cp dial, it is possible to displace the original balance by 200 mmfd, and in this manner increase the capacitance range to 220 mmfd. The capacitance measurement thus becomes essentially one of substitution, since after the unknown is added to the terminals, balance is sought by removing capacity on the Cp dial, 0.1 mmfd at a time. If the measurement of the unknown is not made by the time the C_p dial reaches the +20 point, the 100 mmfd capacitor used for extending the range is removed, the Cp dial returned to —100 and the process repeated until balance is obtained. *In this way although the range-extending capacity is added in an increment of 100 mmfd, it is removed by using the Cp dial in increments of 0.1 mmfd.* In a like manner, other 100 mmfd capacitors, in conjunction with smaller coils, can be used to extend the range of capacitance measurement still further. A variable pre-

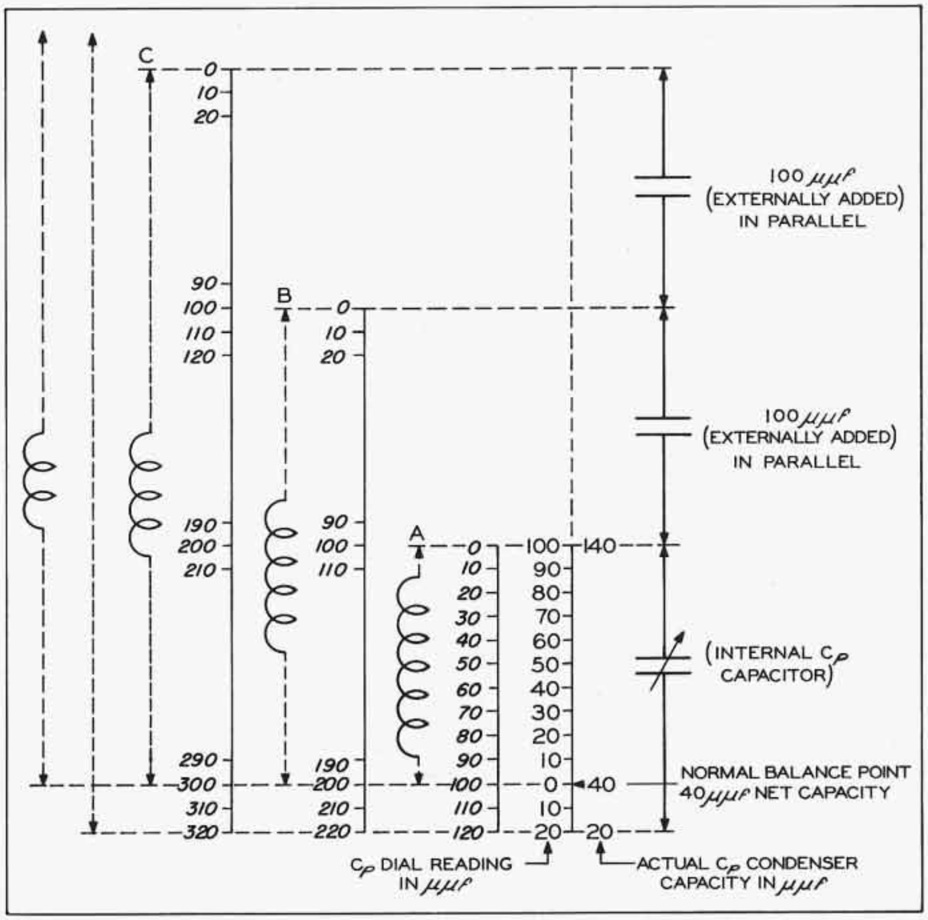

Figure 11. Graphic Illustration of Manner of Extending Capacitive Range of RX Meter 250-A

cision capacitor is a very convenient device in these extensions since it increases the inductance latitude of the coils used for the extension. In all cases the value of capacity employed must be known since it is part of the calibration.

Since the bridge has an inherent residual inductance of 0.003 microhenries (in series with the impedance being measured), the following restrictions are imposed to prevent the residual inductance from becoming a sizeable portion of the reading:

1. Do not use auxiliary coils having less than 0.1 uh inductance.
2. If necessary to use a coil of less than 0.6 uh it must be adjusted to a reactance value within ±20% of the capacitance reactance under test and the following correction formula applied to the RX Meter readings:

$$\text{True Cap} = \Delta C \left(1 + \frac{.003}{L}\right)$$

Where:
C = Difference reading when test is connected in uuf
L = Auxiliary inductance in uh

3. The above limitations and corrections apply only when the junction between test capacitor and auxiliary coil is directly under the knurled binding post nuts.

For those cases where the frequency of operation does not allow the size of the coil used to conform to the above, it is possible to correct for the residual inductance as follows:

$$\text{True } C_p \text{ dial reading} = C_p' \left(\frac{1}{\omega^2 L_1 C_p' - 1} \right)$$

Where C_p' = Capacity as read on the C_p dial

$$\omega^2 = 4 \pi^2 f^2$$

$$L_1 = 0.003 \text{ microhenries}$$

Correcting the dial reading as shown above for the Cp readings with and without the addition of the capacitance under test will make the required allowances for the residual inductance and the capacitance range can be extended in the normal manner. Care must be exercised with respect to minimizing lead lengths, placing components, etc.

Manner of Extending the Inductance Range

For the measurement of the inductance of coils requiring more than the 100 mmfds. available in the 250-A RX Meter to resonate them at the operating frequency, additional known capacity can be added in parallel to the coil to obtain balance. The inductance of the coil would then be

$$L = \frac{1}{\omega^2 (C_p \text{ dial rdg} + \text{ext. } C)}$$

or the reactance

$$X_L = \frac{1}{\omega (C_p \text{ dial rdg} + \text{ext. } C)}$$

In the above, external capacity is considered as having a negative sign as has Cp in this case. It has been found the range of measurement can be extended to include much smaller value of inductance by using an auxiliary resistor, connected in series with the "high" side of the coil. In this manner the overall Q is reduced which in turn allows smaller values of resonating capacitances in accordance with the relationship,

$$L_S = \frac{C_p R_p^2}{1 + Q^2}$$

The value of the auxiliary resistor, which is not critical, depends upon the inductance to be measured and some idea of the required value can be obtained from the following table.

INDUCTANCE RANGE (Microhenries)	REQUIRED RESISTOR (Ohms)
10 to 1000	1000
1 to 10	300
0.1 to 1	100
0.001 to 0.1	33

The value and accuracy of the auxiliary resistor is not critical and need only be of the correct order. The following procedure is suggested for such measurements:

a. Connect the unknown inductance in series with the auxiliary resistor across the RX Meter binding post. Using a minimum length of heavy, conducting strap, short the terminals of the inductance to remove it temporarily from the circuit.

b. Balance the bridge circuit and note the values of C_{p1} obtained for the series resistor alone.

c. Remove the shorting strap from the inductive component, restoring the latter to the circuit, and rebalance the bridge. Note the values of R_{p2} and C_{p2} for the series combination. Then the unknown inductance is obtained by

$$L_S = \Delta C \, (R_{p2})^2$$

$$\text{where } \Delta C = C_{p1} - C_{p2}$$

It should be noted that the inductance is shorted out rather than removed to avoid alteration of the physical configuration of the components which might otherwise affect the results. In dealing with extremely small inductance values, the inductance of the shorting strap itself will become significant and must be considered in interpreting the results.

Extension of the Rp Dial Below 15 Ohms

In dealing with low Q devices it is sometimes desirable to be able to measure resistance values below 15 ohms which is the lower limit of the direct-reading Rp scale.

At higher frequencies (in the neighborhood of 200 mc and above) the residual inductance of most components having series resistance values below 15 ohms such as low-value resistors, may be sufficient to increase the equivalent parallel resistance value above 15 ohms so that it may be measured directly. If not, a small inductance (having negligible series resistance) connected in series with the unknown will be sufficient to increase the Rp of the combination to the range of direct measurement.

At lower frequencies, the Rp of the unknown may be effectively increased for measurement by adding in series a small auxiliary resistor having a value preferably between 15 and 25 ohms. The series combination is measured and the values R_{p1} and C_{p1} are noted. The auxiliary resistor is then measured alone to obtain R_{p2} and C_{p2}.

Then

$$R_S = R_{S1} - R_{S2} \quad \text{and}$$

$$L_S = L_{S1} - L_{S2}$$

Series resistance in each case would be

$$R_S = \frac{R_p}{1 + Q^2} .$$

C_{p1} and C_{p2} can be changed to their respective values of inductance L_{s1} and L_{s2} in accordance with

$$L_S = \frac{C_p R_p^2}{1 + Q^2} .$$

Conclusion

The foregoing discussion has not been presented in an effort to define the limits of the bridge, but rather to give some indication of its application in regions not readily apparent. As with any tool its ultimate potentialities are dependent upon the skill and ingenuity of the person using it.

THE AUTHOR

Norman L. Riemenschneider has been intensively engaged in field work on customers' problems and special applications of Boonton Radio Corporation's equipment since his association with the Company. His background includes eight years with Western Electric in various engineering capacities, and substantial experience in allied fields with other engineering firms. Mr. Riemenschneider was graduated from the evening section of the Newark College of Engineering with a B.S. in E.E. and is a member of the IRE. He is also very active in Amateur Radio circles.

MECHANICAL DESIGN REQUIREMENTS OF ELECTRONIC INSTRUMENTS

DAVID S. WAHLBERG, *Mechanical Design Engineer*

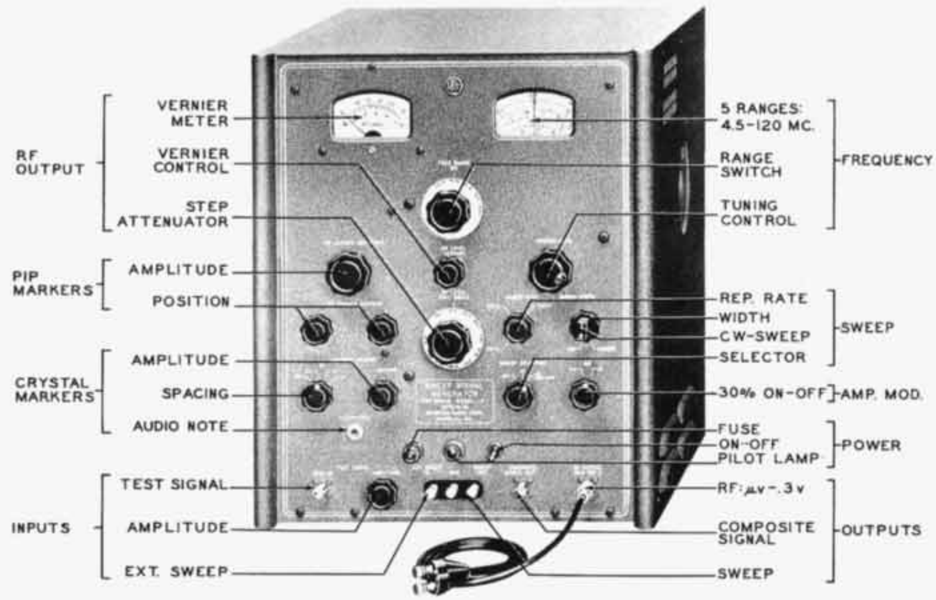

Figure 1. The Front Panel of the BRC Sweep Signal Generator Type, Type 240-A illustrates the final solution of a mechanical design problem involving mechanical placement, electronic function, nomenclature and esthetic factors.

One of the most interesting and challenging phases in the design of an electronic instrument is that concerned with converting a set of specifications and a breadboard model into a practical, economical and useful product. It is at this stage of the endeavor that many of the problems become mechanical in nature.

The Mechanical Designer's Problem

From the moment the mechanical design of an instrument begins, a myriad of other considerations arise to confront what might otherwise seem a straightforward piece of electronic equipment. The mechanical designer must consider the electronic requirements of the Development and Project engineers, the functional and saleable appearance, weight and price insisted upon by Sales, and the mechanical urgencies of simple, rigid designs and drives using the proper materials. In addition the Shop must be allowed reasonable tolerances within the limitations of available processes and equipment, Assembly should have units adapted to smooth work flow, and Inspection (and the user!) needs easy, accessible adjustments. Among many other factors are Purchasing's and Accounting's hopes that standard parts will be used, and Shipping's plea for enough unobstructed cabinet area to allow proper bracing in the packaging.

Thus, as those in industry know, any design comes about as the result of many compromises, all measured against the ultimate goal.

The Front Panel

Almost always, one of the first operations in the design program is the preparation of a front panel layout. However, this drawing also usually turns out to be the last one finished. A typical instance is the Sweep Signal Generator Type 240 A panel of Figure (2). The final symmetrical and functional grouping of the controls was arrived at after eleven distinct drawing revisions. Included were several major and many more minor changes, each one the result of discussion and action as the various problems of mechanical placement, electronic function, and clear titling were solved. As the give-and-take proceeds between esthetic and functional requirements versus circuit and control mechanism considerations, the front panel layout also starts to include the influences of framework and cabinet design.

The Heat Dissipation Problem

At this point the need for ventilation must be reckoned with. Close-accuracy instruments usually require heavy duty, constant voltage power supplies with much attendant heat. Therefore, such a power supply is usually separated from other

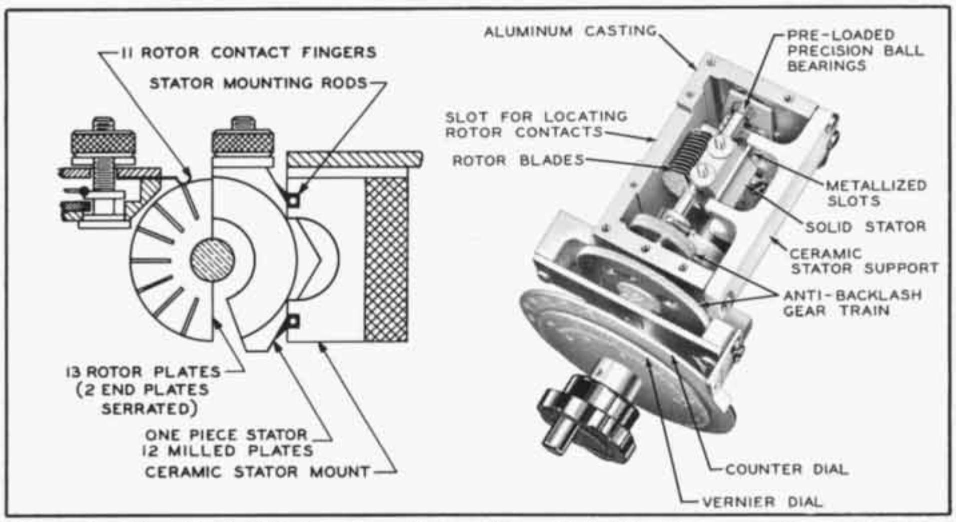

Figure 2. The 190-A Q Unit solves the problem of rigidity, low capacitance and constant inductance.

circuits as far as possible, either physically or by shielding, since it is the largest single source of heat. Once the power supply and other elements are located, and an estimate made of the heat to be dissipated, the ventilation paths and louvers are roughed out. Although most heat is carried off by convection if possible, the complete electrical shielding often needed around RF circuits prevent this. In these cases, heat must be conducted away by providing shields or heavy conductors leading to a large heat sink. Radiant heat is also a factor under these conditions. Bright metal shields can serve to "bottle up" a good deal of heat energy, whereas proper treatment of the surfaces will cause them to absorb and help dissipate heat. Final word as to the adequacy of the cooling provided in an instrument usually awaits the completion of final temperature runs on the prototypes. Convection currents occasionally cause uneven heating of critical components, and such problems must be resolved by baffles or circuit adjustments before the design is completely "frozen"

Dealing with RF Leakage

The means of preventing RF leakage have a major influence in dictating the overall design layout. All circuits carrying heavy RF currents must be carefully bottled up with leakage paths kept to a minimum. Control shaft holes particularly must be bridged by efficient shorting devices. The shafting necessary to operate an RF unit may often be just the right length to perform as an antenna at UHF frequencies. Gaskets or other sealing means are necessary to seal all covers and all elements projecting into an RF field.

RF leakage often does not rear its ugly head until near the end of a design project. As the final tests are being run several instruments may pass well within the limits, only to be followed by another seemingly incurable "leaker". This may need only a slight increase in contact pressure at a crucial point for a cure. But occasionally the mechanical designer finds to his chagrin that a scarely measurable amount of RF has found a configuration of supports and surfaces that needs only a little RF energy to prove itself a resonant circuit of inductance and capacitance. Last minute changes are then in order to tie down this last loose end.

The Need for Rigidity

Mechanical rigidity is a necessity in any accurate tool and is, in fact, often a measure of the accuracy attainable. A brief description of the Rp dial drive of the RX Meter Type 250-A will underline the reasons for the massive structures occasionally required in an electronic instrument. One arm of the 250-A bridge network is adjusted by means of a small variable capacitor, C2, to which is geared the Rp dial, measuring parallel resistance. Although the capacitance range is only about 18 mmf, the dial scale length is expanded to about 28 inches with the graduations spread out approximately logarithmically. Therefore, at the end of the dial indicating infinite resistance, where the capacitance is near maximum, the increments must be extremely small.

This effect is achieved by a special shape of the rotor plates, but the practical realization of such small increases in capacity depends largely on the accuracy and rigidity of the framework and drive. In the 250-A these requirements are met by supporting the rotor on preloaded ball bearings carried in a massive housing. Antibacklash gears are of course a necessity and the entire system is mounted in a rigid casting.These provisions make the rotor capable of resisting any deflection except the deliberate rotational movements needed in adjusting capacity. At the 500K ohm point on the dial, where the capacitance stability must be of the order of 0.025%, an extraneous rotor movement as small as 0.0001 inch will result in inaccuracies beyond the specification limits.

The internal resonating capacitor might well be called the heart of the Q-Meter, and is an excellent example of the interdependence of mechanical and electrical design. Taking the 190-A Q unit as an example, the electronic requirements are low minimum capacitance, together with low and constant values of inductance and resistance all of which are difficult to attain in conventional designs. Mechanically the design must be extremely rigid to assure constant and accurate re-setability. The massive structure ordinarily needed to attain the last-named end is in direct opposition to the minimum capacity requirement.

Reference to Figure (2) will show how satisfactory solutions were found for those conflicting needs.

The stator is mounted by means of two rods soldered into the metallized slots of a high quality ceramic support. Insofar as possible it floats in air dielectric. In addition, the rotor travel is restricted to less than 180°, with the included angle of the stator reduced by a proportionate amount to result in the largest possible angular gap between the two at the minimum setting. By these means the capacity at minimum was limited to the lowest value compatable with sufficient mechanical strength.

Low and constant inductance between the stator plates is achieved by milling out a solid bar to leave only the outer shell and the plates, solidly connected with each other along their entire peripheries. A secondary result of this method is the "built-in" shielding the shell provides from extraneous fields.

The tandem edge wipers, contacting all the rotor blades in parallel, serve to reduce the associated inductance and resistance to a very low and nearly constant value and are rhodium plated to provide good wearing qualities.

Where other considerations do not enter, rigidity is attained in the complete unit by mounting all the parts on a rigid cast frame. All shafts are carried on preloaded ball bearings.

Conclusion

It is hoped that this brief description of instrument building from the mechanical point of view has shown how absorbing this part of the design effort can be, and that it is not separate unto itself but as much a part of the program as is the electronic design. Nevertheless a Mechanical Design Department would be something less than truthful for not admitting to the occasional feeling that it was also the focal point of almost everyone's problems. However, closer to the general truth is the plain fact that the Mechanical Designer has need for and receives much help from many people in the course of a design. A well-designed electronic instrument is the result of the co-operative teamwork of all those concerned with its inception, design and manufacture.

SERVICE NOTES FOR THE RX METER TYPE 250-A

BRUNO BARTH, *Inspection Department Foreman*

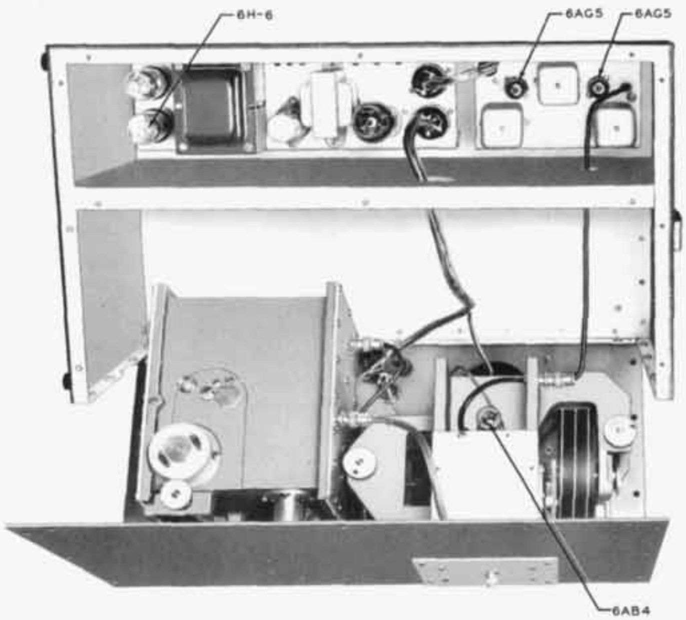

Figure 1. RX Meter showing location of Mixer, Ballast, and I.F. Amplifier tubes.

Operational problems with the RX Meter often can be traced to one of two sources:

Problem No. 1 concerns the mixer tube 6AB4.

Problem No. 2 concerns the ballast tube 6H-6.

Both problems are easily identified and corrected in the field. In most cases less time is needed to make the necessary repair than going through the formality of having a repair order issued!

Symptoms of a noisy 6AB4 mixer tube:

1. Difficult to balance the Rp dial.
2. Impossible to balance above 100 MC.
3. Insufficient range of fine and coarse balance controls.
4. Instability of the null indicator.
5. Increased null reading.

A quick check of the 6AB4 mixer tube is to tune the oscillator for maximum reading on the null indicator meter with the bridge unbalanced. Balance for minimum indication of null indicator. The reading may be 1 to 3 divisions or so. Switch the range switch out of detent. This will disable the oscillator.

If the needle does not fall to zero the 6AB4 is noisy. The amount indicated will reduce the sensitivity and accuracy of the Rp dial accordingly. The mixer tube 6AB4 is found in the bottom rear of the bridge casting which contains the Cp dial assembly. (See Figure 1.) It is advisable to use the same brand tube as found in the instrument and it may also be necessary to try several tubes before satisfactory results are obtained. The company supplies a specially selected 6AB4 tube, BRC #301637.

Incidentally, an increased null reading can also be caused by one or both 6AG5 tubes in the I.F. amplifier—V201 and V202—trying a few tubes and checking the null indication will tell the story.

Be sure to turn the instrument off when changing the I.F. tubes. V201 is in the regulated filament supply. Removal of this tube in operation will overload the 6H-6 ballast tube and also the two oscillator tubes.

Mention of the 6H-6 ballast tube recalls to mind that some instruments were returned for repair because someone replaced the 6H-6 with a 6H6 tube. In all cases replacement of the 6H6 with a 6H-6 was all that was necessary to put the RX Meter back in operation.

Symptoms of a faulty 6H-6 ballast tube are:

1. Oscillator ranges 6-7-8 intermittent or inoperative.
2. Oscillator output low as indicated by the peak reading of less than 30 or 35 on the null indicator.
3. Oscillator output will decrease at the low frequency end of the higher ranges.
4. Visual—any noticable kink in the 6H-6 filament.
5. Oscillator is completely inoperative.

To check voltages use voltage check points of figure (2) below.

Removal from Cabinet: The bridge and oscillator assemblies of the instrument are permanently fastened to the front panel and are removed from the cabinet as a unit. The power supply and amplifier are constructed on a separate chassis, located end-to-end in the rear section of the cabinet and fastened to the bottom of the cabinet by four screws each. All four major sub-assemblies are interconnected by cables with removable plugs.

A large portion of any required maintenance, such as replacement of tubes, may be accomplished by removing the front panel (with bridge and oscillator) and top panel together. This may be done as follows:

1. Remove all 12 black Phillips screws from the top panel. (Do not remove or loosen any of the screws on the terminal plate.)
2. Remove the four Phillips screws from each side of the front panel and the three from along the bottom edge.
3. The top and front panels may now be tilted forward from the cabinet to provide access to the interior of the instrument. If it is desired to remove them entirely, the plug connections on the internal cables to the power supply and amplifier must first be disconnected.

Be sure to replace at least two screws to fasten top panel and two screws to fasten front panel when rechecking operation of instrument after insertion of any new tube.

Two years have gone by since our first delivery of RX Meters. It is about time for some of the older instruments to develop the above symptoms, as the tubes by this time have weakened.

It is hoped that the above information may serve to cut down costly repair and shipping charges. The loss of time and valued use of the RX Meter 250-A in production and in projects is well recognized.

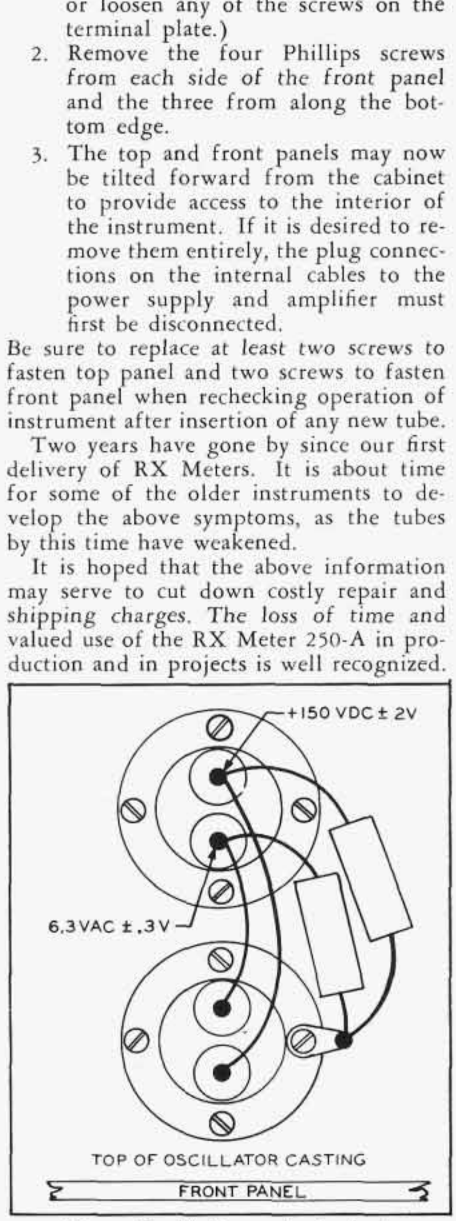

Figure 2. Voltage check chart

EDITOR'S NOTE

Due to a mechanical error Fig.2 and Fig.3 in the previous issue (Spring, 1955) were interchanged. Also, the text in the caption at the foot of column 1 on page 7 should read: "... was produced by the **known** *low level output of the RF Voltage Standard." We shall try to avoid a repetition of this situation in the future.*

Q METER AWARD

Dr. G. A. Downsbrough, President and General Manager of Boonton Radio Corporation, is shown above reviewing the card which he has just drawn to determine the winner of the Q Meter also shown in the picture. This Q Meter, displayed at our booth in the IRE Exhibits at Kingsbridge Armory in March, was to be awarded to one of our guests who completed a registration card at the booth.

The winning card was drawn from several thousand cards completed by our friends at the show and was signed by Mr. Waldemar Horizny, Technical Supervisor and Assistant Director of the Home Study Department, of RCA Institutes, Inc., of New York City. Mr. Horizny was born in Detroit, Michigan in 1921 and was awarded a BA degree from New York University in 1943. For a good number of years, he has been employed by RCA Institutes, Inc., a Service Company of Radio Corporation of America. Initially, he served as an instructor, and is now part of the Administrative Staff. His responsibilities entail supervising all technical operations of the Home Study Department, setting up courses of study, etc. His Department has prepared a Home Study Course in Television Servicing, and recently completed a Color Television Course. The department is now preparing a general radio and electronics course.

Mr. Horizny, in accepting the award, commented "The Boonton Q Meter is no stranger, as it is no stranger to many other workers in the field. I have used the instrument in classroom instruction and for work related to the preparation of our courses."

Mr. Horizny lives at 138 Cypress Street in Floral Park, New York. He expects to use his Q Meter in his work for a period of time after which he will move it to his home laboratory.

We wish to thank all of the people who came by to see our exhibit at the IRE. We'll welcome you at future shows.

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