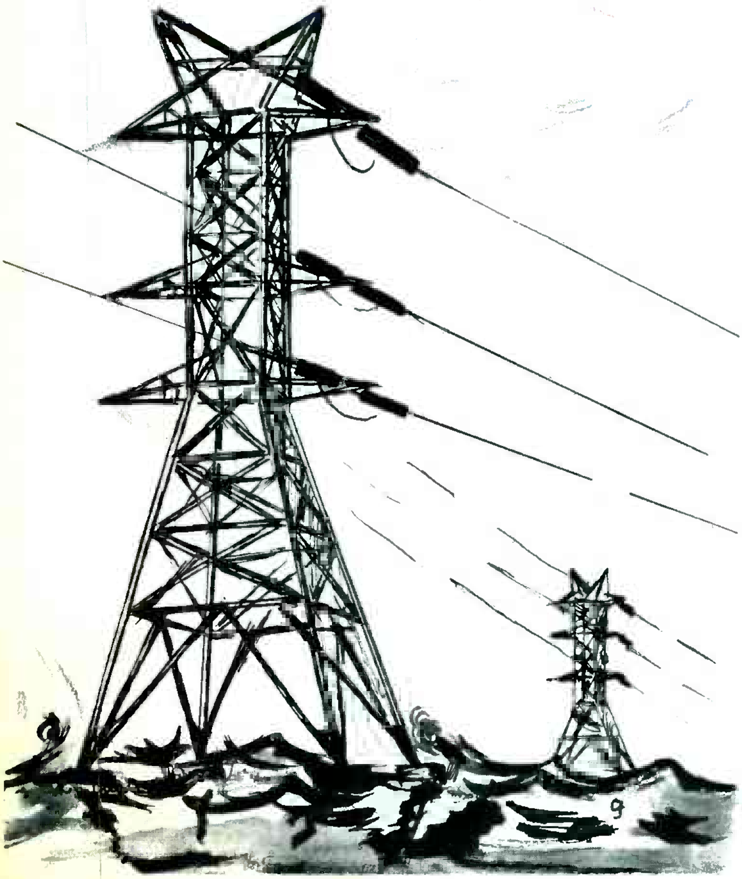
nri journal



IN THIS ISSUE:

What Happened To Cause The Great Power Failure?

Color TV Servicing: Replacing The Tired Picture Tube

Current Flow In Semiconductors

Communications

May-June 1966

35 Cents

Free Probe Set

CONAR

DIVISION OF NATIONAL RADIO INSTITUTE

SPECIAL SPRING OFFER!

BIG BONUS

We're not in the habit of giving away merchandise with purchases of quality NRI designed Conar equipment, but we're breaking precedent this summer! But order now . . . offer ends midnight, June 30, 1966.

ORDER THIS

5" WIDE BAND OSCILLOSCOPE

Advanced design, newest circuitry, exclusive features—a truly professional scope for lab or service shop use at a price far below its true value. Ideally suited for color and monochrome TV, AM-FM and transistor radios, hi-fi and stereo amplifiers plus industrial electronics applications. Even an inexperienced kit builder can assemble it in a few evenings using step-by-step instructions and picture diagrams. Comprehensive operating instructions included.

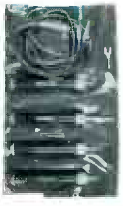
CHECK THESE MODEL 250 FEATURES:

- High sensitivity of .023 (RMS) volts per inch, but not noisy;
- Read peak-to-peak voltages directly without calculations;
- Uses 2400 volts on cathode ray tube—50% more than most scopes. Trace is clear, distinct, bright without darkening room;
- Wide band response with no wave-distorting transients. Actually shows 3.58 color burst;
- Excellent linearity at low frequencies without limiting production of high frequency sweep signals;
- Two-stage retrace blanking amplifier gives 100% retrace blanking at all frequencies produced by scope sweep generator;
- Uses phase splitter tubes in horizontal and vertical amplifiers for push-pull balanced outputs;
- Eliminates need for separate flyback tester costing $40 to $70;
- Sweep range is 10 cps to 500 kc—five times range of most other scopes, using special linearity circuit.

KIT ONLY #250UK **$89.50** Assembled (#250WT): **$139.50**

Low as $8.95 down, $10 monthly (23-lbs; shipped exp. coll.)

GET THIS $16.95 PROBE SET FREE



Place your order for the Model 250 Scope (cash or terms) before Sep. 1st and receive this heavy-duty Probe Set as Conar's gift to you. Includes high impedance, low capacity, crystal demodulator and resistive isolating shielded direct probes plus sturdy roll-up carrying case. Ready to use. Designed specifically for use with the Model 250 Scope. You save $16.95!

UNCONDITIONAL 30-DAY MONEY-BACK GUARANTEE. YOU MUST BE COMPLETELY SATISFIED! ONE YEAR GUARANTEE ON ALL PARTS.

USE HANDY ORDER FORM ON PAGE 27—CASH OR TERMS

NRI journal

MAY/JUNE 1966

VOL. 23, NO. 3

Published every other month by the National Radio Institute, 3939 Wisconsin Ave. N.W., Washington, D.C. 20016. Subscription $2.00 a year. Printed in U.S.A. Second-class postage paid at Washington, D.C.

CONTENTS

SINCLAIR PIPELINE COMPANY
Box 521, Tulsa, Okla.

Will have temporary jobs this summer for students attending trade, technical or vocational schools. These jobs will appeal to NRI students in high school or college who are seeking work during summer vacation. The technical aspects of modern pipelining makes training in electronics especially valuable and may enable some temporary employees to qualify for work at higher rates. The starting salary is $2.67 per hour.

COVER STORY

The answer to the old saw, "Where was Moses when the light went out?" became literally true last November for millions of people stranded in subways and skyscrapers by the Great Northeast Power Failure.

Months later, many are still in the dark as to what happened and why it happened, although reams of material has been written about it---but much of it inaccurate or incomplete.

William F. Dunn's article, "The Great Power Failure", beginning on Page 2, answers in detail the questions still lingering, from his background as an electronics engineer and a native of the Canadian area involved.

On our cover is an artist's conception of a typical power-transmitting station.

CHAPTER MEMBERS INVITED

ATTENTION: NRI Students and Graduates! Is there a local chapter near you (see Directory, page 29)? Have you been to one of its meetings? Read "Alumni News", page 31, to see how valuable and helpful these meetings can be to you. You don't have to be a graduate to join. STUDENTS are just as welcome and eligible to join. We urge you to attend these meetings.

THE GREAT POWER FAILURE

BY WILLIAM F. DUNN

SHORTLY AFTER 5 P.M. on November 9, 1965, the Great Northeast Power Failure occurred. There had been other power failures in this country and in Canada, but never before had one occurred that affected so many people. Power was lost in almost the entire state of New York; in Vermont, Massachusetts, Connecticut, Rhode Island and in a large part of Central Ontario. In New York City alone, millions of people were stranded in subways, in skyscrapers and in office buildings. Industry and transportation came to a halt in a large section of northeastern United States and in Central Ontario.

It is ironical that the various steps that had been taken to provide low cost, reliable power to this large section of the United States and Canada were the chief causes of the failure.

There has been a great deal written about the power failure in the various newspapers; some of the articles were incomplete and others inaccurate. This is a brief story of what happened, and why it happened.

To understand what happened to cause the massive power failure, let's first consider how electricity is produced by power companies and then how and why the various power company systems are all connected together.

HOW ELECTRICITY IS PRODUCED

The electricity furnished by the power companies in the area affected is produced by hydro-electric power, generated by large power facilities on the Niagara River and the St. Lawrence River, and by steam-generating plants scattered throughout the various states affected and in Ontario. In the hydro-electric plants, water power is used to turn giant turbines which turn the generators that produce the electricity. In the steam-generating plants, coal is burned to heat water to steam in giant boilers. The steam is then used to turn high-speed turbines which are connected to the generators that produce the electricity.

In the region affected there are four large hydro-electric generating stations plus a large number of steam generating stations.

Now, if each of these generating stations had been connected only to a load in its immediate area and a defect developed in one of the generating stations, it would have affected only its particular area. However, for reasons that we will see later, these stations are all tied together so they can transmit power back and forth from one station to another. Now, let us see how and why we can do this.

GENERATORS IN PARALLEL

If a dc generator capable of generating a voltage of 250 volts is connected across a load, a current will flow through the load and through the generator armature. The current flowing in the generator armature produces a voltage drop inside the generator itself so that the actual voltage supplied to the load will be something less than the 250 volts that the generator generates. As an example, the current flowing through the armature might produce a voltage drop of 10 volts so that the voltage supplied to the load is only 240 volts. A single generator connected to a load is shown in Fig. 1A.

If the load is too large for the generator to supply, a second dc generator can be connected in parallel with the first as shown in Fig. 1B. The procedure is to first get the generator set up so that the two generators will be connected to the load with the same polarity. Then the second generator to be connected to the load is adjusted so that its output voltage is the same as the load voltage. This can be done by reducing the strength of the field, so that although the second generator also is able to generate 250 volts, the actual generated voltage will drop to 240 volts. Then the second generator is connected across the load, the field strength increased to normal so it will pick up its share of the load, and in a case where the generators are identical, each will share half the load.

The procedure for connecting a second or third dc generator across a load is comparatively simple because all you have to do is make sure that the generator to be connected is polarized correctly and that its voltage is approximately equal to the load voltage.

AC generators can also be connected in parallel, however, so here we have an additional problem. Not only must the generators be generating the same voltage, but they must be generating the same frequency of alternating current, and the generators must be in phase.

In Fig. 2, we have shown an example of the problem encountered. Here the ac produced by generator 1 is 60 cycle ac. Generator 2 must also be operating at 60 cycles and the waveform produced by the second generator must be exactly in phase with the waveform produced by the first generator. The actual procedure used to get these two generators in phase is to run the second generator at a slightly too low or slightly too high a frequency. This will cause its waveform to slowly drift until the two waveforms are exactly in step. Then the second generator is quickly connected across the line, after which the two will automatically lock in step or in phase.

The example shown in Fig. 2 is a simplification of the problems involved in connecting a large number of generating stations to-

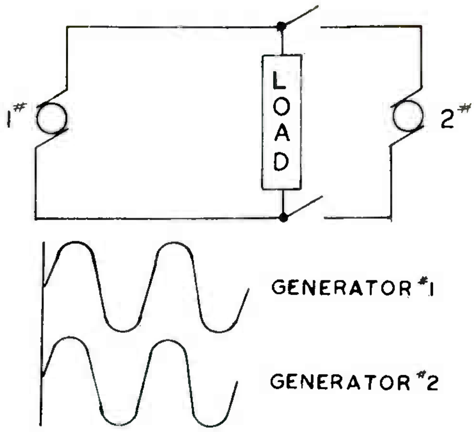


Fig. 2. Sine waves produced by generator 1 and 2 must have the same amplitude, frequencies, and phase, as shown here, before generator # 2 can be connected in parallel across the load.

gether. Actually, the voltage generated by the generators is stepped up by means of a step-up transformer to a very high value. Then the various power stations are connected together by a high-voltage transmission line.

HIGH VOLTAGE TRANSMISSION LINES

The reason for high-voltage transmission lines between the different generating stations is that power can be transmitted at high voltages much more economically than it can at low voltages. Consider the fact that any wire used to connect a generator to a load has resistance and a certain amount of the power transmitted from the generator to the load will be lost due to the resistance of the wire. The power loss will be equal to I^2R. To transmit a given amount of power, the higher the voltage is the lower the current will be. For example, if we are transmitting 1,000 watts and the voltage is 1000 volts the current would be 1 amp. If we increase the voltage to 2000 volts, the current will be only 1/2 an amp.

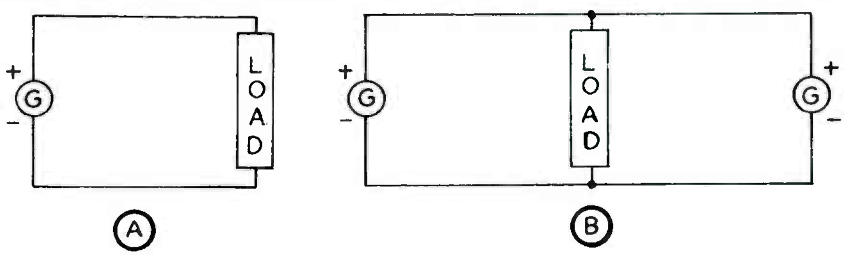


Fig. 1. If a single dc generator cannot supply the load requirements, a second generator can be connected in parallel as shown in B.

This reduces the loss in the line by a factor of 4 - in other words doubling the voltage of the transmission line increases the line capacity by a factor of 4. Therefore, to keep losses between generating stations at a minimum, very high voltages are used in transmitting power from one station to another. Voltages of 230,000 volts and 345,000 volts are used in connecting the various stations together.

ECONOMY IN INTERCONNECTIONS

Later we'll see exactly how the various power utilities that were affected by the blackout are interconnected, but now let's see WHY they are interconnected.

One important reason for the interconnection between the various power generating stations is economy. Electric power in this country and in Canada is one of the greatest bargains we have. It is a bargain because of the ingenuity of power company engineers and the willingness of the companies themselves to invest in modern equipment.

Let us consider two cities separated by some distance, and each having a peak power load of 450,000 kilowatts. We'll call one City A and the other City B. In each city, the power is supplied by five 100,000 kilowatt generators as shown in Fig. 3.

No power company has so much money that it can throw away all its old generators and buy new ones whenever a new generator is announced by generator manufacturers. Power companies are continually adding to their generating capacity, but in the meantime in addition to new generators they must also rely on the services of older generators. New and more modern generators are more efficient than old generators. As a result, the power company will try to use the generator that operates at the best efficiency as much as it can, and the ones that operate with the poorer efficiency as little as possible. The more efficient a generator is, the more economically it can generate electricity.

We mentioned in our example that both cities had a peak load of 450,000 kilowatts. The peak load is the maximum load that the power company must supply to its subscribers. However, the peak load only occurs for a small part of the day. During much of the day, the power consumed by the city is far below the peak load.

Now if in our example City A has a power company with three brand new generators that operate at a very high efficiency, whereas City B has only two new generators, there may be instances where it is more economical for the power company in City B to buy power from the power company in City A than it is to generate its own power. Suppose, for example, each city during some part of the day had a load of 250,000 kilowatts. This load could be supplied by operating the three new high-efficiency generators in City A to supply the 250,000 kilowatt load in that city and the two high-efficient generators in City B plus the extra 50,000 kilowatts from City A to supply the 250,000 kilowatt load in City B. (See Fig. 4.) The two systems might operate like this for some time, with the power station in City A supplying a part of the load for City B.

Later in the day, the load might increase to

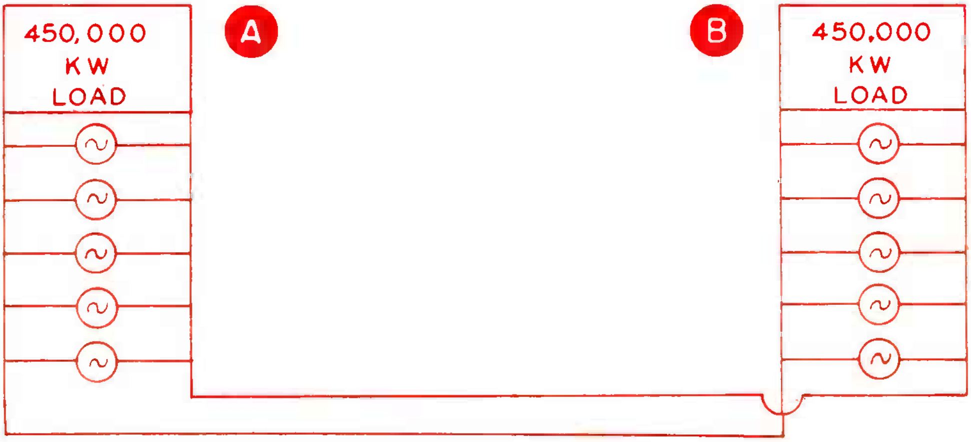


Fig. 3. During peak load period, all five 100,000 kw generators in each city are in operation.

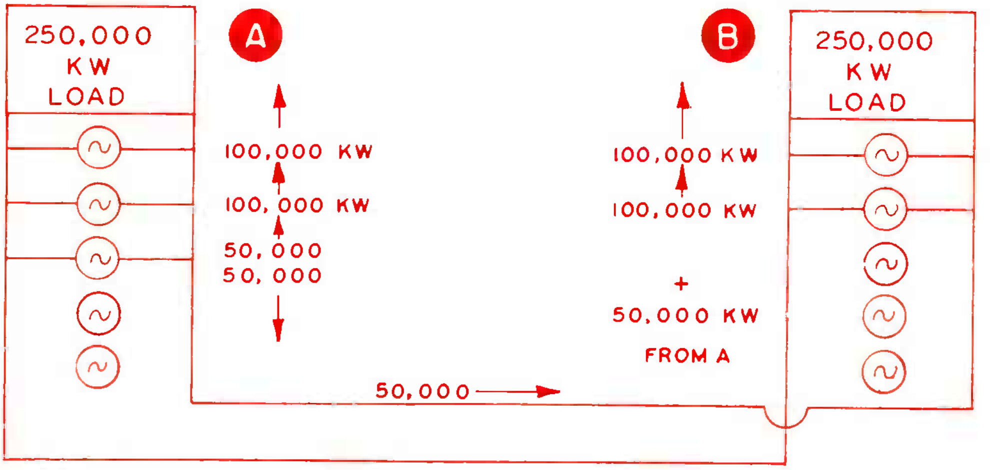


Fig. 4. During period when load in each city is 250,000 kw, three generators at A supply 250,000 kw for city A and send 50,000 kw to city B.

350,000 kilowatts in each city as shown in Fig. 5. This means that an additional 200,000 kilowatts will be required. Now it is conceivable that generators number 3 and 4 in City B are newer and more efficient than generators 4 and 5 in the power station in City A. Under these circumstances, generators 3 and 4 in power station B would pick up the additional load; they would join the two generators already operating in City B to supply the 300,000 kilowatts required and start transmitting the extra 50,000 kilowatts from power station B back to power station A. Thus, during one part of the day when it is more economical for generating station A to produce most of the power, this station operates at a higher capacity than generating station B, but later in the day generating station B can produce the needed power more economically and so it sends power back to generator A.

This is what happens in the power stations affected by the Northeast blackout: Computers are continually in operation figuring where the power can be generated most economically. The generators that can produce the power most economically are put into use and then the power is transmitted over high-voltage transmission lines back and forth between the various power companies in the power network. This system of transmitting power back and forth between power stations is one

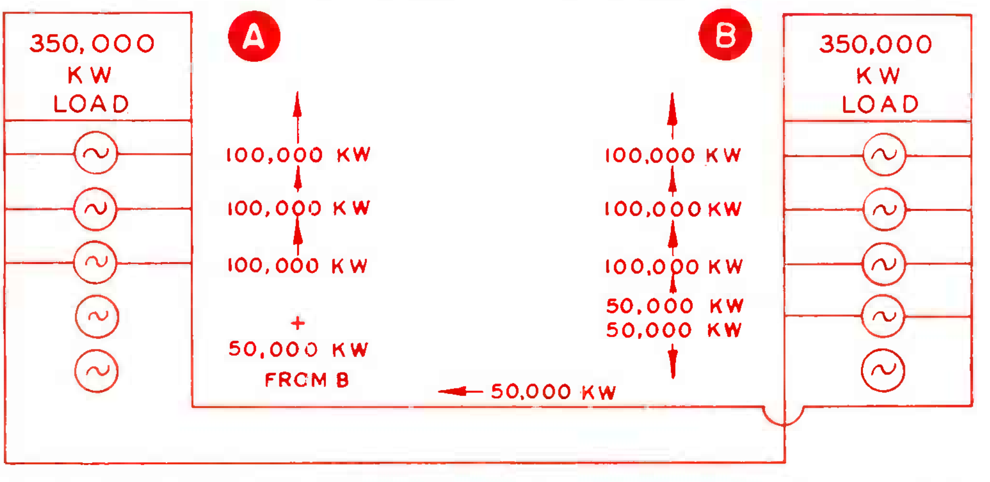


Fig. 5. During period when load in each city is 350,000 kw, B is sending power to A.

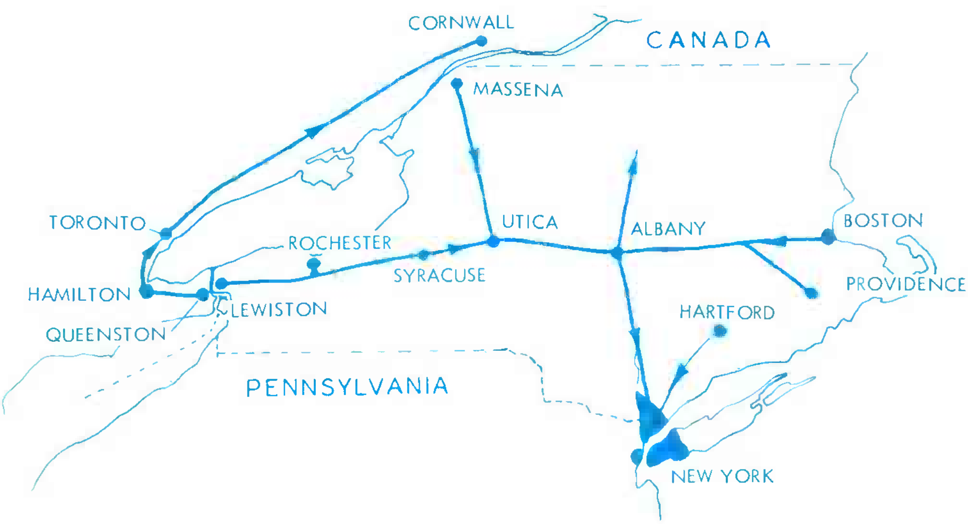


Fig. 6. Simplified diagram of Canuse showing direction of power flow just before the blackout. Opening of lines between Syracuse and Rochester and lines between Massena and Utica caused New York City and New England blackout.

of the major reasons why electric power is as economical as it is today, and also why the privately-owned utilities have the funds available to invest in modern equipment and are capable of keeping ahead of the ever-increasing demand for electric power.

RELIABILITY

Another reason for connecting stations together is reliability. In the example we gave before of power stations A and B, each station had a peak load of 450,000 kilowatts, and a generating capacity of 500,000 kilowatts. Notice that the generating capacity is slightly larger than the peak load. Now, if the stations are not connected together, and one of the generators in station A should fail, then the four remaining generators can generate only 400,000 kilowatts. This means that during the peak load period the station is 50,000 kilowatts short of the needed capacity. This would simply mean that some of its customers would have to do without electric power. However, with stations A and B connected together, the surplus 50,000 kilowatts at station B can be sent over the high-voltage transmission lines during the peak power period to supply the needed 50,000 kilowatts while the generator at station A is being repaired. Of course, if both generating stations had a generator failure at the same time, this would prevent one station from helping the other, but the chances of both stations having a failure at the same time are far less remote than the chances of either one of the stations having a failure. Thus connecting the power stations together provides for increased reliability.

Power failures in isolated areas due to downed power lines or temporary failures in isolated sections of a power system are rare enough, but failures due to a breakdown in the generating station are almost unheard of because of the reliability provided by the interconnected systems.

THE CANUSE NETWORK

Fig. 6 is a simplified drawing of the Canada-United States Eastern Interconnection, called Canuse, that was in operation on the evening of November 9th when the power failure occurred. We'll leave out many of the details about how power was being transmitted back and forth and concentrate only on the important details of what was happening at the time.

Just before the power failure occurred, the Ontario Hydro Electric Power System at Queenston on the Niagara River was generating 6100 megowatts and supplying a load of 6400 megowatts. It was receiving 300 megowatts from the Robert E. Moses power station across the Niagara River at Lewistown, New York. Meanwhile, the Moses station was also feeding power down the transmission lines towards Central New York State.

The power being generated by the Ontario Hydro Electric plant at Queenston and the power received by it from the Moses plant at Lewiston were being transmitted over high-voltage transmission lines to Toronto and Hamilton, as well as a number of other cities in the western part of southern Ontario.

Shortly after 5:15 p. m., a backup relay protecting a high-voltage transmission line traveling from Queenston to Toronto opened a circuit breaker, disconnecting the power plant at Queenston from the transmission line to Toronto. This placed an overload on the remaining transmission lines between Queenston and Toronto, and protective relays disconnected these lines from the generators. This meant that there was suddenly a surplus of approximately 6400 megawatts at the Queenston power station. Now, instead of power flowing from the Moses power plant at Lewiston over to the Queenston plant, suddenly a large amount of power began flowing in the opposite direction. Furthermore, when the Queenston station lost its load, the generators began to turn faster than normal, which resulted in the power generated by these generators being increased in frequency above 60 cycles so it was out of phase with most of the other systems connected to the interconnected transmission line.

After the one line at the Queenston plant opened, the other lines between Queenston and Toronto also opened. Now, power began to flow across the St. Lawrence River from Massena, New York to Cornwall, Ontario and down the line in a westward direction towards Toronto. This immediately overloaded the line, and the safety relays opened, cutting the entire Ontario system away from the New York system except where the power plant at Queenston remained connected to the power plant at Lewiston.

Since the output from the Queenston plant and the Moses plant on the Niagara River could not be handled by the remaining transmission system, the protective devices cut the two systems from the high-voltage transmission line. This opened the circuit between these two generating facilities and the New York City area and New England area between Rochester and Syracuse. This placed an overload on the generating facilities in the New England States and in Southeastern New York State. The massive interconnected system actually broke into four separate regions, the part in Ontario; the part around Massena, New York; the third part encompassing western New York State around the Niagara Falls region, and the fourth part which encompassed the New England States and southeastern New York State, including New York City.

SECTION 4

The power failure in section 4 was the most serious because it lasted for the longest time and affected the most people. In less than 5 seconds following the initial disturbance at the Queenston Heights Ontario plant, the huge Canuse system had split into four parts. The New England area, however, was still tied to the New York City area. At the instant that the power separation occured, the load in this area was 1100 megowatts greater than the power being generated. This means that once the system was separated from the generator on the Niagara River, there was an instantaneous shortage in generation of 1100 megowatts. The generators in these systems were unable to respond quickly enough to the tremendous increase in demand. As a result generators in the New York City area began to slow down; in other words, their frequency went down and their voltage went down. One by one safety devices tripped these generators out, until finally in a matter of seconds from the initial disturbance the entire system had broken up into four separate sections. Then generators in each individual section began to trip out, until soon the entire area was in blackness.

RESTORING POWER

When a generator stops there are many problems associated with getting it back into operation. First, a generator is an extremely large piece of machinery, not something that you can turn on and have running at its normal speed in a matter of seconds. Because of its tremendous size and weight it takes some time to get the generator up to speed.

In addition, since a generator is such a large device, it is also an expensive device. A generator rotating at a high rate of speed must be well lubricated to prevent the armature shaft from developing excessive heat in its bearings. The bearings of the generator are lubricated by oil pumps, which in turn are operated by electric motors. The electric motors in turn depend upon their power from the generators. With the generator stopped as in this case, there was no power to operate the electric motors and hence no oil to lubricate the generators. It was a vicious cycle; they could not start the generators because there was no oil to lubricate the bearings. The motors that operated the pumps which would lubricate the bearings couldn't be run, because there was no electricity from the generators to operate them! However, by patching circuits here and there the power company engineers were able to get small amounts of power into the power stations which could be used to operate the electric motors to pump oil into generator bearings. Then the generators were started and brought up to speed and a part of the load was picked up. This process was repeated over and over again as the various generators were started and brought into synchronization with other generators, and then connected across the various loads.

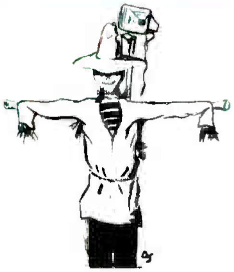
CAN IT HAPPEN AGAIN?

The question most frequently asked after the massive Northeast power failure is can it happen again? The answer is a simple YES. The same conditions exist today as existed at the time of the blackout. Various political leaders have made statements as to how and what should be done to prevent this happening again, but the hard cold fact of the matter is that the cost of maintaining equipment and facilities that would prevent a power failure of this type far outweigh the very remote possibility of a recurrence of such a failure. Even if we are willing to spend the money in increased taxes and increased utility rates to prevent such a failure, we must always remember that men still make mistakes; none of us are infallible. Any power system that we may build, no matter how fail-safe we may make it, will never be completely man-safe; and although the chances are remote, we could have another great power failure.

35 Years Ago

as recorded in National Radio News

Finding that a scarecrow was of little avail in keeping predatory birds from his orchard, an Englishman conceived the idea of connecting a loudspeaker on the back of a scarecrow to his radio set and the birds soon deserted his orchard.



Recently the Weather Bureau converted a motor truck into a weather bureau on wheels for use in its fire-weather-warning service in California. Equipped with radio and meterological instruments, this truck responds to every important forest fire call in the state.

Foreign countries are showing the way to the United States in adopting radios for the entertainment of omnibus passengers. A Czechoslovakian concern is equipping all its buses with radios.

Cigar factories, especially those manufacturing hand-made cigars, long ago employed readers to keep the minds of the workers off the dull routine of their work. They are now fast turning to radio.

"I just ran across an inexpensive way to give my customers music in every room, where the house is equipped with a 'warm air' heating system. Place an extra speaker close to the 'warm air' register in the basement and your customer gets music and warm air from the same source. Be sure the register plate is firmly attached to the wall, otherwise vibrations may result", wrote T. S. Norton, Hamilton, Ohio.

Regular commercial telephone service is now available between North America and Australia, over the longest circuit ever established for commercial use. The cost of a call between New York and any point in Australia is $45 for the first three minutes and $15 for each additional minute.

Reliable statistics point to the fact that the broadcasting stations in the United States utilize fifty three percent of their time on the air to music. Thirty four percent of this amount is devoted to "jazz".

During the year 1930 the Columbia Broadcasting System grew from a chain of thirty eight to a network of seventy six, the largest single broadcasting network in the world. The system showed an increase of fifty two percent in volume of commercial programs over 1929 and a record volume of business for the first quarter of 1931. Gross sales for the last year increased fifty eight percent over 1929.

Where Color TV Servicing Begins: Replacing The Tired Picture Tube

by ***ART WIDMANN***

NOTHING WILL DO so much to bring new life to an old color receiver as replacing a tired old picture tube. This is welcome work for the service technician who is prepared to do the job well. True, there is more to replacing a Color CRT than replacing a black and white tube, but the rewards are greater. Perhaps you have avoided color picture tube replacements because of the added complexity. No need to. Plan the job carefully and you will find the physical replacement time takes only a little longer than for black and white. Of course after the installation, a complete color setup on the receiver is required. Be sure to allow for your color setup time when you price a color CRT replacement job! In this article only the physical installation will be covered without reference to the color setup details.

When you replace your first few color tubes you will want to have the service literature for each receiver. You will need to refer to the manufacturer's instructions for the color setup anyhow. But they are also helpful in identifying the exact manner in which the tube is secured in the cabinet. When you install the new tubes and attach the components to the tube, you may find you need the pictorial diagrams in the service literature to determine the correct position for some of the parts. The service literature on a color receiver can almost always save you time on the job. You need to be very familiar with a set before you can run through the adjustments quickly without at least referring to the sequence of the convergence steps.

The color tube replacement steps in this article apply, in general, to replacing any color tube. The illustrations are mostly of a 21" round color tube. We concentrate on the 21" round color tube for several reasons. In the first place more color sets have been sold with 21" round tubes than all other tube sizes combined. Although the past year has brought rectangular tubes in 12", 16", 19", 21", 23" and 25" sizes, only a few of each size have been sold compared to the millions of sets in the past years that were equipped with 21" round tubes. And even now the 21" round tube remains the industry standard, accounting for over half of the total production. Since it is the older sets that are more likely to need new CRT's, most of your color tube replacement jobs will be the 21" round type for quite a while.

Fig. 1 shows the rear view of a typical color receiver with a 21" round color picture tube. This happens to be an RCA CTC11 vertical chassis in the economy metal cabinet. Many other brand receivers closely parallel this construction. The chassis must be removed before you can remove the picture tube. Many sets have a separate tuner cluster secured to the front of the cabinet that must also be removed.

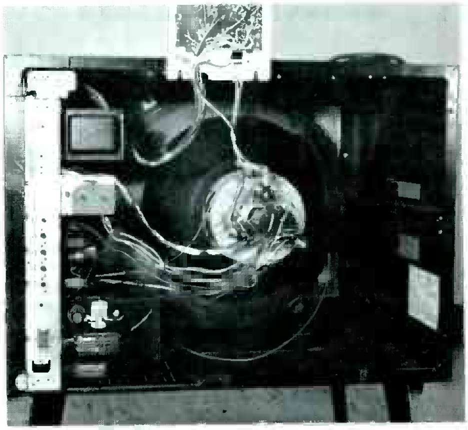


Fig. 1. A typical color receiver with a 21" round color tube.

The first step in replacing a color tube is to get the new tube. It is better to bring the new tube with you if you are doing the job in the customer's home. Then you don't have to leave his set disassembled while you go for the new tube. If you are working in the shop you may prefer to take the old tube with you when you go to the distributor. In either case, be sure to get an exact replacement. You will find the tube number stamped on the tube, on a paper label attached to the tube, or on the tube layout chart. If in doubt, take the old tube with you when you buy the replacement. Or the distributor can usually cross-reference the tube needed for a particular model.

Tubes that are electrically interchangeable but have mechanical differences will almost always prove difficult or impossible to install properly. Where a tube type has been discontinued, the manufacturer may provide an adapter kit with the necessary hardware for fitting the new tube type into certain model receivers. Information on these kits is available at the distributor's.

Plan your installation job carefully. If you are working in the customer's home, be sure to provide a drop cloth for the chassis. You need a sizable work area to make the tube exchange. The cabinet takes up quite a bit of floor space when it is laid face down. Besides room for your tools and the chassis, you need space to set the new tube, the new tube carton and the old tube while you make the exchange. You need a protective pad, such as a rolled-up blanket, on which to lay the cabinet. And you need soft protective surfaces to set the picture tubes on.

REMOVE THE CHASSIS

Unplug the receiver from the wall plug; disconnect the antenna connections; and remove the back cover. On most receivers the components on the neck of the tube are connected to the chassis with wires that terminate in plugs at the chassis. On the receiver in Fig. 1, you unplug the convergence board cable at the top of the chassis. Unplug the picture tube socket at the base of the picture tube. Disconnect the speaker leads at the speaker. In this receiver the deflection yoke is connected to the chassis by five wires terminated in connectors that plug into mating connectors on the yoke. The wires are color coded and the yoke terminals are identified. Even so, you should note where the blue wires are connected at the yoke terminals. Alternate connections are provided to produce a step change in picture width. You will want to replace these leads on the same terminals to get the same picture width because changing the picture tube will not cause a change in the picture width.

Discharge the picture tube before you disconnect the high voltage lead! Most color tubes will store a dangerously high charge even if the set has been turned off for days. Fig. 2 shows an acceptable method of discharging the tube. Connect one end of a clip lead to the metal shank of a well-insulated screwdriver. Connect the other end of the clip lead to the chassis. Slip the blade of the screwdriver under the rubber cup at the high voltage anode and touch the metal connection.

Remove the high voltage lead immediately after discharging the tube. A charge will build up again after the tube sets a while. Never touch the high voltage anode connection on a picture tube unless it is shorted. You will almost always get at least an unpleasant shock.

Remove the knobs from the front of the cabinet by pulling the knobs straight out. On this receiver, four small knobs are located along the lower edge of the control panel. On some receivers a portion of the front decorative panel must be removed before some of the control knobs can be taken off.

Loosen the two 1/4" screws that secure the control bracket at the lower front of the control panel. Lift the bracket clear of the securing screws. The controls on this bracket are connected by leads to the chassis so the bracket and controls come out with the chassis.

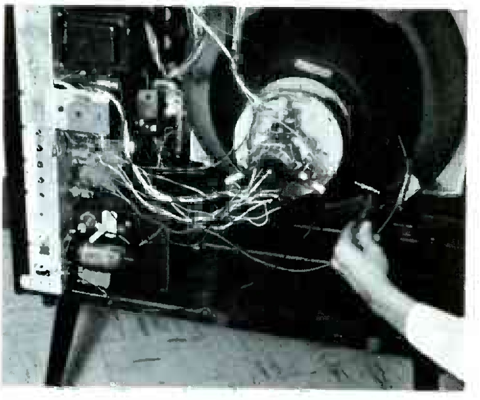


Fig. 2. Discharge the picture tube before removing the high voltage connector.

Unbolt the securing screws that hold the chassis to the cabinet. On the model in Fig. 1, two five-eighths inch bolts secure the top of the chassis to brackets on the side of the cabinet and two bolts extend up through the bottom of the cabinet. Slide the chassis to the rear until it clears the cabinet and set it in a safe place.

Remove the attachments from the neck of the picture tube. Slide off the blue lateral magnet. Leave it connected to the convergence board by its grounding wire. Slide off the purity adjustment magnet assembly. Unbolt the convergence board from its secured position and lay it temporarily in the cabinet. Slide the convergence assembly off the neck of the tube. Sometimes the assembly is held in place with rubber cement. Loosen the cement by rotating the assembly so it will slide freely. Remove the convergence board and the convergence assembly from the cabinet. Loosen the deflection yoke clamp screw and slide the yoke clear of the tube.

Fig. 3. In this receiver, the picture tube is held in the cabinet by the shield which is secured by four nuts.

If the receiver has an automatic degaussing coil, it is usually removed at this time. The coil and some form of shield assembly usually fits close to the faceplate of the tube. Various methods are used to hold the assembly in place. Where the picture tube securing brackets hold the coil assembly, you do not remove the coil until you remove the brackets.

POSITION THE CABINET

Lay the cabinet face-down on a soft surface, such as a blanket, to protect the cabinet finish. Cabinets that have protruding surfaces can be supported on a rolled-up rug. This will support the cabinet without putting pressure on the protruding parts of the cabinet.

Position the cabinet where you will have room to work. You must be able to stand close to the cabinet with your feet in a firm position when you lift the picture tube. Provide a soft surface for setting the tube close to the cabinet. You minimize the possibility of dropping the tube or striking it on a hard surface if you do not have to carry it too far. Arrange to set the old tube in a place that will not interfere with installing the new tube. If you are working in a very small cluttered living room, arrange to take the old tube out of the room before you bring in the new tube. On every installation job, plan each step so that you do not get yourself into a cramped working space that could result in a broken tube.

REMOVE THE PICTURE TUBE

Loosen the securing bolts that hold the picture tube to the cabinet. The receiver shown in Fig. 3 has four nuts that secure the picture tube shield to the cabinet. The shield, in turn, holds the picture tube against the front bracket. Remove the four nuts. Lift the shield clear of the picture tube and cabinet.

On some receivers the shield and mounting brackets are secured to the picture tube. In this case you remove the bolts that hold the bracket to the cabinet. The shield and bracket assembly are then lifted out of the cabinet with the picture tube. The shield and bracket assembly, sometimes called the picture tube mounting harness, is transferred to the new picture tube before the tube is installed in the cabinet.

You should wear goggles and gloves while handling the picture tube. If the picture tube implodes while you are handling it, the flying glass can cause painful cuts anywhere on the body. Goggles prevent the possibility of getting the glass in your eyes which could cause permanent damage to your eyesight. Many technicians do not bother to wear goggles. However, the protection they afford is well worth the small discomfort of wearing them.

Place both hands under the face of the picture tube and lift it straight up. Never pick up the tube by the neck. Stand close to the cabinet with your feet spread and your knees bent slightly. The picture tube is quite heavy so you must be careful not to lose your balance. As shown in Fig. 4, it is sometimes necessary

Fig. 4. The picture tube must be tilted slightly so it will clear the cabinet edges of this receiver.

to tilt the tube slightly so it will clear the edges of the cabinet. Set the tube face down on a soft surface.

Put the old tube in the picture tube carton immediately. The carton will provide breakage protection while you are transporting it. If you do not have a carton, cover the tube with a blanket or furniture mover's pad. Never carry an unprotected tube in your car or truck. A sudden stop or a minor accident could cause it to break.

INSTALL THE NEW CRT

If a mounting harness is secured to the old picture tube, transfer it to the new tube. Loosen the clamp bolts on the mounting harness and lift the harness clear of the old tube. Position the harness on the new tube so the guns are properly oriented to the mounting bracket. The molded letter "U" is stamped

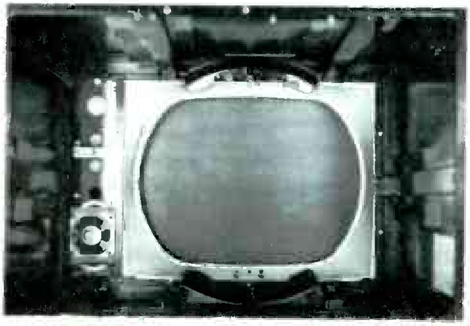


Fig. 5. The picture tube fits against two welded metal brackets in this receiver.

on the glass rim of the picture tube in the position of the blue gun. Align the letter "U" with the hole in the spring strap of the harness. Press the mounting bracket against the edge of the picture tube faceplate and tighten the clamp bolts securely. The mounting brackets can now be used as hand holds to lower the tube into the cabinet.

Fig. 5 shows the interior of the cabinet for a receiver with a separate mounting bracket and shield. The front brackets are welded to the cabinet. The brackets are covered with sponge rubber to separate the faceplate of the CRT from the metal brackets. Orient the picture tube with the letter "U" toward the top of the cabinet and set the tube on the front brackets. Lower the shield assembly over the tube so the cabinet studs protrude through the four holes in the mounting bracket. Attach the nuts and tighten them evenly. Be sure that the tube is centered over the mask opening and that all four nuts are tight.

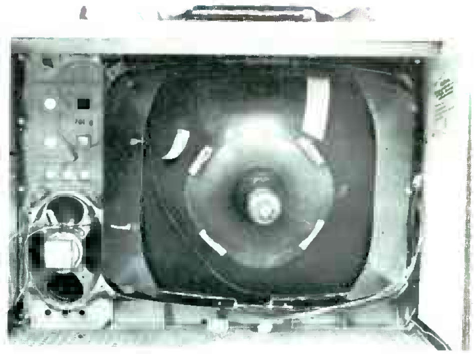


Fig. 6. Rectangular 19" color picture tube showing the shield and automatic degaussing coils.

Set the cabinet upright and observe the front of the picture tube. The tube should be centered in the mask and the mask should fit evenly against the face of the tube.

Many of the new rectangular color tubes have bonded face plates like most black and white tubes. These tubes do not, of course, have a safety glass in front of the tube. The mounting hardware differs from set to set. Fig. 6 shows a typical 19" bonded faceplate color tube with the magnetic shield and automatic degaussing coil. In these receivers the picture tube mounting brackets press the bonded faceplate directly against the mask. The mounting bolts are simply self-tapping screws that screw into the plastic mask. When you tighten the screws, the mask is pulled up against the picture tube faceplate. While these tubes install easily, it is not always obvious which parts come out first. Referring to the service literature on the particular model will save time here.

With the new tube securely in place, you are ready to replace the chassis. For the most part this consists of reversing the steps you followed for chassis removal. Mount the tuner cluster and separate control bracket against the front panel. It is usually good practice to go ahead and attach the control knobs at this time. Then if everything is not exactly right, you will discover it before you get the chassis in place. The receiver shown in Figs. 1 and 2 has the tuner attached to the chassis. However, a separate secondary control bracket attaches to the lower front section of the control panel. Since this bracket is attached by wires to the chassis, it must be secured to the front panel after the chassis is installed. Slide the chassis in place and secure it with just one bolt. Then attach the secondary control bracket. Make sure the connecting leads are not pinched under the chassis. Also locate the speaker leads and connect them to the speaker terminals. When you are sure that the leads are all clear and everything is in place, install the remaining chassis bolts and tighten them.

Next, install the parts in the neck of the picture tube. The yoke comes first, then the convergence assembly, static convergence magnets, and finally the blue lateral magnet. Position these items as nearly as possible in their correct location. Tighten the yoke clamp screw "slip-tight" since the yoke will have to be moved for purity adjustments. Install the convergence board in its service position on the top rail of the cabinet. Now connect the yoke wires to the yoke terminals. Plug the convergence cable into the chassis. Connect the high voltage lead to the picture tube. Carefully install the picture tube socket on the base pins of the picture tube.

Make a quick visual check of the installation before you plug in the set and turn it on. Look for loose tubes and wires or plugs that are not connected. Any tools in the cabinet? It is bad enough to lose a favorite tool but even worse if it shorts out B+ when you turn on the set!

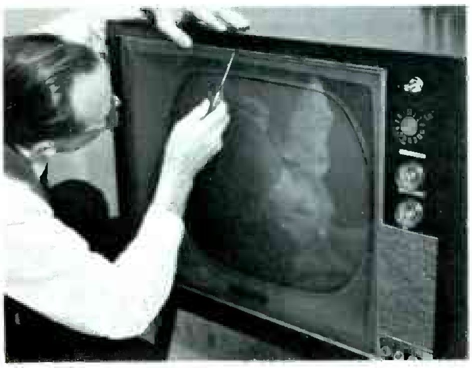


Fig. 7. A removable trim strip secures the safety glass to the cabinet.

CLEAN THE SAFETY GLASS

Always clean the safety glass and mask area when you replace a picture tube. The glass may not look particularly dirty but you will often find a thin dirty film over the entire glass area. This dirt can seriously reduce the light output from the set. The glass is usually secured to the cabinet mask by a piece of metal trim. The receiver in Fig. 7 has a removable trim strip along the upper edge of the safety glass. The screws fit flush into the trim strip and a small Philips screwdriver is needed to remove them. After removing the strip, tilt the glass forward, as shown in Fig. 8, and lift it out of the channel mask that secures the glass along the lower edge.

Fig. 8. The lower edge of the safety glass fits into a channel in the cabinet.

Occasionally the glass will tend to stick to the mask. Be careful about prying it loose with a screwdriver. It is easy to chip the glass. A firm steady pull works best to break the adhesive bond. In stubborn cases, try a plumber's "friend". The large rubber cup on the plunger can be attached to the front of the glass by suction. Wet the front of the glass to produce a firm suction seal between the rubber cup and the glass. Then pull straight out. Keep one hand on the glass to catch it in case the plunger lets loose suddenly.

Use warm soapy water and a soft cloth to loosen the film of dirt. Then rinse the glass surface thoroughly. Dry the surface with a soft lint-free cloth. Cheesecloth works well.

The mask area around the tube may be quite dirty. Try dusting it off with a brush or a soft dry cloth. Avoid washing the mask if possible. You may end up spending a lot of time removing streaks from the plastic surface. Cleaning the mask area adds nothing to the quality of the picture produced by the receiver. If it is free of loose dirt, streaks, and splotches, the customer will be happy. Be sure to carefully check the surface of the picture tube. Bits of dirt or finger marks here are annoying even if they cannot be seen at the normal viewing distance.

Replace the safety glass and secure it in place. As a final step wipe off the outside of the safety glass with a damp cloth. While this surface is normally kept clean by the customer, it leaves a good impression to clean it whenever you return a set to the customer.

FINAL ADJUSTMENT AND TEST

Operate the receiver with the back cover removed. Watch carefully as the voltages come up to their operating values. If you have pinched a wire causing a short circuit, you can quickly unplug the set before serious damage occurs. Let the set heat up to the normal operating temperature while you make preliminary adjustments. A replacement picture tube will sometimes arc momentarily in the gun structure when it is first turned on. This does not necessarily indicate that the tube is defective. Small bits of material may lodge in the gun structure during shipment. Once they burn out, the tube will operate normally.

When you install a new color tube, the set will usually produce a nearly acceptable picture without adjustments. You can expect the focus, brightness, screen controls, and video drive controls to be way out of adjustment. Run through the color setup adjustments quickly while the set is warming up. Make only approximate adjustments. As you know many of the color adjustments interact. By taking care of the large adjustments in this preliminary setup you will minimize the interaction that will occur when you make the final color setup adjustments.

On some replacement tubes, you may find it impossible to make the color temperature adjustment. The picture may have a magenta appearance caused by too much red light. Most receivers are arranged so the red gun cathode gets the maximum video drive. This is done because the red phosphor is least efficient and so requires more drive to produce equal light output. With some replacement tubes, rotating the green and blue drive controls to maximum may not produce enough green and blue color to equalize the red. In this case, interchange the cathode lead from the red gun with the cathode lead from the green gun. The drive control marked "green drive" will then control the video drive to the red gun. You will then be able to equalize the light output from the three colors and produce a neutral gray screen.

Two or three installation jobs on color tubes will make the job routine. The heavier bulky color tube requires a little extra care compared to working with black and white tubes. The other difference is the number of adjustments required after the tube is mechanically in place. Remember that the customer judges the quality of the job by how his favorite program shows up. So do a good job on the color setup adjustment and the customer will recommend your work.

'HUE' IS THE CRY FOR TV STATIONS

New York----The color TV revolution is having its effects on public relations and free films.

Nine out of 10 television stations with color equipment show free, sponsored films in color, according to a survey just completed by Association Films, national distributor.

The survey also showed:

* Eighty-nine percent of the program directors would consider re-running free films originally televised in black and white.

* Color prints are preferred even for black and white telecasts.

* Travel and sports films are heavy color program favorites.

* Sixty-four percent of the programmers would be interested in televising a good color series for color's sake alone.

Forty-seven percent of the stations responding to the questionnaire answered that they are now equipped to originate local color programs both live and on film. Sixty-three percent of this programming is film.

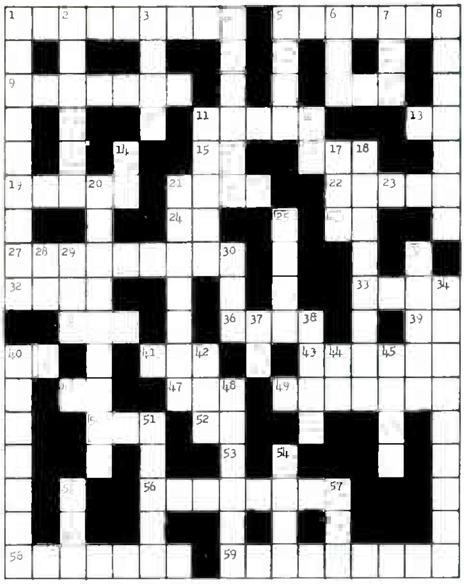
During the week, Monday through Friday, 26 percent of the free-film color programs are shown before 9 a.m. Fourteen percent are televised between the hours of 3 p.m. and 10 p.m. On weekends, 50 percent of the films are shown between noon and 8 p.m. Noon to 3 p.m. is the heaviest period of color film telecasts: 54 percent.

Only 21 percent of the stations that televise free films in black and white prefer black and white prints, the survey also showed. Thirty-one percent prefer color prints, and 40 percent will accept either for televising.

The average number of free films televised in color each week is three for the 124 color-equipped stations who answered the survey. The combined total average, black and white and color transmission is five films.

Ninety-five percent of the color stations are now programming free, sponsored motion pictures in color. Half-hour films are preferred to quarter-hour and other lengths. Replies were received from 266 commercial and ETV stations.

ELECTRONICS CROSSWORD PUZZLE



By James R. Kimsey

ACROSS

1. An amplifier that maintains flat response over a wide range of frequencies.
5. A current, voltage, or radio wave at the assigned frequency of a radio station.
9. Prolonged luminous spots on a TV screen.
10. Electron . . . Device to focus electrons.
11. Circuits which amplify primary colors.
13. One thousand cycles. (abbr)
15. Us.
16. A resistance network used in coupling two impedances.
19. A fixed relation in degree between two similar things.
21. Low audio frequencies.
22. General term for receivers.
24. Type of heat rays. (abbr)
26. Chemical symbol for hard metallic element.
27. Threaded rod that guides a disc cutter.
32. Type of antenna.
33. Proof of authenticity.
35. Used in reference to power ratings.
36. Bridge circuit to measure electrical loss.
39. To perform.
40. Symbol for amplification factor.
41. The standard method of rating single sideband transmitters.
43. Worshipped.
46. Widely used crystal cut in radio frequency transmitters from 4500 to 10,000 kc.
47. Distress signal.
49. A television image.
50. Practical unit of electrical resistance.
52. City division. (abbr)
53. Battery used to supply power for filaments of electron tubes.
56. A refractory metal used for grids and plates of power tubes.
58. The unit of luminance.
59. Used to protect a screen grid amplifier unit from excessive input when grid bias is cut off.

DOWN

1. A frequency determinant in UHF circuits.
2. To rotate as an antenna for best pickup.
3. Frequencies within two limits used for a definite purpose.
4. Components with two electrodes.
5. A system of signals for messages.
6. A complete system of components.
7. An electrically charged atom.
8. A coil or capacitor.
11. Conscious.
12. Symbol for plate resistance in a tube.
14. Negative answer.
17. Luminous discharge between electrodes.
18. Defect in TV image caused by malfunction at transmitter.
20. Instrument to show electrical presence.
21. Harmonics generated in a receiver by rectification in the second detector.
25. A protective device.
29. A circuit that performs the same function in TV as the AVC circuit in a radio receiver.
30. Term for distortion in sound reproduction.
31. Control for changeover of TV camera.
34. Mineral magnetized in natural state.
37. Symbol for ac plate current tube.
38. Extreme finger part.
42. Attracting terminal. (abbr.)
44. Type of current. (abbr.)
45. Coating formed by oxidation.
48. Electrical noise in a receiver.
51. A machine that converts electric energy into mechanical energy.
54. A request.
55. An irregularly shaped rotating or sliding part to convert rotary motion to linear motion.
57. A representation of the earth's surface.

Solution to puzzle on page 28.

Current Flow In Semiconductors

by J. B. STRAUGHN

A quick review and some facts. If you have completed the first ten lessons of your course you have learned three means by which a voltage can cause current to flow in a complete circuit. These means are:

1. Free electrons flowing in a metallic conductor such as a copper wire.
2. Electrons which cross free space as between the cathode and plate of a vacuum tube.
3. Free electrons caused to move in an external conductor due to the orbit distortion of fixed electrons, as in the dielectric of a capacitor.

Now let's take time to look a little further into this business of free electrons and their flow in producing a current. This will make it easier for you to understand current flow in semiconductors.

Electrons, as you know, are negatively charged particles whirling about the positively charged center or nucleus, in much the same manner as Earth, Mars, Venus and the other planets that orbit about the sun. The nucleus and its electrons are called an atom. The electrons contained in the atom of any material, such as the ones in a gold coin or an iron nail, are exactly the same. This is

Fig. 1. Electrons in gold and iron are the same.

also true of the positive charges which make up the center core of the nucleus of the atom. The chief difference between the gold and iron atoms is in the number of positive charges in the nucleus and the number and arrangement of the negative charges (electrons) orbiting about the central mass. In every case the negative and positive charges must balance each other exactly, so the atom is electrically neutral and has no charge. This is a balance which the atom will always try to maintain.

Now, since the atoms maintain their electrical balance and always have the same number of electrons in orbit, how can we have a flow of free electrons?

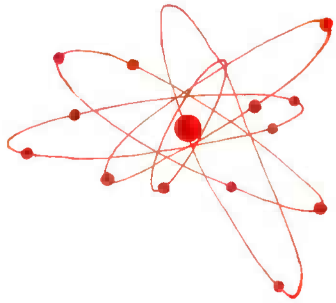


Fig. 2. An imaginary atom.

Let's go just a little further. An imaginary atom is shown in Fig. 2, with a large central nucleus and a number of electrons orbiting around it. The orbits of the electrons are shown by the closed semicircular paths around the nucleus.

Notice that some orbits contain more than one electron and that the various orbits are different distances from the core. The orbit paths can also vary. Note the one near the center with two electrons, which would point to 1 and 7 o'clock if a watch dial was drawn in. This orbit could vary all around the imaginary clock markings and would enclose the nucleus like a shell. Actually these possible orbit positions are called a shell, and an atom can have a number of shells. Because the orbits in Fig. 2 are constantly changing, it is more convenient to draw a two-dimensional atom, like the one in Fig. 3, particularly if we wish to show a number of atoms linked

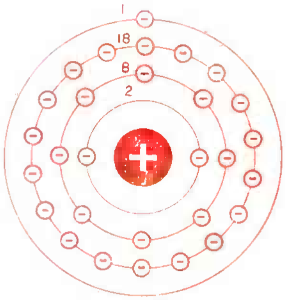


Fig. 3. The nucleus of the copper atom has a positive charge of 29. Around the nucleus there are normally 29 electrons arranged as shown above.

together. This is a copper atom, and you will see that there is only one electron in the outer shell.

Since the atom is an individual particle of matter, supposedly complete in itself, what makes them hang together so we can have

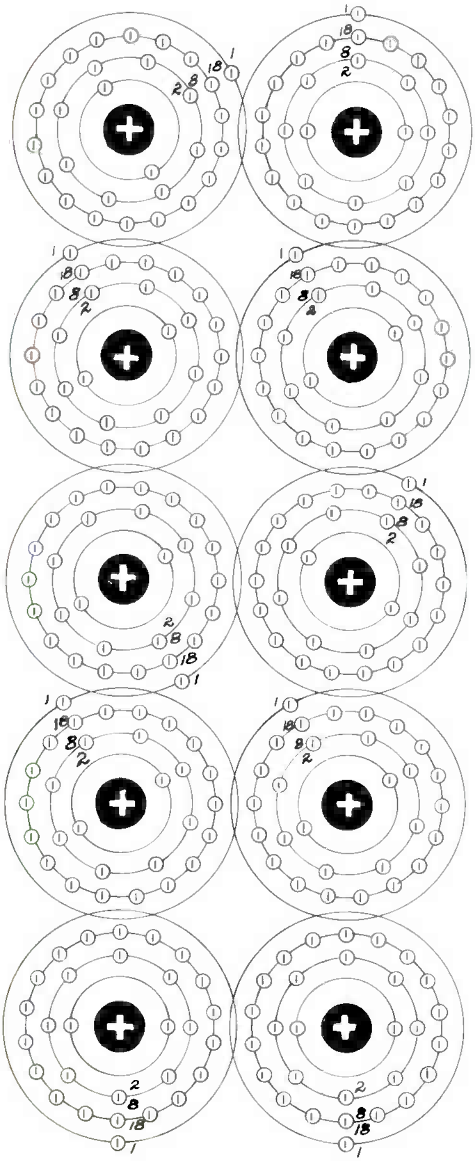


Fig. 4. Ten copper atoms.

enough to be seen, as in a length of copper wire? Look at Fig. 4.

Here we have ten copper atoms. The atoms can get fairly close to each other, so close in fact that their outer shells overlap. This being the case, and the fact that there is no difference between individual electrons, those in the outer shell can switch from atom to atom as long as they are replaced by an electron from another shell. This interchange goes on constantly, decreasing as the copper is cooled and increasing when the copper is heated. The movement is completely random so the electrical result of this electron transfer is the same as if there were no transfer at all. Net result - zero current.

Suppose we were to try and force an electron into the outer shell of one of the atoms. It couldn't get in because the outer shell usually supports only one electron. For the same reason we couldn't pull one out from an outer shell. While the electrons can skip from one shell to another there must be a replacement readily and immediately available. That's why there is no current flow in a wire if we connect only one end of it to either the positive or the negative terminal of a battery. No electrons can be forced in and none can be pulled out.

But if we connect the wire to both battery terminals we have an entirely different situation. The positive terminal of the battery will suck out an electron, while the negative terminal will inject one in the other end of the wire. All the outer shell electrons move over one shell and it is this concerted movement that makes a current. The electrons pumped around the circuit can be numbered in the millions, and together these moving negative charges can produce light, heat, TV, and all electronics as we have it today.

Now let's see what goes on in a semiconductor. A semiconductor is made by specially treating germanium, silicon, or some other crystal type material which, by itself, is a fairly good insulator.

First let it be understood that the following discussion is not meant to be a study of nuclear physics - just enough information will be presented, in simplified form, so you can get an understandable picture of what physicists think goes on within the atom. With basic knowledge of this sort you will not get off the track in your study of transistors. What you learn will seem natural and plausible.

What we wish to show first is nature's way of tying together the atoms of crystals, such

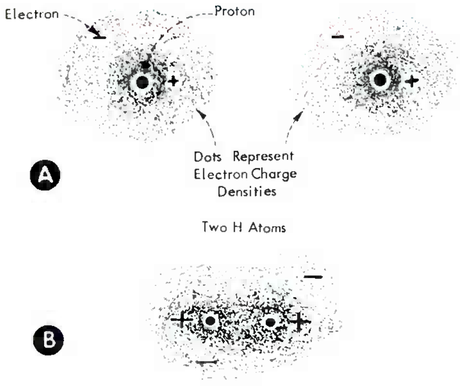


Fig. 5. Electron-Pair Bond in the hydrogen molecule.

as carbon, germanium, and silicon. The latter two elements are used in transistors.

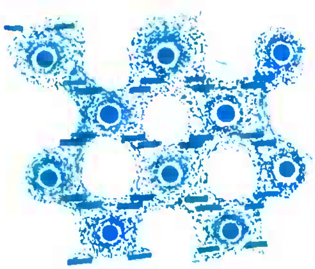
Fig. 5A represents two hydrogen atoms floating freely in space. Note that each has a central core with a positive charge orbited by one electron with a negative charge. The effect of the electron charge increases, as shown by the dot density (Fig. 5B), becoming quite strong near the positive core.

If these two atoms float towards each other the negative charges between them overlap and become quite dense. This negative charge attracts the positive cores and binds them together so they form a molecule of hydrogen. Of course they can only come so close, because a further decrease in separation would cause the two positive charges to repel each other. So, a point of balance is reached and the atoms are stuck together. The effect is called an ELECTRON PAIR BOND. What has this to do with semiconductors? Be patient for a little longer, and you will see how man can play a most unusual trick on Mother Nature!

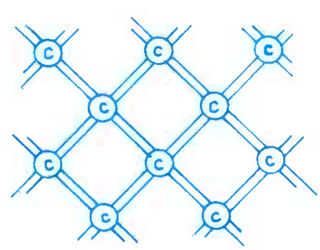
Now, the atoms of metal hang together, but there can be a constant interchange of outer shell electrons. In germanium and other crystals, there are somewhat different forces at work. Here each atom has four electrons in its outer shell. Nature has decreed that each atom will form an ELECTRON PAIR BOND with four other atoms. This is shown in Fig. 6A and in simplified form in Fig. 6C. The outer shell electrons are tightly bound to their cores and cannot enter into a current conduction process. Fig. 6C represents the ideal state present in PURE germanium and in PURE silicon. Notice the diamond shape. This is called a lattice or lattice structure.

Pure elements do not exist in nature but man can produce pure germanium and pure silicon. Also we can add impurities (other elements) replacing some of the atoms in the lattice structure. If the impurity has four electrons in the outer shell it fits right in place and the lattice and the electron pair bonds are not changed.

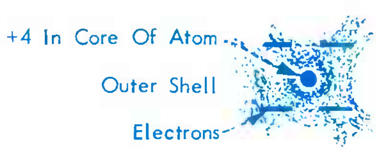
A three-dimensional view of a pure crystal



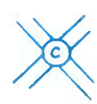
(A) Electron-Pair Bonds.



(C) Plane diagram of diamond lattice with bonds represented by lines.



(B) Each atom, with the charge of its share of outer shell bond electrons, is electrically neutral.



(D) Four bonds.

Fig. 6. How each atom forms an Electron-Pair Bond with four other atoms.

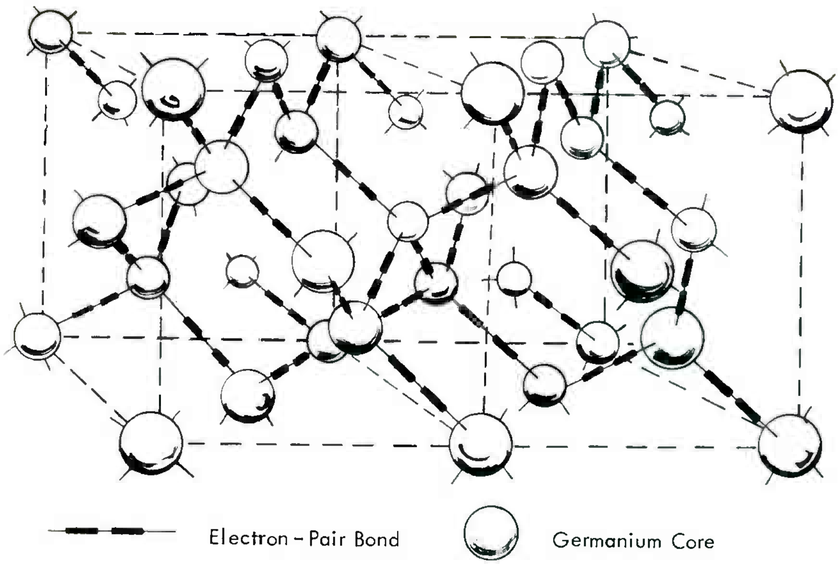


Fig. 7. A three-dimensional view of a pure crystal.

is shown in Fig. 7. All electron pair bonds are not shown to avoid congestion. Suppose we put in an impurity such as arsenic, boron, phosphorous, or antimony, which have five electrons in the outer shell. Four of the electrons will form electron pair bonds with four germanium atoms, leaving one electron dangling. This electron is held to its core in the usual manner, but since it has not entered an electron pair bond it can be moved out and replaced with another electron, if it has somewhere to go.

Fig. 8A shows Fig. 7 with three impurity

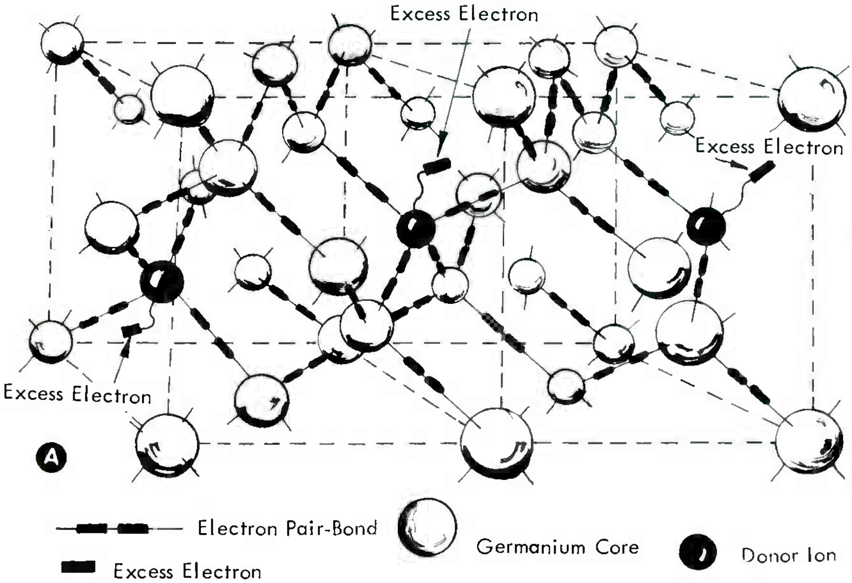
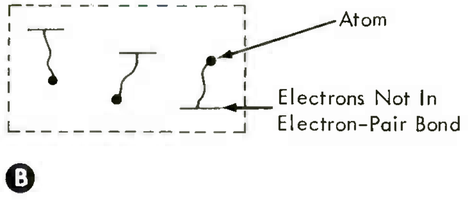


Fig. 8. (A) Germanium crystal with donor atom.



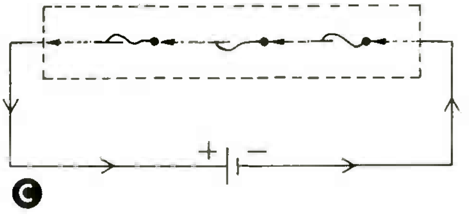


Fig. 8. (B) Electrons may be in any position; (C) current flow in a crystal by excess electrons. Note electrons are repelled by negative terminal and attracted to positive terminal of source.

atoms in the lattice.

The impurity atoms only, each with its excess electron, can be represented as shown in Fig. 8B.

If a voltage is applied we will have electron flow through the crystal with the effect the same as free electrons in a wire. The current is limited by the fact that the impurity atoms are few and may be relatively widely spaced.

But there are also other elements whose atoms contain only three electrons in their outer shell. Examples are aluminum, gallium, and indium.

If they are substituted for germanium atoms in the crystal, their three outer shell electrons will form electron pair bonds with three nearby atoms. However, the bond which should be formed with the fourth atom is incomplete (defective) due to the lack of a fourth electron in the outer shell of the impurity atom. This is shown in three-dimensional form in Fig. 9A.

The position in which an electron would be required to complete the electron bond pair has been named a hole. Because there is room for an electron, one can drop it into this hole. However, the atom can only support three electrons in its outer shell, so one of the original three is forced out and must find an-

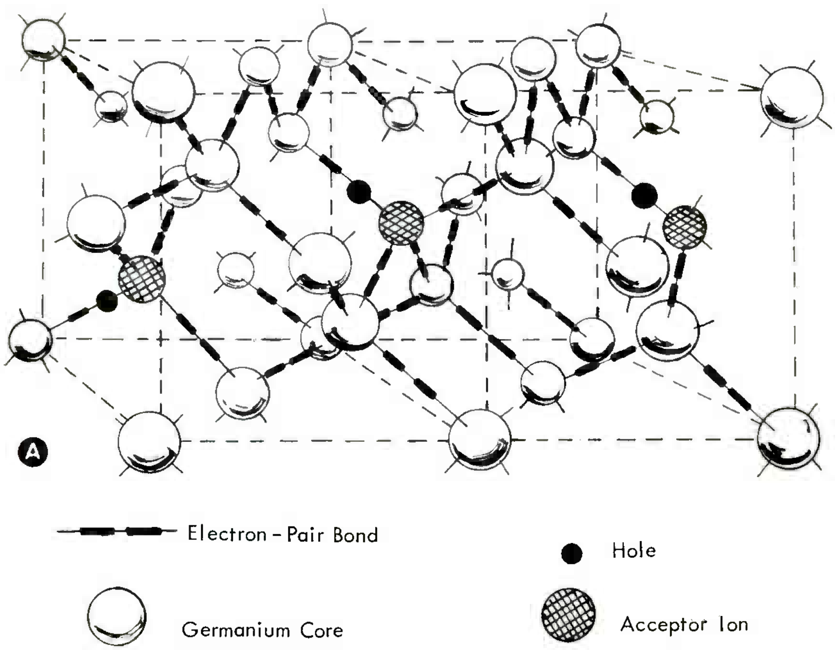


Fig. 9. (A) Germanium crystal with acceptor atom.

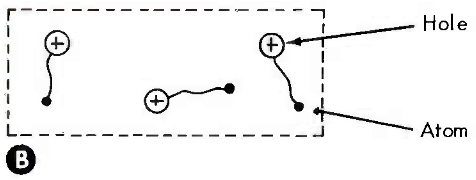


Fig. 9. (B) Random position of holes when no voltage is applied.

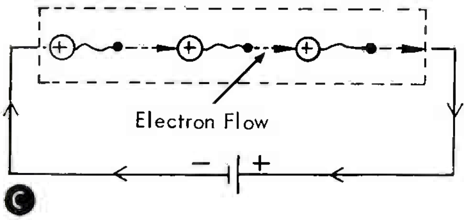


Fig. 9. (C) Electrons flow as always from − to + and pass by way of holes from atom to atom.

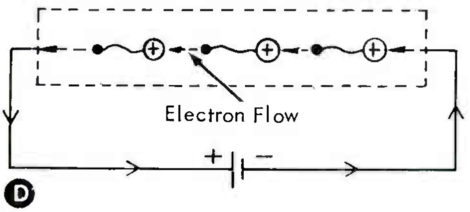


Fig. 9. (D) Reversing the supply voltage reverses the direction of current flow.

other hole. The point at which the electron was forced out now is the hole. Thus the original hole has moved from one side of the atom to the other.

Three impurity atoms only, each with its hole, are shown in Fig. 9B. If a voltage is applied, as shown in Fig. 9C, we will have electrons flowing from hole to hole. Reversing the voltage as in Fig. 9D reverses the direction of current flow and hole position. This is electron conduction by means of holes and can be called "hole" flow. The holes do not leave their atoms, but they can swing around the atoms, pick up an electron and immediately appear on the other side of the atom as an electron is ejected to the waiting hole in the next atom. Note all the holes are on the side of the atom nearest the negative terminal of the source voltage. Hole flow in this material is slower than in the material with excess electrons. The latter, because it has an electron excess, is called "N" (negative) material, while the material with holes is designated as "P", meaning positive.

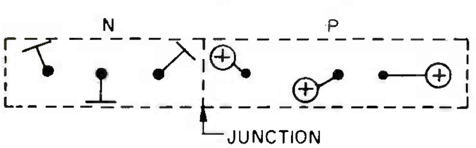


Fig. 10. A PN Junction.

You have now seen how the applied voltage can position the holes in P material and position the excess electrons in the N material around their atoms. What happens if we join a piece of N and a piece of P material? This is known as a PN junction, as shown in Fig. 10.

If a voltage source is connected as shown in Fig. 11A with its negative terminal to the N material and its positive terminal to the P material we will have electron flow as shown. The electrons will easily pass from N to P because the excess electrons in N are forced towards the junction, as are the holes in P.

Now look at Fig. 11B and see what happens when the voltage polarity is reversed.

The electrons are all pointed towards the positive source terminal and the holes are all towards the negative source terminal. Since there are no electrons entering the N material at the junction there is no electron flow through N, and since an electron cannot be pulled out of the P atom material at the junction (this would leave the atom with two holes) no electrons can flow in the P material. Thus we have a rectifier which will conduct in one direction (Fig. 11A) but not in the other (Fig. 11B).

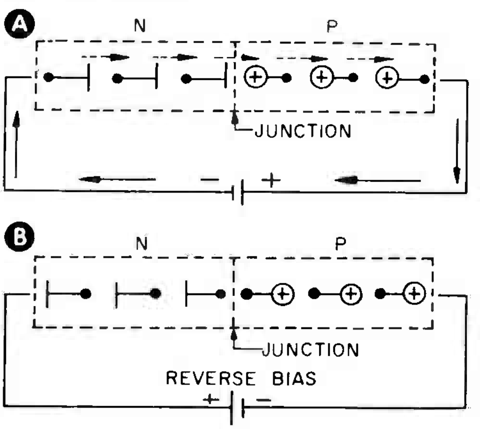


Fig. 11. (A) Forward bias (B) Reverse bias.

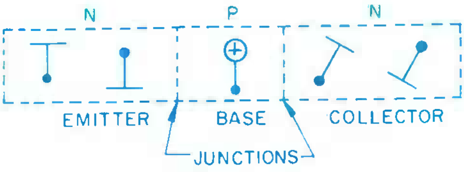


Fig. 12. A transistor is a three-element device.

Now, while the action of a junction is fresh in your mind, let's see how the input current of a transistor can control the output current.

A transistor is a three-element device, as shown in Fig. 12. The elements are the emitter, the base, and the collector. The emitter and collector are always made of one kind of material while the base is the other kind. For our discussion we will consider the NPN transistor, which means the emitter and collector are N material while the base is P material. The other kind of transistor is the PNP. Note that the base is common to both the emitter and collector, so two junctions are formed, the emitter-base and the collector-base.

We will use Figs. 13A, B, and C to show how a transistor can transfer a current from a low-resistance circuit to a high-resistance circuit. By combining the words transfer and resistor, we come up with the name TRANSISTOR, which is quite descriptive.

Fig. 13A shows voltage applied to the emitter-base junction to give forward bias and current flow whose strength is determined by R_S and the forward bias voltage.

Fig. 13B shows reverse bias applied to the collector-base so no current flows. If the bias is reversed, far more current would flow in this circuit than in Fig. 13A, despite the large value of R_L, because the bias voltage is much greater.

Fig. 13C shows both junctions biased for normal operation. The electron flow through R_S is the same as in Fig. 13A. However, when an electron is emitted into the base hole, the one leaving the base atom goes to the collector rather than out of the base, and we have current flow through R_L.

In this diagram we have only shown a single hole in the base and only two semi-free electrons in the emitter and collector. Actually there are millions, and this is a small figure compared to the germanium atoms in all three elements.

As a matter of fact, not all holes filled in the base result in electrons collected by the collector. A few will flow out of the base lead to the positive terminal of the emitter-base battery. However, most will flow out of the collector, through R_L and its battery back through the emitter battery and R_S to the emitter. Since R_L is almost ten times the size of R_S there will be almost ten times as much power developed in R_L as in R_S. Thus we have a power gain.

If a small signal voltage is inserted in series with R_S, this will vary the forward bias and the resulting change in current through R_L will produce a much larger signal voltage.

Since the only thing flowing in the collector is that part of the emitter current which does not flow out of the base, the emitter current is always the largest. The collector current equals the emitter current minus the base current. So now you should understand the basic operation of transistors, making future studies of the subject more interesting and profitable with less chance of your thinking going off on a tangent.

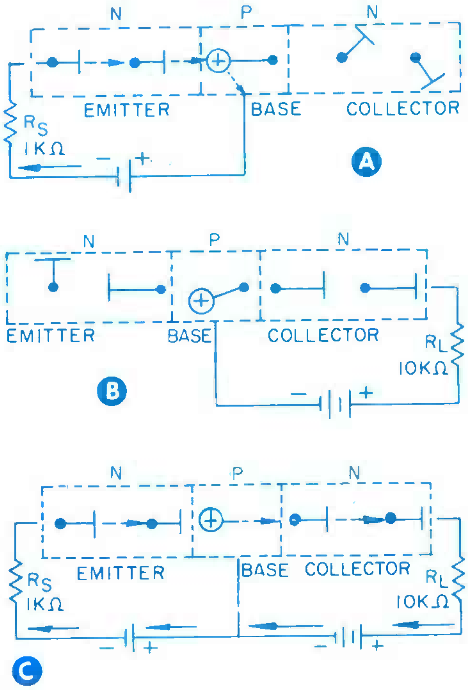


Fig. 13. (A) Voltage applied to give forward bias and current flow; (B) reverse bias applied so no current flows; (C) both junctions biased for normal operation.

If you would like to see more articles of this sort, write and let us know.

EMPLOYMENT OPPORTUNITIES

The following firms have requested that they be listed as continuing prospective employers of NRI graduates in the designated capacities:

RCA SERVICE COMPANY, Camden, N. J.
Needs TV Servicemen at most RCA Service Factory Service Branches. Technical School training essential prefer B/W and Color Service experience. Apply at RCA Branch nearest you, consult Yellow Pages or write to D. A. Giordano, Mgr., Employment, RCA Service Co., Cherry Hill, N. J.

LEONHARDT APPLIANCE INC.
309 Guthrie, Louisville, Ky.
Needs experienced refrigerator man.

RADIATION SERVICE COMPANY
9342 Fraser St., Silver Spring, Md.
Needs Communications Technician with 1st class FCC license to train in Baltimore. No experience necessary. Pays $80 - $125 wkly. Car furnished.

GENERAL TELEPHONE OF INDIANA, INC.
501 Tecumseh St., P. O. Box 1201, Fort Wayne, Ind. 46801
Openings in exchange offices in Indiana. No experience needed for: PBX MAN-To install and maintain mobile telephone systems of electronic relay and electro-mechanical types. SWITCHMAN-To install and maintain mobile telephone systems throughout state.

SIMPSON ELECTRIC COMPANY
5200 Kinzie St., Chicago, Ill. 60644
Openings for technicians, design and development engineers, electro-mechanical and production engineers. Write: W. F. Jones.

SYLVAN STEREO AND TV SERVICE CO.
306 Kennedy St., N. W., Washington, D. C.
Opening for radio-TV serviceman. Call Mr. Lee, 726-5800.

COMMUNICATIONS ENGINEERING CO.
(Division of Sylvan Electronics)
6610 Blacklick Rd., Springfield, Va.
Needs technician with FCC license. Call Mr. Brown, 451-5700.

CHESAPEAKE AND OHIO RAILROAD CO.
409 11th St., Huntington, West Virginia
Needs technicians for electronics maintenance on railroad. Must have 2nd class license or better. Openings in Ill., Mich., Ky., and Va.

STATION WFMD, Frederick, Md.
Needs technician with 1st class license.

LEPPERT, ELECTRICAL APPLIANCES
623 H St., N. W., Washington, D. C.
836 Leesburg Pike, Falls Church, Va.
Occasional need for appliance servicemen.

AERO TV AND APPLIANCE COMPANY
7314 Little River Turnpike, Annandale, Va.
Needs appliance servicemen. Write: A. Berry.

ALL-TRONICS, INC.
560 Portage St., Kalamazoo, Mich., 49006
Needs electronics technician.

UNITED AIRLINES
Wash. Nat'l. Airport, Washington, D. C.
Openings for radio technician.

AMERICAN TEL. AND TEL.
1130 17th St., N. W., Washington, D. C.
Needs electronics technician.

SACRAMENTO ARMY DEPOT
Sacramento, California
At moment needs 120 radio technicians.

AUDIO FIDELITY CORPORATION
6521 West Broad, Richmond, Virginia
Needs audio-visual repairmen and electronics technician.

INDUSTRIAL AND MERCHANDISING SERVICES, S.A. 4201 Mass. Ave., N.W. Wash. D.C.
This is a large European organization which has just begun to establish appliance service shops throughout the U.S.A. It has openings for appliance servicemen, presently in Baltimore and Washington, later in other cities. Address inquiries to Mr. Carl Schleicher.

DECCA NAVIGATOR SYSTEMS, INC.
1706 L Street, N. W., Washington, D. C.
A London-based world-wide organization needs radio technicians with 1st and 2nd class operator's license for jobs in U. S. A. and overseas. Contact Mr. Lederer at the Washington office of Mr. Riley, Decca Navigator Systems, Inc., 386 Park Avenue, S., New York, N. Y.

WESTERN UNION TELEGRAPH CO.
1405 G. Street, N. W., Washington, D. C.
Needs electronics technicians. Write or telephone Mr. B. L. Krise, Manager, Technical Services.

BY STEVE BAILEY

DEAR STEVE,

In Lesson 16BB, I read that the bandwidth of a resonant circuit could be widened by shunting it with a resistor. It seems to me that this would reduce the bandwidth.

Would you clear this up for me?

P. J., Puerto Rico.

First of all, the bandwidth of a circuit is determined by finding the points on the response curve at which the output voltage falls to 70.7% of what it is at the resonant frequency. These are called the half-power points.

Figure 1A shows a parallel resonant circuit that is resonant at 1000 kc. The bandwidth is 40 kc, as shown by its response curve in Fig. 1B.

There is a high circulating current flowing in the resonant circuit. If we shunt it with a resistor as shown in Fig. 2A, a portion of this current would flow out of the resonant circuit and into the resistor. This reduces the current in the resonant circuit which, of course, reduces the voltage drop across it.

With less voltage across the resonant circuit, the amplitude of the response curve would drop. This causes the half-power points to appear at lower points on the response curve. The exact amount of the drop depends upon the value of the resistance used to shunt the resonant circuit. Fig. 2B shows how the response curve in Fig. 1B would be affected when shunted with different values of resistance. As you can see, the bandwidth increases as lower values of resistance are used.

DEAR STEVE,

I have had a great deal of trouble retaining what I have studied in my lessons. Is there any way I can correct this problem?

M. B., Va.

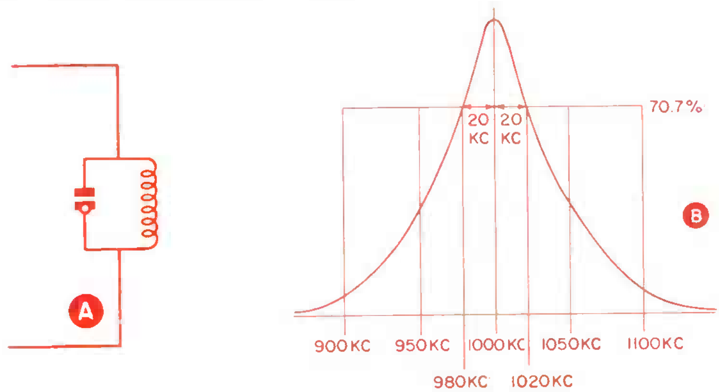


Fig. 1. (A) A parallel resonant circuit; (B) response curve showing two half-power points.

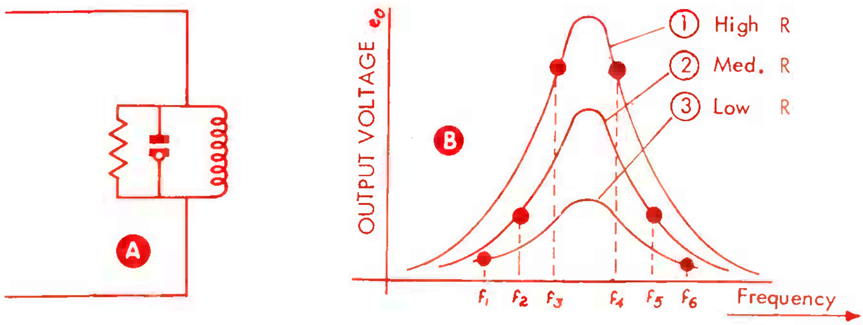


Fig. 2. (A) Shunt-resistance across the circuit; (B) various response curves.

The trouble you have described is most often caused by poor study habits. The chances are that you have been going through the lessons too quickly and that you have not been using our study schedules to best advantage.

The first thing you must do is to set aside a period each evening that you will devote to studying. Quite often, 30 minutes or one hour is all that is required.

Before you start your next lesson, refer to the study schedule at the beginning. You will notice that the text is divided into several sections. The first section is usually short since it contains the introduction to the text.

Go over the study schedule and plan to read at least one section an evening. If they are short sections, you can combine them. Also, try to arrange that you do not stop studying in the middle of a section. Leave the last evening in your schedule for review and for answering the test questions. At this rate you should complete one lesson a week, which is excellent.

The same type of schedule can be followed in working on the kits. Each kit contains ten experiments. If you set enough time aside each evening, you can easily complete an experiment a day. In ten days, you will have completed the kit.

Whether you are working on a lesson or an experiment, the main thing is to set aside a time for studying and stick to it. If you do, you will find that not only are your grades improving, but you will be retaining more.

DEAR STEVE,

In Lesson 2BB, we are told that a primary cell, such as a flashlight battery, cannot be recharged. Yet there are flashlight battery rechargers currently on the market. Is this a mistake in the lesson?

C. D., Calif.

No, the text is entirely correct. A primary cell cannot be recharged. If it could it would be a secondary cell.

The reason why a primary cell cannot be recharged becomes clear when you understand how a flashlight battery (zinc-carbon) works. A zinc-carbon battery is able to produce voltage because of a chemical reaction between the electrolyte and the zinc case in the battery. While current is being drawn from the cell, the zinc is slowly being eaten away. Also, hydrogen bubbles are being developed which eventually are attracted to the carbon rod of the battery. After a period of time, the hydrogen bubbles collect around the rod, partially insulating it from the electrolyte. When this occurs, the battery voltage drops under load.

To restore operation, the recharger passes a small reverse current through the battery which removes the hydrogen bubbles from around the carbon rod. The chemical reaction is now free to take place again and the battery will work.

Personally, I believe that it would be more to the point to call this unit a rejuvenator rather than a recharger. The life of the battery cannot be extended indefinitely. Once the zinc has been eaten away, no amount of recharging will restore the battery to proper operation.

DEAR STEVE,

What is a "swinging" choke and what is it used for?

P. I., Ill.

A "swinging" choke is a device used in power supplies to keep the output voltage nearly constant despite changes in the load current. The swinging effect is so called because the inductance swings or varies with changes in the current through the coil.

This swinging effect is a matter of design. It involves the dimension of the air gap in the iron core. The inductance will be low at high current levels and high at low current levels.

The net effect is such that the output voltage from the power supply remains fairly constant despite changes in the load current.

DEAR STEVE,

I have seen a number of old radios that had an rf stage before the converter stage. Why is it that most modern radios don't have this stage? What was its purpose, and would it be worthwhile to add it to my radio?

M. T., Mo.

RF stages were quite common in radio receivers several years ago. At that time, radio stations were not too numerous. Therefore radios had to be extremely sensitive to pick up distant stations. The rf stage built up the strength of the weak signals before feeding them to the converter stage.

Since then, however, tubes and circuitry have improved to such an extent that an rf stage is no longer necessary. Also, the need for long distance reception has been reduced because almost every city now has at least one local radio station.

As you can see, it would not be worthwhile to add an rf stage to your receiver. Actually, it could prove to be a disadvantage, particularly if you live in a large city. Your radio might pull in distant stations which could overcrowd the band and interfere with local stations.

DEAR STEVE,

How do I go about finding the value of a series-dropping resistor when I do not know the circuit current? I am on Lesson 5BB.

R.J., Mass.

Whenever you do not know the current in a circuit where you must find the value of the series-dropping resistor, you can use one of two methods.

In the first method you must find the current in the circuit. To do this, note the voltage across the load. Then note the value of the load. You can find the current in the circuit by dividing the voltage across the load by its value in ohms.

Since the dropping resistor is in series with the load, it will drop the remainder of the applied voltage. Therefore you can subtract the voltage across the load from the source voltage. This will give you the voltage across the series-dropping resistor. Then you divide this voltage by the circuit current to find the value of the series-dropping resistor.

The second method is one of comparison. You can compare the amount of voltage across the load and the value of the load in ohms to the amount of voltage needed across the series-dropping resistor. For example, if the voltage to be dropped across the series-dropping resistor is twice the voltage across the load, the series-dropping resistor must be twice as large as the load. If the voltage across the dropping resistor is half of the voltage across the load, then the dropping resistor need be only half as large.

DEAR STEVE,

How do you find the amplification factor of a tube?

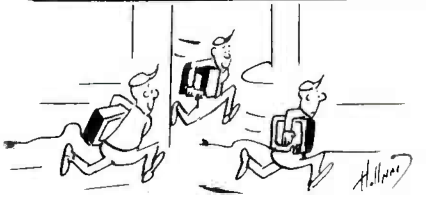
M. E., New Mex.

The formula for determining the amplification factor (u) of a tube is

$$u = \frac{E_P}{E_G}.$$

Notice that the amplification factor is equal to the change ( ) in plate voltage required to obtain a certain change in plate current divided by the change in grid voltage required to obtain the same change in plate current.

For example, assume that a change in plate current of 100 milliamperes can be produced by either a change in plate voltage of 30 volts or a change in grid voltage of 3 volts. To find the amplification factor, divide 30 by 3 which gives you 10. This is the amplification factor.



SYLVANIA DEVELOPS INFORMATION BOOSTER FOR SPACE SYSTEMS

BUFFALO, N. Y.---A flight model of a space communications system that will triple the information-handling capability of medium and low altitude satellites is being constructed for the Air Force by Sylvania Electric Products Inc., a subsidiary of General Telephone and Electronics Corp.

The system includes a 3-feet diameter radiation disc backed by an array of 200 phased antenna elements. Its purpose is to keep the antenna of the satellite constantly aimed toward earth and to steer narrow, intense radio signals to specific ground terminals.

Because the radio signals are precisely directed to terminals, power consumption is only about five per cent of that required for conventional satellite communications systems which spray radio energy over a large volume of space, according to O. John Hayles, vice-president and general manager at the central operation of Sylvania Electronic Systems, a division of the company.

The new system will be flight-tested in aircraft later this year. It was developed for the Air Force Systems Command's Research and Technology Division, Wright-Patterson Air Force Base, Ohio.

The system electronically steers a radio beam back along the same path of a ground-based information request signal. Several ground stations could use the system simultaneously.

Capable of operating on only 1/20th the number of solar cells now required to power conventional satellite communication equipment, the Sylvania system can handle a bandwidth equal to that occupied by 5,000 voice channels, according to Mr. Hayles. Conventional systems transmit less than one-third that amount.

Each of the 200 antenna elements has its own tiny transceiver (transmitter/receiver). "Redundancy of elements in the antenna permits satisfactory operation of the system, even if some of the transceivers should be destroyed," Mr. Hayles said.

You know that according to popular belief Pythagoras, father of the Pythagorean theorem, was a Greek. This is not true; he was an American Indian Chief.

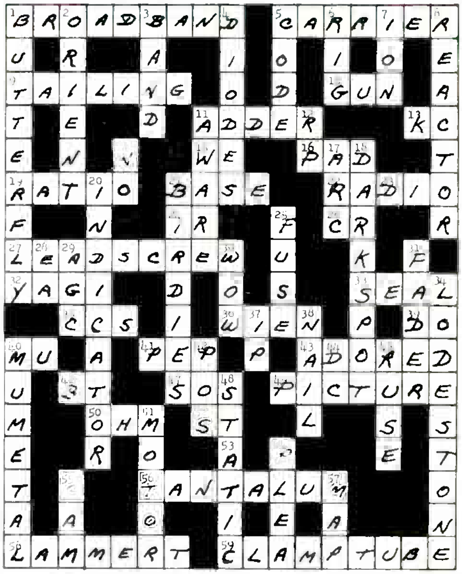
One day while he was walking through his village he came upon three women sitting upon animal skins and playing with their papooses (or would that be papeese). First there was a woman sitting upon a bear skin with a baby boy; next, was a woman sitting on an antelope skin with a baby girl, and the third woman was sitting on a hippopotamus skin. After observing that the woman on the hippopotamus skin had twins, a boy and a girl, he said, "The squaw of the hippopotamus is equal to the sum of the squaws of the other two hides."

It is only through errors in translation that these undying words were warped into the theorem which has caused every mathematician since to have to worry about sides opposite and adjacent and hippopotamus.

(You may ask, how did an American Indian get a hippopotamus hide? Well, this is not for me, the historian, to worry about. This is a matter for the scientists to work out. I only report the facts as they occurred.)

Philip G. Hatzfeld
Cold Bay, Alaska

SOLUTION TO ELECTRONICS CROSSWORD PUZZLE PAGE 15



The greatest difficulties lie where we are not looking for them.
Goethe

Alumni News

Howard Tate — President
Joseph Bradley — Vice President
Edward Bednarz — Vice President
Isaiah Randolph — Vice President
F. Earl Oliver — Vice President
Theodore E. Rose — Executive Sec.

MORE CHAPTERS ANNOUNCE NEW OFFICERS, BEGIN SERVICING PROJECTS AND PROGRAMS

DETROIT CHAPTER devoted an entire meeting to the operation of the Oscilloscope. Chairman Jim Kelley went into considerable detail to explain peak-to-peak voltages and how to calibrate the oscilloscope to measure them. The chapter expects to continue exploring the scope operation periodically until all understand its use as a tool to service radio and TV sets.

At another meeting Earl and Milton Oliver collaborated on an excellent demonstration of troubleshooting the audio section of receivers.

FLINT CHAPTER ADDS TWO NEW MEMBERS

FLINT (SAGINAW VALLEY) CHAPTER'S Andy Jobbagy did make that trip to the Los Angeles and San Francisco Chapters referred to in the March-April issue of the NRI Journal. He writes us that he enjoyed the visit and meeting some of the members, but could not spend as much time with each Chapter as he would have liked.

This is a late report on the officers serving the chapter for the current year. The report did not reach us in time for the March-April issue. The officers are as follows: Clyde Morrissett, Chairman; Arthur Clapp, Vice-Chairman; James Windom, Jr., Secretary; Henry Hubbard, Treasurer; George Martin, Radio Communications; Charles Wotring, Sergeant at Arms; Andrew Jobbagy, Goodwill Ambassador; Robert Poli, Information Director; William Duncan, Entertainment Committee; Raymond Kitt, Librarian; Wayne Todd, Gilbert Harris, Leslie Carley and John Allen, Membership Committee; Ron Dickenson and Robert Newell, Finance Committee.

The members found a number of valuable ideas and suggestions in an RCA recorded lecture entitled "Successful TV Servicing and Salesmanship." It dealt with advertising, how to make a service call, building future customers, keeping old customers, and other points of interest.

Andy Jobbagy gave a short talk on his trip to Tijuana, which the members found entertaining.

Two new members have been admitted to the Chapter, James Burke and Berl Lee. Our congratulations to you, gentlemen!

STOLL REPLACES SCHOPMEIER AS HACKENSACK CHAIRMAN

HACKENSACK CHAPTER elected George Schopmeier as Chairman at the beginning of the year. But because of a change in his duties at work he could not be sure of regular attendance at the meetings and so was compelled to resign as Chairman. George Stoll was thereupon elected to replace him as Chairman. Our congratulations to the new Chairman!

Secretary Frank Lucas gate a very interesting talk on transistors and the remainder of the meeting was given over to troubleshooting "a dog of" a television set brought in by one of the members.

At the next meeting William Colton began a lecture on troubleshooting a TV. He started with the tuner troubles, which he demonstrated with a scope. Time did not permit him to go into the other circuits but he made such a good start that the members are looking forward to a continuation of his talk.

The members have been looking forward to lectures by representatives from the Bell Telephone Company and from Motorola on color Television.

LOS ANGELES CHAPTER SCHEDULES NEW MEETING TIMES

LOS ANGELES CHAPTER Chairman Gene De Caussin brought in a "dog" phonograph player, as a change, and the members enjoyed tackling it and returning it to proper operating condition.

The Chapter meets twice a month, on the second and last Saturdays. Inaugurating a new policy, at the meetings on the second Saturday a regular meeting will be held, followed by a work session or general discussion of any Radio-TV problems brought up by the members. On the last Saturday of the month there will be no regular meeting but the entire evening will be devoted to work on the Chapter's Color Television receiver.

The latest member to join the chapter is Rudy Olson. Welcome, Rudy!

BROTHER FREY VISITS NEW YORK CHAPTER

NEW YORK CITY CHAPTER was very pleased to receive a visit from Brother Bernard Frey, Secretary of the Springfield Chapter and a former chairman of the New York City Chapter. The members were more than happy to see him. He exhibited a series of color slides on transistors and transistor servicing. National Vice President Joe Bradley described the slides, helping to give the members a chance to learn more about transistors and their servicing problems.

Dave Spitzer talked on Radio-TV Servicing. Two of the Chapter's newest members brought in a defective radio. Dave described the methods used in servicing the radio and then by way of demonstration he repaired the receiver. Dave also demonstrated different troubleshooting methods on the Chapter's TV set. It has switches installed that make it easy to introduce defects that can be described and then serviced. This saves time to be used in learning more about servicing TV receivers.

Three new members were admitted to the Chapter: Jaimie Alvarez and Alfonso Mayorga, N. Y. C., and Armand Degenshine, of the Bronx. Welcome to these new members!

PHILADELPHIA-CAMDEN MEMBERS ENJOY SPEAKER

PHILADELPHIA-CAMDEN CHAPTER again welcomed one of their long-time favorite guest speakers, Bill Heath, Westinghouse representative. Bill seems to get better and better, if possible, with his lectures and demonstrations. This time he brought with him the new Westinghouse Portable Jet TV and explained everything in detail about it. To each member present he gave out literature and a gift of a ball-point pen with a memo pad, then arranged for refreshments after the meeting. Bill sets great store by the fact that he is an honorary member of the Chapter and the Chapter is proud to have him.

As we go to press, Bernie Bycer was scheduled to be featured at a meeting and to deliver a talk on horizontal circuits and troubles. This is a subject that the members can never get enough of. Bernie is always welcome, too, at the meetings of the Chapter.

Also scheduled was a visit to Channel 48 for a tour of the station. The Chapter has made a number of such visits to stations and the members always enjoy them.

TEXAS CHAPTER BENEFITS FROM SLIDE-TAPES PROGRAM

SAN ANTONIO ALAMO CHAPTER has adopted the practice of featuring slide-tape presentations from Howard Sams Company. The first one exhibited was entitled "Semi-Conductor Fundamentals". The presentation was encellent and the members decided to continue the series in the months ahead.

Accordingly, at the next meeting there was another slide-tape presentation from Howard Sams Company. This one was Circuits and Associated Components from the "Transistor Review Series". This was equally as good as the first. One member commented that this is the type of program "eaten up" by both students and graduates.

The members have agreed that at each meeting hereafter there will be some form of refreshments. A different member each month will furnish the "goodies" to make the meetings even more enjoyable. The Chapter has had refreshments on and off in the past but not regularly.

SAN FRANCISCANS CHANGE MEETING PLACE

SAN FRANCISCO CHAPTER members, also students and graduates in the area, should note the change in address of the Chapter meetings to 1259 Evans Ave.

News of the officers elected for 1966 was too late to be included in the previous issue. Here they are: Isaiah Randolph, Chairman; Willie Hawkins, Vice-Chairman; Phil Stearns, Secretary; Anderson Royal, Treasurer; Peter Salvotti and Rubin Ellis, Finance Committee; J. Arthur Ragsdale and Willie Hawkins, Program Committee. Our congratulations to these officers!

Willie Hawkins, using a blackboard, demonstrated the functions of Colpitt, Hartley, multi-vibrators and blocking oscillators. Rubin Ellis demonstrated the use of the B and K TV Analyst, showing the video signal through the i-f into the video output.

Percy Ellis was recently welcomed as the newest member of the Chapter.

SPRINGFIELD CHAPTER HOLDS CLINIC FOR COLOR TELEVISION

SPRINGFIELD (MASS.) CHAPTER'S Arnold Wilder held a color clinic at his home in Agawam. Arnold reviewed the important terminology associated with Color TV. Then, using the questions at the back of NRI Lesson 58, he quizzed the members and explained the answers to them in graphic form by actually pointing out the circuits on the bottom and top of the Chapter's up-ended CT-100 chassis. Some of the questions brought out the relationship of vertical and horizontal troubles in both color and black-and-white sets. Antennas and transmission lines were discussed with experienced members describing to the others the problems encountered and their solutions.

The next meeting was held at Norman Charest's shop. Norman had set up a theatre in an adjoining room, where the members watched three films from the Bell Telephone Company: "The Bell Solar Battery", "TV Optical Maser", and "Telstar". All present found these films were as instructive as they were fascinating.

A new member, Stanley Socha, attended this meeting and donated an extra projection screen to the Chapter. Welcome to the membership, Stanley!

The Chapter has ordered and is eagerly awaiting the arrival of a Transistor Demonstration Board. Chairman Joe Gaze has already assigned different transistor radio circuits and components to the various members for their special study and presentation to the Chapter.

Since the last issue of the Journal we have received word that the following members of the Alumni Association have passed away. We extend the sympathy of the Alumni Association to their families.

Peter Van Bendegom, Grand Rapids, Mich.

Elvin Fourhman, Maryland Line, Md.

Rohland F. Behncke, Burbank, Calif.

DIRECTORY OF ALUMNI CHAPTERS

DETROIT CHAPTER meets 8:00 P. M., 2nd 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: Clyde Morrissett, 514 Gorton Ct., Flint, Michigan., OW. 4-6867.

HACKENSACK CHAPTER meets 8:00 P. M., last Friday of each month, St. Francis Hall, Cor. Lodi and Holt St., Hackensack, N. J. Chairman: George Stoll, 10 Jefferson Ave., Kearney, N. J.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER meets 7:30 P. M., 2nd Thursday of each month at George Fulk's Radio-TV Service Shop, Boonsboro, 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, 4912 Fountain Ave., L. A., NO 4-3455.

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: John Schumott, 1778 Madison Ave., NYC. 722-4748.

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.

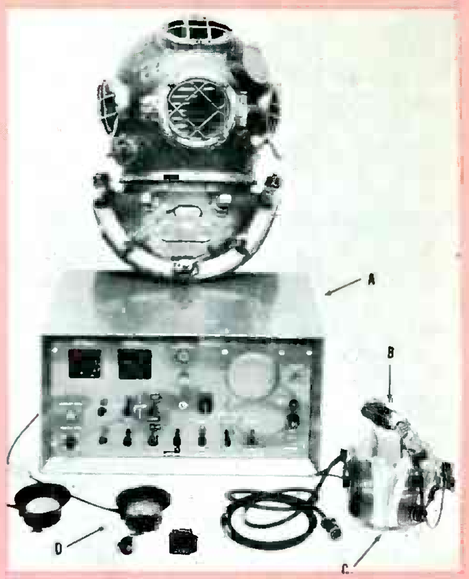
PITTSBURGH CHAPTER meets 8:00 P. M., 1st Thursday of each month, 436 Forbes Ave., Pittsburgh. Chairman: Joseph Burnelis, 2268 Whited St., Pittsburgh, Pa.

SAN ANTONIO ALAMO CHAPTER meets 7:00 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., 2nd Wednesday of each month, 1259 Evans Ave., San Francisco. Chairman: Isiah Randolph, 523 Ivy St., San Francisco, Calif.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8:00 P. M., last Wednesday of each month at home of John Alves, 57 Allen Blvd, Swansea, Mass. Chairman: Daniel DeJesus, 125 Bluefield St., New Bedford, Mass.

SPRINGFIELD (MASS.) CHAPTER meets 7:00 P. M., last Saturday of each month at shop of Norman Charest, 74 Redfern St., Springfield, Mass. Chairman: Joseph Gaze, 68 Worthen St., W. Springfield, Mass.



A. Diver's control amplifier; B. Diver's noise cancelling mike with boom; C. Diver's headphones; D. Tender's headphone—noise cancelling mike.

VOICES FROM THE DEEP SPEAK UP FOR THE NAVY

The "Divers I-Com" is a deep sea voice unscramble communications system successfully developed and delivered to the Navy by ISC/Telephonics, 770 Park Avenue, Huntington, New York. This equipment represents a major break-through in voice communication by personnel who are breathing helium under water whether in a diving bell, in a underwater laboratory, using full-face mask scuba equipment or hard hat pressure suit. The Navy's program of going deeper under water requires the use of helium mixed with air and other gases. In this mixed atmosphere the voice is completely distorted and unintelligible when the diver tries to communicate with the surface vessels. The ISC/Telephonics equipment reconstructs the diver's words so that they become intelligible. The Diver's "I-Com" used by the Navy in Sealab I and II is available to industry. The equipment provides communication between individual divers and any diver to the tender.

THIS SPECIAL SALE Continued by popular demand

ORDER THIS **anchor**

PICTURE TUBE TESTER — REJUVENATOR

(BEFORE JUNE 30, 1966)

FOR COLOR AND BLACK & WHITE TUBES. It's the finest test instrument available for TV Picture Tube servicing. You can test, analyze, and *repair* all picture tubes in use today. In the shop . . . or on the job . . . you'll have the proper tool to do the job completely. This Model 471 welds open cathodes; eliminates inner element shorts. Tests for opens or shorts between all elements. Provides emission check and two stages of re-activation. Determines useful life of picture tube. Filament switch covers exact voltages; automatically selects $grid_1$ and $grid_2$. Checks each individual color gun separately. Includes all necessary adapters, 4½" meter, "aircraft" type panel and sturdy, attractive case.

$53.85 STOCK #471WT

Low as $5.38 down, $5 monthly
Shipped Express Coll.

GET THIS DELUXE SPEEDEX AUTOMATIC WIRESTRIPPER FREE!

Strips insulation automatically from wire easily and cleanly without crushing it. Just squeeze the handles and the job is done. Deluxe model has fully automatic delayed return action which prevents crushing of fine stranded wire. Jaws remain open until wire is removed. Sturdy, easy to use with narrow grip handles for easy handling. A $5.94 value!

USE HANDY ORDER FORM ON PAGE 27.

NRI JOURNAL
3939 Wisconsin Ave.
Washington D.C. 20016

Second-class
postage paid
at Washington, D.C.

Mr. Willard F. Velline 25323-?
1322 S. 14½
Fargo, N.Dak. 58101