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IN THIS ISSUE:

- TRANSISTOR TYPES
- COLOR TV SERVICING: BIG BUSINESS
- CONAR MODEL 211 REFINEMENTS
- GOODWILL ON WHEELS

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CONTENTS

ON OUR COVER

NRI's color TV expert, technical editor Art Widmann, checks the new 19-inch portable color TV receiver, new in this year's market, with a degaussing coil to eliminate the effect of stray magnetic fields.

WILLIAM F. DUNN
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CONFUSED ABOUT TRANSISTOR TYPES?

It All Boils Down To Method of Manufacture

By WILLIAM F. DUNN

In the early days of radio, when tubes were first developed, they were developed in a more or less orderly fashion over a period of a number of years. The first tube was the diode or two-element tube, and then after it came the triode or three-element tube. Later came the tetrode and then eventually the pentode tube. There was a reasonable interval between the introduction of these types and the technician was able to keep up with their development.

In the few short years since transistors were first introduced they have come through a stage of extremely rapid development. Almost every time you pick up a technical magazine, you find a new type of transistor has been developed. There is no doubt that most service technicians begin to wonder if it is possible to keep up with these developments. When you see terms such as grown-junction, alloy-junction, mesa, planar, etc. you begin to wonder what it is all about. Are these all different types of transistors - do they operate on completely different principles? The purpose of this article is to try to bring some order out of the chaos that has developed through the rapid expansion of the semiconductor field.

TWO TYPES

There are two basic types of transistors, the NPN and the PNP transistors. Both types will be found in entertainment type equipment and therefore the service technician should be prepared to service equipment with both these types of transistors.

We do not intend to go into a review of transistor theory in this article; if you need to brush up on transistor theory you should refer to your regular lessons.

However, you will remember that in the NPN transistor, electrons are the carriers, whereas in the PNP transistors, holes are the carriers. The NPN transistor has an advantage over the PNP transistor in that the mobility of the electron is about double that of the holes. This means that if you had two transistors, one an NPN and the other a PNP, having emitter, base and collector regions of exactly the same size and configuration, an electron could move through NPN transistor in half the time that a hole could move through the PNP transistor. As a result, the NPN transistor could be used at a higher frequency than the equivalent PNP transistor.

This might make you wonder, "Why make PNP transistors if this is true?" The answer is that many manufacturing techniques lent themselves to the manufacture of PNP transistors more readily than they did to the manufacture of NPN transistors. Thus, while the NPN transistor may have had an inherent advantage, the hard, cold fact of the matter was that the PNP transistor that could be manufactured was a better transistor than the NPN transistor. However, new techniques have been developed so that now NPN transistors manufactured using more modern techniques are far better than earlier PNP transistors.

Almost every day new techniques are being proposed and some are being put into use. The result is that it is impossible to say that in the future all transistors are going to be of one type or the other. The chances are that both NPN and PNP transistors will be manufactured for some time and that due to the various manufacturing techniques employed, the chances are that for a given application it will be difficult to say which of the two types is the better.

Since there are two basic types of transistors it is essential that you understand how both of these transistors work. If you know how they work, and if you will remember that all of the transistors in use in entertainment type of equipment fall into one of these two categories, then you should have no difficulty being able to understand how a particular circuit using a NPN or a PNP transistor works.

Since there are only two basic types of transistors, perhaps you wonder why there are so many different names given these two types. Actually, the names indicate the manufacturing technique used to manufacture the transistor rather than the particular type. As a service technician, you have no need to go into great detail studying how the various types of transistors are made. However, some

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understanding of the manufacturing processes will help you better to understand the various types of transistors and will perhaps help you remember some of the important characteristics of the various types.

GROWN JUNCTION TRANSISTORS

The first commercially available junction transistors were of the grown junction type. This type of transistor is made from a rectangular bar, cut from a germanium crystal that has been grown. Suitable impurities have been added so that the NPN regions such as shown in Fig. 1 are formed. The base of the transistor is usually located midway between the two ends. Suitable contacts are then welded to the emitter, base and collector regions.

The actual rectangular bar used for the transistor is quite small. The emitter and collector sections of the transistor are usually considerably larger than the base. The base, as a matter of fact, is usually kept as small as possible and may have a thickness of .001 inches or less.

Most of the early transistors of this type were germanium NPN transistors. Germanium was used in the earlier transistors because the highly purified germanium required for the manufacture of transistors was much more readily available and less expensive than the equivalent silicon. Most of the transistors were NPN transistors because the germanium did not require such a high degree of refining as was required with the manufacture of PNP transistors. However, either NPN grown-junction or PNP grown-junction transistors can be made using either silicon or germanium.

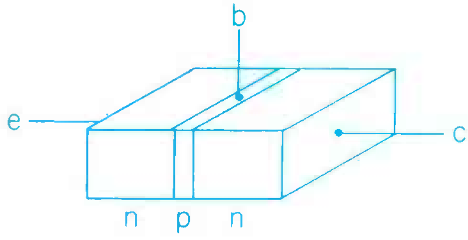

Fig. 1. A grown-junction transistor.

While the grown-junction transistor was a big breakthrough in the field of electronics, the usefulness of this type of transistor was quite limited. It is not particularly suitable to high frequency applications. In addition, the transistor is quite temperature-sensitive, and can become somewhat unstable if the temperature becomes too high.

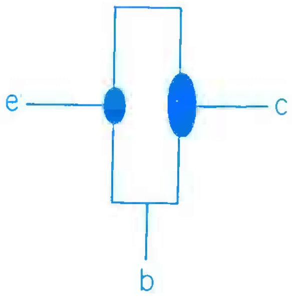

Fig. 2. An alloy-junction transistor.

ALLOY JUNCTION TRANSISTOR

The alloy junction transistor is made from a rectangular piece of germanium to which suitable donor impurities have been added. This results in an N type piece of germanium. Small dots of indium are fused into the opposite sides of the germanium wafer as shown in Fig. 2. The result is that P type germanium will be formed where the dots are fused into the wafer so that we will have a PNP transistor.

Notice that in the figure the emitter dot is shown smaller than the collector dot. In the manufacture of the transistor, the collector is made larger than the emitter.

One of the advantages of the alloy junction transistors over the grown-junction transistors is that they are usable at a somewhat higher frequency. In addition they have a high value of alpha and the alpha remains stable as the temperature increases.

You will remember that alpha is equal to the ratio of collector current to emitter current. Since the collector current is normally less than the emitter current, the value of alpha is always less than 1. However, generally speaking, the closer alpha is to 1, the better the transistor. The value of alpha for alloy transistors is higher than the value of alpha for grown junction transistors. In addition, as the temperature increases, the value of alpha for an alloy-junction transistor remains constant. However, in a grown-junction transistor, the value of alpha may go over 1; this will cause instability in the circuit.

The alloy-junction transistor we described is a PNP type. An NPN type alloy-junction transistor may be made by fusing a lead-antimony alloy into each of the two opposite phases of a P type germanium wafer. In this type of transistor it is possible to get more uniform penetration of the binary alloy which in turn leads to better junction spacing. This

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will cut down the width of the space region and will give improved performance at higher frequencies. In addition, because electron mobility is more than twice that of holes, the NPN transistor will be better at high frequencies. Therefore the NPN alloy junction transistor will outperform the PNP alloy junction transistor at high frequencies. The PNP type was developed first; the NPN type came along later as a result of newly discovered manufacturing techniques.

Surface Barrier Transistor.

This type of transistor is similar to the alloy type, except that depressions are etched into the N type wafer. This permits smaller emitter and collector contacts. The smaller contacts result in lower capacities between sections of the transistor which in turn permits usage at higher frequencies.

In the manufacture of this type of transistor, the N type wafer is placed between two jets from which suitable salt solutions are directed at each side of the wafer. The solution etches depressions into the wafer. The wafer and the jets are set up so that there is a current flow which dissolves the germanium. This manufacturing technique makes it possible to shape the depressions as required by controlling the current flow.

When the wafer has been etched to the proper depth, the polarity of the voltage applied between the jets and the wafer is reversed. When this happens, the salts from the jets are deposited on the wafer and these form the emitter and collector regions. In the manufacture of the surface-barrier transistor, the blanks used are only a few thousandths of an inch thick. After etching, the surface-barrier region between the emitter and collector contacts may be etched down to a ten-thousandths of an inch or less.

This type of transistor is ideally suited for use at high frequencies. It has high gain and because of the small contacts and the small size of the various sections the time taken for a hole to travel through the transistor is extremely small. Basically the transistor is a PNP type, but in spite of this, due to its small size, is very well suited for use at high frequencies.

The sketch in Fig. 3A shows the surface-barrier transistor. Notice that as in the case of the alloy-type transistor, the emitter contact is smaller than the collector. Holes flow from the emitter through the base region and spread out to the collector as shown in Fig. 3B.

There are a number of variations of the surface barrier transistor. One type is the micro-alloy transistor. In this type of transistor a suitable N or P type impurity is first plated in the etched depression and then alloyed into the semi-conductor wafer. By means of this technique either PNP or NPN surface-barrier transistors can be manufactured.

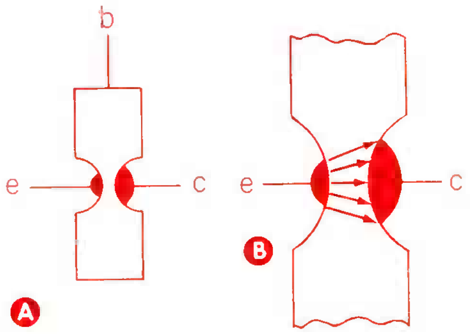

Fig. 3. A simplified sketch of a surface barrier transistor is shown in (A). The hole movement across the base is shown in (B).

Variations of this technique permit the manufacture of either silicon or germanium transistors. Different materials are evaporated or plated on the etched depressions depending on the type of transistor being manufactured and whether the transistor is to be an NPN or a PNP transistor. However, basically these transistors are very similar and all have the characteristic of giving good performance at high frequencies.

DIFFUSION TRANSISTORS

Diffusion can take place from within the crystal or it can be gaseous diffusion. The process can be controlled to provide either very uniform base, emitter and collector regions or it can be controlled to provide non-uniform base, emitter and collector regions.

To understand diffusion you have to understand a little bit about the molecular structure of materials. If you look at the wall of a glass jar, to the eye it appears solid with no space between the various molecules making up the jar. However, if you were to fill the jar with hydrogen and store it for any length of time, you would find that in a short while the jar was no longer filled with hydrogen only, but contained a mixture of hydrogen and air. The reason is that the small hydrogen atoms are able to diffuse or pass right through the spaces between the molecules in the glass. At the same time molecules of air will diffuse through the glass and pass on into

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the inside of the bottle. The hydrogen molecule is smaller than the air molecule, therefore the hydrogen will diffuse out of the jar faster than the air will diffuse in.

This process of the molecule going through an apparently solid wall of molecules is known as diffusion. This is the diffusion technique used in the manufacture of diffusion-type transistors.

The Drift Type.
One of the most important uses of the diffusion technique is in the manufacture of transistors with a non-uniform base region. If the emitter and collector junctions are made by the alloy technique, but the base region is made by the diffusion technique and the impurities in the base region varied, we have what is known as a drift transistor. In a typical PNP drift transistor, acceptor impurities are added in the emitter and collector region. These impurities are controlled so that their concentration is uniform throughout both the emitter and collector region. At the same time donor impurities are added to the base region. Their concentration is controlled so that it is highest in the region of the emitter-base junction and then drops off fast and finally reaches a constant value, which it maintains over to the base-collector junction, as shown in Fig. 4. This type of tran-

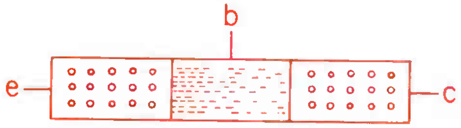

Fig. 4. A diagram showing how a large number of donor impurities increase the electron concentration in the base near the emitter-base junction in a drift transistor.

sistor is called a drift transistor, and its most important characteristic is excellent performance at high frequencies. However, notice that it is still a PNP transistor and the basic theory of its operation is similar to that of any other PNP transistor. The improved performance is obtained by varying the concentration of the donor impurities in the base region.

The Mesa Type.
One of the advantages of the diffusion technique is that it gives a great deal of flexibility to the manufacture of transistors. We just discussed the drift transistor in which the concentration of impurities in the base region is varied by diffusion technique. It is also possible to manufacture a transistor using diffusion techniques entirely. An example is the mesa transistor.

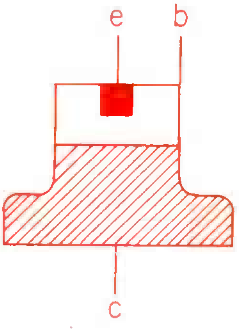

Fig. 5. A mesa transistor.

In this type of transistor a semi-conductor wafer is etched down in steps so that the base and emitter regions appear as plateaus above the collector region as shown in Fig. 5. The advantages of the mesa transistor are good high frequency performance and very good consistency. By this we mean that it is possible to control the manufacturing techniques quite closely so that the characteristics of mesa transistors of the same type number can be controlled quite closely. This is not necessarily true of other types of transistors - often their characteristics vary over a fairly wide range.

The Planar Type.
Another type of transistor manufactured by the diffusion technique is the planar type of diffused transistor. This type of transistor is shown in Fig. 6. Notice that each of the junctions is brought back to a common plane whereas in the mesa type the various junctions are built up in plateaus. The importance of the planar type of transistor is that the junctions can be formed beneath a protective layer. As a result, many of the problems associated with other types of transistors having junctions exposed at the surface are avoided in this type of construction. Important characteristics of the planar transistor are generally very low reverse current and improved dc gain at low current levels.

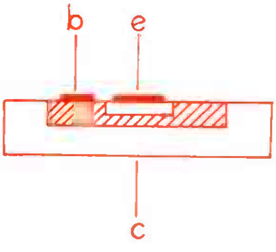

Fig. 6. A diffused planar type transistor.

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In manufacturing transistors it is possible to manufacture two of the regions by means of the alloy technique and one region by means of a diffusion technique. It is also possible to manufacture two of the regions by the diffusion technique such as in the planar transistor and it is also possible by triple diffusion to manufacture all three regions by means of the diffusion technique. Diffusion type transistors can be controlled quite closely and the characteristics of different regions of either the emitter, base, or collector can be varied by means of this technique.

EPITAXIAL TRANSISTORS

One of the disadvantages of the diffusion type transistors is the relatively high resistance of the collector region. This results in slow switching time; it limits the usefulness of the transistor in high frequency applications. Reducing the resistance of the collector region reduces the collector junction breakdown voltage, and this in turn again reduces the usefulness of the transistor.

These problems can be overcome by the epitaxial technique. In this technique a thin high-resistance collector region is produced by thermal decomposition on a suitable low-resistance material. The base and emitter regions are then diffused into the collector region. The result is a transistor that looks something like the one shown in Fig. 7. The primary advantage of a transistor of this type is very fast switching time and good performance at very high frequencies.

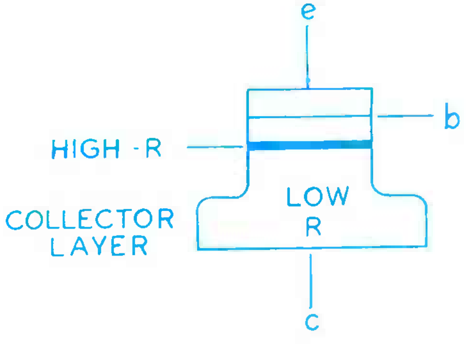

Fig. 7. A double-diffused epitaxial transistor.

This technique can be combined with other techniques to produce transistors having varying characteristics. The epitaxial transistor can be referred to as a double-diffused epitaxial transistor. The thin collector region is formed by the epitaxial technique and the base and emitter are formed by the diffusion process, hence the term double-diffusion.

An epitaxial-collector transistor can be formed using the planar technique, and this type of transistor is referred to as the planar epitaxial transistor.

A transistor can be made by epitaxial depositing of a base region of one conductivity type upon a collector region of the opposite conductivity type. The emitter region can then be formed either by alloying or diffusing, which would result in the epitaxial-base transistor.

SUMMARY

We have not tried in this article to acquaint you with the techniques used in the manufacture of transistors. We have gone into some of the techniques briefly, primarily to point out some of the differences in the different types of transistors, and to acquaint you with the advantages of the various types. Sometimes two or three different manufacturing techniques are combined to obtain transistors with special characteristics. However, you should remember that the resulting transistor will be a NPN or a PNP transistor, and if you know how these transistor types work then you should have no difficulty understanding how the circuit works. The manufacturer will already have selected a transistor that is suitable for use in the particular application in which the transistor is used. If the particular unit you are working on happens to be a UHF TV tuner, you can be sure that the transistor used in it will be one that will give good performance in the UHF region. On the other hand, if you are working on an FM tuner and you are concerned about the transistor in the mixer or oscillator stage, you know that it will be a transistor type that will work well in the 100 megacycle region. Its high frequency performance may not be as good as the transistor used in the UHF TV tuner, but certainly it will be far better than other transistors which you might find in the audio section of an FM receiver. However, even though the high-frequency characteristics of one transistor may be much better than those of the other, if both transistors are PNP transistors or if both transistors are NPN transistors, then they work on the same basic fundamentals.

Next time you service a piece of transistorized equipment and see a fancy name tied on to the end of one of the transistors do not let it concern you. Look at the diagram, find out if it is an NPN or PNP transistor, and once you know this you should be able to figure out how the transistor operates in the circuit in which it is employed.

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COLOR TV SERVICING: COLOR IT GREEN$$$$

By FOREST H. BELT

Said a recent news release from Television Digest, reporting a survey they had conducted: "In the next five years, nearly half of America's television-equipped homes will convert to color." Open almost any magazine or newspaper and you'll read of astounding advances color TV is making--networks are pushing color programs, manufacturers are pushing color receivers, and furniture dealers are mouthing color-TV "bargains," especially in last year's models. In fact, dealers all over the country report that new color TV is now a seller's market; supply just isn't keeping up with the increasing demand.

EDITOR'S NOTE: Forest H. Belt, Editor of Radio Electronics, and former Editor of PF Reporter is an NRI graduate.

Okay, so you've heard or read all of this; what does it mean to you? Just this: Every set that is sold should be installed and adjusted by someone familiar with the techniques of color servicing and convergence.

An antenna assures best color reception, so there is outside work for someone; and every set that is sold will need servicing sooner or later.

WHERE'S THE MONEY

Let's delve into a few "dry" statistics, and see if we can liven them up for you, converting them into potential dollars and profits.

What are the dollar potentials right now for color-set service technicians? There are almost 5 million color sets in use already, and in January 1966 the figure topped that. (Experts say there would be even more in use except for a shortage of sets brought about by heavy demand and a scarcity of color picture tubes.) Imagine, 5 million sets!

Table 1. Color Service Yearly Profit
Based on one set each work day

SERVICE				
$ 7.50/call	243 work days	$1750		
$25.00/bench job	73 sets	1825		
Total service income			$3575	
Color-service part of technician salary			2150	
	Gross profit -- service			$1425
PARTS				
$25/set	100 sets	2500		
	Total parts income	2500		
	Cost of parts	1500		
	Gross profit -- parts			1000
Total Gross Profit				2425
Portion of expense and overhead				1825
NET PROFIT	$600			

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Now, let's add another interesting statistic. Estimates indicate about 100,000 fulltime service technicians in the United States, are either in business for themselves or employed fulltime. Of these, about 55% can service color receivers--about 55,000. Connect this with the number of color sets in operation and you can conclude that there are already about 100 sets for every technician capable of working on them. This means a set every 2-1/2 working days or 2 sets per week, if each receiver needs service only once a year.

Expand this a little further. Experience has shown that color sets require service a bit more than twice a year, on the average. You can see the implication: There's a set every day for each technician to service, even at the present low level of color-set saturation. Are you servicing at least one color set every day? If not, continue reading and see what you're missing in $$$$$.

THE DOLLARS

It's not difficult to calculate the approximate service income generated if one color-set job reaches your shop every day. You can follow Table 1 if that makes it easier to understand.

More than 95% of color jobs start with a service call to the home. Charges for this range from as little as $6.00 to as high as $12.50. With an arbitrary $7.50 for our example (a survey shows this to be a popular rate), and allowing 5% for carry-ins, service calls bring in about $1750 each year. Okay for just a starter?

Remember, however, this figure is only for service calls. About 30% of these sets, if a really good maintenance job is to be done, will require shop servicing. So, we must also figure the service income from the almost 75 sets (including carry-ins) that actually reach the shop. (The service-call charge is left standing to cover pickup, delivery, and final adjustment in the home--a necessity with color.) A specific price for a shop repair job is more difficult to pin down. However, a well-equipped shop with a competent technician can do a thorough repair and preventive-maintenance job on a color receiver for about $25 (this, too, is a popular "round" figure all over the country, although actual charges fluctuate widely above and below this amount). So, add another $1825 of service income to the $1750 and you have: $3575 per color technician. If you service color, therefore, statistical chances are that you'll add nearly $3600 a year to your income.

But we're not finished yet.

Consider the parts used in servicing color receivers. Tubes and fuses on home calls; resistors, capacitors, coils, and transformers in the shop; sweep components; a picture tube every now and then: the charges for all these components are part of your gross income. Replacement parts for color sets, at list price, average about $25 per year per set over a 5-year span.

The Net Profit Picture.

To analyze profit, first develop some gross-profit figures.

Gross profit for service income is equal to total imcome minus salary (yours or your technician's). Of your $3575 service income, you may have paid your employee or yourself as much as 60% or $2150. Gross profit is thus $1425.

Gross profit from parts is found by subtracting their cost from total parts income. If your markup averages 40% (it's more on tubes and on a few other components if you buy wisely), your gross parts profit in this example will amount to $1000.

Total gross profit is $1425 plus $1000, which is $2425.

Naturally, this amount is reduced by overhead expense to find net profit, although your color-servicing activity should be charged only its fair share of overhead. A realistic portion shouldn't amount to more than 75% of gross profit, which leaves a net profit of $600 per year. That's $600 profit, mind you, over and above your (or employee's) salary; that's $2.50 profit every working day and more than $50 profit every month. Is it worth it? You decide.

THE OUTLOOK

So far, we've talked only about how you can make money servicing color right now. What is the future going to hold? To all appearances, the future of color is certainly bright. Present trends indicate there will be 25 million color receivers in operation by 1970--only 5 short years from now! Consider this in terms of dollars and the net-profit picture, and it will be more meaningful.

In 1970, there will be five times as many color sets as there are today. Assume there will be the same number of color-television servicemen. Each man will have to repair an average of 5 sets every day to keep them all going. Better equipment will be necessary, along with faster ways to hunt trouble. Even if charges stay exactly the same (they're likely to rise as all other prices will), the total

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service income for a color technician will average $17,875. About $10,500 of that should go for salary, which incidentally means a competent color-TV technician can earn a good salary from color sets alone--fixing only 5 sets a day.

And what about net profits in 1970? Parts sales for the five-sets-per-day you're servicing then will produce a gross profit around $5,000. Total gross profit, then, will be $7375 for service and $5,000 for parts, a total of $12,375. It's likely that overhead costs will have risen along with other prices and will take a bigger bite out of gross profit. A $3000 net profit would be acceptable, and don't forget that's over and above whatever salary you pay yourself or your color technician.

Something else to keep in mind: all this means that 55,000 color-TV technicians will have to work practically fulltime to keep up. The few black-and-white sets that are left and the other electronic gadgets which will have been sold by 1970 will be taken care of by the remainder of the probably 100,000 technicians. Many of them will be specialists in their own type of electronic equipment. And of course color experts will be able to do other servicing, too.

WHERE'S YOUR SHARE?

Yes, there is money to be made in color-television servicing. You can be having your share today. Apply yourself to the task, and you can take more than your 1/55,000 of the color-TV service work that's available; lots of service shops already have more than that. Specifically, here's how.

(1) Learn the basic operation of circuits in color chassis, even if you must spend much of your precious time in study, in school, in clinics, or in solitary evenings of reading, reading, reading about color television. You won't get your full share of today's servicing, let alone tomorrow's, unless you understand the sets.

(2) Learn the most modern and speedy troubleshooting techniques. Time wasted today may mean only that you don't make many dollars; in the future, it may mean you can't handle the load of sets you'll be asked to service, and the good wages will go to servicemen who have learned to do a thorough job quickly.

(3) Buy test equipment to do, in a reasonable time, the complete job your customer expects of you. You can't make money (profits) if you can't repair sets fast enough both to please the owner and to move several through in a day. Color sets require closer alignment, more thorough testing, and more careful servicing than monochrome receivers. Skimp on the job, and you'll soon get the reputation. Proper instruments, and knowledge of how to use them, are essential.

(4) Get experience as soon as possible. Don't wait until the work load is burying you (perhaps from your lack of skill). Work with an expert (even if he's younger than you). Learn by doing. Work on sets the cut-and-try way if you have to, but do it. Don't have time? You'll have less time later when more and more sets are demanding more and better technicians. Work on your own set. Work on your customers' sets. You gain experience only by working on sets. Now!

(5) Be sure you're charging enough--for your time and knowledge and for your investment in equipment and parts inventory. Don't forget your overhead expenses. If you don't ask enough for your specialized work on these complicated tinted sets, you'll discover that you can't afford the time- and labor-saving devices you'll need to handle the volume of sets you'll soon be asked to service. If you can't handle them properly, your customers will go somewhere else for service, and you would have far less than your fair share of this booming color-TV servicing market.

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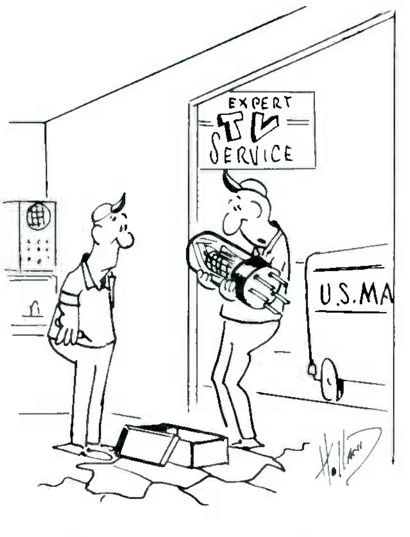

"Sure looked a lot smaller in the catalog."

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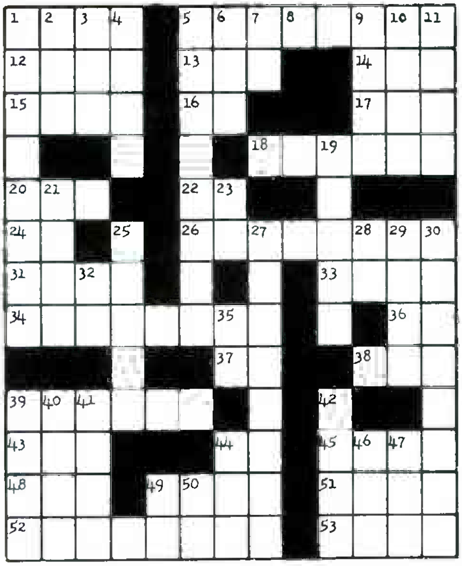
ELECTRONICS CROSSWORD PUZZLE



By James R. Kimsey

ACROSS

1. A small bracket in a cathode-ray tube on which "getter" material is deposited prior to exhaustion of the tube.
5. The application of extremely high negative grid bias to a vacuum tube, thus reducing the plate current to zero.
12. Tardy.
13. Be sick.
14. Old sailor.
15. Notion.
16. Abbreviation of a coil winding.
17. Biblical character.
18. Molded.
20. Watch chain ornament.
22. French article.
24. Southern state. (abbr)
26. The points of maximum current or voltage in a standing-wave system.
31. Masculine name.
33. An end that one strives to attain.
34. Any substance which becomes luminous as a result of exposure to radiant energy or bombardment by atomic particles.
36. Myself.
37. Chamber. (abbr)

DOWN

1. A color television term which indicates changes in color phase. (2 wds)
2. Young boy.
3. Consumed.
4. Wheel with cogs.
5. Form of mechanical hysteresis in which there is a lag between application of a driving force and response of the driven object.
6. Glowing.
7. Suffix used in chemical compound.
8. Third letter.
9. Bit of news or information.
10. Nostril.
11. An electrode used to control electrons from cathode to anode.
19. Extent of coverage.
21. Declaration of truth.
23. Printer's measure.
25. Sat for a portrait.
27. Fitting for convenience in making electrical connections.
28. Word element meaning "egg".
29. Any woman. (slang)
30. The elementary charge of negative electricity.
32. Toward.
35. Conjunction.
39. A track for those on foot.
40. Region.
41. To portion out, as cards.
42. Diagram.
44. Petroleum.
46. Malt drink.
47. Japanese statesman.
49. Type of current.
50. Regarding.

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38. Period of time. (abbr)
39. Any small capacitor inserted in series with a main capacitor to adjust its capacity to some predetermined value.
43. Form of "to be".
44. Switch position.
45. Den.
48. Beverage.
49. Solo operatic melody.
51. Portion of the troposphere located about 40 to 60 miles above the earth's surface.
52. An electrode submerged in a suitable electrolyte and used for measuring single electrode potentials. (2 wds)
53. An inert element from Group 0 of the Periodic Table of Chemical Elements.

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WANT TO ADD REFINEMENTS TO YOUR VTVM? HERE'S HOW

BY STEVE BAILEY

Since we first made the Model 211 VTVM available to our students, we have received many inquiries concerning the addition of certain features to the instrument. For one reason or another, some of these features were not incorporated. So, this article has been written to help those of you who wish to make some of the more common modifications requested by others. A list of the parts you will need is in Table I, found at the end of the article.

Before we get started, I would like to point out that the modifications should not be attempted unless you have completed the experiments in your course. This is because you will not be able to use the VTVM while the modifications are being made and you would be delayed in your studies if trouble should develop. Also, to make the modifications as quickly and accurately as possible, you should have the necessary tools on hand and be familiar with their use.

PILOT LIGHT

A pilot light is very handy as it is a constant reminder as to whether the VTVM is on, off, or receiving power. Also, it improves the appearance of the front panel when installed properly.

I found that a Drake Type 116 lamp with a 100K resistor in series with one of its leads works very well and is most attractive. To install this, refer to Fig. 1. The hole is located directly above the hole for the probe in the front panel. The center of the hole is in the exact center of the panel and 1-7/8" from the bottom. At this point drill a hole with a 5/16" drill. Slip the pilot light leads and its base through the hole in the front of the panel. The spring clip is pressed on the back of the lamp to hold it in place.

To connect the bulb in the circuit, wrap one of its leads around one end of a 100K, 1/2-watt resistor and solder the connection. Cut 2 pieces of hook-up wire, one 5 inches long and the other 9 inches long, and strip the insulation from the end of each one. Solder one end of the 9" wire to the free end of the resistor and the other end to terminal 24. One end of the 5" wire should be soldered to the other pilot light lead. The other end of this wire should be soldered to terminal

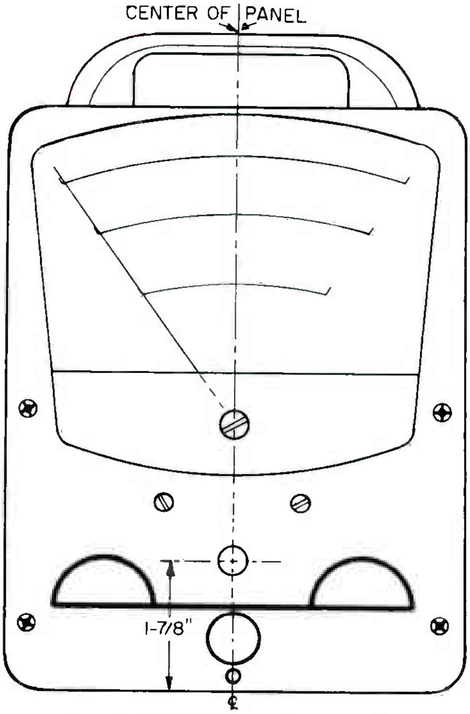

Fig. 1. Pilot light on front panel.

32. The pilot light leads should be insulated with tape or spaghetti.

DETACHABLE TEST LEADS

The VTVM probe and ground lead can be made detachable through the use of a microphone connector. When this is done, the test leads can be disconnected, folded, and carried when the VTVM is taken along for service calls. The biggest disadvantage in making this modification is that leakage may eventually develop between the front panel and the receptacle, resulting in improper and erratic VTVM operation. Normally, the receptacle is isolated from the front panel by fiber washers. If leakage should develop, the fiber washers or the connector (or both) may have to be replaced.

The microphone receptacle can be installed in the original probe hole by first disconnecting the probe and ground lead from the Func-

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tion switch. These should be removed completely from the VTVM.

Next, remove the metal washer from the probe hole by filing the inside of the hole with a rat-tail file. When the inner surface of the washer has been filed away, it will break off from the panel. The diameter of the hole should now be measured and filed until it is exactly 1/2". The hole should be completely cleaned of all metal particles.

Locate the two fiber washers now. One should be installed from the back of the panel with the shoulder facing the front. The other should be installed from the front with the shoulder facing the back of the panel.

Install the receptacle in the hole now. A solder lug should then be slipped over the body of the receptacle behind the fiber washer. Then a nut is threaded onto the receptacle holding the solder lug firmly in place. The installed receptacle is shown in Fig. 2.

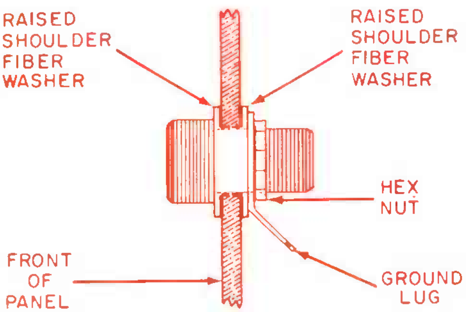

Fig. 2. Installed receptacle of the VTVM.

You are now ready to connect the receptacle to the function switch. Cut 2 pieces of hook-up wire 3" long and twist them together. They should be of different colors to assist in identification. Strip about 1/4" of insulation from the end of each wire.

Solder one end of one wire to the solder lug on the receptacle. The other end of the wire should be soldered to lug 11 on Deck B of the function switch.

Insert the end of the other wire nearest the receptacle into the center hole of the receptacle and solder the connection. Clip off any excessive lead that extends beyond the soldered connection. Then, solder the other end of the same wire to lug 12 on Deck C of the function switch.

We must now connect the probe to the connector unit. The probe is shown in Fig. 3.

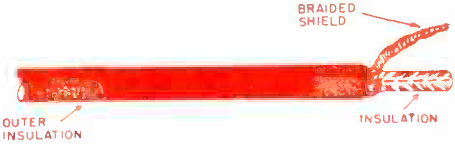

Fig. 3. The prepared probe.

Remove the spring from the connector unit by loosening the setscrew.

Now, place the ground lead beside the probe lead so that the stripped end of the ground lead lies on the braided shield as shown in Fig. 4. Then, insert the spring over the leads. Twist and turn it until about one inch of the probe lead extends beyond the end of the spring. The ground lead and the braided shield should be twisted together and soldered to the end of the spring as shown in Fig. 5. Any excess should be cut off as close to the soldered connection as possible. Strip the plastic insulation from the end of the probe lead now.

Mount the spring and probe lead in the connector. To do this, insert the probe lead in the hole in the connector as far as it will go. Then, solder the connection and clip the excess probe lead as close to the soldered connection as possible. Finally, tighten the setscrew in the connector unit. The modified probe should appear as shown in Fig. 6.

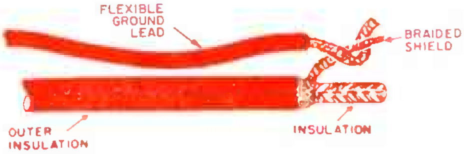

Fig. 4. Shield and ground lead together.

To check your work, attach the connector to the receptacle. Turn the VTVM to the ohmmeter range. See if you obtain any reading. If not, connect the ground clip and probe together. The pointer should go nearly to zero. If it doesn't, you have a poor connection. If the pointer remains over the infinity mark on all ranges of the ohmmeter with the probe

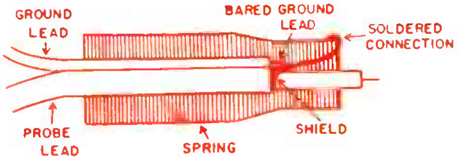

Fig. 5. Probe with spring.

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and ground lead separated, you have made good connections and the unit is working properly.

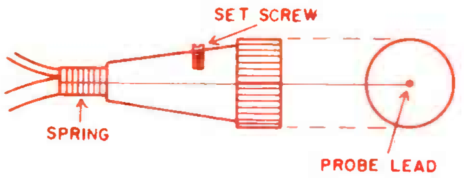

Fig. 6. The modified probe.

CALIBRATION JACKS

After the VTVM has been installed in a cabinet, calibration becomes a more involved procedure since the VTVM must be removed from the cabinet for you to gain access to the battery. This can be simplified by the installation of pin jacks, as shown in Fig. 7.

The pin jacks are to be installed in 3/8" holes drilled 1/2" from the top of the bottom row of ventilation holes on the left side of the cabinet as you are facing it. The pin jacks are installed from the outside of the cabinet and are attached with the nuts provided with them.

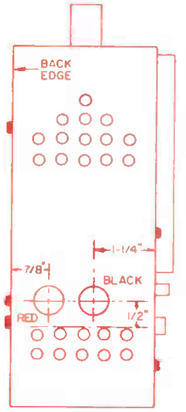

Fig. 7. Installed pin jacks from the outside of the cabinet.

One of the pin jacks is red. You can connect a 12" wire from this jack to pin 2 of the 6X4 socket or to the positive terminal of the "D" cell battery clip which we will discuss later. This will connect the jack to the 1.5 volt source so the VTVM can be calibrated without removing it from the cabinet. All you have to do is insert the tip of the probe into the pin jack to get a 1.5 volt reading.

The other pin jack is black. This is to be used for a ground point. You can connect the lug of the pin jack to the center shield of the 6X4 socket with a 12" wire, or to the negative terminal of the battery clip mentioned previously.

To calibrate the VTVM using the pin jacks, you turn it on to the +dc, 3 volt range, and allow sufficient warm-up time. Then, you set the pointer over zero using the zero set control.

Next, insert the probe tip into the red pin jack. The meter will indicate a reading. The pointer is then adjusted over 1.5 with the calibration control.

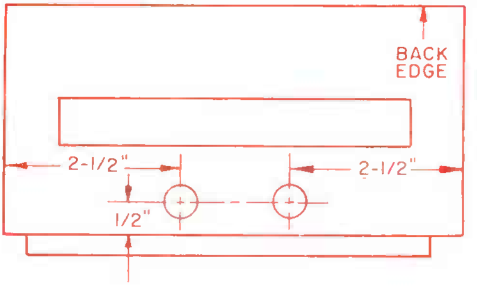

Fig. 8. Dimensions necessary to drill access holes.

To calibrate the VTVM on the ac function, remove the probe from the red pin jack. The pointer should return to zero. Turn the VTVM function switch to the ac position and insert the probe in the black pin jack. Then, adjust the ac zero-adjust control until the pointer is over zero.

Remove the probe now. The VTVM is completely calibrated.

CALIBRATION HOLES

It would not do much good to install pin jacks without providing easy access to the calibration potentiometers. Fig. 8 gives the dimensions necessary to drill access holes to the Calibration Control and the ac Zero Adjust Control.

The holes are located 1/2" from the front edge of the cabinet. There are 2-1/2" from each side to the centers of the holes.

After the holes are drilled, they can be labeled for easy identification.

BATTERY CLIP

The final modification is to install a battery clip. I have not found this as necessary as some of the other modifications. It should not

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be necessary to replace the battery more than once every twelve months. Also, there is always the possibility of leakage developing in the clip, which will upset the operation of the ohmmeter circuit.

The most convenient place to install the clip is on the back of the cabinet itself. Fig. 9 shows the location of the holes from the back of the cabinet. Hole A is drilled 2" from the left side and 1-1/4" from the top. Hole B is 3-7/8" from the left side and 2" from the top. Each hole is to pass a 6/32 screw.

To make the electrical connections, you can solder one end of a 12" piece of hookup wire to the positive terminal of the battery clip and the other end to pin 2 of the 6X4 socket. If you installed the pin jacks, connect the wire to the red pin jack instead of pin 2.

The wire from the negative terminal of the battery clip can be connected to the center shield of the 6X4 socket or to the black pin jack if you installed it.

Unsolder the original battery from the circuit now. Remove the wire that was connected to the positive terminal of the battery from pin 2 of the 6X4 socket. Also, remove the wire that was connected to the negative battery terminal from lug 11 on Deck C of the Function switch. You can now install the original battery or discard it and install a fresh one in the battery clip.

You can perform all of the modifications listed here if you wish, or any one of them. In any event, be sure to follow the instructions carefully and observe the precautions that were mentioned. Do a good job and you will be proud of your instrument.

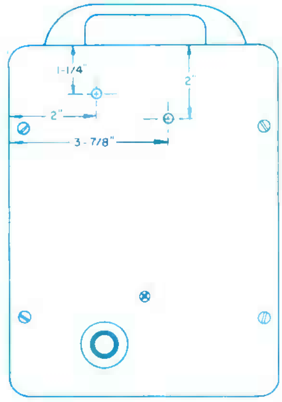


Fig. 9. Location of drilled holes in the rear of the cabinet.

PARTS LIST

Pilot Light

1 - Drake Type 116 Lamp NRI No. LP-8 $.25
1 - 100K Resistor NRI No. RE36 $.10

Detachable Probe Leads

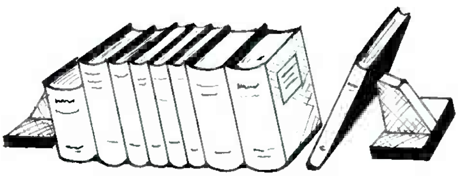
Connector - Amphenol 75 MC IF
Receptacle 75 PCIM
Probe (NRI No. PR-1 - $.75)

Pin Jacks

NRI No. JA3 red Pin Jack $.32
NRI No. JA4 black Pin Jack $.32

Battery Clip

Standard Clip for "D" cell.



Perhaps you've seen the new electric drills with an electronic variable-speed control -- or a new table lamp with a built-in dimmer. They are examples of an important new development in electronic controls -- silicon controlled rectifiers.

These are important new semiconductors, now coming into widespread use, capable of switching currents on and off many thousands of times a second without deterioration. Although SCR's may be operated by extremely small signals -- the output of a photocell or a thermocouple -- they can control kilowatts of power. Yet, they are only a fraction of a size of the bulky mechanical components or large electron tube circuits formerly required.

A new Sams book, ABC'S OF SILICON CONTROLLED RECTIFIERS, by Allan Lytel, clearly and simply explains their principles of operation by comparison to transistors and diodes. It details the various types of input signals which may be used and how they may be obtained using capacitors, unijunction transistors and saturable reactors.

The practical book includes typical SCR circuits and applications and the many applications which are becoming practical with the elimination of large mechanical or electronic circuits.

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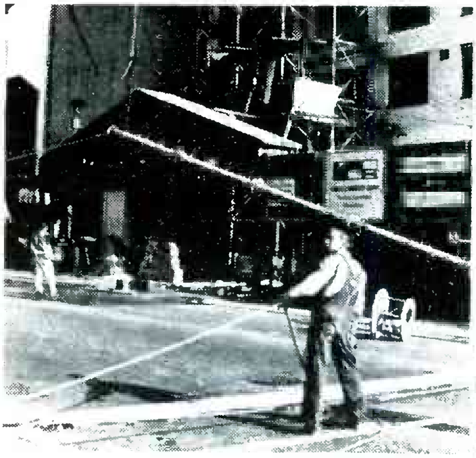
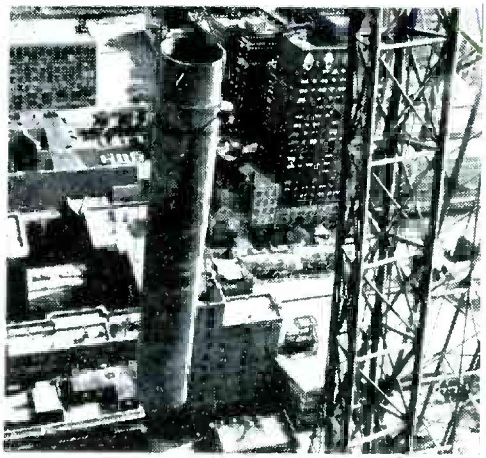


GOING UP. . . .

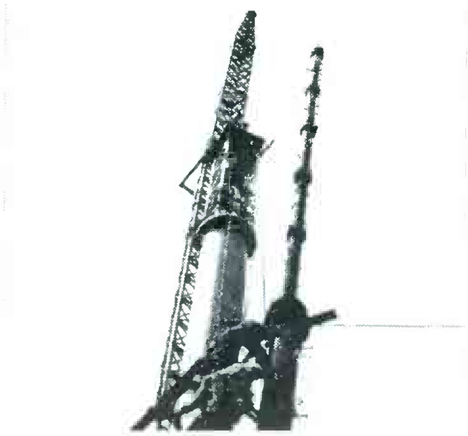


AND UP . . . .

COMBINED UHF-VHF ANTENNA OPERATING ATOP 55-STORY APARTMENTS IN CHICAGO

The first UHF and VHF helical television antenna to be combined in a single tower is operating in Chicago atop the newly built 1000 Lake Shore Plaza, a 55-story, 590-foot high apartment building. Photos show step-by-step sequence of the antenna's positioning by ACRO Engineering. The largest section was a 30-foot high, 36-inch diameter, six-ton pipe that serves as a base for the antenna. The antenna transmits for Chicago's two educational television stations, Channel 11 and Channel 20. The 250-foot tower prevents interference from any other buildings in the Chicago area. Rent-free accommodations for the antenna and the two-story penthouse housing the transmitter were donated to the Chicago Educational Television Association by the developer, Harold L. Perlman.

TO THE TOWER . . . .



AND READY FOR BUSINESS.

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"SORT OF A GOODWILL ON WHEELS"

NRI GRADUATE, PARTNER FIX UP A FIX-IT BUSINESS

John Thomas and Alphonso Moore, co-owners of a fix-it shop on wheels, are like good-humor men on a July afternoon---they don't have to go far before they are swamped with orders.

Their route covers the entire metropolitan Washington area, including adjacent Maryland and Virginia towns. "Some days we only get to go six or eight blocks all day," says Thomas. Like NRI graduate Moore, he is handicapped, and the repair bus, operating since last March, is their answer to finding new employment of their old talents as well as maybe helping some others out.

The bus is fully equipped to handle just about any kind of repair, from appliance and radio-TV servicing to jewelry mending to sharpening lawn mowers (or snow shovels) to light welding. A 200-amp welder-generator takes care of the power problem.

When the bus enters an area on one of their six-day schedules, they just stop it and announce on their PA system that they're there, ready to do business, and then the rush begins.

Heavier welding and furniture repairs or upholstering are handled at their auxiliary shop at 6104 Central Ave. in Capitol Heights, Md., but the work done on the bus is generally about 90 per cent of their total output. Work they have to take back to the shop is returned within a week.

Thomas calls the bus a "sort of goodwill on wheels", referring to the fact that the other three men who staff the bus and the two who stay at the shop full time are all handicapped in some fashion, and all received further training in their respective fields through the Maryland State Vocational Rehabilitation Administration. Rehab counselor for both Thomas and Moore was Joseph Proctor, who

The bus that gets the business.

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Alphonso Moore shows off bus to Joseph Proctor.

encouraged them in the fix-it bus idea. (Maryland provides on-the-job training and some hand tools for testing equipment for self-employed handicapped who are under their auspices.)

Along these latter lines, Moore and Thomas hope to interest other handicapped persons in learning their trades, and in fact do advertise that they will provide on-the-job training, as well as telling their customers that if they know of anyone who is interested, to have the prospective students get in touch with them or the State Vocational Rehabilitation agency.

The business seemed a natural for them; both received their disabilities while working on government jobs, Moore as a certified welder and Thomas as an auto and diesel mechanic; both felt they had "too much background to waste."

Moore is the radio-TV expert of the fix-it crew. His NRI training wasn't put to too much use while he was working as a welder; he enjoyed servicing, but it was "just a hobby" to him. Now he's really appreciating it, and NRI is becoming a family affair...his son-in-law is an NRI student now. (Owen H. Tucker, one of the two who stay at the shop all day, is also an NRI graduate.)

Moore's knowledge of radio-TV servicing and his conscientiousness have made him "a very valuable man" to the enterprise, Thomas says. "He'll work on the bus all day and then go back to the shop and work until 10 or 10:30 at night."

With less than a year in business, overhead and operating expenses and $7,000 worth of equipment to pay for are still cutting deeply into profits, but the idea (don't come to us - we'll come to you) is going over so well that Thomas foresees---hopefully---a not-too-distant time when "there'll be more handicapped fix-it buses on the road, and shops all over", and they hope, many more handicapped men trained in servicing work.

John Thomas, foreground, in shop.

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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 (Division of Radio Corporation of America) Camden, N. J. Openings exist for TV Servicemen at most RCA Service Company Factory Service Branches. Technical School training essential and B and W and Color Service experience preferred.

Interested applicants may apply at the RCA Branch near their home - consult "Yellow Pages" - or by writing to D. A. Giordano, Manager, Employment, RCA Service Company, Cherry Hill, N. J. These positions offer excellent starting salaries and benefits program. RCA is an Equal Opportunity Employer.

RCA SERVICE CO.
5400 Lafayette St., Hyattsville, Md.
Needs several radio-TV technicians.

LEONHARDT APPLIANCES INC.
309 Guthrie, Louisville, Kentucky
Needs experienced refrigerator man

RADIATION SERVICE CO.
501 Tecumseh Street, P. O. Box 1201
Fort Wayne, Indiana 46801
Openings for qualified candidates in any of its exchange offices throughout Indiana. No previous experience needed for: PBX MAN--Will install and maintain mobile telephone systems of electronic relay and electro-mechanical types.
SWITCHMAN--For mobile telephone systems. Will 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 engineers, and production engineers.
Write: W. F. Jones, personnel director.

SYLVAN STEREO AND TV SERVICE CO.
(Division of Sylvan Electronics)
306 Kennedy St., N. W., Washington, D. C.
Openings for radio-TV serviceman. Call Mr. Lee at 726-5800.

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

CHESAPEAKE AND OHIO RAILWAY CO.
409 Eleventh St., Huntington, West Virginia
Openings for technicians for electronics maintenance on railroad. Must have second-class license or better. Present openings in Illinois, Michigan, Kentucky, and Virginia.

STATION WFMD
No. 1 West Seventh, Frederick, Md.
Opening for technician with first-class license.

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

AERO TV AND APPLIANCE CO.
7314 Little River Turnpike, Annandale, Va.
Write: Ashton Berry
Opening for appliance servicemen.

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

UNITED AIR LINES
Washington National Airport
Washington, D. C.
Opening for radio technician.

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

SACRAMENTO ARMY DEPOT
Sacramento, California
At moment needs 120 radio technicians. There will be continuing need for such technicians.

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

> The reason a lot of people do not recognize opportunity is because it usually goes around wearing overalls looking like hard work.
>
> Ben Franklin

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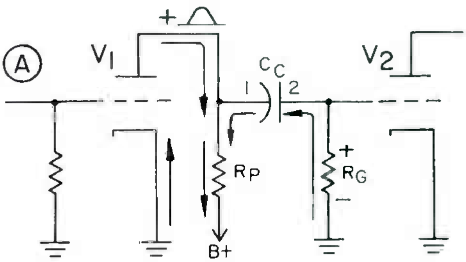
BY STEVE BAILEY

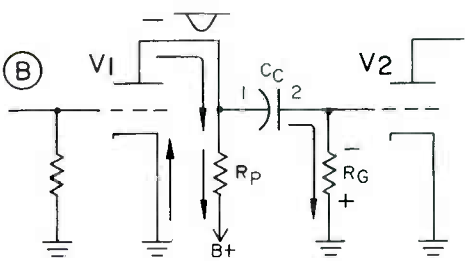
DEAR STEVE,

Would you show me exactly how the ac signal from the plate of one stage reaches the grid of the next stage through a coupling capacitor?

B. T., Maryland

In Fig. 1A, I have shown a diagram of a simple R-C coupled amplifier. Before a signal is applied to this amplifier, the dc current in the plate will charge the coupling capacitor. This charge will remain steady until an input signal is applied. Then the voltage will vary above and below the steady voltage, becoming more positive and less positive with changes in the signal voltage.





When a signal is applied, it will cause the plate current to vary at the same rate as the signal current. When the plate voltage increases, the voltage at plate 1 of the coupling capacitor becomes more positive. The voltage on plate 2 will attempt to equalize the positive voltage on plate 1. This causes electrons to be drawn upwards through the grid resistance to plate 2 of the coupling capacitor. The electrons flowing through the grid resistance will develop a voltage drop with the polarity that is shown. Notice that the polarity is the same as the polarity of the signal on the plate of V1.

When the signal on the plate of V1 reverses and becomes negative, the charge on plate 1 of the coupling capacitor also becomes negative (less positive). An excess of electrons will build up on this plate which will repel electrons from plate 2. These electrons will flow downwards through the grid resistance developing a voltage drop with the polarity shown. Again notice that this is the same polarity as the voltage at the plate of V1.

The actual voltage on the grid will vary according to the variations of the signal on the plate of V1. Thus, the voltage across the grid resistor is ac and is the input to this stage.

DEAR STEVE,

According to lesson 11BB, the plate is at signal ground potential in a cathode-follower amplifier, yet Fig. 27 shows it connected to B+. Does this mean that B+ is at ground potential?

A. D., Iowa

The statement on Page 33 of Lesson 11 is quite correct. The plate of the circuit shown in Fig. 27 is at ground potential. Also, effectively B+ is at ground potential as far as the signal is concerned. (See Fig. 2.)

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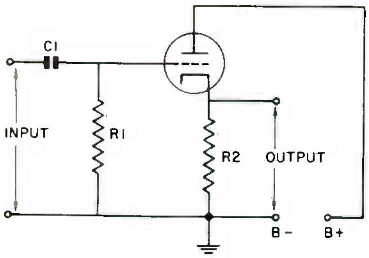


Fig. 2. Schematic diagram of a cathode-follower stage.

The key to understand this is understanding the portion that says, "as far as the signal is concerned." If you refer to Fig. 3, you will notice that there is a battery in the plate circuit. One side of the battery connects to ground. This is B-. The other side of the battery connects to the plate. This is B+. The signal that appears in the plate circuit will flow to ground through the battery or power supply since the battery or power supply represents a capacity to it. Since the signal will be ac, there will be little or no opposition to it. So, as far as the signal is concerned, B+ is at ground potential.

DEAR STEVE,

I am currently studying the grounded-cathode circuit in lesson 10. I don't quite understand how this circuit is able to amplify a signal and why the input and output voltages are 180° out of phase. Could you clear this up for me?

S. T., Mich.

Refer to the diagram in Fig. 4. This shows a basic grounded-cathode amplifier circuit. The symbol in the grid circuit represents the input signal applied between the grid and the cathode. The bias voltage is chosen so that the input signal will swing over the straight

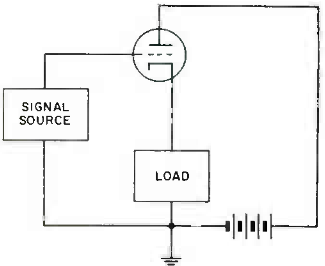


Fig. 3. A grounded-plate or cathode-follower circuit.

portion of the characteristic curve to give amplification without distortion. As the grid voltage varies, the plate current of the tube will also vary. The amplified signal across the plate resistance is coupled into external circuits through the coupling capacitor. This is a brief summary of amplification.

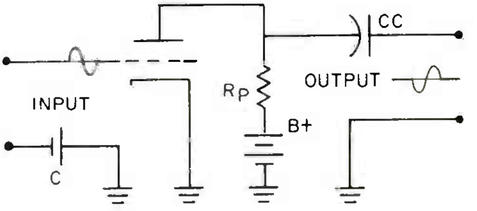
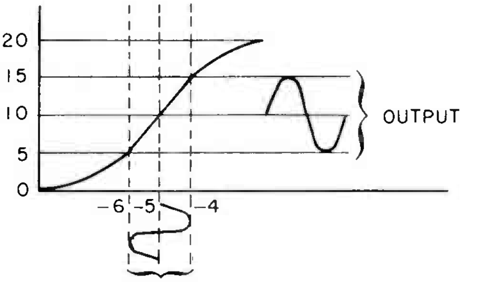


Fig. 5 shows the characteristic curve of a typical tube. To obtain an output voltage that is an enlarged reproduction of the input voltage, the tube must be operated on the straight portion of the curve. Notice that 5 volts of bias allows a 2-volt peak-to-peak signal to stay within the straight, but relatively steep, portion of the curve.



When a signal is applied to the tube, the potential on the grid varies to either side of the normal bias point. As the grid becomes more negative, the plate current decreases; and as the grid becomes less negative, the plate current increases. This produces a plate current that is pulsating dc. These pulsations are dependent upon the changes in voltage at the grid of the tube. The plate current of the tube flows through the load resistor. As the current through this load changes, the voltage drop across the resistor will also change.

For example, the plate current of the tube is 10 ma when negative 5 volts are applied to the grid of the tube. The changes in grid voltage cause the plate current to vary between 5 ma

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and 15 ma; this variation in current will produce a varying voltage drop across the load.

Suppose the load resistance is 10,000 ohms. Also, consider 10 ma as a reference point because it is the value of plate current when no signal is applied to the tube. With no input signal, 100 volts will appear across the plate load resistor.

When the grid voltage decreases to 4 volts, the plate current will be 15 ma, and the voltage drop across the plate resistor will be 150 volts. When the grid voltage is negative 6 volts, the plate current will be 5 ma, and the voltage drop across the plate resistor will be 50 volts. You can see that the voltage across the plate resistor is varying in an ac manner; that is, the voltage across the load is increasing to a value greater than the reference value and decreasing to a value that is less than the reference. The voltage is actually pulsating dc.

Pulsating dc can always be considered as pure dc plus an ac component. In this particular case, we have the dc plate voltage of the tube plus a 100-volt peak-to-peak (150-50) ac signal.

This ac signal in the plate circuit of the tube is produced by the 2-volt peak-to-peak (6-4) ac signal in the grid circuit. The signal has been amplified 50 times.

The B+ end of the load resistor is connected to ground, so far as the signal is concerned. Therefore, we say that the ac signal in the plate circuit appears between the plate of the amplifier tube and ground.

The coupling capacitor couples the signal into external circuits. As the capacitor will not pass dc, only the amplified ac signal appears at the output terminals.

Now let's consider the current-voltage relationships for a moment. As the grid becomes more negative with respect to the cathode, the plate current decreases; and as the plate current decreases, the voltage drop across the plate load decreases. Therefore, the voltage between the tube plate and cathode becomes more positive as the tube grid becomes more negative. Likewise, the voltage between the tube plate and cathode becomes less positive as the grid voltage becomes more positive. This effect keeps a steady 180-degree phase difference between the input circuit and the output circuit.

DEAR STEVE,

How is the formula $X_C = \frac{159{,}000}{F \times C}$ derived from $X_C = \frac{1}{6.28 \times F \times C}$ as shown in Lesson 7?

W. R., Wisconsin

The formula for capacitive reactance can be rearranged so that you can determine the reactance by multiplying the frequency by the capacity, and then dividing this number into 159,000. To arrive at the number 159,000, we first convert farads into microfarads. When we do this, we must compensate for the change by inserting 1,000,000 into the formula as shown:

$$X_C = \frac{1 \times 1{,}000{,}000}{6.28 \times F \times C}$$

Next, we multiply 1 × 1,000,000 which, of course, gives us 1,000,000. We can eliminate the 1,000,000 by dividing it by 6.28 which gives us 159,000. Our formula is now:

$$X_C = \frac{159{,}000}{F \times C}$$

Keep in mind that this formula is used only when you express the value of capacity in microfarads. If the value is given in farads or picofarads, you will have to convert the number to microfarads. Then, this simple formula can be used.

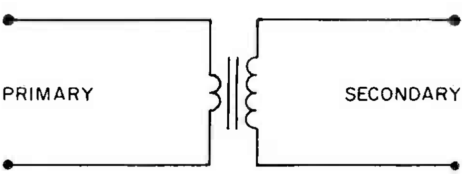
DEAR STEVE,

Would you tell me how I can tell from a diagram whether a transformer is step-up or step-down?

R. F., Venezuela

You can tell a step-up transformer from a step-down transformer by the number of turns in the secondary winding in relationship to the number of turns in the primary winding. A step-up transformer will have more turns in the secondary than in the primary. On the other hand, a step-down transformer will have more turns in the primary than in the secondary.

To illustrate this, I have shown two diagrams.



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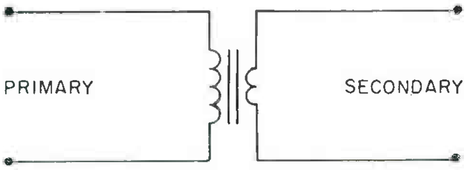
In Fig. 6 we have shown a diagram of a step-up transformer. You will notice that there is one turn in the primary and three turns in the secondary. Thus, the turns ratio is 1:3 step-up.



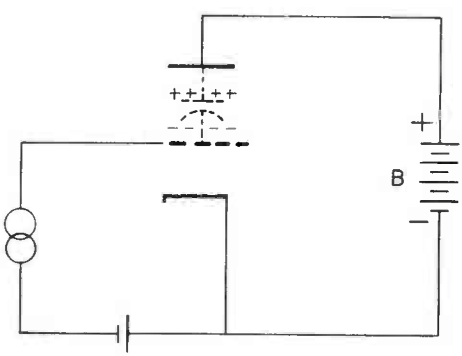
In Fig. 7, I have shown three turns in the primary and only one in the secondary. Thus, since there are more turns in the primary than in the secondary, this is a step-down transformer.

If we were to apply 100 volts to the primary of the step-up transformer, there would be 300 volts in the secondary because it is a 1:3 step-up transformer. However, if we applied 100 volts in the primary of the step-down transformer with a 3:1 step-down turns ratio, there would be only 33.3 volts in the secondary.

DEAR STEVE,

What does the term "inter-electrode capacitance" mean and how does it cause feedback?

M. J., Ohio



Inter-electrode capacity refers to a capacity formed by the electrodes in a tube. As you know, any two conductors separated by a dielectric will form a capacitor. The electrodes of the tube are such conductors. The dielectric is the vacuum between them.

A capacity can exist between the cathode and the grid, the grid and the plate, and the cathode and the plate of a tube. Because of the small area of the conductors, these capacitors have small capacitance. Even though it is small, the capacitance provided by the combination of the grid and the plate can cause considerable trouble. By means of this small capacitive effect, the output circuit (the plate circuit) and the input circuit are linked and feedback can occur.

In Fig. 8, I have shown a capacitor connected between the plate and the grid of a tube. The "B" battery in the plate circuit places a positive charge on the plate. The plate current will fluctuate because of changes in the applied signal. This, in turn, will cause the plate voltage to fluctuate.

Now, consider the plate and grid as two conductors forming a capacitor. The plate of the tube, having a positive charge, causes a certain number of electrons to gather on the grid. Thus, the grid gets a negative charge. The more positive the plate becomes, the more electrons are pulled over to the opposite electrode of the capacitor, the grid. The less positive the plate, the fewer electrons will be attracted to the grid.

As you can now see, the electron fluctuation in the grid circuit varies at the same rate as the input signal, thus adding to it and causing feedback.

ANSWER TO CROSSWORD PUZZLE
ON PAGE 10

1 F	2 L	3 A	4 G	■	5 B	6 L	7 O	8 C	K	9 I	10 N	11 G
12 L	A	T	E	■	13 A	I	L	■	■	14 T	A	R
15 I	D	E	A	■	16 C	T	■	■	■	17 E	R	I
P	■	■	R	■	K	■	18 F	O	19 R	M	E	D
20 F	21 O	B	■	■	22 L	23 E	■	■	A	■	■	■
24 L	A	■	25 P	■	26 A	N	27 T	I	N	28 O	29 D	30 E
31 O	T	32 T	O	■	S	■	E	■	33 G	O	A	L
34 P	H	O	S	P	H	35 O	R	■	E	■	36 M	E
■	■	■	E	■	■	37 R	M	■	■	38 S	E	C
39 P	40 A	41 D	D	E	R	■	I	■	42 P	■	■	T
43 A	R	E	■	■	■	44 O	N	■	45 L	46 A	47 I	R
48 T	E	A	■	49 A	50 R	I	A	■	51 A	L	T	O
52 H	A	L	F	C	E	L	L	■	53 N	E	O	N

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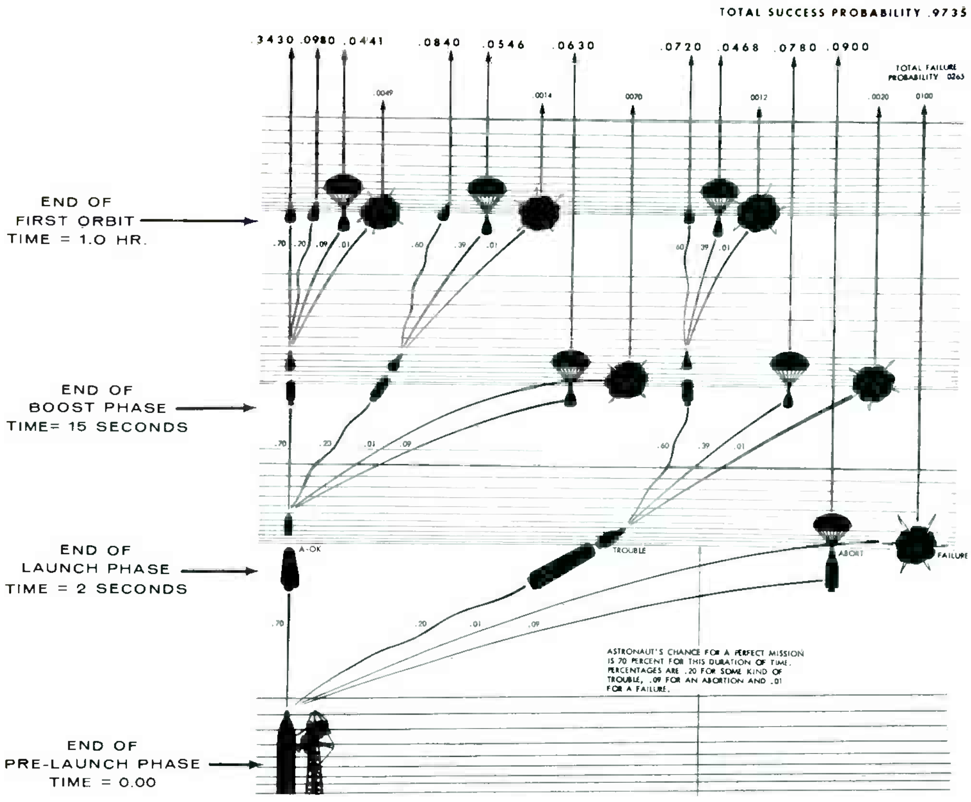

PREVIOUS TO LAUNCH, A SAFE MISSION IS PROBABLE.

DRIFT Predicts Outcome Of Space Flights

NEW YORK -- A mathematical technique which would permit mission chiefs to predict instantaneously and continuously the outcome of a space flight has been described here by an engineer of Sylvania Electric Products Inc. Sylvania is a subsidiary of General Telephone and Electronics Corporation.

Known as DRIFT (Dynamic Reliability Instantaneous Forecasting Technique) the technique is shown above in an artist's concept. The technique could visually depict alternate choices and their probability of success in percentages by analyzing past performances and relating them to equipment failures during a space flight.

Using telemetered information and computers to calculate the probability of success or failure, the technique could be utilized in a space flight control room to assist a mission chief in making instantaneous decisions throughout a mission.

The chart shows three stages of a representative flight together with forecasts of the flight (left to right) (1) proceeding A-OK, (2) encountering trouble, (3) forced to abort, or (4) resulting in failure. An astronaut's chances during a mission are the products of percentages at the end of the various mission phases.

The technique was described by Norbert Jagodzinski, a research engineer at Sylvania Electronic Systems, a division of the company, at the Institute of Electrical and Electronics Engineers (IEEE) Fourth Annual New York Conference on Electronic Reliability.

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NRI GRADUATES: Where They Are, What They're Doing

Thousands of Graduates of the National Radio Institute are profitably employed in Electronics -- using their NRI-acquired knowledge and skills in Industry, the government, and their own businesses.

They are in practically every branch and every activity in the field of Electronics, as this partial list shows.

IN INDUSTRIAL-GOVERNMENTAL ELECTRONICS

Gaston Belanger Camp Valcartier, P. Q. Canada	Telecommunications Technician	Army
William J. Bennett Winfield Park, N. J.	Technical Field Representative	Magnus Organ Corp.
Ira H. Bevill Baytown, Tex.	Radio Technician	Texas Eastern Trans. Corp.
Laurent O. Blouin Lawrence, Mass.	Mfg. Engineer	Avco Rad
Frank Bolen Atlantic Highlands, N. J.	Instructor	U. S. Army Signal School Ft. Monmouth, N. J.
James J. Bollinger New Orleans, La.	Maintenance Supervisor	Western Union
Robert M. Bond Garland, Tex.	Field Support Engineer	Collins Radio Co.
Charles W. Boomhower Seattle, Wash.	Signal Technician	City of Seattle Traffic Eng.
Raymond Boucher Lowell, Mass.	Testman	Raytheon
Edward S. Boutwell Hattiesburg, Miss.	Electronic Repair Supervisor	Mississippi National Guard
Dale A. Branson Concordia, Kans.	Transmitter Engineer	KFRM, Inc.

RADIO-TV REPAIRMAN-SERVICE TECHNICIAN

Clayton P. Johnston	Service Manager - Electronic Technician	Montgomery Ward Shippensburg, Pa.
Felix F. Kyle	Radio, TV and Electrical Appliance Serviceman	Vaughn Hardware Co. Winchester, Tenn.
Jerome T. Langr	Television Technician	Parkland Hall Appliances West Concord, Minn.
Raymond A. Ludwig	Shop Foreman	Lahmer's TV Sales and Service, Uhrichsville, Ohio
Albert D. McKnight	Serviceman	Sears, Roebuck Co. Salisbury, N. C.
William J. Morkert	Service Manager	Ted's TV Service Rapid City, S. Dak.
Ernie Nichols	TV-Radio Serviceman	Camp Television and Appliance Spencer, W. Va.
John R. Reiner	TV Repairman	RCA Service Co., Inc. Hyattsville, Md.
David E. Roberson	TV Repairman	Dougan's TV Service Jacksonville, Fla.
Edward J. Rogers	Television Technician	Radio Service Co. Astoria, Oregon
Stanley Sadowski	Radio and TV Repairman	Loeb and Wernett, Inc. Dunkirk, N. Y.
Russell D. Skaggs	Radio, TV and Electrical Appliance Serviceman	Sears Roebuck
Bernie H. Taylor	Radio-TV Repairman	Sechrist TV Hellam, Pa.

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Their Positions Cover A Broad Range In Electronics Field Throughout U.S.

FULL-TIME OWNER OF RADIO-TV SERVICE-APPLIANCE BUSINESS

Richard P. Boylan Kansas City, Mo.	Boylan Electronics
James R. Bramley Bainbridge, N. Y.	Ray's Radio Shop
Dale E. Brown Peterstown, W. Va.	Brown's Radio and TV Service
Kenneth O. Brown Marmora, N. J.	Ken's Television and Radio
Olen B. Bullard Lake Charles, La.	Bullard's Radio and TV
John Burnett Chicago, Ill.	Owner
John D. Campbell Chicago, Ill.	Partner, Ellis and Campbell's A-1 Radio and TV Service
Alfred Chibante Atwater, Calif.	Al Chibante Radio and TV
Lewis James Clark Colton, N. Y.	CIC Electric Home Appliance Repair Service
Charles E. Climer N. Little Rock, Ark.	Climer's TV Service
Reid D. Coldfelter Lexington, N. C.	Reid's Radio and TV Shop
Othal Cluse Canfield, Ohio	Youngstown Hearing Aid Co.
Eddie Coleman Birmingham, Ala.	Coleman and Peterson TV (partner)
Lester Corey Norwich, Conn.	Corey's Radio and TV Service

SELF-EMPLOYED PART-TIME RADIO-TV-APPLIANCE SERVICING

Valle Burke
Portsmouth, Ohio
George Lee Cameron
Kingston, Ont. Canada
John E. Cannon
Albright, W. Va.
James L. Chance
Encinitas, Calif.
Al Coffman
Del City, Okla.
LeRoy F. Cool
Albany, N. Y.
Anthony F. Coppoletti
Rockford, Ill.
Grover H. Defenbaugh
Columbus, Ohio
Veryl L. Dunn
Hot Springs, Ark.
Charles B. Floyd
Filmore, Calif.
Elbert H. Foster
Forestburg, Tex.
John D. Gibbello
Napa, Calif.

Edward P. Grinarml
Brandywine, Md.
Edward J. Gross
St. Paul, Minn.
George Hardy
Youngstown, Ohio
Rupert Hardy
Roxobel, N. C.
H. C. Harmon
Paris, Miss.
Irving W. Hedges
Kincheloe AFB, Mich.
Harvey W. Herdman
Branchville, N. J.
Raymond Howell
Andrews, Tex.
Joseph T. Knapp
Mentor, Ohio
Robert F. Knotts
Birmingham, Mich.
R. Eugene Lenherr
Greencastle, Pa.
Zeldon O. Little
Johnstown, Pa.

R. E. Loughman
Dunns Station, Pa.
Lemmuel T. Martin
Indianapolis, Ind.
Cliff McBay
Mt. Hope, Ont. Canada
Karle W. McInturff
Bridgeport, W. Va.
F. D. McLendon
Dawson, Ga.
Ralph E. McLeod
Columbus, Ga.
Charles L. Miles
Terre Haute, Ind.
Maurice H. Miller
East Stroudsburg, Pa.
Samuel C. Minetti
Madison, N. J.
Harold C. Nolff
Inkster, Mich.
Ansel Orr
Mountain Rest, S. C.
Clarence N. Pedigo
Roanoke, Va.

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35 Years Ago

As recorded in National Radio News

South Carolina's proposed state tax on radio receiving sets had been declared unconstitutional by the state's supreme court, which ended the first attempt to levy fees on the listening public for the reception of radio programs.

A statistical report compiled by the Electrical Equipment Division, Department of Commerce, from information furnished by manufacturers, showed that 158,965 tons of material went into the estimated annual production of 3,900,000 receiving sets.

Testing of the radio telephone link between New Zealand and Australia had commenced. Initial tests had proved satisfactory and telephone conversation was exchanged without difficulty between two radio stations.

There were approximately 1,100 broadcast stations in the world, one half of which belonged to the United States.

Short-wave radio was used for communication between the end of freight trains, sometimes more than a mile long.

Regular commercial telephone service was available between North America and Australia, over the longest circuit ever established for commercial use. It consisted principally of two radio links--one across the Atlantic and another between England and Australia. Service was available to all points in the United States, Cuba and to the principal cities of Mexico.

Compared to $5,000,000 in radio sales for 1922, present indications point to the American public spending more than a billion dollars for radio sets during 1931, stated M. S. Burns, vice-president of E. T. Cunningham, Inc., radio tube manufacturers.

O. H. Caldwell, former radio commissioner, announced that any city's smoke problem was curable by the use of automatic electronic smoke detectors. Simply an adaptation of the ordinary radio tube, these "electrical brains" installed at the source of the smoke, "saw" the smoke released and automatically applied correctives without the intervention of human hands.

It was estimated that 10,000,000 people had been added to the weekly motion picture audience by "Sound Pictures", a direct branch of radio because vacuum tubes, audio amplifiers, electrical phonographs, pick-ups, photoelectric cells and loudspeakers are used in the systems.

The change from the former 48-line, 15 pictures per second scanning to the present 60-line, 20 pictures per second scanning system of WZXCR and other television stations, "provides not only greater pictorial detail, but also reduces flicker negligible minimum."

A new aid to radio in connection with its use in automobiles has been developed by engineers of the A. C. Spark Plug Company. This plug eliminated interference from the automobile's ignition system, and certainly should do a lot to improve radio reception in automobiles. In addition to being particularly beneficial in police cars equipped with radio, this should certainly be a valuable improvement which will tend to popularize automobile radio.

A new microphone setup was developed, based on the principle that sound waves have a tendency to move upward. Before, mikes had been placed in front of the instruments and only a few inches above them, failing to reproduce the orchestra in its true balance. At a rehearsal, engineers arranged their microphones about 10 feet above the misicians' heads with excellent results. Every Columbia leader who heard tests immediately insisted that the setup be applied to his orchestra.

President of Crosley Manufacturing Co., Powel Crosley, Jr., made the statement that there were approximately as many radio receivers in use as there were residence telephones. He also pointed out that telephones had increased only 5,000,000 in the last year and a half, while radio receivers had increased to nearly 3,000,000.

The radio exports trade reached the figure of $13,606,000 in 1931 as compared with $10,905,000 in 1930 as radio continued to furnish a bright spot in American foreign trade conditions.

Two major broadcasting networks announced that their gross income from the sale of time in the first half of 1931 amounted to $17,399,720, while in the same period in 1930, the gross revenue was nearly $5,000,000 less.

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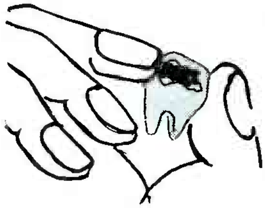
what's new ?

Not to be outdone, the FAA has ordered production of a test model of an electronic "nose", an electro-chemical device reacting pretty much as a human nose does. Its purpose: to detect explosives that might be smuggled aboard an airplane. The Illinois Technology Research Institute, which did the preliminary testing under contract to see if it could be developed, is to deliver a prototype by August, 1966.



It's turnabout at the University of Michigan School of Dentistry, where a volunteer is putting the "bite" on researchers. That is, the volunteer is testing an artificial tooth Ian S. Scott and Dr. Major M. Ash developed over a period of two years, that contains six miniature radio stations. As the device chews, occlusal force (bite and jaw adjustments) data is broadcast to waiting monitors. Now it can only broadcast a distance of one foot, but its developers are thinking of adding a vest-pocket booster apparatus that will increase transmitting power to a distance of several miles. It contains 28 electronic components with special bondings and two rechargeable batteries.

A television receiver with a 3/4" screen has been developed by the Westinghouse Corp. in Baltimore, Md. Idea was to demonstrate the uses of thin-film integrated circuits. The little device's only discrete components are silicon-controlled rectifiers, used for electrostatic deflection in the picture tube. It has no channel selector, but can be tuned to receive any VHF or UHF channel. The power supply is outside the receiver, which measures 1-1/2" by 3" by 4".

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In Memoriam

The Philadelphia-Camden Chapter started the new year with its customary optimism and enthusiasm. But it soon met with quite a shock: the death of one of its oldest leaders, MR. CHARLES FEHN.

"Charlie" was one of the charter members of the chapter when it was organized 32 years ago. From the very beginning he was a loyal and steadfast member, always took an intense interest in the activities and welfare of the chapter, was always willing and anxious to do his share and more. The members recognized this by repeatedly electing him to various offices and often expressed their appreciation to him for his many contributions to the chapter. His death is a tragic loss to the members of the Philadelphia-Camden Chapter.

The Detroit Chapter likewise suffered the loss of one of its members, MR. STEVEN BUBEL, who passed away in December. Mr. Bubel enrolled with NRI for his course in Radio and Television Servicing in December, 1955, and graduated in April, 1960.

Still another local chapter member who has passed away is MR. JOHN WALSH, Taunton, Mass. Mr. Walsh was a charter member of the Southeastern Massachusetts Chapter when it was founded in 1957.

New York City Chapter also sustained the loss of one of its members, MR. CHARLES CONRADSON. He was the chapter's oldest active member.

Other members of the Alumni Association who have recently passed on are MR. HERBERT WAYNE HARPER, Terre Haute, Ind.; MR. NORMAN CREECH, Selma, N. C.; and MR. JOHN KULIK, Campbell, Ohio. None of these members had local chapter affiliations.

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

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

Date ________________ Your written signature ________________

CREDIT APPLICATION

Print Full Name ________________ Age ________

Home Address ________________

City & State ________________ How long at this address? ________

Previous Address ________________

City & State ________________ How long at this address? ________

Present Employer ____________ Position ____________ Monthly Income ________

Business Address ________________ How Long Employed? ________

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

Bank Account with ________________ Savings ☐ Checking ☐

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

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

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

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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.

CHAPTERS HAVE INSTRUCTIVE SESSIONS, SEVERAL ADD TO MEMBERSHIP ROSTERS

DETROIT CHAPTER members decided to present a series of lectures on the oscilloscope, the first one to be given by Jim Kelly on the fundamentals.

The Chapter was happy to play host to Andy Jobbagy of the Flint Chapter during a recent visit he made to Detroit. Andy gave a blackboard lecture on high voltage troubles encountered in TV, which was the feature of the meeting.

SAMS COMPANY PROVIDE FILMS FOR FLINT CHAPTER

FLINT (SAGINAW VALLEY) CHAPTER members feel that they have been having some exceptionally good meetings lately. They have shown Howard Sam's lecture films twice and held one meeting that was devoted servicing color TV receivers. The members were also invited to the Flint Junior College as guests during a lecture and demonstration on Laser programming.

And more is in store for the future. Professor DeJenko, Programming Director, has promised to deliver more lectures and demonstrations at the Chapter's meetings.

Andy Jobbagy, one of the guiding spirits of the Chapter, has been thinking about a trip to the West Coast. If he does make this trip he plans to visit the Los Angeles and San Francisco Chapters.

HACKENSACK CHAPTER spent an entire evening watching two extremely absorbing films shown by Program Chairman George Schalk. They were entitled "Gateway to the Mind" and they compared the electronic pulse of machinery to the human brain. These were indeed two fascinating and entertaining films, well worth taking a whole meeting to exhibit.

At the next meeting the officers for the year were sworn in, after which each gave a short speech. They are: George Schopmeier, Chairman; George Stoll, Vice-Chairman; Franklin Lucas, Secretary; Paul Schaeffer, Treasurer; and George Schalk, Program Chairman.

The Chapter is planning more films from RCA plus more time to be devoted to trouble-shooting. Members are also looking forward to visits from representatives of Motorola and the Bell Telephone Company.

Flint Chapter members and their slide projector.

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NEW MEMBER FOR HAGERSTOWN

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER was pleased to welcome a new member, Gerald Strite, Chambersburg, Pa. Congratulations, Gerald!

Bob McHenry, a color TV technician, gave a technical discussion and demonstration of AM-FM servicing and TV distribution systems, and then looked into a TV vertical system and explained a few points of interest in searching for vertical trouble.

All the Chapter's programs for 1966 are directed toward the beginner as well as the advanced student. Of special interest is the fact that the Chapter has planned to conduct a programmed transistor course, one session of which has already been held.

Officers for 1966 are Bob McHenry, Chairman; Robert Erford, Secretary and Treasurer; and George Fulks, Program Chairman.

The Chapter is planning a trip to WMAR-TV, Channel 2, in Baltimore to tour its studios and other facilities.

LOS ANGELES CHAPTER, for the last two out of three issues of the Journal, has reported the acceptance of new members into the chapter. It is a pleasure to report two new members for this issue. They are Wilbur F. Porter and Duane W. Robinson. Congratulations, gentlemen!

The chapter has also informed National Headquarters of the officers to serve the chapter for 1966. They are: The ever-popular Eugene DeCaussin, Chairman (incidentally Gene has been absent from meetings only twice in the last four years -- quite a record!); Robert Belew, Vice-Chairman; Kenneth K. Kellogg, Treasurer; and Jerry Dougherty, Secretary. Our congratulations to these new officers, too!

At this same meeting, Gene DeCaussin gave a demonstration of the B and K Television Analyst which was much appreciated by the members.

The chapter has still been devoting a good deal of time working on its color television set; lately the members took turns in checking out the regular condensers of the set. It is hoped that before long the chapter can buy a new picture tube so that the members can finish off with some first-class servicing and aligning of the set.

NEW YORK CITY CHAPTER members were favored with a second visit by Mr. Donald Tutshulte as a guest speaker, together with his assistant, Mr. Bob Davies. Mr. Tutshulte described "The Sage" and illustrated his talk on an ingenious new display board. This was followed by a film entitled "Seconds for Survival" which showed our country's readiness to repel an enemy attack. The chapter members were well pleased with Mr. Tutshulte's lecture and also with his promise to return for another talk in May.

Straughn and Rose Schedule 3 More Visits To Chapters

J. B. Straughn and Ted Rose will soon wind up their tour of visits to the NRI Local Chapters for the 1965-1966 season. The last remaining visits are:

CHAPTER	DATE
New Orleans	March or April
Hackensack	April 29
Pittsburgh	May 5

At a subsequent meeting the members were equally pleased with two films loaned by the Channel Master Antenna Company. These films were the "Vital Link" and "Quest", which depicted the process of manufacturing antennas so as to get the best possible reception. Four series of Howard Sams slides on Color TV were shown. They described and illustrated in detail how a Color Television receiver works and included how to service a color Television set.

Serving the chapter for 1966 are John Schumott, Chairman; Al Bimstein, Executive Chairman; Jim Eaddy and Frank Lucas, 1st and 2nd Vice-Chairmen; Frank Szpiech, Secretary; and Sam Antman, Treasurer. Congratulations, gentlemen!

One new member has been admitted to the Chapter, Mr. Felipe Santiago. Welcome to the membership, Felipe!

PHILADELPHIA-CHAPTER members were grateful to their own Bill Davis for a fine talk on servicing color TV in the home. Bill runs his own very successful TV Servicing business in Morrisville, Pa., and employs an assistant. In his talk he concentrated on house calls and how to go about them. He gave a good many suggestions and encouraged other members to get into color TV servicing, saying that it is not as tough as it may seem to the uninitiated.

Joe Donnely, another Chapter member who does a lot of troubleshooting in Electronics

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Time out for snacks at a Philadelphia-Camden Chapter meeting for, from left, Charles Fine, Blan Straughn, John Krepol, John Krepol, Jr.

for the Government and travels all over the world, is trying to get a Radar specialist to attend one of the chapter meetings and give a talk on Radar. This would be intensely interesting and would be a "first" for the chapter.

The chapter's officers for 1966 are: John Pirrung, Chairman; Harvey Morris, Vice-Chairman; Joe Burke, Financial Secretary; Jules Cohen, Recording Secretary; Anthony Skrutt, Librarian; Walter Thomas, Sgt.-at-Arms.

The chapter's plans for this year are to stress the importance of preparing for and getting into color TV servicing and to learn a great deal more about transistors.

PITTSBURGH CHAPTER members were truly fascinated by a program "Reaching for the Moon" (Project Appollo) staged by Mr. Rohleder, Supervisor of Customer Information for the Bell Telephone Company. Such a trip to the moon aboard a Project Apollo Spacecraft riding a Saturn rocket was described in detail by Rohleder, who illustrated it by free-hand drawings and art panels in luminous colors under black light. He described the various stages of the National Aeronautics and Space Administration program for human exploration of the moon and the part being played by the Bell Telephone System in this project.

The program was followed by a question and answer session in which Mr. Rohleder tried to answer questions from the members without divulging classified information.

The Chapter reports its officers for 1966 as follows: Joseph Burnelis, Chairman; James Wheeler, Vice-Chairman; William Sames, Treasurer; Jack Fox, Recording Secretary; Howard Tate, Corresponding Secretary (who is also National President of the NRIAA this year); Charles Kelly, George McElwain and David Benes, Directors. Our congratulations to these gentlemen!

At the next meeting Mr. Clement McKelvy, a retired Electronics Instructor and honorary member of the Chapter, gave a talk on TV i-f alignment. Mr. McKelvy demonstrated a practical alignment procedure on an old Crosley receiver brought in by J. Benoit, who was quite pleased with the results as were the rest of the members present.

SAN ANTONIO (ALAMO) CHAPTER, like most of the other local chapters, elected its officers to serve for 1966 in December and they took office on January 1. The winning candidates were Sam Stinebaugh, Chairman; Sam Dentler, Vice-Chairman; John Chaney, Jr., Treasurer; Harold Wolff, Secretary. These are the same officers that served last year except that Sam Dentler replaced Ronald Smith.

A Radio brought in by Adolph Herrera was repaired. The oscillator coil was found to be open.

Apple pies furnished by Harold Wolff are still enjoyed by the members. Harold makes them himself and they are delicious. Fruit cake was also supplied by Sam Stinebaugh. The Chapter has been considering the use of a transistor review series from Howard Sams and this project may have been started by now.

SPRINGFIELD (MASS.) CHAPTER members were quite taken with a tour of the New England Telephone Company building in Springfield. They were surprised at the great security surrounding the building. This was

Pittsburgh Chapter's 1966 officers are, seated from left, William Sames, Joseph Burnelis, and James Wheeler; standing, Charles Kelly, David Benes, George McElwain, and Howard Tate.

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given as the reason they were not allowed to see many things they were interested in, but what they did see was fascinating.

The last meeting of which we have a report was held at Chapter Member Arnold Wilder's home. The secretary, Brother Bernard Frey, discussed the Thyrector with the aid of some large diagrams. By means of the questions asked during the talk, the members reviewed and clarified a lot of semi-conductor theory and then discussed the Zener Diode family.

The program then proceeded to the color TV Lessons with Arnold Wilder leading the discussion. Arnold had assigned NRI Lesson 51 for the men to study for this session. He used the questions in the back as leads and guides. He edited the RCA Color TV slides and flashed pertinent ones on the screen as needed. Many questions flew and many of the answers (right and wrong) came from the members. Arnold, with all his experience in servicing and his willingness to share his knowledge, is just the man for presenting such a program in language the men can understand. The Secretary expressed some surprise in noting how interested the members were in what was pure theory - so much so that they regretted coming to the end of the program.

DIRECTORY OF ALUMNI CHAPTERS

NRI STUDENTS -- as well as Graduates -- are welcome at the meetings of all the local chapters and are ELIGIBLE TO JOIN. This is a wonderful way to meet fellows in the Radio-TV-Electronics field, to discuss problems and get valuable advice from men with practical experience in the industry.

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: Henry Hubbard, 5497 E. Hill Rd., Grand Blanc, Mich., 694-4535.

HACKENSACK CHAPTER meets 8:00 P. M., last Friday of each month, St. Francis Hall, Cor. Lodi and Holt St., Hackensack, N. J. Chairman: George Schopmeier, 935-C River Road, Milford, 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, Sokol Hall, 739 Page St., San Francisco. Chairman: Isaiah Randolph, 523 Ivy St., San Francisco, Calif.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8:00 P. M., last Wednesday of each month 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.

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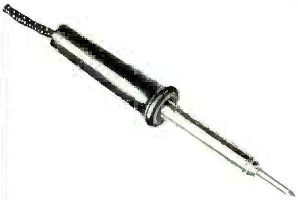

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