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___8CS7	.74	___12BQ6	1.16	___12SF7	.69	___36AM3	.36
___8EB8	.94	___12BR7	.74	___12SK7GT	.95	___50B5	.69
___8FQ7	.56	___12BV7	.76	___12SL7	.80	___50C5	.53
___9CL8	.79	___12BY7	.77	___12SN7	.67	___50EH5	.55
___11CY7	.75	___12BZ7	.86	___12SQ7GT	.91	___50L6	.61
___12A4	.60	___12CN5	.56	___12U7	.62	___70L7	.97
___12AB5	.60	___12CR6	.67	___12V6	.63	___117Z3	.85
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ON OUR COVER

Diane Cavitt shows off a "solar steam boiler" developed by space scientists. The flower-petal arrangement of the device, developed by Bendix Corp. engineers, enables it to use heat from the sun to generate electricity for the operation of control and communications systems in satellites. The metal petals open to capture solar energy and close when enough energy has been stored in the cylindrical unit (at end of the "handle"), called an energy converter. It can operate even when its satellite is in the shadow of a planet. The space power plant operates in a way similar to conventional steam boilers, but uses a liquid metal instead of water. Other aspects of what's doing in outer space ---particularly of television's new role---appear on Pages 14 and 15, with photographs televised from Ranger VII of the moon's surface, and of the northeastern part of the United States from weather satellite Nimbus.

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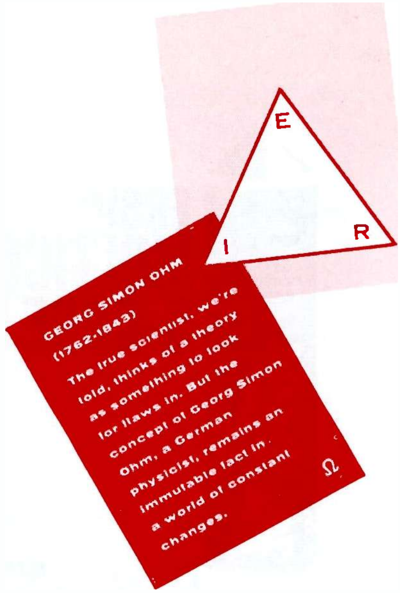


Ohm's Law

BY DALE STAFFORD

EDITOR'S NOTE: This article by the late Dale Stafford, who was an NRI consultant, is so clearly and simply written that we are reprinting it as a guide to beginning students.

To the beginning student in electronics, everything is new and strange and wonderful. For a time, he gets along fine, learning new terms and facts and fitting them in with the things he already knew. Then he runs headlong into Ohm's Law and, all too often, falls flat on his face.

For the benefit of those who may have this experience, we will try to explore this subject and point out some of the common pitfalls. If you are already well acquainted with Ohm's Law, the material in this article will probably be too elementary to be of much interest. It is hoped, however, that the new student may find it to be of real help.

To keep the discussion as simple as possible, we will attempt, in this article, to cover Ohm's Law first as applied to dc circuits. When Ohm's Law is applied to ac circuits, we must consider the fact that the opposition offered to the flow of current in a circuit is not the same for ac as it is for dc. This makes any attempt to cover both types of circuits in a single discussion rather involved and is apt to create more confusion than it clears up. It is best for the beginner to learn dc circuits first. Then ac circuits are much easier to understand.

Actually, there is nothing so very difficult about Ohm's Law. It is simply a fundamental law which explains, or defines, the relationship between the voltage, current, and resistance in a dc circuit. At first glance, there seems little reason to suspect that it can be a very severe stumbling block for the beginner. There is even less to show why some students have little or no trouble while others, equally clever, flounder badly before they get straightened out.

Much of the trouble one sometimes has with Ohm's Law may be avoided if he remembers the following facts: Ohm's Law deals with three different things. These things are related in a definite way, so closely related, in fact, that the values of any two may be used to find the value of the third. However, no matter how closely they are related, they are completely different things and are measured in entirely different units of measurements.

Once a student has learned just what voltage, current, and resistance are and has learned to apply the proper units of measurement to each, he doesn't have too much trouble in using Ohm's Law. Unfortunately, at the time he first encounters the subject he is trying to learn so many new things all at once that it is difficult to keep them neatly sorted out and get a clear view of the over-all picture. A phrase which describes the situation rather aptly is the old saying about "not being able to see the forest for the trees."

As a result, he becomes confused and we hear such questions as "How many ohms are there in a volt?" or "How many volts are there in an ampere?" The answer, of course, is none. Volts, ohms, and amperes are completely different units of measurement used to measure different things. We can't say "So many volts equal one ampere" or "So many ohms equal one volt" any more than we can say "Two feet equal one hour" or "two tons equal one mile."

Everyone knows, of course, that when we measure anything we must use the correct unit of measurement, feet, pounds, gallons, or whatever the situation may require. For this reason, it may seem unnecessary to stress anything so elementary. The trouble is that when the student first starts to study the subject, he doesn't know either the units of measurement or just what it is he is supposed to be measuring.

It is not so hard to learn to measure time in hours or distance in miles when one knows what time and distance are. If, however, one had never heard of either, it would be a lot more difficult, wouldn't it? It is small wonder then that a stranger to electronics sometimes becomes confused.

HAVE THREE CONCERNS

In any dc circuit, there are, as already mentioned, three things with which we must be concerned. The first is the current flowing in the circuit. The second is the force which causes the current to flow. The third is the opposition which is offered to the flow of current by the parts which make up the circuit.

Current flow in a circuit is due to the movement of electrons through the connecting wires and parts of the circuit. You know that all matter is made up of extremely small particles called atoms. These, in turn, are made up of even smaller particles called protons, neutrons, and electrons. The electrons make up the outermost portion of the atoms.

In the atoms of some materials, the electrons are tightly bound like the members of a loving and happy family and it is extremely difficult to make them leave home. In other materials, some of the electrons in the atoms can be easily dislodged. In fact, in a good conductor such as copper or silver, the outermost electrons in the atoms are continually flying off in all directions even when no force is applied to the circuit.

The vacant spaces in the atoms are filled by electrons dislodged from other atoms while the wandering electrons go on to fill vacant spaces in other atoms which have lost an electron. Thus, we have countless free electrons flying at high speed in all directions through the spaces between the atoms.

When a force is applied to the circuit, the free electrons all move in one direction. While it is unlikely than any individual electron will move more than a few inches per second, the force is felt almost instantly around the entire circuit. The reason is that the instant an electron is forced into motion, it repels the electron ahead of it and forces it to move. This electron, in turn repels an electron ahead of it and so on all around the circuit. The electrons repel each other because they are all negatively-charged particles and, as you know, like charges repel each other.

The effect is somewhat as if you had a pipe filled from end to end with marbles and suddenly tapped the end marble with a hammer. The marbles would begin to move at a fairly slow speed but the shock would travel almost instantly the full length of the pipe.

However, in an electrical circuit, we get a pulling as well as a pushing effect. Whenever an electron is forced out of an atom, the atom will then attract a free electron. For this reason, whenever an electron is forced into motion, another electron moves up to take its place. Thus, we have a force pushing and pulling the electrons around the circuit.

This movement of electrons around a circuit is what makes up a flow of current. The unit which is used to measure current flow is the ampere. An ampere is not a unit of quantity like a bushel or a dozen. Rather, it is a unit of rate-of-flow like the gallons-per-minute unit used to measure the flow of water through a pipe.

An ampere represents a certain number of electrons flowing past any point in a circuit in one second. The exact number of electrons is not important. You will seldom need to know this and it is such a large number it is hard to remember.

The force which causes electrons to move around the circuit is called several names which all mean the same thing. These are electromotive force, difference in potential, potential difference, electric pressure, and voltage.

Let's see what voltage means. There will be an electrical pressure or strain existing between two objects if one of them has too many free electrons while the other has too few. There will also be a strain existing if both objects have too many or too few electrons but one has more than the other. In any of these cases, electrons will attempt to move from the object which has the greater number of free electrons to the object which has the smaller number. If the two objects are connected by a conductor, electrons will flow from the object having the greater number to the object having the smaller number until the number in each is equal.

When an object has too many free electrons, we say that it has a negative charge or simply that it is negative. When an object has too few free electrons, we say that it has a positive charge or that it is positive. When both objects have too many electrons, both are negative but the one having the greater number of electrons is more highly negative than the other. When both objects have too few electrons, both are positive but the one having the fewer number of electrons is more highly positive than the other.

FLOWS TOWARD POSITIVE

Electrons will attempt to flow from a negative point to a positive point, from a negative point to a point which is less negative or from a positive point to a point which is more highly positive. The strain of the electrons trying to move in this way is what we call voltage.

A voltage can be generated in several different ways. Two common ways of doing so are by the chemical action of a battery or by the use of a generator. The latter is a machine made especially for this purpose and works by moving a conductor, several of them in fact, through a magnetic field. It has a rotating part called an armature. This has several slots in which coils of wire are wound. In the frame of the generator are other coils, called field coils, wound on pole pieces arranged around the armature. A dc current flows through these coils, setting up magnetic fields across the armature. When the armature turns in these fields, a voltage is generated in the armature coils. The armature may be turned by a gasoline engine or some device may be used to turn it by using steam, a stream of water, or the wind.

The unit of measurement is the volt. This is the amount of pressure that is needed to force one ampere of current through a resistance of one ohm.

The opposition that a material offers to the flow of current is called resistance. As we previously mentioned, some metals such as copper have a great number of free electrons continually in motion flying in all directions through the spaces between the atoms. When a voltage is applied between the ends of a wire made of such a metal, a large number of free electrons travel through the wire and we have a large flow of current. We say that such a metal has a low resistance.

Other materials, such as a carbon resistor, have a great many fewer electrons in motion between the atoms. Thus, when a voltage is applied between the ends of a resistor, fewer electrons will travel through the material and the flow of current is much less than in the copper wire. We say that such a material has a high resistance.

The unit used to measure resistance is the ohm. It is the amount of resistance which will permit a pressure of one volt to cause one ampere of current to flow in the circuit.

Remember, the force which is pushing and pulling the electrons around the circuit is the voltage and is measured in volts. The electrons moving around the circuit make up the current and the size or rate-of-flow of the current is measured in amperes. The opposition to the flow of current offered by the parts and wires of a circuit is the resistance and is measured in ohms.

When very large or very small quantities are to be measured, different units of measurement may be used. However, the names of these units are formed by taking the name of the original unit, volt, ohm, or ampere, and combining it with another word. If you will remember this, these other units should cause you no trouble.

Now, let's see how the voltage, current, and resistance are related in the simple circuit shown in Fig. 1. Here we have a 6-ohm resistor, R1, connected across the terminals of a 6-volt battery. For the sake of simplicity, we will say that R1 represents all the resistance in the circuit. Electrons will leave the negative terminal of the battery and flow upwards through R1 to the positive battery terminal.

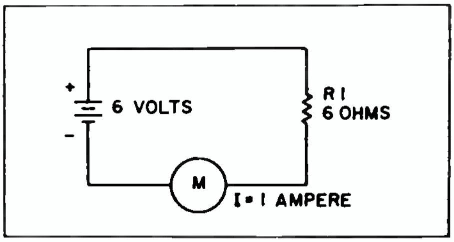


FIG. 1. A simple dc circuit.

The meter, M, shows that the circuit current is one ampere. This is what we would expect it to be. It takes one volt to force one ampere of current through a resistance of one ohm so it would take six volts to force one ampere of current through a 6-ohm resistor.

CHANGE PROPORTIONAL

Since the voltage is what causes the current flow, if we increase the voltage, the current will increase and if we decrease the voltage the current will decrease. The change in the current will be directly proportional to the change in the voltage. If we double the voltage by using a 12-volt battery, the current will be doubled and the meter will read 2 amperes. If we halve the voltage by using a 3-volt battery, the current will decrease to one-half its original value and the meter will read one-half ampere.

Since the resistance is what opposes the flow of current, the current will also change if we change the resistance. The change in the current is also proportional to the change in the resistance, but, of course, in the opposite direction. The current increases when the resistance is decreased and decreases when the resistance is increased.

If we double the value of R1 in Fig. 1, making it a 12-ohm resistor, the current will decrease to one-half its original value and the meter will read one-half ampere. If we cut the resistance in half by using a 3-ohm resistor as R1, the current will be doubled and the meter will read two amperes.

DIVIDE THE VOLTS

The fact that voltage, current, and resistance are related in this way makes it possible for us to use the values of any two of these to find the value of the third. Suppose, in Fig. 1, page 6, we have no meter to measure the current, but we do know the battery voltage and the value of R1. We know it takes one volt to force one ampere of current through a resistance of one ohm. Therefore, we simply divide the number of volts by the number of ohms to find the number of amperes. Six divided by six gives us a current of one ampere.

Suppose we know that the battery voltage is six volts and the meter shows that the current is one ampere but we do not know the value of R1. We know that for each volt applied to a circuit, one ampere of current will flow if the resistance in the circuit is only one ohm. Since we have six volts applied to the circuit but only one ampere of current, we know the resistance is more than one ohm. We can find out how much more by dividing the number of volts by the number of amperes. In this case, six divided by one gives us six ohms as the resistance of the circuit.

Suppose we know that R1 is six ohms and the meter shows that the current is one ampere but we do not know the voltage of the battery. We know that it will take one volt for every ohm of resistance to cause one ampere of current to flow so we simply multiply the number of ohms by the number of amperes to find how much voltage the battery is providing. In this case, six multiplied by one gives us six volts as the voltage of the battery.

SHOWS RELATIONSHIP

We can do the same thing with any other dc circuit so long as we know two of the values. If we know the values of the voltage and resistance, we divide the voltage value by the resistance value to find the value of the current. If we know the values of the voltage and current, we divide the value of the voltage by the value of the current to find the value of the resistance. If we know the values of the resistance and the current, we multiply the value of the current by the value of the resistance to find the voltage value. Ohm's Law, which shows this relationship between voltage, current, and resistance is usually written in the form of three simple equations, $E = IR$, $I = E/R$, or $R = E/I$.

Here again is a common pitfall for the beginner. To the newcomer in electronics, equation is a strange and frightful word. He is not exactly sure what the purpose of an equation is, nor is he used to seeing things expressed in this manner. Therefore he feels that it is sure to be very hard to understand.

If the student has seen some of the equations used by engineers, he can scarcely be blamed for feeling uneasy. In some of these, the number or quantity on one or both sides of the equal mark (=) is made up of several numbers added together, subtracted from one another, or multiplied by each other. However, the simple equations used in Ohm's Law are no more complicated than a recipe for making lemonade.

IT'S JUST A RECIPE

There is nothing frightening about a recipe, is there? You know that if you add certain quantities of water, sugar, and lemon juice, you wind up with something entirely different-lemonade. Thus, the equation for this action might be written "1 gal. water + 2 cups sugar + juice of 6 lemons = 1-1/8 gal. lemonade."

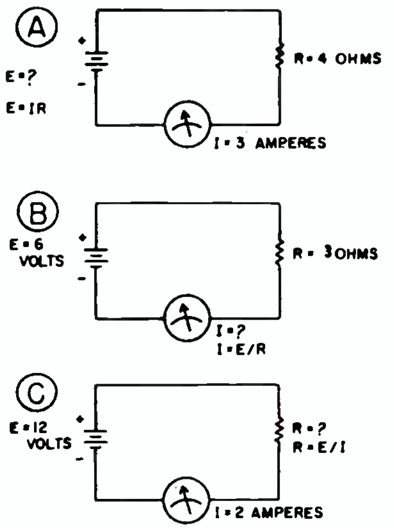


FIG. 2. Ohm's Law problem in dc circuit.

These may be the wrong quantities--I never made much lemonade--but you can see what I mean. At any rate the equation simply means that one quantity is equal to another. In this instance, certain amounts of water, sugar, and lemon juice are equal to a certain amount of lemonade.

The equations used in Ohm's Law are much like simple recipes. Call them recipes if it makes you feel any better. Let's examine these recipes and see what each of them mean. The first is E = IR. Here E stands for voltage, given in volts. I stands for current, given in amperes. R stands for the resistance, given in ohms.

The equation E = IR means that the voltage is equal to the current multiplied by the resistance of "the number of volts is equal to the number of amperes multiplied by the number of ohms." The fact that the number of amperes is to be multiplied by the number of ohms could be written in any one of three different ways. We could write it: I × R, I (R), or simply IR. Any one of these methods mean that one number is to be multiplied by the other. You can see that E = IR is a much simpler way of stating that "the number of volts is equal to the number of amperes multiplied by the number of ohms" than it is to write out the statement.

You may often see this written "volts = amperes times ohms. This effort by the writer to simplify the discussion is fine except that it sometimes confuses the new student. Some students get the idea that if "amperes times ohms = volts" all three must be different units of the same thing just as pints, quarts, and gallons might be different quantities of water. This is not true, of course. Regardless of how the equation is written, it means that if the current in the circuit is a certain number of amperes and the resistance in the circuit is a certain number of ohms, the voltage applied to the circuit must be a certain number of volts.

Our next recipe is I = E/R. This means that the current is equal to the voltage divided by the resistance or "the number of amperes is equal to the number of volts divided by the number of ohms." The fact that a number is to be divided by another can be shown in three ways. We could write it E ÷ R which means that the first number is to be divided by the last. We can separate the two numbers by a diagonal line called a slash mark, "/", like this: E/R. This means that the number ahead of the slash mark is to be divided by the number following it. In the third method, we can write one of the numbers, draw a line under it, and put the second number under the line, like this: $\frac{E}{R}$. This means that the number above the line is to be divided by the number below the line. Thus, we can write the equation,

I = E ÷ R, I = E/R, or I = $\frac{E}{R}$. They all mean that "the number of amperes is equal to the number of volts divided by the number of ohms."

Our third recipe is R = E/I. Here, of course the slash mark means the same thing as in the previous equation. Therefore, the equation means that the resistance is equal to the voltage divided by the current or "the number of ohms equals the number of volts divided by the number of amperes."

STICK TO SUBJECT

Remember, when you use these equations that you are not saying that a volt is the same as an ampere or that an ohm is the same as a volt. You can no more divide volts by ohms than you could divide dollars by apples. Yet you can divide a number of dollars by a number of apples to find something else which is entirely different . . . in this case the number which represents the cost of the apples. In Ohm's Law you are simply using the number of volts and the number of ohms to find the number of amperes or the number of volts and the number of amperes to find the number of ohms.

Let's try a few more examples just to be sure we know how to use our "recipes." In Fig. 2, we show three simple circuits. In each of these, two values are given and we are to find the third. The correct equation for finding the unknown value is shown near the diagram of each circuit.

In Fig. 2A, the current is given as 3 amperes and the resistance is given as 4 ohms. We are to find the voltage of the battery. To do this, we use the equation $E = IR$. This tells us that "the number of volts = the number of amperes multiplied by the number of ohms" so we substitute the number of amperes and the number of ohms for I and R in the equation. Now it reads $E = 3 \times 4$. Multiplying 3 by 4 we get 12 which is the voltage of the battery.

In Fig. 2B, the voltage is given as 6 volts and the resistance as 2 ohms. We are to find the value of the current. To do this we use the equation $I = E/R$. This tells us that "the number of amperes = the number of volts divided by the number of ohms." When we use the number of volts and the number of ohms given, we have "amperes = 6 divided by 3" or "$I = 6/3$." Six divided by three is two so the current is 2 amperes.

In Fig. 2C, the voltage is given as 12 volts and the current as 2 amperes. We are to find the resistance. Here we use the equation $R = E/I$, which tells us that "the number of ohms = the number of volts divided by the number of amperes." When we use the values that are given we have $R = 12/2$. Dividing 12 by 2, we find that R is 6 ohms.

As you can see by these examples, it is not really so hard to apply Ohm's Law to dc circuits. The only difficulty is in getting headed in the right direction. We hope that we have been able to post a few signposts to guide the stranger to this subject.

Now . . . What about grounding?

In any piece of electronic equipment, ground is simply the point of zero potential. Potential, by the way, is just a five-dollar word for voltage - they both mean the same thing.

The term ground came from the early days of the ac radio. In those sets, it was customary to connect zero voltage points in the receiver circuits to the chassis. To make sure the chassis did not change in potential, a wire was run from the chassis to a metal rod driven into the earth. Thus, the name ground originally came from earth ground.

Later, it was found that the precaution of connecting the chassis to earth ground was seldom necessary. The metal chassis showed no tendency to change in potential when the receiver circuits were connected to it. For this reason, the connection to earth ground came to be omitted in a great many cases. However, the name ground was still used whether the chassis was actually connected to the earth or not.

When ac-dc sets came along, the practice of making connections to the chassis was no longer advisable. In fact, it was downright dangerous. Let's see why.

The ordinary ac receiver uses a power transformer with a center-tapped high-voltage secondary winding in a full-wave rectifier circuit Fig. 3A shows a partial schematic of such an arrangement. To simplify the diagram, only the plate and cathode circuits of a single tube, the output tube, is shown.

Before we consider this circuit, however, let's stop for a moment to look at a phrase we will want to use - one you will encounter frequently in any discussion of electronic circuits. The phrase is "with respect to." What we mean by this is that we are making a comparison.

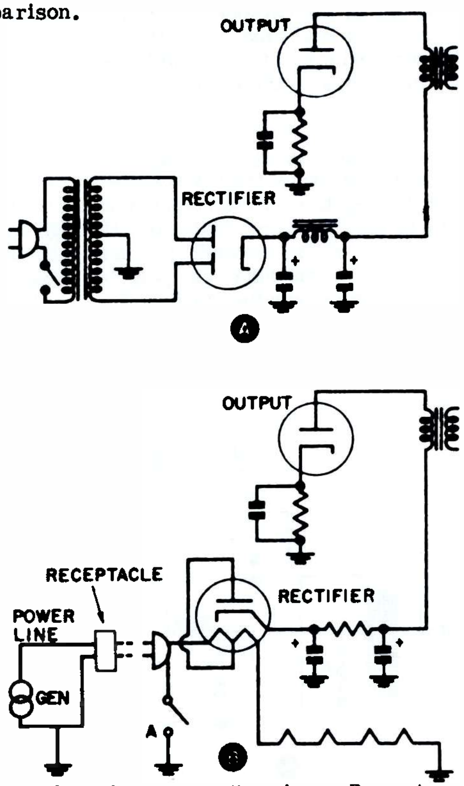


FIG. 3. Power supplies. A, ac; B, ac-dc.

When we say that "the grid is negative with respect to the cathode," we mean that the voltage at the grid is negative in polarity when we compare it with the voltage at the cathode. If we say that "terminal A is positive with respect to terminal B," we mean that the voltage at terminal A is positive in polarity when we compare it with the voltage at terminal B. The phrase "with respect to" points out the particular point in the circuit that we are using as a reference point for our comparison.

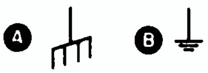


FIG. 4. Ground connection symbols.

Now, let's get back to our power supply. When the voltage across the secondary winding makes the upper end of the winding positive with respect to the lower end, the upper plate of the rectifier is positive with respect to the cathode while the lower plate is negative.

Electrons leave the cathode and travel to the upper plate and through the upper half of the secondary winding to the center-tap. From here, the path is through the chassis to the lower end of the cathode resistor, up through the resistor and tube, down through the output transformer primary and through the filter choke back to the cathode.

During the next half-cycle of the ac voltage across the secondary winding, the lower plate of the rectifier is positive while the upper plate is negative. Electrons travel from the cathode to the lower plate and through the lower half of the secondary winding to the center-tap. From here, the path is the same as during the preceding half-cycle.

Electrons leave the power supply at the center-tap and return to the cathode of the

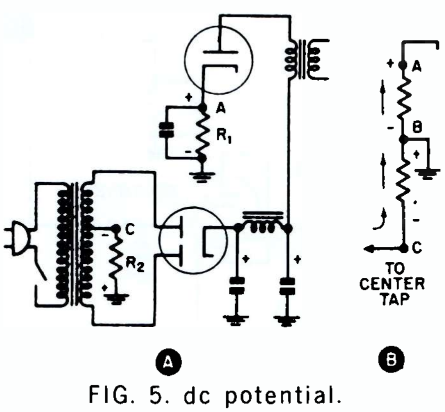


FIG. 5. dc potential.

rectifier. Thus, we may consider these points the negative and positive terminals of our power supply much like the negative and positive terminals of a battery used for the same purpose. The grounded center-tap is the zero-voltage reference point for all the B+ voltages in the receiver.

In this power supply, we have a complete circuit through our power supply and the output tube that is isolated from the ac power line by the transformer. Things do not work out this way with an ac-dc set, however. Let's look at Fig. 3B.

The only way we can trace a complete circuit is from the cathode of the rectifier to the plate, to the filament tap, through part of the filament to the upper wire of the line cord and on to one prong on the plug. From here, the path goes along the ac power line, through the generator in the power plant, back along the ac line to the other prong on the line cord and through the on-off switch to terminal A.

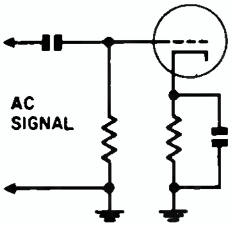


FIG. 6. Grid circuit.

From terminal A, the path is to the lower end of the cathode resistor of the output tube, through the tube and the primary of the output transformer to the filter resistor and to the rectifier cathode.

Since there is no other way to complete the circuit, we have to use one side of the ac line as the negative terminal of our power supply. If we made our ground connections to the chassis, we would also have to connect the ac line to the chassis by grounding terminal A.

One side of the power line is grounded to earth ground as shown. As long as the plug is always inserted in the position shown, everything will be all right. The chassis will be at zero potential.

Suppose, however, that the plug is turned over so that terminal A is connected to the hot side of the power line. Then there would be a difference in voltage of 120 volts between the chassis and earth ground. If one touched the chassis and, at the same time, touched some grounded object, he could be badly or even fatally shocked.

This problem is solved by the use of a common negative circuit called B-, which is isolated from the chassis. One wire of the line cord is connected to one of the terminals of the on-off switch. From the other terminal, terminal A in Fig. 3B, a circuit leads to a series of insulated terminals throughout the receiver. Connections, which in an ac receiver would go to the chassis, go to these insulated terminals instead. In referring to this common negative circuit, we call it B-. When we speak of ground, we normally mean chassis ground or earth ground.

The symbols used for ground connections are shown in Fig. 4. The one in Fig. 4A indicates a connection to the chassis. It is used on a schematic diagram when a few of the connections go to the chassis and the rest go to B-.

The one shown in Fig. 4B may stand for a connection either to chassis ground or to B-. When used on a diagram along with the symbol shown in Fig. 4B, it indicates a connection to B-. However, when all the ground connections go to the chassis, this symbol is used instead of the one shown in Fig. 4A. Thus, this symbol could stand for a connection to either the chassis or B-.

If you are working on a receiver, you can look to see how the connections are made. However, if you are just looking over a diagram and don't have the receiver, the easiest way to be sure what it means is to look at the notes on the diagram. On the schematic, you should find a note telling you whether the voltages were measured to the chassis or to B- (the note may say common negative).

The dc voltages in a receiver may be either positive or negative with respect to ground. It all depends on the direction of current flow in the ground connection. Let's look at Fig. 5. Here, again, we have used only a partial schematic to simplify the drawing. It is the same as the one in Fig. 3 with this exception.

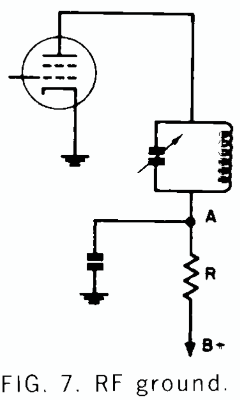


FIG. 7. RF ground.

In this set, we'll say we need a source for a small negative voltage to provide bias for some of the tubes. For this purpose, the center-tap of the secondary winding was lifted from ground, and resistor R_2 was connected between the center-tap and ground.

Current flows from the center-tap to ground through resistor R_2 so the voltage drop across the resistor has the polarity shown. As you see, terminal C is negative with respect to ground.

FLOWS TO CATHODE

Resistor R_2 is the cathode resistor of the output tube. In this resistor current flows from the chassis to the cathode. The voltage drop across resistor R_2 has the polarity shown on the diagram and terminal A is positive with respect to ground.

To show this more clearly, the two resistors have been redrawn in Fig. 5B. As you can see, the ground connection, terminal B, is positive with respect to terminal C but it is negative with respect to terminal A.

Now, let's look at Fig. 6. Here you see the grid and cathode circuits of a tube. As you can see, the lower end of the grid resistor goes to ground. There are two reasons for this. Let's take them one at a time.

First, we want any ac signal voltage appearing across the grid resistor to be applied between the grid and cathode of the tube. The lower end of the cathode resistor is grounded, so we also ground the lower end of the grid resistor. The cathode bypass capacitor bypasses the signal around the cathode resistor so that only the signal voltage appearing across the grid resistor is applied between the grid and cathode.

The second reason is that we want to keep the grid at the proper dc potential with respect to the cathode. The bias for the tube is provided by the voltage drop across the cathode resistor. Current flowing upward through this resistor makes the upper end positive with respect to the lower end. Thus, the voltage at the cathode is positive with respect to ground by the value of the voltage drop across the cathode resistor.

When we connect the lower end of the grid resistor to ground, the grid will be at dc ground potential. The grid can't attract electrons from the cathode, which is positive, so no dc current will flow in the grid resistor.

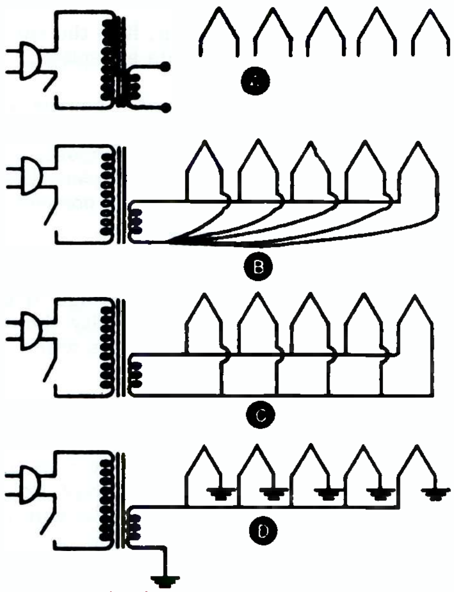


FIG. 8. Filament circuit.

With no dc current flowing in the resistor, there will be no dc voltage drop across it. Therefore, the dc potential at the upper end of the resistor will be the same as at the lower end.

Since the cathode is positive with respect to ground, it will be positive with respect to the grid, or to say it differently, the grid is negative with respect to the cathode.

We get into a different type of ground connection when we deal with rf ground potential or signal ground potential. The two phrases are used to describe the same thing.

When we say that some point in a circuit is at rf ground potential, we mean that it is at ground potential only so far as an rf signal is concerned. So far as dc is concerned, it may have any potential. Therefore, the ac signal must be grounded in a way that does not short out any dc voltage present.

Suppose, for example, we want to ground the lower side of the plate tuned circuit in the i-f amplifier shown in Fig. 7. We need a connection from the lower side of this circuit to the cathode. This is to complete that portion of the ac plate-cathode circuit that lies outside the tube and to prevent resistor R from being part of the signal plate load.

Since the cathode is grounded, we can complete the rf circuit by grounding terminal A. A direct connection to the chassis would short out the power supply. We can, however, use a capacitor.

The reactance of a capacitor is given by the formula

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

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

All we need to do is find a capacitor that has a much lower reactance than the ohmic value of resistor R at the frequency of the signal and connect the capacitor from terminal A to the chassis. By doing so, we ground the lower end of the tuned circuit for rf without shorting out our dc voltage.

In most inexpensive sets, this capacitor is omitted and the connection is made through the output filter capacitor.

USED TO COMPLETE CIRCUIT

Another way in which ground connections are used is in completing one side of a circuit (or a number of circuits). You know that when electrical energy is to be used to operate any device, one must have a complete circuit from the source of the energy to the load and back to the source. This is true whether we are going to use dc or ac to operate the device. In many cases, we can ground one side of our source and one side of our load and complete one side of the circuit through the chassis. This greatly simplifies the wiring of a piece of equipment.

Let's look at Fig. 8. Fig. 8A shows the filaments of five tubes that we want to operate in parallel from the filament winding of the transformer. To connect each filament individually to the filament winding would require a wire from the top of the winding to the filament and another wire from the other side of the filament to the lower end of the winding.

In Fig. 8B, we have simplified things a little by connecting one side of each filament to the top of the winding and running a wire from the other side of each filament to the lower end of the winding. However, things are still pretty badly cluttered up.

In Fig. 8C, we have helped things a little. more by running a single wire from the top of the winding to one side of each filament and another single wire from the lower side of the winding to the opposite side of each filament.

We can do even better, however. Look at Fig. 8D. Here we have grounded the lower end of the filament winding. Then we ground one side of each tube filament. After that, a single wire is used to connect the top of the filament winding to the ungrounded side of each filament, and we're in business. One side of the filament circuit for each tube is completed through the chassis.

It may seem that with currents flowing in all directions through the chassis, the electrons

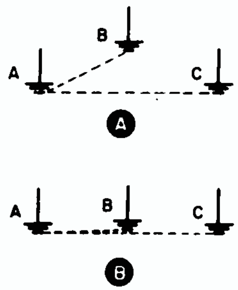


FIG. 9. A, right ground connection; B, wrong.

would become completely lost and wind up almost anywhere except where they were headed. Actually, this does not give as much trouble as one might expect.

The number of electrons flowing into a particular point in a circuit can't be any greater than the number of electrons leaving that point. In any of the tiny currents, the number of electrons arriving is great enough to take the place of those that are leaving. Therefore, there is no tendency for one current to attract electrons from some other current. So the currents do not mix as long as a reasonable separation between them is maintained.

It is possible to cause mixing by improper choice of ground connections. Look at Fig. 9A. Here we have three ground connections with currents flowing from terminal A to both terminals B and C. So long as the currents are separated like this, no mixing results.

Suppose we move the connection at point B to another point on the chassis, as shown in Fig. 9B, so that the current flowing from A to C has to flow very close to terminal B. In this case, we are going to have mixing and possible trouble.

For this reason, you should not change ground connections around, indiscriminately. If you move a ground connection, be sure you know exactly what you are doing.

Be careful moving ground connections, make sure ground connections are made when they are needed, and be very, very careful of accidental grounds. Happy grounding.

In Memoriam

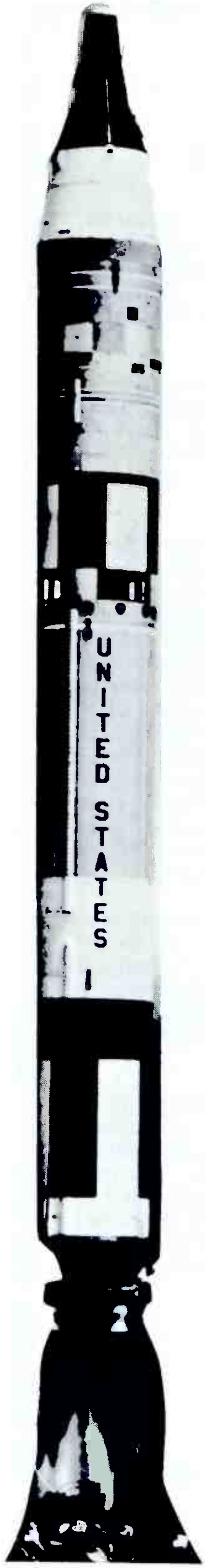
Mrs. James Ernest Smith, 83, wife of the founder of National Radio Institute and mother of its president, James Morrison Smith, died January 29 after a brief illness.

Also surviving are two daughters, Mrs. Guilford Galbraith of Dallas, Texas, and Mrs. B. Robert Sarich, McLean, Va.; eight grandchildren and four great grandchildren.

Mrs. Smith, the former Sarah Morrison, was a graduate of Washington School of Law, and was admitted to practice before the District Bar. She was a member of the legal fraternity, Kappa Beta Pi, and a charter member of the Washington Readers Club; a member of the Shakespeare Society, and was the first president of the Washington Chapter of the Ladies of the Round Table. She was a member of the Westmoreland Congregational Church and of its women's guild.

She and her husband, who had been married 54 years, had visited every state in the U. S., and had made numerous trips abroad, returning from an extensive tour in the Far East and India only a few months ago.

To her very active family, civic, and social life she contributed her inherent charm, distinction, and vivacity. As one NRI employee said after meeting her at its 50th anniversary luncheon, "She was the sort of person you meet once and never forget."

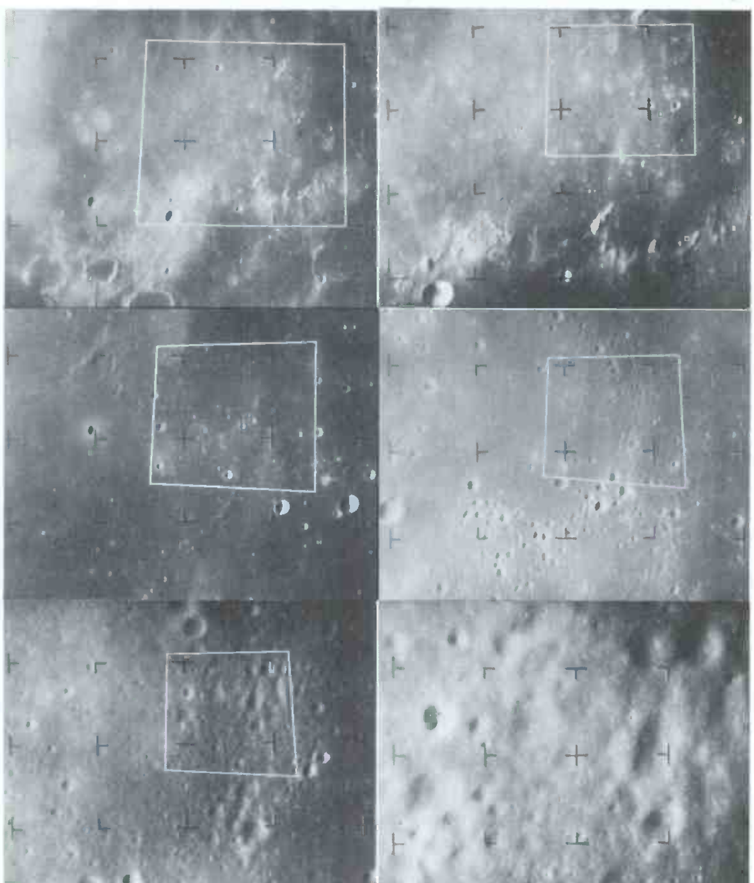


TV's New Role

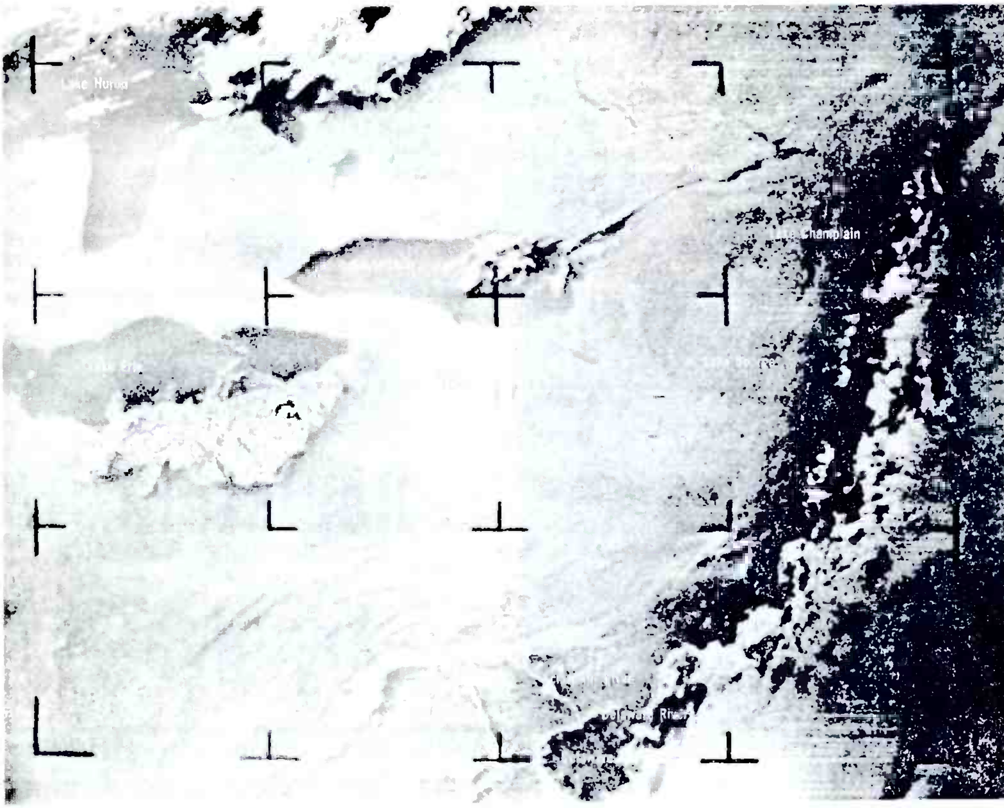
SHOOTING for THE MOON

". . . hailed by scientists as the most dramatic forward leap in astronomy since Galileo first directed his telescope toward the heavens: the extension of man's vision to within a few hundred yards of the moon's surface by means of a high resolution 6-camera TV system carried aboard a complex and ingenious space vehicle. . . . In one stroke, electronics and space technology transcended by 2,000 times the limit of resolution of the most powerful earth-bound telescopes to provide in more than 4,000 pictures information needed for landing men on the moon."

Photos and excerpts from 'Television In Space' Courtesy RCA and Electronic Age



NEARER AND NEARER . . .These photos were taken as Ranger VII neared the moon's surface. Altitude: top left, 480 miles, right 235 miles; center left, 85 miles, right 34 miles; bottom left, 12 miles, right 3 miles.



VIEW FROM THE TOP . . . This image televised from the Nimbus weather satellite shows a large part of the northeastern United States.

The news of two more Ranger shots---one by now most likely completed, and the other scheduled for later this month---gives an exciting new acceleration to the program of landing men on the moon.

And that isn't all---also in the NASA works are two more lunar reconnaisance projects after Ranger flight results are assayed. There's Project Surveyor, designed to deposit TV camera and other equipment on the moon for on-the-spot observation; Project Orbiter, which is designed to circle the moon with camera-carrying satellites. More TIROS and Nimbus (weather satellite) vehicles, TV camera-equipment manned flights (so far only robots which disintegrate on impact have been used), and the Orbital Astronomical Laboratory are among other planned programs.

Much has been discovered, although it'll take months and perhaps years yet to properly evaluate the findings. Too, the dust has not settled yet on such things as the nature of the moon's surface, and how robot findings will relate to man.

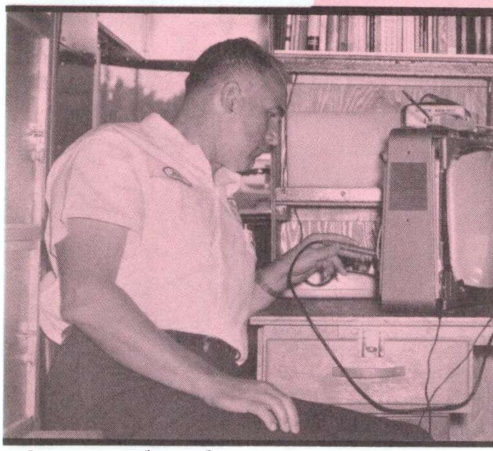
What is established is television's new role, one undreamed of not too long ago in its still infancy, in outer space. If the Ranger moon shots and the following Nimbus flight hadn't been so spectacularly successful, the entire program would have had severe setbacks. That "will eventually include not only the observation of the earth and moon but also the study of planets at close range, the scanning of the universe through space environment, and channels of communication linking astronauts visually with their bases on earth."

"Two statistics demonstrate the potential of television in space. Beginning with....Tiros I in 1960, nearly 42,000 television pictures have been sent to earth from satellites and other spacecraft. Yet this vast output has come from only 26 cameras....The flood of visual information will mount in the near future with the launching of additional.... vehicles.

"Unlike conventional TV cameras, those so far used to scan weather and lunar features have provided a succession of still photos rather than moving images of broadcast TV."

SUCCESS STORY

BY STEVE BAILEY



Graduate Registers An Idea

Thousands of NRI graduates are actively employed in radio and television servicing in shops all over the country. A good many are operating their own businesses. Thus, it is not surprising that an NRI graduate would develop a unique method to improve and modernize service to the customer. In this case, the graduate is Bob Jones of Fort Bragg, North Carolina. His development is a mobile TV repair service for registered customers.

Bob is a veteran of 24 years of Army service. Four years before he planned to retire, the day came when he had to consider what he was going to do after leaving the Army. He first wanted to choose a secure and profitable career. He chose television repair. The next decision was where to get the best training. He chose NRI.

During the next four years, he was transferred twice. However, he pursued his training vigorously and was soon rewarded with his NRI Diploma. This enabled him to obtain a bench job doing television repair immediately upon retirement from the Army. He stayed at this for a year, during which time he obtained valuable practical experience.

It was also during this year that Bob learned the ins and outs of the repair business. He realized that he would have to improve on the services already offered by local shops in order to make a successful business of his own. After giving much thought to this, the idea of a mobile, registered TV repair service came to him.

His first move was to purchase a Chevrolet Step-Van with a 12-foot body. He and a friend then installed shelves, a workbench, and storage space. Six electrical outlets on the workbench insured facilities for as much equipment as necessary to complete any repair job. For power, Bob simply installed a 30-foot extension cord that could be plugged into one of the customer's electrical outlets. With work completed on the van, Bob next installed his test equipment, which included everything from a vacuum tube voltmeter to a B and K 1076 Analyst. He even installed file cabinets to keep his Sam's Photofacts right on hand.

Bob's next step was to advertise. He adopted the policy, still in use, of sending potential customers a letter of introduction describing his business along with photographs of his mobile shop. Included in his advertisement is the small card that makes his service unique.

The card he sends is a registration card. It is perforated in the middle so as to be detachable. One section contains a self-addressed business reply card on one side and a form on the other. The customer fills in his name, address, and telephone number. Also, he fills in the make and model number of his television set and any other equipment he has. Then all he has to do is to mail the card. Bob even pays the postage on it. The other section of the card can be attached to the back of the customer's set. It identifies him as a registered customer. Also, it has Bob's telephone number on it so the customer can locate it quickly. He can call any time, day or night, since Bob has a 24-hour answering service available seven days a week.

As soon as the card is received, Bob registers the new customer. He then checks to be sure he has a Sam's Photofact on the customer's set. If he doesn't have it, he gets it. Then he checks the schematic to be sure he has all the parts necessary to do an on-the-spot repair job whenever he is called upon. Since every set is registered, he has advance notice and can be fully prepared to do a first-rate job at any time. All parts needed are in the mobile shop ready for use long before any defects occur.

The idea of a registered TV service is certainly progressive in that it allows the serviceman to be prepared to handle any complaint quickly and efficiently. Add to this the benefits of repairing the set at the customer's home and you have an unbeatable combination. Needless to say, a satisfied customer is the best means of adding new customers.

Bob Jones is to be commended for his imaginative idea. He has successfully demonstrated that the business of Radio-TV servicing can always be modernized and streamlined to keep up with the advancing times. Respect for the local Radio-TV serviceman will continue to grow as long as graduates such as Bob are serving the public.

What are YOU doing with your NRI training? If you have an unusual story to tell, we'd like to hear it. Write Managing Editor, NRI Journal, 3939 Wisconsin Ave., N.W., Washington, D. C.

Exclusive FOR NRI GRADUATES

We are preparing a directory of NRI graduates who have benefited as a result of NRI training. If you would like your name listed, please fill out this application. Use of your name will bring a reward.

Circulation and distribution of the NRI Graduate Directory will be subject to your approval.

There is still time to forward your name to us.

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Name ____________________
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City ____________________ State ____________
Area Code ____________ Phone No. ____________

Device Of The Month:

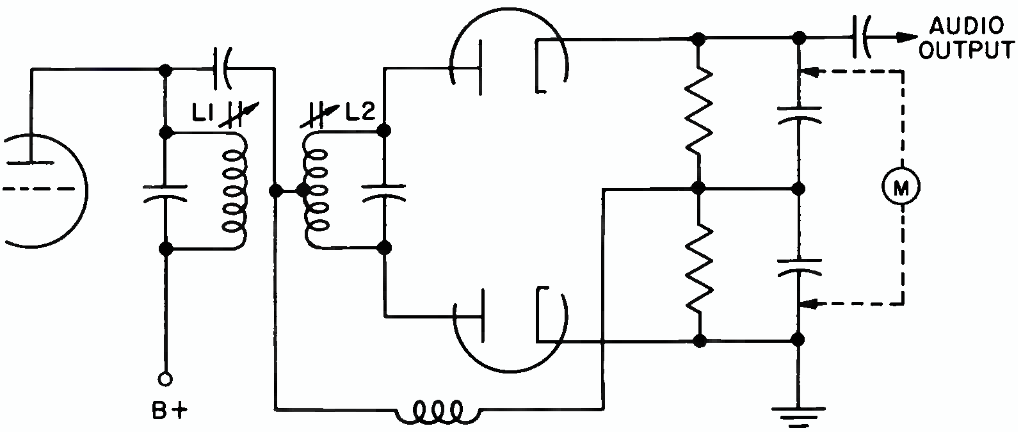
GATED-BEAM FM DETECTOR

BY LEO G. SANDS

A new, better and simpler FM detector for sound channel of TV sets, FM broadcast receivers, and FM mobile radio system receivers employs only one tube and can reduce receiver tube requirements by as many as three tubes. The gated-beam tube performs the functions of IF limiter, FM detector, and audio amplifier. Heretofore, the Foster-Seeley type FM discriminator has been used in most high quality FM receivers and TV sets as well as in FM mobile radio system receivers. Other substitutes for the standard FM discriminator, such as the Bradley, Beers, and ratio detectors have been used. In spite of the excellent performance that can be obtained with these detectors, none came anywhere near achieving the popularity of the standard FM discriminator.

But the gated-beam FM detector is rapidly gaining acceptance, not only in TV receivers, but in FM broadcast and communications receivers. Many mobile radio service technicians were prejudiced against the Bradley detector when it was introduced by Philco in its mobile radio equipment back in 1948. Many now still oppose the gated-beam detector. But their opposition seems to be based on either ignorance of the facts or unwillingness to learn new techniques.

The standard FM discriminator used in most FM mobile receivers, as well as FM broadcast receivers, requires at least two limiter stages ahead of it, plus an audio voltage amplifier between it and the audio power amplifier. A meter is required when zeroing the discriminator on an incoming or shop reference signal. (See Fig. 1.) Often it is adjusted improperly and is more effective on a signal at one frequency only, and produces distortion on signals that are slightly off the frequency to which it was adjusted.



NOTE:

(M) METER CONNECTED HERE FOR MAXIMUM VOLTAGE WHEN ADJUSTING L1 AND FOR ZERO VOLTAGE WHEN ADJUSTING L2 AGAINST UNMODULATED SIGNAL.

FIG. 1. Conventional FM discriminator.

It should be adjusted for zero output when an unmodulated signal is fed to it which is at the exact center of the receiver's IF bandpass. This is the correct adjustment when the incoming signal is at exactly the correct frequency and all of the receiver's local oscillators are at the right frequency. Any error in these signals causes a change in the frequency of the IF signal fed to the discrimi-

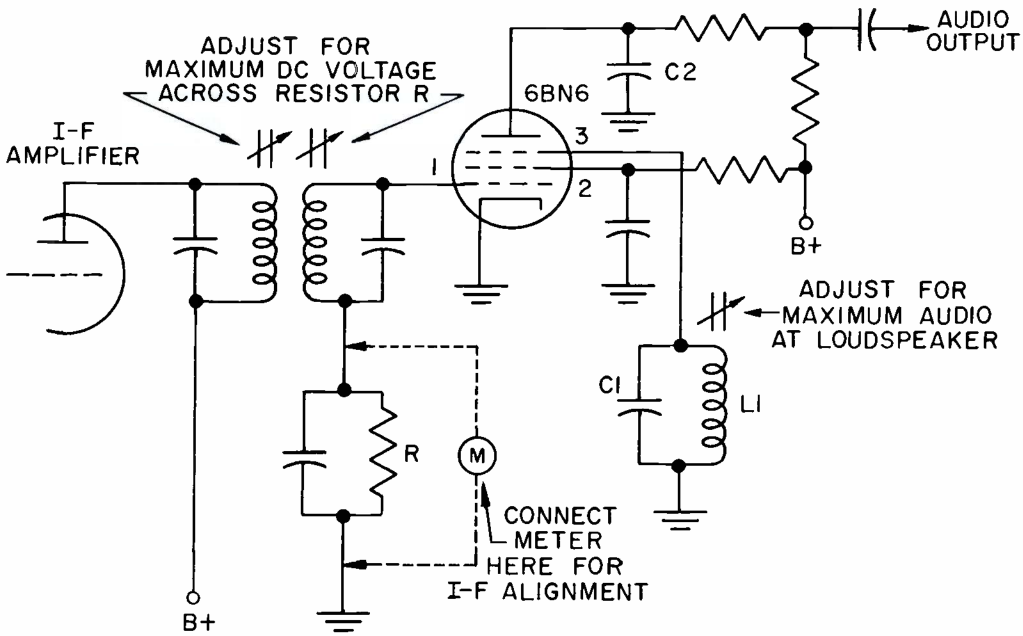


FIG. 2. Gated-beam FM detector/limiter/audio amplifier.

nator. When there are no frequency errors, the IF signal fed to the discriminator should be at the IF bandpass mid-frequency, such as 290 kc, 455 kc, 1650 kc, etc., depending upon the receiver design.

Service technicians often use an off-the-air signal when zeroing the discriminator and "net" all receivers in a system to the same signal. As a result, the discriminator may not be zeroed at the center of the IF bandpass and one sideband of the FM signal may be clipped. As the various transmitters in the system vary from their correct frequencies as much as plus and minus 800 cps, still remaining within FCC tolerances, the adjustment of the discriminators in the receivers is no longer correct unless the receivers are equipped with AFC.

The gated-beam FM detector, on the other hand, is not critical in adjustment. Its response curve is such that one adjustment remains essentially correct within the frequency drift tolerances of transmitters and receivers. Adjustment is very simple. No meter is required. Simply adjust one coil slug for maximum audio volume. The signal may be an off-the-air modulated signal or a frequency modulated signal from a signal generator.

Fewer components are required in the receiver. The gated-beam tube combines the functions of the IF limiter, FM discriminator, and first audio amplifier. As shown in Fig. 2, the IF signal is fed into the tube's control grid through a conventional IF transformer. A special transformer with a tapped secondary is not required. However, another tuned circuit is required, L1-C1 in the diagram, which is known as the quadrature tuned circuit.

The schematic symbol for the gated-beam is the same as for a conventional pentode. There are three grids. In a pentode, these are the control grid, screen grid, and suppressor grid. In a gated-beam tube, the grids are known as the control grid, accelerator grid, and quadrature grid. In the diagram, they are identified as 1, 2, and 3.

In a pentode, the suppressor grid has but small effect on plate current. But, in a gated-beam tube, the quadrature grid has almost as much effect on the plate current as the control grid. When both grids 1 and 3 are positive, plate current flows. When either is only a little bit negative, plate current ceases. In both types of tubes, grid 2 is maintained at a relatively high positive voltage.

When used as an FM detector, limiting action is provided by the control grid (1) which is normally biased negative by only a very small amount. Some plate current flows. When the incoming signal swings positive, plate current increases to its maximum amount. A further swing in the positive direction will not cause any further increase in plate current. When the signal swings negative, plate current is cut off. The resulting plate signal therefore consists of a train of pulses.

The incoming IF signal applied to grid 1 causes a signal voltage to develop across the quadrature tuned circuit (L1-C1) through space charge effect. When the incoming signal is unmodulated, the signal at grid 3 is about 90° out of phase with the signal at grid 1. When the signal is frequency modulated, the signal at grid 3 tends to stay at the signal center frequency while the signal at grid 1 varies in frequency above and below the center frequency.

Thus the phase relationship of the signals at grids 1 and 3 changes. Maximum plate current flows when the signals at both grids are positive and most nearly in phase and vice versa. Plate current thus consists of a train of pulses whose width depends upon the phase relationship of the signals at the two grids. The number of plate current pulses flowing per second depends upon the frequency of the modulation. Hence, the average plate current represents the demodulated FM signal (audio). Capacitor C2 smoothes out the pulses so that a clean audio signal is produced.

The audio recovery of the gated-beam FM detector is much greater than that of a conventional FM discriminator since audio amplification occurs in the tube simultaneously with IF signal limiting and FM demodulation. The gated-beam FM detector has some limitations, of course. To obtain optimum performance, the tube must be driven hard enough by the IF amplifier. This means that the receiver must have ample gain to cause weak signals to drive the gated-beam tube into saturation. Thus, in some FM communications receivers, a limiter stage is used ahead of the gated-beam tube, which limits strong signals and amplifies weak signals.

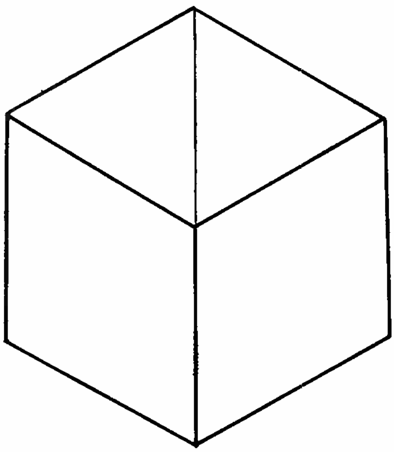
Among the gated-beam tubes now on the market are the 3BN6 and the 6BN6. The true potentials of the gated-beam tube have not been exploited. (I have tried one as an AM detector and found it to be excellent.) It can be used in logic circuits, such as OR and AND gates, and as an electronic switch. The important features of the gated-beam tube are (1) making either grid negative can cause plate current cut off, (2) making both grids positive causes plate current saturation, and (3) the mutual conductance of the tube is extremely high. The service technician will find gated-beam FM detectors easy to adjust and service, and the experimenter will find this tube performs better in many functions than conventional tubes.

'We'll make it up in volume.'

CREED FOR TODAY

.....I do not choose to be a common man or woman. It is my right to be uncommon if I can, to seek opportunity —not security. I do not wish to be a citizen humbled and dulled by having the state look after me. I want to take the calculated risk; to dream and to build, to fail and to succeed. I refuse to barter incentive for a dole. I prefer the challenges of life to the guaranteed existence; the thrill of fulfillment to the stale calm of Utopia. I will not trade freedom for beneficence nor dignity for a handout. I will not cower before any master nor bend to any threat. It is my heritage to stand erect, proud and unafraid; to think and act for myself; enjoy the benefit of my creation and to face the world boldly and say: this, with God's help, I have done. All this is what it means to be an American........

The Largest Square That Fits In A Cube



PROBLEM: A boy carrying a metal box visited a machine shop. The inside dimensions of the box were exactly 1" × 1" × 1" making a volume of 1 cubic foot. The box was open at the top. The boy was told that he could carry home the largest square of sheet metal that would fit into the box without bending. The square was not to protrude at the top.

Except for the thickness of the metal, what were the dimensions of the square? (Solution below.)

BY ROBERT HANES

SOLUTION: In Fig. 1, mark $\overline{DB} = \overline{CB}$, and $\overline{EA} = \overline{FA}$, and call each of these segments X. Triangles FAE and DBC when joined by straight lines form a prism. Since they are isosceles right triangles, CD = $\sqrt{2}\times$ and the line $\overline{CF}$, a side of the metal square, is a diagonal of the rectangle CDEF, Fig. 2. and therefore $\overline{CF} = \sqrt{1^2 + (2\times)^2}$. $\overline{CF}$ equals $\overline{CH}$, the hypoteneuse of the triangle CGH, or $CF = \sqrt{2}(1 - X)$.

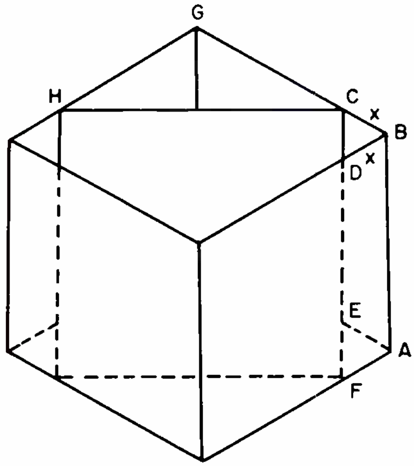


FIG. 1.

Solving for X,

$$\sqrt{1^2 - (\sqrt{2x})^2} = \sqrt{2}\,(1 - x)$$
$$1 + 2x^2 = \sqrt{2} - \sqrt{2}x$$
$$1 + 2x^2 = 2 - 4x + 2x^2$$
$$4x = 1$$
$$x = \frac{1}{4}$$

For the side of the metal square,

$$S = \sqrt{(1 - x)^2 + (1 - x)^2} = \sqrt{9/16 + 9/16} = \frac{1}{4}\sqrt{18}$$

ANSWER: Each side of the square equals $\frac{1}{4}\sqrt{18}$ ft. = (1.06066 ft.)

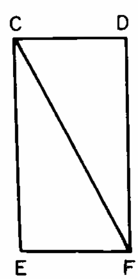


FIG. 2.

"In the old days couples raised large families to get farm labor. I have a new twist----raise kids to be plumbers, appliance repairmen, carpenters, etc. It's the only way you can get hold of them nowadays."

----Chan Harris in Door County Advocate, Sturgeon Bay, Wis.

BY
STEVE
BAILEY

DEAR STEVE:

In Lesson 7BB, we are given the formula $6.28\frac{1}{x}$ FXC determining capacitances reactance. Also, we are given the formula $\frac{159,000}{FXC}$. Which one is correct?

E. M., Wake Island

Both of the formulas you have shown are correct. The difference is in the way the value of the capacitor is expressed.

Whenever you are trying to find the reactance of a capacitor with a value expressed in farads, you use the formula $\frac{1}{6.28 \times FXC}$. F (frequency) is expressed in cycles and C (capacity) is expressed in farads.

If the value of the capacitor you are working with is expressed in microfarads, you use the formula $\frac{159,000.}{FXC}$ Again, F is expressed in terms of cycles, but C is expressed in terms of microfarads.

Should the value of the capacitor be in micro-microfarads, you can convert to microfarads by moving the decimal point six places to the left. You can then use the formula $\frac{159,000}{FXC}$.

DEAR STEVE:

I would like you to clear up a small problem I encountered in Lesson 5BB.

On page 24, resistor tolerance is discussed. When it is said that a resistor has a tolerance of 10% and the rated value is, for example, 220,000 ohms, does it mean that the resistance is varying between 242,000 ohms and 198,000 ohms, or does it mean that it has a set value between these two?

E. L., Calif.

First of all, a 220K resistor should have a value of 220K, regardless of its tolerance. The tolerance is mainly a measure of its usefulness.

When we place a resistor in a circuit, we are placing it there because it contains a needed amount of resistor. However, this resistor may not be exactly at its rated value or it may change to another value after being in use for a length of time. If it changes beyond a certain point, it is of no use to us. So we have the tolerance rating.

If the resistor has a value of 220K, ± 10%, it can measure as low as 198,000 ohms or as high as 242,000 ohms and still be useable. However, if it is higher than 242,000 ohms or lower than 198,000 ohms, it is no longer useable.

DEAR STEVE:

Why does an audio signal have to be amplitude-modulated to be transmitted? I am studying Lesson 2BB at present.

W. W., Kentucky

An audio signal does not have to be amplitude-modulated. It can be frequency-modulated as well. However, the audio signal must be modulated.

Because of the frequency of audio signals, they cannot be directly transmitted. They need a vehicle on which to ride just as an astronaut needs a rocket if he wishes to go to the moon. For radio, the vehicle is the carrier signal.

In amplitude modulation, the audio signals vary the amplitude of the carrier. For frequency modulation, the frequency of the carrier is varied.

DEAR STEVE:

According to Lesson 2BB, a primary cell cannot be recharged. Recently, however, I have seen several devices on the market that are supposed to recharge flashlight cells which are primary cells. How can this be?

A. M., Texas

Rejuvenation types of units usually consist of a small transformer, a rectifier, and a fixed resistor. A small amount of rectified ac is passed through the dry cell and gives the appearance of having recharged it.

For a standard dry cell, electricity is produced because of a chemical action between the electrolyte and the zinc case. The zinc is slowly eaten away as the battery is used. As this is happening, hydrogen bubbles are produced which gather around the carton (positive) electrode. Eventually, the bubbles surround the electrode and the battery cannot operate.

Since I have never used this recharging device, I can only assume that the rectified ac serves to remove the bubbles, which permits the chemical action to continue. Once the zinc has been completely eaten away, however, no amount of recharging will restore it.

DEAR STEVE:

In Lesson 11, we told that the circuit shown in Fig. 27 is a grounded plate circuit. The plate, however, is connected to B+, so how is the plate grounded?

B. B., Virgin Islands

In the circuit you mentioned, the plate is considered to be at signal ground potential. This means that the plate is grounded as far as the signal is concerned.

The circuit from plate to ground is through a filter capacitor in the power supply. This capacitor has very low reactance at signal frequencies, so it will offer very little opposition to the ac signal. It is because of this that we can consider the ac signal to be fed directly to ground.

One easy way to recognize a signal of this type is to notice that the load is in the cathode circuit rather than the plate circuit.

CORRECTIONS

(Jan./Feb. column)

3rd letter, final sentence: 1:2 should be 2:1

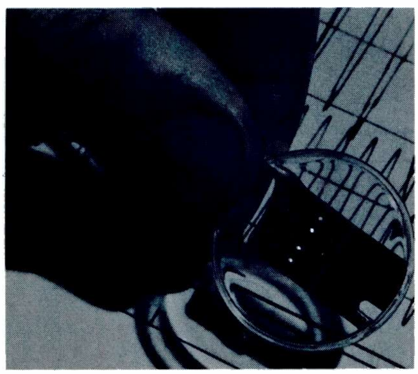
5th letter, formulas: should be

$$\frac{N1}{N2} = \frac{\sqrt{Z1}}{Z2} \text{ and } \frac{N1}{N2} = \frac{\sqrt{100}}{1}$$

'Turn right this side of my radio tower.

what's new?

* * * * * * * * * * * * * * * *



Ten pinhead-size incandescent lamps in a half-inch space are a prime feature of a recording unit for graphing produced by Brush Instruments Division, Clevite Corp., of Cleveland. The unit fits into a light beam oscillograph without disturbing existing analog channels, permits recording of ten channels of high-speed events within a half-inch space on the chart paper margin. The unit is situated at the edge of the chart paper with the lamps practically butted up against it. When a lamp is energized a trace appears on the paper.

* * *

The use of ultrasound as a medical tool is becoming widespread. One recent device is a sonar-type machine that "looks" at the progress and size of an unborn baby. A vibrating crystal, immersed in a water-filled bag resting on the mother's abdomen, sends out high-frequency sound waves (unaudible to humans) in a moving beam. The high-powered B-scan apparatus works like radar, giving a two-dimensional picture of the tissue involved.

* * *

James E. Smith, founder of National Radio Institute, election to honorary membership and professor emeritus in HUTRADENA Club (Howard University Training Detachment National Army) with citation: "The service as technicians that we were able to render our country in World War I combat with the enemy was due to the special technical training we received under your excellent tutelage as chief instructor . . ."

* * *

A tiny new mike by Shure Brothers, Evanston, Ill., retains maximum performance and excellent voice characteristics. The new unit, only 2-5/8" in length by 3/4" in diameter, is a moving coil, dynamic type with a flat frequency response from 50 to 10,000 cps. It has a single impedance that properly matches any low impedance input from 50 to 250 ohms. The output level is -60.5 db (0 db 1 mw with 10 microbars.

* * * * * * * * * * * * * * * *

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Light-amplifying tubes that permit soldiers to see in the dark without their own presences being revealed will be produced in Springdale, Conn., for the U. S. Army by the Machlett Laboratories, Inc. (subsidiary of the Raytheon Co.). The tubes intensify the natural low level of night illumination to present a bright image, thus providing the soldier with fire power and mobility comparable to daytime levels.

* * *

The secretary who can't locate her boss now has an aid in a pocket-size radio receiver. With it in his pocket, her voice goes automatically from the phone to the receiver Message Mate, although there's no attachment to the phone. A radio base station and electronic coder tie in with building switchboard, with range extending to several miles. It's marketed by General Electric Communication Products Dept., Lynchburg, Va.

* * *

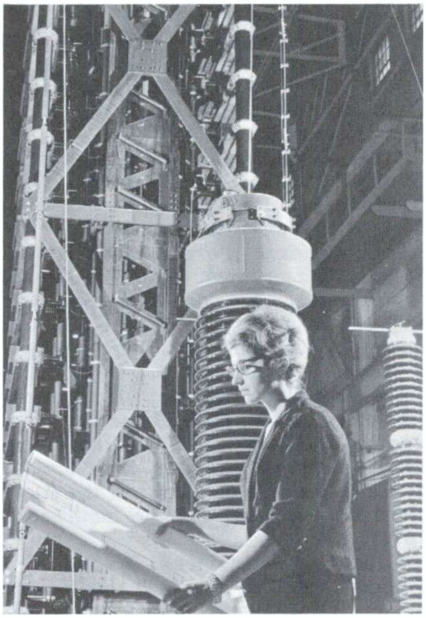
EXPO, the 1967 World Exhibition in Montreal, plans the use of robots to welcome visitors. The robot will stop in front of you, using his radar equipment; welcome you in English or French and explain what he is, using recorded talking ability; and then probably move on to a power outlet and recharge his battery. The robots, however, will not be in the movie image of man-shaped giants. They are more like little boxes on wheels. "After all, they're just machines," says deputy administrator Commodore O.C.S. Robertson.

* * *

"Fit" Shrinkable Tubing produced by Alpha Wire Core, New York City, shrinks under heat to form a tight, mechanical bond that promises insulation, protection, and strengthening of wire, cable, connectors, or components. Its sample presentation is good, too...on application of a match to the bit of tubing, you can see how it works.

* * *

First girl to enroll in the Allis-Chambers cooperative training program for student engineers in its 40-year history is Martha Toshner of Milwaukee. Martha, a junior at Marquette in electrical engineering, alternates a semester in the classroom with on-the-job training at Allis-Chambers. Pictured with her here is a 40-foot impulse generator for testing electrical equipment that simulates lightning surges of up to 4 million volts.



* * *

An automatic fire-detection and prowler-alarm system that links private homes directly with local fire and police departments is being mass-produced by Westinghouse Electric Corp., to be marketed by Wafa Corp. this spring. The 24-hour monitored system, to be offered to home owners at a service charge of $19 per year plus installation costs, operates through a network of sensor devices---smoke detectors, fixed temperature and rate-of-rise detectors---installed throughout the dwelling.

* * *

Fragile electron tubes used in radar and radio transmission systems on the ground and in missiles (valued at $10 to $40 each) are now being packed in juice-size, tab-top cans at Eithel-McCullough, Inc., in San Carlos, Calif. The tubes, nestled in soft polyurethane foam and sealed in the can, remained unharmed in test drops on a concrete surface from a three-story building. Cans are produced by American Can Co., with bodies of tin-coated steel plate and tops of aluminum. Each can is identified as to tube content.

* * * * * * * * * * * * * * * *

EMPLOYMENT OPPORTUNITIES

Sperry Gyroscope Co., Syosset, N. Y., $7,830,438 from Navy for engineering services related to inertial navigation systems for fleet ballistic missile submarines.

Link Group, General Precision, Inc., Binghamton, N. Y. $7 million from Grumman Aircraft Engineering Corp. to design, develop and produce a Lunar Excursion Module mission simulator for Project Apollo.

Canadian Aviation Electronics, Ltd., Montreal, about $1 million from Canadian Pacific Airlines for a DC-8 simulator.

Bell Aerosystems Co., Buffalo, $4.1 million from Kollsman Instrument Corp. for navigation and stabilization equipment used in the airborne mapping and survey system.

Republic Aviation Corp., Farmingdale, N.Y., $4,228,572 from Air Force for provision of modification kits, engineering services and data in support of F-105 aircraft.

Hewlett-Packard Co., Oscilloscope division, Colorado Springs, $1,166,211 from AF for a 30-millisecond oscilloscope.

Philco Corp., Communications and Electronics division, Philadelphia, $1,206,895 from Army for VOcoder systems (voice coders) with ancillary items.

Space General Corp., El Monte, Calif., $3,353,042 increment to a previously awarded contract from AF for fabrication, assembly and checkout of Able-Star space vehicles.

Radio Corp. of America, Defense Electronics Products, Camden, N. J., $2 million fixed-price-incentive contract from Army for classified electronic equipment.

Boeing Co., Seattle, $2.5 million from NASA Langley Research Center, Hampton, Va., for dynamic simulation work on the supersonic transport project, using a modified Boeing 707.

International Business Machines Corp., Poughkeepsie, N. Y., $1.9 million from AF for an IBM 4044/1416 computer system to be installed at Cambridge Research Laboratories, Hanscom Field, Mass.

General Electric Co., Syracuse, N. Y., $36,930,004 letter contract from Navy for sonar sets, spares, data training, and engineering services.

Philco Corp., Western Development division, Palo Alto, Calif., $5 million initial increment to a $24.5 million contract from AF for work on the communications satellite.

Lockheed - Georgia Co., Marietta, Ga., $1,032,421 from AF for modification of the malfunction detection and recording system for the Hound Dog missile.

TRW Space Technology Laboratories, Inc., Redondo Beach, Calif., $3,050,000 initial increment to a $9,331,700 AF contract for work on space-ground communications.

Sperry-Rand Corp., Univac division, St. Paul, $15 million from Army for electronic communications systems.

Columbia University, New York, $2,640,000 from Navy for continued long-term basic research in underwater sound and related subjects to improve submarine detection.

Bendix Corp., Mishawaka, Ind., supplemental $3 million from Navy for long lead time material for Talos missile guidance, control and airframes.

Western Electric Co., Inc., Winston-Salem, N. C., letter contract from Navy with a maximum liability of $1,036,000 for installing sonar classification sets aboard submarines, spare parts, books, and engineering services.

United Aircraft Corp., Farmington, Conn., $4,259,373 follow-on AF contract for the 433L weather observing and forecasting system.

Honeywell, Inc., Minneapolis, $4 million from North American Aviation's Automatics division for production of accelerometers for the Minuteman II guidance system.

Philco Corp., Aeronutronic division, Newport Beach, Calif., $5.6 million from Army for industrial engineering services for the Shillelagh missile system.

General Dynamics Corp., Pomona, Calif., $3.9 million from Army for Redeye missile system engineering services.

Lockheed Aircraft Corp. Missile and Space Co., Sunnyvale, Calif., $3,087,236 from Navy for repair of Polaris equipment.

Avco Corp., Everett, Mass., $1 million initial increment to a $4.5 million Air Force contrace for radiation research.

Atlantic Research Corp., Duarte, Calif., supplemental $4,280,295 from AF for development of special test vehicles for re-entry vehicles systems.

Collins Radio Co., Dallas, Texas.

General Dynamics/Convair, San Diego, Calif.

Beckman Instruments, Inc., Fullerton, Calif.

Sylvania Electric Products, Inc., Mountain View, Calif.

Emerson Electric Co., St. Louis, Mo.

Ling-Temco-Vought, Inc., Dallas, Texas.

North American Aviation, Inc., Automation Div., Anaheim, Calif.

General Dynamics Corp., Pomona, Calif.

Univac Div., Sperry Rand Corp., St. Paul, Minn.

General Motors, AC Spark Plug Div., Milwaukee, Wis.

Collins Radio Co., Richardson, Texas.

Major contracts ($1 million or more) were recently awarded by government agencies or major contractors to the Electronics firms listed here. Such large orders frequently require the hiring of additional personnel. Those interested in possible employment should contact the companies.

Space Sciences, Inc., Waltham, Mass., $1 million plus, AF, receiving equipment and related material.

Dynalectronic Corp., Washington, D. C., $2,508,377 from Army for services performed in the installation, operation, and maintenance of Government-owned data-collecting facilities.

Opening for student or graduate in electronics at American Telephone and Telegraph Plant Dept. in Monrovia, Md. Apply Mr. Clatterbuck, central office chief, by telephone at 301 865-5410. An Equal Opportunity employer.

Basic electronics instructors needed for Midwest and West Coast Naval Training Centers. Prefer recent graduates. Men interested should send resumes to Mr. Bob Levy, personnel officer, H. L. Yoh Co., Engineering consultants, 123 S. Second St., Philadelphia.

Technical Operations, Inc., Burlington, Mass., $2,130,000 from Army for research and scientific development studies.

Radio Corp. of America, RCA Service Co. division, Camden, N. J., $1,131,100 from Army for furnishing personnel, vehicles, spare parts, and equipment required for installation, operation, maintenance, repair and removal of communication systems and supporting facilities.

Telecomputing Services, Inc., Panorama City, Calif., $1,199,873 modification to a previously awarded cost-plus-fixed-fee contract from Army for preparation of data reduction reports on missiles and test vehicles.

Fairchild Hiller Corp.'s Electronic Systems division, Bay Shore, N. Y., $6.2 million from McDonnell Aviation Corp. for production of additional auxiliary data annotation sets for reconnaissance aircraft.

NEW BOOKS

Newest in the Hayden series of applied mathematics is GRAPHICAL ANALYSIS: UNDERSTANDING GRAPHS AND CURVES IN TECHNOLOGY. Author Philip Stein aims his book at engineering technicians, relating it to needs in present technology. The book's defined (and reached) objectives are: to teach the student technician how to correctively and effectively plot data on various types of graph grids used in technology; to develop ability to read significant information from curves and graphs and make predictions from them; to teach thinking in terms or rates of change, curve bounded areas, and limiting values; to find the properties of curves and waveshapes common in technology; to teach that graphs are an effective tool in the study and understanding of laws and phenomena in science and technology.

(Hayden Book Co., 270 pp., $9.95)

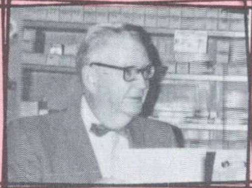
Virtually all standard electronic products sold through distributors are included in the newly released RADIO-ELECTRONIC MASTER catalog, available at parts distributors (Write publisher for list). More than 185,000 items and 12,000 illustrations are used.

(United Catalog Publishers, Inc., 645 Stewart Ave., Garden City, N. Y.)

To help the service technician update his knowledge and skills is the new ADVANCED SERVICING TECHNIQUES in two volumes by John F. Rider, Publisher. The first volume, written by Paul B. Zbar and Peter W. Orne, uses effective illustrations to bolster information on understanding and servicing color and black-and-white TV, and includes troubleshooting procedures utilizing the latest test instruments.

The second volume, by five authors, covers maintenance, repair, and troubleshooting procedures for home audio equipment, including stereo amplifiers, record changers, tape recorders, and home intercom systems.

(Rider: Vol. I, 298 pp. clothbound, $8.25; Vol II, 192 pp. clothbound, $5.95)



Alumni News

David Spitzer............President
Jules Cohen.........Vice President
F. Earl Oliver.......Vice President
Joseph Stocker......Vice President
James L. Wheeler..Vice President
Theodore E. Rose...Executive Sec.

INSTALLATIONS, ASPECTS OF COLOR TV BRIGHTEN WINTRY CHAPTER MEETINGS

FLINT (SAGINAW VALLEY) CHAPTER -- in order to give all members an opportunity to learn more about color Television including those working in the factory at nights -- has been holding meetings on Sunday afternoons. Now the men can come during the week or on a Sunday afternoon or both. Under this system the chapter is averaging two to three sessions per week, which is working out quite well.

The Chapter owes a debt of thanks to its new member, John Allen, for obtaining an RCA color television receiver for the members to practice on at several of the meetings.

The Chapter reports its officers for 1965 as follows: Henry Hubbard, chairman; Donald Darbee, vice-chairman; Andrew Jobbagy, secretary; Clyde Morrissett, treasurer; James Windom, Jr., sergeant-at-arms; Charles Wotring, entertainment committee; Robert Poli, educational director; Leroy Cockrell, photography; Richard Jobbagy, movie operator; Art Clapp, civilian communications radio; Paul Crippen, Leslie Carley, William Duncan, George Martin, John D. Allen, and Robert Newell, membership drive committee and planning committee.

HACKENSACK CHAPTER members were entertained by a lecture, "Accent On Sound," delivered by Mr. Frank P. Sullivan, Public Relations Supervisor, New Jersey Bell Telephone Company. Using an oscilloscope and tape recording, he showed an electrical picture of sounds ranging from the trill of a piccolo to the wail of a crying baby. He described the problems in transmitting sound and how many of the early difficulties were overcome. A reproduction of the first trans-

Saginaw Valley Chapter meetings of late have been devoted to talks and demonstrations of the color bar generator and use of degaussing coil.

continental telephone call in 1915 was played along with the old Edison discs and hi-fi stereo recordings.

At the next meeting Cres Gomez spoke on the public address intercom system and the signal tracer. The new officers elected for 1965 were then installed. They are: Matthew Rechner, chairman. Ed Halvey, vice-chairman; Franklin Lucas, secretary; and Paul Schaeffer, treasurer.

The Chapter has had tentative plans on demonstration of automobile radios from Delco, also lectures on the scope and other test equipment.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER has set up an ambitious program for the study and troubleshooting of color TV sets. This is a timely and practical program and should prove interesting and profitable to the members.

At the conclusion of this program the members expect to undertake a group study program to prepare for FCC second class telephone licenses.

LOS ANGELES CHAPTER has devoted much of its time to a general study of color TV problems. Chairman DeCaussin has taken the lead in this program. He has used his B and K Television Analyst in discoursing on the subject and the members are grateful to him for the wealth of practical information he has brought them.

Serving the Chapter for this year are: Eugene DeCaussin, chairman; Bill Edwards, vice-chairman; Earle B. Allen, secretary; and Ted Lathema, treasurer.

The membership has been following with much interest the case of a local corporation which was found to be over-charging for television repairs. The upshot of the case was that the corporation was fined $800.

NEW YORK CITY CHAPTER'S Officers for 1965 are: Brother Bernard Frey, chairman; Frank Lucas, executive chairman; Albert Bimstein, first vice-chairman; Charles Vevo, second vice-chairman; Frank Szpiech, secretary; and Samuel Antman, treasurer.

Frank Zimmer, formerly executive chairman, who after thirty years of continuous service to the chapter decided not to run for office again, was presented with a brass plaque in recognition of his "unremitting and untiring work."

Two of the Howard Sams tape-slide lectures were shown: Semiconductor Fundamentals and Circuits, and Associated Components, which gave considerable opportunity to members to refresh their memories on many points, with some rather stiff design considerations thrown in. After this mental feast, coffee and cake were served by Mmes. Zimmer and Spitzer.

NYC Chapter chairman Dave Spitzer, left, presented plaque to Frank Zimmer to commemorate the latter's 30 years' service to the chapter.

Vice-Chairman Albert Bimstein gave a very practical talk on Picture Tubes and some of the connected problems, along with appropriate cures. There was considerable interest and many questions from the floor, which, together with some very clear diagrams, helped to give a clear understanding of the subject.

PHILADELPHIA-CAMDEN CHAPTER is on the ball again in getting new members. The latest are William Helkowski and Lynwood Wright, both of Philadelphia. Welcome to the membership, gentlemen!

Bill Davis, a member of the chapter, gave an excellent talk and demonstration on the B and K Television Analyst. The members got a good insight on how to use the instrument--- now they'll know how to use it when they get their own.

As we go to press, the chapter members were expected to be guests of the General Electric

Company in Philadelphia for a program on the transistor. Secretary Jules Cohen says that General Electric has produced a course on transistors which offers great value for the money. This is of interest because one of the two subjects on which the Chapter's programs are going to concentrate during 1965 is transistors. The other is color TV.

Except for the vice-chairman and sergeant-at-arms, all of the 1964 officers were re-elected to serve for the current year. They are: John Pirrung, chairman; Harvey Morris, vice-chairman; Jules Cohen, recording secretary; Joe Burke, financial secretary; Charles Fehn, treasurer; George Dolnick, librarian; and Ray Hollenback, sergeant-at-arms.

PITTSBURGH CHAPTER re-elected most of its officers to serve for 1965. The entire slate is: James L. Wheeler, chairman; Joseph M. Burnelis, vice-chairman; Jack Fox, recording secretary; Howard A. Tate, corresponding secretary; William F. Sames, treasurer; David C. Benes, William J. Lundy, and George McElwain, executive committee.

The above officers were installed by past chairman Thomas D. Schnader.

SAN ANTONIO CHAPTER members, attention! The Chapter's meeting night has been changed from the third Wednesday of each month to the fourth Friday. The change has been in effect since January 22.

The Chapter's 1965 officers are Sam T. Stinebaugh, chairman; Ronald V. Smith, vice-chairman; Harold Wolff, secretary; and John C. Chaney, treasurer.

Instead of a regular meeting in December, the chapter favored a dinner for members and their wives or sweethearts, held at Wolfe's Inn. The dinner was very tasty and the entire evening most enjoyable. Some of the members favor many repeats.

Jesse Delao and Sam Stinebaugh have teamed up to prepare a program on "TV Vertical Circuits." The different types of vertical oscillators will be explained and various vertical troubles discussed. Members are asked to bring information on these circuits or any questions they want answered.

SAN FRANCISCO CHAPTER has been encouraging members to bring their tough-dog television sets to the meetings. Peter Wiwel and Andy Royal are demonstrating the troubleshooting and repair of these tough dogs. The members derive a great deal of help and knowledge from these demonstrations.

The Chapter held its sixth anniversary Celebration at its January 6 meeting. Before the festivities commenced a short business meeting was held and the new officers for 1965 were installed. They are: Isaiah Randolph, chairman; Phil Stearne, vice-chairman; J. Arthur Ragsdale, secretary; Willie Hawkins, assistant secretary; Anderson Royal, treasurer; J. C. Caraway and F. Goodall, finance committee.

After the business meeting the party began with the ladies who were present serving the goodies. A huge platter of delicious chicken sandwiches and a large homemade cake brought by Mrs. Hawkins were much appreciated. Mrs. Royal brought several cakes and

Obviously (note smiles) San Antonio Chapter's holiday party was a successful event.

pies and Mrs. Ragsdale contributed the punch. Isaiah Randolph supplied a generous quantity of hot coffee and other members brought ice cream and cookies. Willie Hawkins with his saxophone and Mrs. Hawkins at the piano supplied the music for dancing and singing which continued until a late hour.

SOUTHEASTERN MASSACHUSETTS CHAPTER'S slate of officers for this year are: Danuel DeJesus, chairman; John Alves, vice-chairman; Ernest Grimes, secretary; and Edward Bednarz, treasurer.

Back in the fold are two formerly active members, Manuel Raposa and Henry Rockon. It goes without saying they're very welcome. The chapter has been pleased to admit a new member, Leonard DeMoranville. Congratulations, Leonard!

SPRINGFIELD CHAPTER has sustained quite a blow. Howard Smith has forsaken his native New England, having retired and moved to Michigan.

Howard was the organizer of the Chapter back in 1954, was for years its chief guiding spirit, and worked very hard for the chapter's welfare. It's a real loss to the membership.

As we go to press, the chapter was busy with plans for its annual party. The members always look forward to this for a thoroughly enjoyable time.

DIRECTORY OF LOCAL CHAPTERS

CHICAGO CHAPTER meets 8:00 P. M., 2nd and 4th Wednesday of each month, 666 Lake Shore Dr., West Entrance, 33rd Floor, Chicago. Chairman: Frank Dominski, 2646 W. Potomac, Chicago, Ill.

DETROIT CHAPTER meets 8:00 P. M., 2nd and 4th Friday of each month. St. Andrews Hall, 431 E. Congress St., Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Mich., VI-14972.

FLINT (SAGINAW VALLEY) CHAPTER meets 8:00 P. M., 2nd Wednesday of each month at Andrew Jobbagy's Shop, G-5507 S. Saginaw Rd., Flint. Chairman: Henry Hubbard, 5497 E. Hill Rd., Grand Blanc, Mich., 694-4535.

HACKENSACK CHAPTER meets 8:00 P. M., last Friday of each month, St. Francis Hall, Cor. Lodi and Holt St., Hackensack, N. J. Chairman: Matthew Rechner, 42 Campbell Ave., Hackensack, N. J.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER meets 7:30 P. M., 2nd Thursday of each month at the YMCA in Hagerstown, Md. Chairman: Francis Lyons, 2239 Beverly Dr., Hagerstown, Md. Reg 9-8280.

LOS ANGELES CHAPTER meets 8:00 P. M., 2nd and last Saturday of each month, 4912 Fountain Ave., L. A. Chairman: Eugene DeCaussin, 4816 Fountain Ave., Apt. 401, L.A.

MINNEAPOLIS-ST PAUL (TWIN CITIES) CHAPTER meets 8:00 P. M., 2nd Thursday of each month, at the homes of its members. Chairman: Edwin Rolf, Grasston, Minn.

NEW ORLEANS CHAPTER meets 8:00 P.M., 2nd Tuesday of each month at Galjour's TV, 809 N. Broad St., New Orleans, La. Chairman: Herman Blackford, 5301 Tchoupitoulas St., New Orleans, La.

NEW YORK CITY CHAPTER meets 8:30 P. M., 1st and 3rd Thursday of each month, St. Marks Community Center, 12 St. Marks Pl., New York City. Chairman: Br. Bernard Frey, 213 Stanton St., New York 2, N. Y.

PHILADELPHIA-CAMDEN CHAPTER meets 8:00 P. M., 2nd and 4th Monday of each month, K of C Hall, Tulip and Tyson Sts., Philadelphia. Chairman: John Pirrung, 2923 Longshore Ave., Philadelphia, Pa.

PITTSBURGH CHAPTER meets 8:00 P. M., 1st Thursday of each month, 436 Forbes Ave., Pittsburgh. Chairman: James L. Wheeler, 1436 Riverview Dr., Verona, Pa. 793-1298.

SAN ANTONIO ALAMO CHAPTER meets 7:30 P. M., 4th Friday of each month, Beethoven Home, 422 Pereida, San Antonio. Chairman. Sam Stinebaugh, 318 Early Trail, San Antonio, Texas.

SAN FRANCISCO CHAPTER meets 8:00 P.M., 1st Wednesday of each month, 147 Albion St., San Francisco. Chairman: Isaiah Randolph, 523 Ivy St., San Francisco, Calif.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8:00 P. M., last Wednesday of each month. Chairman: Daniel DeJesus, 125 Bluefield St., New Bedford, Mass.

SPRINGFIELD (MASS.) CHAPTER meets 7:00 P. M., last Saturday of each month as shop of Norman Charest, 74 Redfern St., Springfield, Mass. Chairman: Steven Chomyn, Powder Mill Rd., Southwich, Mass.

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