MODERN RADIO

EDITED BY ROBERT S. KRUSE

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September Number 15 20 cents

An amateur vertical 5-meter antenna, held clear of the house by a 5-foot wooden bracket. Actually this is a wire 1½ waves (7½ meters) long folded into a 2-wire feeder and a ½ wave antenna. The feeder goes through drilled window panes to the transmitter. Large antennas working on a harmonic are also used. (Both illustrations courtesy "Below Ten Meters"—National Company.)

5-Meter Amateur Radio

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■

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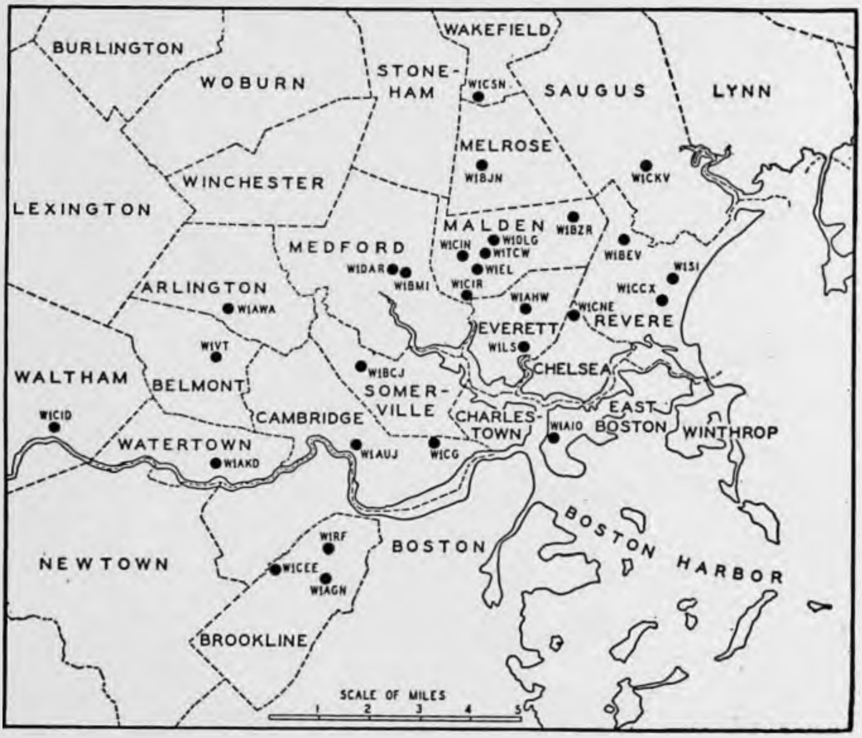

A typical colony 5-meter, low-power amateur radio phone stations employing modulated oscillators of 1 to 10 watts output. Communication, though variable, is dependable at all times. The 5-meter band contains 90% of all amateur frequencies!

Simplified Inductance Charts

By R. R. Batcher*

Before the advent of radio, engineers were rarely interested in inductance coils without iron cores. Radio provides a place for practically every type of inductance coil from a single turn of wire, one inch in diameter to massive iron cored choke coils weighing hundreds of pounds.

> *The Batcher charts given here tell you more about sending and receiving coils, with less work, than any charts or tables we have ever seen.*
>
> THE EDITORS.

Of air core coils there are dozens of design formula, each adapted to a particular coil, in fact so many that it is often difficult to select the right one to use. In the case of iron core coils, variations in the iron make formulae more or less ineffectual and much less has been published. Even when the inductance of an iron core has been measured accurately under a given set of conditions, it will be found that the value will change rapidly if the current changes through it. If an abnormal direct current is passed through the coil, a PERMANENT change in the inductance is probable. There is an additional core loss with an iron cored coil when used with alternating currents. For these reasons air core coils are required in many cases.

Experience, it seems, has indicated to the present day experimenter the general type of coil that has been used by others for a particular job so that very little original thought has been put on the subject of late. This practice is not infallible, however.

Merely to suggest a few of the things to be kept in mind when designing coils, the following outline is offered.

Among the things to be considered in selecting the coil shape are: 1. inductance required, 2. maximum value of distributed capacity permissible, 3. resistance permissible, 4. current carrying capacity, 5. voltage to be impressed across terminals, 6. alternating or direct current use, 7. constancy.

1. The first item will often determine whether the coil should be wound on an iron core or not. Coils of the order of one henry or more are generally wound on iron cores unless other considerations prevent.

2, 3, and 4. Coils used in radio frequency tuning circuits are generally designed to have the minimum amount of distributed capacity possible. They furthermore have a minimum resistance. Factors controlling these items are thus largely dormant in the design of these coils. Very often as for a particular use the extent of the external field affects the shape best adapted. Often coils have to carry a large current without heating. In direct current circuits or low frequency circuits this means that relatively large wire must be used. In high frequency circuits special wire must be used that is capable of carrying large currents at such frequencies.

5. The insulation between turns and between the wire and other conductor parts will depend upon the voltage to which the coil will be subjected.

TURNS OF WIRE PER INCH FOR VARIOUS INSULATION

(Use with Chart 103, page four)

Wire Size	Enameled	S. S. C.	D. S. C. or S. C. C.	D. C. C.
10	9.5	9	8.75	8.5
14	15	14.5	13.5	13
16	18.9	18	16.5	16
17	21	20	18.5	18
18	23.5	22.5	20.5	20
19	26.5	25	22.5	21.5
20	29.5	27.5	25	24
21	33	31	27	26
22	37	34	30.5	28
23	41	38	34	31
24	46	42	37	34
25	52	47	41	37
26	58	52	45	39
27	65	58	49	42
28	72.5	64	54	46
29	81.5	71	59	49
30	90.5	78	65	51
31	101	85	71	55
32	113	95	78	59
33	127	105	85	63
34	143	115	90	66

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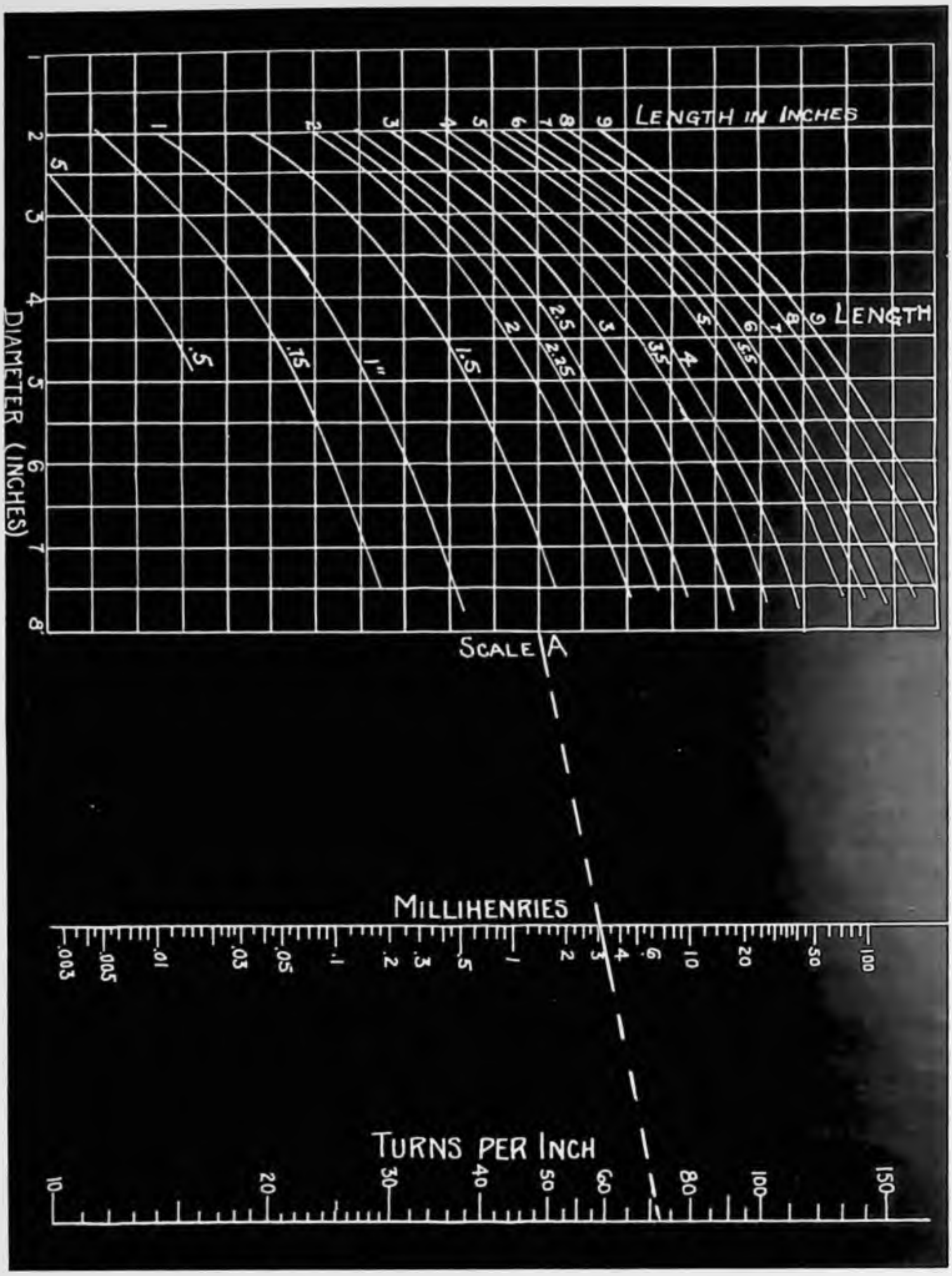

CHART 103. INDUCTANCE OF ONE-LAYER COILS
(Cylindrical or Helical)

The dashed line illustrates the use of the chart for two different problems. View the chart, right side down.

Problem A. A 3 millihenry coil is to be wound of No. 31 D. S. C. wire. What dimensions are necessary? From the wire table we find that No. 31 D. S. C. winds 72 turns per inch, therefore, we draw the dashed line from 72 on the "turns per inch" scale, through 3 on the "millihenry" scale to the scale A. The horizontal line we are following crosses the 1.5-inch (length) curve right at a diameter of 7 inches and so on. Offhand we can write down:

Length	Diameter
6	2.2
5	2.5
4	3.1
3	3.5
2	5.1
1.5	7.0

Problem B. On a coil-form 4½ inches in diameter and only 2¼ inches long we are to wind a 3 millihenry coil. How many turns are needed? Starting at 4½ on the "diameter" scale, go up until the 2¼-inch length-curve is touched, then go right to "scale A". From the point at which scale A is touched, draw a line through the desired 3 millihenry point on the inductance scale as shown. This line touches the "turns per inch" scale at 72. Now use the wire table on page 3.

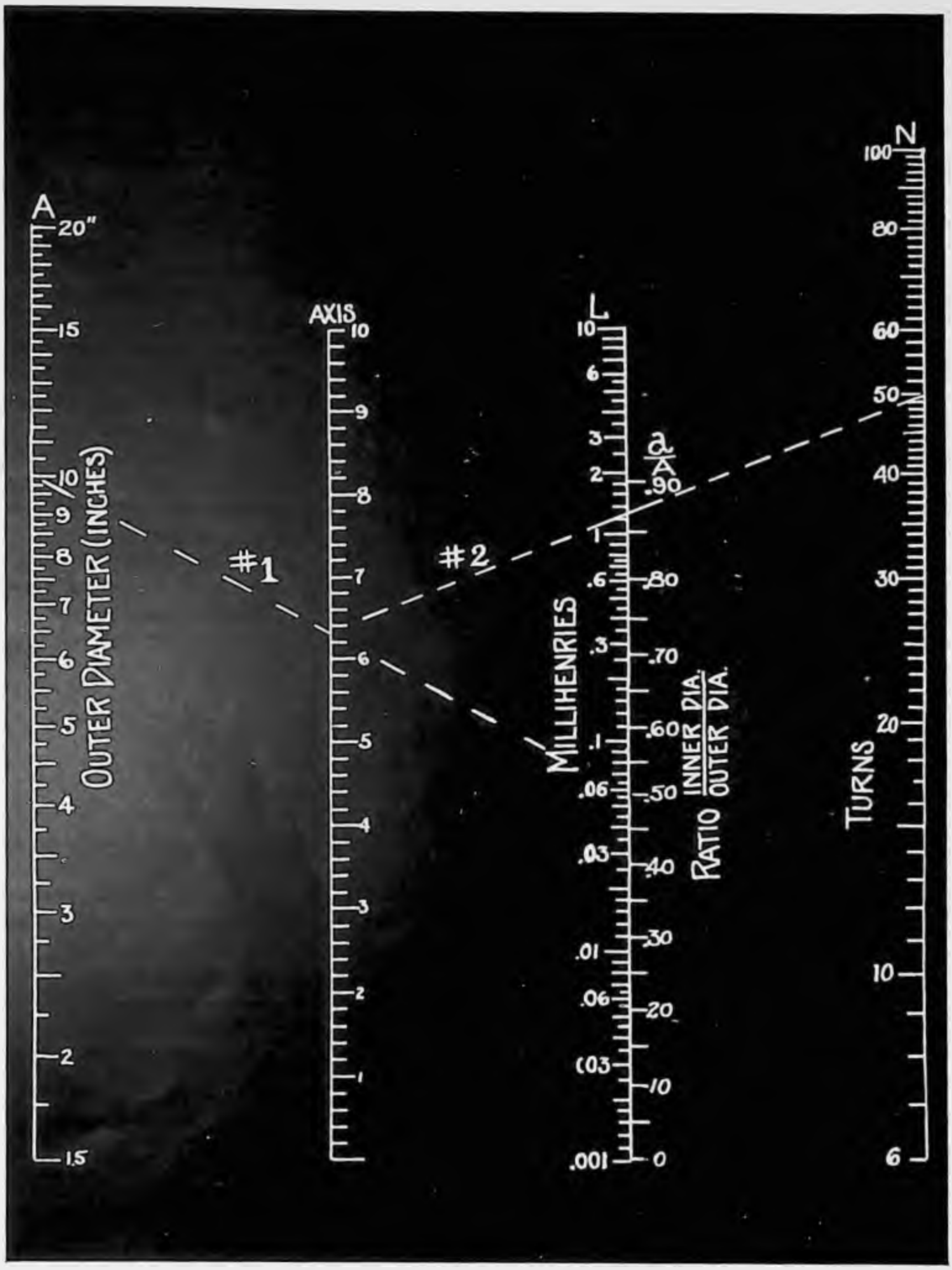

CHART 104. INDUCTANCE OF "PANCAKE" OR FLAT SPIRAL COILS

The dashed lines illustrate the use of the chart.

Problem A. A pancake coil has 50 turns of metal ribbon. Its outer diameter (largest turn) is 10 inches and its inner diameter (smallest turn) is 5 inches. What is the inductance? First divide inner diameter by outer diameter. 5/10=.5. Now from this value (.5) on the "ratio" scale, draw line No. 1 to the "outer diameter" scale at the proper point, which is 10 inches. Now from the point where line No. 1 crossed the "axis" draw line No. 2 to the "turns" scale, striking it at 50. Where line No. 2 crosses the "millihenries" scale, read off the inductance, which is found to be 1.28 millihenries.

Problem B. We need a 1.28 millihenry coil for a transmitter and have room enough so that its outer diameter may be 10 inches. How many turns shall the coil have? Since small turns are inconvenient, we prefer not to make the inner turn less than half as large as the outer, that is to say, we will assume a/A=.5 and see if it works out. We now draw line No. 1 from 10 on the A scale to .5 on the a/A scale. Where this line crosses the axis we will start and draw a line through the desired point, 1.28 on the L scale, and this line strikes the N scale at 50. Thus we will need 50 turns.

6. Certain precautions, which cannot be discussed now, are generally required when iron cored inductances are used in filter circuits and for other similar uses, when a direct current is superimposed on the alternating current.

7. Finally the factor of constancy often enters into the design of a coil, whenever the coil is required to maintain a practically constant inductance for a long period of time.

The above rather meager outline is, as was said, to indicate the extent of the problem only.

Basis of the Charts

Inductance has been defined in various ways. It is a ratio between turns squared and reluctance of path

$$TL = N^2/R$$

or for air coils

$$2L = N^2\ A^2/1$$

where A and 1 are area and length of path. Thus it will be seen that the inductance depends upon the turns and and the dimensions of the coil only (air core coils).

The ordinary unit is the henry with the following subdivisions:

Millihenry=1 henry x .001.

Microhenry=1 henry x .000001.

Centimeter of inductance=1 henry x .000000001.

Air core inductances will be taken up first since they are the most common in radio work. The author has found* that all types of inductances may be computed with the general formula $L = an^2Q$ where

a=diameter in inches (average).

n=turns in coil.

Q=a factor depending on dimensions of coil.

Several charts will be given for the value of L for various types of coils. All physical dimensions of coils required in the charts and formulas following will be in inches. However, if anyone desires to take down all measurements in centimeters, go ahead and use the formula or charts just the same with the centimeter values, but in the end **the** RESULT must be divided by the constant 2.54.

Similarly, if a formula is used that requires all values in centimeters, inches may be used throughout if desired, but multiply the result by 2.54.

Chart 103 gives a very simple method of solving for the inductance of single layer coils. It not only permits the rapid determination of the inductance of a given coil, but also for the selection of the dimensions of a coil to give a desired inductance.

A pancake, or spiral coil, (as well as numerous other types, such as spiderweb, etc.) may be solved by means of chart 104. The scales are self explanatory.

The inductance of a coil with an iron core cannot be obtained with accuracy as explained in previous pages, due to the variable nature of the iron.

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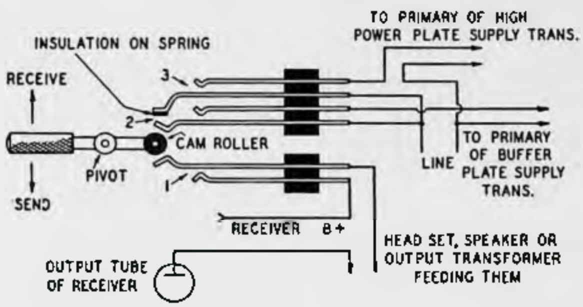
Better Than Breakin

After reading about a number of the complicated breakin or duplex radiophone schemes, which work (most of the time) if the other fellow's wave isn't too near your own, L. E. Toth of W1BNR (Unionville, Conn.) began to wonder if it wasn't a lot of wasted effort.

Accordingly he went back into history and resurrected the send-receive switch—and is having a lot of fun in explaining to the other fellow that his "remarkable breakin system" is nothing but a 1932 version of an 1890 idea. The real joke is that it works every time, regardless of the other fellow's wave, has no tricky adjustments, is lightning fast, doesn't touch any of the r.f. circuits—and costs $2.50 if you have to buy everything brand new.

The diagram shows the scheme as used in a transmitter with a 50 watt final r.f. tube which is plate-modulated by a class A audio stage. In one position the switch (spring pair No. 1), cuts the plate supply from the last tube of the receiver—in the opposite position it restores the plate supply to this tube and cuts the supply from the plates of the transmitting buffer (spring pair No. 2), the 50 watt r.f. tube and the audio system (spring pair No. 3). Nothing has to start, or stop, or get hot or cold—you can toss a laugh into the other fellow's sentence and catch the next word!

Since there may be fireworks if the buffer stops when plate voltage is on the large tubes it is necessary to set the buffer-supply springs (2) a little closer so they will close earlier and open later than the high-power springs (3). The buffer B plus lead can probably be cut directly if the contacts are shunted by 100 ohms in series with one mike. If not, use contacts to operate a FAST relay—and always have a bleeder on the buffer-supply filter so it will not be strained when the load is off. If the buffer plate supply comes from the same filter as the high-power plate supply you probably have a voltage divider anyway. If contacts (3) don't want to handle the B plus line to the high-power tubes, break the 110 volt input to them, directly or through a relay which must be a little slower than that on contacts (2). If two of the same sort are used a mere difference in the contact gap will provide the difference in speed. A revamped sounder isn't a bad relay—just add a bakelite extension onto the arm, mount a contact on it and run a flexible lead to the contact. Copper and carbon make a contact combination that does not weld or stick.

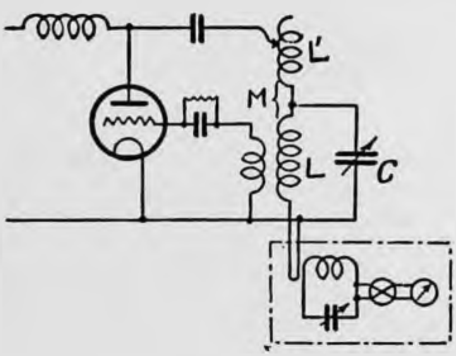


A Harmonic Reducer

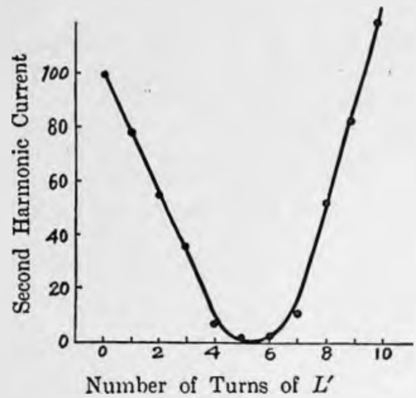
In the February issue of Proceedings of the Institute of Radio Engineers is a brief article by Yuziro Kusunose on a simple method of reducing harmonics radiated from a transmitter—and, after listening on 5 meters for a while one can work up a grand list of amateur and commercial c. w. stations that need such a thing.

The Kusunose arrangement is dead simple, works beautifully on amateur transmitters and we're pleased to call attention to it.

Briefly, a coil L' is placed in series with the tuned tank LC of the last r. f. tube of the transmitter and the clip on this coil is moved until minimum harmonic power is shown by a wavemeter coupled to the tank. The wavemeter appears in the dashed rectangle. Its indications will be in the manner of the curve, and of course the low point of the curve is the best point—in this case



a bit over 5 turns, though that's not uniform, nor is it the same for all the various harmonics. The tank current will drop somewhat, but it's the harmonic current that's gone, and all it did was to provide electric heating. In a 204A oscillator Mr. Kusunose found it possible to reduce the second harmonic about 96%. A second harmonic trap in place of L' was not as effective. Of course this, or any other circuit whatever, will put the least harmonic power into the antenna if the antenna coupling is capacitive—which seems to be distressingly rare in all classes of c. w. stations though nearly standard in broadcasting where "harmonic elimination" isn't a dream.



Just one warning—DON'T accidentally tune the wavemeter to the "main" (fundamental) wave

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NOT FUNNY

This cut came too late for our August issue, but it's run now to show all that the surprising 55 and 85 tubes look quite normal. See page 9, August "Modern Radio", for details.

Making Ohmmeters

By L. W. Hatry, Associate Editor

The amateur familiar with his home-built receiver needs only a continuity rig (ohmmeter), screwdriver, pliers and soldering iron to service it. Making the statement more general: The radio man familiar with fundamental radio circuits and their variations can service any radio receiver with the same equipment. True, he can work faster with an analyzer, but he simply cannot do without suitable ohmmeters. The ohmmeter is nothing more than a voltmeter and battery; or milliammeter, resistor and battery, as in Figure 1. It is the simplest, as well as the most useful, of test equipment in any shack or shop. Calibration is never a matter of difficulty, a paper and pencil is all that is required.

The circuit of the simplest ohmmeter is shown in Figure 1. It, as with all electrical devices, obeys ohm's law in spite of its operator. Unknown resistors are tested in series with the circuit.

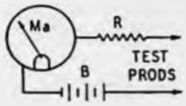


Fig. 1.

This form of ohmmeter may have any resistance range: The proper range is easily obtained from a simple and easily understood rule.

1. **The center of the ohm scale will show a resistance equal to the value of the resistor R of Figure 1. The useful range of the ohmmeter will be from a resistance a tenth as large as R to a resistance ten times as large as R.**

2. The meter M is operated by the CURRENT through it, regardless of whether it is a milliammeter or a voltmeter. (We have just said that a voltmeter is nothing but a milliammeter with a series resistance either inside or outside of the case.) Now suppose we start with a "1 mil." meter M, a 45,000 ohm resistor R and a 45-volt battery—and for the moment assume the

A typical ohmmeter scale.

meter itself has no resistance at all—which is practically correct for this example. Now if the test prods are touched together we will have one milliampere flowing through the circuit. 45 volts/45,000 ohms=.001 amp.=1 milliampere.

3. The meter will therefore just show full-scale deflection. It is, in fact, a 45-volt voltmeter.

Now if the test prods are separated and another 45,000 resistor placed between them, we will have 90,000 ohms altogether, instead of 45,000, hence the CURRENT will be one-half as great and the meter will give one-half of the full-scale deflection or "center scale". No matter what the actual values are, this type of ohmmeter will always give a half-scale ("center scale") deflection when the "test resistance" just equals the other resistances. Thus, theoretically, we would in our "example meter" find everything from zero to 45,000 ohms on the right half of the scale and everything from 45,000 on up to infinity (open circuit) on the left half. Since there is a terrible lot of ohms between 45,000 and infinity this part of the scale is unavoidably cramped—see the meter pictured herewith.

Figure 5 shows the best reason why "10-times-middle" and ".1-middle" represent the total useful part of the range of an ohmmeter from minimum to maximum. The scale above 10 times center is too crowded and that below .1 center likewise is too crowded. If the meter is 4 to 6 inches in diameter or else of exceptional precision (.25% or better), the rule may be ignored reasonably to extend the scale; otherwise extension is mere waste of time.

Practical use of the rule is quite simple: Given a 6-volt voltmeter, 66.66 ohms per volt and hence of 399.96 total ohms. With a six-volt battery the resistor under test is to all intents 400 ohms when the meter reads three volts.

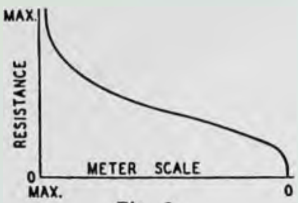


Fig. 2.

This combination consequently will show decently resistors between 4,000 and 40 ohms, incidentally a very useful range, and will give indications on 20 ohms or 10,000 ohms. The range above 4,000 or below 40 is inaccurate.

Or, you need an ohmmeter which reads only up to 10 ohms as its highest resistance. 10 ohms is accordingly 10 times the middle scale reading and also 10 times the resistance required at R. R, accordingly, is 1 ohm. What voltage do you want to use? The unit cell is 1½ volts in dry-cells or 2 volts in storage cells. The meter M, therefore, should show in the case of 1½ volts a current (in amperes) equal to 1½ divided by 1 which is 1½ amperes so a 1½ ampere meter is required. For 2 volts a 2 ampere meter. This meter will show a tenth ohm nicely. But a low range ohmmeter can be made without such heavy current consumption as will be explained later.

Suitable Ohmmeters for Radio Service

Judging by my experience in repair work, the radio man needs three ohmmeter ranges at least, to cover the most useful series of test problems.

These are ranges of 10-1,000 ohms, 100-100,000 ohms and 100,000 to 10,000,000 ohms. These ranges can all be built into one meter operated from a switch. The basic meter would be necessarily a 1 ma. meter. Due to the fact that standard dry-cells are 1½ volts each the requirements tailor to fit that limit. Range one calls for a 15 ma. current, 100 ohm circuit resistance and 1.5 volts. Starting with a Weston 1 ma. meter, buy it with the necessary shunt for 15 ma. (S1, Figure 3) (or make a shunt for it—shunts should not be made unless the meter is furnished the maker of the shunt) and buy a 100 ohm precision resistor made by Shallcross, I. R. C., Hickok, Weston (or Jewell). The next step, 1,000-100,000 ohms calls for 10,000 ohms for the meter. This does not work with standard cells, which add to 9, 10½ or 13½ volts, two C batteries, seven cells or three C batteries. Compromise on two C batteries or else seven cells, whichever you prefer. For 9 volts drop a half-volt for ADJUSTMENT and figure on 8½ volts, which with a 1 ma. meter calls for 8,500 ohms and gives an ohmmeter range of 850 to 85,000 ohms. This, of course, will hit the 100,000 mentioned with small compromise. A shunt variable resistance (S2, Figure 3)

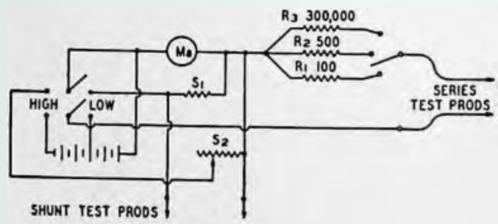


Fig. 3.

across the meter proper give a zero resistance adjustment (full scale current that is quite reliable and practically harmless to precision). This brings us to the circuit shown in Figure 3, which is self-explanatory. Of course, one may choose seven cells, 10½ volts, a 10,000 ohm resistor (R2), an exactly 1,000-100,000 scale and have the specified needs; you can settle this for yourself.

This brings us to the highest range or 100,000 to 10,000,000 ohms, which, because of the sets now in service, is becoming increasingly important. Accuracy on this range likewise is advisable and easily got with the S2 arrangement already made for zero adjustment. The required resistor is 1 megohm, the required voltage 1,000. Obviously impractical.

Consequently you and I have to compromise with available voltage sources (since precision resistors of 1 megohm are easy to get). Most every shop or shack has a source of 200 to 500 volts, I happened to have 300 volts. Consequently with my 1 ma. meter I used a 300,000 ohm resistor and a 300 volt B supply. I knew that the resistance of the chokes of my B supply was only 800 ohms so that the B sub. was not, at 1 ma., introducing an inaccuracy greater than about a quarter per cent. —unimportant. Therefore, 300 volts gives the very useful resistance range of 30,000 to 3,000,000 ohms, indications of 20 megohms for condenser leakage and thus covers major needs quite practically. If the chokes were of importance because of excessive resistance, they could be shorted out of the circuit without harm, the condensers alone being sufficient filtering at 1 ma. Zero adjustment is made with S2 as before.

Calibration

Calibration of the ohmmeter is easy if a precision R3 is used as recommended. Any point on the scale may be calculated with absolute accuracy from that knowledge used in the ratio below:

Scale reading=

$$\frac{R}{R + Rt.} \times Sf. \qquad (A)$$

R is the resistance R1, R2 or R3 in the circuit Figure 3, the ohmmeter's basic resistance. Rt. is the resistor under test. Sf. is the full scale of the meter (1, in this case).

For example: We have made the meter mentioned, the full scale is 1 (1 ma.), the resistor is 100 ohms and we are ready to calibrate. The first point we get is the 100 ohm point, at center of scale or .5 ma. We decide to find the 10 ohm reading, which is to say Rt. equals 10 ohms. Our base resistor is 100 ohms. The formula accordingly turns into:

Scale reading=

$$\frac{100}{100 + 10} \text{X } 1 = \frac{100}{110} \text{X } 1 = \frac{10}{11} \text{X } 1$$

Whence we know that 10 ohms will show up at 10/11 of the scale or at .91 ma. approximately. Therefore, we proceed to mark that point on the meter dial as 10 ohms or else to count that as one point in a graph of calibration. Another example: If we drop back to the 6 volt, 399.96 ohm, meter used as illustration a while back. Wanted: Dial reading for 850 ohms. First call 399.96, around 400 ohms, from which:

Scale reading=

$$\frac{400}{400 + 850} \text{X } 6 = \frac{40}{125} \text{X } 6 = 1.92$$

and so on.

Continuing the Ohmmeter

The ohmmeter of Figure 3 has other uses. This is fortunate since the serviceman can use lower scales than 10-1,000 ohms. The lower scale can be easily got by using the ohmmeter as a SHUNT instead of a series test-rig.

The fundamental circuit is shown in Figure 4. Here the test resistor is shunted across the meter movement. A

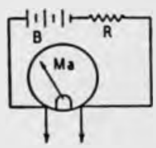


Fig. 4.

1 ma. 30 ohm Jewell meter will give a range of 3 to 300 ohms. In other words, rule 1 still applies although the resistance R is now the MOVEMENT resistance and the test is essentially independent of external circuit resistance PROVIDED IT IS NOT TOO LOW.* Since 3-300 ohms is not the desirable range, we have to aim at the next best range: This is available with the constants given, since in Figure 3 the shunt S1 raises the meter to 15 ma. and reduces the total meter resistance to, say 1.875 ohms ($\frac{1}{16}$, an original [Jewell meter] 30 ohm resistance). This means a range of .187 to 18.75 ohms; which

nicely covers the necessary resistance range met with in poor solder joints, loose screws, tuned circuit coils (2.5 to 12 ohms) and so on. This is not a precision range, accuracy is not as important as comparative readings. For this range the resistance scale increases in the SAME DIRECTION AS THE CURRENT RANGE, from left to right, and

Fig. 5.

just the REVERSE of the series ohmmeter scales (Figure 5). Calibration accordingly is from the formula rearranged to:

Scale reading=

$$1 - \frac{R}{R + Rt.} \times St. \qquad (B)$$

Thus: Scale reading of 10 ohms=

$$1 - \frac{1.875}{1.875 + 10} \times 1 = .84 \text{ ma.}$$

Just remember that R in (B) is the resistance of the meter coil, Rt. is the test resistor to be shunted across the coil, Sf. the full scale figure, whether amperes, milliamperes or volts and "1 minus" is always the same.

* Part 2 will discuss avoiding inaccuracies; other versions of the ohmmeter for greater accuracy, and equally divided scales in place of the type of scale in Figure 5.

LAWSUIT?

"Your belated letter of the 1st, requesting permission to publish my previous letter, comes with the latest issue of 'Modern Radio' and leaves me with no alternative but to bring suit for unauthorized publication.

"There is no doubt that 'Modern Radio' grows progressively better, as witnessed by the last number.

"More power to you!"

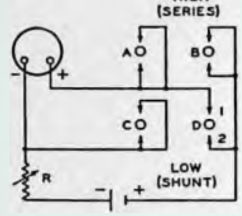
L. C. F. Horle, New York City.

MORE ON THE COOPER OHMMETER

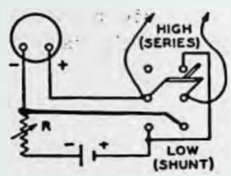
We've been asked a number of questions on the Improved Cooper Ohmmeter described in our August issue. Here are the answers:

The meter used was a Weston model 506 with 0-1.5 Ma. range, for which we will be pleased to send you scales as explained in the article. If you wish to make up your own scale you may use any 2 or 3-inch meter with a full-scale range of 1 or 1.5 Ma.

In the original Cooper diagram, shown again herewith, each pinjack is represented by a circle and two arrows. We still don't see anything mysterious about this but are perfectly willing to explain



—the circle is the hole in the bakelite, the arrows are the jack-springs, two to a jack so as to improve contact and guide the pin. In jack D they are not connected together and, therefore, serve the further purpose of acting as a switch which (in effect) closes when the pin is pushed between D1 and D2.



The variation using the switch was shown with one wire missing—the one that's heavy now.

Now as to transformer work. The idea is that with the 1 to 100 ohm range (useful range that is) one can easily and quickly tell which is the line winding, which the high voltage winding and which the filament winding, also a rectifier filament winding is readily distinguished from the regular 2.5-volt filament winding. With sets using 6.3-volt tubes it isn't quite so easy, so one must "look a little out".

Audio Transformer Impedance Estimation

The experimenter, or the amplifier builder, is frequently in the position of needing to know the impedance of transformer. The serviceman often has the same problem. This can be done with bridges (that few of us have), but useful approximations can be made with a multi-range a.c. voltmeter. Nothing more.

Finding the Primary-to-Secondary Turns Ratio.

The turns ratio of a transformer is related to its impedance ratio by a square law. This is probably simpler to think out if we remember that when a transformer has 3-1 ratio and the primary has 10,000 ohms impedance the secondary has 3 times the turns of the primary but 9 times the impedance; or conversely if we know the secondary impedance to be 900,000 the primary would be one-ninth, which is 100,000 In other words, if we know one impedance and the turns ratio we can always get the other impedance. In most cases we get (or guess reasonably) at one impedance and have to find out the turns ratio.

To find out the turns ratio. As in Fig. 1.. Connect the higher impedance side of the transformer (or the higher resistance side if you are not sure of windings) to the 110-volt a.c. line. This gives a step-down transformer connection and measurement of the a.c. voltage out of the remaining winding will give the voltage ratio of this transformer if we divide the output voltage into the line voltage, having measured both. The turns ratio and voltage ratio of a transformer may be regarded as identical, for all practical purposes, so we have the actual ratio. (One exception is explained a bit later.)

When the transformer is of too low impedance on both sides to allow it to be connected to the 110-volt line safely (even for a short while), a lower a.c. voltage should be used and this of course is easy to get from an a.c. receiver or from any ordinary filament or power-pack transformer.

Trouble Ahead.

Errors caused by this method of getting turns ratio are a result of the heavy current requirements of the normal a.c. voltmeter. A rectifier type a.c. voltmeter generally eliminates this worry. However, we may approach reasonable correction of such errors by remembering the load that the a.c. voltmeter puts on the transformer; on the average figure about 100 ma. for 4 or 8-volt a.c. scales, 50 ma. for 16-volt scale, and 20 ma. for the 100-150-volt scale. 750-volt scales will take about 10 ma. These figures are in general high because it is best to play safe and figure a little

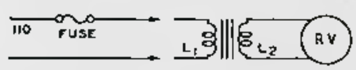


Fig. 1. L1 is for the moment the highest resistance winding, found by ohmmeter, Rv is a rectifier-type voltmeter with a scale of at least 0-100 volts. If that fails to read try lower scales. If no such meter is available, estimate as explained in the text. The ohmmeter used to identify windings MUST have a decent, scale down to 1 ohm. This is just one more reason for building the extra-simple device described in our August issue.*

too much. In any case, knowing the ohms per volt of the meter in question will settle the problem. The d.c. resistance of the winding under measurement should not be more than a tenth of the meter resistance for fair accuracy.

Our job is to measure approximately normal operating conditions, meaning that the transformer's load should be about what it was designed for. If the transformer is intended to work into an extremely high-resistance load (Class A grids) for instance we should theoretically measure with a vacuum tube volt-

* Copies at 20c, of course.

meter only! The windings of such transformers are of fine wire and the voltage-drop of the voltmeter current tends to give a low reading, therefore a false voltage ratio—and turns ratio. For such a transformer it is accordingly especially important to use the rectifier-type of voltmeter, whereupon the error is small.

Estimating Low-note Fidelity.

On the other hand if the transformer is supposed to work into a low impedance (say 200 ohms) we will have a somewhat false result if we load it only with a voltmeter of many ohms more. However, this very thing enables us to

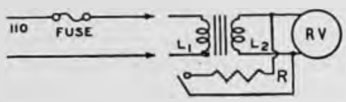


Fig. 2. The resistance R should have a resistance such that it and the voltmeter together produce the proper load impedance. Fortunately it is usually good enough to neglect the meter-drain and make R equal to the design-load of the transformer.

get (very simply) a fair idea of the low-note performance of the transformer. First connect as in Fig. 1 and read the voltmeter, then connect R as in Fig. 2 and again read the voltmeter. If the voltmeter reading changed very little the transformer is quite good at 60 cycles; if the change is large the transformer is NOT good at 60 cycles and if good audio fidelity is desired we must devise some sort of a circuit-trick to "bump up" the low end.

If the transformer being measured has a push-pull primary for 245 tubes, we know that it is supposed to have about 7500 or 8000 ohms impedance for the tubes. If we measure with the voltmeter, find an apparent voltage ratio of 2-1 from primary to secondary (secondary shows 55 volts or near that) we know that the secondary impedance is supposed to be one-fourth of the primary impedance or 2000 ohms. The meter may have, say, 11,000 ohms rating (100 ohms per volt, 110-volt sale). Shunt the secondary in addition to the meter with the correct approximate load impedance of 2000 ohms as in Fig. 2.

The first is that two important considerations must be kept in mind, the test schemes described use the transformer "step-down" and the load is put on the "low" winding and must be suitable for that side. Thus in Fig. 3 the loads marked X are the proper ones to duplicate, even though we ordinarily work some of these transformers in the opposite direction.

Impedance Estimation.

We now come to the matter of estimating impedances. The most useful guide to this is tube tables; if we have reason to believe a transformer is supposed to work from a 227 to a pair of push-pull grids we are reasonable in assuming that the 227 winding is about 12,000 ohm impedance from which once we have measured the voltage or turns ratio we can find the total secondary impedance. Notice I said TOTAL secondary impedance. This secondary is center-tapped, either half of the secondary will have a quarter of the impedance of the total secondary; figure it out.

So on with any transformer. A transformer suitable for working out of 171A into a speaker will have a primary impedance of about 4000 ohms, and the

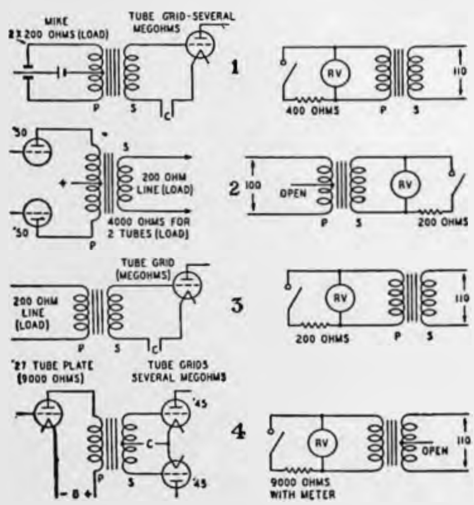


Fig. 3. A few cases that may be confusing. These are all for Class A operation. For testing Class B equipment some modification of the test schemes is required. We hope to show these later. 1 is a microphone transformer. 2 is an output transformer. 3 is a line to grid transformer. 4 is a tube to push-pull-grids transformer. Nos. 1, 2 and 4 are reversed for testing, else a proper load is impossible.

same applies to the 245 and 250, since the load requirements of these tubes run from 3500 to 4200 ohms. We double these figures for transformers with push-pull primaries, remembering that half the primary has not half the primary impedance, but one-quarter as much.

One other detail to remember is that a transformer specified for a certain impedance has that impedance if the load is a pure resistance, and will tend to have an impedance based on the load as long as the load is a pure resistance; if we put 200 ohms across a 2000 ohm impedance the tendency of the transformer is to have 200 ohms reflected through the impedance ratio to the other winding as, e.g., 2000 to 6000 changes to 200 to 600 under the new load conditions. If the load is not a pure resistance, such as a microphone, but an inductance such as a transformer, we must match windings on their apparent impedance basis at any one frequency; they will then stay reasonably well in match at other frequencies.

Of course, do not forget that the lower frequency limit of a transformer is always bound to occur at some frequency when operated on audio and hence varying frequency; this is due to the inductive reactance change. A primary winding on a transformer of 10 henrys aimed at a 227 tube for example, will show less than 13,000 ohms reactance at any frequency below 200 cycles approximately and hence will gradually become worse and worse below it. In general, the reactance of a transformer primary at this limit will be approximately ten times the d.c. resistance so that this limit and the inductance may both be safely estimated for practical purposes. This rule is useless if the wire-size is changed a great deal and hence must be used with some judgment. A transformer, for example, wound for 9 ma. and 5000-ohm impedance will have a higher d.c. resistance than one wound for 20 ma. and the same impedance, but current ratio is approximately the ratio of d.c. resistance as a modifier for the 10-1 rule which is applied to a transformer aimed at 10 ma. usually.

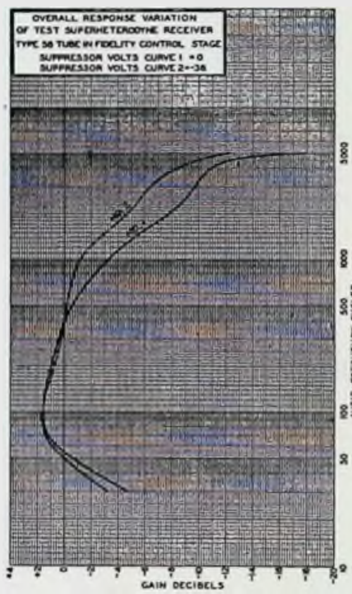
LOOKIT!

Did you see the Quiz-Matic on page 19?

Automatic Tone Control

The Engineering Service of RCA-Cunningham has proposed in its bulletin the possible usefulness of an automatic tone control. The idea is this—as one goes from a strong station to a weak one (or if the strong one fades down) the noise-background becomes more noticeable. The usual cure is to cut down the tone control so as to eliminate high notes of which most noises consist.

It is suggested that the thing be done with a 58 tube in the i.f. stage just before the second detector. The preceding stage is made quite selective and



the last i.f. stage is used for volume and tone control by varying its suppressor-grid voltage from 0 to about minus 40 volts. As is seen from the chart the resulting change in the internal plate resistance of the tube so changes the selectivity of the tuned circuits joined to it (the i.f. transformer) as to produce the desired "cutting" of the high notes. The change of suppressor voltage can be accomplished by an additional potentiometer on the manual volume control, or in a number of possible ways by devices associated with the automatic control system.

Audio Output Tubes

TYPE	210 Triode	220 Triode	231 Triode	233 Triode	238 Pentode	LA Pentode	241 Pentode	242 Pentode	245 Triode	46* Class A Triode	46* Class B Triode	247 Pentode	250 Triode	89 Class A Pentode	89 Class A Triode	89 Class B Triode
Bulb	S-17	T-8	S-12	S-14	S-12	......	S-17	S-17	S-17	S-17	←	S-17	S-21	Dome	←	←
Base	4 Pin	4 Pin	4 Pin	5 Pin	5 Pin	5 Pin	6 Pin	6 Pin	4 Pin	5 Pin	←	5 Pin	4 Pin	6 Pin	←	←
Pin No. 1	Grid	Grid	Grid	Grid	Screen (to + 135)	Grid	Screen (to + 167)	Screen (to+250)	Grid	Inner† Grid	←‡	Grid	Grid	No. 2 Grid§	←¶	←‖
" No. 2	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	←	Plate	Plate	Plate	←	←
" No. 3	F+ or −	F +	F +	F +	F + or −	F + or −	F + or −	F + or −	F + or −	F + or −	←	F + or −	F + or −	F + or −	←	←
" No. 4	"	F −	F −	F −	"	"	"	"	"	"	←	"	"	"	←	←
" No. 5	None	None	None	Screen (to + 135)	Cath. and Suppressor	Screen (to + 165)	Cathode	Cathode	None	Outer† Grid	←‡	Screen (to + 250)	None	Cathode	←	←
" No. 6	None	None	None	None	None	None	Grid	Grid	None	None	←	None	None	No. 3 Grid§	←¶	←‖
Cap	None	None	None	None	Grid	None	Grid	Grid	None	None	←	None	None	No. 1 Grid§	←¶	←‖
Filament V	7.5	3 to 3.3	2.0	2.0	6.3	6.3	6.3	6.3	2.5	2.5	←	2.5	7.5	6.3	←	←
Filament A	1.25	0.125	0.13	0.26	0.30	0.3	0.65	0.65	1.5	1.75	←	1.75	1.25	0.4	←	←
Input Grid Bias	− 39	− 22.5	− 22.5	− 13.5	− 13.5	− 11.0	− 12.5	− 16.5	− 56	− 33	0	− 16.5	− 84	No. 1 at − 18	No. 1 at − 20	No. 1 and 2 at 0
Mu	8	3.3	3.8	70	100	100	215	220	3.5	5.6	Varying	150	3.8	135	4.6	Varying
Plate Res.	5,000	6,300	4,950	50,000	100,000	50,000	120,000	100,000	1,670	2,380	"	6,000	1,800	80,000	3,000	"
Mutual Cond.	1,600	525	760	1,450	975	2,000	1,800	2,250	2,100	2,350	"	2,500	2,100	1,600	1,570	"
Plate V	425	135	135	135	135	165	167	250	275	250	400	250	450	160	160	180
Plate Mils	18	0.5	6.8	14.5	9	17	16.5	34	36	22	6 Each	31	55	17	17	3 Each
Load	10,000	6,500	9,000	7,000	13,500	8,500	......	......	4,600	6,400	1,450 × 2	7,000	4,350	9,000	6,000	3,400 × 2
Audio M. Watts	1,600	110	150	700	525	1,200	......	......	2,000	1,200	20,000 per Pair	2,500	4,600	1,500	300	6,000 per Pair

* 46 tubes have two grids. If pin 5 is tied to the plate (pin 2) see Class A column, but if it is tied to the input grid (pin 1), see Class B column. Class B tubes are always used in push-pull pairs.

† Pin 1 used for input, pin 5 tied to pin 2 (plate).

‡ Pins 1 and 5 tied together, serving as one grid.

§ No. 1 grid (cap) for input. No. 3 grid (pin 6) tied to pin 5 (cathode). No. 2 grid (pin 1) used as screen, with 3 Mu at 180 volts.

¶ No. 1 grid (cap) for input. No. 2 grid (pin 1) and No. 3 grid (pin 6) tied to plate (pin 2).

‖ No. 1 grid (cap) and No. 2 grid (pin 1) tied together for input. No. 3 grid (pin 6) tied to plate (pin 2).

General Note — Class B tubes are very high mu. Their "resting" plate currents are shown. With signal it may rise to 10 times this value.

SUPER-SELECTIVITY

Mr. James J. Lamb, Technical Editor of "QST", has devised a short-wave superheterodyne with controllable three-range selectivity, obtained by switching in the i.f. system. With the switch in the position for highest selectivity a crystal is switched in as a filter, in a manner reminiscent of the Robinson "Stenode." The resultant selectivity is such as to permit c.w. reception virtually one signal at a time. For other classes of transmission the selectivity is reduced in two steps, putting the crystal in parallel or cutting it out altogether.

The device is described in the August and September issues of "QST."

THE FIFTH ONE

Jenkins & Adair of 3333 Belmont Avenue, Chicago, offer the fifth successive type of broadcasting microphones in their Type E, which is a condenser microphone carrying a TWO-STAGE amplifier in the microphone head. For

Type E-6.

this latest design are claimed further improvements in fidelity (calibrations are available), a very high output level because of the two-stage amplifier (16 db., which is about 20 db. above the usual carbon mike), non-microphonic performance because of the use of 864 tubes, good appearance due to the use of a brown-enameled and gold finish, and adaptability for floor, table or suspension mountings, including boom mountings. The price, with a 20-foot shielded cable, is $225. The device operates at .25 amp, 6 volts and 3 Ma., 180 volts.

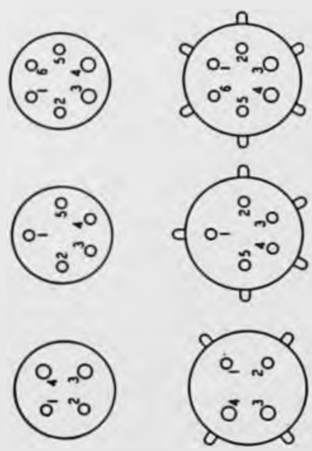
NEW UNIVERSAL MICROPHONE

The Universal "Bullet" microphone is a carbon unit with sex-appeal. A heavy chromium plated metal tube as shown accommodates a single dry-cell as microphone battery and also contains an "acoustic modifier" for tone corrections which is adjusted by means of a screw set into the tube. The microphone proper is any one of three double-button units regularly manufactured by Universal. In all the microphone makes a very handsome appearance in public address or similar work. Prices range from $50 to $100, list.

The "Bullet" is made by the Universal Microphone Co. of 424 Warren Lane, Englewood, Calif.

STANDARD NUMBERING OF 4, 5, AND 6-PIN BASES AND SOCKETS

To be used with table facing this page.



The Allied Arts

BOWING TO EDISON

The phonograph industry—which includes "electrical transcription"—has spent a great deal of time and effort in dodging Edison's original phonograph principles. Edison recorded on a cylinder, therefore a disc had to be used. Edison's reproducing needle was of sapphire and never needed renewing; therefore, everyone else had to use all sorts of temporary and semi-temporary needles of metal. Edison provided a mechanical device for drawing the reproducer across the record; wherefore everyone else decided the record would have to drag it along unaided. Finally, Edison's recordings were done by the so-called "hill-and-dale" method; which is to say, the little ditch did not wiggle, but merely changed its depth—the needle always following the center of the groove. Edison stuck to every one of these ideas except that of the cylindrical record. He, too, adopted the disc and his "diamond disc" was certainly the best phonograph the industry produced until aided by the radio and telephone arts.

Gradually the correctness of Edison's ideas has been admitted. The better machines now provide a drive for the reproducer, they use a sapphire (or other jewel) stylus for reproduction, and in the latest Bell telephone method of sound recording, the wiggle-waggle method of cutting is finally added to the junk heap and replaced by the hill-and-dale cut. We now have an Edison phonograph, 1932 version, greatly improved by Bell Laboratories, but fundamentally, the phonograph of Thomas Alva Edison.

DIRECT-TO-LINE SUNLAMPS

The sunlamp, which has been such a genuine relief and benefit to those of us condemned to live in the sunless states during the winter, has always been troublesome because it operated at a low voltage, around 10, and started at a somewhat higher voltage around 30. Its use, therefore, necessitated a step-down transformer which furthermore had to be somewhat special so as to run at 30 volts under light load—dropping to 10 volts (or thereabouts) when the mercury arc started. One had to buy or make this transformer. In a new lamp just announced by Arcturus Radio Tube Company, the transformer is avoided and the bulb operates on the 110-volt mains, also it is available in 60, 100, 150 and 300 watt sizes. Like other health lamps it is intended to radiate the wavelengths in the vicinity of 2,800-3,100 Angstrom units, and to filter out (by use of proper glass) the shorter wavelengths, which are not safe in amateur hands.

DYNAMOMETER METERS AT LAST

The Hickok Electrical Instrument Company of Cleveland, Ohio, is offering reasonably priced dynamometer-type meters. The beauty of such meters is in that they are correct at d.c., and at all frequencies to 5,000 cycles, furthermore the a.c. scales are not badly cramped at the LOW end.

Vacation Scars

Apparently we are not over-staffed; as soon as one man went on his vacation we made errors! Under Figure 12 (August, page 16) we said "in the amateur form, the iron-wire termination (of the diamond antenna) becomes a simple resistance as in Figure 13."

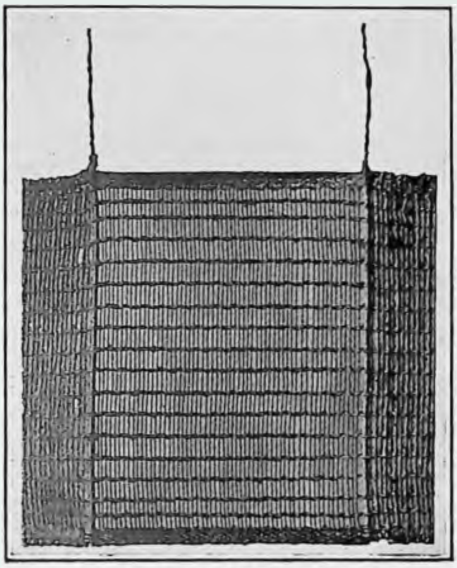


Fig. 13a. "Ohmspun".

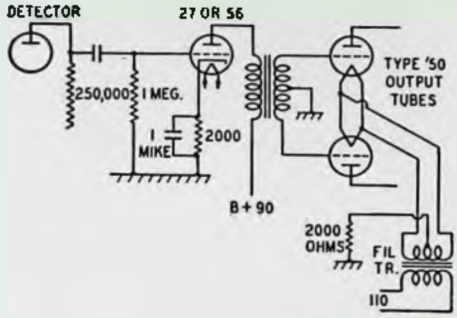
Fig. 13b. "Truvolt".

Here's Figure 13! For receiving or low-power sending use a 1,000 ohm adjustable Electrad "Truvolt" with a watt rating four times that of your output tube. For larger powers use States Company "Ohmspun" mica-and-asbestos resistance cards, three of 230 ohms, two tapped ones of 115 ohms. Any details you need can be had from "Modern Radio".

The antenna structure of the diagram continues to work very well for us and we'll tell you more about it later.

MODERN RADIO QUIZMATIC

This amplifier will, unlike the one of last month, produce plenty of gain and poor fidelity.



1. Why is the fidelity poor? What is to be done about it?

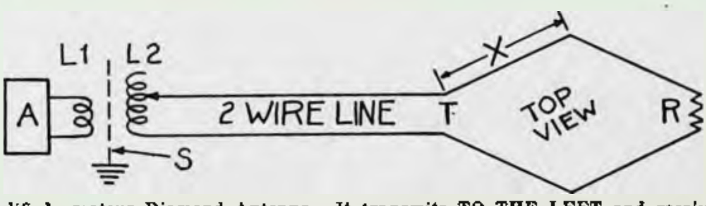
2. Why will the output be low? What is the cure?

Three things are wrong. For the best explanation we will give one year's subscription (or extension), and for each of the next four we will give six months. The editors do the judging and may print the winning answer. Use diagrams, if you please.

Another QUIZMATIC next month.

Winners for the August QUIZ-MATIC will be announced in the October issue.

A VERY SPECIAL QUIZMATIC IN OUR NEXT ISSUE.



The simplified amateur Diamond Antenna. It transmits TO THE LEFT and receives FROM THE LEFT. If R is wrong it may work a little to the right. Reception and transmission at right angles —negligible.

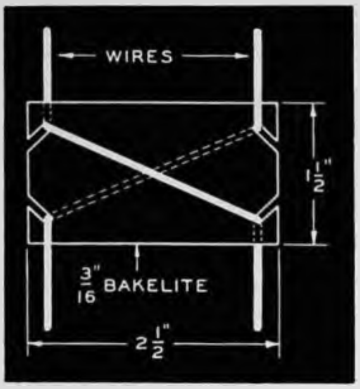


Fig. 1. Makeup of the Wallace Block.

Wallace Blocks

By L. W. Hatry, Associate Editor

In "Radio" for April, 1932, Don C. Wallace,* well known for his fine amateur station and winner of the Hoover Radio Cup, described the transposition feed-line antenna system he has been using for many moons. "Modern Radio" is presenting this abstract to its readers because shielded leadin anti-noise aerials are dissatisfactory for short-wave reception, whereas the Wallace transposition leadin is highly satisfactory and may be used on a variety of receivers.

The essentials of the antenna are shown in Figure 1. The top portions A1 and A2 are of any useful length. The feed-line is transposed every fifteen inches across small blocks of bakelite such as the Wallace block shown in the photograph, Figure 2.

Transposition of the leadin in this fashion reduces **pickup by the leadin** to a very small amount. But the advantage of having transposed the leadin will not have been gained if some judgment is not used in putting up the antenna.

The top A1-A2 should if possible be placed in an open space free from light-lines, houses and as remote from passing automobiles as possible. In this way the open top of the antenna is probably free from noises of the various sorts which of course are strongest near lighting wiring and house-wiring. The leadin then may run to the receiver, and since the leadin is incapable of pickup, noise sources near the leadin will not have great effect.

* Western Representative for "Modern Radio," 4212 Country Club Drive, Long Beach, Calif.

Of course, although the leadin properly transposed is greatly reduced in pickup, SOME pickup is possible. Therefore (if possible) keep the leadin from being near to, or parallel to, lighting wiring.

A properly installed system of this sort will result in double benefit: Reception will be stronger and noise lower, with the overall result that noise seems actually to be reduced tremendously.

The transposition leadin system will benefit antenna users who have not the

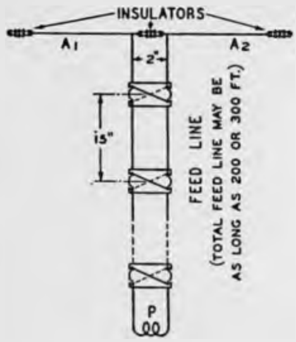


Fig. 2. Transposition leadin system using Wallace Blocks. P is the antenna winding of the short-wave receiver. If P is "grounded" in the receiver it must be disconnected so that Fig. 1 may be followed exactly. Feedline and top are made of No. 14 solid copper enameled wire.

advantages of open lots or other spaces which are reasonably free from noise. It will benefit because the average antenna top is far more free of noise pickup than the leadin wandering about the house and near the house wiring. By using a transposed leadin system the leadin is rendered worthless as a pickup and the relatively quieter top A1-A2 will then give maximum benefit; which is considerable.

In any case remember that the one direction always available for movement into lower noise area is UP; raise the antenna top and depend on height. A vacant lot is often just as good and calls for less "up."

Twisted leadins and the like give anti-

(Please turn to page 23)

You can't imagine how convenient it is to have the *Christian Science Monitor* collect for us "shorts" like the following three:

Among our special ambitions is to be the weak link in a chain letter.—*Toledo Blade.*

What this country needs is a 50-cent decoy lawn mower for lending. (If its past lawn-mowing time in your state make that a 10-cent snow shovel.)—*Detroit News.*

But if you are so law abiding, why do you slow down when you hear a motor cycle coming from behind?—*San Francisco Chronicle.*

Resistor News

INTERNATIONAL

International Resistance Company offers both 3 and 5 watt "PB" resistors with wire windings and a tough, heat-resisting vitreous enamel covering.

Several sorts of resistor "kits" are offered for the convenience of the service man. One contains 20 of the 2 watt MR-4 resistors ranging from 500 to 500,000 ohms, another contains 10 resistors of such value (resistance and wattage) as to bias almost any tube or pair of tubes.

The Two Kits.

"DIVIDOHMS"

The Ohmite Mfg. Co., of 636 North Albany Avenue, Chicago, offers a new line of adjustable-contact resistors of

the vitreous-enameled sort wound on isolantite in 3 sizes, 2, 4, and 6 inch—30, 55, and 75 watts, with resistance ranges from 1 to 1,000,000 ohms. Ask for their Bulletin 10.

SPEAKING OF RESISTANCE

About the best way to make a sales prospect too angry to buy is to begin your sales talk with—"Do you know that———"

WALLACE BLOCKS

(Continued from page 20)

noise effect and work very well in the broadcast band but in the short-wave region the losses in such leadin are so high that the benefit gained is appreci-

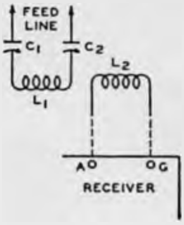


Fig. 3. A better coupling to converters and receivers of standard type is the circuit above. C1 and C2 are 100 uufd. midgets ganged to one knot (or two knobs). L is 15 turns No. 22 D. S. C. on 1½" tubing or coil form. L2 will have 4 to 10 turns depending on the receiver. C and C help tune the feeders and give improved reception on certain stations.

ably reduced; transposition leadins are much better.

This form of antenna has aroused so much interest and has proved so effective that as a result of the article in "Radio" by Mr. Wallace other individuals have followed in his footsteps and publicized the transposition leadin for practical short-wave reception.

The ORIGINAL Wallace blocks are made by Twining-Scott, Inc. of 215 E. Washington Boulevard, Los Angeles.

THANK YOU!

"Indeed, 'Modern Radio' has won its spurs. It is the one magazine out of many that we receive here at the factory which we all read including Mr. DuPuy, our chief engineer."

Wright-DeCoster, Inc.,
G. H. Wright,
President.

" 'Modern Radio' is great. If you keep up the good work you ought to gain prominence rapidly. Allow me to compliment you on the frank manner used in the articles. The concise and interesting article appeals to a great many who are 'fed-up' on the rambling style so popular in present-day periodicals."

C. Howlett, Jr.,
Utica, N. Y.

HURRAH!

The transmitting amateur must be pretty sick of "plug in" transmitting coils that don't plug in at all, but require wingnuts or even tools to make a connection good enough to carry the heavy currents of the so-called "high-C" tank circuits. Now we have pointed out before that this "high-C" business is much overdone and costs a lot of money needlessly, but used in the right places there's good reason for it—so we cheer at the new States Company (Hartford) spring plug which will carry a hundred amperes without seeming to get heated up about it, yet comes out decently when pulled gently. Truly it must be handled to be appreciated. The plug part is drilled so that a ¼" copper tube can be put into it and soldered, easily. The jack is in two pieces so it may readily be mounted through a strip or sheet of metal or insulation, but there's a through-hole for ¼" wire or tube, and a husky screw to clamp it—or the same screw may be used to make a lug connection, non-turning type or plain, ordinary lug. "Modern Radio" will be glad to send further details.

"MODERN RADIO'S" ANSWER FACTORY

How?—What?—Why?—Who?—When?

A—Letter with one question........$ .50
No charge for small incidental pencil sketches.
B—Additional questions, each...... .25
C—Schematic diagrams of battery-driven receivers up to 6 tubes, transmitters up to 5 tubes, antennas (other than beam types), switching schemes, metering, and power circuits of reasonable simplicity...... .75
D—Matters such as given under C, where all constants are desired.... 2.00
E—a.c. or d.c. socket-power receiver circuits without constants......... 1.50
F—Same as E but with all constants 3.00
G—Transmitter diagrams of greater complexity, bibliographies, operating instructions, analysis of complex operating difficulties in apparatus, and other questions not covered by the above will be estimated on receipt of a clear and complete statement of the problem.

NOTES

1. Keep a copy of your letter, including diagrams, numbering questions 1, 2, 3, 4 and lettering diagrams a, b, c, d.
2. The right is reserved to return remittances for any questions which it is impossible to answer.
3. No attention will be paid to radiograms, telegrams or letters (other than those under class G) which are not accompanied by a remittance. Please use money order—loose cash may not arrive.
4. Address letters, "Modern Radio", 101 Allyn Street, Hartford, Connecticut.

HICKOK STATIKTESTER

The Hickok "Statiktester" is so named because it contains equipment for measuring the inductances, resistances and capacities of a radio receiver which is completely inoperative, "dead"—static. The device also provides for the usual

tube and rectifier tests and a gas test, also for measuring tube voltages and currents while the tubes are in the set. A line-voltage adjustment permits the use of standard conditions.

The measurement ranges of the various meters follow:

D.C. volts, 4 ranges to 1,000 volts, 1,666 ohms per volt.

A.C. volts, 0-8-40-160-800.

D.C. mils, 0-40-200.

A.C. mils, 0-40-200.

Microfarads, .1-1-14 μ.

Inductance, ½-20-hy.

Ohms, 0-2,000-200,000-20,000,000.

Leakage of electrolytic condensers.

RUBE RUMINATION

I admire an honest boast. Down at Deep River, Conn., there's a black-and-gold sign at the edge of the town which says, "Deep River, A Place You Will Remember". What a feeble statement—and how vastly better was the old sign which bore the noble brag, "Deep River, Queen of the Valley". THAT was something you really did remember the town by—that and the real beauty of the place. When you have something—say so!

NATIONAL . . . .

IN STOCK

. . . . CARDWELL

CARDWELL CONDENSERS
MIDWAYS

THE 164B

Type	Mmfd.	Net
401B	26	$1.24
402B	50	1.30
403B	70	1.36
404B	105	1.42
405B	150	1.47
406B	260	1.62
407B	365	1.76

TRANSMITTING MIDWAYS

408B	22	$1.80
409B	35	1.92
410B	50	2.20
411B	70	2.50
412B	100	2.92
413B	150	3.77

STANDARD TRANS. CONDS.

141B	250	$2.91
123B	480	3.43
137B	960	4.12
F183	110	6.86
164B	220	3.43
T199	330	6.86
511B	23	2.74
513B	50	4.80

NATIONAL DIALS, ETC.

Type B Vernier	$1.48
Type BM Vernier	1.18
Precision Type N	3.83
Full Vision UKC	2.36
R-39 Coil Forms	.45
Type 100 R.F.C.	.45
Coil Sockets (Isolantite)	.36
Tube Shield TS	.24
B-30 Coil Shield	.30
S-W Manual, No. 1	.50
S-W Manual, 1 to 10 Meters	.50
Filament Trans., 2.5 v.	1.80
S101 Screen-Grid Coupler	3.24

NATIONAL RECEIVERS

SW. 58

SW-58 RECEIVER, wired, with four pair coils ready to use, less power supply $52.63

SW-34 RECEIVER, D.C., for 2 volt operation, wired, four pair coils, ready to use $49.98

Power pack for SW-58, wired, ready to use $23.25

SW-3 NATIONAL 3-tube A.C. short wave with band-spread coils, wired and tested $32.38

SW-3 for 6 volt D.C. or A.C. $32.38

SW-3 A.C. power pack $20.29

NATIONAL CONDENSERS
TRANSMITTING

Type	Mmfd.	Net
TM35A	35	$2.66
TM50A	50	3.54
TM100	100	2.66
TM100A	100	5.91

TYPE S. E. U.

$2.66

TM150	150	2.96
TM150A	150	8.28
TM230	230	5.29
TM230A	230	9.99
TM350	350	6.52
TM450	450	7.06
TMP100	100	7.36
TMP230	230	10.30
TMP100A	100	11.27
EMP	100	2.97

"A" indicates 6,000 v., otherwise 3,000 v.

Include postage and insurance or we ship express collect.
C. O. D. orders on 25% deposit.

Hatry & Young

203 Ann St. H/Y **Hartford Conn.**

Short Circuits

When calling Joe Furey we deliberately speak unclearly because we enjoy hearing the telephone operator repeat back a number by saying, "Sev-un, sev-un, fi-yuv, fi-yuv, ni-yun".

Almost 4,000 commercial station licenses are in force, said to employ more than 10,000 operators. In view of the regular schedules of the commercials there must be many hours of the day where these operators outnumber the amateurs "on the air" at the same time.

A really cheap article shows cleverness; it takes cleverness to do a good job cheaply. A really good article also shows cleverness, but the mediocre is frequently merely something shoddy with an extra coat of paint.

The "Washington Star" some time ago carried a feverish item about a call pirate's capture. The only interest in such a yarn is that it still attracts attention enough to rate a two-deck headline and circus adjectives.

The precision of any method of frequency control lies largely in the degree of engineering effort spent in the design of the circuits AND IN THE CARE EXPENDED BY THE OPERATING PERSONNEL IN MAINTENANCE AND SUPERVISION.

D. E. Replogle in "Radio Engineering."

Addenda to Webster

Altruist: Every "Modern Radio" reader who realizes that he should write to some manufacturer as follows: "I can't buy your products because there is no information on them advertised in my favorite radio magazine 'Modern Radio'."

Patriot: See Altruist.
Evangelist: See Patriot.
Prophet: See Altruist.
Gentlemen: See Altruist.
Good Egg: See Altruist.

There's an amateur 'phone operator at Meredith (N. H.) who consistently calls it Merideth, (Merry Death).

WHERE TO BUY "MODERN RADIO"

ARIZONA
Nielsen Radio & Sporting Goods Co., Phoenix

CALIFORNIA
Associated Radio Buyers, Oakland
Coast Electric Co., San Diego
I. S. Cohen's Sons, Inc., San Francisco
El Cajon Radio Exchange, San Diego
Electric Supply Co., Oakland
High Frequency Engineering Lab., Los Angeles
Inter-City Radio Stores Co., Long Beach
Offenbach Electric Co., San Francisco
Radio Doc., Los Angeles
Radio Manufacturer's Supply Co., Los Angeles
Radio Supply Co., Los Angeles
Radio Technical Labs., Long Beach
Warner Bros., San Francisco
Warner Bros., Oakland
Wenger-Brill Co., Oakland
Western Wholesale Radio, Inc., Los Angeles
Zach Radio Supply Co., San Francisco

CONNECTICUT
Hatry & Young, Inc., Hartford
S. S. Kresge Co., New Haven

ILLINOIS
Abbott's Sweet Shoppe, Berwyn
Chicago Radio Apparatus Co., Chicago

MARYLAND
Radio Electric Service Co., Inc., Baltimore

MASSACHUSETTS
T. F. Cushing, Springfield
Neisner Bros., Boston
Sager Electrical Supply Co., Boston

MICHIGAN
Radio Specialties Co., Detroit

MINNESOTA
Lew Bonn Co., St. Paul

NEW JERSEY
Kaltman & Kennyhertz, Newark

NEW YORK
Blan, the Radio Man, Inc., New York City
Jerry's Place, New York City
Leeds Radio, New York City
Roy C. Stage, Syracuse
Sun Radio, New York City

OREGON
Northwest Radio Supply Co., Inc., Portland
Wedel Co., Inc., Portland

PENNSYLVANIA
Cameradio Co., Pittsburgh
Hall's, Harrisburg
M. & H. Sporting Goods Co., Philadelphia
Radio Electric Service Co., Inc., Philadelphia

RHODE ISLAND
City Hall Hardware Co., Providence
W. T. Grant Co., Providence

WASHINGTON
Spokane Radio, Inc., Spokane
Wedel Co., Inc., Seattle

FOREIGN
R. C. O'Connor, Tearo Book Depot, Wellington, New Zealand
McGill's, Melbourne, Australia

MORE NEXT MONTH

THE BAZAAR

Please abide by these rules:
1. 5c per word, payment with ad.
2. Ads for an issue must reach us the first of the preceding month.
3. Used, reclaimed or surplus items must be so described.
4. Please PRINT your name and address.
5. We reserve the right to refuse any part of an ad.
6. Ads designed to stand out cost extra. 7c a word all capitals, $2.00 an inch for unfilled space.

Corona 4 Typewriter, $20.00; new R. C. A. 852, $15.00; slightly used National SW-3, $22.00; 40-meter power crystals, $6.00, 80, $3.25; guaranteed. 866's, WE 211D, $5.00, dozens of other bargains, send for list. Trades O. K. W9DOQ, Route 1, Duluth, Minn.

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