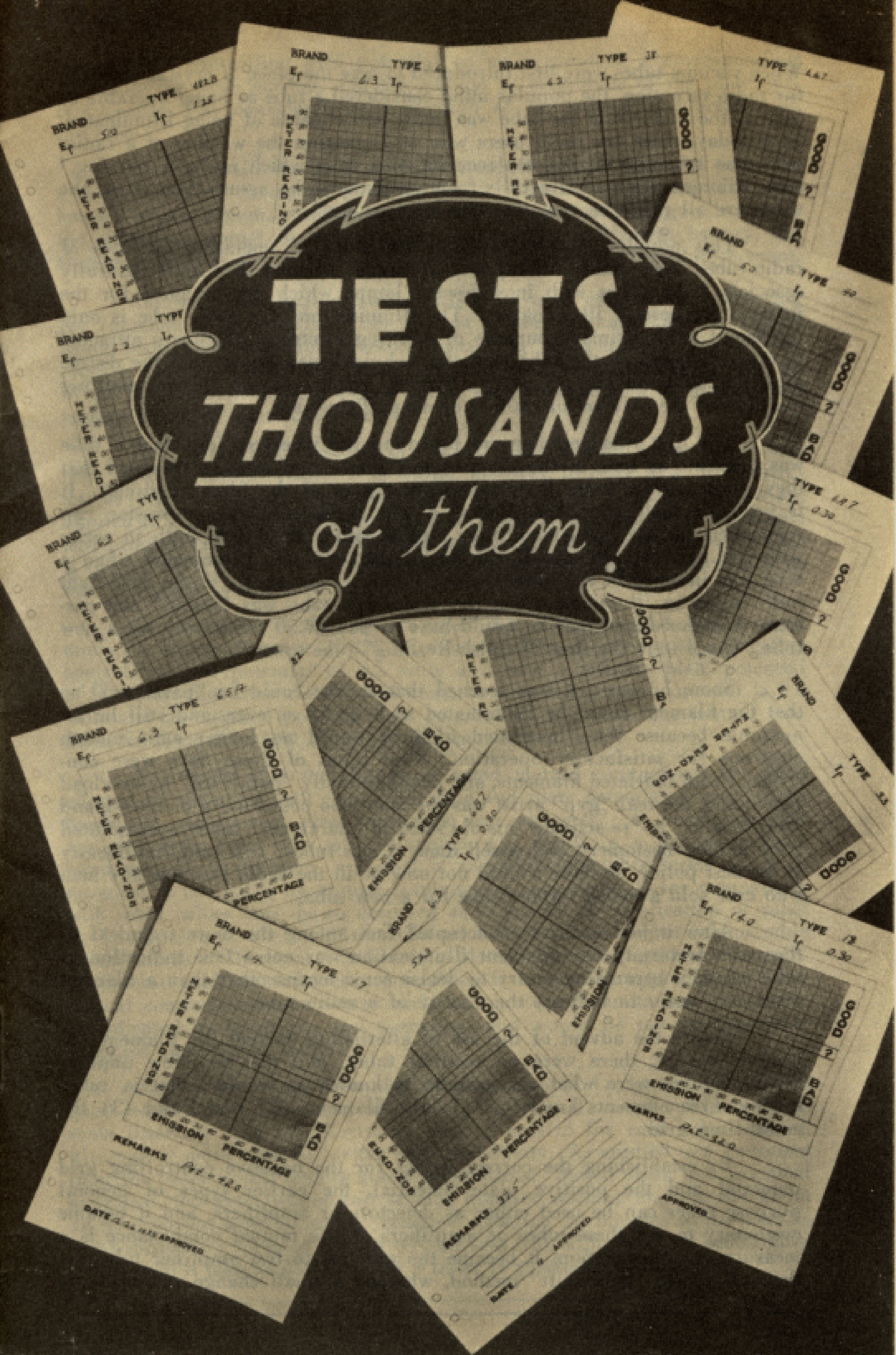

TESTS-
THOUSANDS
of them!
BRAND
TYPE
GOOD
?
BAD
METER READINGS
EMISSION PERCENTAGE
REMARKS
DATE
APPROVED

When vacuum tubes were first introduced to take the place of crystal detectors for radio reception, the popular mind considered a tube as being operable as long as the filament of the tube was intact and capable of being illuminated. Even today, there are radio users who will question the wisdom of a radioman who recommends the replacement of a tube which is "still burning," and radiomen often receive calls from customers who assure them that "the tubes are all right, because they are all burning."

This popular misconception of the index of operating qualities of radio tubes is excusable for laymen, of course, because they quite naturally associate radio tubes with incandescent lamps which are designed for the primary purpose of illumination. The illumination of a radio tube is only incidental to its primary purpose of emitting electrons which are attracted to other elements in the tube, and the technical man knows that the degree of illumination is not necessarily directly related to the electron-emitting qualities of the filament or cathode element of the tube.

The first tube testers were based on the incorrect idea that a tube was operable as long as the filament was intact, and were so designed that they were nothing more than continuity testers of the filament circuit. It is probable that most "old timers" of the radio servicing profession can remember the old home-made tube testers with a flash-light bulb in series with the filament circuit.—If the flash-light bulb was illuminated when a tube was inserted in the tester socket, the tube was good; if the flash-light bulb failed to illuminate when the customer's tube was "tested," the customer was convinced that he would have to pay $7.50 (or more) for a new tube. Those were the first "English-Reading" tube testers!

Soon, however, it was learned that a tube could be "paralyzed" so that the filament could be illuminated as brightly as ever, and still be inoperable because the illuminated filament would no longer emit enough electrons for satisfactory operation. Most tubes of those days were constructed with thoriated filaments, and could be easily "paralyzed" by overload potentials; the real "gyp" artist was the man who could use a monkey-gland "rejuvenator" to "re-activate" his old stock of "paralyzed" tubes, accumulated from hapless customers, and re-sell them as new tubes. It is said that honesty is the best policy, so there should not now be in the radio business any man who ever sold a monkey-gland tube for a new tube.

After it had become an accepted fact among the more technical of the radio fraternity that filament illumination was not a true indication of tube merit, it became necessary to devise some means other than a filament continuity tester to indicate the quality of a radio tube.

Before the advent of the use of alternating current for filament (or heater) energy, there were no rectifier tubes, and the very few popular types of tubes were what are technically known as triodes; that is, tubes having three elements known as (1) the filament, (2) plate, and (3) the controlling grid.

By establishing the correct values for the negative controlling grid potential and the positive plate potential, the earlier types of general purpose tubes can be used either as detectors or amplifiers, and it became customary to test these tubes as amplifiers. Since mutual conductance is a measure of amplification, it became the practice to test amplifier tubes by the well-known "grid shift" method, whereby a small change was made in the negative controlling grid potential so as to produce a corresponding change in the plate current, and the amount or magnitude of the plate current change was considered an indication of the mutual conductance of the tube.

Since a small change in negative controlling grid potential produces a relatively large change in plate current it is seen that an amplifier tube has a "trigger action," and may be crudely compared to a gun in which the stored up energy in the cartridge represents the filament battery, the trigger represents the grid, and the discharge represents the plate current.

Another crude analogy which has been used consists of comparing the function of an amplifier tube to that of the ordinary city fire engine which takes water from low-pressure mains and "steps up" the pressure for the fire hose. The additional power is supplied from the energy stored up in the fuel used in the fire engine which may be compared to the filament battery of stored up electrical energy.

The "grid shift" method of testing tubes is well known as it has been used for several years. It is wrong, however, to refer to a "grid shift" test as being a mutual conductance test, unless rated D. C. potentials are applied to a tube during the test. Any variation from rated D. C. potentials will produce corresponding variations in mutual conductance ratings. This is proved by a casual observation of a table of tube characteristics such as that published by any tube manufacturer.

For example, it may be observed that the type O1A has a rated mutual conductance value of 725 micromhos when operated with a negative controlling grid potential of 4.5 volts and with a positive plate potential of 90 volts; but when the applied negative controlling grid potential is 9.0 volts and the applied positive plate potential is 135 volts, the mutual conductance is rated at 800 instead of 725 micromhos.

It is noted that the change in rated mutual conductance has been effected by changing both controlling grid and plate potentials; what would happen if only one of these potentials were changed? It is obvious that any departure from any rated potential will result in a departure from rated mutual conductance, and that a mutual conductance tester which is designed to test tubes by mutual conductance measurements for comparison with rated values must be so designed as to enable the application of rated D. C. values, and when it is remembered that there are almost innumerable combinations of filament (or heater), plate, controlling grid, screen grid, suppressor grid, pentode, etc., potentials, it is readily appreciated that a mutual conductance tube tester, made up as a single unit, would be quite complicated in its design and operation, and would be too expensive for practical commercial purposes.

Such a tester would require batteries or a D. C. "power pack" with good regulation and designed to supply all of the D. C. potentials and currents listed by tube manufacturers, with a control for each tube element, plus one or more controls for the meter sensitivity. As applied to a 7-element tube, the tester would require about ten controls. Boiled down to a practical appraisal, the tester would cost several hundred dollars, and require about an hour to test a set of tubes. Imagine spending 30 minutes to an hour to test a customer's tubes to make a 60-cent sale with a profit of 24 cents! How long would it take to pay for such a tester in profits from tube sales?

The high cost and operating complications of a true mutual conductance tester have resulted in efforts on the part of testing equipment design engineers to make such compromises in absolute accuracy as are necessary to strike a balance between absolute accuracy and practical utility; such a practical compromise involves (1) a commercially acceptable selling price, (2) a reasonable degree of simplicity of operation, and (3) a practical degree of accuracy. This results in a departure from the use of the various rated D. C. values to a compromise of a few average values which can be applied to all tubes alike, thereby lowering the number of controls and providing the desired element of simplicity of operation, without a serious sacrifice of accuracy, so that the practical radioman can obtain, at a cost under $50.00, a simple tester with an accuracy in the order of 90% instead of having to pay several hundred dollars for a more complicated tester with an accuracy of 95% or more; but never 100%, as perfection can only be approached but never attained by human effort.

The "grid shift" tester with its compromise of applied potentials was simple enough until the sudden avalanche of about 150 types of new multiple-element tubes, when the simple "grid shift" tester had to take on a larger number of sockets, or a larger number of controls, or both, with additional compromises with accuracy. It was then that the design engineers began to study the possibilities of other types of testers which could be designed with a more desirable element of operating simplicity, without too much sacrifice of the desirable element of practical accuracy.

Some of these research efforts were directed towards a design which would consist of an r. f. oscillator combined with an output meter, so as to make comparative tests of tubes in operative radios. This method, however, has not been accepted as having any outstanding merit, because its application requires (1) an operative radio, is (2) based on the assumption that all new tubes, with which old tubes are to be compared, are perfect and that no new tubes are damaged in transit, and (3) this method is quite deceptive when applied to radios in which A. V. C. circuits are involved to compensate for the differences between the tubes which are subjected to the test.

Furthermore, the use of an oscillator and output meter combination for tube testing is restricted almost altogether to shop work, as the average radio owner would not want to listen to the weird noises emitted by the loud speaker of his radio while the oscillator is connected thereto when the tube testing operations are performed in the customer's home.

As the result of the practical necessity for eliminating the oscillator and output meter combination for general tube testing practices, the emission tester came into favor, because it was found that an emission tester is just as accurate as the "grid shift" tester with compromised potentials and controls. After all, about all that can happen to a radio tube, within the realm of probability, after the tube is placed in service, is a depreciation of the emitting qualities of the cathode element, so why not test a tube by measuring the emission current?

There are other possible causes of tube failure, of course, such as lightning strokes, air leakage through the glass envelopes, etc., but we are speaking of a probability and not of extremely unlikely possibilities, so that it is quite practical to conclude that an amplifier tube loses its mutual conductance in service by reason of a lowering of the emission incidental to the prolonged service; in other words, all tubes, amplifiers and rectifiers,

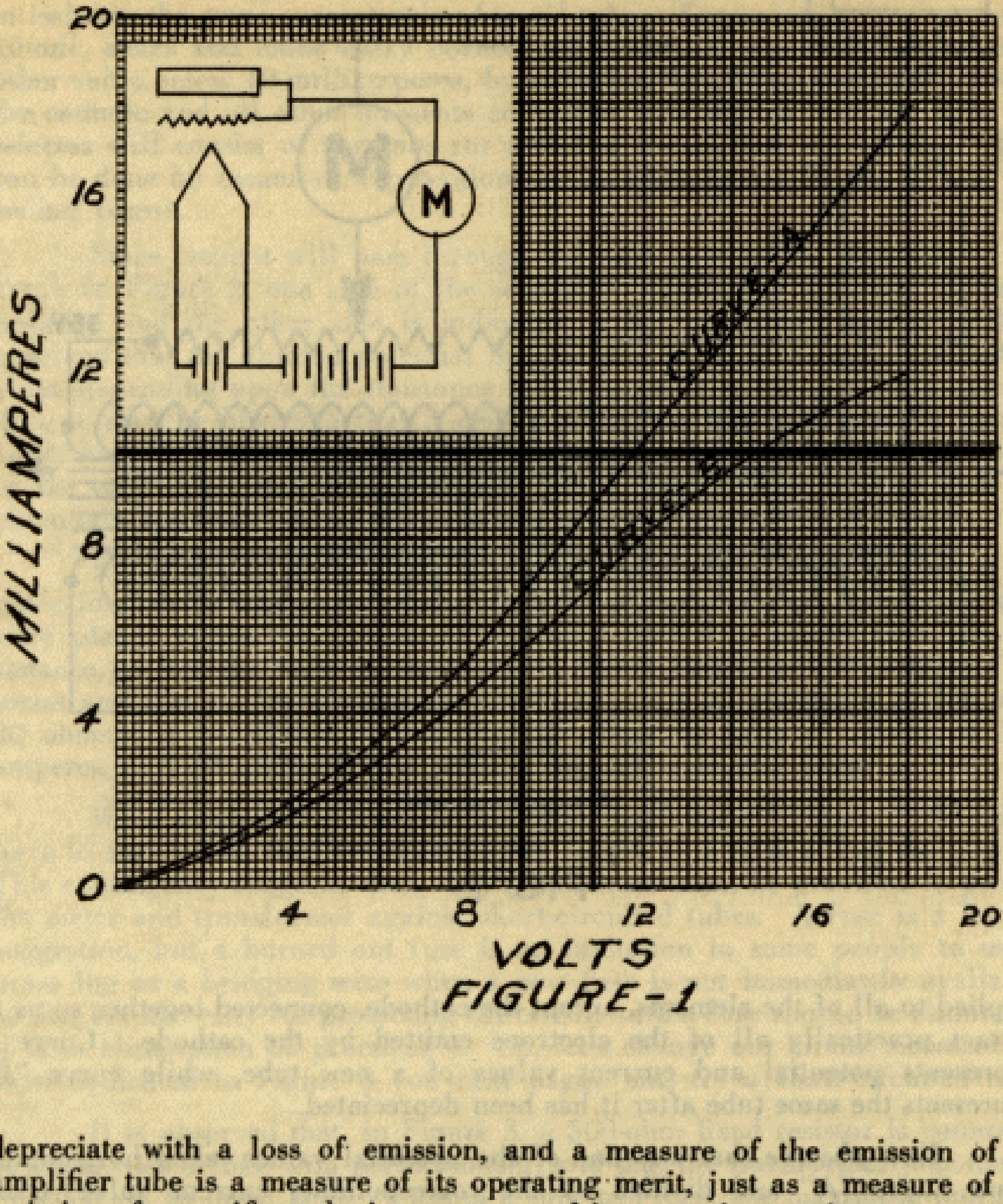


FIGURE-1

depreciate with a loss of emission, and a measure of the emission of an amplifier tube is a measure of its operating merit, just as a measure of the emission of a rectifier tube is a measure of its operating merits.

Having arrived at the conclusion, then, that a well-designed emission tester is as reliable as a "grid shift" tester and having confirmed the accuracy of this conclusion by laboratory comparisons of the two types of testers, we are ready to study the details involved in a well-designed emission tester, such as the Supreme Model 85.

For the purpose of analyzing the factors involved in the design of a tube tester of this type, it is convenient to resolve tube characteristics into resistance values so that, under a given set of conditions, a particular tube will act as a resistance except that it will pass current in only one direction. In order to better understand the resistive characteristics of tubes, let's refer to figure 1 which represents a type O1A tube with varying positive potentials

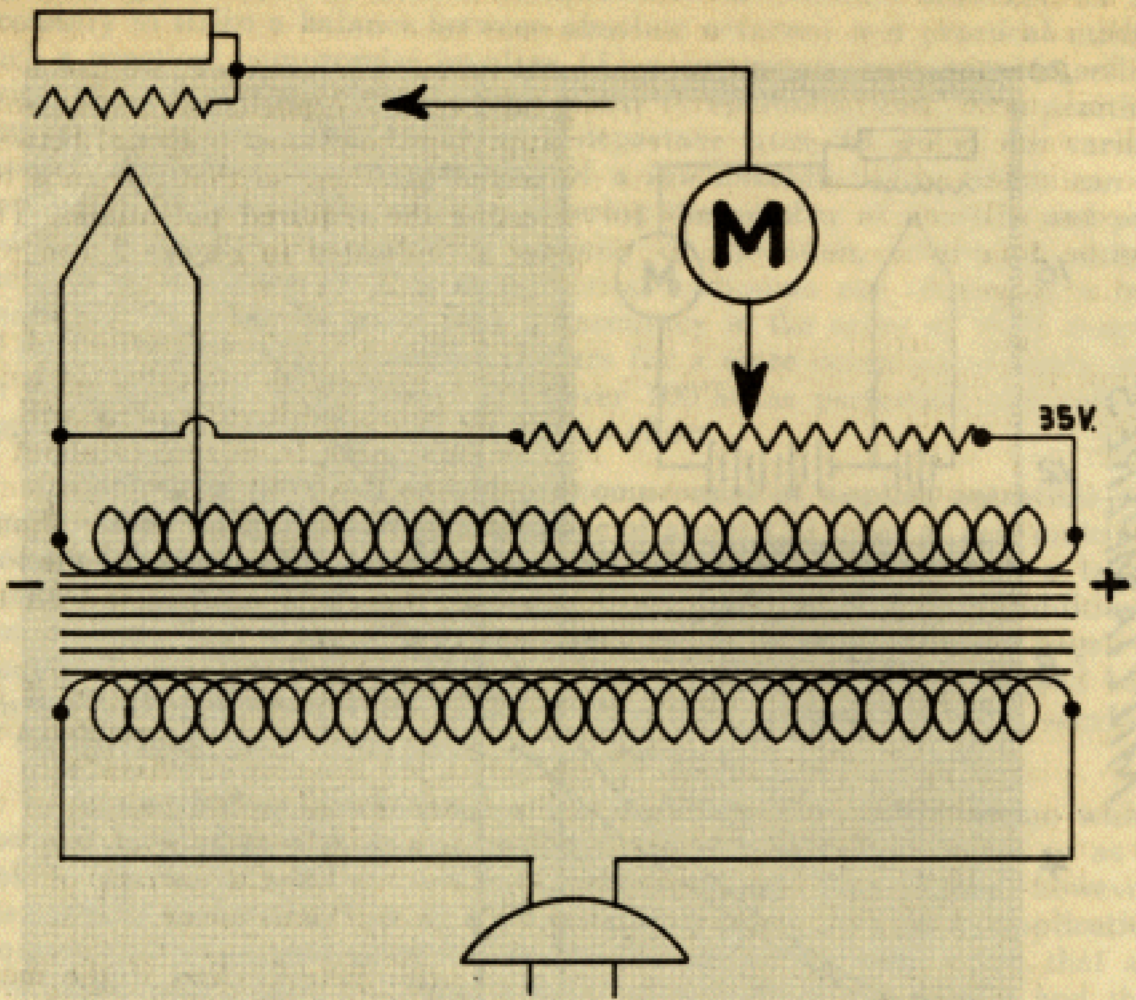


FIG. 2

applied to all of the elements, except the cathode, connected together so as to attract practically all of the electrons emitted by the cathode. Curve A represents potential and current values of a new tube, while curve "B" represents the same tube after it has been depreciated.

Now observe that any one of the potential values taken horizontally from Curve "A" and divided by the corresponding current value, taken vertically from the same curve, will indicate the resistance value of the tube under the particular load conditions. It is seen that, with an applied potential of 18 volts, the current load on Curve "A" is 17.8 milliamperes, from which we derive, by Ohm's Law, a resistance value of 101 ohms. Similarily, with 18 volts on Curve "B," the current load is 11.8 milliamperes, from which we derive a resistance value of 152.5 ohms. We can determine the percentage of depreciation at 18 volts by substracting 11.8 milliamperes from 17.8 milliamperes, and dividing the difference by 17.8 or by substracting 101 ohms from 152.5 ohms and dividing the difference by 152.5; in either case, the tube depreciation from Curve "A" to Curve "B" is found to be about 34% at 18 volts. Accordingly, Curve "A" can be said to represent the resistance of a normal tube and Curve "B" can be said to represent the resistance value of the tube after its emission has depreciated.

A careful consideration of the factors presented in the last paragraph leads us to conclude that we may choose, for our tube tester, a milliammeter of a range which falls below the saturation point of every radio receiving tube, and apply a potential to each normal tube which will cause the meter to indicate the same current value for all tubes. For example, we can use a 10-mil. meter and make every normal tube read 7.7 milliamperes, or some other value below 10 milliamperes, by applying the correct potential between the cathode and all other elements connected together, so that our tube test selector will consist of a means for selecting the required potentials. This can be done by means of a potentiometer as indicated in Figure 2 (on preceding page).

Since current will pass through the tube only in the direction of the arrow in Figure 2, one side of the secondary winding is indicated as being negative and the other side is indicated as being positive, and it will be observed that the applied potential may be any value from zero to about 35 volts, depending upon the resistance through the tube. By a simple calculation, it may be observed that a center setting of the potentiometer should apply half of the potential, or 17.5 volts, to the tube, if we disregard the load of the tube. We will discuss, farther along, the effect of the load on the potentials applied through the potentiometer.

Referring again to Figure 2, let's observe what might happen if the potentiometer be left at the full potential setting and a short-circuited tube were placed in the test circuit. A short-circuited tube would have zero resistance, so that the only resistance in the meter circuit would be that of the meter and that of the transformer winding, or a total resistance of less than 20 ohms. If we divide 35 volts by 20 ohms we have a current of 1.75 amperes, or 1750 milliamperes passing through a 10-mil. meter.

What happens? It would be "good-bye" meter! And if the meter were to stay intact, then the transformer would soon pass out of the picture. This contingency suggests, then, that some means must be provided to protect the meter and transformer against short-circuited tubes. A fuse is a logical suggestion, but a burned out fuse is an invitation to some people to use a brass lug or a bridging wire when a new fuse is not immediately available, so that the necessity for protecting the circuit with a fuse should be eliminated if such elimination be practicable. So, let's change our circuit constants to those indicated in Figure 3 (on next page) and try a short-circuited tube.

It is observed that, in Figure 3, a 500-ohm fixed resistor is connected in series with a 1500-ohm potentiometer, and that the transformer potential is raised from 35 to 45 volts. Without a tube test load, the maximum potential applicable to a tube is still 35 volts, as there is a 10-volt drop through the 500-ohm resistor. This value of 10 volts is obtained by observing Ohm's Law; the total current is obtained by dividing 45 volts by 2250 ohms, or 20 milliamperes. By multiplying 20 milliamperes by 500 ohms, we have the IR drop of 10 volts, when there is no tube in the tube tester sockets. Now, let's try the short-circuited tube again.

This time, we have at least 500 ohms in the circuit, so that the current through the meter cannot exceed 90 milliamperes, and, since the meter can be expected to withstand a "ten-times" overload, the meter and transformer cannot be harmed by a short-circuited tube. The use of a fuse is no longer necessary.. The 250-ohm resistor of Figure 3 is used merely to enable the use of a potentimeter of even value and to prevent a crowding of control

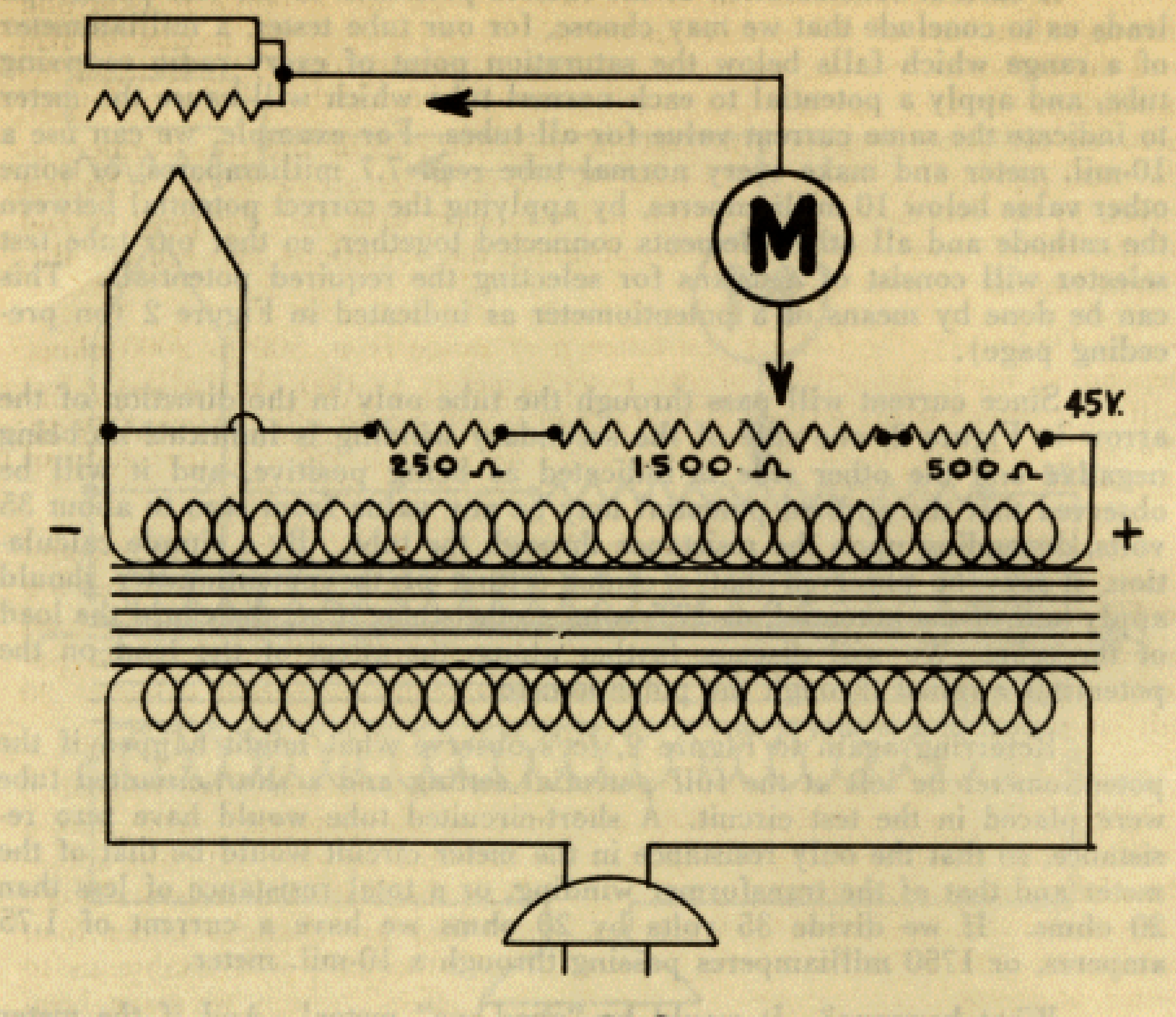


FIG. 3

settings, as there are no tubes which would require a potentiometer setting below 250 ohms.

In the discussion so far, we have made references to applied potentials under no-load conditions; that is, without a tube in the tube test sockets. A further study of Figure 3 will reveal that the resistance of a tube under test parallels the resistance between the potentiometer arm and the negative end of the transformer, so that the insertion of a tube into the tube test socket lowers the total resistance of the circuit and causes more current to pass through the 45-volt transformer winding.

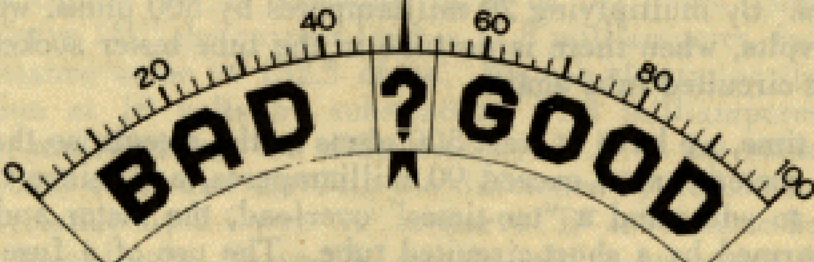


FIG. 4

All of the additional current passes through the 500-ohm resistor and through that part of the potentiometer which is between the moveable arm and the 500-ohm resistor, so that the potential drop is increased between the potentiometer arm and the positive end of the transformer, and decreased between the potentiometer arm and the negative end of the transformer, as the total potential remains at 45 volts. We have, therefore, a desirable ballast effect, in the resistance between the potentiometer arm and the positive end of the transformer, which tends to minimize the variations between the different brands of new tubes.

Obviously, the ballast resistance may range from 500 to 2000 ohms, depending upon the setting of the potentiometer, so that the ballast effect will be greater for some types of tubes than it will be for other types of tubes. We will refer, again, to this ballast effect as we proceed with the study of this tester.

Let's observe, now, our potential limits under no-load conditions, and then compare the potential conditions under load conditions. Again referring to Figure 3, but without a tube in the test socket, let's calculate the no-load potentials. The transformer potential of 45 volts divided by the total potentiometer circuit resistance of 2250 ohms indicates a current value of 20 milliamperes.

This current value, when multiplied by each of the three resistance values of the potentiometer circuit will give us the potential value across each of the resistors, or 10 volts across the 500-ohm resistor, 30 volts across the 1500-ohm potentiometer. and 5 volts across the 250 ohm resistor. Let's keep these values in mind and see how much they are changed under load conditions with tubes in the test socket. This procedure will enable us to better understand and appreciate the "ballast effect" which we have been discussing. First let's divide our meter scale as indicated in Figure 4 (see preceding page), so that the first 46% of the scale constitutes a "BAD" sector, the center 8% a questionable or "?" sector, and the remaining 46% a "GOOD" sector.

Now, if we use the circuit, without a potentiometer, as shown in Figure 5, there will be no resistance in the circuit to produce a ballast effect, so that if we adjust the applied potential for a meter indication of 77 at the center point of the "GOOD" sector, the meter indication will decrease in almost direct proportion to the increase of the tube resistance as the tube depreciates, and the relation between the meter readings and the depreciation can be represented by the straight line from zero to 77 in Figure 5.

Someone may ask why the tester is not designed without a potentiometer; the answer is found in the fact that (1) a potentiometer is necessary to enable a smooth and uniform selection of applied potentials and (2) it is advisable to incorporate a resistive value in the meter circuit for meter protection and for (3) a ballast effect to minimize the meter indication of variations as between different tube brands.

For the purpose of discussing the calculations involved in plotting the curves which will follow, it is necessary that we determine the average resistance value of (1) the most used tubes, (2) the lowest resistance value of available tubes, and (3) the highest resistance value of available tubes, under the conditions involved in this tester. It is found that the ten most used types of tubes which constitute more than 75% of the tube market,

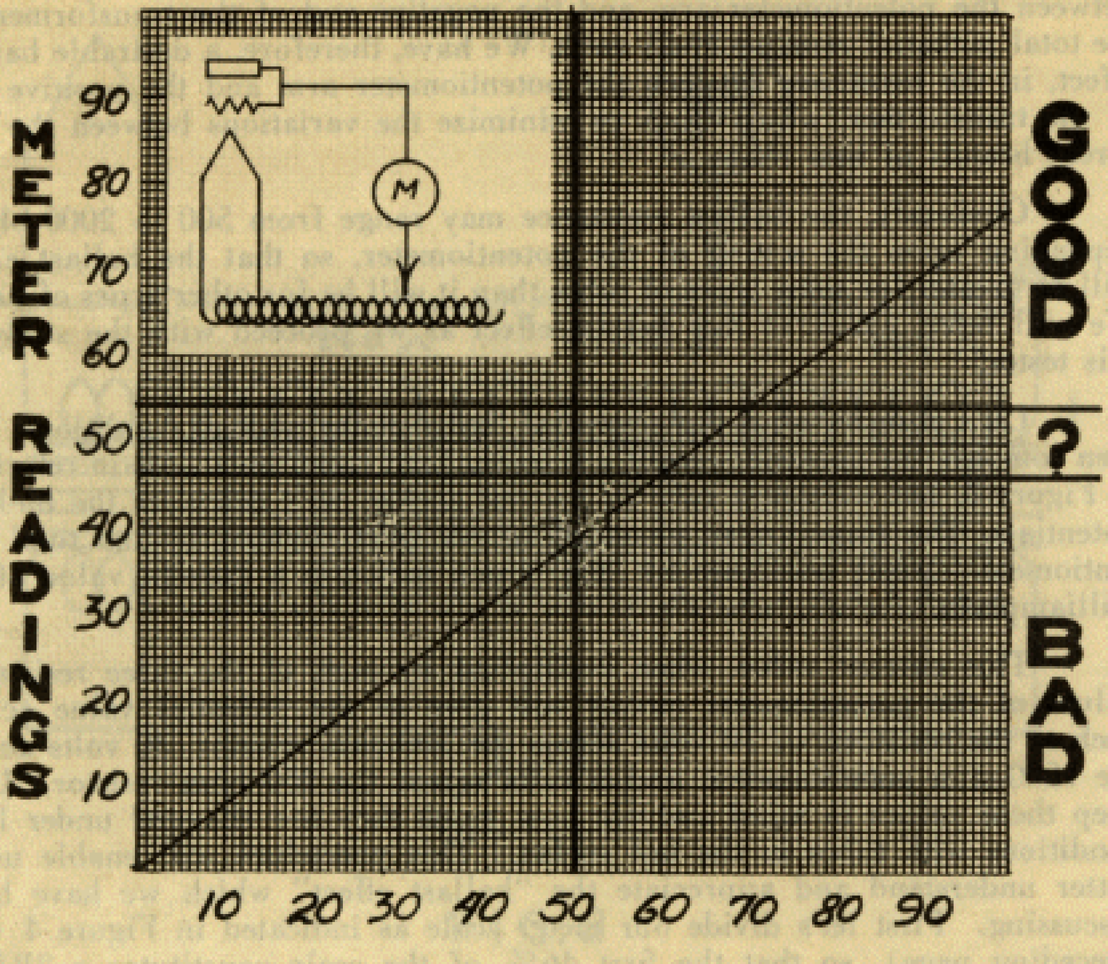


FIGURE-5

have an average resistance value of about 642 ohms; the lowest resistance value is about 126.5 ohms, and the highest is about 1625 ohms, of available tubes. These values must be considered as approximate, only, as they were experimentally determined from thousands of tests in the Supreme laboratories, and this discussion is based on the data which has been tabulated from these "Tests—Thousands of Them!"

Now, let's use an average tube with a resistance value of 642 ohms, and plot a curve of the meter readings against depreciation, using the circuit constants of Figure 6. The resistance value of 940 and 1310 ohms, totalling 2250 ohms, are determined by assuming that the meter should indicate a value of 5.4 milliamperes, when the tube is depreciated 50%. Since the milliameter reading of 4.6 milliamperes is the average of a pulsating current through the tube, we must multiply this reading by 2 to find what the average would be in a rectified full-wave circuit, which gives us a value of 9.2 milliamperes; this value of 9.2 milliamperes must, in turn, be multiplied by 1.11 to convert average D.C. values into corresponding R. M. S. values, so that we may assume, for the basis of our calculations, that the tube under test is carrying a load of 10.2 milliamperes. A tube which normally has a resistance value of 642 ohms will, when depreciated 50%, have a resistance value of 1284 ohms. For our problem, then, we have:

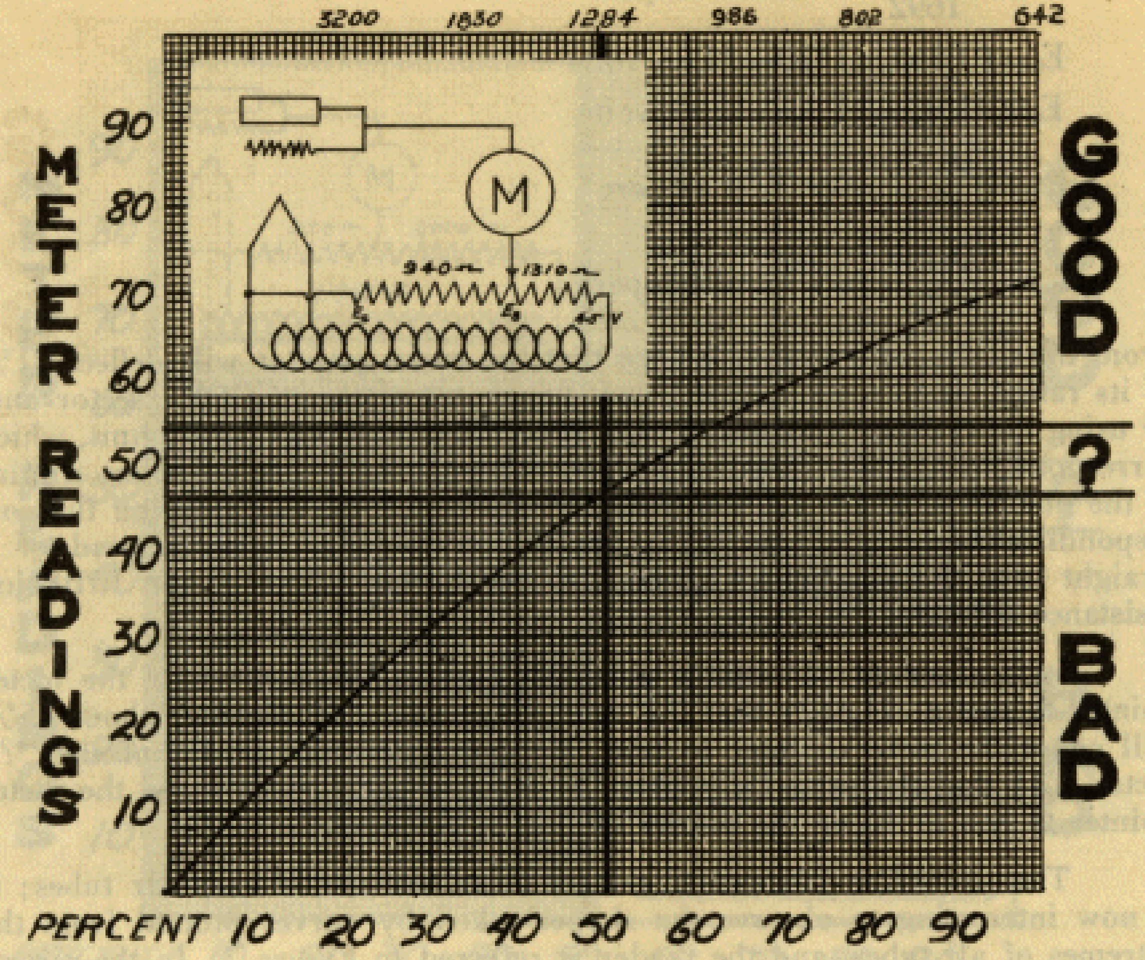


FIGURE-6

$I_t = 0.0102$ ampere

$R_t = 1284$ ohms

and we are to find R_s and R_b which total 2250 ohms. The solution is as follows:

$E_s = 0.0102 \times 1284 = 13.12$ volts

$E_b = 45.00 - 13.12 = 31.88$ volts

$$R_s = \frac{13.12}{I - 0.0102} \qquad R_b = \frac{31.88}{I}$$

$$\frac{13.12}{I - 0.0102} \times \frac{31.88}{I} = 2250 \text{ ohms}$$

$R_s = 940$ ohms $\qquad R_b = 1310$ ohms

With the potentiometer adjusted so that we have 940 ohms on one side, and 1310 ohms on the other side of the moveable contact arm, let's see what the meter will indicate with a normal tube which has a resistance value of 642 ohms:

$$R=\frac{642\times940}{1582}+1310=1692 \text{ ohms}$$

$$I=\frac{45}{1692}=0.0266 \text{ ampere}$$

$$E_0=0.0266\times1310=34.85 \text{ volts}$$

$$E_s=45.00-34.85=10.15 \text{ volts}$$

$$I_t=\frac{10.15}{642}=0.0158 \text{ ampere}$$

$$I_m=\frac{0.0158}{2.22}=7.1 \text{ milliampere}$$

From the above calculation, we see that the meter pointer will deflect 71% of its range, or to a point just below the center of the "GOOD" sector and, by using the resistance values of 802, 986, 1284, 1830 and 3200 ohms, which correspond to different degrees of tube depreciation, in calculations similar to the one we used for finding a meter reading of 71, and plotting the corresponding meter readings in Figure 6, we obtain a curve instead of a straight line, the curvature representing the ballast effect of the 1310-ohm resistance value.

It is observed (1) that a normal 642-ohm tube will cause the meter pointer to rest at 71, (2) that the same tube, when depreciated about 35% will cause the meter pointer to rest at about 54 on the border of the "?" sector, (3) that the same tube when depreciated 50%, will cause the meter pointer to rest at 46 on the border of the "BAD" sector.

The preceding paragraph relates to an average of popular tubes; it is now interesting to observe the shapes taken by curves plotted from the extremes of all tubes, and the reader is referred to Figure 7. In the circuit designated, "LOW R," in Figure 7, the potentiometer is rotated to the extreme left or counter-clockwise position of the control, and the control is rotated to the full right or clockwise position in the circuit which is designated "HIGH R" in Figure 7. When we plot curves downward from a meter indication of 71, using the two circuits shown in Figure 7, it is observed the "LOW R" curve has considerably more curvature than the "HIGH R" curve, indicating the difference in ballast effects of the 500-ohm and 2000-ohm resistance values of the two circuits.

Observe that a tube on the lower curve is classed as being "?" (questionable) when the tube is depreciated about 26%, whereas a tube must be depreciated about 50% before it enters the "?" sector on the upper curve. This suggests that the tube test limits should not be established downward from a meter indication of 71, but should rather be established at some intermediate point so as to make the curves cross each other at that point.

The circuits of Figure 7 are duplicated in Figure 8 which differs from Figure 7 in that the curves are made to cross each other, as suggested above. This has been accomplished by choosing a depreciation of 35% as the point at which all tubes should enter the "?" sector of the meter scale, and then by extending our curves from that point. In other words, the tube test limits are determined by establishing a potentiometer setting for each type of tube so that the meter pointer will rest at 54 when the tubes are depreciated 35%, or when the emission is 65% of the normal value. Thus it is observed

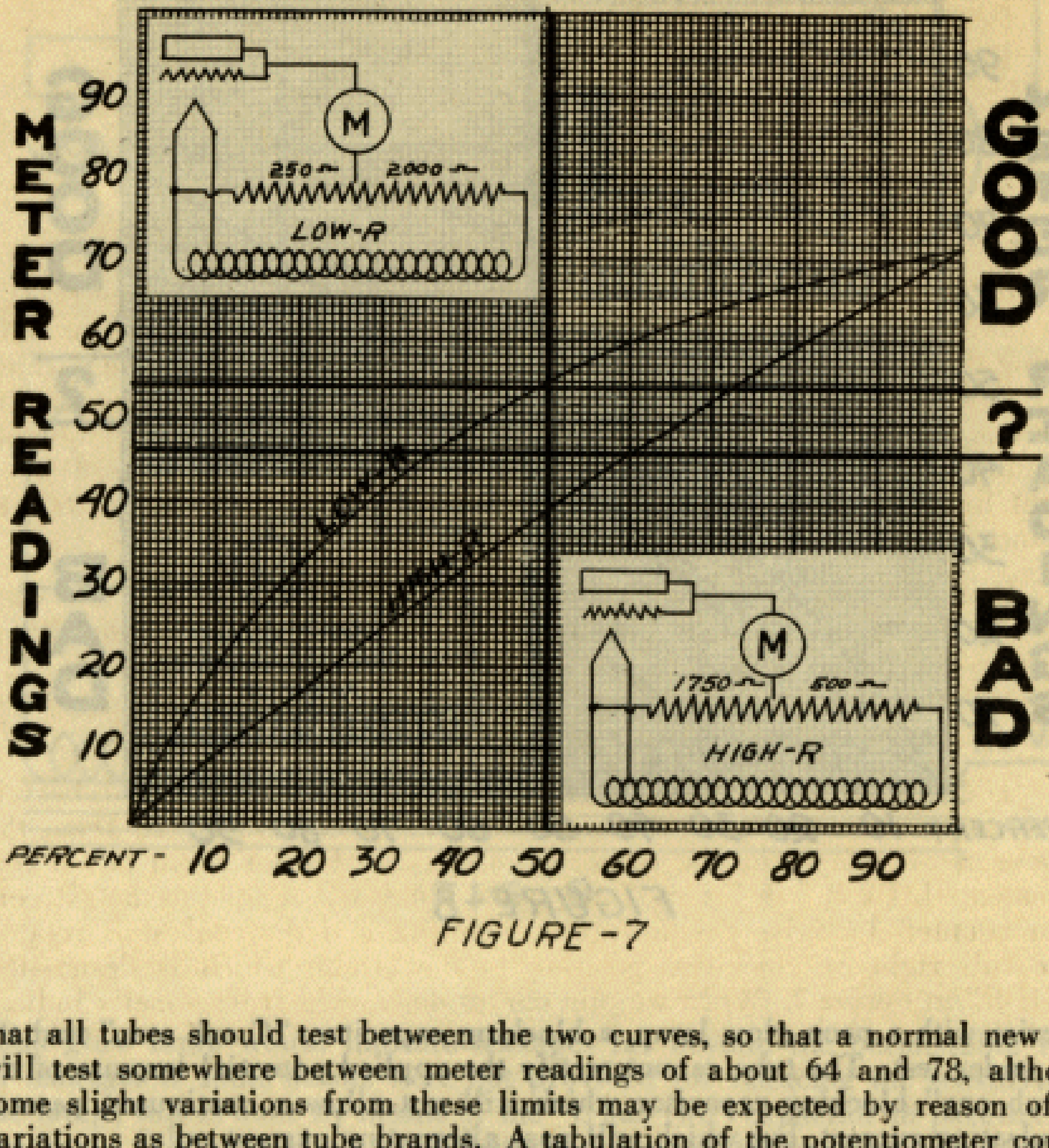


FIGURE-7

that all tubes should test between the two curves, so that a normal new tube will test somewhere between meter readings of about 64 and 78, although some slight variations from these limits may be expected by reason of the variations as between tube brands. A tabulation of the potentiometer control settings, which are established by the procedure just outlined, constitutes the "tube testing table" or "TUBE LIST" card which accompanies each tester.

This tester is equipped with (1) a set of four sockets, ranging from four contacts to seven contacts per socket, connected in parallel, (2) a set of seven single-pole, double-throw, push button switches, one for each possible tube element, to enable a shift of the cathode element (or elements) from the other elements to the negative side of the transformer, and (3) a double-pole, double-throw, tumbler switch for the purpose of shifting the meter from the potentiometer circuit to a 110-volt circuit in series with a self-contained rectifier tube for power supply adjustments, and for the neon glow lamp leakage tests which will now be described.

It is the purpose of Figure 9 to indicate the circuit arrangement for indicating a leakage between the heater and the cathode, or one of the other elements of a tube. It is observed that a 110-volt A. C. potential is applied

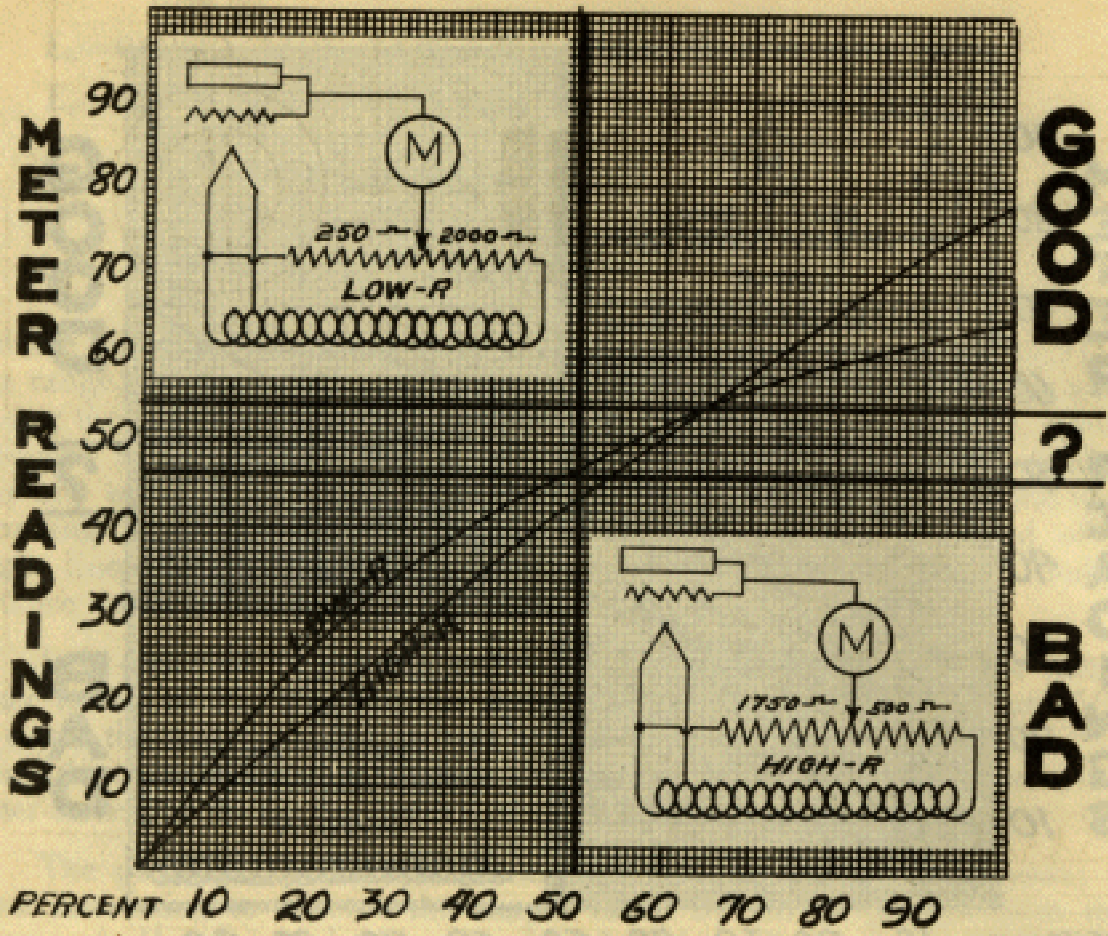


FIGURE-8

in series with a neon glow lamp, a blocking capacitor, "C sub one," and the tube under test. The tube cannot rectify the applied potential because of the "C sub one" blocking capacitor which will not allow a continuous passage of pulsating current, but which will pass alternating current only.

However, an alternating current cannot pass through the tube, unless there be a leakage through the tube, in which case the neon glow lamp will indicate the passage of the A. C. leakage current by a glow of both elements of the neon lamp. The circuit of Figure 9 represents the arrangement which results from depressing the No. 3 push button of the tester. If the No. 3 button be released, and the No. 5 button be depressed, the circuit arrangement will be that of Figure 10 (see next page) and if the neon lamp still glows, it should be concluded that the leakage is between the No. 3 (heater) and the No. 5 (Cathode) elements. By similarly depressing the remaining push buttons, any leakage between any two elements of any tube may be indicated, and the panel markings associated with the switch buttons will indicate to the user just what two elements are involved in the leakage.

The reader may now ask the purpose of the "C sub two" capacitor in Figures 9, 10 and 11, and the answer is found in the fact that the sensitive

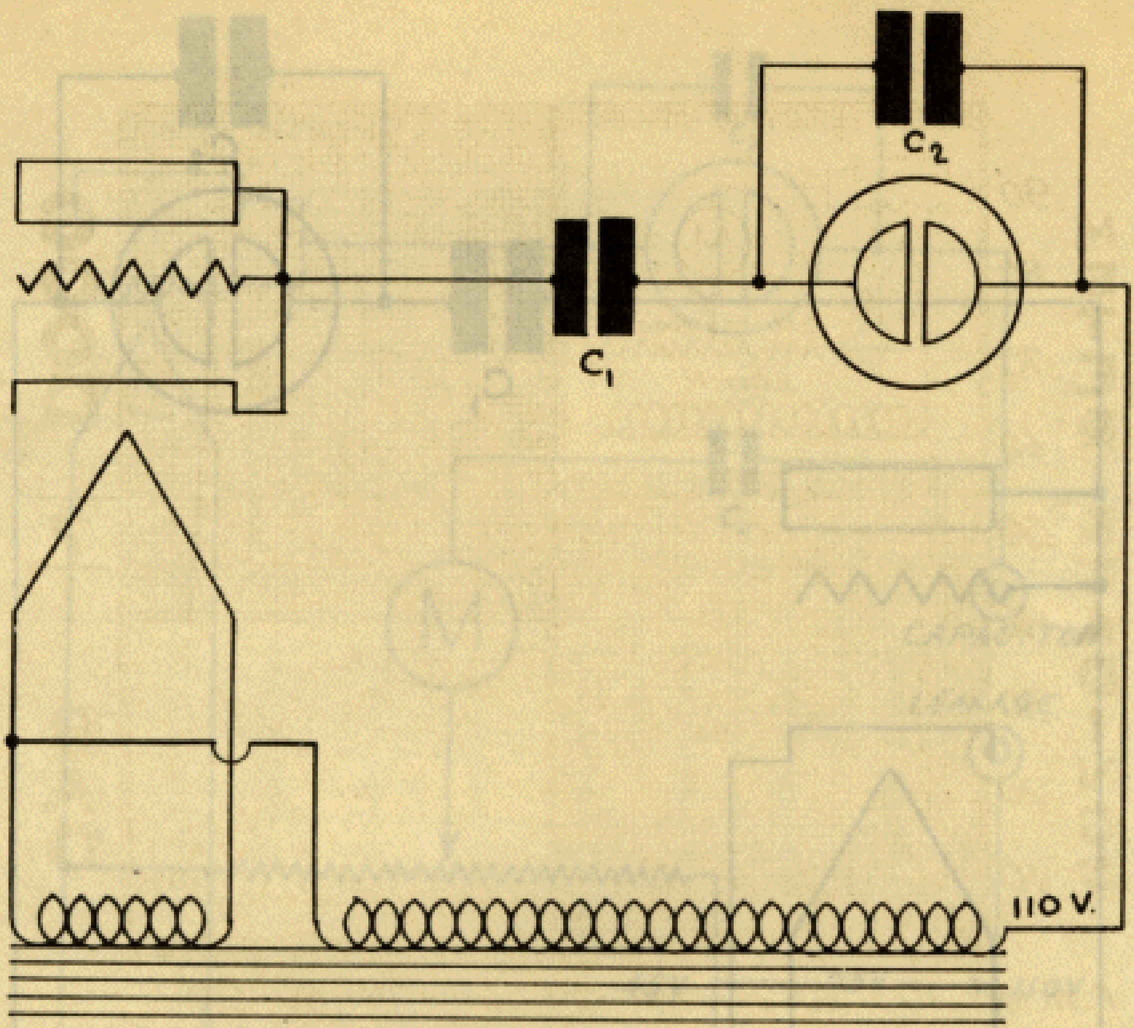


FIG 9

neon glow lamp would indicate leakages far beyond the permissable range of leakages if some means were not provided for reducing the sensitivity of the lamp; this is done by means of the "C sub two" capacitor in parallel with the lamp. It is generally agreed that a leakage resistance value below 100,000 ohms between the cathode and the heater elements is detrimental to the proper functioning of a tube but that a leakage resistance above 100,000 ohms may be permissable.

Therefore, it is advisable to so design the tester that it will indicate leakages below about 100,000 ohms and not indicate leakages much beyond this value. This dividing line is not critical, and it is probable that a value of 200,000 ohms could just as well be chosen for the leakage limits. However, it is probable that some new tubes may have leakages as low as two or three megohms, and be entirely satisfactory for radio operation, so we would not want the tester to suggest that those tubes are unsatisfactory by indicating such high leakages.

For capacitor leakage tests, the tester circuits are resolved into the scheme suggested by Figure 11. In this circuit, the tube is the self-contained rectifier tube, instead of being a tube in one of the test sockets. The current

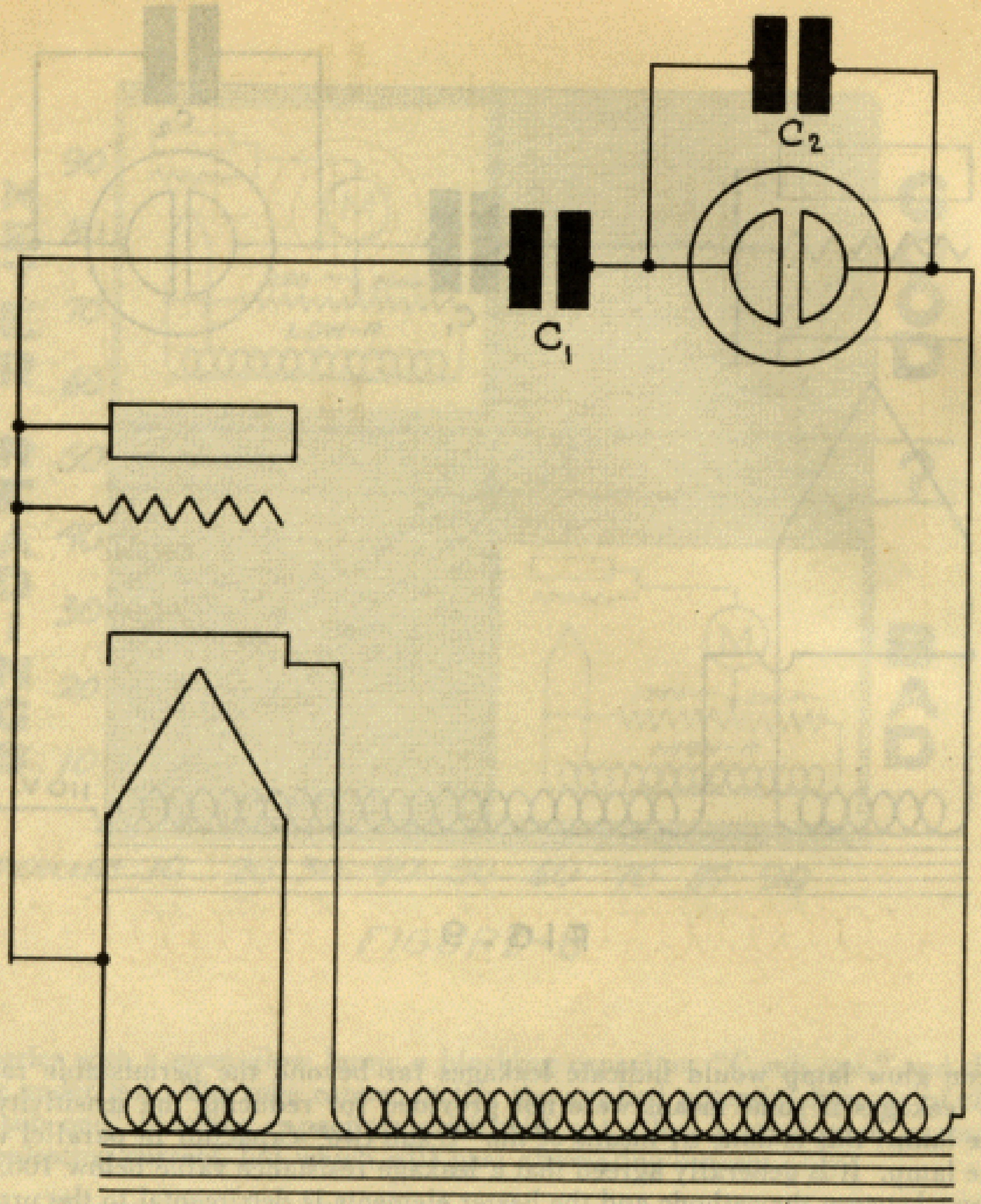


FIG 10

through a capacitor of unknown condition which may be connected to the "CAPACITOR LEAKAGE" pin jack terminals has two possible paths. If the capacitor is of the average bypass size and is not open-circuited, a small value of alternating current will pass through the unknown capacitor, the "C sub one" capacitor, the meter and through the 65-volt section of the transformer. The "C sub one" capacitor and at least 500 ohms of the potentiometer circuit protect the meter against a short-circuit across the pin jack terminals. The other path which may be followed by the current through an unknown capacitor is through (1) the neon glow lamp and its parallel

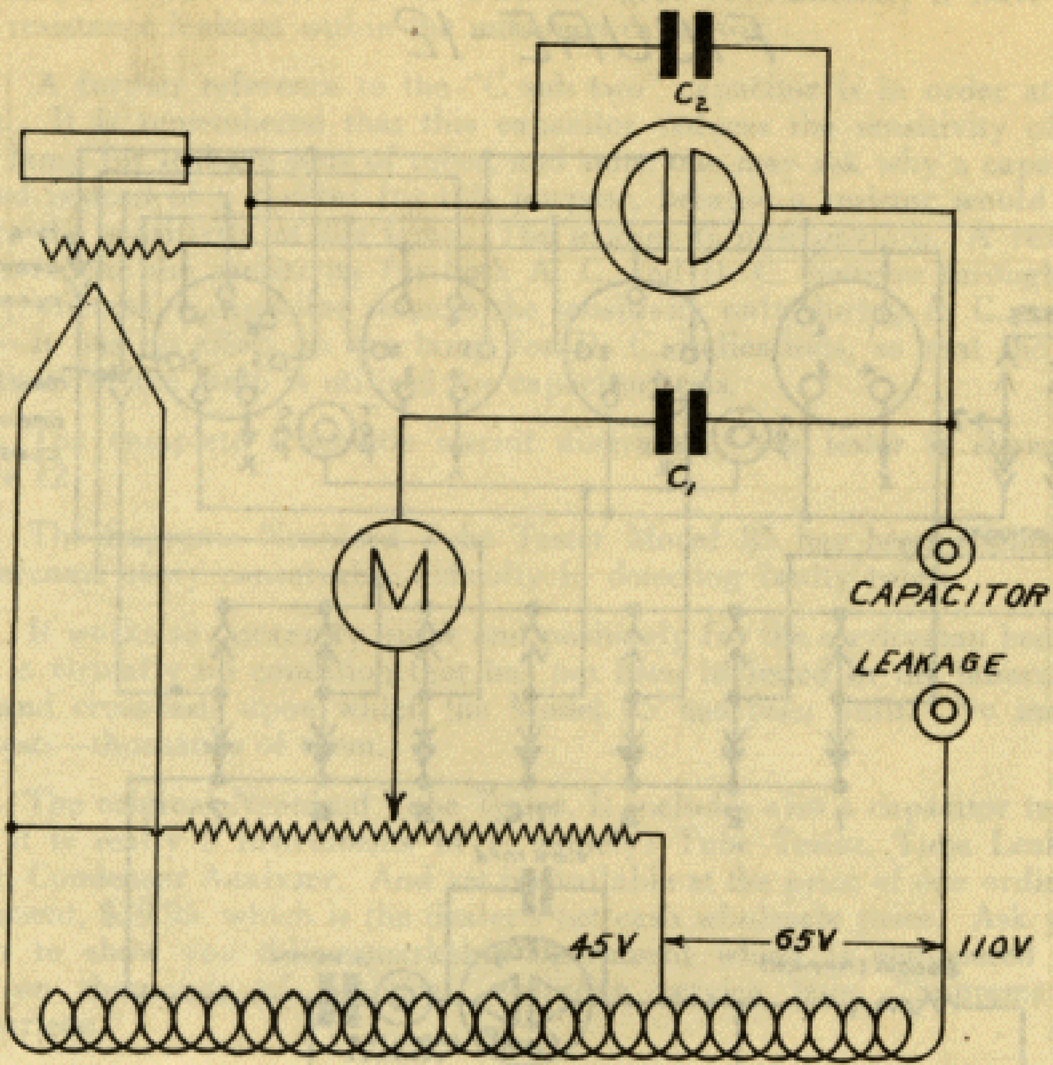
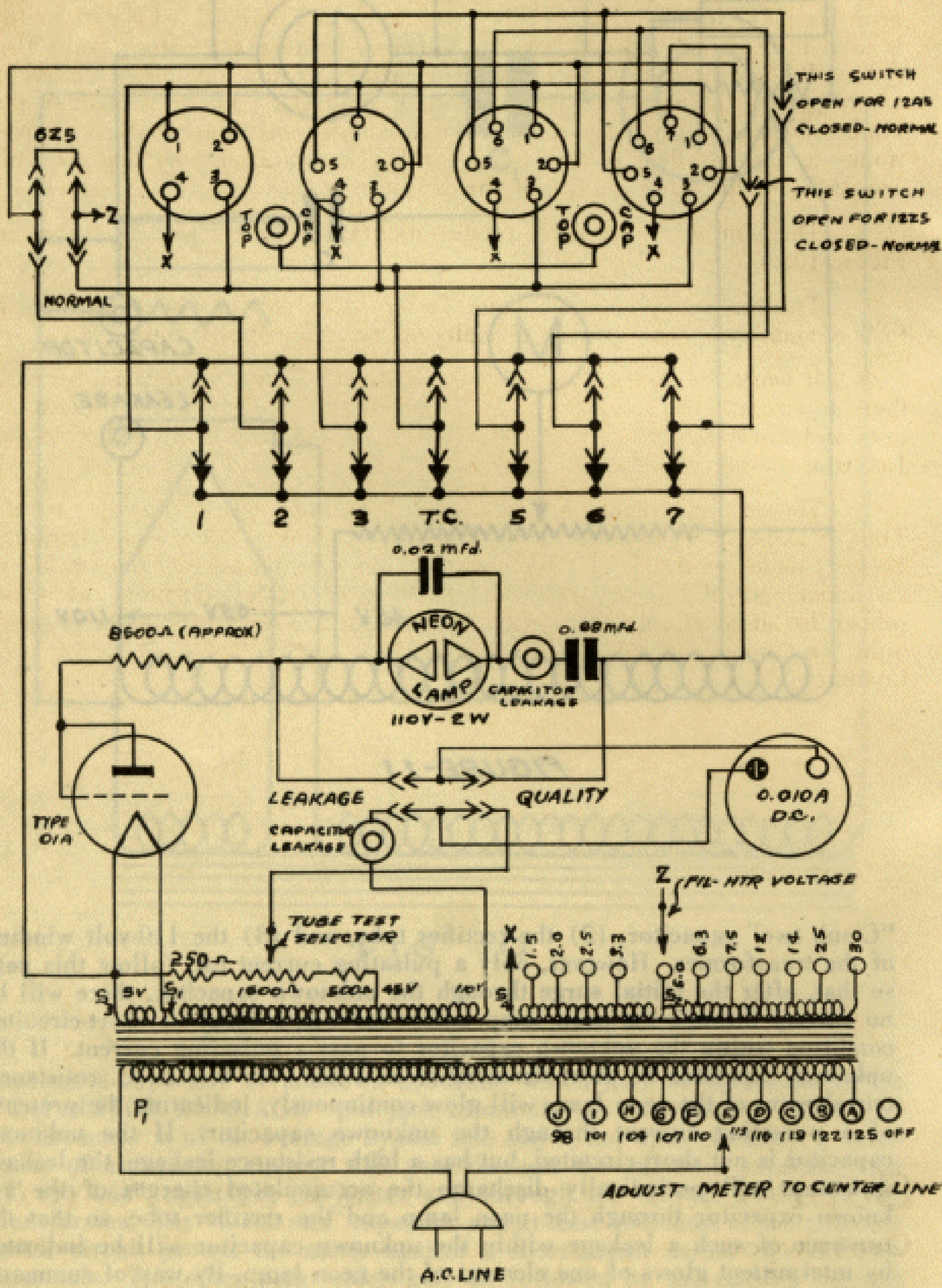


FIGURE-11

"C sub two" capacitor, (2) the rectifier tube, and (3) the 110-volt winding of the transformer. However, only a pulsating current can follow this path so that, after the initial surge through the unknown capacitor, there will be no current through the neon lamp unless there be a leaky or short-circuited condition within the unknown capacitor to pass a pulsating current.. If the unknown capacitor be short-circuited or if it has very low D. C. resistance, one element of the neon lamp will glow continuously, indicating the presence of a pulsating current through the unknown capacitor. If the unknown capacitor is not short-circuited, but has a high resistance leakage, the leakage resistance will periodically discharge the accumulated charges of the unknown capacitor through the neon lamp and the rectifier tube, so that the presence of such a leakage within the unknown capacitor will be indicated by intermittent glows of one element of the neon lamp. By way of summary, it may be said that the meter pointer will vibrate slightly about its zero

FIGURE-12


6Z5
NORMAL
Z
X
TOP CAP
THIS SWITCH OPEN FOR 12A5 CLOSED-NORMAL
THIS SWITCH OPEN FOR 12Z5 CLOSED-NORMAL
1 2 3 T.C. 5 6 7
0.02 mfd.
8600Ω (APPROX)
NEON LAMP
0.08 mfd.
CAPACITOR LEAKAGE
110V-2W
LEAKAGE
QUALITY
0.010A D.C.
TYPE 01A
CAPACITOR LEAKAGE
Z FIL-HTR VOLTAGE
TUBE TEST SELECTOR
250Ω
5V 1600Ω 500Ω 45V 110V
1.5 2.0 2.5 3.3 5.0 6.3 7.5 12 14 25 30
P_1
J I H G F E D C B A
98 101 104 107 110 113 116 119 122 125 OFF
ADUUST METER TO CENTER LINE
A.C. LINE

position to indicate that an unknown capacitor is not open-circuited, one element of the neon lamp will glow continuously if the capacitor be short-circuited, and one element of the lamp will glow intermittently if there be a high resistance leakage within the unknown capacitor.

A further reference to the "C sub-two" capacitor is in order at this point. It is remembered that this capacitor reduces the sensitivity of the neon lamp for leakage tests of tubes, and some one may ask why a capacitor is used instead of a resistor for this purpose, because a resistor would also reduce the sensitivity of the lamp. The answer is now obvious. A resistor would reduce the sensitivity for both A. C. and D. C. energies through the lamp; whereas, a capacitor reduces the sensitivity only during A. C. indications—it has no effect on the lamp for D. C. indications, so that the full sensitivity of the lamp is utilized for capacitor tests.

The complete schematic circuit diagram of the tester is shown in Figure 12.

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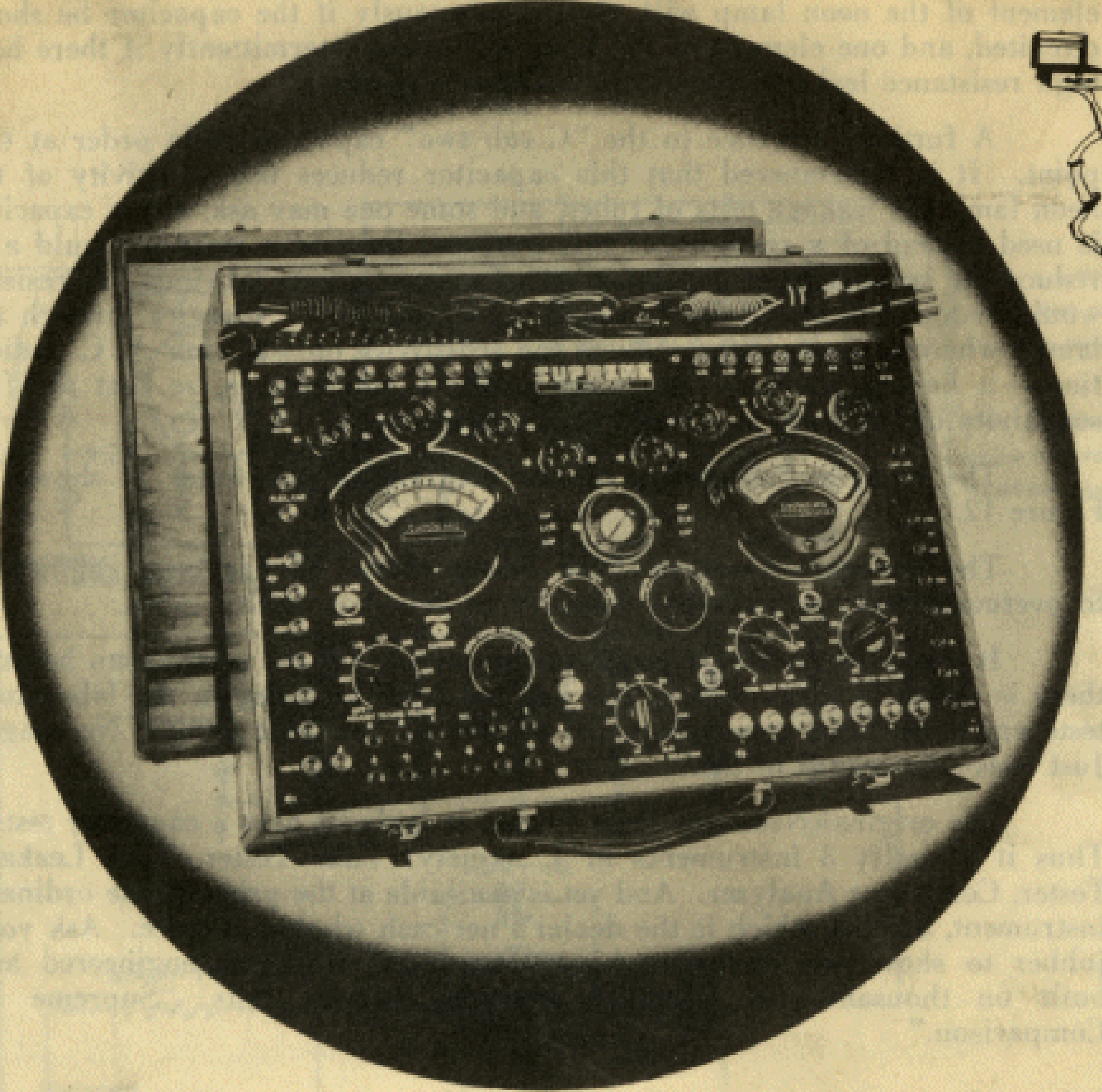

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