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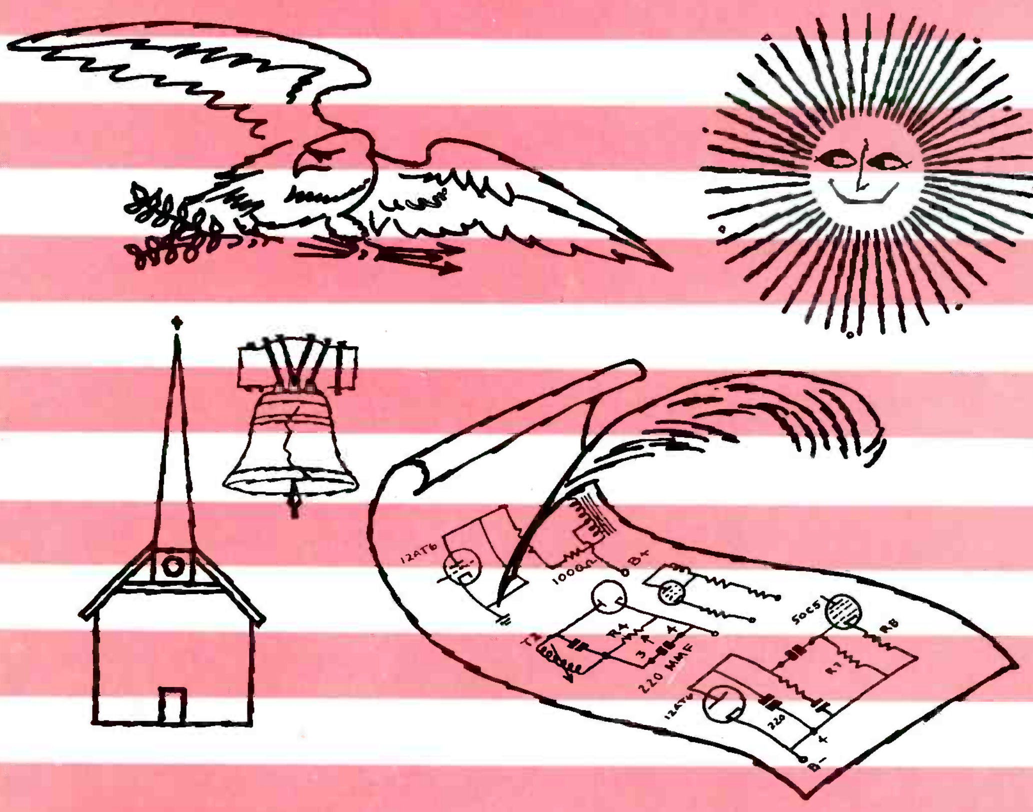

IN THIS ISSUE:

- ANOTHER LOOK AT OHM'S LAW
- THE CONAR 221 TUBE TESTER
- COMMUNICATIONS
- AA NOMINATIONS OPEN

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3DT6	.54	6CB6	.55	8CM7	.70	12K5	.75
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3Q4	.63	6CG7	.61	8CS7	.74	12SF7	.69
3S4	.75	6CG8	.80	8EB8	.94	12SK7GT	.95
3V4	.63	6CL8	.79	8FQ7	.56	12SL7	.80
4BQ7	1.01	6CM7	.69	9CL8	.79	12SN7	.67
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4DT6	.55	6CQ8	.92	12A4	.60	12U7	.62
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5CL8	.76	6DG6	.62	12AL8	.95	19BG6	1.39
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5EA8	.80	6DK6	.59	12AT6	.50	19T8	.85
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5T8	.86	6DT5	.81	12AU7	.61	25C5	.53
5U4	.60	6DT6	.53	12AV6	.41	25CA5	.59
5U8	.84	6DT8	.94	12AV7	.82	25CD6	1.52
5V6	.56	6EA8	.79	12AX4	.67	25CU6	1.11
5X8	.82	6EB5	.73	12AX7	.63	25DN6	1.42
5Y3	.46	6EB8	.94	12AY7	1.44	25EH5	.55
6AB4	.46	6EM5	.77	12AZ7	.86	25L6	.57
6AC7	.96	6EM7	.82	12B4	.68	25W4	.68
6AF4	1.01	6EU8	.79	12BD6	.50	32ET5	.55
6AG5	.70	6EV5	.75	12BE6	.53	35C5	.51
6AH4	.81	6EW6	.57	12BF6	.60	35L6	.60
6AH6	1.10	6EY6	.75	12BH7	.77	35W4	.42
6AK5	.95	6FG7	.69	12BK5	1.00	35Z5	.60
6AL5	.47	6FV8	.79	12BL6	.56	36AM3	.36
6AM8	.78	6GH8	.80	12BQ6	1.16	50B5	.69
6AQ5	.53	6GK5	.61	12BR7	.74	50C5	.53
6AS5	.60	6GK6	.79	12BV7	.76	50EH5	.55
6AT6	.49	6GN8	.94	12BY7	.77	50L6	.61
6AT8	.86	6H6	.58	12BZ7	.86	70L7	.97
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JULY/AUGUST, 1965

VOL. 22, NO. 4

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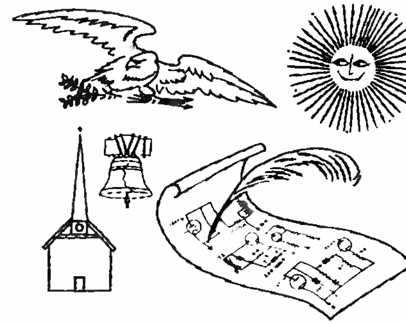
CONTENTS



ON OUR COVER

Give Art Editor Marion Tiger "a rag, a bone, and a hank of hair" and she would probably turn it into a prize neo-impressionistic Degas ballet dancer. Or something intriguing, anyway. As it is, she was given the idea: What does the Fourth of July make you think of in relation to an NRI Journal cover? Herewith her answer, which encompasses the symbolisms of American heritage, complete with scrolled schematic, done in her own inimitable style. And if you wonder why similar artistic treatments in future issues of the Journal are lacking, it's because we're losing her with this issue.

She and her State Department officer husband, Gordon, and their daughters, Becky and Judy, are leaving for his new assignment, a four-year tour of duty at the U. S. Embassy in New Delhi, India.

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In case we get too chesty about all the modern inventions that make life easier, we should remember that thousands of years before the first man learned how a wheel worked, the lowly turtle had a streamlined body, hard top, retractable landing gear and a mobile house.

Bruce V. Snow

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Northern Michigan University has an opening for a man with a thorough knowledge of basic Electronics who has a first class radiotelephone license. He must also have a theoretical and working knowledge of basic FM Radio and Television broadcasting systems. He should have sufficient experience in the mechanical and electronics end of broadcast equipment to install components as well as repair breakdowns and system failures in FM, TV, and allied instructional equipment. He will be expected to perform general engineering duties and serve as chief engineer for WNMR-FM, the university's institutional broadcast Radio station. Salary will depend on training and experience. Those interested should contact Mr. S. Kenneth Bergsma, Coordinator, Instructional Communication, Northern Michigan University, Marquette, Mich.

Let's Take Another Look at Ohm's Law

By WILLIAM F. DUNN

It is a sad state of affairs, but the hard cold truth of the matter is that today there are far more jobs available than there are qualified applicants. This is true in spite of the fact that there are over four million unemployed in this country. The problem is that even though these jobs exist, the unemployed are not qualified to fill them.

Today many new jobs in electronics are opening for technicians. Many radio-TV service technicians who want to get into industry are applying for and getting these jobs, but too many technicians are not applying simply because they insist on selling themselves short.

Before employing a technician, most companies give him a test. The test usually is not very difficult, but it does involve the solutions of a number of problems. Here is where many technicians fall down. Some refuse to take the test, others who take the test fail because they refuse to think; they have a mental block that defeats them before they start.

And what is that mental block? It's the same old thing over and over again -- "I can't do the problems because the mathematics is too difficult. I've been away from math a long time; I can't remember how to do the problems." Or another reason, "I didn't have much math in school so I can't work the problems." The fact is most of the problems on these tests are very simple and involve no more math than we all use in everyday life. You can do the problems; you are using all the math you need right now.

Before we go into some problems in Ohm's Law, let's have a quick math review. Don't freeze up -- we're not going into anything new; we're simply going to start by counting some money.

Let's look at fractions. What is the sum of

$$1/4 + 1/4?$$

If you have two 25-cent pieces in your pocket, how much money do you have? You know right away you have 50 cents or half a dollar. So if you add

$$1/4 + 1/4 = 1/2$$

You know this is true because one quarter of a dollar plus another quarter of a dollar gives you two quarters which is equal to half a dollar.

You can also write a quarter of a dollar as $.25. Here we have expressed twenty-five cents as a decimal equivalent of a dollar. So how much money do you have if you have two quarters? Adding we get

$$\begin{array}{r} .25 \\ \underline{.25} \\ .50 \end{array}$$

You've seen fifty cents written as $.50. So now you're adding decimals. What if you had two quarters, one dime, and one nickel? How much money do you have? Right away you say sixty-five cents, so why be afraid to add decimals?

$$\begin{array}{r} .25 \\ .25 \\ .10 \\ \underline{.05} \\ .65 \end{array}$$

Any decimal addition is as simple as the preceding example, but what if the values had been given to you as fractions? Twenty-five cents is a quarter of a dollar (1/4), ten cents is a tenth of a dollar (1/10) and five cents is one twentieth of a dollar.

$$1/4 + 1/4 + 1/10 + 1/20$$

We know the answer must be sixty-five cents, which when written as a fraction of a dollar is $\frac{65}{100}$ of a dollar, but how do we get the answer?

To add these fractions we need to find a common denominator. These are big words, but what they really mean is that we can't add quarters, tenths, and twentieths directly; we must change them all into the same units. We change them into the smallest units, in this case twentieths.

How many twentieths are there in a quarter? You find the answer simply by dividing four into twenty to get five. Why did you do this -- stop for a minute and you'll see. If you add together a quarter and a nickel you must stop and think how many nickels there are in a quarter -- there are five. So how many twentieths are there in a quarter? The same answer, five. So our addition of fractions becomes

$$1/4 + 1/4 + 1/10 + 1/20 =$$

$$\frac{5 + 5 + 2 + 1}{20} = \frac{13}{20}$$

But $\frac{13}{20} = \frac{65}{100}$ because 20 goes into 100 five times and we can multiply the top and bottom of a fraction by the same number without changing its value.

You see you are using math every day in handling money. You add and subtract, multiply and divide, do problems in fractions and decimals daily -- so why not do a few equally simple problems in electronics?

OHM'S LAW

Let's look at Ohm's Law. It states that the voltage is equal to the resistance times the current. We express it in a formula as:

$$E = IR$$

Is this complicated? Not one bit. Suppose we said:

$$6 = 2 \times 3$$

This is the same thing. We have left out the times sign in Ohm's Law but it means the same thing. The times sign is omitted because mathematicians agreed it was unnecessary. When two letters are written together in this way it means the quantities they represent are to be multiplied together.

Now let's take the expression $6 = 2 \times 3$ and manipulate it. How about

$$3 = \frac{6}{2}$$

or

$$2 = \frac{6}{3}$$

What is different between this and

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

or

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

We've done the same thing in each case. When we take the basic expression

$$6 = 2 \times 3$$

we might remember that it can also be written as:

$$\frac{6}{1} = \frac{2}{1} \times \frac{3}{1}$$

Now we can move a term from one side of the equals sign to the other by cross-multiplying. For example, to move the two across we proceed as:

$$\frac{6}{1} \times \frac{1}{2} = \frac{2}{1} \times \frac{3}{1}$$

so now we have

$$\frac{6}{2} = 3$$

and we can reverse this and write it as

$$3 = \frac{6}{2}$$

We handle Ohm's Law the same way. Remember that $E = IR$ is the same as $6 = 2 \times 3$ and if you have to manipulate the equation and forget how to do it write down $6 = 2 \times 3$ and manipulate it to see how to get Ohm's Law into the form you need it in.

FINDING THE VOLTAGE

Now let's look at a few simple Ohm's Law problems and see how we do them. Look at the circuit shown in Fig. 1. We are given the current flowing in the circuit and the resistance and asked to find the voltage. We put the value of I and R into the formula:

$$E = IR$$

$$= 2 \times 30$$

$$= 60 \text{ volts}$$

Before going on to another example, let's examine in detail what we have done. We were given the current in amperes and the resistance in ohms. From these values we were able to calculate the voltage in the circuit using the formula E = IR. Notice that when we calculated the numerical value of the voltage as 60, we wrote volts after the 60. If we left the answer

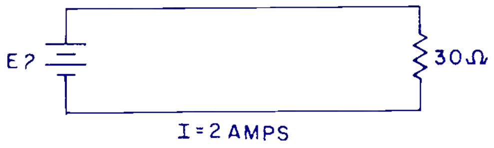


Fig. 1. A simple series circuit.

as 60 it is meaningless; 60 what, houses, cows? We must give the units to complete the answer. When we are looking for the voltage, the answer must be expressed in volts. Some technicians are very careless with their units and sometimes when the voltage is required do all the calculations correctly and then might write the answer as 60 ohms or 60 amps. Of course both answers are wrong -- it's far better to make a mistake in arithmetic than to use the wrong units. Expressing the answer in the wrong units either indicates a great deal of carelessness or a complete lack of understanding of the subject.

Now look at the problem in Fig. 2. Here we are given the value of three resistors in series and the current flowing in the circuit. How do we find the voltage? First we must find the total resistance in the circuit. To do this we simply add the resistances because

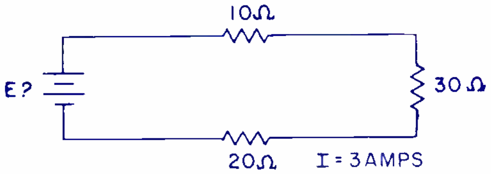


Fig. 2. Find the voltage when three resistors are in series.

in a series circuit, the total resistance is equal to the sum of the individual resistances. Therefore

$$R_t = 10 + 30 + 20$$
$$= 60 \text{ ohms.}$$

Now we put the values I = 3 amps and R = 60 ohms into the equation to get the voltage:

$$E = IR$$
$$= 3 \times 60$$
$$= 180 \text{ volts}$$

The problems in Figs. 1 and 2 were quite simple because we were dealing in whole numbers. But suppose the current had been given as 30 milliamps. To use Ohm's Law, the current must be in amps and the resistance in ohms. This means we must convert the current in milliamps into amps. There are 1000 milliamperes in an ampere. Thus one milliamp is equal to one thousandth of an amp. To express milliamps as amps we simply move the decimal point three places to the left. For example

30 milliamps = 30. milliamps

We usually omit the decimal point because it has no meaning. Now to express 30 milliamps in amps, we move the decimal point three places to the left:

30. milliamps = .030 amps.

Notice we had to add a zero to the left of the three in order to get three decimal places. We can drop the zero to the right of the three if we wish and write

30 milliamps = .03 amps.

Now that we have the current in amps and the resistance in ohms, we can find the voltage.

$$E = IR$$
$$= .030 \times 60$$

To perform this multiplication we proceed as follows:

$$\begin{array}{r} .030 \\ 60 \\ \hline 01800 \end{array}$$

The total number of decimal places we had in the two numbers we multiplied together was three; therefore we must have three decimal places in our answer. We count off three places from the right and get our answer as 01.800 volts, which we can write as 1.8 volts.

FINDING THE RESISTANCE

Now let's look at Fig. 3. Here we are given the voltage and the current and we want to find the resistance. We have the formula:

$$E = IR$$

from which we can get

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

If you do not see how to get the formula into this form, remember 6 = 2 ×3. Write it down and manipulate it into this form.

From Fig. 3 we know that the voltage is 50

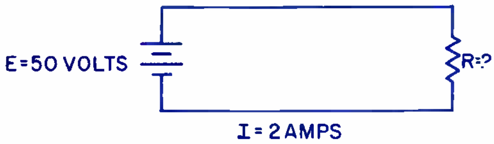


Fig. 3. Find R in this simple series circuit.

volts and the current is 2 amps so we substitute these values in the formula:

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

$$= \frac{50}{2}$$

$$= 25 \text{ ohms.}$$

Notice we are finding the resistance, so our answer is in ohms. Also notice again we have the voltage in volts, the current in amperes and the resistance in ohms. As we pointed out, sometimes one of the values given is given to you in something other than the basic units. Suppose the current is given in milliamps as before. You must convert the current into amps before you can use it in the formula. For example, suppose the current in Fig. 3 was 2 milliamps. Convert 2 milliamps to amps by writing it as 2. milliamps and then moving the decimal point three places to the left. Thus 2. milliamps = .002 amps.

Now substituting in the equation:

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

$$= \frac{50}{.002}$$

To change this decimal division into a division by whole numbers, we multiply the numerator (top) and denominator (bottom) of the fraction by 1000. This will get rid of the decimal and give us

$$R = \frac{50{,}000}{2}$$

$$= 25{,}000 \text{ ohms}$$

(When you multiply a decimal by 1000 you move the decimal point three places to the right. Thus .002 × 1000 = 2 and 25 × 1000 = 50,000.)

A slightly different problem is given in Fig. 4. Here we have three resistors in series and we are given the resistance of two. We are given the total voltage applied to the circuit and the circuit current and we are to find the value of the unknown resistance.

In a circuit where a voltage of 85 volts is applied such as in Fig. 4, the current that will flow will depend on the total resistance in the circuit. This is the value you will get when you substitute the total circuit voltage and current in the Ohm's Law formula. Thus

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

$$= \frac{85}{1} = 85 \text{ ohms.}$$

Now we know that the total resistance in the series circuit of Fig. 4 is equal to 85 ohms. We also know that the resistance is equal to the sum of the individual resistance. One resistor is 50 ohms, another is 25 ohms so the total resistance of these two must be 75 ohms. If the total circuit resistance is 85 ohms, the value of the unknown resistor must be 85 - 75 = 10 ohms.

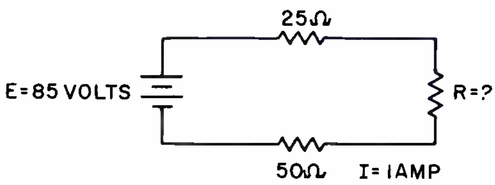


Fig. 4. Find the value in the unknown resistor.

FINDING THE CURRENT

Now let's see how we find the current in a circuit if we know the voltage and resistance. Look at the circuit shown in Fig. 5. Here we have the voltage as 111 volts and the series resistance equal to 37 ohms. We substitute these values in the formula:

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

$$= \frac{111}{37} = 3 \text{ amps.}$$

Notice the voltage is in volts, the resistance in ohms, and our answer, the current, in amps.

Another example is shown in Fig. 6. Here we are given the voltage as 6 volts and the resistance as 2000 ohms. Again, we use the formula

Fig. 5. Find I in the series circuit.

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

$$= \frac{6}{2000}$$

Now to divide 2000 into 6 we proceed as follows:

2000 / 6.

Since 2000 will not go into 6, we place a 0 above the six and add a 0 to the right of the decimal point. This gives us:

```
        0.
2000 / 6.0
```

We still can't divide 2000 into 60 so we place

Fig. 6. Find I in milliamps in the series circuit.

a 0 above the 0 we added and add another 0 after the decimal point. Now we have:

```
        0.0
2000 / 6.00
```

Now we have 2000 into 600. We still can't divide, so we place another 0 in our answer above the second 0 we added and then place a third 0 to the right of the decimal point. Now we have:

```
        0.00
2000 / 6.000
```

But 2000 will go into 6000 three times so we place a 3 above the third 0 we added and proceed:

```
        0.003
2000 / 6.000
       6.000
           0
```

So our answer to the division of 2000 into 6 is .003. This means that the current is .003 amps. To change amps to milliamps, we move the decimal point three places to the right. Thus,

.003 amps = 3 milliamps

RESISTORS IN PARALLEL

Now look at the circuit shown in Fig. 7. Here once again we have a 2000-ohm resistor connected across a 6-volt battery, so the current through this resistor must be the same as in the circuit of Fig. 6. However, there is an extra path of current to flow; it can flow through the 3000-ohm resistor also. The current through the 3000-ohm resistor can be found the same way as the current through the 2000-ohm resistor

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

$$= \frac{6}{3000}$$

$$= .002 \text{ amps.}$$

Therefore the total current flowing in the circuit must be .005 amps; .003 amps through the 2000-ohm resistor plus .002 amps through the 3000-ohm resistor.

Now that we know the total current flowing through the circuit of Fig. 7, we can find the resistance of the 2000-ohm and 3000-ohm resistances in parallel. This will be the total circuit resistance. Using the formula:

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

$$R = \frac{6}{.005}$$

$$= \frac{6000}{5}$$

$$= 1200 \text{ ohms}$$

Notice that the resistance of the two resistors in parallel is less than the value of either resistor. Inspecting the circuit of Fig. 7 and the formula we used for finding the resistance enables us to see why this will always be so. Once you connect a resistor across a voltage source, a current will flow

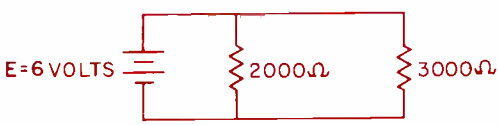


Fig. 7. Find total current flow in this parallel circuit.

through it. If you connect a second resistor in parallel with the first, the current must increase because you have provided a second path for current flow. Now if we look at the formula

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

we see that any increase in current makes our divisor larger. In other words I is larger. If E remains the same and I increases, the value we get for R must decrease.

Suppose you have two 600-ohm resistors in parallel as shown in Fig. 8 and want to find the total resistance of the parallel combination. You can use Ohm's Law as we have before. Since there is no voltage source connected across the resistors, you assume some convenient voltage and find what current would flow. Let's assume a voltage of 600 volts so our work will be easy. Using the formula:

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

$$= \frac{600}{600}$$

$$= 1 \text{ amp.}$$

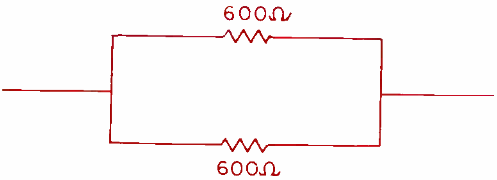


Fig. 8. Find value of two resistors in parallel.

This means with a voltage of 600 volts a current of 1 amp would flow through each resistor. Therefore the total current flow would be 1 + 1 = 2 amps. Now to find the resistance of the parallel combination, we use the formula:

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

$$= \frac{600}{2}$$

$$= 300 \text{ ohms.}$$

Thus the total resistance of two 600-ohm resistors in parallel is 300 ohms. Notice that the resistance worked out to be half the value of one of the resistors. Try this yourself with different values of resistors and you'll find that it always works out this way. The total resistance of two equal resistors in parallel is equal to one half the value of one of the resistors.

If you try this with three equal resistors you'll find the total resistance is one third the resistance of one of the resistors. For example, if we had a third 600-ohm resistor in Fig. 8 and assumed 600 volts across all three as before, 1 amp would flow through each so the total current would be 3 amps. 600 ÷ 3 = 200, so the total resistance is 200 ohms. If four equal resistors are connected in parallel, the total resistance is one quarter the value of one of the resistors and so on.

Another way of finding the total resistance of two resistors in parallel is to use the formula:

$$R_t = \frac{R_1 \times R_2}{R_1 + R_2}$$

Let's use this formula to find the parallel resistance of R_1 and R_2 in Fig. 9.

$$R_t = \frac{6 \times 8}{6 + 8}$$

$$= \frac{48}{14}$$

Performing this division we get:

```
      3.42
 14 / 48
      42
       60
       56
        40
        28
        12
```

We can carry this division further, but 3.42 ohms is close enough.

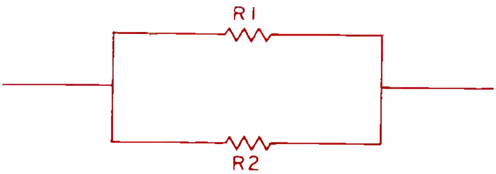


Fig. 9. Find the parallel resistances of R1 and R2 if R1 equals 6 ohms and R2 equals 8 ohms.

OHM'S LAW IN USE

Now look at the circuit shown in Fig. 10. We are asked to find the value of the applied voltage E. Looks like a tough problem, doesn't it? Actually it is no more difficult than the

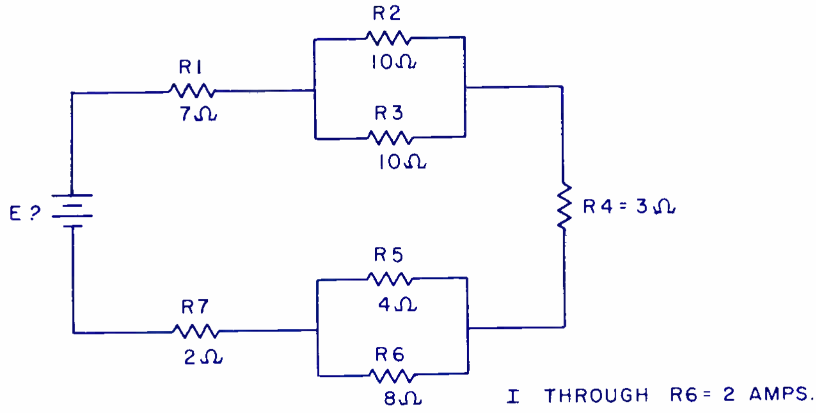


Fig. 10. Find the applied voltage E in the circuit shown.

problems we have been doing; it is just longer. We solve it using the same procedure we have been using in the preceding problem.

The problem here is where to start. We look for a place to start using Ohm's Law. We know that if we have two of the three values E, I, or R we can find the other. There's only one place where we have two of the values and that is R_6. We know the resistance of R_6 is 8 ohms and the current through it is 2 amps. Using this information we can find the voltage across R_6.

$$E = IR$$
$$= 2 \times 8 = 16 \text{ volts}$$

This means that the voltage across R_6 is 16 volts. But R_5 and R_6 are in parallel, therefore the voltage across R_5 must also be 16 volts. Now we know two of the values E, I, or R across R_5 so we can find the third. We have E = 16 volts and R = 4 ohms. We can find I

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

$$= \frac{16}{4} = 4 \text{ amps.}$$

If the current through R_6 is 2 amps and the current through R_5 is 4 amps, the total current flowing in the circuit must be the sum of these two currents.

$$I_t = 2 + 4 = 6 \text{ amps.}$$

Now we can go around the circuit and find the voltage across each of the parts. The voltage across R_1 is:

$$E = IR$$

$$= 6 \times 7 = 42 \text{ volts}$$

The total resistance of R_2 and R_3 in parallel will be half the value of either resistor or 5 ohms. Therefore the voltage across the combination is

$$E = 6 \times 5 = 30 \text{ volts.}$$

The voltage across R_4 is:

$$E = 6 \times 3 = 18 \text{ volts}$$

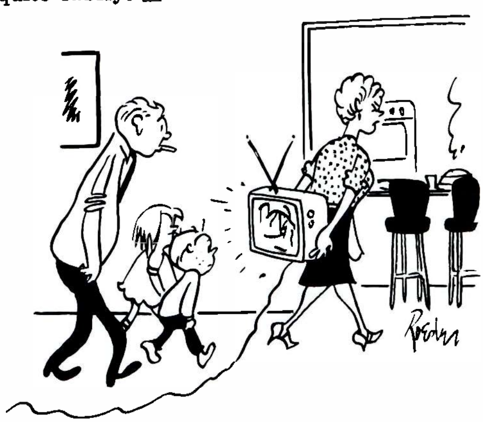
and the voltage across R_7 is

$$E = 6 \times 2 = 12 \text{ volts}$$

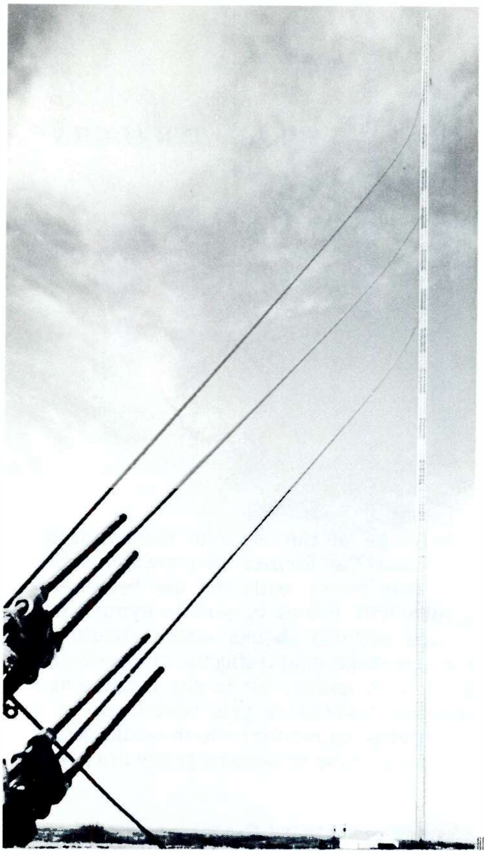
Therefore the total voltage is:

$$42 + 30 + 18 + 16 + 12 = 118 \text{ volts.}$$

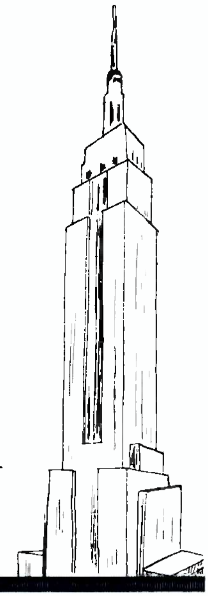
So as we pointed out earlier, this problem wasn't too difficult. At first glance problems often look tougher than they really are. Be sure to look the whole problem over, look for a place to start, and go to work on the problem one step at a time. If you are not afraid to tackle them, most problems can be solved quite easily. ☐



taller than the Empire State Building



1909-FOOT ANTENNA TOWER FOR TULSA



TULSA, OKLA. --- Latest TV station to reach for the sky is KTUL-TV, just outside Tulsa. Dresser-Ideco Co., a Dresser Industry, topped out the station's new 1909-foot antenna tower, world's second tallest structure. (KXTO-TV, in Fargo, N. D., is the tallest at 2,069.) If placed beside the Empire State Building with its attendant TV tower, the new facility would tower 437 feet further into the blue.

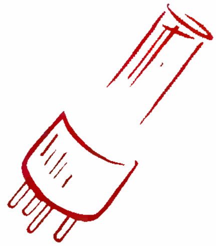
Purpose of the new tower is to upgrade the station's services to audience and advertisers, and so lay the groundwork for added revenue. The new transmitting equipment and a new antenna will improve picture reception, and also will permit KTUL-TV to telecast in color. The unusual height of the tower has made it possible for the station to locate its transmission facilities more favorably in relation to the Tulsa-Muskogee trading area. At the same time it puts the antenna 858 feet higher above average terrain than formerly. As a result 33 communities have been added to the station's coverage, to bring the projected FCC audience to nearly 100,000, largest among Oklahoma stations.

Almost as unusual as the height of the structure was the speed of its construction. First steel was set in late January, and there were fewer than 30 working days with favorable weather for high steel work before completion. On one day alone, the crew put up 180 feet of tower, an amazing footage considering that it included setting and resetting temporary guy wires several times. Such erection speeds demand the utmost attention to design and fabrication details and precise organization of material handling from production on through final placement of the steel. The completed tower is designed to withstand wind loads of 50 psf exerted by high velocity jet streams prevalent to the site. Such winds occasionally reach speeds of 110 mph.

Dresser-Ideco, a specialist in the field, was directly responsible for design, fabrication, and construction of the tower, and for installing the antenna and coaxial transmission lines. Field erection was subcontracted by TESCO Corp. KTUL-TV is a facility of Griffin-Lake Television, Inc.

CONAR MODEL 221 EMISSION-TYPE TUBE TESTER

By J.B. STRAUGHN



There are two basic types of tube testers, the mutual-conductance tube tester and the cathode emission-type tester.

The mutual conductance (Gm) tester is generally thought of as being far superior to the emission tester, but that is not necessarily true. In operation, the Gm tester must be designed to place normal dc operating voltages on each tube electrode, provide an ac signal to the grid, and translate the resulting change in plate current into mutual conductance, expressed in micromhos. In addition it must test for interelectrode shorts and for leakage and gas. The great variety of tubes which have been produced in the past and which will be produced in the future makes the Gm tester not only very expensive, but large, hard to lug around due to its weight, and unfortunately subject to rapid obsolescence. A new series of tubes, even those which may fit the sockets present, can outdate the most expensive Gm tester. On the other hand, only tubes which will not fit the sockets provided can make an emission tester obsolete.

Let's consider for a moment just what Gm is and what will affect this characteristic. Gm is the change in plate current divided by the change in grid voltage, or $Gm = \frac{IP}{eg}$. Thus, Gm shows the ability of the grid to control the plate current. But what can make the Gm of a once satisfactory tube decrease to the point where tube replacement is necessary?

The grid can sag so its physical spacing with reference to the cathode can change, but with today's tube structure this is not a problem. The only other thing which can happen is for the cathode emission to fall off. So this means that Gm is a function of cathode emission, and if the emission is satisfactory the Gm will in all probability be normal. Therefore, the only real advantage of the Gm over the emission tester is that the former can check for gas content. This never bothered me because a gassy tube will result in certain symptoms. There are definite checks which should be made in the stage containing the tube, not only to see if it is gassy, but to see if there are any troubles (excessive grid resistance or a leaky coupling capacitor) which would cause a replacement tube to become gassy in a short time.

Thus, considering that a Gm tester costs about three times as much as an emission tester and is more subject to obsolescence, the emission tester is the best buy for the serviceman.

Of course if you are in the business of checking tubes customers bring loose to your shop, you can do a somewhat better job with a Gm tester.

How Tubes Fail . . . .

The troubles encountered with tubes are limited. They can have burned-out filaments; permanent or intermittent interelectrode shorts can occur or cathode-to-heater leakage can become a problem; the Gm may fall off due to a worn-out cathode, resulting in low emission. Other troubles are best located by in-circuit tests or by tube substitution.

An Emission Tester's Function . . .

All tube testers must be able to locate shorts and leakage, because an attempt to check the emission of a shorted tube will generally result in damage to the tester. The tester must be able to supply any filament voltage which a tube requires and must do so accurately, regardless of the possible variations in line voltage. Thus a tube tester must be able to be adjusted for line voltages between 105 and 125 volts, which is about the greatest variation you can expect to encounter. Normal filament voltage is particularly important, since an increase in this voltage will increase cathode heat and emission so a bad tube will test "good."

In an emission tester all tubes are connected and are tested as diodes and this must be done regardless of tube basing arrangements. Thus you must be able to connect together any of the other electrodes except filament and cathode. This is accomplished by a separate switch for each pin on the tube socket. A method of handling the wide range of current drawn by any diode-connected tube is necessary so a single good-?-bad scale on the meter may be used. The tester must be able to check filament or heater continuity, since there is no object in proceeding with tests on a tube with a burned-out filament. You cannot depend on the filament having continuity by the light given off by the heater because this is not visible in some glass tubes, and of course cannot be seen in a tube with a metal envelope.

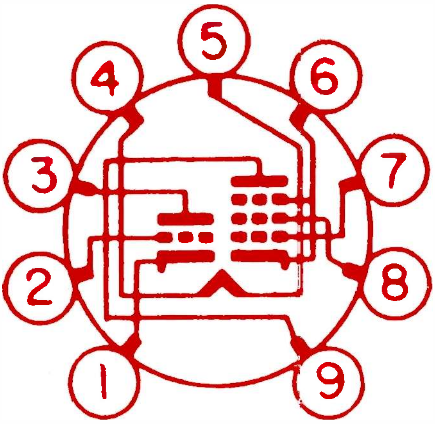


Fig. 1. Base layout of a triode-pentode type tube.

What do we mean by connecting a tube as a diode if, for example, it is a triode-type tube? Fig. 1 shows the base layout of a triode-pentode type tube. If we want to make a diode of the triode section we can connect the control grid and plate together. Then if an ac voltage is applied between the cathode and the other two electrodes the tube will act as a diode rectifier. The diode arrangement can be obtained by connecting together pins 2 and 3. To connect the pentode section as a diode, tie pins 7, 8, and 9 together. It's as simple as that!

Fig. 2 shows a complete working drawing of the CONAR Model 221 Tube Tester, with the exception of the sockets. The compactron socket has the greatest number of terminals (12), so we need 12 lever switches, one for each electrode pin. The number 1 terminals of all sockets are wired together and to the No. 1 lever switch. The same goes for the No. 2, No. 3, No. 4, etc., tube socket terminals and lever switches.

Let's analyze the circuit so we can see just how the tube tester accomplishes its job. Even with a simple schematic such as this it is difficult to visualize the various functions and operation of the instrument so, to make it easier to understand, we have broken the complete schematic down into individual circuits.

Fig. 3 shows the heart of the emission tester which consists of the 12 single pole, three-position lever switches connecting to the tube socket terminals. The 8BA8A tube shown has only 9 terminals, so switches 10, 11, and 12 are not shown connected.

The levers are all originally in the N or normal position which connects all tube elements together, and to the common side of the filament winding and the common side of the ac test voltage winding. Position C connects to the hot side of the filament winding, the exact voltage being determined by the filament switch SWB in Fig. 2. Position T is the test position and a voltage, operating the short-test neon lamp, NE51, is available at this point. By depressing switch SWD in Fig. 2 the short-test voltage is removed and an ac test voltage is applied through the meter circuit, so the emission from the cathode can be checked with the tube connected as a diode. Note that if lever 4 is thrown to C, filament voltage will be applied to the tube in Fig. 3, and that if levers 9, 8 and 7, are thrown to T, the pentode is diode-connected and is ready to check for emission characteristics. This free-wheeling type of switch enables us to take care of all tubes, regardless of the basing employed or the number of elements in the tube.

Line Voltage Adjustments . . . .

In Fig. 2 you will note that the meter is connected to a portion of the voltage divider across the 110-volt filament winding. A high grade meter rectifier shown (red and yellow leads) permits the dc meter to sample the secondary voltage. Only one lead (the negative) of the meter needs to be switched by SWD to go from the line voltage-adjust position to the cathode emission test.

Fig. 4 shows the basic circuits involved in the line voltage-adjust function of the tube tester. The T position of the 12 lever switches has been left out so it will not complicate the drawing. The first thing to do is to insert the tube in the socket which fits its base, set the

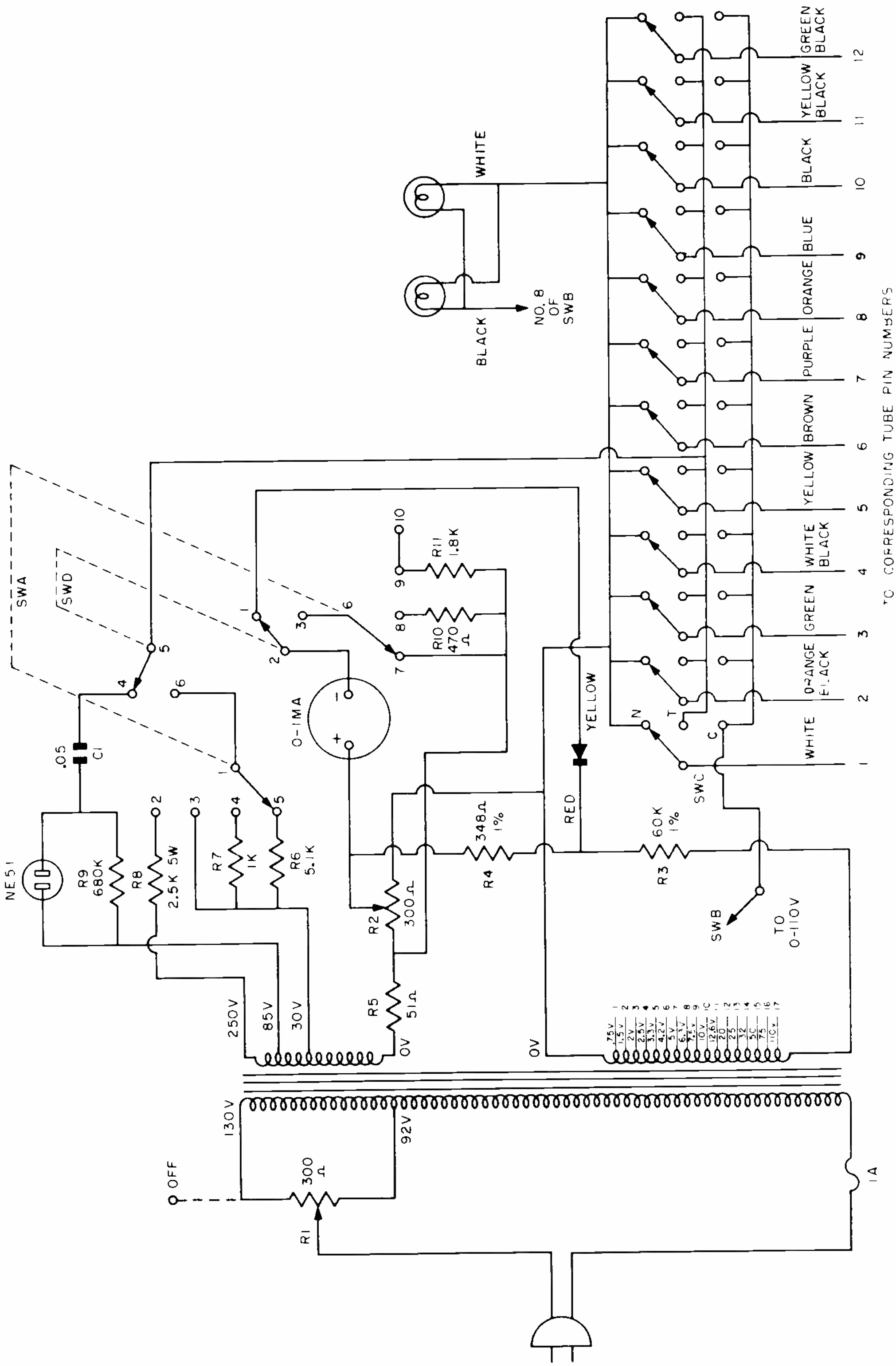


Fig. 2. Schematic of a CONAR Model 221 emission-type tube tester.

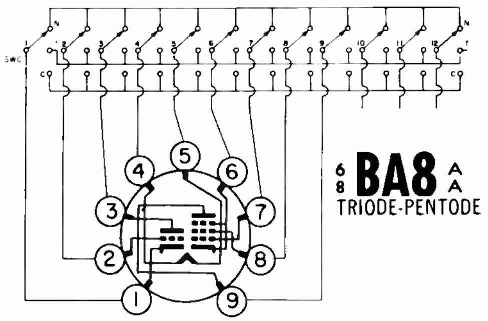


Fig. 3. The free-switching heart of an emission-type tester.

filament voltage switch to the 6.3-volt position if you are checking a 6BA8A tube, throw one of the filament lever switches (either 4 or 5 - not both) to the C position. Then plug the tube tester line cord into the wall outlet and advance the knob of R1 so the slider moves on to the resistance element of the 300-ohm potentiometer. The pilot lamps will light, voltage will be applied to the 6BA8A filament, and the meter will deflect. Adjust the knob of R1 so the meter pointer is over the vertical line in the middle of the scale marked "ADJUST-LINE." When this point is reached the secondary voltages on both windings of the transformer will be within the necessary range of accuracy and the tester setup adjustments will be correct for the tube under test.

From Fig. 4 you will see that the divider across the filament winding consists of resistors R3, R4, and R2 with the meter connected through its rectifier across R4. However, R2 is variable, and when its slider is moved to the 0 position, is completely out of the circuit. At first thought you would decide that moving the slider of R2 would affect the meter reading. As a matter of fact in the first design it did and I thought about adding another switch contact to SWD (Fig. 2) that would connect the positive meter lead and the end of R4 directly to OV on the filament winding. This would have resulted in a large increase in the cost of SWD, so a little thought solved the problem. The voltage drop across R4 is a function of the current through R4 and changing the value of R2 affects this current. However, by making the total resistance of R2 + R4 + R3 very high, a variation of a few hundred ohms at R2 does not cause any appreciable change in the total current and in the voltage drop across R4. This is the reason why R3 has a value of 60,000 ohms. By varying the resistance of R2 from its maximum value of 300 ohms to zero the total resistance will vary from 60,648 ohms to 60,348 ohms and the change in current and voltage across R4 cannot be noticed. As a matter of fact, a

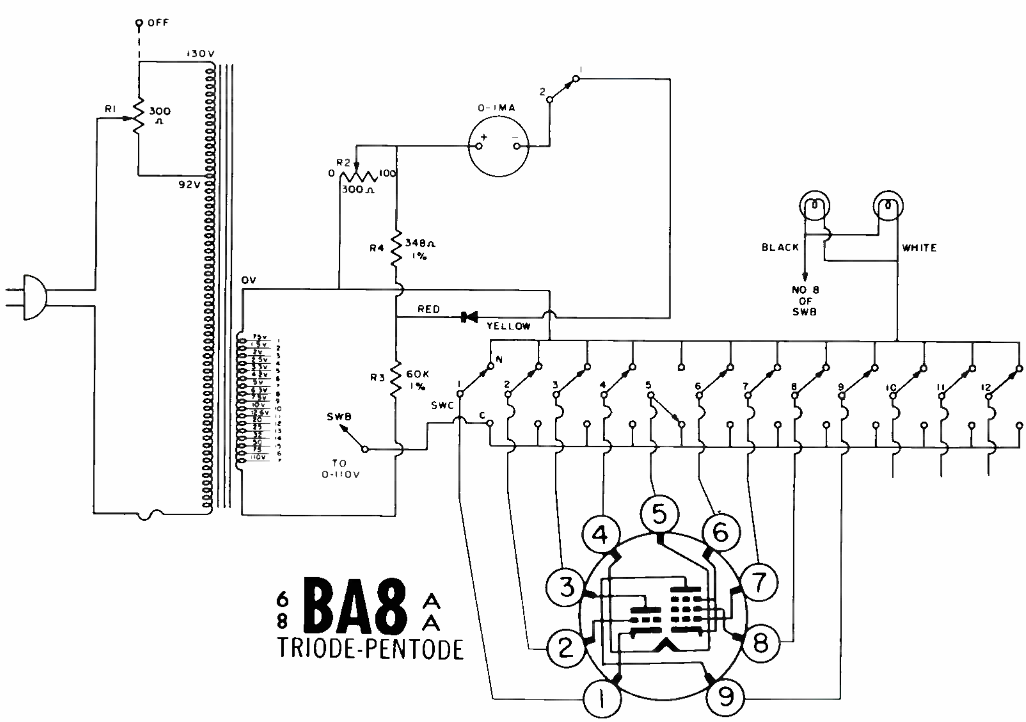


Fig. 4. Setup for line voltage adjustments and filament voltage.

5% ± variation in the value of R3 would result in a greater total circuit resistance change than is obtained by changing R2 from 300 ohms to zero. Such a variation could be tolerated if it were not for R2, so that is why R4 is a 1% resistor.

Short Check, Filament Continuity. The breakdown of the short check and filament continuity test circuit is shown in Fig. 5. Here we have used a 6AS11 compactron as an example. This is a double triode-pentode tube. Before lever 1 or lever 12 is thrown to the C position, to apply filament voltage, the filament continuity is checked. This is done by throwing either 1 or 12 (not both) to the T position. By tracing the circuit you will see that one side of the filament is connected through the N position of its lever switch, through R2 and R5 to the 0 voltage side of the high-voltage secondary winding of the power transformer. The other filament lead is connected through its lever switch to the T position and through C1, NE51 in parallel with R9 and to the 85-volt tap on the high-voltage secondary. Thus we have a series circuit of which the tube filament is a part. The resultant current flow will cause the neon lamp to light, showing that continuity exists in the entire circuit. If the filament does not have continuity (is burned out) the neon lamp will not light and you know the filament is open. In this case no further tests are performed and the tube must be replaced.

If the filament is not open the filament lever No. 1 is set to the C position and the line voltage is adjusted with R1. When the filament heats up, tests are made for cathode-to-heater leakage and for shorts between any of the other electrodes. Suppose we first check the left-hand triode in Fig. 5. The cathode connects to socket terminal 5 so we throw 5 to position T. There will probably be a momentary glow as C1 charges up. Disregard this as a normal action. Any glow or flashing after the lever has been thrown indicates continuity between the cathode and some of the other electrodes still in position N. Snap the tube with your finger during the test so any loose elements that may intermittently short will be disclosed. Put lever 5 back to the N position and repeat the tests one at a time on electrodes No. 3 and No. 4. Next check the electrodes in the other triode with levers No. 5, No. 6, and No. 8. Finally check the pentode with levers No. 9, No. 11, No. 10, and No. 2. If cathode-to-heater leakage exists you can continue to the emission test and you may even be able to use the tube, depending on its location in the circuit and the circuit design. Symptoms caused by cathode-to-heater leakage MAY be hum, distortion, and in an oscillator, failure to oscillate. If leakage or a short exists in any other electrode the tube is not only unsatisfactory but should

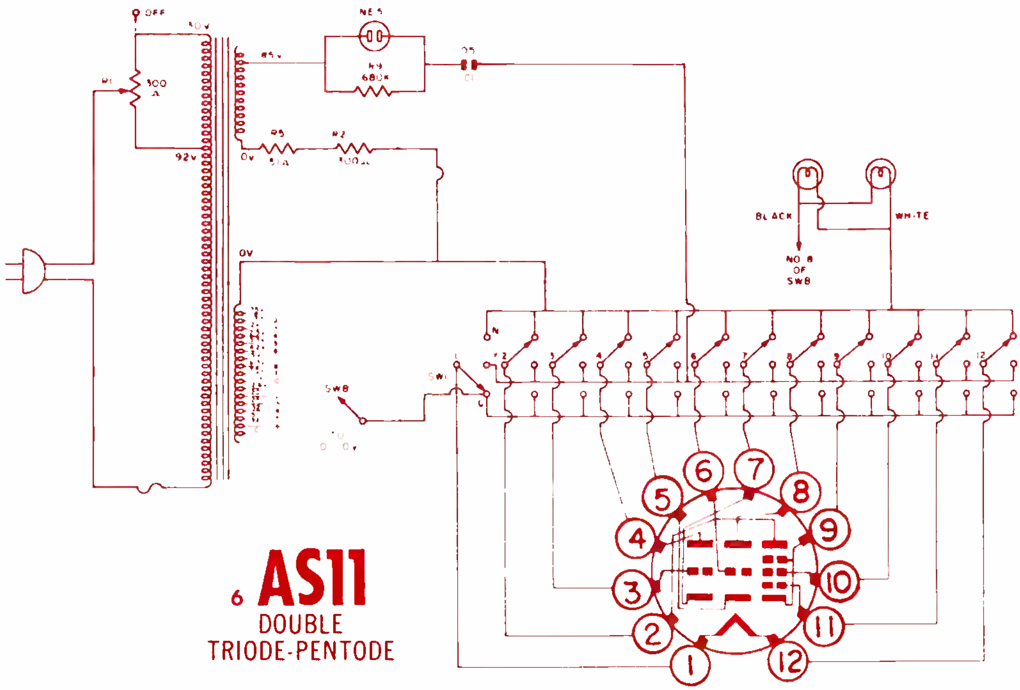


Fig. 5. Short check circuitry.

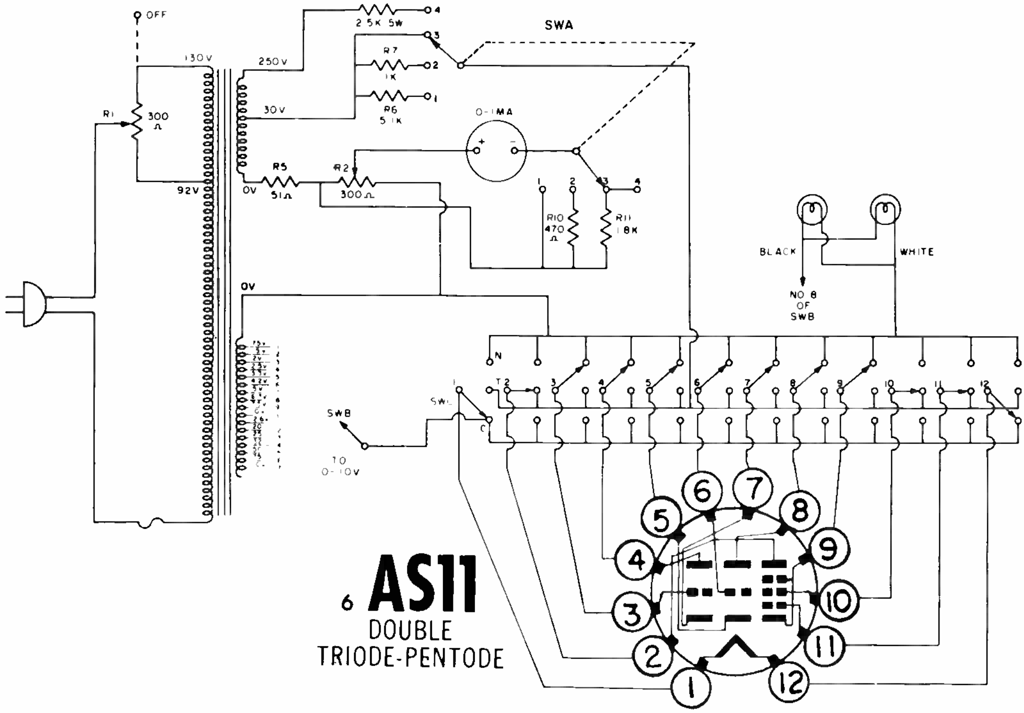


Fig. 6. Testing the pentode section of a compactron for emission.

not be tested for emission, as damage to the meter might result.

Checking for Emission . . . . The final check of the tube is to connect it as a diode and measure the cathode emission. We will use the 6AS11 again as an example. This part of the circuit is shown in Fig. 6 and the switches are all set to check the pentode section of the tube. Note we have applied filament voltage by throwing lever No. 12 to the C position. Actually either No. 1 or No. 12 could be used for this purpose.

Notice that cathode lever No. 9 is left in the N position and that all other electrodes (No. 11, No. 10, and No. 2) are thrown and connected together through Position T. A lead runs from position T through the upper section of 3 of SWA to the 30V ac tap on the high-voltage secondary. The OV end of the secondary connects to N through R5 and R2. The meter connects across R2, whose adjustment determines the amount of cathode current through the meter. If R2 is set up correctly for the tube and if the tube is satisfactory, the meter will read in the green or good part of the scale. If it reads in the yellow or red portion of the scale, the cathode emission will be low and the tube should be discarded, as its mutual conductance will be below normal.

After one section of a tube is tested, all levers in the T position are returned to the common N position and the emission of the next section may be checked in the same manner after setting SWA and R2 to the values indicated in the roll chart. Why do we have different settings for SWA? Couldn't the meter be adjusted to read properly with R2 along? The answer is that in many cases R2 could take care of everything, but the settings on R2 would be widely divergent. In other cases, more current would flow than could be handled by R2 and the meter. To limit the current flow, resistors R6 and R7 are inserted in series with the 30-volt supply in positions 1 and 2 of SWA, and resistors R10 and R11 are inserted in series with the meter in positions 2, 3, and 4 of SWA.

Fig. 7 shows the actual circuitry for testing tubes in each position of SWA. Position 1 of SWA is for low current signal diodes which pass only a small current. Note that the current is limited by the 5.1K-ohm resistor in the plate circuit and that part of R2 across the meter acts as a shunt, extending the meter range. As the knob of R2 is turned from 0 toward 100 more and more current passes through the meter, resulting in a higher reading.

In position No. 2 of SWA low voltage, low

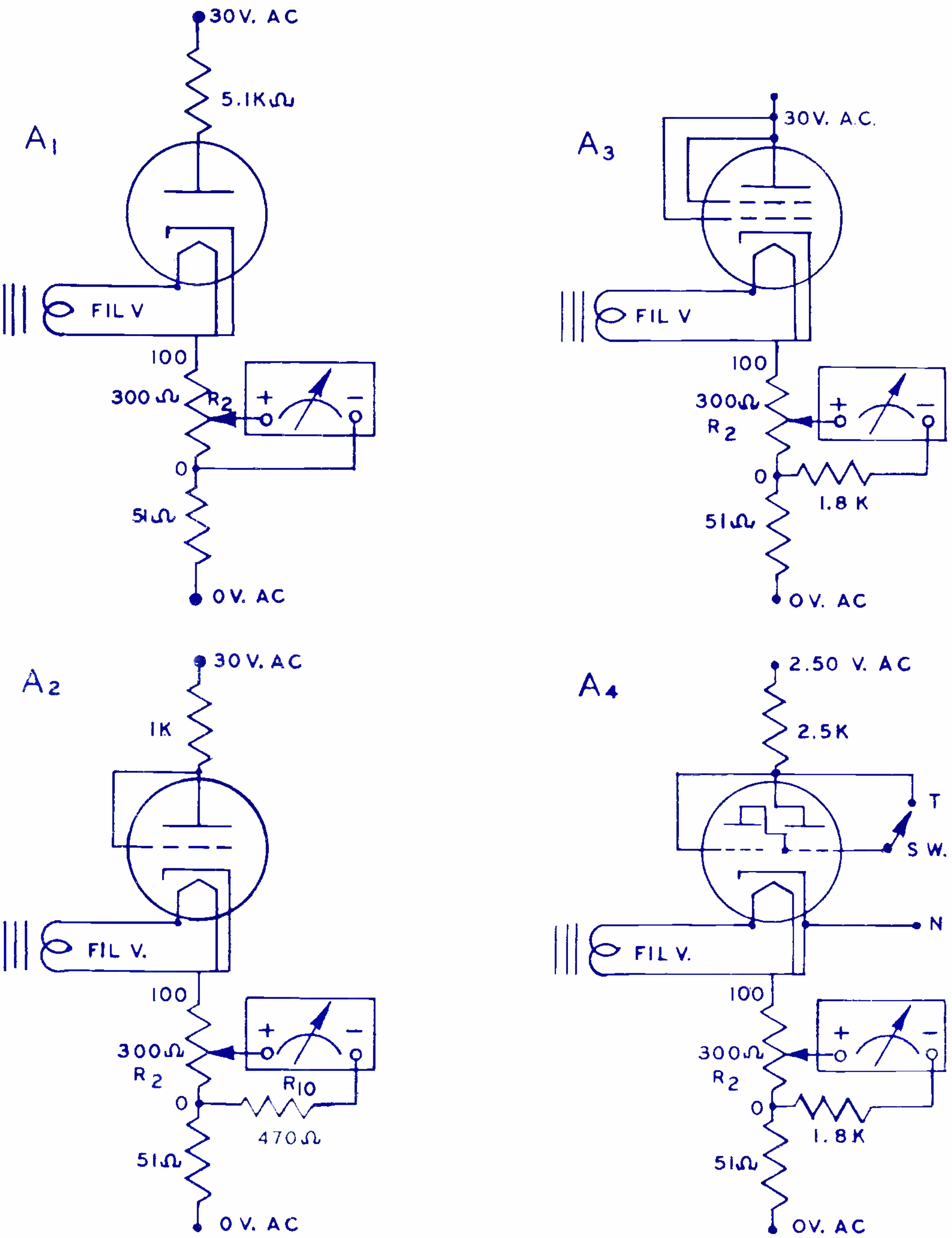


Fig. 7. Basic setups to check cathode emission.

current triodes are checked. Note that only a 1K-ohm resistor is used in the plate supply so more current can be drawn by the diode-converted tube than is possible in position No. 1. The current through the meter is reduced by the insertion of R10, a 470-ohm resistor in series with the meter.

Tubes whose cathodes are capable of supplying a high current such as power pentodes and medium power rectifiers are checked in position No. 3 of SWA. Here no series current-limiting resistor is used, but the current through the meter is limited by R11, an 1.8K-ohm resistor in series.

The 250-volt supply applied in position No. 4 of SWA is primarily used for checking tuning eye tubes and some high current rectifiers. The high voltage is necessary to get the tuning eye tubes to fluoresce. By returning the triode plate and its internally connected grid to N, with its electrode lever switch, the eye will open up if the tube is good. Again we have considerable current and use the 1.8K-ohm resistor R11 in series with the meter to limit the current flow through the meter.

We have covered all functions of the tube tester, and the schematic in Fig. 2 should now be more meaningful. What has been said about the CONAR 221 applies to all emission-type testers, as they are basically the same.

What To Do About New Tubes . . . . Until such a time as new roll charts are issued, and we do this periodically, you can set up your tester to check newly released tubes with the information you have learned from this article.

You will need a base layout for the tube and must know its filament voltage. The only unknowns are the setting of the range switch SWA and the setting of potentiometer R2. Follow these general rules for SWA:

Range No. 1
Use for signal diodes - for example the diodes in a twin diode - high mu triode. The triode section could be checked in Range No. 2 or Range No. 3.

Range No. 2
Use for low power triodes, pentode voltage amplifiers, and converter tubes.

Range No. 3
Use for high power, triodes and pentode power amplifiers and medium current rectifiers.

Range No. 4
Tuning eye tubes and high power rectifier tubes.

Actually it will not hurt to experiment - if you cannot get a satisfactory reading on one range of SWA with R2, set at 25 or lower, try another range on SWA.

The proper setting for R2 is a meter reading of about 70 on the meter scale with push button SWD depressed.

Of course you must choose the correct filament voltage, throw one of the filament levers to the C position, and run through the cathode leakage and all short tests on the other electrodes. Then, looking at the tube-basing diagram, switch all electrodes except the cathode and filaments to the T position to form a diode, set SWA, push SWD, and adjust R2 for a reading of 70. In multisection tubes, check each section separately. Do this on tubes known to be good and, if possible, use two tubes, aver-

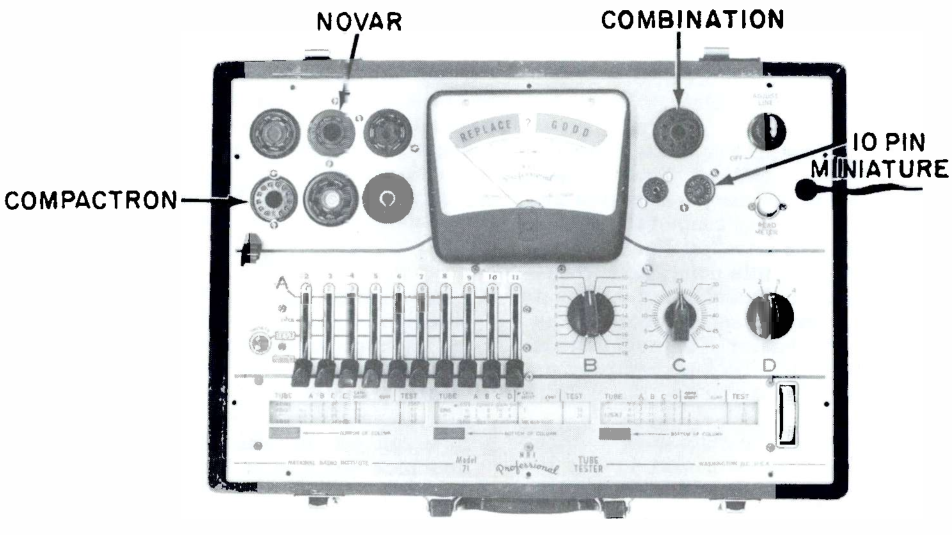


Photo of a modernized old tube tester.

aging the R2 settings. Make a list of all settings similar to the one in your roll chart and you will be prepared to check these tubes whenever they are encountered in service work.

HOW TO MODERNIZE AN OLD TUBE TESTER

Your old emission-type tester, as you have already learned, will check all tubes which will fit into its sockets. If your tester has less than 10 lever switches, it would be too much of a job to bring it up to date, but with 10 lever switches you can add a compactron socket, a novar socket, and a 10-pin miniature socket.

The 10-pin socket, which is a standard 9-pin miniature socket with its tenth pin in the center, can be substituted for the present 9-pin socket. Tie its center pin to the same point as the regular top cap connector. Use this socket for both 9 and 10-pin tubes.

For the novar and compactron sockets you need two large mounting holes. The easiest thing to do is to remove the original 4 and 5-pin sockets and discard them, since the chances are that you will never get to test a 4 or 5-pin tube. Tape up the bare ends of the leads you removed.

Wire the novar socket (it has nine pins) in parallel with the 1 through 9 pins of the 10-pin miniature socket you installed.

Now examine your lever switches in the common or neutral position. All the terminals are wired together in this position and to the 0 voltage lead on the power transformer filament winding. Connect terminal No. 1 of the compactron socket to this point.

Now throw one of the levers to the filament position (not the test position). You will find all lever terminals for this position tied together and to the traveling contact of the filament switch. Connect terminal No. 12 of the compactron socket to this point. Now whenever a compactron is inserted in the socket and the filament switch set to produce the required voltage, the heater of the compactron will light. This will occur because compactron heaters are always No. 1 and No. 12.

Now you must wire up the remaining 10 terminals of the compactron socket to the 10 lever switches, or to points which connect to them. Use the top cap connector for one tie point and the socket terminals of the novar socket for the remaining nine connection points. Use the following table:

Compactron Socket →	To →	Novar Socket →	Connect To Lever No.
2		1	1
3		2	2
4		3	3
5		4	4
6		5	5
7		6	6
8		7	7
9		8	8
10		9	9
11 →	TO	Tie point for top cap connector →	10

When using a tube chart in setting up your tester to check compactrons, use this table to locate the proper levers for various electrodes. Also remember there are no levers to throw for filament power.

If you have to connect the electrodes for pins 6, 9, and 10 together in the test position, you will throw levers 5, 8, and 9 to test.

The photo shows a conversion on an old NRI 71 tube tester. The 4 and 5-prong sockets were removed to make room for the novar socket in the original 5-prong socket position and the 4-prong socket was replaced by a 4, 5, 6-prong combination socket used in the CONAR 221 tube tester. Thus you have two sockets which will take a 6-prong tube!

The 71 was equipped with a blank socket which was removed for the compactron socket, and the 9-pin miniature socket was replaced by the 10-pin miniature socket which takes both 9 and 10-pin tubes.

Note at the top of the lever switches the new numbers 2 through 11 for the compactrons. I found this to be more confusing than helpful, because the tendency is to use the wrong levers when two sets of numbers are present. I suggest that you prepare your setup for compactrons using the original lever number markers. If you bear this in mind when you accumulate setup data you will encounter no trouble in testing any tubes. □

A decision goes through a life cycle, from infancy to maturity to old age. If you make the decision during its infancy, you don't have enough facts. If you wait until it's senile, you have no effect on the outcome. How do you know when a decision is ripe? How can you tell when an apple is ripe? You pick some, and learn. You have to practice decision-making like any other activity.

--Don Paarlberg in Farm Journal

ON BEATING THE HEAT

We've Come A Long Way Since The Days of Xerxes When Everyone But the King Fanned for Himself

NEW YORK, N. Y. (ED) -- Five thousand years ago an Assyrian merchant cooled his courtyard by having his servants spray water in a room below it. Roman slaves laboriously hauled snow from distant mountaintops for the comfort of their rulers. In 775 A.D. Caliph Mahdi of Baghdad built a summer house of hollow walls packed with imported snow.

In the 16th century a few energetic people pumped fresh air into their dwellings with a clever adaptation of the bellows. Then in the 1600s an intricate system of weights and pulleys was designed to swing a fan pendulum-fashion across a room, and a few more sweltering folk had a measure of relief.

These were man's earliest efforts at climate control, and although they may seem ingenious, it's doubtful they were very effective. In fact, they were useless for the masses who unfortunately had to rely on the age-old fan to try and beat the heat.

Now millions of air-conditioning units are in use in homes and cars throughout the country, with hundreds of thousands more of the units produced---and sold---every year. (In fact, servicing of the units has gotten to be big business itself, as graduates of NRI's appliance servicing courses are finding out.)

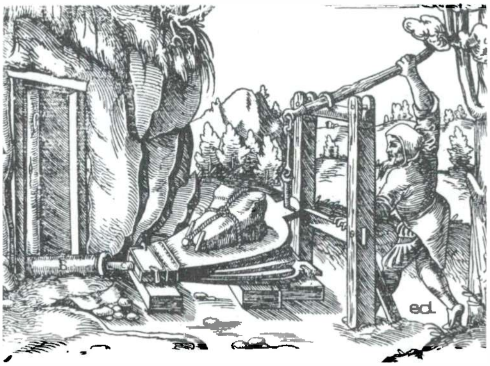
It wasn't until the mid 19th century that man learned to manufacture ice, and a crude form of air conditioning was enjoyed by the masses for the first time. Four tons of ice were used to keep the patrons of New York's Madison Square Theatre cool. Many buildings were cooled by embedding air pipes in ice and salt, then circulating the chilled air. Others were equipped with refrigerated coils over which air was drawn.

During the civil War, when the North cut off the South's supply of ice, France brought a new cooling system, using liquid ammonia, to the scorching Southerners. This "air-conditioning" system used a generator, which separated the ammonia from its water base, and drove the ammonia into a condenser to liquefy. The liquid ammonia next was evaporated, bringing its temperature down to 5° F.

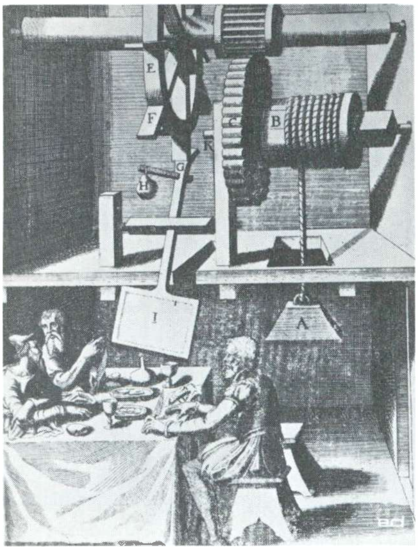
Although another step in the right direction, this system was still rather crude. Then, in 1902, Willis Carrier, the father of modern air-conditioning, discovered how to cool great quantities of air more efficiently -- and a new industry was born. He also used a new refrigerant which was named Carrene in his honor.

Carrier was given the job of solving the printing problems of a Brooklyn publishing com-

COOL KING--King Xerxes, ancient ruler of Persia, kept three fan bearers busy keeping him cool.



BELLOWS VENTILATOR--An ingenious adaptation of the bellows was 16th-century way of keeping cool.



DINING IN COMFORT--These 17th-century gentlemen enjoyed the effects of an intricate fan system.

pany, greatly troubled in hot, humid weather by expanding and contracting paper. Colors, too, were affected. They overlapped or failed to match those printed on another day. An effective air-cooling and dehumidifying system was needed to eliminate costly and wasteful reprinting of jobs and the reduced speed of the presses.

Carrier came up with the solution. His system, which revolutionized air conditioning, involved cooling and dehumidification of the air by two sections of cooling coil. One used cold water from an artesian well, the other was connected to a refrigerating machine. Taken together, their cooling effect totaled 54 tons, the equivalent of melting 108,000 pounds of ice in 24 hours. It was a milestone in man's control of his indoor climate.

Through this research, Willis Carrier was also the first to put into theory and practice the four necessary results of an effective air-conditioning system -- comfortable temperature, controlled humidity, clean air, and proper ventilation -- still the desired results of any air-conditioner today.

Then, two years after he developed his revolutionary contraption to cool and dehumidify the air, the air-conditioning genius discovered the principle of the world's first spray-type air-conditioning equipment, designed to dehumidify the air with cool water. At first his idea of taking moisture out of the air with water was greeted with ridicule, but he proved his theory to be true.

Now we use heat to cool the air, but instead of being greeted with ridicule, it's greeted with relief -- by many cool customers. Actually the method used is a refinement of the original French system introduced a century ago. It employs four laws of nature: boiling under a vacuum, condensation, evaporation, and absorption. Burning natural gas supplies the energy to operate this system.

Heat is also used indirectly in conventional, mechanical air-conditioning equipment. In this case, natural gas-fueled engines -- similar to those in cars---provide the necessary energy.

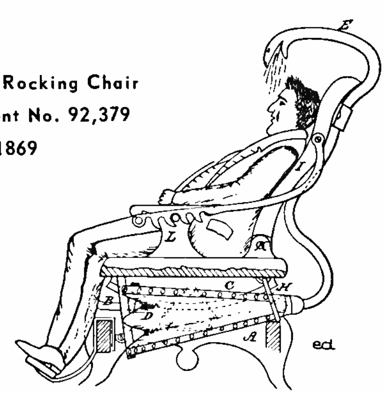
Nowdays, fantastic feats of air-conditioning with heat are everyday occurrences. For instance, the mammoth new domed stadium in Houston uses gas cooling equipment to keep its 66,000 sports fans comfortable on the hottest days. In New York, the entire terminal complex at Kennedy International Airport is heated and air-conditioned from a central gas plant, as is a large downtown development in Hartford, Conn.

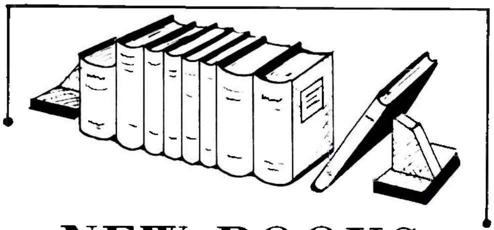
Another air conditioning wonder: most of the pavilions at the New York World's Fair cool their millions of visitors with modern, natural gas-powered equipment. Largest of the installations is the Ford Pavilion, which uses a 1600 ton capacity cooling system in its huge rotunda and exhibit area.

The same type of equipment, on a much smaller scale, is being used more and more in homes across the country. Beating the heat is no longer a problem and a house without a cooling system is considered by many as incomplete as a house without a heating system.

What will they think of next? Covered, air-conditioned sidewalks for pedestrians? What better way to beat the heat then by going from air-conditioned building to air-conditioned building via an air-conditioned walkway!

Improved Rocking Chair
U.S. Patent No. 92,379
Granted 1869





NEW BOOKS

COLOR TV REPAIR

Gernsback Library, Inc. Edited by Martin Clifford. 160 pp, $4.60 clothbound, $2.95 paperback.

With more than one billion dollars spent on color TV by the American public last year, and with 15 million color sets expected to be in operation by 1968, knowledge of color TV repair may be the most important single service the technician can offer. There's a key to a solid future in COLOR TV REPAIR, a practical servicing book from Gernsback to help make the transition from black-and-white easier. Includes a glossary of terms.

SELECTED SEMICONDUCTOR CIRCUITS

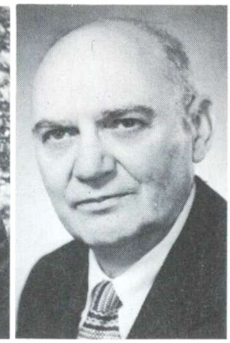
TechPress, Inc. compilation
80 pp, $1.25.

If, as an old Chinese proverb goes, a picture's worth a thousand words, Tech-Press's SELECTED SEMICONDUCTOR CIRCUITS is worth volumes. It's treated in a very simplified manner, no math, no formulas, just easy-to-build schematics of popular circuits such as RF and AF oscillators, i-f amplifiers, power supplies and regulators, preamplifiers. Good reference source, much of it supplied by major manufacturers of their own devices.

THE ELEMENTS

Howard W. Sams & Co. Dr. Samuel Ruben.
112 pp, $1.95. Wall Chart, $5.95.

Modern technology has increased the importance of recognizing the properties of the elements in terms of their atomic structures. Today, with the evolution of atomic structure theories, these properties concern the advanced student as well as the research engineer and the physicist. THE ELEMENTS, from Sams, outlines the atomic structure in sufficient detail to serve as a reference in advanced research. A compact compilation by Dr. Samuel Ruben, inventor of the mercury dry cell and the dry electrolytic capacitor. A periodic table wall chart is also available separately.



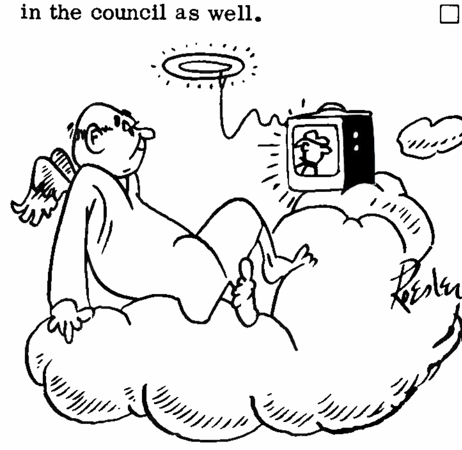
STU ARMSTRONG E.L. DEGENER

FORMER NRI EMPLOYEES RECEIVE NHSC AWARDS

Two retired, long-time NRI employees, Stuart M. Armstrong and Edward L. Degener, have been honored by the National Home Study Council.

Armstrong, who retired last year as Public Relations Director after 36 years with the company, was given the NHSC Distinguished Service Award. The award is made to a person who has rendered outstanding service and "has significantly enhanced the progress, efficiency, and image of home study". He had been chairman of NHSC's Public Relations Committee for 10 years.

Degener, who retired as NRI's General Manager after 41 years with the company, was elected to the Home Study Hall of Fame. Selection is made from those who have retired from major participation in the home-study field and whose lifetime contributions and accomplishments merit permanent recognition. He was formerly on the NHSC Board of Trustees, and had filled numerous offices in the council as well. □



Alumni News

Once again it is time for the members of the Alumni Association to choose their National Officers -- a President and four Vice-Presidents -- for the next year.

First we will nominate the candidates, two for the Presidency and eight for a Vice-Presidency. The nominating votes must be received at NRI on or before July 25, where they will be tallied. The names of the winning nominees will appear in the September-October issue of the Journal.

Only members of the NRI Alumni Association -- that is, graduates of NRI who have joined the Association since they graduated -- may vote. And, of course, only members of the Alumni Association are eligible as candidates for national office.

For the benefit of new members of the Association who have not yet become familiar with these elections, and for other members who may be a bit hazy on this subject, it is advisable to review the limitations on the number of times office-holders may serve. The limitations are given in Article VI, Section 2 of our Constitution, which reads as follows:

> "The President shall not be eligible for re-election until after expiration of at least eight years following his last term of office and, further, may be a candidate for Vice President only after expiration of at least a year following his term of office as President. Vice-Presidents may not serve more than two consecutive terms; when re-elected for a second consecutive term they shall not thereafter be candidates for Vice-President until after expiration of at least three years following their second term of office."

Here is how these restrictions affect those members now serving as National Officers. David Spitzer may not run for either the Presidency or a Vice-Presidency this year. Howard Tate is not eligible as a candidate for Vice-President but he is for the Presidency. Indeed, because of the strong showing he made against David Spitzer in last year's election he is likely to be the Number 1 candidate for that office this year. Eugene DeCaussin is in the same boat: He cannot run again for a Vice-Presidency but is eligible for the Presidency. Jules Cohen's case is just the opposite situation; he cannot run as a candidate for the Presidency (he served as President in 1961) but is qualified as a candidate for Vice-President. Frank Zimmer, long a leading member of the New York City Chapter who has held National Office before, is the only current officer who is eligible to run for either office this year.

Other members, whose names were selected at random according to geographical location, are listed under "Nomination Suggestions" (see Page 28). You are free to vote for any other members of the Alumni Association that you wish, but be sure they are members before casting your vote for them.

Mail your ballot (see Page 27) in time to reach us on or before July 25.

☆☆☆

ABOVE AND BEYOND

Franklin Lucas, who is Executive Chairman of the New York City Chapter as well as Chairman of its Program Committee, is also Secretary of the Hackensack Chapter. As Joe Bradley of the NYC Chapter points out, it is a rare man who is willing to devote that much time to the cause.

CHAPTER CHATTER

Tough Dogs and Demonstrations Headline Meetings

DETROIT CHAPTER completed a series of lectures and slides by H. W. Sams on color TV. This program was a feature which had been carried over to several meetings.

The latest member to be admitted to membership was Mr. Charles Fouchey. He celebrated his admittance to the chapter by bringing in a Magnavox TV receiver in which all the members took part in working out the sweep problem which it presented.

FLINT (SAGINAW VALLEY) CHAPTER ended the season with a series of "cram" sessions. Throughout the month of May a lecture on color TV was held once a week. Professor DeJenko conducted this program, which was a fitting finale to the season. The chapter will resume meetings in September.

HACKENSACK CHAPTER devoted one entire evening to an open discussion on trouble-shooting. A few members brought in some of their dog sets. Each member present who had an idea to offer was given the floor and his suggestion was carried out. The results were that by the end of the evening, of the five sets dealt with, four were successfully repaired. This was a very interesting and rewarding meeting.

The program committee arranged for a tour at WPAT and George Schopmeier was scheduled to deliver a talk and demonstration on the oscilloscope.

LOS ANGELES CHAPTER used to show educational films on a variety of subjects at its meetings. These films were secured and exhibited by the late Earl Dycus, a chapter member who passed away sometime ago. This feature came to a halt with his passing.

Considerable discussion was given to resuming this feature at several meetings earlier this year. The chapter has now finally decided to reinstate the showing of the films at its meetings. We are sure that all members will be glad to learn about this, for these films add a great deal of interest to the meetings.

NEW YORK CITY CHAPTER's Joseph Bradley has continued his series of talks on the operation of the scope. He pointed out the ways this instrument is used in servicing Radio and Television receivers. His discription of the way to analyze the waveforms is very helpful to members who use scopes in service work.

A film entitled "Satellite Communicating" was shown by Mr. Thompson of the N. Y. Telephone Co. It showed the process used in making such satellites as Echo and Telstar. Mr. Thompson promised to visit the chapter again in December.

Shortwave radio communications has come under close study with the help of Father Rian Carson. He explained the different circuits involved and demonstrated the operation of this type of system by bringing a complete shortwave station to the meeting and tuning in on a broadcast in progress, showing how good the reception of this type of system really is.

Al Bimstein has continued his talks on TV picture tubes and their associated components. One of his talks was about picture tube yokes and their many symptoms when they are defective, and how to make different tests to judge whether a yoke is defective. Al is a professional TV serviceman. His experience, plus diagrams which he shows during his talks, along with samples of the actual parts under discussion, makes his talks probably the ones from which members learn the most.

Bill Heath of Westinghouse was guest speaker to Philadelphia-Camden chapter.

PHILADELPHIA-CAMDEN CHAPTER admitted Mr. Nathan Burgess of Philadelphia as its newest member. Congratulations, Nathan!

Bill Heath of Westinghouse, always a very welcome guest speaker at the chapter, gave another of his fine talks and demonstrations, this time on the Westinghouse Transistor Portable TV and the Westinghouse Walkie-Talkie. Mr. Heath makes such excellent presentations that the members claim that they "could listen to him all night and never find it boring."

For a long time the members have wanted a talk on alignment. Secretary Jules Cohen finally prevailed on the ever-reliable Harvey Morris to give one and Harvey as usual cooperated to the fullest. It turned out that it was impossible to do this subject justice in one evening but Harvey started on his alignment procedure and the first turned out to be a crackerjack of a talk. The members definitely want more on this subject from Harvey.

Jules Cohen has also been trying to contact some of the UHF stations in the Philadelphia area to see if he can arrange for the members to visit one of these stations and see how they operate. This should prove to be extremely interesting if Jules is successful in his efforts.

The chapter started a dynamic TV Board project a couple of years ago but, as busy as this chapter always is, it sort of got sidetracked. After all, this is a pretty ambitious and time-consuming project. Nevertheless, the members have decided to resume the task and finish it. The practical value of the board and the demonstrations that can be made with it certainly justify the time and effort.

SAN ANTONIO ALAMO CHAPTER Secretary Harold Wolff, who is a radio repairman at Kelley Air Force Base, Tex., gave a fine talk on the repair of transistorized circuits. This was a highly practical lecture, too, due to Harold's job and experience.

At another meeting, the chairman, Sam T. Stinebaugh, conducted a general TV trouble-shooting session. These sessions always provide interesting and helpful discussions.

SAN FRANCISCO CHAPTER's Art Ragsdale, who is secretary of the chapter, demonstrated how a scope can be used to detect hum in the audio section of an ac-dc radio receiver or in the audio section of a TV. (See PF Reporter for January 1965, Page 26.) At this same meeting, Vice-Chairman Phil Stearns demonstrated the construction and operation of a transistorized tape recorder.

At the next meeting, Art showed how loss of high voltage could be caused by a loose solder joint between the coupling condenser and the grid of the horizontal output tube. The

San Francisco chapter officers are, from left, seated, Isaiah Randolph, chairman, J. Arthur Ragsdale, secretary; standing, Anderson P. Royal, treasurer, Phil Stearns, vice-chairman.

resulting loss of signal at the grid of the output tube killed the boost voltage. As a result, insufficient B+ voltage appeared at the plates of the 6SN7 AFC and oscillator tube. This was a very interesting demonstration.

Because a number of the members were on vacation in June, no meeting was held for that month. The next meeting will take place on July 14 instead of the usual first Wednesday of the month.

All members please take note: the chapter is now holding its meetings at Sokol Hall, 739 Page St., between Steiner and Pierce Streets.

SOUTHEASTERN MASSACHUSETTS CHAPTER was pleased to welcome Irving B. Auger as the latest member to join the chapter. Congratulations, Irving!

Manny Sousa and John Alves, assisted by Daniel DeJesus, used different cathode ray tube testers to show the procedure in testing the CRT of a color TV.

The same two members, John Alves and Manny Sousa, were the featured speakers at the next meeting when they reviewed the color section of a TV to make certain that all the members have a clear idea of the functions of the different stages.

The Chapter held its annual banquet on May 12.

(Directory is on Page 3 of this issue.)

1966 NOMINATION BALLOT

T. E. ROSE
Executive Secretary
NRI Alumni Association,
3939 Wisconsin Ave.,
Washington, D. C. 20016

(POLLS CLOSE JULY 25)

I am submitting this Nomination Ballot for my choice of candidates for the coming election. The men below are those whom I would like to see elected officers for the next year.

MY CHOICE FOR PRESIDENT IS . . . .

City . . . . State . . . .

MY CHOICE FOR FOUR VICE-PRESIDENTS IS

1. . . . .

City . . . . State . . . .

2. . . . .

City . . . . State . . . .

3. . . . .

City . . . . State . . . .

4. . . . .

City . . . . State . . . .

Your Signature . . . .

Address . . . .

City . . . . State . . . .

Student Number . . . .

CONAR ORDER BLANK

DIVISION OF NATIONAL RADIO INSTITUTE, 3939 WISCONSIN AVE., WASHINGTON 16, D.C.

PLEASE PRINT

NAME

ADDRESS

CITY ZONE STATE

NRI STUDENT NUMBER

☐ CASH
☐ C.O.D. (20% Deposit required)
☐ EASY PAYMENT PLAN (10% Deposit)

Quantity	Model	Name of Item	Price Each	Total

If you live in Washington, D.C., add 3% sales tax. All prices are net, F.O.B. Washington, D.C.

TOTAL

ON TIME PAYMENT ORDERS please be sure to complete the Easy Payment Plan credit information form on the reverse side of this page and include 10% down payment with your order.

RANDOM 1966 NOMINATION SUGGESTIONS

Clinton J. Kenard, Birmingham, Ala.
Kermit D. Hinkle, Huntsville, Ala.
T. H. Dinwiddie, Tucson, Ariz.
Arthur L. Dillon, Phoenix, Ariz.
Charles N. Bragg, Benton, Ark.
Albert J. Thompson, Little Rock, Ark.
Julio Solis, Los Angeles, Calif.
Kenneth Williams, Orange, Calif.
Gerry Dougherty, Long Beach, Calif.
Isaiah Randolph, San Francisco, Calif.
Anderson Royal, San Francisco, Calif.
Phil Stearns, San Francisco, Calif.
George Keller, Colorado Springs, Colo.
Edward Gordon, Denver, Colo.
William D. Warner, Stamford, Conn.
Herbert J. Brady, Norwich, Conn.
Lewis B. Best, Wilmington, Del.
Earl F. Clow, Dover, Del.
Walter S. Battle, Washington, D. C.
Charles T. Frye, Washington, D. C.
Carl Fernstrom, Tampa, Fla.
J. Stanley Ross, Miami, Fla.
Jesse C. Smith, Savannah, Ga.
A. H. Moorhead, Sr., Atlanta, Ga.
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Paul L. Kline, Carbondale, Ill.
Walter E. White, DeKalb, Ill.
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John A. Mitchell, Arlington Heights, Ill.
Howard M. Howell, Indianapolis, Ind.
Donald A. Martin, South Bend, Ind.
P. L. Bishop, Cedar Rapids, Iowa
Normand E. Wood, Sioux City, Iowa
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T0

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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 ______

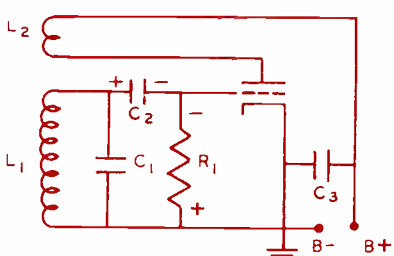
BY STEVE BAILEY

DEAR STEVE:

Would you describe the operation of a tuned-grid oscillator circuit? I don't quite understand how the bias is developed.

R. A., Fla.

First of all, I would like you to refer to the simplified diagram of a tuned-grid oscillator shown below.



In this circuit, when the power is applied plate current will begin to flow. The current flowing through L2 will produce a changing magnetic field which will induce a voltage into L1. The induced voltage charges C1, which starts the oscillation in the tank circuit (L1-C1). The voltage across C1 becomes the grid voltage because the value of C2 is so large that its reactance is small at the frequency of oscillation. In effect, C1 is connected directly to the grid.

As the plate current increases, more voltage is induced in the tank circuit. This makes the end of C1 connected to the grid more positive. Of course, with a positive potential on the grid, the plate current increases even more, which causes the positive potential on the grid to increase even further and, at the same time, causes grid current to flow. The grid, being positive, will attract electrons which will charge C2 with the polarity shown on the diagram.

Eventually, the negative voltage across C2 will become exactly equal to the positive voltage across C1. When this happens, no more voltage will be induced into the tank circuit and C1 will begin to discharge into L1, setting up oscillation again. Of course, the negative voltage on the grid will now cut off the flow of plate current.

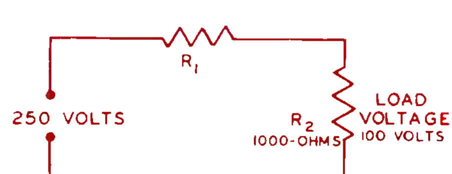
Meanwhile, C2 will discharge through R1, setting up a voltage drop with the polarity shown on the diagram. During the following half cycle, the voltage on the grid end of C1 will become positive and what has already been described here will be repeated.

DEAR STEVE:

Please explain how the value of a series-dropping resistor can be determined. I am currently studying lesson 5BB.

P. L. R., N. H.

Refer to the diagram shown below. Here you have a source voltage of 250 volts, a load resistance of 1000 ohms, and you need 150 volts to be dropped across the series resistance.



The first method you could use to determine the size of the series resistance is to use Ohm's Law to find the current in the circuit and then to find the value of the resistance. You know that the load will drop 100 volts and the resistance is 1,000 ohms. Dividing 1,000 ohms into 100 volts ($I = \frac{E}{R}$) gives you .1 ampere.

Since this is a series circuit, the same amount of current will flow through both resistors. For this reason, you can divide the voltage drop across the series resistance by the current to find the resistance. The load will drop 100 volts, so the series resistance must drop 150 volts (250 - 100 = 150). The current is equal to .1 ampere. According to Ohm's Law, $R = \frac{E}{I}$, so $R = \frac{150}{.1} = 1500$ ohms.

The second method is even easier. You simply use comparison. You know that you are to drop 100 volts across the load and 150 volts across the series-dropping resistor. Therefore, you can see by comparing them that the series-dropping resistor must drop 1-1/2 times the voltage that the load does. It stands to reason that the series resistance must be 1-1/2 times as large. 1.5 times 1,000 ohms will give you a total resistance of 1500 ohms.

DEAR STEVE:

Would you give me a description of positive and negative feedback? Also, how does this effect the phase of an output signal?

A. R., N. M.

Positive feedback is feedback which has a component in phase with the input voltage, while negative feedback has a component which is out of phase with the input voltage. Positive feedback results in regeneration, whereas negative feedback results in degeneration.

A 180-degree phase shift in the signal voltages occurs only when you have a purely resistive load in the plate circuit. However, when there is a reactance in the plate circuit, phase rotation may occur so that the voltage which is fed back is not completely in phase or completely out of phase with the input voltage.

For example, in the diagram below, if e is the input voltage, then the output voltage is E which will be ideally 180 degrees out of phase with the input voltage. Due to the shift introduced by the grid-to-plate capacity, the feedback component for this load is E2 and there is no feedback.

If the load is capacitive, the output voltage vector will fall between E and E2. Suppose the output voltage is BE1, then the feedback voltage is 0A, which opposes voltage e and results in negative feedback.

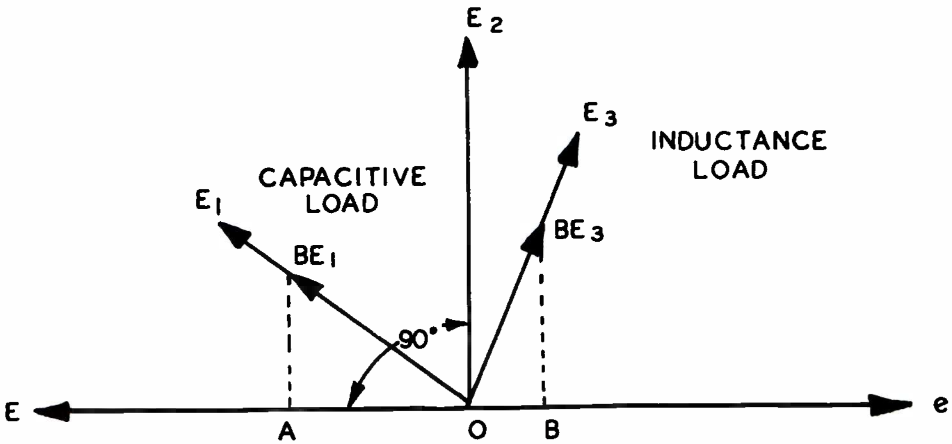
With an inductive load, the output voltage vector falls between E2 and e. If it is Be3, the feedback voltage is OB. If OB is large enough to overcome the losses in the input circuit, the stage goes into oscillation. If it is not large enough, then only regeneration may occur.

DEAR STEVE:

I have just completed my 7YY receiver. It works very well except at high volume control settings. The receiver tends to go into oscillation at this point.

Do you have any recommendations for correcting this?

W. C., Va.



Recently, I made certain modifications in the 7YY receiver designed to eliminate this particular trouble. The changes are listed below:

1. Unsolder the twisted wires from pins 1 and 2 of socket N. Unravel them to make straight wires. Then, solder the wire from the orange terminal of the oscillator coil to pin 1 of the tube socket. The wire from the red terminal should be soldered to pin 2. These should be single straight wires now and they should be pressed close to the chassis.
2. You have a wire from terminal P1 to pin 2 of socket E. Remove this wire from the circuit. However, be sure to leave the short bare wire between the center shield and pin 2 connected. The wire from pin 1 of socket E to terminal KB1 should be pressed close to the chassis. Also, you should press down the wire from terminal KB2 to terminal P3.
3. Connect a short wire from terminal P1 to terminal P5. Solder both terminals.
4. Connect a 100 mmf capacitor between the center shield and pin 7 of socket E. Be sure to cut the leads as short as possible when making the connections. Solder both pin 7 and the center shield.
5. Connect a short bare wire between terminal DT2 and the rivet that holds the mounting foot to the DT terminal strip. Solder both connections.
6. There is a .001-mfd disc capacitor connected between terminal DB1 and pin 7 of socket B. Disconnect the lead of the capacitor connected to terminal DB1 and solder it to pin 1 of socket B.
7. Connect a 15 megohm resistor between pin 1 of socket N and terminal KB3. Solder both connections.

It will now be necessary for you to check the alignment of the radio. After this has been done, your receiver should work properly.

DEAR STEVE:

We studied how to determine the turns-ratio in a transformer, but how do you determine how many turns to use? I am sure you could not successfully use a one-turn primary and a two-turn secondary in a 1:2 transformer.

B. R., Pa.

The turns-ratio of a transformer does not tell you exactly how many turns to use, only the ratio of the number of turns. The actual number of turns will depend upon the amount of power and current in the circuit. However, once you know this, you can select transformers by merely knowing the circuit impedances.

DEAR STEVE:

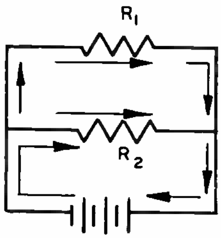
I do not quite understand the difference between an open circuit and a short circuit. Could you explain this?

T. K., Va.

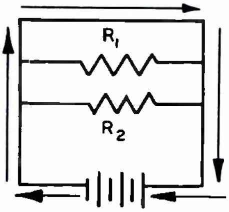
In Figure A, I have shown a simple battery and parallel resistor circuit. Current will flow from the negative battery terminal, through R1 and R2 and return to the positive terminal. The battery voltage will be dropped across the resistors.

In a circuit where a short is present, the current will take the path of least resistance. This is represented in Figure B by a wire directly across the circuit. Instead of flowing into R1 and R2, the current will take the path of least resistance and flow through the wire. No voltage will appear across the resistors.

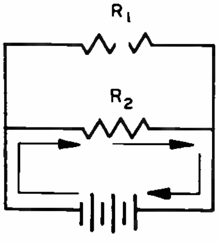
In Figure C, R1 is shown as being broken, so the circuit through R1 is open. The full circuit current will flow through R2. No current can flow through R1.



(A) COMPLETE CIRCUIT



(B) SHORTED CIRCUIT



(C) OPEN CIRCUIT

NRI tour party included, from left, James Shurbet, W.F. Stanis, N.S. Chezednichenko, Art Widmann, A.M. Kolosov, Alexis Tatistcheff.

RUSSIAN EDUCATORS TOUR NRI

BY JAMES SHURBET

NRI's international reputation as a correspondence school put it on the recent tour agenda of three Russian educators.

The three, W. F. Stanis, professor of economics at Moscow State University, N. S. Chezednichenko, First Deputy Minister of Education of the Ukrainian, and A. M. Kolosov, D. Sc., rector of All-Union Agricultural Institute in Moscow, were accompanied by Alexis Tatischeff, a contract interpreter loaned by the U. S. Department of State.

Their conversation indicated the strong emphasis on education in Russia, with the general public encouraged to enroll for night school and correspondence studies. The system of home-study education is highly developed in Russia, they said, with degrees equivalent to classroom studies given for appropriate work.

Their afternoon at NRI began with a meeting with its president, J. M. Smith, who gave them a resume of NRI programs and purposes, followed by a question-and answer session with James Shurbet, customer relations director of the CONAR division of NRI.

Then the group toured the institute, accompanied by Mr. Shurbet. And though an interpreter was required for the interchange, the conversation never lagged, nor did there seem to be any difficulty in conveying meanings.

The visitors took a keen interest in the "skinning down" of NRI and CONAR Kits for mailing, the Achievement Kit that goes to all students upon enrollment, the research and development laboratories with their complex electronic equipment----and the soft-drink vending machines. There seemed to be some difficulty in conveying meanings at that point; they had to be shown how to put coins in the machines, and how to uncap the bottles!

Throughout the afternoon the visitors took copious notes. Technical Editor Art Widmann did much of the explaining of operations and equipment, and Technical Editor Ted Beach, who doubles in photography, took the picture above.

Evidently the visitors thought the time was well spent: they postponed the next appointment on the agenda to expand their time at NRI. And, upon leaving, they presented "medals" to President Smith and Messrs. Shurbet, Widmann, and Beach.

The visit was made under the auspices of the U. S. Office of Education's exchange program, through the cooperation of the U. S. Department of State. Other leading correspondence schools will be included in the groups' study of U. S. education.

So---a little thaw in the cold war, at least on a person-to-person basis. □

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