SIMPLE AC CIRCUIT CALCULATIONS

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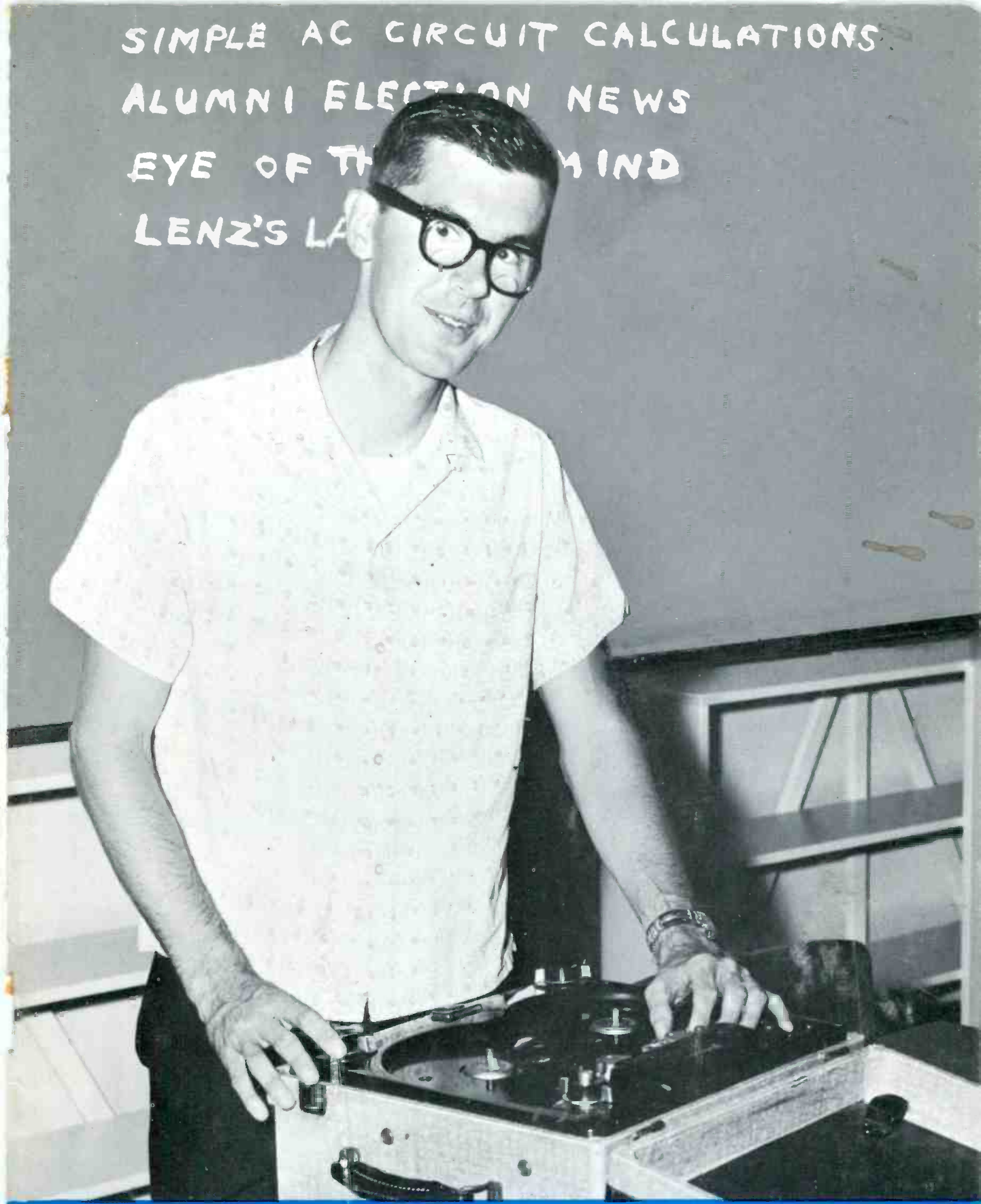

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what's new ?

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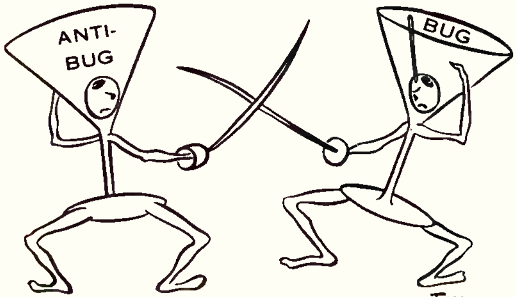
There's an antidote for everything (well, almost), as Dectron Industries is proving with its "Antibug", designed to neutralize its own previous product that could make a martini's olive eavesdrop. The new device jams radio frequencies over a 200-megacycle bandwidth. Three and 3/8ths inches high, 1-1/2 inches wide, and 5/8 inches thick, it fits into a shirt pocket and operates for 10-hour segments on a standard four-volt nickel cadmium battery. It is, however, ineffective against hidden tape recorders, telephone taps and other direct-wire connections, but will work against miniature transmitters, spike mikes, telephone bugs and other eavesdropping devices. The problems: Though its components are discrete, its presence in a room isn't if there are any other radios there --- they'll be jammed, too. It's also difficult to hold down the "bug killer's" bandwidth. Circuitry is relatively simple.



"EN GARDE"

Scientists at the Atomic Energy Commission's Argonne Laboratory have been using very intense neutron beams to take still radiographs through lead shields for nuclear fuel studies. Now they can take moving pictures with a neutron image intensifier tube developed by Rayland, a subsidiary of Zenith. Images are projected on a TV screen safely away from the reactor's radioactive field. Its advantages: the atomic scientist can watch the action inside the nuclear fuel chamber; the biologist can observe hydrogen-carbon compounds, such as chromosomes in human cells, as they affect the growth of an organism; the quality-control engineer can take nondestructive tests on materials that X-rays either couldn't penetrate or couldn't detect.

EXPO TO ERECT $10 MILLION BROADCAST CENTER

A permanent broadcasting center will be built at the site of EXPO, Canadian world exhibition slated for 1967, to the tune of $10,000,000. It will offer six radio stations, two TV studios, and be available to all media, with programs in 12 languages to be relayed worldwide via communications satellites, cable TV, microwave networks, and tape recordings. Indications are that at least 200 broadcasting teams will take advantage of the facilities of the broadcasting center.

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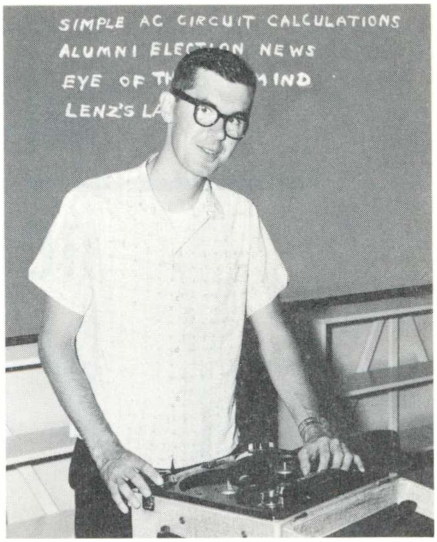

ON OUR COVER

The blackboard of the classroom where Maynard Simmons teaches is often as blank as the wall behind him really is in our cover photo...because his students are, as he is, blind or nearly so. Yet Simmons plans to hang out his shingle soon as a radio-TV technician, as the story on Page 11 tells. And NRI student Simmons is not alone in the field. Recording For The Blind calls electronics "one of the most popular fields" that blind people are entering professionally.

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SIMPLE AC CIRCUIT CALCULATIONS

By WILLIAM F. DUNN

Many technicians who are familiar with dc circuits and dc circuit calculations steer clear of even simple ac circuit calculations because they think they are too difficult. Actually, most ac circuit calculations are no more difficult than dc circuit calculations. They usually take a little longer, because there are more factors to evaluate, but it is very seldom that anything more complicated than grade-school arithmetic is involved. In this article we are going to look at some of the simpler ac circuit calculations and see how simple they actually are.

Before going into ac circuits, let us look at the simple dc circuit shown in Fig. 1. Here we have a voltage source, E, and across this voltage source we have a resistance, R, and flowing in the circuit a current, I. We know from Ohm's Law that the voltage, current, and resistance in this circuit are related in

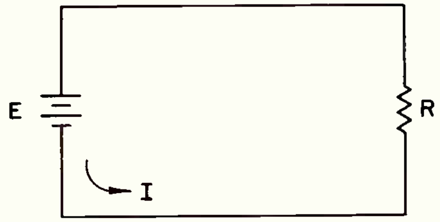


Fig. 1. A simple dc circuit.

such a way that if we know two of the values, we can find the third. For example, if we know the value of the current and the resistance we can calculate the voltage, using:

$$E = IR$$

If we know the voltage and the resistance we can find the current, using the formula:

$$I = \frac{E}{R}$$

Similarly, if we know the voltage and the current flowing in the circuit, we can calculate the resistance, using the formula:

$$R = \frac{E}{I}$$

The preceding three formulas are the various forms of Ohm's Law for dc circuits. However, what about ac circuits? Do these formulas apply? In an ac circuit that contains only resistance, such as the simple ac circuit shown in Fig. 2, the formulas DO apply.

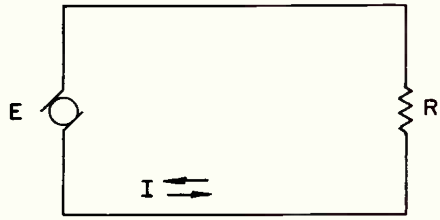


Fig. 2. A simple ac circuit.

The voltage, current, and resistance are related in exactly the same way as they are in a dc circuit. If you know the value of two of the three quantities, you can use Ohm's Law to calculate the third. As long as the circuit is purely a resistive circuit, the frequency of the ac voltage has no bearing on the current that will flow in the circuit, nor does it have any bearing on the opposition the resistance will offer to the flow of current through it.

An example of the use of Ohm's Law in a purely resistive ac circuit is as follows:

A 100-watt electric light bulb has a resistance of about 140 ohms at its normal operating temperature. Find the current drawn by the bulb in a 120-volt ac circuit. Since we know the voltage and the resistance, we use Ohm's Law in this form:

$$I = \frac{E}{R}$$

Substituting 120 volts for E and 140 ohms for R we get:

$$I = \frac{120}{140}$$

therefore I = .85 amps approx.

If all ac circuit calculations involved only resistance, the calculations would be quite simple, as you can see from the preceding example. However, in most ac circuits, we become involved with inductance and capacity as well as resistance, and therefore we have to consider the impedance of the circuit rather than just resistance. Let us look at impedance and see how this affects our calculations.

IMPEDANCE

The impedance of an ac circuit is the total opposition to current flow. Impedance may contain resistance, inductive reactance, capacitive reactance, or any combination of the three. However, once we have found the impedance of the ac circuit, calculations in the circuit are no more difficult than in dc circuits. For example, the use of Ohm's Law for ac circuits is exactly the same as Ohm's Law for dc circuits, except we substitute Z for R. In other words, if we know the current flowing in the circuit and the impedance of the circuit, we can find the voltage using the formula:

$$E = IZ$$

If we know the voltage applied to a circuit and the impedance of the circuit, we can calculate the current, using the formula:

$$I = \frac{E}{Z}$$

and similarly if we know the voltage and the current in an ac circuit we can calculate the impedance, using the formula:

$$Z = \frac{E}{I}$$

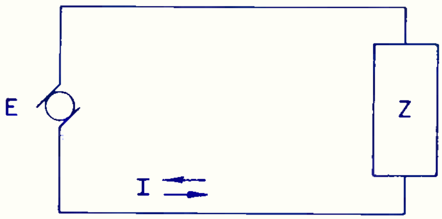


Fig. 3. A typical ac circuit.

Now let us see how the three simple forms of Ohm's Law are used in calculations where we know the impedance. Look at Fig. 3. If in one example we know that the current is .25 amps and the impedance 100 ohms, we can calculate the voltage using the formula:

$$E = IZ$$

Substituting .25 for 1, and 100 ohms for Z we get,

$$E = .25 \times 100 = 25 \text{ volts.}$$

In another case, suppose that the applied voltage is 225 volts and the impedance is 75 ohms. With this information we can calculate the current, using:

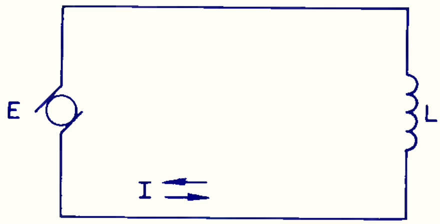


Fig. 4. A simple inductive circuit.

$$I = \frac{E}{R}$$

Substituting 225 volts for E and 75 ohms for R we get,

$$I = \frac{225}{75} = 3 \text{ amps.}$$

In a third situation, if we know that the applied voltage E is 150 volts and the current flowing is 2 amps, we can calculate the impedance in the circuit:

$$Z = \frac{E}{I}$$

Substituting 150 volts for E and 2 for 1, we get,

$$Z = \frac{150}{2} = 75 \text{ ohms.}$$

Now that we have seen how easy ac circuit calculations are once we know the impedance of the circuit, let us go ahead and see how we go about finding the impedance.

FINDING THE IMPEDANCE

In Fig. 4 we have shown a simple inductive circuit. Here we have a coil (or inductance, as a coil is often called) connected across an ac generator. Under these circumstances, with the voltage, E, applied across the coil, a current, I, will flow through the coil. The amount of current will depend on how much opposition the coil offers to the flow of current and the applied voltage.

$$I \text{ will be } = \frac{E}{Z}$$

where Z is the opposition offered by the coil. However, there are several interesting things about this opposition and the current that flows. To get a better understanding of exactly what is happening, let us consider what we mean by inductance.

We say that a coil has inductance, and as a result of this inductance offers a certain inductive reactance to the flow of ac through it. Inductive reactance is more or less the equivalent of resistance. It is the opposition the coil offers to the flow of ac current through it.

The inductive reactance of a coil varies with the frequency. To put it simply, the inductive reactance of a coil to dc is zero; the inductive reactance of a coil to ac increases as the frequency of the ac increases.

The inductance of a coil is the ability of the coil to generate an ac voltage which opposes any change in current through the coil. The inductance of a coil does not change with frequency...it depends on the physical construction of the coil.

Inductive Reactance.

The inductive reactance of a coil is usually represented by the symbol X_L. To find the inductive reactance, we use the formula:

$$X_L = 2\pi fL$$

We know that $\pi = 3.14$, and therefore $2\pi = 6.28$, so we can write the formula as

$$X_L = 6.28 fL$$

Now let us work out a couple of examples and find the inductive reactance of the several coils. Find the inductive reactance of a three-henry coil at a frequency of 60 cycles. Using the formula:

$$X_L = 6.28 fL$$

and substituting 60 cycles for f and 3 henrys for L we get:

$$X_L = 6.28 \times 60 \times 3 = 1130 \text{ ohms.}$$

Finding the preceding answer was quite simple, because the frequency was in cycles and the inductance in henrys. However, often the inductance will be in millihenrys or microhenrys, and the frequency might be in cycles, kilocycles, or megacycles. However, this should not present any particular problem. For example, find the inductance of a 50-millihenry coil at a frequency of 3,000 cycles. To calculate the reactance we must change millihenrys to henrys. There are 1,000 millihenrys in a henry, or in other words a millihenry is one thousandth of a henry. We can express millihenrys in henrys simply by multiplying by 10^{-3}. In other words, 50 millihenrys equals 50×10^{-3} henrys.

Three thousand (3,000) cycles equals 3 kilocycles and we can express this as 3×10^3 cycles. Thus our equation becomes:

$$X_L = 6.28 \times 3 \times 10^3 \times 50 \times 10^{-3}.$$

$10^3 \times 10^{-3}$ are equal to 1, so

simply cancel them out, and we have

$$\begin{aligned} X_L &= 6.28 \times 3 \times \cancel{10^3} \times 50 \times \cancel{10^{-3}} \\ &= 6.28 \times 3 \times 50 \\ &= 944 \text{ ohms.} \end{aligned}$$

Find the inductive reactance of a 2-microhenry coil at a frequency of 255 megacycles. This problem can be worked the same way as the preceding example. Microhenrys can be converted to henrys by multiplying by 10^{-6}. Thus two microhenrys = 2×10^{-6} henrys. Similarly, megacycles can be converted to cycles by multiplying by 10^6. Thus 25 megacycles equals 25×10^6 cycles. Now our formula becomes:

$$\begin{aligned} X_L &= 6.28 \times 25 \times 10^6 \times 2 \times 10^{-6} \\ &= 6.28 \times 25 \times \cancel{10^6} \times 2 \times \cancel{10^{-6}} \\ &= 6.28 \times 25 \times 2 \\ &= 314 \text{ ohms.} \end{aligned}$$

Vector Addition

Now let us look at the simple RL circuit shown in Fig. 5. In the first example of inductive reactance, we found that if the frequency was 60 cycles and the coil had an inductance of 3 henrys that the inductive reactance of the coil would be 1130 ohms. Suppose that in Fig. 5 we have this coil and in series with it a resistor whose resistance is 1,000 ohms, and

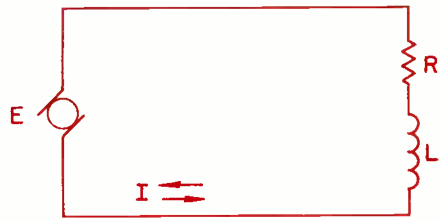


Fig. 5. A simple R-L circuit.

we want to find the impedance of the circuit.

We cannot simply add the inductive reactance and the resistance to get the impedance, because although resistance and inductive reactance both oppose flow of current through the circuit, they do so in different ways. You will remember that in a resistance the voltage is always in phase with the current, but in an inductance the voltage across the coil is 90° ahead of the current through it. Here we have two opposing forces which oppose the current in a somewhat different way.

An example of what we have is shown in Fig.

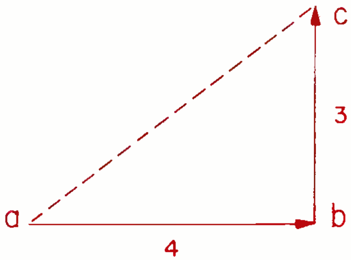


Fig. 6. A simple vector addition.

6. Suppose a man starts at point "a" and walks in an easterly direction for four miles until he reaches point "b." At point b he turns north and walks for three miles until he reaches point "c." In both cases he was moving away from point a, but because he went in different directions, the distance from a to c will not be equal to the sum of 4 + 3. However, we can find how far it is from a to c quite easily. Notice that the angle formed by the two directions of travel is a right angle, or 90°. Thus the triangle formed by a, c, and b is a right-angle triangle. In any right-angle triangle the square of the hypotenuse (the side opposite the right angle) is equal to the sum of the squares of the other two sides. In other words,

$$\begin{aligned} ac^2 &= ab^2 + bc^2 \\ &= 4^2 + 3^2 \\ &= 16 + 9 \\ &= 25. \end{aligned}$$

Since $ac^2 = 25$ and we know that the square root of 25 is 5, ac = 5.

We use exactly the same procedure to find the value of $R + X_L$. Substituting 1000 ohms for R and 1130 ohms for X_L we have:

$$\begin{aligned} Z &= \sqrt{R^2 + X_L^2} \\ &= \sqrt{1000^2 + 1130^2} \\ &= \sqrt{1{,}000{,}000 + 1{,}276{,}900} \\ &= \sqrt{2{,}276{,}900} \end{aligned}$$

Now all you have to do to find the value of the impedance is to get the square root of 2,276,900.

In case you have forgotten how to do square roots, we will go through this problem step by step. The first thing you do is write down the number and then start by marking the number off in groups of two digits, working from the decimal point. Since there actually is no decimal point in this number, it is understood to be to the right of the last zero. In other words, you mark the number off in groups of two, working from the decimal point to the left as shown.

2'27'69'00.

Once you have the number marked off in groups, begin by finding the nearest square of the first number or two numbers. In this case, since we have an odd number of digits in the figure, we have a single number first. The closest square root to two is one, so we place a 1 in the upper bracket as shown below, and then place the square of 1 which is 1 beneath the 2 and subtract a 1. We then bring down the next two numbers so that we will have 127 as shown.

```
2'27'69'00 |1
1
1 27
```

Now we draw a place for a divisor beside the 127 as shown below, and then multiply the digits we have already obtained for our square root by two. In this case the only digit we have is one, so 2 × 1 is 2; then we place the 2 in the first digit in the divisor.

```
  2'27'69'00 |1
  1 27
2|1 27
```

Now we need to find the second digit and we can approximate what it will be by dividing 2 into 12. 2 into 12 goes 6 times, so we might think of 6 as a second possible digit. If we multiply 6 × 26, however, we get 156, and since this is greater than 127, 6 is too large a number. Now we try 5, and place the 5 to the right of the 2 in the divisor and also to the right of the 1 in our answer. Five times 25 is 125, so we write this down beneath 127, and subtracting, we get 2. We then bring down the 69 as the next two figures.

```
    2'27'69'00 |15
    1
25| 1 27
    1 25
       2 69
```

In the next step of our division we try to find a three-digit divisor to go into 269. We start with twice 15, which is 30. If we try to divide 301 into 269, it will not go, and therefore the next figure in our answer is zero. So we place 0 after the 5 up at the top right and the 0 after the 30, and bring down the next two digits, both of which are zeros. Now we divide 300 into 2690 and we get 8 as a possible divisor. Writing 3,008 we see this will go into 26900 eight times with some over, therefore the square root is 1508 plus a decimal. Actually, we would round this square root off as 1500 and say that the impedance of the circuit was 1500 ohms.

```
     2 27 69 00 |1508
     1
25  |1 27
     1 25
  3008|26900
       24064
```

Now let us look at the second example where we had a 50-millihenry choke coil and the frequency was 3,000 cycles. Find the impedance in a series circuit such as Fig. 5, if the resistance of R is 725 ohms. Using the formula:

$$Z = \sqrt{R^2 + X_L^2}$$

$$= \sqrt{725^2 + 944^2}$$

$$= \sqrt{525{,}625 + 891{,}136}$$

$$= \sqrt{1{,}416{,}761}$$

Now we set up the square root as before, breaking the number into groups of two, starting from the decimal point, and then proceed as before:

```
        1'41'67'61 |1190
        1
       21|41
          21
  229    |2067
          2061
      2380|661
```

Notice that in this example we proceeded exactly as before. We found that the first digit in the square root was a 1. We placed this beneath the 1 and subtracted and got 0. We then brought down the next two digits, which were 41, and doubled the 1 which we had for our first digit, and placed the 2 as the first digit in the divisor. 2 × 22 would be 44, and since this is too large to go into the dividend, the next digit must be 1. 1 × 21 is 21, giving us a remainder of 20. Bringing down the next two digits, we have 2067. Multiplying the two digits we have in our square root by two we get 22 as the first two digits in our divisor, and we find that 229 × 9 is less than 2067, so 9 is the next figure in our square root. 9 × 229 is 2061 and subtracting this from 2067 we get a remainder of 6. We bring down the next two digits, which are 61, and then for our divisor we double the three digits we have already in our square root, and we get 238. 2381 will not go into 661 and therefore the next digit in our square root must be 0. This gives us a square root of 1190 plus a decimal, but we do not have to calculate the decimal, because 1190 ohms is close enough. As a matter of fact, in most problems we would probably round this off as 1200 ohms.

Let us look at one more example. We found that at a frequency of 25 megacycles our 2-microhenry choke coil had an inductive reactance of 314 ohms. Suppose this is used in a circuit like the one in Fig. 5 in series with a 200-ohm resistor. Find the impedance of the circuit:

$$Z = \sqrt{R^2 + X^2}$$

$$= \sqrt{200^2 + 314^2}$$

$$= \sqrt{40{,}000 + 98{,}596}$$

$$= \sqrt{138{,}596}$$

Now to find the value of Z we find the square root of 138, 596 as shown below:

```
       13'85'96 |372
        9
   67 |4 85
       4 69
  742 | 1696
        1484
```

Notice that again we divided the number into groups of two digits. This time we ended up with two digits as our first number -- we had to find the nearest square to 13. In this case the nearest square is 9, and we put 3 as our first digit in an answer, and 3^2 is 9, which we place below 13 and subtract. Then we bring down the next two digits, which are 85, and double the first digit in the root, giving us a 6 as the first digit in our new divisor. We know that 6 × 7 is 42, so 7 looks like a good bet for the second digit. It works out 7 × 67 is 469, so we subtract it from 485 to give us 16. Then we bring down the next two digits, which are 96, and doubling 37 to give us 74 as our next divisor, we see that the next digit is 2 and 2 × 742 is 1484. Thus the square root is 372 plus a decimal which we are not concerned about.

In the preceding three examples you can see that there are no highly complicated mathematics involved in finding the impedance of an ac circuit. There are a number of steps that must be taken, but none of these are particularly complicated. In a circuit consisting of a coil and a resistance you must first find the inductive reactance of the coil, using the formula:

$$X_L = 6.28\ fL$$

Once you have the inductive reactance of the coil you can get the impedance of the circuit by using the formula:

$$Z = \sqrt{R^2 + X_L^2}$$

You will seldom find that the square root works out to an exact value, but this is not important, because in electronics considerable variations in parts values are permissible. Simply round the number off to the nearest whole number, or in the case of very large numbers to the nearest convenient number.

CAPACITIVE CIRCUITS

In a simple capacitive circuit such as the one shown in Fig. 7, the current flowing in the circuit will depend on the voltage of the source and the capacitive reactance of the capacitor. The capacitive reactance of a capacitor is given by a formula:

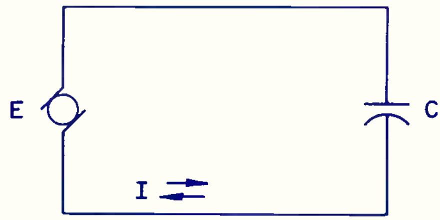


Fig. 7. A simple capacitive circuit.

$$X_C = \frac{1}{2\pi fC}$$

This formula can be simplified somewhat if we substitute 6.28 for 2π and then divide 2π into 1. This will give us the formula:

$$X_C = \frac{.159}{fC}$$

This formula is valid for frequency in cycles and capacity in farads. However, the farad is a very large unit and you will usually be dealing in microfarads (a millionth of a farad) or picofarads (also called microfarads; a millionth of a microfarad).

We can convert microfarads to farads by multiplying by 10^{-6}. When we do this and substitute in our formula we get:

$$X_C = \frac{159{,}000}{fC}$$

where f is the frequency in cycles and C is the capacity in microfarads.

Now using this formula, find the capacitive reactance of a ten-microfarad capacitor at a frequency of 1,000 cycles per second. Substituting these values in the formula we get:

$$X_C = \frac{159{,}000}{1000 \times 10}$$

$$= \frac{159{,}000}{10{,}000}$$

$$= 15.9 \text{ ohms.}$$

Sometimes the frequency will be given in kilocycles instead of cycles. You can convert kilocycles to cycles simply by multiplying by 10^3. When you do this simply divide 10^3 into 159,000. Do this by knocking off the three zeros and you get:

$$X_C = \frac{159}{fC}$$

where f is in kilocycles and C is in microfarads.

An example of how you use this formula is as follows:

Find the capacitive reactance of a .1 mfd capacitor at 100 kilocycles. Substituting these values in the formula we get:

$$X_C = \frac{159}{100 \times .1}$$

$$= \frac{159}{10}$$

$$= 15.9 \text{ ohms.}$$

In circuits that contain both resistance and capacitance, such as shown in Fig. 8, the impedance of the circuit is found in exactly the same way as the impedance of circuits containing both resistance and conductance. The formula for the impedance of the circuit is:

$$Z = \sqrt{R^2 + X_C^2}$$

To find the impedance of such a circuit you proceed exactly as before; you find the capacitive reactance of the capacitor, and then the sum of the square of the resistance and capacitive reactance, and then get the square root to find the circuit impedance. An example of a problem of this type is as follows:

Find the impedance of the circuit shown in Fig. 8 if the resistance is 120 ohms and the capacity in the circuit is .015 microfarads. The frequency of the applied voltage is 100 kc.

First we find the capacitive reactance by using the formula:

$$X_C = \frac{159}{fC}$$

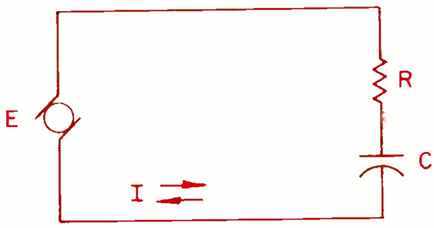


Fig. 8. A simple R-C circuit.

the f being in kilocycles and the C in microfarads. Substituting 100 for f and .015 for C we get:

$$X_C = \frac{159}{100 \times .015}$$

$$= \frac{159}{1.5}$$

$$= 106 \text{ ohms}$$

Now we find the impedance as follows:

$$Z = \sqrt{R^2 + X_C^{\ 2}}$$

$$= \sqrt{120^2 + 106^2}$$

$$= \sqrt{14{,}400 + 11{,}236}$$

$$= \sqrt{25{,}636}$$

$$= 160$$

Therefore Z = 160 ohms.

CIRCUITS CONTAINING R,C, AND L

Fig. 9 shows a circuit containing a capacitor, a coil, and a resistor. We are given:

The capacitive reactance of the capacitor is 290 ohms, the inductive reactance of the coil is 160 ohms, and the resistance of the resistor is 110 ohms. The voltage is 200 volts. We want to find the current flowing in the circuit.

In a problem of this type if we can find the impedance of the circuit we can find the current quite easily by using the formula:

$$I = \frac{E}{Z}$$

In a circuit containing both inductive reactance and capacitive reactance, the two tend to cancel each other out. Inductive reactance is more or less the opposite of capacitive reactance and vice versa. The effective reactance in the circuit is the difference between the two reactances. The impedance of the circuit is therefore made up of the net reactance and resistance in the circuit. We find the impedance in a circuit of this type, using the formula:

$$Z = \sqrt{R^2 + (X_C - X_L)^2}$$

Substituting 110 ohms for R, 290 ohms for X_C and 160 ohms for X_L, we get

$$Z = \sqrt{110^2 + (290 - 160)^2}$$

$$= \sqrt{110^2 + 130^2}$$

$$= \sqrt{12{,}100 + 16{,}900}$$

$$= \sqrt{19{,}000}$$

$$= 138$$

$$\therefore Z = 138 \text{ ohms.}$$

Now using this value of Z and the voltage of 200 volts we get:

$$I = \frac{200}{138}$$

$$= 1.45 \text{ amps.}$$

In the preceding example if the inductive reactance had been larger than the capacitive reactance we would simply have subtracted the capacitive reactance from the inductive reactance. It makes no difference which one you subtract from the other because even if you get a minus value, when you square it it becomes positive.

As a serviceman you will have no occasion to make calculations of this type. However, many technicians like to be able to do this type of circuit calculation; it helps to see exactly what is happening in the various circuits. If you should want to advance to the level of an advanced technician or junior engineer, you will have to learn how to work out problems of this type. As you can see, while it takes a little time and a little patience, that there is really no very complicated mathematics involved. ☐

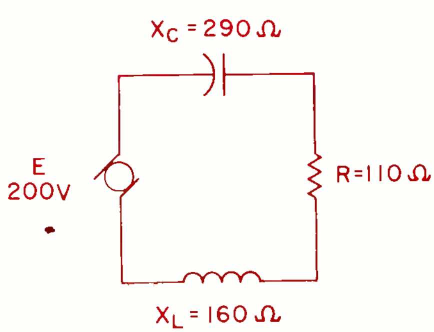


Fig. 9. A circuit containing R, C, and L.

THE EYE OF THE MIND

sights (NRI) course for Maynard Simmons

By ALLENE MAGANN

How does your day begin?

Start with the sound of the alarm, opening one sleepy eye to still its buzz, perhaps dozing 10 minutes; jumping up then, hastily, grabbing your clothes to head for a shave and a shower. With your eyes not quite open yet, if you're like a lot of us, perhaps you bump into a familiar piece of furniture (in the same place where it was when you went to bed); perhaps you grab a green tie before you remember that you're wearing blue socks. You smell the coffee perking, and it's great, but not as great as when you see that first cup, dark and steaming ...

Shaving, the planes of your face are familiar to you, too, so it doesn't take much looking, but a squint in the mirror does help to explore all the crevices where a stray hair might lodge.

Now shut your eyes and go through that first 30 minutes or so again. Pretty hard, isn't it?

USE YOUR IMAGINATION

If your imagination has taken you this far, project it a little further and visualize how it'd be not to be able to see at all. And since you're studying electronics, try to imagine how you'd handle the whole procedure of your course, poring over textbooks, schematics, manuals; figuring the angle where the current leads or lags, connecting wires to terminals, testing, testing--- if you couldn't see what you were doing!

Staggers the imagination, doesn't it? Probably gives you a few shudders as well... there's nothing kid stuff about wiring and voltages. For the ordinary routines of living, you'll concede, like the hypothetical morning scene described, having "a place for everything and everything in its place" could discount much of the difficulty, but HOW could it work in a technical field like servicing radios and television?

Yet, the field of electronics, according to Annette O'Neill, who's in a position to know--- she's program coordinator for Recording For The Blind, Inc., New York--"is one of the more popular fields which blind people study to enter professionally." She cites higher mathematics and advanced physics as other subjects blind persons are "entering in increasingly large numbers."

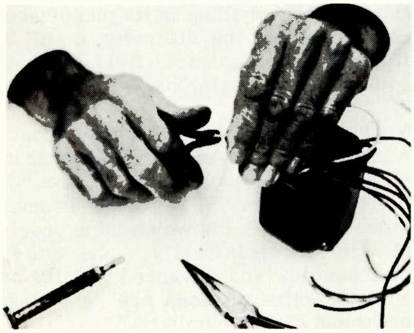
A case in point is NRI student Maynard Simmons, young teacher at the private Maryland School for the Blind in Overlea, a Baltimore suburb. He is "fascinated" by electronics. To be strictly fair, he is classified as "visually handicapped", not blind, since he retains some residual vision in one eye. However, his doctor discourages him from using that little eyesight for longer than a few minutes at a time, since prolonged usage results in severe strain and "terrific headaches." For reading, mostly he sticks to Braille, or highly magnified printing.

But his mien and manner place him in no atypical world. At the door of the sprawling, wooded complex of dignified buildings that is the Maryland School For The Blind, he was serenely waiting to act as guide back to the classroom where he teaches. If anything, he seemed mildly surprised that anyone could think there was anything extraordinary about an almost completely blind man wanting to go into radio-TV servicing.

And decidedly, his goals are clear: to use his NRI training by opening a part-time radio-TV servicing shop; later, a nebulous plan to expand from elementary teaching (he now teaches fifth and sixth grade mathematics at the school) and utilize the secondary teaching license his degree from Tellison State Teachers College entitles him to, in the field of electronics. (There's a precedent for the latter course in Peter Balter, who teaches music and high-school electronics. At the school for some 30 years, the totally blind Balter does all of the repairing of the school's tape recorders, record players, radios, sound systems, doorbells, etc., using his students as assistants.)

TOUCH IS HIGHLY SENSITIVE

Like other visually handicapped people, Simmons is what is defined as a tactile, one in whose mind tactual images, produced by his sense of touch, are especially distinct.



He feels that this is especially helpful in electronics, which has been a hobby with him for a long time. His interest in the field accelerated about the time he graduated from Tellison two years ago. He's been teaching at the Overlea school, which he attended, ever since.

And since he's a strong-minded person--that's evident five minutes after you start talking to him--he naturally decided to do something about it, and enrolled in NRI. But this was only the first step...his sight condition precluded just straight reading for the theory he needed instruction in.

WROTE NRI FOR BOOKS

And that's where Recording For The Blind came in. At his request, they in turn wrote to NRI president J. M. Smith requesting permission and copies of the complete radio-TV servicing course of 65 books.

"We are delighted to be able to help in this work in any way we can," he responded. "Currently I am vice-president of the Washington Society For The Blind, which is the group that operates the vending-stand program for the District of Columbia.

"So...I have a concern with the problems of the blind..."

There were some delays, principally due to the organization being "rather overwhelmed with electronic materials that had specific class deadlines," Mrs. O'Neill wrote Mr. Smith, but in a relatively short time the process began.

In fact, she adds, "We seem to spend our lives in an effort to enlist more and more readers for this type of book....and then worry about getting them done."

(As is customary, six copies of each disc was made, which will be available to other visually handicapped or blind persons. By using slow-speed recordings, 16-2/3 rpm, the organization can get about an hour's reading time on one 7-inch disc; an average textbook of 500 pages takes about 25 such discs and is about the same size as the printed book, which means ease in handling and storage space.

SERVES 2700 STUDENTS

(The organization, with the slogan, The Eye of The Mind, is currently serving 2700 students and blind adults with free-on-loan textbooks, recording about 1800 titles a year with some 11,000 copies, a production of 270,000 discs annually. It also maintains a library of around 50,000 books, extending but not duplicating services of the Talking Book Program of the Library of Congress, which offers no educational material.

(Educational material is recorded only on request; the average cost per copy of each book is about $25. The organization, supported by gifts from foundations, business corporations, and individuals, moved last fall into a new million-dollar building which consolidated its three widely separated divisions of library, tape-recording and disc production, and will greatly increase its facilities so that more people will be served.

(The process of recording the discs is painstaking. For such a specialized field as electronics, volunteers familiar with the course of study are chosen from the more than 2400 scientists, businessmen, lawyers, teachers, housewives, etc., on call at headquarters and at the 15 other units across the country. Each recording requires a reader, and a monitor who follows the reader with a second copy of the book and operates the tape recorder, stopping the reader if a mistake is noted for correction. Each reader or monitor must have a college education or the equivalent.

(The tapes are then transcribed at the headquarters, and the discs sent to students. The discs can be run on phonographs or on Talking Book Machines, supplied at no charge by the Government.)

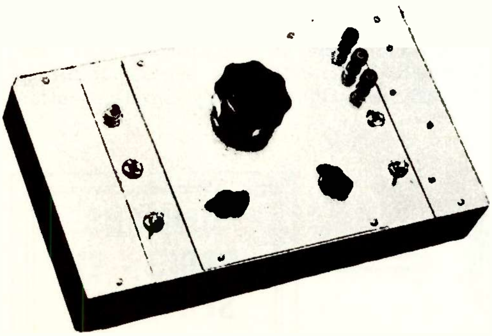
So far we have two credits in Simmons' favor: his tactile sense, and a thorough grounding in theory. What about its application?

The slim, personable young man is aware of the inherent danger, but feels a large dose of common sense---"You know the dangerous areas and trouble spots, and you act accordingly"---will get him past that hurdle...with another aid available, if he wishes, in auditory equipment adapted especially for the blind by the American Foundation for the Blind, on the sound-touch principle.

The foreword of the Foundation's catalog, revised annually, advises: "In general, items thought to be universally available are not included. Thus metal measuring cups, which every blind housewife would probably want, are not offered since they can be found at any dime store...

"Those who encounter problems for which there does not appear to be a solution in this catalog are advised, nevertheless, to submit the problem to the sales division. Often a special device may be constructed; and even more often, a special technique may be suggested. Blind people in all sorts of trades and professions co-operate in disseminating such techniques, and this pooling of experience can prove to be among the greatest of aids for the blind."

The Foundation-built equipment, according to its catalog, includes such things as an auditory circuit analyzer, which embodies a multi-range, precision bridge-type ohmmeter; a multi-range 20,000 ohms per volt DC voltmeter; and a multi-range DC milliammeter. Measurements are obtained as nuls in an audible signal from a pair of headphones, and readings are taken from a single raised scale. Connecting an external diode rectifier affords measurement of AC voltages. RF voltages may be measured in a similar manner.



AFB Auditory Circuit Analyzer.

In the device, external plugs are provided for inserting external rectifiers as well as resistors to increase ranges. A large raised scale has 10 major divisions marked by double raised dots. Mid-points between the divisions are marked with single dots. It includes a change-over switch as well as a main switch.

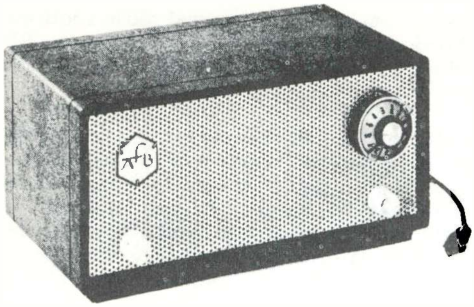
Maximum error of measurement, the foundation catalog attests, should be less than 2-1/2%. The device is available in the following ranges:

DC Volts	Milliamperes	Ohms
1	1	0-1
5	100 ma	0-10
10	10 ma	0-100
40	1 ma	0-1000
100	100 microamperes	0-10000
500	10 microamperes	0-100000
1000	1 microamperes	0-1 meg.
	.1 microampere	0-10 meg.

Other instruments include a multi-purpose hand tool for radio servicing, combining a wire stripper, wire antlers, wire gauge, and a device to connect solderless connectors; a soldering iron; an AFB Servo-Voltmeter, a DC millivolt electronic meter with a full-scale range of 20 millivolts and an input resistance of greater than 5 megohms. The latter has a 6" circular scale for tactual readout, with raised marks in a clockwise position: zero at 12 o'clock, 6 at bottom and 3 and 9 at right and left respectively. There are minor readout indications for each 2% increment, and it can be read tactually to an accuracy of better than 1% full scale.

Transducers, to measure voltage, current length, resistance, angle, temperature, pressure, ph, illumination, etc., must be built or obtained from a local supplier. It's all silicon solid-state circuitry, protected against mechanical and electrical overload, with required power 115 volts, 60 cycles, 25 watts.

Or for quick mathematical calculations (Simmons isn't apt to need this) there's a telescopic click rule made of aluminum, which clicks at every 1/16th" and has raised graduations at each half inch. The rule itself slides into a 7-5/8" housing and is fitted with a knurled locking screw, riding along a slot in the housing. Six inches back from the starting ends is a shoulder 1/4" thick, which makes possible the taking of inside measurements



AFB TV Audio Receiver.

from 6-1/4" to 12-1/4". Depth measurements can be taken up to 6" and outside measurements up to 12" can be taken accurately to 1/16".

And no, Virginia, there is no Braille TV. However, if Simmons wants to relax from fixing other people's television sets and doesn't want to listen to radio or record player, he can get a TV audio receiver for his own entertainment from the Foundation. It's a 7-tube, 12 channel VHF band with raised dots to indicate channel location. It's provided with an output jack for headphones or amplifier and an input jack for connecting an FM tuner, with volume and tone controls. It operates on 100 to 120 volts.

GETS A FEW MORE 'BITES'

Simmons has found, and this is confirmed by Balter (who, remember, is totally blind) that the visual handicap may mean the technician gets a few more "bites" than the person who can see. "But a sense of feel is (our) most valuable asset. Once the fundamentals are there and you know what you're looking for, it's comparatively easy...you learn caution."

Apparently the way the instruments help the blind person in testing is that the signal vibrator tone is sounded when it hits a resonant point; with a Braille-type dial and calibrator the aforementioned tactual checking is possible. Adaptors are installed from the top of the chassis, where there are no open voltages.

Basically, they agree that theory is the most important aspect, "and the rest is experience. You can't let (such) obstacles handicap you."

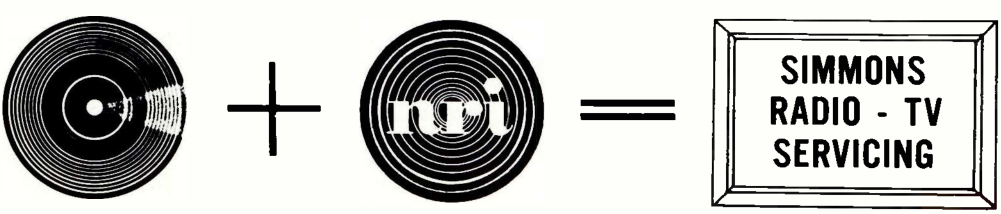
(Balter, who "grew up with it," starting back in the days of radio's infancy, builds instruments such as transmitters and audio equipment for others as well as himself, and says he relies most on orthodox circuits.)

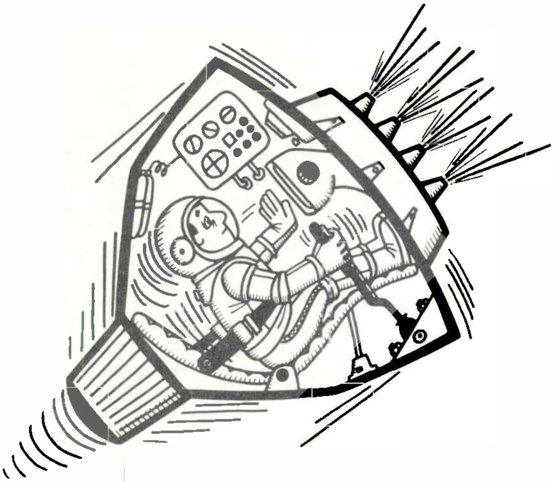
"On some old models if repairs did come up, you'd be pretty well stuck in the beginning at least. It's better if you build from scratch; you know what's in it."

Simmons' plans are pretty well under way. His work at the school is both "interesting and rewarding", but the involvement is such, with the individual attention required for the 12 to 14 allowed in the classes, that he has been pursuing electronics as a hobby, anyway, and he sees no reason why he can't parlay his interest, knowledge, and his helpful strong math background into a paying sideline he can follow in his free evenings and summers. His biggest problem right now is slowing himself down in studying the NRI textbooks on discs; he's afraid new discs won't come in fast enough and he'll be left without any new lessons to study!

Following his marriage a year or so ago to a fourth-grade teacher at the school (its campus, fields, and peach orchards cover some 90 acres), he and his wife bought a two-story home which has a full basement. He's just finished the basement off, paneling walls, etc. for a club room, but has set aside one section for his projected shop, with the workbench already in place and the tools he's collected over the years in orderly array. His wife encourages him in the project, and he feels he can get "substantial business" from fellow faculty members alone, and the immediate neighborhood...although the area has built up a great deal in recent years, there are few nearby technicians.

He feels very strongly that NRI's course is one of the best, strong on fundamentals. And to Simmons, the mathematician, with time, determination, and a few breaks, it all apparently adds up to a very simple equation:





space quiz

NEW YORK, N. Y. (ED) -- As modern man probes deeper into the outer reaches of space, his curiosity about this new, exciting frontier continues to grow. And, though our knowledge of space has increased a thousand-fold during the past 10 years, many misconceptions and half-truths still remain to puzzle the public.

But, although puzzling, space exploration seriously concerns the public because of the increasing role it plays in our lives every day. Just recently, Mariner IV successfully kept a photographic rendezvous with Mars; from Cape Kennedy a couple of months ago, Project Gemini sent a two-man team on a successful orbit of the earth. At last count, some 40 man-made satellites were in orbit and sending signals, and the U.S. plans to put a man on the moon in this decade.

These are only a handful of reasons we should come out of the dark about space. What do you really know about the space above? Here's a space quiz, compiled by researchers for the Thiokol Chemical Company. See where you stand.

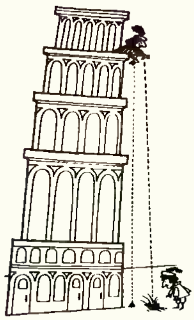
TRUE OR FALSE?

1. The Greeks first knew of the modern rocket principle.
2. During summers on Mars the temperature reaches 50° F.
3. The heavier a body, the faster it falls to earth.
4. Space is empty.
5. In space, the chance of a space craft being struck by a meteoroid is virtually zero.
6. It is five times easier to escape the moon's gravity then it is to escape the earth's.
7. An astronaut can endure speeds in space up to 30,000 mph.
8. Moving objects in space actually contract.
9. A space craft uses flaps to slow its orbital speed in order to return to Earth.
10. A space craft travels at phenomenal speeds before it leaves its launch pad.
11. Space is free of gravity.
12. It might be easier for man to reach the moon than to close the door of his space craft once there.
13. Man will be able to explore more of space from the moon than from earth.
14. The Soviet Union has the most powerful rocket motors.
15. Rocket power is not needed to keep a space craft at required velocity once in orbit.

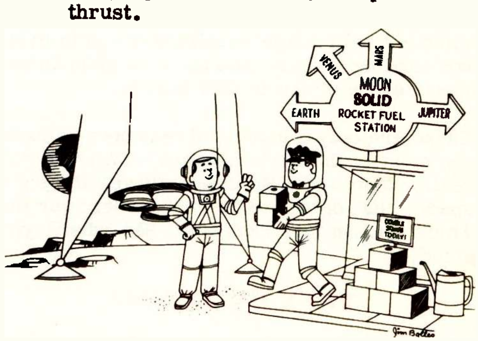
(Now turn the page for answers.)

ANSWERS TO SPACE QUIZ ON PRECEDING PAGE

1. True. In the third century, Greek scientist Hero demonstrated the jet engine principle.
2. True. But the temperature of Mars is generally lower than earth's. The range is from -70° F to 50° F.
3. False. Galileo disproved Aristotle's 20-century old theory that heavy bodies fall faster with this experiment: at the same instant he dropped a heavy object and a light object from the Tower of Pisa, and both landed simultaneously.



4. False. Space is not empty. It is filled with gases, mostly hydrogen, and millions of particles of matter.
5. True. Even though there are millions of meteoroids 1/10th of an inch or larger zooming around up there, space is so vast, and a space craft so relatively minute, that the chances of it being struck are remote.
6. True. The gravitational pull of earth is approximately five times greater.
7. False. There is no speed beyond human endurance provided a space craft accelerates gradually enough, and fortunately so, for it will take phenomenal speeds to get man to his destinations without his dying of old age en route.
8. True. According to Einstein's Theory of Relativity strange things happen in our curved universe. When objects move at very high speeds over long distances, they actually contract in the direction of their motion. So if you could see a space craft soaring through space, it would appear as if it were squeezed "bumper-to-bumper."
9. False. Retro rockets powered by solid fuel are used to "brake" the space craft's speed, enabling it to come out of orbit and return to Earth. These unique Thiokol solid fuel rockets have been used with 100% reliability in all the Mercury capsules and will be used in the Gemini Project and for "safe soft landings" on the Moon.
10. True. Before a space craft ever leaves its launch pad, it's already traveling in one direction at about 1,000 mph (due to earth's rotation) and about 40,000 mph in another direction (due to earth's revolving around the sun).
11. False. There is no place free of gravity. As a space craft moves away from earth, the force of the earth's attraction rapidly diminishes, but never disappears. The space craft is also subject to the gravitational pull of the sun and other planets, and if permitted to move aimlessly, it will eventually be attracted to one of them and either go into orbit around it or plunge into it.
12. True. Scientists still do not really know if lubrication will be a serious problem in space. Space craft require special lubricants, as well as hydraulic and cooling fluids.
13. True. A dream of scientists is to establish a lunar observatory equipped with a large telescope. Unhampered by atmospheric haze, like that which surrounds earth, astronomers for the first time would have a crystal-clear view of the stars and planets, and previously closed doors of scientific knowledge would be opened.
14. False. Rocket motors estimated at more than twice as powerful as those fired by the Soviet Union were successfully tested recently by Thiokol. They produce 3,000,000 pounds of thrust.



15. True. In space there is nothing to slow down the space craft, so it obeys Newton's law which says that an object in motion will continue in motion in a straight line until acted upon by an outside force. The space craft tries to obey Newton's law and follow a straight line (actually a tangent to earth's horizon). But gravity pulls the space toward earth at the same rate at which it rises to follow the tangent -- hence it goes into orbit.

LENZ'S LAW:

ITS UNDERSTANDING IS AN IMPORTANT BASIS OF THE STUDY OF COILS AND TRANSFORMERS

BY STEVE BAILEY

The study of Electronics involves the study of many basic principles. In this article, I am going to discuss one that is very important ... Lenz's Law. An understanding of this law is very important to the study of such things as coils and transformers. It shows why voltage and current will not be in phase in an inductance, how an induced voltage is produced, and how inductive components work. As you can see, the study of magnetism should be followed by a study of Lenz's Law before the study of transformers is undertaken.

Effects Current Flow . . . .
When the turns of a coil are cut by a magnetic field, current will flow in the circuit. To see how this is done, refer to Fig. 1.

In Fig. 1A, a magnet is plunged into a coil of wire. The magnetic field surrounding the magnet will cut the turns of wire in the coil producing a current flow in the direction shown.

In Fig. 1B, the magnet is inserted in the coil, but it is stationary. Thus, the lines of force surrounding the magnet are not cutting the turns on the coil. For this reason, no current will flow in the external circuit.

Fig. 1C shows what happens when the magnet is removed from the coil. The lines of force once again cut the turns of the coil, again producing a current flow in the circuit. Notice, however, the current flow is in the opposite direction as it was in Fig. 1A.

Another important point is demonstrated in Fig. 1. As the north pole of the magnet enters the coil, a current will be induced in this coil. Since the magnetic field around the magnet is cutting the turns of the coil, the coil becomes an electromagnet. The current flowing in the coil flows in such a direction that the end of the coil facing the north pole of the magnet becomes a north pole, too. Since like poles repel, the magnet must overcome the force of repulsion in order to enter the coil.

When an attempt is made to remove the mag-

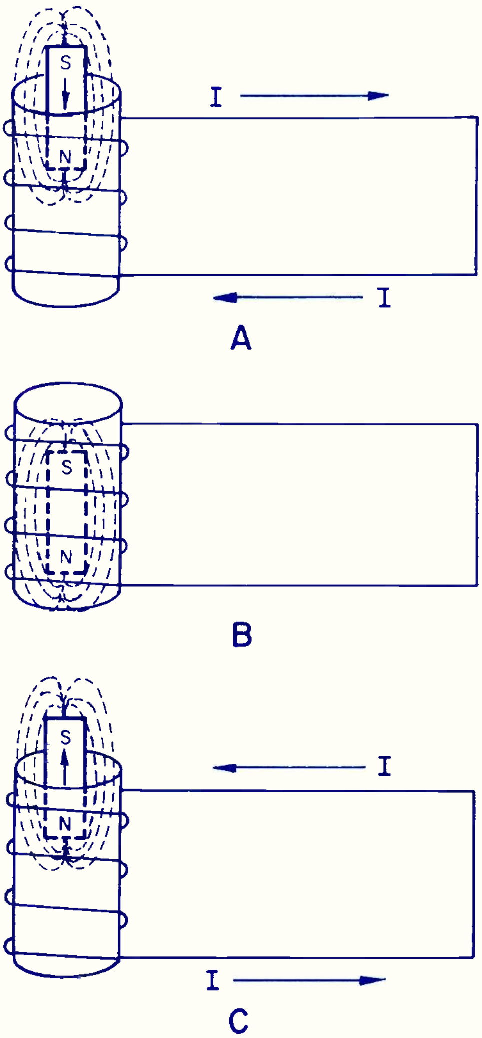


Fig. 1. (A) How an induced voltage is produced using a coil and a magnet; (B) the importance of having a changing magnetic field to produce an induced voltage; (C) an induced voltage can be produced when the magnet is withdrawn.

net, the current flow is reversed. The top of the coil becomes a south pole. This attracts the north pole of the magnet and tries to prevent removal. This force, of course, must be overcome before the magnet can be removed.

These results may be summarized by the statement of Lenz's Law: An induced current set up by the motion of a conductor and a magnetic field always flows in such a direction that it forms a magnetic field that opposes the motion.

Induced voltage is set up only when lines of force are cut. The faster the lines of force are cut, the greater the amount of induced voltage. The stronger the magnetic field, the more lines of force there are.

If we have more than one conductor cutting the lines of force, the greater the number of lines that will be cut.

It now becomes clear that the strength of the induced voltage depends upon the number of lines of force cut per second. Through experimentation, it has been found that 100,000,000 lines of force must be cut per second to produce an induced voltage of one volt. The induced voltage can be increased by (a) increasing the number of turns of wire on the coil, (b) increasing the speed at which the lines of force are cut, and (c) increasing the strength of the magnetic field.

COUNTER EMF

According to Lenz's Law, when an induced current is set up in a moving conductor, the current always flows in such a direction that it forms a magnetic field opposing the motion of the conductor. Also, if a current is applied to a coil from an external voltage source, a magnetic field appears around this coil. As the magnetic field expands, it cuts the turns of the coil inducing a second induced current into it. The direction of this second induced current is such that it will oppose the original current. This will tend to reduce the expansion of the magnetic field.

When the original current begins to decrease, the magnetic field starts to collapse. In doing so, the turns of the coil are cut and a second current is again induced into the coil. This time, however, the induced current will flow in such a direction that it again will oppose the original current, but will try to keep it from decreasing. Thus, it will keep current flowing in the circuit for a small amount of time after the original current has stopped flowing.

Lenz's Law can now be expanded to state

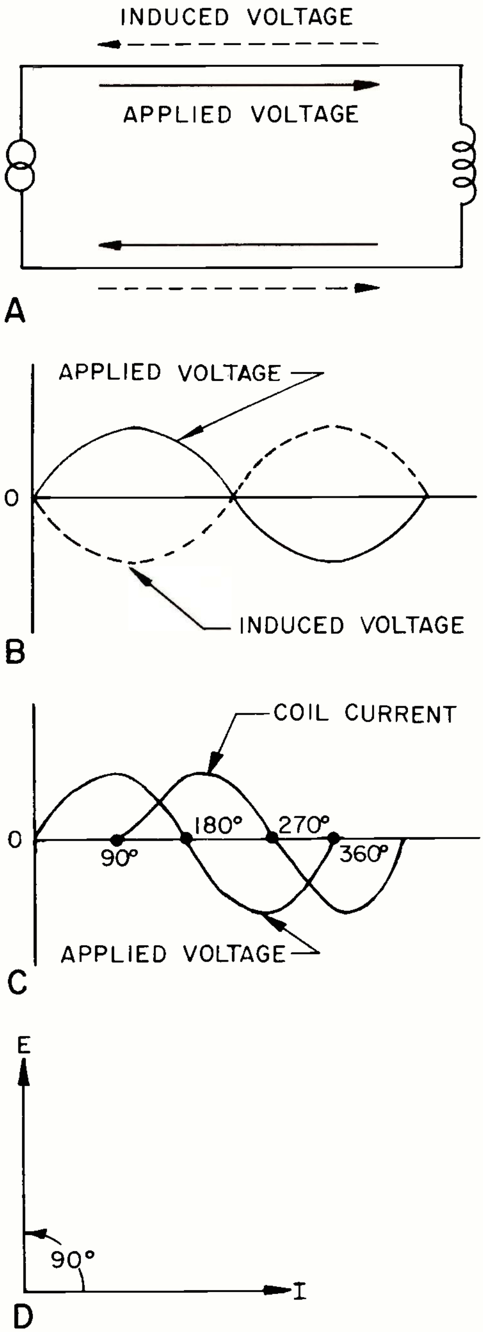


Fig. 2. (A) Circuit containing a generator and a coil; (B) the applied voltage and induced voltage produced by it; (C) voltage and current out of phase; (D) relationship between voltage and current vectorially.

that: an induced current is always in such a direction that it opposes the current that produced it. For this reason, an induced voltage is often referred to as a counter-electromotive force.

INDUCTANCE

Whenever a coil is described, it is described in terms of inductance. Inductance is the property of a circuit which opposes any change in the current flowing in it. The unit of inductance is the henry. A henry is defined as being the amount of inductance present when a current change of one ampere per second in a circuit produces an induced voltage of one volt.

PHASE RELATIONSHIP

In Fig. 2A, a circuit containing an ac generator and a coil is shown. The generator will produce a changing magnetic field. The coil can be compared to a stationary conductor. Notice that the applied voltage and the induced voltage are flowing in opposite directions.

Inductance has been defined as being the property of a circuit which opposes a change in current. This will prevent the circuit current from flowing until the opposition encountered will allow it to flow. Fig. 2B shows the applied voltage and the induced voltage produced by it.

Since this opposition has delayed the current and prevented it from flowing at the same time as the voltage was applied, the voltage and current will not be in phase as shown in Fig. 2C. As you can see, the current follows the voltage by 90°. Fig. 2D shows the relationship between voltage and current vectorially.

This phase delay action can be compared to what would happen if you were to try and pull a car with a truck while they were connected with a heavy coil spring. The truck might move a considerable distance before the spring stopped absorbing the energy. The truck would then be able to pull the car. As you can see, the truck was in motion before the opposition produced by the spring allowed the car to be put into motion.

If the truck suddenly stopped, the energy stored in the spring through tension would continue to move the car in the direction of the truck. This same type of delay occurs between the voltage applied to a coil and the current flowing in the circuit. Of course, the energy in an inductance is stored in the magnetic field.

STRAUGHN, ROSE SCHEDULE VISITS TO AA CHAPTERS

For the past several years J. B. Straughn, Chief, NRI Consultation Service, has accompanied NRIAA Executive Secretary Ted Rose on the latter's annual visit to the local chapters of the NRI Alumni Association. At these meetings Mr. Straughn delivers lectures and holds demonstrations, particularly on Radio-TV service problems but also on other Electronics subjects. Chapter members always warmly welcome these two NRI representatives.

All NRI men, students and graduates alike, whether or not members of the local chapter, are cordially invited to chapter meetings and especially so when Messrs. Straughn and Rose make their annual visit. You are urged to take advantage of this invitation. See the "Directory of Local Chapters" on Page 3 for full information on the meetings.

The schedule of visits for the 1965-1966 season is as follows:

CHAPTER	DATE
Southeastern Mass.	September 29
Flint	October 7
Detroit	October 8
Philadelphia-Camden	November 8
Hagerstown	November 11
New York City	November 18
New Orleans	March 8
Hackensack	April 29
Pittsburgh	May 5

U.S. Hits The JACKPOT

It's a little gruesome to think about, but reassuring too to know that constant improvements and innovations in communications are under way under contracts from the Armed Services. Gruesome when you consider that the ultimate ends are to facilitate combat procedures, and reassuring because obviously we must keep up.

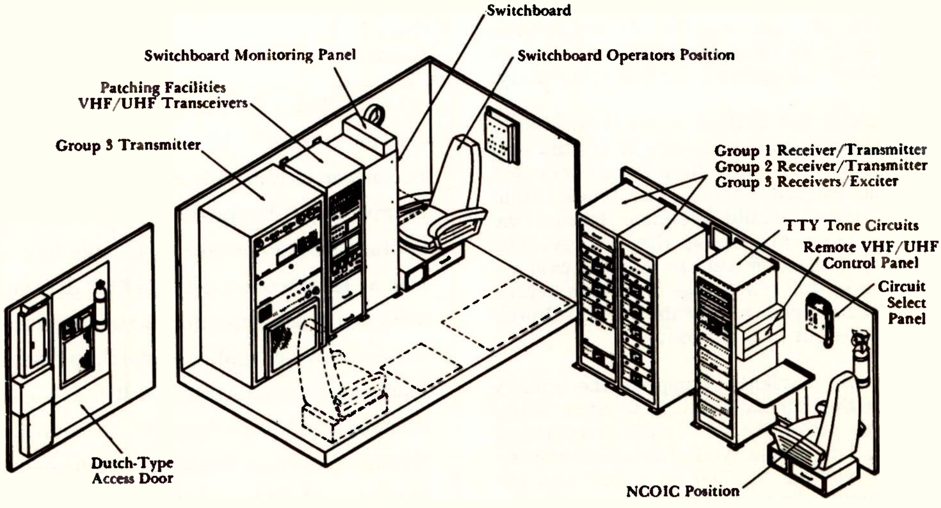
Such a system has been devised by Westrex Communications, a Litton subsidiary, under contract for the United States Strike Command (U. S. STRICOM). Delivered to Hanscom Field only 54 days after award of the contract, JACKPOT (Joint Airborne Communications Center/Command Post) provides command and control of Strike Command Forces during contingency operations or limited warfare. Designed for airborne as well as ground-based operations, the dual-mode capability of JACKPOT permits rapid deployment and optimum operation in combat areas with limited logistic support.

Each systems consists of two S-141 shelters mounted on goat-type transporters---a command post and a communications center---power generators and auxiliary equipment. The Command Post provides facilities for housing five operations personnel: the Joint Task Force Commander, the Operations Officer, two staff officers, and a secure communications operator. Facilities are provided for a switchboard operator and a non-commissioned officer in charge within the Communications Center.

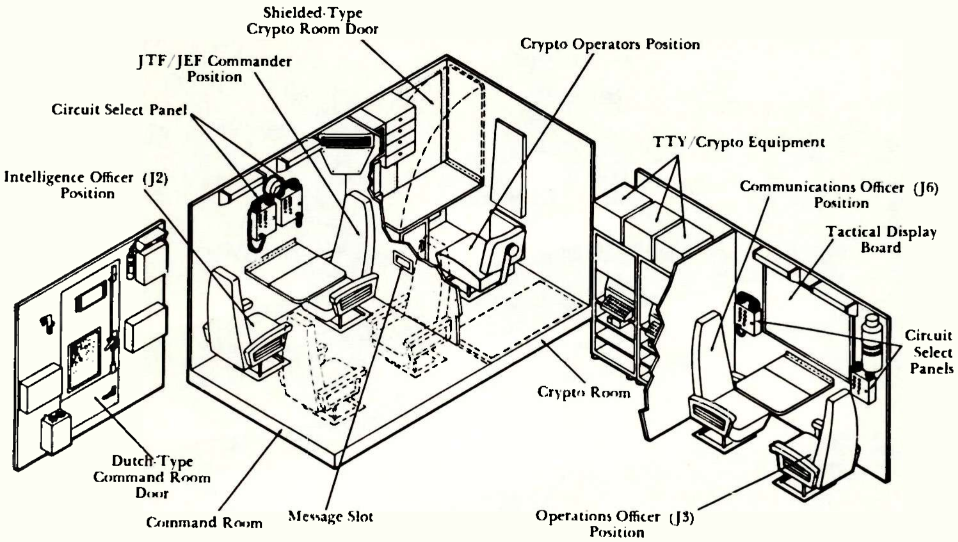
The system is transported by means of a C-130E assault transport suitably modified to permit airborne operation. In the air, JACKPOT provides command and control of combat forces during the initial action periods. Ground-based command and control of STRICOM forces follows after ground positions have been secured. Voice and teletype (clear text and secure) communications are available for both operational modes.

From the airborne command post, the Joint Task Force Commander and his aides can maintain continuous voice and teletype contact with ground stations as well as with other aircraft. The system also provides for screening and dissemination of incoming messages, maintenance of status information, and visual display of Strike Force deployment by means of an illuminated status display board and specialized communications equipment.

During airborne operations, the Communications Center uses a 1-kw HF single sideband transmitter for four-channel communication with distant DCS terminals. Three VHF and UHF channels are used for communications with ground forces, escort planes and other strike aircraft. Radio sets AN/ARC-51X, AN/ARC-54, and AN/ARC-73 are used



Communications Center



Command Post

for this purpose. When airborne, the aircraft antenna and power subsystems are used. Operational liaison between the Command Post, the Communications Center, and the aircraft crew is accomplished by interface of the JACKPOT intercom system with that of the aircraft.

Upon landing, JACKPOT is immediately deployed to a designated ground-base area, the antenna systems are erected, and the system becomes fully operational in a minimum time (approximately two hours). Or, if required by extreme tactical emergencies, the system may be operated in its stowed position within the aircraft, necessitating only the removal of the transportable power unit.

During deployed ground-based operations, four additional HF channels are available, providing a total channel availability of 12 HF, 2 VHF (1 AM and 1 FM) and 1 UHF. The additional HF channels are obtained by using the second 1-kw SSB transmitter and the 10-kw SSB transmitter and SSB receivers. Communications distances of more than 5,000 miles are obtained during good propagation conditions. Under normal conditions the operating range is approximately 2,000 miles, more than sufficient for reliable communications with one or more DCS HF stations. The 1-kw transmitters are used for short-distance communications to establish contact with area headquarters and other communications stations.

Local area communications are accomplished with four man-pack set transceivers which are used as soon as the system becomes ground-based. They comprise the AN/PRO ( ) and provide HF-SSB, VHF-AM, UHF-FM, and UHF-AM communications modes.

Two 60-kw power generators, for primary and standby use, are supplied with each JACKPOT system. Interconnection facilities are provided so that in the event of a failure by the primary power generator, the standby generator will start and accept the load automatically. Two 500-gallon collapsible fuel tanks are used to supply the generator. In addition to the electronic equipment, the generator provides power for the system's air-conditioning equipment.

The system has since undergone extensive field testing and has proved to be a highly reliable system for tactical applications. All tests were successful at Stewart Air Force Base, Operation Desert Strike in California, operations in the Congo, Liberia, Ethiopia, and Saudi Arabia; and a month's continuous operation at MacDill Air Force Base. ☐

At the Bronx Zoo, four quarrelsome gorillas were tranquilized through winter cage-confinement by installation of a 16-inch TV receiver. Their favorite programs, says curator Joseph A. Davis, Jr., are westerns and teenage dance programs. Only one of the four retained the tendency to heckle cage mates, "only during commercials". Or like a lot of us, he just goes ape then.

U.S.-MADE RADAR GUIDES MARINE AMBULANCE ON MERCY MISSIONS IN THE CHANNEL ISLANDS

A high-speed, sea-going ambulance has been fitted with a Raytheon radar to guide it on mercy missions among Great Britain's Channel Islands.

The Channel Islands embrace a total of 75 square miles and have a population of approximately 105,000 persons. Included in the group are Guernsey, Jersey, Sark, Brecqhou, Herm and Jethou. The islands were the only British soil occupied by German troops during World War II.

The "Flying Christine II" is operated by the Guernsey St. John Ambulance Brigade to provide medical assistance to residents of the remote islands in the English Channel as well as to ships passing through the area and to aircraft forced into the sea. The marine ambulance is based at Guernsey, an island about the size of Nantucket 45 miles off the coast of France and 90 miles from Plymouth, England.

The new Raytheon Model 1900 radar was imported from the United States to permit the mercy boat to maneuver among the storm-shrouded islands in all weather. It will aid in detecting persons adrift in the sea, and in bringing aid to tourists who frequently fall from the windswept cliffs into gullies accessible only from seaward. The high speed and maneuverability of the craft will also enable it to rush to the aid of persons cut-off by the sudden tides that boil into the craggy coves of the islands.

The new radar gives the ambulance boat's crew a 12-mile view in all directions. The radar's definition enables it to define extremely small targets in the water.

BY STEVE BAILEY

DEAR STEVE,

I have often seen the term "loading" used, but I do not know exactly what it means. Could you tell me, using an example?

M. L., Iowa

First of all, I would like to remind you of a term you have seen used frequently in relationship to various circuits. This term, as you well know, means that something is connected to a circuit that will consume power. Keeping this definition in mind, it follows that the word "loading" means that something is drawing current and power from the circuit. For example, a VTVM can load a circuit under certain conditions. The way it does this is to alter the circuit characteristics so that the amount of power and current consumed will be changed. If the voltage is measured in a circuit where the impedance is equal to the impedance of the voltmeter, the voltmeter may serve as a parallel path and effectively reduce the impedance of the circuit under test. Of course, this will change the

A letter in the July-August Communications Column concerning transformer turns-ratios prompted a very interesting letter from Mr. Walter E. Peek, vice-president, Customer Relations, of Centralab. I am reprinting a portion of this letter for those of you who wish additional technical information on the subject.

Also, I wish to extend many thanks to Mr. Peek for his interest and consideration.

DEAR STEVE,

The number of turns required depends on the voltage applied to the transformer and the area of the core. A general rule of thumb for 60 cycles is 6.57 turns for each square inch of center leg area. In other words, in laminations where the center leg is one inch wide and stacked to one inch high, 117 turns would be required for 117 volts line. Now, if 300 volts were required on the secondary, 351 turns would be required as the ratios are directly proportional to voltage with the exception of corrections being made for the resistance loss of the wire involved.

Audio transformers require a slightly different approach because the transformer must be designed for the lowest frequency at which it is expected to deliver. If an audio transformer is required to meet a 30-cycle response, going back to the 1×1 cross-section area, then 13.14 turns per volt would be required on the primary. The secondary, however, is not in direct ratio as in the voltage step-up or step-down transformer where the turns are determined by the square root of the impedance ratio. For example, a 5000-ohms input impedance stepped down to a 5-volt voice coil results in an impedance ratio of 1000:1. The turns-ratio is the square root of 1000 or approximately 32.

Sincerely yours,

Walter E. Peek, Vice President
Customer Relations
Centralab
Milwaukee, Wis.

amount of power and current being consumed in the circuit. Under these conditions, any voltmeter indication would be inaccurate.

This can be best avoided with the use of a meter with a high sensitivity rating. For example, a meter with a sensitivity of 20,000 ohms-per-volt would not load a circuit as much as one with a rating of only 1000 ohms-per-volt.

DEAR STEVE,

It is stated in Lesson 7BB, page 11, that at high frequencies it takes a smaller change in capacity to cause a given frequency change than it does at low frequencies. Could you tell me why this is so?

B. R., Pa.

It is quite true that at high frequencies it takes a smaller change in capacity to cause a given frequency change than it does at low frequencies. Actually, the electrical capacity will decrease at high frequencies. For example, a capacity that measures .5 mfd at a low frequency may measure slightly less than this at high frequencies. This means that a small change in capacity at high frequencies will cause a greater percentage of change than at low frequencies. Thus, you can say that the tuning capacitor is more sensitive at high frequencies that it is at low frequencies.

DEAR STEVE,

How do you tell one type of transistor circuit from another? I am studying Lesson 12BB now.

G. L., Mass.

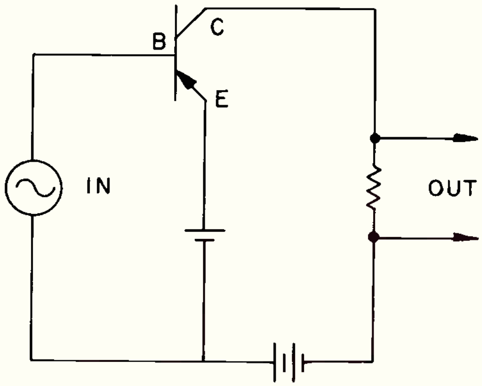
The best way to identify the various types of transistor circuits and to tell one from another is to notice how the signal is applied to the circuit and where it is taken off.

For example, in the simplified diagram of a common-emitter circuit shown at right, the signal is applied between the base and emitter and is taken off between the emitter and the collector.

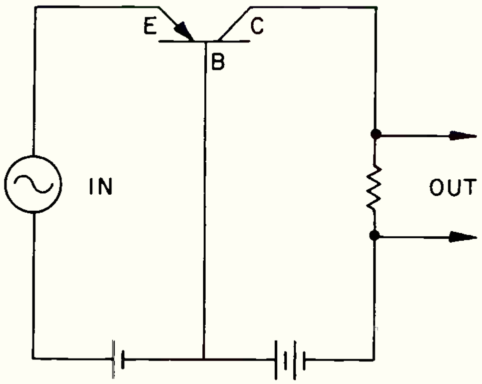
In the common-base circuit, center, the signal is applied between the base and emitter and is taken off between the base and the collector.

The signal is applied between the base and collector of a common-collector stage and is taken off between the emitter and the collector.

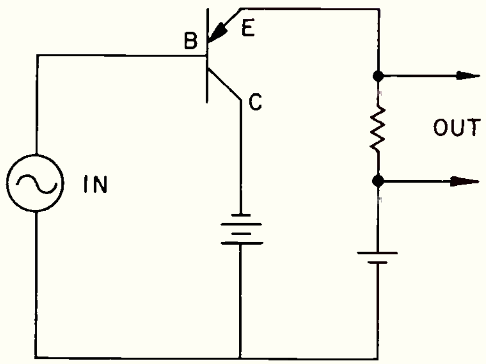
Notice that in the common-emitter stage, the emitter is common to both the input and output stages. The base is common in the common-base circuit and the collector is common to both the input and output in a common-collector circuit.



COMMON-EMITTER CIRCUIT



COMMON-BASE CIRCUIT



COMMON-COLLECTOR CIRCUIT

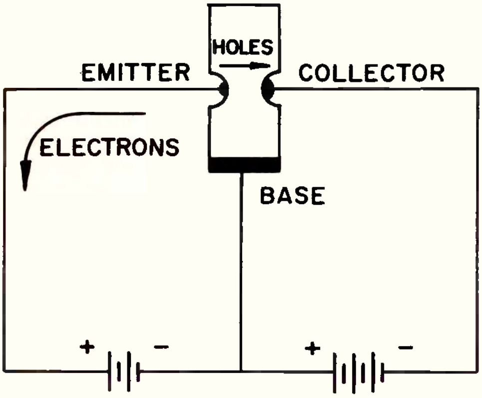
DEAR STEVE,

In Lesson 12BB, we are told about "hole" movement in transistors. Since a hole is actually an empty space, how can it move?

S. P., N. Y.

The first thing you should remember about transistor current flow is that it is accomplished by means of electron movement. Secondly, a hole is not a physical body. A hole is a space left empty by an electron. It can "move" only by being filled by an electron. When an electron fills a hole, it must leave another one empty. Thus, the space that the electron leaves becomes a hole. Effectively, the original hole has moved over. By this happening numerous times, a hole can move from one point to another.

In the circuit shown below, you have two current flows. First of all, electrons are being drawn from the emitter by the positive potential on the battery. This leaves empty



SURFACE-BARRIER TRANSISTOR

spaces which become known as "holes." At the same time, you have current flow in the collector circuit. The electrons will fill the holes left empty by the electrons drawn from the surface of the emitter. Thus, the spaces that the electrons leave to fill the holes become new holes or the original holes have "moved" over. Eventually, these holes reach the collector. However, they have been able to do this only as a result of being filled by an electron.

DEAR STEVE,

At this time I am studying Lesson 5X on dc circuit calculations. The main problem I am having here is in finding the total resistance of complex resistance networks. It is not that I do not know how to determine the resistance, but I have considerable trouble finding out whether a circuit is series, parallel, or series-parallel. I would appreciate any help you can give me.

D. J., La.

I will be very glad to help you.

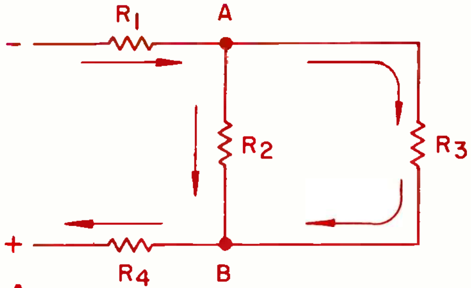
The way you have resistors connected together will determine the direction of cur-

SPECIAL NOTICE

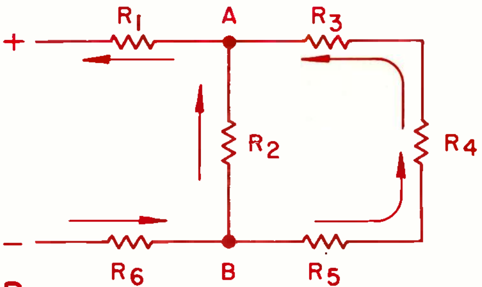
Recently the Consultation Department received a letter in which a student complained that his meter pointer deflected sharply when he changed from the +dc position to the -dc position and from the -dc position to the +dc position. This deflection was only momentary and the meter pointer returned to zero. The student wished to know whether this was normal or not and, if it was not normal, what could be done to correct the trouble. At the time the letter was received, we believed that the trouble was completely natural and told the student this. However, since the letter has been answered, we have found that the trouble is not at all natural and can be quite severe in some cases. However, it can easily be corrected. It is caused by a temporary opening of the power transformer primary between function switch positions. The cure for this is given here for the benefit of the student who originally wrote and for anyone else who has noticed this same condition in his VTVM.

This trouble can be corrected by connecting all four power-transformer primary-switch connections together, using a bare wire. The switch contacts for the various positions are lugs 7, 8, 9, and 10 on the back of Deck B of the function switch. To connect the lugs together, cut a piece of hook-up wire about two inches long and remove the insulation to form a bare wire. Connect one end of this wire to lug 7 on the back of Deck B of the function switch and run the remainder through the adjoining lugs 8, 9, and 10. The wire should be wrapped at lug 10 and the excessive wire should be cut off. Then all four terminals should be well soldered.

The trouble should now be corrected, but be certain that the mechanical calibration is set properly. Also, the zero set control should be adjusted with the function switch in the +dc position and with it in the -dc position.



A



B

rent flow. Thus, by tracing the probable path of current flow, you can determine whether resistors are connected in series, series-parallel, or parallel.

To illustrate this, I have shown two drawings. Refer to Fig. A first.

You will notice that I have designated one terminal of the circuit as being negative and the other as being positive. Current will flow from the negative terminal and attempt to reach the positive terminal. The current will begin by flowing through R1. Since the full circuit current will flow through here, it is a series resistor.

When the current reaches point A, it will have to divide. Part will flow through R2 and part will flow through R3. However, the current will combine at point B. Thus, R2 and R3 are connected in parallel with each other.

The full circuit current will be at point B. So it will then flow through R4 to reach the positive terminal. As you can see, R4 is a series resistor.

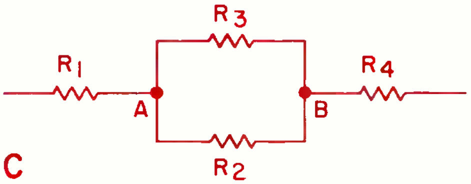
In summary, R1 and R4 in Fig. A are series resistors and R2 and R3 are parallel resistances.

In Example B, I have reversed the polarity of the terminals and also have added several additional resistors. Again, current will flow from the negative terminal. It will first flow through R6. So R6 is a series resistor. At point B, the current will divide. Part will flow through R2 and part will flow through R5. Notice that the current that flows through R5 must travel through R4 and R3 to reach point A, whereas the current that flows through R2 will reach point A directly. It flows through no other resistors to get there. This means that R3, R4, and R5 are connected in series with each other and in parallel with R2. At point A, the full circuit current will recombine and flow through R1.

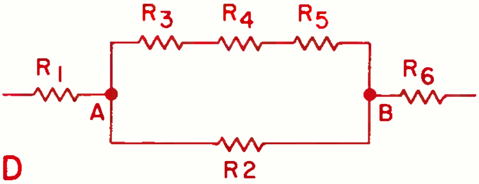
There is another method that can be used to determine the type of resistance circuit you have. Refer to Fig. A again; notice that the negative terminal is the top terminal and the positive terminal is the bottom terminal. If we mentally took the bottom portion of the circuit and stretched it around counterclockwise or to the right until the circuit was directly from left to right, it would appear as in Fig. C. Fig. B would appear as shown in Fig. D if we did this here. By straightening the circuit out, you can easily see that we have a series-parallel circuit in each case.

You would begin at the left calculating the value of each resistance. For example, in Fig. C, you would first make a notation of the value of R1. Next, you would find the total resistance of R2 and R3 in parallel. Then, you would make a notation of the value of R4. Finally, to find the total resistance, you would add the three figures together.

In Fig. D, you would first make a notation of the value of R1. Then, you would determine the total resistance of the top branch of the parallel circuit by adding R3, R4, and R5 together. You could then use your parallel formula to determine the total resistance of the parallel circuit. Finally, you would make a notation of the value of R6. By adding the three figures together again, you would have the total resistance of the circuit. ☐



C



D

Mr. and Mrs. Milton Rubin, left, and Mr. and Mrs. Jules Cohen with Ted Rose, center, in the latter's NRI office.

PHILADELPHIA-CAMDEN CHAPTER MEMBERS RUBEN, COHEN AND WIVES PAY NRI A VISIT

Following a day spent at the New York World's Fair, Alumni Association Secretary Jules Cohen and Milton Rubin with their charming wives drove to Washington for a couple of days of sightseeing and a visit to NRI. This was quite an occasion for NRI. After renewing acquaintances with J. M. Smith, President, and Harold E. Luber, Vice-President, and a short tour of the building the party enjoyed a scenic drive in the country to Normandy Farms, one of the area's famous suburban restaurants, for dinner. J. B. Straughn and Ted Rose of the NRI Staff served as hosts. It was a delightful event. Come back again soon, folks!

ALUMNI ELECTION BALLOT

FOR PRESIDENT (VOTE FOR ONE MAN):

- ☐ Howard Tate, Pittsburgh, Pa.
- ☐ Eugene De Caussin, Los Angeles, Calif.

FOR VICE-PRESIDENT (VOTE FOR FOUR MEN):

- ☐ Joseph G. Bradley, Jr., New York, N. Y.
- ☐ William Lundy, Pittsburgh, Pa.
- ☐ F. Earl Oliver, East Detroit, Mich.
- ☐ Edward Bednarz, Fall River, Mass.
- ☐ Frank Zimmer, Long Island City, N. Y.
- ☐ James L. Wheeler, Verona, Pa.
- ☐ Isaiah Randolph, San Francisco, Calif.
- ☐ Ernest M. Fix, Portland, Ore.

POLLS CLOSE SEPTEMBER 25, 1965.

SIGN HERE:

Your Name ....

Your Address ....

City .... State ......

MAIL YOUR COMPLETE BALLOT TO:

T. E. Rose, Executive Secretary

NRI ALUMNI ASSOCIATION

3939 Wisconsin Ave.

WASHINGTON, D. C. 20016

CONAR EASY PAYMENT PLAN

TO

Note: Easy payment contracts cannot be accepted from persons under 21 years of age. If you are under 21, have this sheet filled in by a person of legal age and regularly employed.

Enclosed is a down payment of $________ on the equipment I have listed on the reverse side. Beginning 30 days from the date of shipment I will pay you $________ each month until the total payment price is paid. You will retain title of this equipment until this amount is fully paid. If I do not make the payments as agreed, you may declare the entire unpaid balance immediately due and payable, or at your option, repossess the equipment. Your acceptance of this will be effected by your shipment to me of the equipment I have listed.

Date ____________________ Your written signature ____________________

CREDIT APPLICATION

Print Full Name ____________________ Age ________

Home Address ____________________

City & State ____________________ How long at this address? ________

Previous Address ____________________

City & State ____________________ How long at this address? ________

Present Employer ____________ Position ____________ Monthly Income ________

Business Address ____________________ How Long Employed? ________

If in business for self, what business? ____________ How Long? ________

Bank Account with ____________________ Savings ☐ Checking ☐

CREDIT REFERENCE (Give 2 Merchants, Firms or Finance Companies with whom you have or have had accounts.

Credit Acct. with ____________ (Name) ____________ (Address) Highest Credit ________

Credit Acct. with ____________ (Name) ____________ (Address) Highest Credit ________

Alumni News

TATE OUT IN FRONT AS PRESIDENTIAL NOMINEE, DE CAUSSIN TAKES SECOND PLACE IN SELECTIONS

The members of the NRI Alumni Association have chosen two of the former Vice-Presidents as nominees for President of the Association for 1965. Howard Tate of Pittsburgh received the greatest number of nominating votes, and Eugene De Caussin of Los Angeles was favored with the second highest number.

Tate has long been a leading light of the Pittsburgh Chapter. Indeed, he was one of two men who in 1952 proposed organizing a Pittsburgh Chapter and who were the most responsible for its being founded. (The other was Frank Skolnik, who was elected to the Presidency of the Association for 1962.) Since then Tate has held with distinction every office in the chapter, and at the end of last year brought his second term as a National Vice-President to a close.

Eugene De Caussin has likewise contributed much to the Los Angeles Chapter. Not only has he provided the chapter with his valuable leadership continuously for the past half-dozen years but also its meeting place. The owner of a successful, full-time Radio-TV service business, he has a well-equipped shop and an attractive store where the chapter holds its meetings. Like Tate, he also has completed two full terms as a National Vice-President.

The eight members nominated for Vice-Presidents are listed in the ballot on Page 28. Zimmer, Wheeler, Lundy, and Oliver are all former National Officers; the other four are running for National Office for the first time. All are members of local chapters except Fix. This campaign has turned up two pairs of contestants in the same local chapters, Zimmer and Bradley of the New York City Chapter, and Wheeler and Lundy of the Pittsburgh Chapter. This of course will mean a split vote in these cases.

Be sure to mail your ballot early, as soon as you can. The winners will be announced in the next issue of the Journal.

CHAPTER CHATTER

DETROIT CHAPTER, following a long established custom, celebrated the last meeting of the 1964-1965 season with its usual annual stag banquet. Also as usual, everybody ate far too much. But the kind of food served on this occasion is just too good to resist.

Discussion of business matters was held to a minimum. One item acted on was that the entire slate of officers for 1964-1965 was re-elected to serve for the 1965-1966 season.

The other business matter decided upon was one which all chapter members should note carefully. For many years meetings were held on the second and fourth Friday of each month. This will be done in September. But in October and thereafter only one meeting will be held each month, on the second Friday.

Sam White rejoined the chapter after a long absence due to illness. His return was enthusiastically welcomed.

FLINT (SAGINAW VALLEY) CHAPTER, in its final meeting of last season, concentrated on that always-absorbing subject, servicing color TV receivers. As in past years, the chapter suspended meetings for the summer, will resume them in September.

HACKENSACK CHAPTER members are indebted to George Schopmeier for an absorbing lecture on the oscilloscope. In the first half of the meeting he discussed the procedure on measuring peak-to-peak voltage and also explained, with the aid of blackboard drawings, that a fundamental frequency is a sine wave; that the addition of harmonics, which are also sine waves, gives a very distorted, non-sinusoidal output. Then he went through each stage of a TV receiver explaining the scope trace. In the second half of the meeting he concentrated on alignment. The members felt that this was a much-needed lecture and that they derived a great deal of useful knowledge from it.

At the next meeting, due to the absence of a scheduled speaker, member Bruno Ottino volunteered to give a lecture on color television. He held the attention of everyone for the entire evening. There were so many questions from the members that Bruno did not have time to answer them all, and promised to try to prepare to answer any and all questions that members have in the future.

The remainder of the summer meetings were scheduled to feature troubleshooting films from Howard Sams.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER has continued its concentration on troubleshooting of color television sets with a B and K Analyzer, tough-dog TV service jobs, and proper installation of antennas.

LOS ANGELES CHAPTER'S latest member is Mr. Kenneth K. Kellogg. Welcome to the Chapter, Ken!

The members were very pleased to receive a visit from Sam Stinebaugh, Chairman of the San Antonio Chapter. This was a very unusual event. In addressing the members, Sam talked about the San Antonio Chapter and particularly about its battle with the Texas Electronic Association on the latter's policy toward part-time radio-TV servicemen.

Earlier this year the decision was taken to resume showing educational films at meetings as was done in the past. Since then a good many very interesting films have been exhibited, one by Motorola on how a Television receiver works, another by Westinghouse on the same subject but also on a TV receiver factory assembly line, and several films from Bell Telephone. The membership is heartily in favor of showing these films at the meetings.

In addition, it was proposed to hold a series of lectures on color Television provided that Secretary Earle B. Allen, Jr., can get the slides from H. W. Sams.

MINNEAPOLIS-ST. PAUL (TWIN CITY) CHAPTER celebrated the end of the 1964-1965 season with its usual banquet attended by members and their wives. This time it was held at the Maplewood Bowl in Minneapolis. The members and their wives always enjoy this annual event.

Like so many of the others, the chapter suspended its meetings for July and August, the first of the 1965-1966 season to be held in September.

NEW YORK CITY CHAPTER'S highlight of the 1964-1965 season was a three-hour lecture on color TV Servicing by Mr. Larry Black, RCA Training Administrator. He dealt at length with color TV circuitry, the technique to use in degaussing the color TV picture tube, getting the best center and dynamic convergence, and obtaining purity in the picture.

He stressed the importance of explaining the

RCA training administrator Larry Black demonstrated color TV principles at New York City chapter meeting.

NRI guests Blan Straughn, right, and Ted Rose, center, with Charlie Fehn petition Chairman John Pirrung for more hot dogs and sauerkraut. Eugene Patrick, background, finally got refills, too.

color TV picture to the customer and of being thorough, sincere, and honest in your explanation. He pointed out that the servicing of any TV set can be properly and correctly done by a planned, well-organized procedure. Time and again he explained the theory, illustrated it on the blackboard, and then demonstrated it on the color TV set he had brought along. Using a color bar generator, he gave a thorough explanation of the many stages, their functions and operations, in a color TV system.

The chapter is indebted to Mr. Black and to RCA for the finest talk and demonstration on color TV that has been presented at any of its meetings.

Chapter members Frank Lucas, Jim Eaddy, and Ontie Crowe have continued to contribute their part to the meetings by their lectures and demonstrations.

One new member was recently admitted to membership. He is Reinaldo Lima of Brooklyn. Congratulations, Reinaldo!

Former Chairman Brother Bernard Frey was compelled to resign due to being transferred by his church superiors to Springfield, Mass. The members expressed their appreciation to Brother Bernard for his many efforts on behalf of the chapter.

Executive Chairman Frank Lucas was then nominated and elected as Chairman to replace Brother Frey.

PHILADELPHIA-CAMDEN CHAPTER was saddened by the recent death of Fred Seganti. One of its oldest and most loyal members, Fred had gone to Florida and engaged in Radio-TV servicing in Tampa, but passed away only a short time later.

Raymond Rosen and Ty Yonkers of the Raymond Rosen Company, distributors for RCA, arranged for members to be guests of the company. Raymond Rosen is its vice-president in charge of parts and service. RCA field engineer Bill Powell delivered a talk on basic transistor application. He was very good indeed, making it easy to follow his lecture. He left out the sometimes confusing theory of transistors and explained it in a way that everyone could understand. Books on the transistor were given out, also door prizes. Secretary Jules Cohen says he is sorry for the members who were absent, as they missed a lot of valuable, useful information and everyday working knowledge in servicing transistors.

After holding only one service meeting in July and August, the chapter will again take up its usual two-meetings-per-month in September.

PITTSBURGH CHAPTER members were facinated by a lecture given by Mr. Glenn Mumber, an old-timer NRI graduate, who is service manager of Westinghouse. It was about electronic organs. He traced the development from a single-pipe flute used by early man up to the magnificent organs of today. He then discussed the electronic version of the pipe organ and how it attempts to duplicate the tones by blending the proper amount of higher harmonics with the fundamental frequency.

Time ran out. Mr. Mumber had to continue

RCA field engineer Bill Powell, left, and Ty Yonkers of the Raymond Rosen Co. holding the chassis of the all-transistor portable Powell demonstrated for Philadelphia-Camden meet.

his talk at the next meeting, but even then he did not finish and it took still another meeting to complete this program.

Scheduled for the September and October meetings are programs by Westinghouse on its all-transistor 19-inch TV and new 1966 receivers, and by Motorola on its 23-inch compact color TV receiver.

The chapter's newest member is Mr. Edward Uhlig. Welcome to the ranks, Ed!

SAN ANTONIO ALAMO CHAPTER chairman Sam Stinebaugh presented a lecture on business practices, a subject to which all radio-TV servicemen should give careful study and attention if they are to maintain their customers' confidence and good will.

Bill Whittaker brought in some old tube books and price lists dated 1928. The members were astounded by the information contained in them. Bill is a retired radio technician. He enjoys reminiscing about the good old days and the members enjoy listening to him.

The chapter attended a color TV servicing seminar sponsored by RCA in San Antonio. Approximately 150 people were present. The members found this seminar worthwhile.

SPRINGFIELD (MASS.) CHAPTER held its final meeting for the 1964-1965 season at Norman Charest's shop, 74 Redfern St. The chapter was honored with the presence of Brother Bernard Frey, former Chairman of the New York City Chapter. He was transferred to the Springfield area. If the transfer becomes permanent, he expects to join the Springfield Chapter and all the members are eager to have him do so. They hope Brother Frey does not think they are all too talkative ---they kept him up rather late, but they found him too interesting to let him go.

John Parks brought in a Television receiver and swore that it would not work at all, had no sound or picture, but when he said a few magic words (or a prayer) the set came to life. John likes to kid a lot but the members privately suspect that he forgot to plug the set in.

Election of officers was postponed until the chapter begins the new season. □

35 Years Ago

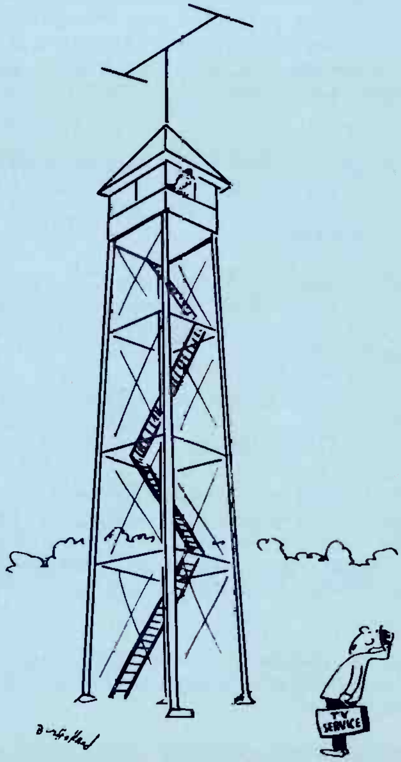
In National Radio News Sept., 1930

RADIO TRANSMITTERS FOR BROADcasting motion pictures were the newest thing in entertainment; the prediction: "Photographs, motion pictures, and talking pictures may be flashed into homes as a commonplace procedure a few years hence... this will mean that radio will enter another great era of prosperity..."

EDWARD K. COHON, DIRECTOR OF technical operations for CBS, predicted that "the transmission of programs on a one-wave channel will be the next step in broadcasting."

OUT OF SOME 600 RADIO BROADCASTing stations in the U.S., 80 employed NRI-trained men; NRI graduates operated radio stations in 32 states, Canada and Cuba.

LIFE-SIZE TELEVISION IMAGES HAD been publicly demonstrated by Dr. E.F. W. Alexanderson in a theater at Schenectady, N.Y., and, the NEWS marveled, "Only three years ago pictures were shown in a frame only three inches square!"



"$5 if you bring it down here, $25 if I have to go up there."

Useful items for students and technicians

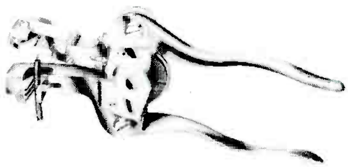
CONAR

DIVISION OF NATIONAL RADIO INSTITUTE

knicknack cabinet

Store and find small parts *fast!* Breakproof styrene cabinet has 15 transparent drawers with safety stops, removable dividers, bottom runners, index tabs. Order several for extra storage room. Cabinets can be stacked with interlocking effect. Each drawer 5¾" long, 2⅝" wide, 1⅛" high.

$2.99 **Stock #15CY, 4 lbs. parcel post**



speed-o-matic wire stripper

New, improved, faster wire stripper made by the GC Electronics Co. Fully automatic, it features new "Delayed Return Action" which prevents crushing of fine stranded wires. Sturdy and simple to use, the Speed-O-Matic has narrow grip handles for effortless operation. A handy tool to save time . . . for technicians, hobbyists, electricians.

$5.94 **Stock #766TO, 2 lbs. parcel post**

CONAR "BEST BUYS" TO HANDLE EVERY SOLDERING JOB

WELLER EXPERT SOLDERING GUN KIT

Dual-heat gun, aid tool cleaning brush, solder. "Triggermatic" control for 140 watt or 100-watt heat. Spot light illumination. Easy-to replace tip heats in five seconds.

CONAR PRICE: **$6.48** (8200AC)

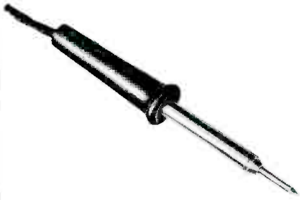
4 lbs. parcel post

UNGAR SOLDERING PENCIL KITS

Low heat, light in weight, small tips. Perfect for circuit board and transistor work. Senior Kit has 47½, 37½, and 23½ watt elements. Junior Kit has 37½ watt element only. *Ten* ⅛" tips included.

CONAR PRICES: **$7.40** Senior Kit (S776TO) **$3.98** Junior Kit (J776TO)

1 lb. parcel post



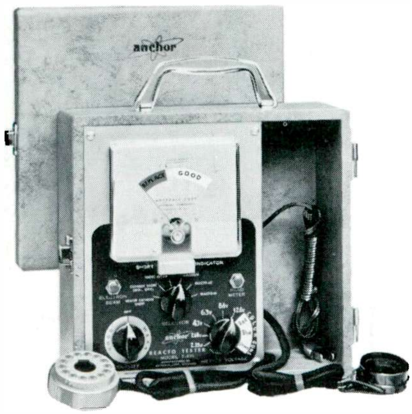
AMERICAN BEAUTY SOLDERING IRON

Perfect for kit assembly, radio-TV wiring. Nickel-plated, copper tip resists corrosion, easily replaceable. Stainless steel casing with 30 watt element. Insulated stand, ⅛" and 3/16" tips.

CONAR PRICE: **$4.47** (3120TO)

1 lb. parcel post

USE HANDY ORDER FORM ON PAGE 27



FULLY ASSEMBLED — READY TO USE

Test, analyze and repair all picture tubes in use today —black-white and color. Reacto Model T-471 includes all necessary adapters, 4½" meter, filament switch to cover exact voltage of all tubes, switch for checking individual guns of color tubes, short and open indicator lamp and contact switch to weld open cathodes and eliminate inter-element shorts. Only instrument in price range with so many features. Size 10" x 9¾" x 4½".

SALE PRICE

$47.85 **Stock #471WT**