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J. E. Smith

Efficiency Is Not Enough

If someone asked you, "Why do you work?," you would probably answer, "I work because I must—to feed and clothe myself and family—provide for the necessities of life." This is a logical, straight-forward answer.

But do you ever stop to think that besides earning your daily bread, your work provides you with the real zest for living? It gives you personal satisfaction, offers opportunity for self-expression, and makes your rest and leisure more meaningful.

Have you ever noticed how a house painter stands back and admires his work? Or have you ever watched how carefully a carpenter fits lumber together when building a house.

A fellow named John Zeigler was just such a carpenter. "I never cut a board short in my life," he used to say proudly. But one day he did just that, or so it appeared at the time. The board he'd just cut didn't fill up the space he'd intended it for. But John was a proud craftsman. He hunted around the house and soon spotted another opening where the "short" piece fitted exactly. "Like I always say," he nodded with satisfaction, "I never cut a board short in my life!"

If you seek happiness through your work—and where else are you to find it?—you must accept a new role. As a working man, you're not a sheltered individual—not an infant or invalid. You alone must decide what your attitude toward your work will be, what your purposes are, and

(Page two please)

AGC SYSTEMS

By Art Widmann
NRI Technical Staff

Automatic gain control circuits are in common use in both radios and television receivers. In radios, these circuits are usually called automatic volume control (AVC). The use of "volume" instead of the more accurate word "gain" arose from advertising reasons. The set-buying public might not know the meaning of gain of an amplifier whereas they readily understand the word volume. Inasmuch as the gain of a receiver does affect the volume, avc is descriptive of the effect on the operation of a radio. In a television receiver however, the gain of the receiver affects both audio volume and picture contrast. The circuits providing automatic gain control in television receivers are almost always correctly labeled agc.

AVC and AGC circuits all work on the same basic principle—the gain of one or more stages is automatically varied in accordance with the strength of the received signal.

The need for automatic gain control is readily apparent when you consider that the received signal strength may vary from 1-microvolt from distant stations to one million microvolts from strong local stations. If the gain of the receiver is constant, the strong stations will cause annoying "blasting" when you tune across the band. Also, if the receiver gain is sufficient to bring in distant stations, the strong local stations will cause overloading and distortion. Automatic gain control will overcome both of these difficulties. In addition, agc will correct for

(Continued page two)

— n r i —

"The future of the servicing industry is extremely bright and profitable but your share of that future depends on what you do NOW to prepare for it."

Donald H. Kunsman
President, RCA Service Co.

(Editorial—from page one)

how strongly you desire the happiness you seek.

To have ideals, to seek wise advice, to apply common sense, to admit the necessity of discipline, to be broad-minded, to believe in and practice fairness and to

do honest work efficiently. These are traits *just as important* to personal satisfaction and contentment on your job as skill and knowledge. Remember, your job may feed you but your attitude toward your work keeps you "alive."

J. E. Smith
Founder

(AGC Systems—continued)

variations in signal strength due to fading.

AVC Systems in Radios

Let's review the basic principles of a typical avc circuit by referring to Fig. 1. This partial diagram shows the rf stage

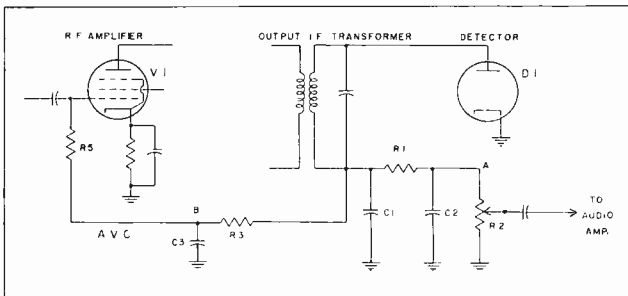


Fig. 1. Typical AVC system used in a Radio receiver.

and the second detector where the avc voltage is developed. The i-f signal at the output i-f transformer causes the diode to conduct each time the signal swings positive at the plate of D1. Current through the diode also flows through the secondary winding, through R1 and R2 to ground and back to the cathode of the diode. C1, R1 and C2 filter out the i-f, producing a negative voltage at point A that is varying at the audio rate.

Resistor R3, and capacitor C3 make up another filter network that removes the audio signal and produces a pure negative avc voltage at point B. The strength of this negative AVC voltage is directly proportional to the i-f carrier signal.

The time constant of the avc filter must be long to filter the lowest frequency of the audio signal. On the other hand, too long a time constant will prevent the circuit from responding to rapid changes in signal strength such as occur with fading. A compromise is made using a time constant of about 1/10 to 1/5 of a second.

The filtered avc voltage is applied to the

control grid of V1 through resistor R5. The negative avc voltage decreases the gain of the rf stage and tends to hold the output of the receiver constant with changes in rf signal strength. The avc voltage cannot hold the output perfectly constant because it requires a change in output to produce a change in avc voltage. Most receivers have at least two avc controlled stages to give a greater range of control.

These are usually the i-f and rf stages. In sets having no rf stage, the avc voltage is applied to the rf grid of the converter stage.

Notice that the avc voltage always decreases the gain of the receiver. Even a very weak station will develop some avc voltage. In order to have the receiver run wide open on weak signals, circuit variations have been devised to prevent avc from

taking effect until a certain size signal is received.

Delayed AVC. To prevent development of an avc voltage when receiving weak signals, the avc voltage is delayed. This does not refer to a time delay but rather to the amplitude of the signal. No avc is developed until the average value of the IF carrier signal exceeds a pre-determined value.

Fig. 2 shows a typical second detector, delayed avc, and first audio stage. Diode D1 is the second detector while diode D2 produces the avc voltage. The triode section of the tube is the first audio amplifier stage.

The i-f signal is rectified by D1 and the audio signal is developed across C2-R1. Notice that diode D1 will conduct on weak signals because its circuit is returned to the cathode. The ac signal path for diode D1 is from the plate of D1 through the transformer winding, through C2 to the cathode of the tube. Thus even very weak signals will make the plate positive with

(Continued page sixteen)

Magnetic Cartridges for Stereo

by John G. Dodgson
NRI Consultant



John G. Dodgson

At the present time there are many types of magnetic cartridges and, no doubt, many more will be developed. We will look at the types most often used.

One of the earliest types of magnetic cartridges was the variable reluctance. One version of this type cartridge is shown in Fig. 1, page 4. As can be seen here, the stylus is mounted on a cantilever arm which moves between two coils. The other end of this arm is connected to the south pole of a permanent magnet. A T shaped yoke connects the other end of the magnet to two pole pieces on which two coils are wound. The flux path is from the magnet through the yoke to the two pole pieces and then across the air gap to the cantilever spring. As the stylus follows the record grooves, it moves from side to side, nearer one or the other of the two coils. As it does so, the air gap on one side decreases, so the reluctance on that side decreases and the flux increases. At the same time, the air gap on the other side becomes wider increasing the

reluctance and decreasing the flux. Since the flux changes are in opposite directions, the voltages induced in the two coils will be opposite polarity. By connecting the two coils in series-opposition, the two voltages are added in the output.

Simply then, lateral movements of the stylus will cause a varying output due to the varying reluctance in the magnetic gap.

One advantage of this variable reluctance type pick-up is that it responds only to lateral motion of the stylus. Consequently, there is little needle scratch or surface noise picked up. Since vertical motion of the stylus causes the same flux change in both coils, the induced voltages are of the same polarity and are cancelled in the output.

As shown in Fig. 2, the monophonic variable reluctance type cartridge is easily
(Page four please)

Long Distance Phone Calls To NRI

Students who call us long distance AND WHO USE DIRECT DIALING may save themselves money on their phone bill if they tell our operator, "This is a long distance call from (name of place)." Unless the student tells our operator, she cannot know.

When we know, we give the incoming long-distance call preference over other local calls and all other delaying factors.

The student should, of course, give his name promptly, and be ready with his student number. If we have to look up the number for him, his phone bill is running up while we are looking.

But whether he has his student number or not, he should tell us when the call is long distance.

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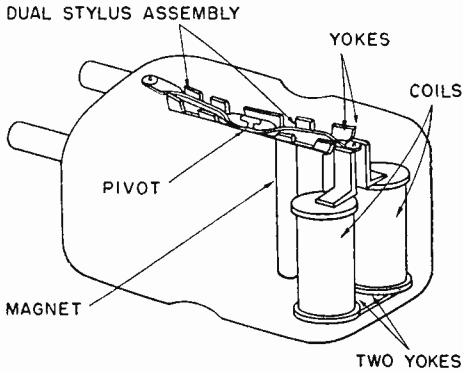


Fig. 1. The General Electric variable reluctance cartridge.

changed to a stereophonic type. In the stereophonic version, the ends of the coil pole pieces are bent 45° angles to the stylus and disc and are at 90° angles to each other. Instead of connecting the coils together, each coil provides the signal for a separate channel.

Since only one coil is used for each channel, it is evident that there will be less signal output. In fact, in the example shown, the output level of the stereo version will be exactly half the output level of the mono version. In practice, however, improvements in the coil and magnet assemblies have resulted in more output than this although it is still below 10 millivolts (.001 volt) per channel.

Another variable reluctance type cartridge, the Pickering shown in Fig. 3, operates in a slightly different way. As can be seen in the phantom view of Fig.

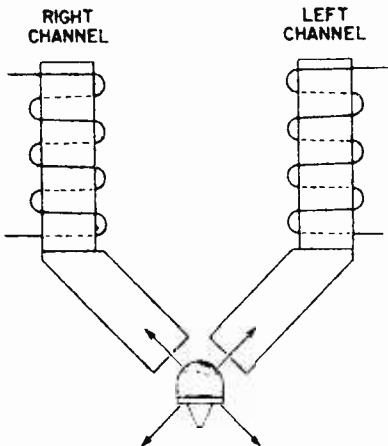


Fig. 2. Front view of a stereophonic variable reluctance cartridge.

4 this cartridge uses four coils, two for each channel. The magnet is in the center of the group of coils and is coupled through a pivot to the armature, a thin straight tube with the stylus mounted at one end.

Fig. 5 is a simplified plan view, looking up at the bottom of the pickup. The armature is pivoted at its center in a bearing that allows the stylus end free motion in all directions in the plane perpendicular to the record surface. The front end of the armature carrying the stylus is coupled to the magnetic circuit through the two 45° pole pieces at the front end of the cartridge. The reverse end of the armature is coupled to the magnetic circuit also, through identical pole pieces at the rear of the cartridge.

The moving armature modulates the magnetic circuit at the rear of the cartridge with an amplitude equal to the modulation at the front of the cartridge, and



Fig. 3. The Pickering Fluxvalve cartridge. Photo courtesy of Pickering and Co., Inc.

180° out of phase with it. The coils are so phased that the two signals in each channel are added. It is evident that this push-pull arrangement, with the armature pivoted at its center, has a higher signal level.

THE MOVING COIL CARTRIDGE. Another type of high quality stereo cartridge is the moving coil such as the Grado Cartridge shown in Fig. 6.

The generating system of the Grado Stereo Cartridge is shown in Fig. 7. A plastic stylus arm is attached to a hollow plastic cube approximately .07-inch square which is molded as one piece. Two coils are then wound on the flats of the cube at 90° to each other. The symmetry of the coils allows cancellation of one coil and the generation of the other coil with a 45°/45° movement of the stylus. Each coil generates equally on either a vertical or lateral movement. The coils can also generate mixed components as dictated by the groove. Each coil contains 1000 turns of silver copper alloy wire

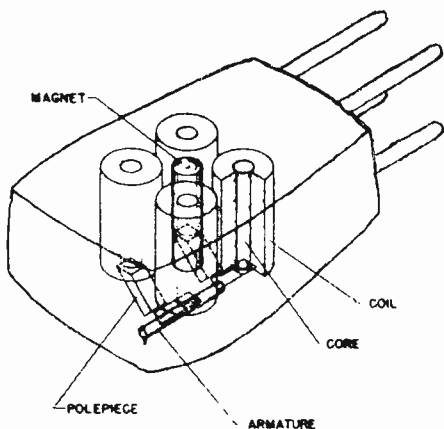


Fig. 4. A phantom view of the Pickering cartridge.
Courtesy Pickering and Co., Inc.

.0004 inch in diameter, triple gold plated to prevent corrosion. The four leads of the two coils are thermal welded to four silver contact pins which are color coded to facilitate the proper electrical connections.

This generating system is then mounted within a toroidal grommet made from a special rubber. Care is exercised in the compounding of this rubber material to minimize cold flow or hardening tendencies. The grommet, as shown in Fig. 7, has a groove around its edge which is

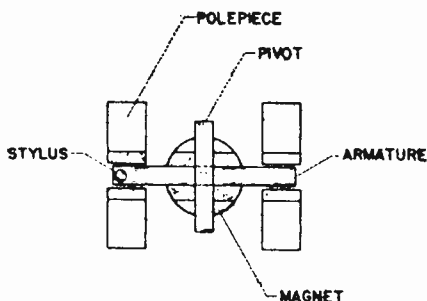


Fig. 5. A view of the Fluxvalve from underneath.
Courtesy Pickering and Co., Inc.

used to mount the complete coil system in a metal bracket. The generator and bracket are then assembled to a highly damped plastic base. Since the coil is placed within a magnetic gap, movements of the stylus cause the coils to break flux lines and produce voltages. Both coils are rotational and electrically bound and since there is only one moving mass within a single magnetic gap, the repro-
(Page eight please)

NRI Graduates Discover - -

- new earning power
- greater hopes for the future
- higher community prestige



Hobby
Becomes
Profitable
Pastime

Taking the NRI Radio and Television course was to give me the knowledge and experience to maintain my own electronic equipment. It was only to be hobby but has become a profitable pastime. It has given me many enjoyable evenings working on projects that are entertaining and challenging.

I give all the praise and respect that can be given to your NRI course. There isn't any school that can match it for material, cost, and instruction value. I take pride in showing my NRI diploma and saying I'm a graduate of NRI. In the near future, I am going to take your Professional TV Servicing course.

William L. Rice
1935 Rock Ave.
Roseville, Michigan

Radio-TV
Technician
With Sears-
Roebuck



*I made extra money while taking the course a few months after beginning. I even had to cut down on the service work for awhile in order to continue the course. At present, I am doing Radio-TV service work for Sears-Roebuck, a position I was able to obtain a month after graduating. I could not have passed the entrance examination for position of TV serviceman
(Continued page six)*

had it not been for NRI. I answered all questions correctly except for two which the examiner said was the second best score they'd had in a long time. I owe it to NRI—a salaried position with 5% commission on paid service calls and service contracts I sell.

Manuel H. Morales
214 Morelia
San Antonio 7, Texas



**Earned \$2,000
Spare Time
Plans Own
Shop**

I've found NRI training to be everything you said it would be and I've earned \$2000 the past 12 months, part-time work. I plan to put in a full-time modern shop. The NRI course enabled me to work for myself and make good wages while I'm doing so.

I recommend your course highly to anyone interested in this kind of work. Every graduate should be proud to be an NRI trained man. It has given me new earning power and greater hopes for the future.

George D. Guthrie
Route 1, Box 361
Orange, Texas



Operates Own Sales-Service Store

NRI training put me on the way into my own business. For sometime, I was doing part-time service work. But for the past two years, I have owned and operated my own shop. It sure feels good to know (Column two, page seven)

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT AND CIRCULATION OF

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1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, National Radio Institute, 3939 Wisconsin Ave., N. W., Washington 16, D. C.

Editor, Theodore E. Rose, 3939 Wisconsin Ave., N. W., Washington 16, D. C.

Managing editor, None.

Business manager, None.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.)

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Elsie Smith Davis, RFD 1, Rochester, N. H.
The National Radio Institute Charitable Trust c/o J. E. Smith, 4521 Crest Lane, McLean, Va.

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Emma Smith Stuart, 2108-A San Miguel Canyon Rd., Salinas, Calif.

James Morrison Smith, Susan Morrison Smith, Lee Morrison Smith, James Morrison Smith, Jr., Terry Morrison Smith, 4523 Crest Lane, McLean, Va.

Marjory M. S. Sarich, Charles B. Sarich, James R. Sarich, 4519 Crest Lane, McLean, Va.

David H. Smith, RFD 1, Rochester, New Hampshire.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds mortgages, or other securities are: (If there are none, so state.) None.

4. Paragraphs 2 and 3 include in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semi-weekly and triweekly newspapers only.)

NATIONAL RADIO INSTITUTE
E. L. Degener, General Manager

Sworn to and subscribed before me this 1st day of October, 1959.

Charles Alexander, Notary Public
(My commission expires January 14, 1964.)

Progress Needs Reliability

The U. S. Aircraft Industry has a proud record for building reliability into its aircraft, but its toughest chore today is building reliability into its rockets and guided missiles because of their great complexity.

The average guided missile has 37,000 parts (and many of these are made from several pieces.) If each of these items can be made so reliable that it would fail only once in 100,000 times, the mathematical chances are that one missile in three would misfire.

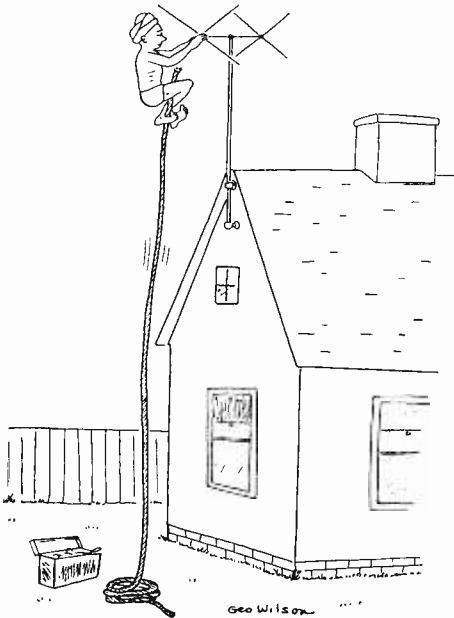
The goal the industry is striving to reach is for each item to be so reliable that it would not fail in 300,000 times. That's reliability!

Miniaturesque Miniature Precision Bearings

— n r i —

Our imagination is one of our most important functions. We can use it to worry with or we can use it to work with. If we let it become a source of worry, we invite destruction; but if we put it to work we will create something useful—something we can always be proud of.

Nuggets



there was a school that gave me a chance to get started. I would recommend your training to everybody.

*Tony Shyskowski
Beverly
Alberta, Canada*



In Charge of Cadillac Distributor Radio Department

There are a lot of fellows right now who know nothing about Electronics and think they couldn't learn. But they have not done what it takes to find out. For a four-cent stamp they can discover NRI speaks a language they can understand.

That little word "curiosity" has caused me to be placed in the charge of the Radio Department of the St. Louis Cadillac Automobile Distributor. I specialize in the servicing and installation of Delco signal-seeking radio and Autronic Eye headlight controls. I also repair TVs and automatic antennas.

All of this on the down to earth knowledge gained at NRI.

*Carl Brinkmeyer .
3431 Alberta St.
St. Louis, 18, Mo.*

It does not take much strength to do things, but it requires a great deal of strength to decide what to do.

Elbert Hubbard

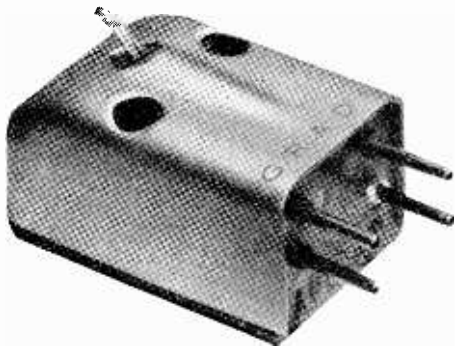


Fig. 6. A moving coil cartridge, the Grado "Custom." Courtesy Grado Laboratories.

(From page three)

duction from both channels is exactly the same.

Variations of the moving coil design shown here were also used in monophonic cartridges. In such an application, of course, it is only necessary to utilize one coil instead of two.

MOVING MAGNET TYPE CARTRIDGES.

A typical moving magnet type cartridge is shown in Fig. 8. This particular type of cartridge is very similar to the moving coil type cartridge, except, as the name implies, the coils are stationary and the magnet moves according to the stylus movement.

The interior of a high quality moving magnet type cartridge is shown in Fig. 9. It is evident that such cartridges are extremely complicated since they are so

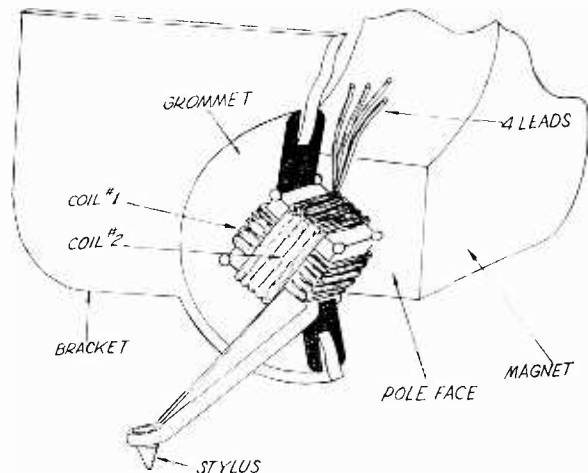


Fig. 7. The interior of the Grado cartridge. Courtesy Grado Laboratories.

small. However, the operation of the cartridge is not particularly difficult to understand.

Although the following discussion refers specifically to the Audio Empire 88 Stereo Cartridge, the general operation is applicable to all moving magnet cartridges.

As can be seen in Section B of Fig. 9, the stylus lever is firmly attached to a small magnet. This magnet is actually .04 by .1 inches long.

The stylus magnet assembly is inserted into a coil structure as shown in B and pivoted at the center. Coils A and B, wound in series opposition, form one coil structure which develops signals from the inner groove wall (left channel)

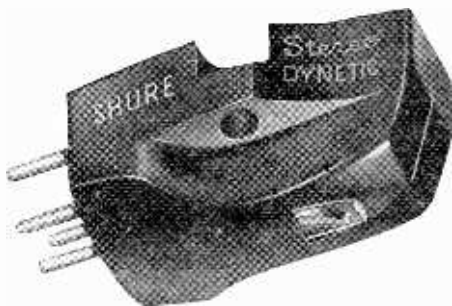


Fig. 8. The Shure M3D, a moving magnet type cartridge.

modulation. Coils C and D, also wound in series opposition, develop the outer wall signal (right channel). Modulation of the left channel will create a force (F1) which will rotate the poles of the magnet toward and away from the pole faces of coils A and B and create a variable flux in the coil structure. This force, F1, however, has not caused any air gap variation relative to Poles C and D since the magnet is moving parallel to these pole faces. Therefore, there is no current generated in the C and D coil combination. Conversely, a signal in the right channel will create a force, F2, which will in turn cause a flux variation in the C and D coil structure while isolating the A and B coil structure.

Since it obviously would not be possible to mount the four coils as shown in B of Fig. 9 (the stylus arm from the magnet to the record would be too long), the coils are positioned vertically as shown in C of Fig. 9

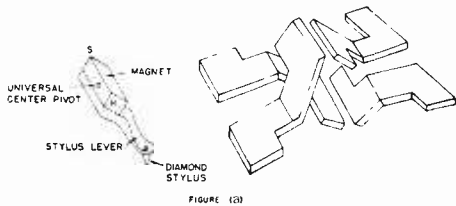


FIGURE 1(a)

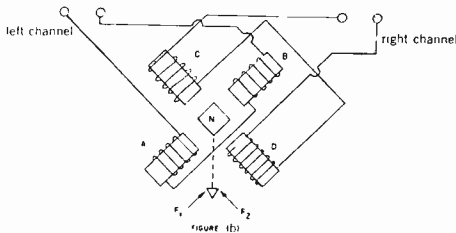


FIGURE 1(b)

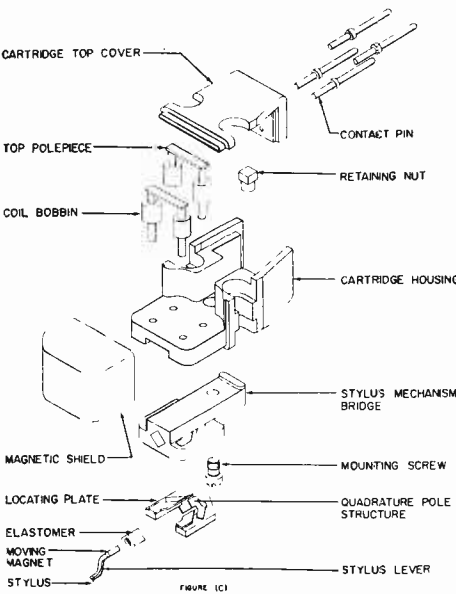


FIGURE 1(c)

Fig. 9. Interior of the Empire 88 moving magnet cartridge.

and a metal structure called a quadrature structure is used to couple the magnet movements to the coils.

As might be expected, this moving magnet system can also be utilized in monophonic cartridges simply by using one set of coils instead of two.

CARTRIDGE CHARACTERISTICS. As pointed out previously, the cartridge is a transducer since it converts the minute record groove undulations to an electrical signal. This is an extremely diffi-

cult job and as a result, the cartridge along with the loudspeaker, another transducer, is usually less perfect than the remaining parts of the over-all high-fidelity system.

There are many characteristics that affect the over-all quality of a cartridge among which are the dynamic mass, compliance, frequency response, and resonance. In fact, these key characteristics of a cartridge are dependent upon one another for the over-all performance of the cartridge.

The compliance indicates how easily the stylus will move; in other words, it is the opposite of stiffness. Low compliance will cause excessive record wear, reduced high frequency response, and impair transient response. The compliance figure normally specifies what part of a centimeter a stylus will move when a certain amount of force, measured in dynes, is applied to it. Normally the force is 10^{-6} dynes, a very small force, since the record groove width is measured in thousandths of an inch. Although it was considered as an achievement just a few years ago to reach a compliance of unity, that is, 1×10^{-6} centimeters per dyne, it is normal and acceptable now to expect a compliance of 2×10^{-6} centimeters per dyne or more. The Audio Empire cartridge in Fig. 9, for example, has a compliance of 5×10^{-6} centimeters per dyne.

Since the stereo cartridge must move horizontally and vertically, it is rated at both vertical and horizontal compliances.

The compliance of a cartridge depends on the structure of the stylus mechanism and on its mass.

This mass is determined by the physical size of the stylus system and the density of the material used in the system. The mass figure is generally in grams or milligrams and indicates the mass reflected to the stylus tip. In very high quality cartridges this mass should be 1-milligram (.001 gram) or less. The Grado cartridge of Fig. 7, for example, has a mass of .7 milligram (.0007 gram).

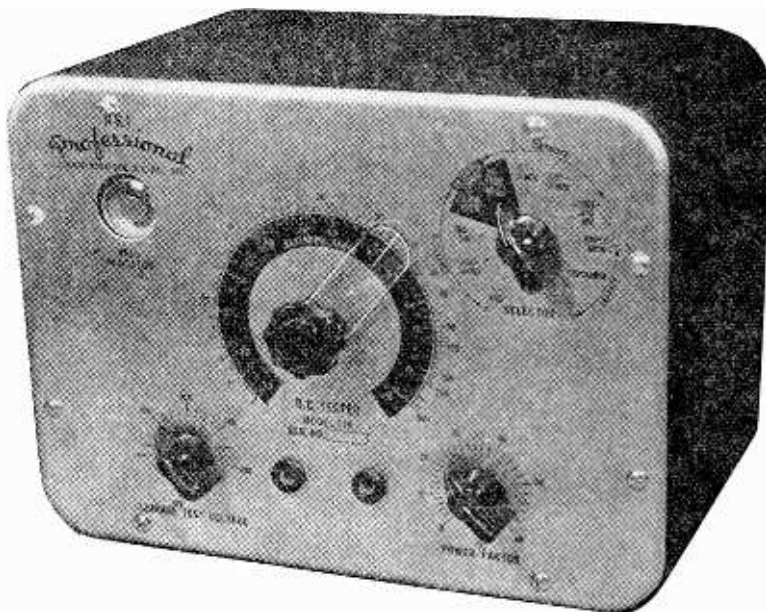
All phonograph cartridges exhibit mechanical resonance at both upper and lower ends of the frequency spectrum due to vibration of the mechanical parts of the cartridge. A typical cartridge will resonate at 12 cycles per second and 18,000 cycles per second.

Inexpensive and poorly designed cartridges will have these resonant points
(Continued page twelve)

NRI engineered to save time—increase earnings . . .

NRI Professional Model 114

Resistor-Capacitor Tester



Measures:

- **Resistance**
- **Capacity**
- **Leakage**
- **Power Factor**
- **10 mmfd. to 1500 mfd.**
- **1 ohm to 150 megohms**

Gives:

- **Greater profits**
- **Satisfied customers**
- **More efficiency**
- **Added confidence**
- **Dependability & long-life**
- **Professional appearance**

This service instrument has a definite place in every modern Radio and Television Service Shop. It speeds up servicing and gives you more confidence. Increases profits and customer good will.

Uses Highly Accurate Bridge-Type Circuit

Bridge type measuring devices are widely accepted by laboratory engineers because of their great accuracy. The NRI Model 114 is guaranteed to be accurate $\pm 5\%$ or better. It is no trouble to select matched resistors or exact capacity condensers for use in critical circuits. Especially valuable in servicing AM, FM, TV receivers, and High Fidelity equipment.

Tests All Types Condensers In Radio-TV

This tester is designed to do a complete job of testing all condensers used in Radio and Television receivers. This it does with ease, checking capacities as low as 10 mmfd. and as high as 1500 mfd. You can determine the capacity of small, color-

coded condensers more quickly than you can figure out their values using the color code—and you check the condenser at the same time! Testing electrolytic filter condensers is just as easy. You measure capacity, leakage, and power factor. (A high power factor tells you in advance that a filter condenser will need replacing soon.) Checking video low-frequency compensating condensers, by-pass condensers, and coupling condensers is just as simple.

Extra Sensitive Leakage Test Circuit

The leakage test circuit provides two ranges of sensitivity, one for paper, mica, and ceramic condensers, and the other for electrolytic condensers. The paper-mica range is ultra-sensitive. Detecting leakage resistance well above 100 megohms. Actual d.c. working voltage of condensers, up to 400 volts, is applied giving an indication far superior to conventional low-voltage leakage checks made with an ordinary ohmmeter. And the leakage test voltage is continuously variable. An ideal source of d.c. voltage for polarizing electrolytic condensers.

Power Factor Test

As electrolytic condensers age, their power factor usually increases. Electrolytic condensers with a power factor of more than 15% should normally be replaced. This test tells you which condensers are likely to fail soon. Saves time and headaches. Enables you to guarantee your work. Your repair jobs stay fixed. The Model 114 indicates power factor directly. This is a test which cannot be made with an ohmmeter.

Measures Wide Range Of Resistance

Four overlapping resistance ranges, from 1 ohm to 150 megohms. Bridge type circuit is much more accurate than conventional ohmmeter.

Operating Instructions Supplied

Easy to operate. A manual giving step by step instructions is supplied. A professional serviceman needs professional instruments. Note excellent appearance of controls and dials on front panel. You will be proud to own this instrument.

Specifications

1. Four Capacity ranges: 10 mmfd. to 1500 mfd.
2. Four resistance ranges: 1 ohm to 150 megohms.

3. Power Factor Scale: 0 to 50% direct reading.

4. Bridge-type measuring circuit with tuning eye null indicator.

5. Variable leakage test and polarizing voltage, 0 to 400 volts. Dual sensitivity leakage test circuit.

6. Uses type 6X4 rectifier and type 6E5 null indicator.

7. Extra heavy rubber-covered test leads and two special test plugs for use in measuring very small capacity or very high resistance.

8. Power requirements: 50-60 cycle, 110-125 volts A.C. (Cannot be operated on D.C. or 25 cycle A.C.)

9. Size: 9 7/8" x 7 1/2" x 6 1/4". Actual weight: 5 1/2 lbs. Shipping weight 8 lbs.

10. Black wrinkle finish cabinet. Deep etched brushed aluminum panel with etched black lettering.

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(Stereo Cartridges—from page 9)

within the audible spectrum, that is, between 20 cycles per second and 15,000 cycles per second. When this occurs, it is necessary to introduce mechanical damping of the cartridge system in order to deflate these resonant peaks. No matter how well the damping does reduce the peaks, it is generally of such a nature that it cannot recover rapidly. Thus, a damped system, although it would not cause peaks in the response, could destroy transient response. Excessive damping to reduce audible resonances is generally found in low cost magnetic type cartridges and in ceramic and crystal cartridges. Of course adding damping material to the stylus mechanism will increase its mass and reduce compliance.

Thus, it is evident that a cartridge can have superlative frequency response and still be considered totally unsatisfactory. Remember that the ability to reproduce loud bursts of music is probably more important than a flat frequency response.

The stylus force or tracking pressure specification of a cartridge indicates how much downward pressure must be exerted on the cartridge to keep the stylus riding properly in the record groove. The required tracking pressure depends upon the design of the cartridge just as a vacuum tube's bias voltage depends on the tube design. It is desirable to have the cartridge designed to operate with as light a pressure as possible since this reduces friction between the stylus point and the record groove and reduces wear. Excessive friction smooths out the microscopic waves of the groove, thereby wiping out the high frequency modulations. In addition, the noise content rises excessively.

Excessive wear of a stereo record not only eliminates the high frequencies and increases the noise level but the channel separation is reduced. If the wear continues, the separation will be reduced to the point where the record will no longer be "stereophonic."

Since the stereo cartridge uses a smaller stylus radius, .0005 to .0007 inch, than the regular monophonic .001 inch cartridge, there is more pressure per square inch when using the same stylus force on both. It is more important then for a stereo cartridge to be designed for optimum operation with less stylus force.

The material used for styli is generally of three types: metal, sapphire, and diamond.

Metal styli, often plated with other materials like osmium, were very popular with 78-rpm records and are still widely used in inexpensive phonographs. A metal stylus is entirely unsatisfactory because it wears too quickly even on the relatively soft modern vinyl records. In fact, when playing a standard 12-inch LP record, the metal stylus will become worn before the record is completely played and it will thus begin to wear out the record grooves before the entire record is heard.

Synthetic and real sapphire styli are very popular, particularly because of their moderate cost. However, even though these styli are much harder than metal, they will generally last only thirty hours before beginning to wear. Naturally, less stylus pressure will result in longer playing time before wear and more pressure will result in less playing time before wear. This means that approximately 15 to 20 records can be played before the stylus will begin to deteriorate the records. A diamond stylus is generally considered to last approximately 1000 times as long as a sapphire stylus. It is, to put it lightly, a "best buy."

Incidentally, the above hourly ratings are rather relative. The actual life of any stylus will depend upon the compliance of the cartridge, the necessary stylus force of the cartridge, and is also affected by the tone arm quality and other factors. Probably the most important single factor is the dust on the record. Very



fine dust particles in the groove act as an abrasive and wear both the groove and stylus. Keeping records clean can extend the life of the stylus and cartridge considerably.

TERMINATION. For the best possible frequency response, a cartridge must be terminated correctly at the input of the amplifier. That is, in all cases, the manufacturer of a cartridge will recommend a resistance value optimum for that particular cartridge. This value generally ranges from 47,000 ohms to 100,000 ohms for magnetic cartridges and from 1 megohm to 4 megohms for ceramic cartridges.

Using a higher resistance than recommended for a magnetic cartridge will result in excessive high frequency response. This, by itself, is not particularly undesirable since the tone control can compensate for the problem but the high resistance will reduce necessary electrical damping on the cartridge system and cause peaks in the response.

Using too low a resistance to terminate a magnetic cartridge will always result in reduction of the high frequency response.

The resistance value used to terminate a ceramic cartridge has the opposite effect as it does with a magnetic cartridge, that is, it affects the low frequency response.

Using too small a resistance will reduce the low frequency response while using too high a resistance will increase the low frequency response. In addition, some ceramic cartridges require more elaborate R-C networks for proper equalization.

Due to the extremely low output of some types of magnetic cartridge design, it is necessary to use an input or step-up type of transformer between the cartridge and the preamplifier. All transformers suffer, to some degree, from frequency, phase, wave-form and other types of distortion. In addition, step-up type transformers tend to inductively pick up hum from magnetic fields. The use, then, of such transformers should be avoided if at all possible. However, the picture is not as black as it might at first seem. Many of the input transformers available today are very high quality units and distortions are kept to a very minimum. It is possible to obtain a low output cartridge of such high quality that it would offset any slight troubles from the transformer as compared to obtaining a high output cartridge of less quality that would not need a transformer.

Step-up transformers designed for these applications are generally liberally shielded by Mu-Metal to prevent hum pick-up. Even so, the transformer should be mounted as far away as possible from hum producing transformers and motors.

\$250,000 "Radar Telescope" Nears Completion

A dish antenna as tall as a 15-story building will soon appear on the Stanford University campus, Stanford, California.

It will be a "radar telescope" with a parabolic reflector 142 feet in diameter. When completed in about a year, the big dish will be America's largest and the world's second largest.

A 20-60 megacycle radio transmitter—the most powerful ever built in this frequency range and requiring a millionwatt power supply—will be installed near the dish, making the combined installation a new and sensitive tool for space research.

Usually radio telescopes are equipped only to receive naturally occurring electromagnetic radiation from the cosmos. But with the high-powered transmitter it will be possible to bounce signals against heavenly bodies, as was recently done with the planet Venus.

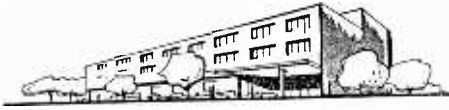
This technique is becoming increasingly

important in studies of the solar system, and the Stanford group will attempt to obtain radar echoes from Mars and from the sun itself. The radar-echo method is called "radar astronomy" to distinguish it from "radio astronomy," which does not involve reflection of man-made signals but only reception of natural radiation.

Some of the research findings the group anticipates: 1) more accurate measurements of cosmic distances; 2) surface explorations of the moon and planets by radar; 3) the rotation speed of Venus, whose surface is hidden by perpetual fog; 4) the ionization density and distribution in the sun's outer corona, and around various planets; 5) data on the amounts and movements of ionized gases and space debris between the earth and the moon, and in interplanetary space.

The cost of the 142-foot dish is estimated at about \$250,000. Special use of welded structural members and aluminum fabrication methods will cut some costs 90% in comparison with other big dishes. The antenna is designed for use at frequencies between 20 and 2000 megacycles.

NRI ALUMNI NEWS



Thomas Hull President
F. Earl Oliver Vice President
John Babeock Vice President
Roland Tomlinson Vice President
Howard Smith Vice President
Theodore E. Rose Executive Sect.

Chapter Chatter

NEW ORLEANS CHAPTER was given an explanation of the workings of the State of Louisiana Television Licensing Board by Mr. Charles Osborne, Chairman of the Board, who attended the chapter's December meeting as guest speaker.

Gaston Galjour is continuing his TV clinic at the meetings, from which the members get a great deal of practical help with their TV service problems.

SAN FRANCISCO CHAPTER at one of its dog sessions worked over a table model TV receiver brought in by Robert Charles. He was getting no sound or raster but all the tubes lit up. Fred Goodall, Robert Charles and J. C. Caraway located the trouble as an open fuse-ohm resistor.

At the same dog session, Chairman Art Ragsdale, Edward Persau and Shuck Joe worked on a yoke tester, which Edward Persau volunteered to take home and complete the wiring of. At the following meeting, he gave an excellent demonstration of the purpose of the yoke tester on his oscilloscope.

The Chapter is understandably proud of the fact that one of its members, Roland Tomlinson, was elected as a National Vice-President of the NRI Alumni Association for 1960. Mr. Tomlinson wishes to express his appreciation to all the members of the Association who voted for him.

LOS ANGELES CHAPTER has been pleased to admit four new members: Isiah Jordan, Charles Mangle, Joseph Robbins and Henry Dominguez. Welcome to the Chapter, gentlemen.

Eight members were assigned to tackle the repairs on the Chapter's oscilloscope and on a dog Radio belonging to Secretary Earle Allen.

Eugene DeCaussin brought in and exhibited a Westinghouse film "How A TV Set Works." The film not only depicted what each part does in a TV receiver, but also showed the inside of a Westinghouse

Television factory and how the receivers are put together. The members found this film to be very interesting indeed.

The Chapter's newly-elected officers for 1960 are: Eugene DeCaussin, Chairman; C. M. Sparks, Vice-Chairman; Earle Allen, Secretary; and Lee Chavez, Treasurer. Congratulations to these officers!

SOUTHEASTERN MASSACHUSETTS CHAPTER'S John Alves conducted a blackboard theory discussion and actual trouble-shooting on a "dog" TV receiver. Members were asked what the probable causes of the defects were. These were noted on the blackboard and then checked out.

At another meeting John Alves read and gave a blackboard explanation of the article "Unloading The TV Flyback" appearing in an issue of the "Electronic Technician" magazine. This article deals with the quick checking of flyback transformers without all the labor of substituting a new one. The author gives his method of checking step by step. The members agreed that this is an article all Radio-TV technicians should read, evaluate, and adapt to their own methods—and that the article serves as an example of why a service magazine belongs in every technician's shop.

MINNEAPOLIS-ST. PAUL (TWIN CITY) CHAPTER at one meeting was presented with problems in the form of three tough "dog" sets brought in by members. These provided a real challenge to the group to locate the defects. Chairman Berbee had a very recent, practically new receiver with an almost-open resistor with which he demonstrated the improvement in picture quality when the defective component was replaced.

John Berka gave another of his always-interesting and informative talks, this time on AGC systems. Starting with the simple systems used in the older sets, he traced their evolution to the the present day and discussed component failures and trouble-shooting techniques.

Walter Menk, who drives all the way from Sleepy Eye to St. Paul to attend the meetings, won the Chapter's \$20 door prize drawing which was held at this meeting.

CHICAGO CHAPTER devoted almost an entire meeting to earnest consideration and discussion of how it could make still further improvement in its programs, particularly for 1960. Secretary Frank Dominski recommended a plan for having two-man teams work on a selected project to be presented to the members at a subsequent meeting, a different team to be assigned with a different project each month. Robert Kirtley suggested that members itemize their weak points and send them in at the meetings. Charles Meade in this connection reminded the members of the Chapter's Question-and-Answer Box into which members are to drop their questions for answering on the following meeting night. The members felt that this was one of their most constructive meetings and that they accomplished a good deal. The rest of the evening was devoted to the members' personal experiences and problems in service work.

Former Treasurer Morris Lerner regretfully explained that due to a change in his working hours, he would be unable to attend meetings for some time in the future and would therefore have to give up his post as Treasurer. Charles Meade graciously volunteered to take over his duties and the members unanimously elected him to the post.

The members expressed their deepest sympathy to the family of Harry Gaters, who passed away recently.

DETROIT CHAPTER is grateful to Mr. Frank Paternel for inviting the members for another tour through his factory, during which he showed and explained how picture tubes are made, how they are taken apart, cleaned, re-screened, guns replaced, evacuated, and tested. This was the third tour through this factory for many of the members, but of course some of the new members had not made the tour before. In any event, the tour was as fascinating to all as the first two.

The Chapter's officers for 1960 are: James Kelley, Chairman; Ellsworth Umbreit, Vice-Chairman; George Langlois, Recording Secretary; Edward Atkinson, Assistant Secretary; F. Earl Oliver, Treasurer; John Stanish and Asa Belton, Finance Committee; Prince Bray, Librarian; and Charles Mills, Sergeant at Arms. Congratulations gentlemen!

SPRINGFIELD (MASS.) CHAPTER over a
(Continued page twenty-three)

Directory of Local Chapters

Local chapters of the NRI Alumni Association cordially welcome visits from all NRI students and graduates as guests or prospective members. For more information contact the chairman of the chapter you would like to visit or consider joining.

BALTIMORE CHAPTER meets 8:00 P.M., second Tuesday of each month, 100 N. Paca St., Baltimore. Chairman: Joseph Doliyva, 717 N. Montford Ave., Baltimore, Md.

CHICAGO CHAPTER meets 8:00 P.M., second and fourth Wednesday of each month, 666 Lakeshore Dr., West Entrance, 33rd Floor, Chicago. Chairman: Charles Teresi, 3001 N. Norica, Chicago, Ill.

DETROIT CHAPTER meets 8:00 P.M., second and fourth Friday of each month, St. Andrews Hall, 431 E. Congress St., Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Mich.

FLINT (SAGINAW VALLEY) CHAPTER meets 7:30 P.M., second Saturday of each month, 3149 Richfield, Flint. Chairman: William Neuman, 1613 S. Kiesel, Bay City, Mich.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER meets 7:30 P.M., second Thursday of each month, North Hagerstown Senior High School, Hagerstown, Md. Chairman: Reginald Ankeney, 138 Main St., Clear Spring, Md.

LOS ANGELES CHAPTER meets 8:00 P.M., second Friday of each month, 11523 1/2 S. Broadway, Los Angeles. Chairman: Eugene DeCaussin, 5870 Franklin Ave., Apt. 407, Hollywood, Calif.

MILWAUKEE CHAPTER meets 8:00 P.M., third Monday of each month. Radio-TV Store & Shop of S. J. Petrich, 5901 W. Vliet St., Milwaukee. Chairman: Philip Rinke, RFD 3, Box 356, Pewaukee, Wis.

MINNEAPOLIS-ST. PAUL (TWIN CITY) CHAPTER meets 8:00 P.M., second Thursday of each month, Walt Berbee's Radio-TV Shop, 915 St. Clair St., St. Paul. Chairman: Walter Berbee, 328 E. Co. Rd., A-2, St. Paul, Minn.

NEW ORLEANS CHAPTER meets 8:00 P.M., second Tuesday of each month, home of Louis Grossman, 2229 Napoleon Ave., New Orleans. Chairman: Herman Blackford, 5301 Tchoupitoulas St., New Orleans, La.

NEW YORK CITY CHAPTER meets 8:30 P.M., first and third Thursday of each month, St. Marks Community Center, 12 St. Marks Pl., New York City. Chairman: David Spitzer, 2052 81st St., Brooklyn, N. Y.

PHILADELPHIA-CAMDEN CHAPTER meets 8:00 P.M., second and fourth Monday of each month, Knights of Columbus Hall, Tulip & Tyson Sts., Philadelphia. Chairman: Herbert Emrich, 2826 Garden Lane, Cornwell Heights, Pa.

PITTSBURGH CHAPTER meets 8:00 P.M., first Thursday of each month, 134 Market Pl., Pittsburgh. Chairman: Thomas D. Schnader, R.D. 3, Irwin, Pa.

SAN FRANCISCO CHAPTER meets 8:00 P.M., first Wednesday of each month, 147 Albion St., San Francisco. Chairman: J. Arthur Ragsdale, 1526 27th Ave., San Francisco, Calif.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8:00 P.M., last Wednesday of each month, home of Chairman John Alves, 57 Allen Blvd., Swansea, Mass.

SPRINGFIELD (MASS.) CHAPTER meets 7:00 P.M., first Friday of each month, U. S. Army Hdqts. Building, 50 East St., Springfield, and on Saturday following the third Friday of each month at a member's shop. Chairman: Rupert McLellan, 233 Grove St., Chicopee Falls, Mass.

(Continued from page two)

respect to the cathode causing the diode to conduct and to produce an audio signal.

This audio signal is coupled through C4 and developed across R5. From the arm of R5, the audio signal is coupled directly to the grid of the triode section of the tube where it is amplified and coupled out through C6. The triode section of the tube is biased Class A by the drop across cathode resistor R2.

The voltage drop across R2 also provides

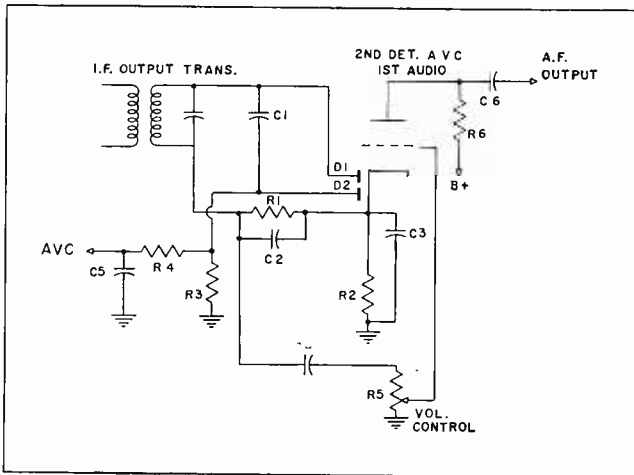


Fig. 2. Delayed AVC.

the avc delay. The i-f signal is coupled through C1 to diode D2. Diode D2 will not conduct until the amplitude of this i-f signal is larger than the drop across R2. When the i-f signal is large enough to make the plate of D2 positive with respect to the cathode, diode D2 conducts and electrons flow from the plate of D2 down through R3 developing a negative voltage at the top of R3. This voltage is filtered by R4-C5 to produce the avc voltage. This delay in producing the avc voltage assures that the receiver will be operated at maximum sensitivity on weak signals. On strong signals, the delayed avc voltage affects the receiver in the same manner as ordinary avc.

AVC For 12-Volt Tubes. The avc system in an automobile radio must be very good to compensate for changing signal levels caused by the auto moving past obstructions. Also automobile receivers have an rf stage so the over-all gain of the set is higher than most ac-dc home radios. Therefore, the avc system must be able to reduce the gain a great deal to handle the large signals from local stations. Car

radios, using conventional tubes, use avc systems similar to the one just discussed. However, when 12-volt tubes are used, the effective range of avc is limited because only a few volts change of grid voltage drives the tube from saturation to cut-off. A novel circuit arrangement allows the avc voltage to completely cut-off the rf tube reducing the gain of that stage to zero.

Fig. 3 shows a partial schematic of the rf stage of an automobile receiver using 12-volt tubes. The avc voltage is applied through resistors R2 and R1 to the control grid of the rf tube. A small avc voltage reduces the gain of this stage in the usual manner. At the same time, the avc voltage is applied to the suppressor grid which is connected to the junction of R1 and R2. The avc voltage on the suppressor grid further reduces the gain of the stage. When a large received signal produces a large avc voltage, the tube cuts off and the gain of the tube is reduced to zero.

The tube is still able to pass the rf signal through the inter-electrode capacitance between the suppressor grid and the plate. The rf signal across the grid tank circuit is coupled through C1 and developed across R1 and R2. A small part of this signal appears across R2, and is felt by the suppressor grid. With the tube cut off, this signal is coupled through the inter-electrode ca-

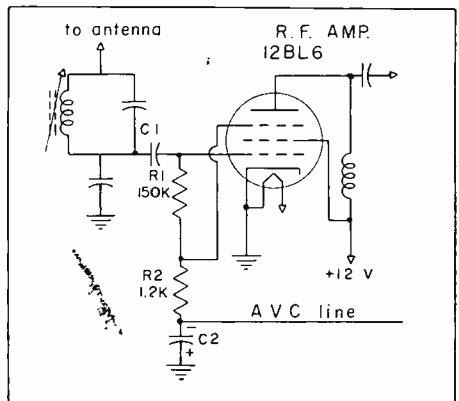


Fig. 3. AVC applied to 12-volt RF stage.

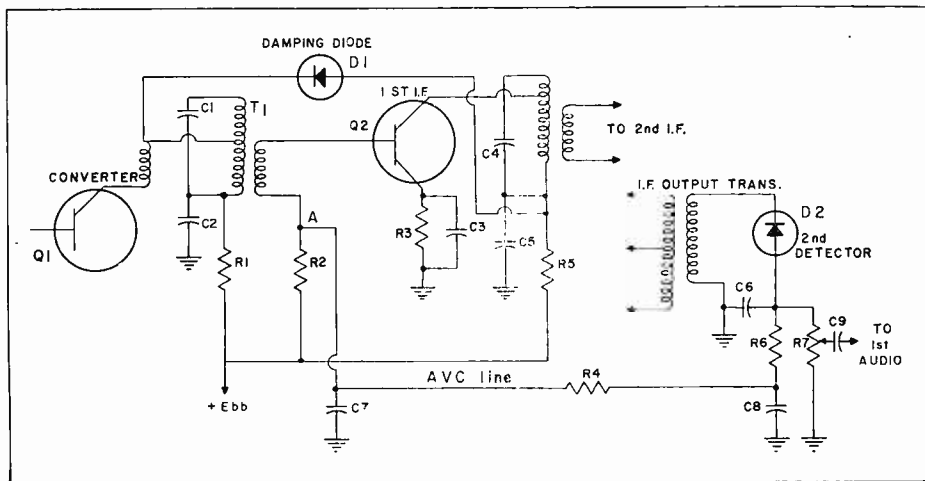


Fig. 4. AVC in transistor Radio and damping diode.

capacitance to the plate where it is developed across the tuned plate circuit. In this way, the rf stage is effectively removed from the circuit when receiving very strong signals. The tuned circuits in the grid and plate circuit still perform their usual functions of frequency selection and image frequency rejection.

Additional avc action is sometimes produced in sets using 12-volt tubes by applying an avc voltage to the first audio amplifier stage. The audio amplifier tubes such as the 12F8 is a remote cut-off pentode. By applying a small amount of avc voltage to the control grid of this tube, the gain is varied and some avc action is effected. The avc action produced in this stage is particularly effective against sudden signal strength changes.

Numerous circuit variations are used to provide avc in radios. However, it is always easy to locate the avc circuit. Simply trace the grid return from the rf stage or the rf grid of the converter if no rf stage is used. This grid return will lead you through the avc filter to the circuit that develops the avc voltage. While most prints have the avc circuit labeled, it is usually not difficult to figure out where the voltage is developed and how the circuit works. This is fine for radios using tubes, but when transistors are used, the circuits are a little different.

AVC In Transistor Radios

Transistor radios develop the avc voltage in the same manner as tube radios, but the characteristics of transistors must be taken into consideration when applying the avc voltage to the transistor stages.

The most practical method of controlling the gain of a transistor stage is by emitter-current control. The emitter current is reduced by applying the avc voltage in such a way as to oppose the forward bias on the transistor. Reducing emitter current affects the gain of the transistor in two ways. First, reduced emitter current reduces the current gain of the stage by decreasing the collector current. Second, reduced emitter causes a change in the impedance match of the transistor to the input and output circuits. This impedance mis-match further reduces the over-all gain of the stage.

Fig. 4 shows a typical avc circuit in a partial diagram of a transistor radio. The avc voltage is developed by the second detector diode D2. The i-f signal from the i-f output transformer causes current to flow down through diode D2 and diode load resistor R7 which also acts as the volume control. The detected audio signal is then filtered by R6, C8, R4 and C7 to produce a negative avc voltage at the top of C8.

The filtered avc voltage is applied to the base circuit of the first i-f transistor Q2. The forward bias for Q2 is supplied from +Ebb through R2, through the secondary winding of T1, to the base of Q2. The avc line is connected to point A at the junction of R2 and the secondary winding of T1. Thus the negative avc voltage opposes the forward bias and reduces the emitter-base current of Q2. As previously explained, reducing the emitter current reduces the gain of the stage. This tends to keep the output of the receiver more nearly constant.

Unlike vacuum tubes, transistors cannot be completely cut-off by a large negative base-to-emitter voltage. There is always a small collector leakage current. Also the inter-element capacitance in transistors is large. The base to collector capacitance is enough so that even with a large negative avc voltage, an appreciable i-f signal is coupled directly from the base to the collector. Both of these factors tend to limit the effectiveness of avc control of transistor stages.

To obtain improved control, many transistor sets use an auxiliary avc diode.

Damping Diode. When operating at high signal levels, enough signal can be directly coupled through the avc controlled transistor to cause overloading and distortion. To take care of these large signal conditions, the damping diode D1 is used in the circuit in Fig. 4.

When receiving normal strength signals, this diode does not conduct because it is back biased by the drop across R1 and R5. As the signal strength increases, the avc system causes Q2 to conduct less and less. The decreased current flow through Q2 decreases the drop across R5. The top of R5 becomes more and more positive until a voltage is reached that forward biases D1 allowing it to conduct.

When D1 conducts, it acts as a low impedance shunt across part of the primary of T1. This greatly reduces the amount of signal coupled through the transformer and prevents overloading on strong signals.

AGC in TV Receivers

As mentioned earlier, the gain of a TV receiver affects both the volume of the audio and the contrast of the picture. Small changes in picture contrast are much more noticeable than small changes in sound level. Therefore, the agc system is very important to the proper operation of a TV receiver. In some early TV receivers, a manual control varied the bias on the rf and i-f stages. This control was usually marked "contrast" and had to be adjusted for each change in signal strength. With the addition of agc circuits the contrast control is placed in the video circuit.

Because small variations in signal strength are so noticeable in the picture, a fast acting agc circuit is needed for a TV receiver. However, the only part of the video signal

that is directly proportional to the carrier strength is the sync pulses. The level of the picture portion of the video is constantly changing with picture detail. Therefore, it is desirable to produce the agc voltage from the amplitude of the sync pulses.

A simple agc system for a TV receiver is shown in Fig. 5. Negative going video is fed to the cathode of diode D1 causing the diode to conduct. Current flow through the diode charges C1 to the peak value of the negative sync pulses. Since C1-R2 forms a long time constant at the repetition rate of the sync pulses, the capacitor does not discharge appreciably between pulses. The negative voltage across C1 holds the plate of D1 negative. Thus the diode conducts only when the negative sync pulses drive the cathode negative with respect to the plate. Since the amplitude of the sync pulses is proportional to carrier strength, the agc voltage changes only when carrier strength changes.

Fig. 5B shows two lines of the negative video signal applied to the agc tube. The dotted line between the horizontal sync pulses shows the discharge path of C1 between sync pulses. The discharge path shows that C1 discharges only a small amount between pulses. This means that C1-R2 is a rather long time constant and the agc will not respond to rapid changes of carrier strength. If the RC time of C1-R2 were made shorter, agc voltage would change each time a broad vertical pulse was received. This would tend to cause the receiver to lose vertical sync.

Due to the long time constant of C1-R2, the agc system is not as fast acting as is desirable. Another disadvantage of this simple agc system is that large noise pulses occurring at any time can produce a large agc voltage. Since the time constant of the agc filter is long, the receiver will be slow in recovering from the effect of noise pulses.

To overcome the disadvantages of this simple agc system, many TV sets use keyed agc.

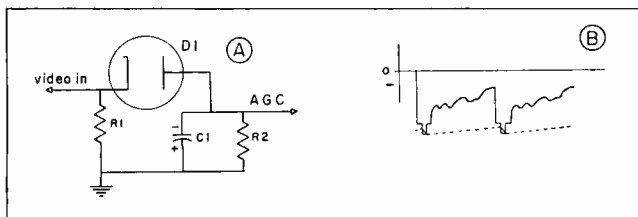


Fig. 5. Simple AGC system.

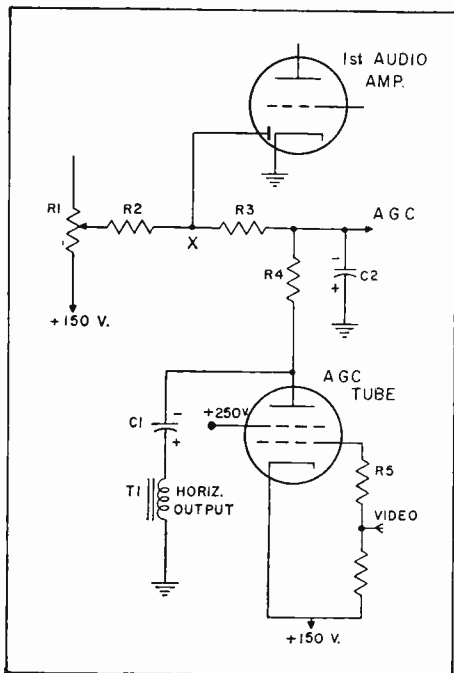


Fig. 6. Keyed AGC.

Keyed AGC. A keyed agc system is designed so that the agc voltage is produced only when horizontal sync pulses occur.

In this way, noise pulses arriving between sync pulses do not produce any agc voltage. Also the system can be made fast acting because there is no chance of picture level or vertical sync pulses affecting the agc operation.

While the exact details of keyed agc circuits vary widely, a typical keyed agc system is shown in Fig. 6. The pentode agc tube is biased to plate current cut-off by the +150 volts applied to its cathode. The screen is supplied by +250 volts. A winding on the horizontal output transformer T1 supplies sharp positive pulses through C1 to the plate of the agc tube. These pulses arrive at the horizontal frequency rate and occur at the same time as the horizontal sync pulses. Each time a pulse is coupled through C1 to the plate, the tube conducts. The amount of conduction depends on the voltage of the control grid during the time the positive pulse is on the plate. A positive going video signal is applied to the control grid through R5. The horizontal sync pulses in this video signal arrive at the same time that the positive pulse is applied to the plate. Thus the amplitude of the horizontal sync pulse determines the amount of conduction of the tube.

The pulses of current arriving at the plate charge C1. This capacitor is small so that it will discharge rapidly and make the agc system fast acting. C1 discharges through R4 and charges C2 to an average negative agc voltage.

Resistors R3, R2 and R1 provide a return path for plate current and determine the "threshold" of agc. The setting of the threshold control R1 sets the level of agc voltage. With the entire resistance of R1 in the circuit, the agc voltage will be so negative that the i-f stages are completely cut-off and we lose our picture. This is possible with this circuit because the agc tube will conduct with each positive pulse on its plate even though there is no video on the control grid.

Decreasing the resistance of R1 decreases the agc level. R1 is adjusted while receiving the strongest local station. With contrast control set at about mid-range, adjust R1 for a good contrast picture. The agc system will then compensate for changes in carrier level. The only set adjustment required when changing stations will be setting the contrast control to the preference of the viewer.

The circuit in Fig. 6 has provision to prevent putting a positive voltage on the agc line. Point X between R2 and R3 is connected to a diode in the first audio section of the receiver. If point X tries to become positive, the diode will conduct and clamp the voltage at about zero.

Like radios, TV sets will be found with a wide variety of agc systems. Some TV sets use an amplifier stage in the agc line to increase the receiver response to signal level changes. Many receivers have separate agc voltages for the rf tuner stage. The tuner stage receives a lower level of agc voltage. This allows it to be more sensitive to weak signals. Some sets have a switch or control to select different proportions of agc voltage for the tuner stage.

Separate Tuner AGC. Fig. 7 shows the distribution of the agc voltage in a typical TV receiver. Separate levels of agc are provided for the tuner and i-f stages. A "local" - "suburban" - "distant" switch permits changing the amplitude of the agc voltage. This switch mainly affects the tuner agc voltage and allows the tuner to operate nearly wide open on weak distant stations. Changing the switch when receiving strong local stations supplies more agc voltage to the tuner to prevent overloading.

When the switch is in the local position,
(Continued page twenty-two)

A Handy Handful

Now and then, something new in equipment comes on the market that makes servicemen wonder, "Why didn't I think of that?" It's usually a simple instrument that does a certain job that has bothered servicemen for years.

The instrument shown on the facing page has proven itself about the handiest thing since the invention of plug-in tubes.

Every serviceman who has tried to check the filaments of tubes used in series-string equipment appreciates how difficult it is to hold a tube, and at the same time, hold the two ohmmeter prods against the proper pins of the tube. Also, there is the problem of not knowing which pins are the filament pins. Of course, this isn't too much of a problem on modern tubes, but it can give beginners considerable trouble.

With the "handy handful" shown on the facing page, there are no more problems using an ohmmeter to check filaments.

Suppose you have a 5-tube ac-dc receiver and none of the filaments light. This tells you one of the filaments is defective. The normal system is to remove the tubes one by one and check the individual filament with an ohmmeter. With the popular NRI Model O Series String Filament Tester, you simply remove the tubes one at a time and plug them into the corresponding socket on the panel of the instrument. If tester bulb lights, the filament is good; if it doesn't, the filament is bad. It is as simple as that.

The filament testing arrangement in this instrument is such that you can check all tubes that are likely to be used in a series-string arrangement. This includes the older tubes such as the 25Z6, and the very latest tubes such as the 600-ma tubes designed for use in modern TV receivers. Special test terminals are also provided

for checking fuses. It's generally easy to tell when a fuse is blown out simply by looking at it. But there are times when the appearance of a fuse may fool you, and you would normally be forced to check the fuse with an ohmmeter. No more. Simply lay the ends of the fuse across the two terminals at the bottom of the panel, and if the bulb lights, the fuse is good.

The Model O Filament Tester is battery-powered. There are two small 1.5 volt pen-light cells inside the instrument. Since batteries eventually wear out, a testing circuit is provided. There are two terminals at the lower right of the panel. To check the batteries, short those two terminals together. If the bulb lights, the batteries are good. If it doesn't replace the batteries.

A cable (not shown in illustration) coming out of the left side of the case terminates in a plug especially designed to fit the filament pins of picture tubes. Since pins 1 and 12 of a picture tube are always the filaments, simply slipping this socket-like device up over the filament pins of the tube—pins 1 and 12—will allow you to check the filament. If the tester bulb lights, the picture tube filament is good.

This handy little tester weighs just 8½ ounces—is small enough to fit in a man's trousers pocket. Because of its small size and light weight it's easy to carry, and will prove to be a valued helper on service calls.

Another point: Two "pin straighteners"—one for 7-pin tubes and one for 9-pin tubes—are also provided on the panel. These are very convenient if you accidentally bend the pins of a tube trying to get it out of a crowded TV set.

And finally—it checks pilot lamps too!

METERS FOR "E" MULTITESTERS STILL AVAILABLE

In 1956, the "E" series of kits in the Radio-TV Servicing course were superseded by our present kits known as the "W" series. The "W" kits include a VTVM instead of a multitester (identified by its slanted panel).

To dispose of extra "E" kit multitester meters, they are now offered to "E" kit students and graduates at a reduced price of \$2.00 each. An adequate supply of these meters have been set aside for "E" kit students who have not yet completed their courses.

If you have an "E" multitester, you'll want to take advantage of this special offer. To order, just drop a short note to the NRI Supply Division, 3939 Wisconsin Ave., Washington, D. C. enclosing check or money order. Ask for meter ME-6. No limit on quantity. Order two or three if you wish.

POPULAR NRI MODEL O FILAMENT TESTER

Only **5.50** postpaid, complete with batteries

Low Price Means Worth-While Savings On This Handy Instrument

IMPORTANT FEATURES:

- completely self-contained, uses 2 long-life penlight cells
- can be conveniently carried in jacket. Size: 1" x 3½" x 5⅝"
- easy to use—complete instructions on back
- built in pin straighteners for miniature 7-pin and 9-pin tubes
- handsomely styled. Custom-made case, brushed aluminum panel with black lettering

QUICK CHECKS:

- ✓ Receiver tubes for filament continuity
- ✓ TV picture tubes for filament continuity
- ✓ TV and Radio set fuse continuity
- ✓ Pilot lamps, bayonet and screw-base types
- ✓ Most TV filament strings

Made for NRI by a well-known manufacturer, the Model O Series String Filament Tester is a real buy at \$5.50 . . . substantially below the selling price of comparable instruments.

The most frequent cause of tube failure is an open filament. With the NRI Model O, you can check the filaments of tubes in series string Radio-TV receivers FAST. Just plug tube into the socket it fits. If test lamp lights, filament is good. (7-pin battery tubes use a plainly marked socket.) To check fuses, place ends on contact points. If pilot lamp lights, fuse is good.

Convenient to use in customer's home. Carry in pocket or tool box. Speed up your service work. Order today.

ORDER BLANK

USE THIS BLANK TO ORDER YOUR SERIES STRING FILAMENT TESTER

National Radio Institute
3939 Wisconsin Ave.
Washington 16, D. C.

Name

Student Number

Address

CityZoneState

I enclose \$5.50 for which send me, postpaid, one NRI Model O Series String Filament Tester.

(If you live in Washington, D. C., add 2% for D. C. Sales Tax)



(from page one)

the tuner and i-f stages get the same agc voltage because there is no voltage drop across resistor R4. With the switch in the "suburban" position, a circuit is completed from the agc line through R4, through the switch, through resistor R6 and R7 to ground. Current flow through this circuit produces a drop across R4. The drop across R4 subtracts from the agc voltage leaving a smaller voltage at point X to be applied to the tuner stage. This small agc voltage to the tuner allows it to operate at a high gain.

With the switch in the "distant" position, resistor R6 is bypassed causing even a larger drop across the resistor R4. The agc voltage at point X falls to an even lower value and this small tuner agc voltage allows the tuner to operate at maximum gain.

The additional filters in the grid circuit of each i-f stage perform an important function. These filters prevent feedback that could cause oscillations.

Some type of agc level adjustment is found on many TV receivers. It may be labeled "fringe-local," "D-X range finger," or "agc control." Most of these controls operate to attenuate part of the agc voltage like the circuit in Fig. 7. Sometimes the control adjusts the agc delay. Delayed

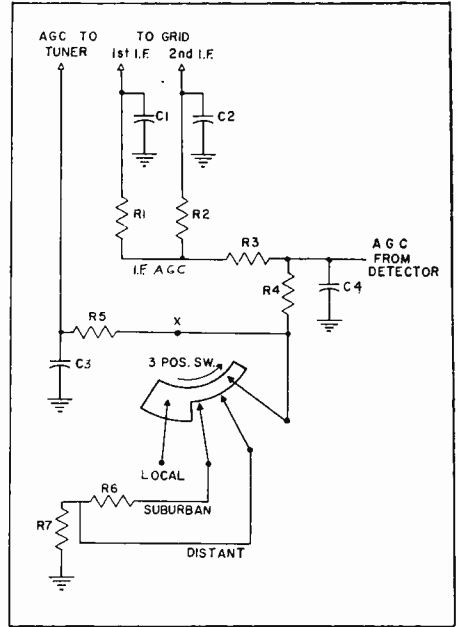


Fig. 7. Distribution of AGC voltage in a typical TV receiver.

agc is used in TV receivers in the same way as in radios.

— n r i —

— n r i —

Lifting and Leaning

There are two kinds of people on earth today,
Just two kinds of people, no more I say,
Not the good and the bad, for it's well understood
The good are half bad and the bad are half good,
Not the happy and sad, for the swift-flying years
Bring each man his laughter and each his tears,
Not the rich and the poor, for to count a man's wealth
You must first know the state of his conscience and health,
Not the humble and proud, for in life's busy span
Who puts on vain airs is not counted a man,

No! The two kinds of people on earth I mean
Are the people who lift and the people who lean,
Wherever you go you will find the world's masses
Are ever divided in just these two classes,
And, strangely enough, you will find too, I ween,
There is only one lifter to twenty who lean,
In which class are you? Are you easing the load
Of overtaxed lifters who toil down the road?
Or are you a lifter who lets others bear
Your portion of the worry and labor and care?

Ella Wheeler Wilcox



Springfield Chapter digging into refreshments at the close of a meeting.

(Springfield—from page 15)

year ago requested the film "The Teacher Wore White" from the General Electric Company. It arrived just in time for the regular December meeting and it turned out to be well worth waiting for. The "Teacher Wore White" is excellent for showing at local chapter meetings, with enough of a story to make an interesting film which basically describes the manufacture of receiving tubes. Following the showing of the film, refreshments were served.

For the balance of the evening Technical Advisor John Michnovetz told of some of his experiences at the Radio Station and gave a fine talk on Ohm's Law.

Any other local chapter wishing to get the film "The Teacher Wore White" should write to Mr. R. W. Newbolt, General Electric Company, Receiving Tube Dept., 316 East Ninth Street, Owensboro, Ky.

NEW YORK CITY CHAPTER at its customary Christmas party extended a warm welcome to Executive Secretary Ted Rose, who was present on his annual visit to the Chapter. One of the highlights of the evening was Ted Rose's administering the oath of office to Thomas Hull, who was elected National President of the NRI Alumni Association for 1960. This was followed by an excellent supper and lively talks and discussions. Everyone attending enjoyed the evening.

James Eaddy expressed his appreciation and that of the rest of the members to everyone connected with the NRI News for the valuable information it contains. He particularly pointed out that the data on the Zenith Space Command TV set

came to him just as he was working on such a set and it helped him immensely.

The meetings continue to be educational and enjoyable, thanks to the Chapter's own very adept speakers. Tom Hull showed how to find a defect in a set that was completely dead. Using the Chapter's RCA Demonstrator, which he "bugged" up, he started from the speaker and worked forward until he reached the aerial; when he finished, the set worked perfectly. This was an enlightening demonstration.

Frank Zimmer went through a list of all the different types of equipment the Electronic Technician can service. The large quantity is amazing. This reminded Cres Gomez how he repaired an oil burner simply by cleaning the face of a light-sensitive tube.

Cres Gomez, Frank Zimmer, Frank Catalano and Ralph Pincus continue recounting various experiences of theirs which are of interest to the members.

The officers elected to serve the Chapter for 1960 are: David Spitzer, Chairman; Thomas Hull, Exec. Chairman; Frank Zimmer, First Vice-Chairman; James Eaddy, Second Vice-Chairman; Harry Gerdts, Secretary, and Frank Catalano, Treasurer. Congratulations to these gentlemen!

The members were saddened by the passing of Emil C. Ruocco, a much-respected and active member since 1944, whose death represents a real loss to the Chapter.

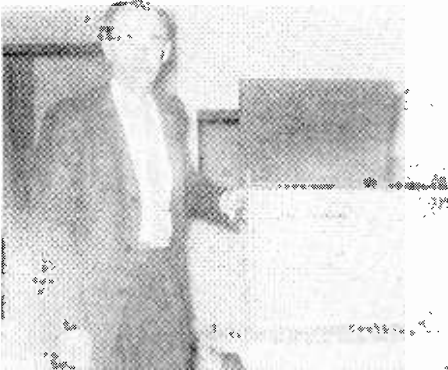
PITTSBURGH CHAPTER enjoyed another talk by Mr. Clement McKelvey, a highly respected Honorary Member of the Chapter. His talk this time was devoted to horizontal oscillators and control circuits. The members always look forward eagerly to Mr. McKelvey's excellent talks.

The Chapter held its Annual Christmas Party at its December meeting. First was the election of officers for 1960, as follows: Thomas Schnader, Chairman; Howard Tate, Vice-Chairman; Ray Bender, Secretary; Jack Fox, Treasurer; William Lundy, Earl Uhl, and Charles Kelly, Executive Committee. Ted Rose, Executive Secretary of the NRI AA, who was present at the meeting on his annual visit to the Chapter, administered the oath of office. This was followed by a short question-and-answer

swer period conducted by Chairman Tom Schnader. The evening ended with a buffet supper with a more than abundant supply of tasty items.

The Chapter informs National Headquarters that it is making plans for an even bigger and better year in 1960.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER attended a Sylvania Clinic conducted by a Sylvania Electronic Engineer at the Hotel Alexander in Hagerstown. The chief topic of discussion was the company's TV receivers. A forecast of probable things-to-come was given, which included the possibility of a post-accelerated picture tube that would eliminate the yoke, video amplifier, etc., and work on very low voltage. The members were of course extremely interested in this advance information.



Mr. Bill Heath, Service Supervisor, Westinghouse Corp., delivering talk to Philadelphia-Camden Chapter members.

PHILADELPHIA-CAMDEN CHAPTER is enjoying some unusually fine programs and consequent high attendance (78 members at a December meeting).

One meeting featured Mr. Russ Mauger, Service Supervisor, and Mr. Herb Telling, Service Manager, of Philadelphia Distributors of Motorola. Mr. Mauger delivered a talk on the 1960 Motorola portables and table models. Schematics were given out with other literature about Motorola receivers and Mr. Telling used a visualcast projector for slides to explain the circuitry of the sets.

At another meeting the members were hosts to Mr. Bill Heath, Service Supervisor of Westinghouse Corporation, who turned up plentifully equipped with slide projectors, film, consoles, table models, and port-



Messrs. Russ Mauger and Herb Telling, respectively Service Supervisor and Service Manager of Philadelphia Distributors for Motorola, at a meeting of the Philadelphia-Camden Chapter.

ables. Mr. Heath went through his sets in trouble-shooting and his description of the sets was such that it was a pleasure to sit and listen to him. He also gave out Service School books loaded with schematic and useful information on the Westinghouse sets. The membership was proud that Mr. Heath gave his talk as an exclusive, the Chapter being the first to get information on the 1960 sets. The members voted Mr. Heath as a lifetime Honorary Member.

Officers elected to serve the Chapter for 1960 are: Herb Emrich, Chairman; Harvey Morris, Vice-Chairman; Jules Cohen, Recording Sec'y; Joe Burke, Financial Sec'y; Charles Fehn, Treasurer; Charles Wells, Librarian; Ray Stout, Sgt. at Arms. Our congratulations to these officers.

The Chapter has admitted four more new members to membership: Donald Kowalewsky, Joseph Glacker, James Corrigan, and Eugene Patrick. Welcome to the Chapter, gentlemen!

— n r i —

HOW YOU CAN HELP NRI GIVE FASTER SERVICE

When you write to NRI—whenever you send a payment, lesson or order, please be sure to give your full name, complete address *and* your NRI Student Number. If you are a *graduate*, write "Grad" after your name or "G" after your Student Number. If you will remember always to do this, we will be able to give you quick efficient service.

Hi

Fi

Corner

By **JOHN G. DODGSON**

NRI Consultant

Product Report:

Eico AF-4 Stereo

Amplifier Kit

This 8-watt stereo amplifier is one of the few high-quality amplifiers on the market which is specifically designed for economy stereo systems using ceramic cartridges and small efficient speaker systems.

Besides this obvious use in setting up an inexpensive system, the AF-4 should be "just the ticket" for upgrading a package system or converting one to stereo operation.

No difficulty was encountered in assembling the AF-4. Despite the simplicity of the unit, there are quite a few parts in it and it does take time to build it—about 10 to 20 hours depending on experience.

The AF-4 comes complete with a metal case like most other Eico high fidelity equipment. It features a tone control for each channel that can be operated separately or together, a separate on-off switch, a selector switch, a mode switch, and dual gain controls that can be operated separately or together. There are more input and output jacks than could ever be used including tape output and

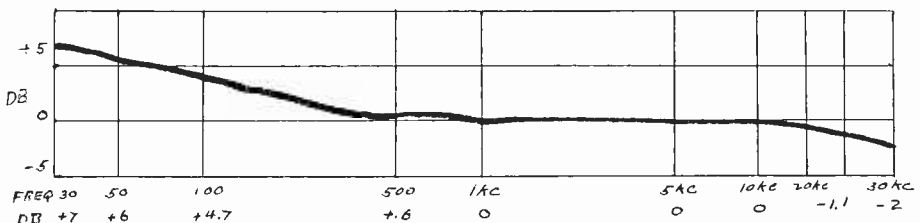
even a plug to provide power for a separate preamp.

The circuitry of the AF-4 is unusual in several ways. First of all, both channels use single-ended output which has traditionally been condemned for hi fi because of the inherently high distortion. To reduce this distortion Eico uses 27-db of feedback—an unusually high amount. (Most amplifiers employ only 15 to 20-db.) Because of the high feedback the AF-4 is quite stable and no ringing trouble was encountered in square-wave tests.

The tone-control system of the AF-4 is rather unique; the control for each channel provides for either bass cut or treble cut—no boost. This type of control system is used to reduce distortion since it permits the available gain to be used for distortion reducing feedback instead of being expended on excessive bass or treble boost. Although I did have reservations about this tone control system at first, I found it quite satisfactory when actually used in an inexpensive system.

My measured frequency response of the AF-4 is shown in Fig. 1. It is evident that the high end is quite satisfactory, being only -1 db down at 20-kc. The rise in bass response below 500 cps is due to an ABC (automatic bass compensation) circuit connected to taps on the gain controls. With this network removed (by cutting two wires) the bass response is within $\pm .6$ -db to 25 cps. Hum and noise were inaudible at listening level. The power output was found to be slightly over 13 watts before clipping. Incidentally the rated power output of 8 watts, 4 watts per channel, may seem to be very low in comparison to some of the 60 and 70 watt amplifiers now being sold. However, 4 watts is more than enough to drive most 8 or 12-inch speakers to a very loud level. Remember that most Radio and TV receivers seldom have over 1.5 watts output and are rarely turned up all the way! Of course, more power does insure low distortion on peak reproduction.

Instead of using standard screw type terminals for the speaker connections the



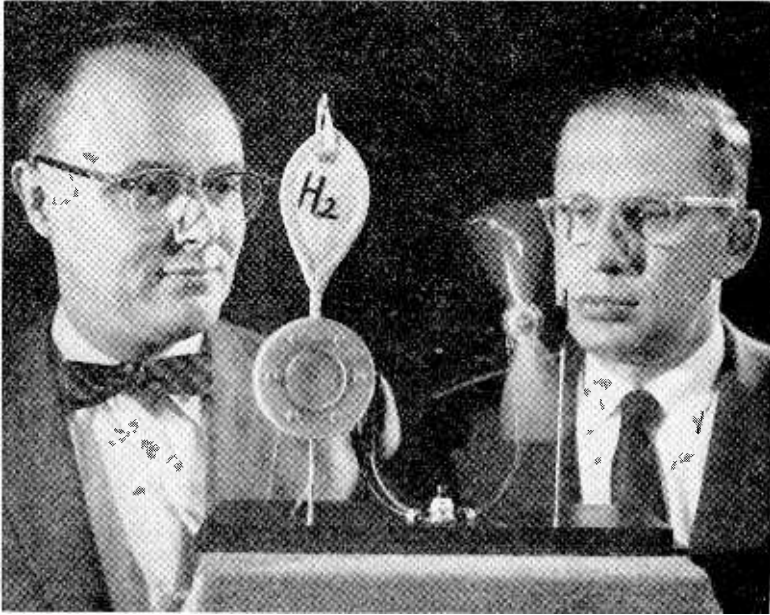
AF-4 offers a plug arrangement. That is, speaker leads are soldered to special plugs (furnished) and jacks are provided on the chassis to receive the plugs. Of course, there's nothing wrong with this arrangement but it would have been easier to use conventional terminal strips.

My only criticism of the AF-4, and this is more of a comment, is that it simply has too many inputs, outputs, switch positions, and other such gimmicks that just aren't necessary. Disregarding this the EICO AF-4 is a well engineered unit that easily meets its specifications.

— n r i —

— n r i —

New "Fuel Cell" Device Produces Electricity



A device that produces electricity directly from gaseous fuel has been developed in a new, improved form by General Electric scientists, it has been announced by Dr. Guy Suits, General Electric Vice President and director of research.

"For more than a century," said Suits, "scientists have been trying to develop a successful 'fuel cell,' as such a device is called. It has been a continuing challenge because it offers the possibility of generating electricity much more efficiently than by conventional methods. Fuel cells are also attractive because they are compact, light-weight power sources. Studies conducted at the GE Research Laboratory have now resulted in a practical design."

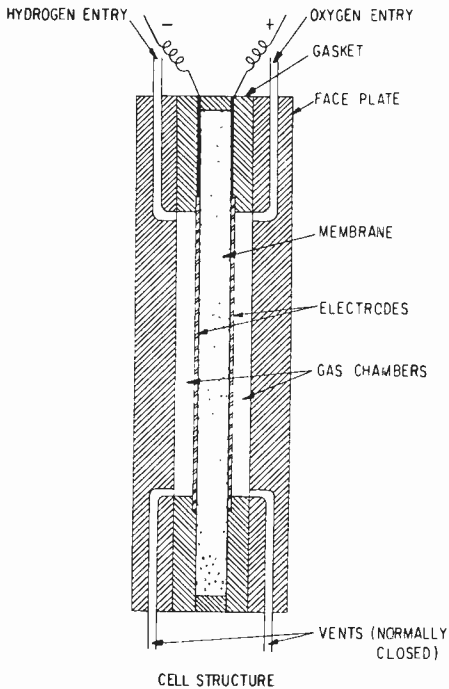
The fuel cell generates electricity by means of a chemical reaction. In the present version, hydrogen and oxygen produce an electric current, with water as a by-product.

The model described and pictured above

consists of a round plastic disk about one-half inch thick and three inches in diameter. Its hollow interior is divided into two chambers by a special plastic membrane, which has an electrode in contact with each of its sides. Hydrogen is fed into one chamber, and oxygen into the other (or oxygen in the air can be used). At one electrode, the hydrogen molecules break up into electrons and positively charged hydrogen. The electrons travel through an external circuit to the other electrode, thus creating an electric current. The positively charged hydrogen moves through the membrane to the other electrode, where it combines with oxygen and the electrons from the external circuit to form water.

The new device operates efficiently at room temperature and normal atmospheric pressure. Thermal efficiencies over 60 per cent have been obtained.

"The fuel cell may find both civilian and military uses," said Suits, "despite the fact



that it produces low-voltage direct current. We cannot yet determine how competitive it will be with other power sources, but its special characteristics may well fit it for a variety of uses. It is likely that the present cell will be useful for specialty applications, rather than for the production of large quantities of power for general distribution. Military and space vehicle applications might make use of the fuel cell's high reliability, simplicity, portability, light weight, and small volume."

TECHNICAL DATA
General Electric Research Laboratory
FUEL CELL

The broad principles of this device are common to all fuel cells, but the type described above is novel in employing an *ion exchange membrane* as an electrolyte. This has an advantage over aqueous electrolytes, in that the electrolytically conducting ions are "locked in," and cannot be leached from the cell. These membranes also reject water when they reach saturation, and, therefore, no difficulty is experienced from dilution effects. These features combine to simplify the operation of the cell, because they provide built-in controls for maintaining the electrolyte concentration and the water balance.

In addition, the electrolyte may be *acidic*,

consisting of a cation exchange resin in its hydrogen form. The use of an acidic electrolyte makes it possible to use gases containing carbon dioxide, e.g., air.

In cells using caustic electrolytes, such as potassium hydroxide, the hydroxyl ion is the charge carrier, and the water produced by the net cell reaction forms at the fuel electrode. In the present device, the hydrogen ion is the charge carrier, and the water forms at the oxidant electrode. This is advantageous when the cell is operated on air, since the water can be disposed of by controlled evaporation.

Among the other features that should be noted are the following: the solid polymer electrolyte makes possible very compact cell structure, operation on static heads of gas is possible, no moving parts are involved, and close tolerances are not involved in the construction cell.

A number of cells have been operating continuously for from 75 to 100 days, and these tests have not yet been concluded. One cell has operated for more than 100 days, and is still running. Two cells have been operated with their cathodes exposed to the air; one of them is still running after more than 75 days. Portions of these tests have been conducted at current densities of 30 ma/cm², although most of the operation has been at lower current densities.

The cells have been operated mainly on commercially available hydrogen and oxygen.

Because of the thinness of the cell itself and the small size of the gas chambers, the performance of the cell in terms of net power per unit weight (or per unit volume) is attractive. Power densities of the order of one to two kilowatts per cubic foot have been calculated on the basis of present data.

————— n r i —————

Don't be so busy sawing wood that you haven't time to sharpen the saw.

————— n r i —————

Chicken In Every Pot Department

A growing number of American families have solved the problem of whether to watch Ed Sullivan or Maverick. According to a survey reported in the Ziff-Davis magazine *Electronics world*, almost 25% of the U. S. families now own at least two television sets.

The Best Teacher*

By Henry Farad

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Actually, the advanced student will recognize in this article the NRI Practical Training Plan. We are pleased to present this article, however, because it tells the story in an interesting manner and we feel that it is practically impossible to say too much on the subject of how to gain experience.

HE DRIFTS into my TV repair shop two or three times a year. He's a different individual each time, but his problem is always the same. He has studied TV theory until it's running out of his ears; what he needs now is on-the-job experience to make that theory worth something in terms of dollars and cents. He is up against a problem as old as civilization—he hasn't been able to find a job because he has no experience; he can't get any experience because he can't find a job!

I can't help him directly. I'm a smallbore operator on a side street; my shop is in front of my home. You know the setup; in slack season not half enough work for one man; when things get snowed under, a few 12- or 14-hour days clear the decks. I get by, which is just fine. But hired help I can't use.

However, I can explain how I got my experience after I'd run up against the identical problem. Like many others, I learned my TV theory at home in my spare time; making a living occupied most of my daylight hours. My only teachers were books, magazines, and a study course.

Inevitably, as does every student, I reached a point where the books began to blur. I'd absorbed all the wordage I could handle for the time being. I needed actual contact with TV sets—preferably in bad order.

I could have gotten that contact in a residential TV school, but I had a family to support and no rich uncles. A job as a helper or apprentice in a TV shop was another possibility, but a shop helper's pay is too low and his progress not fast enough for any but single, unburdened individuals. I solved the problem by creating my own experience. The method is simple and relatively cheap; it can be duplicated anywhere. It can supply any student—as it supplied me—with experience at exactly the right pace; never too fast, never too slow; whenever he wants it—evenings, week-ends, any time.

My first step was to become what amounted to a part-time dealer in TV

junk. This was simple enough. I inserted a classified ad in a local paper, offering to buy old TV sets—any size, shape, or condition for cash. You don't have to be a big dealer to do this. I put a \$50 maximum on my offer, thus side-stepping big stuff; I never paid more than \$30 for any of the ten-inch clonkers I dragged home. \$30 was my top a couple of years back—a \$20 maximum would be more in line with today's situation.

Having dragged a relic home, I proceeded to restore it to working condition, which frequently took a little doing. As might be expected, there was something badly amiss with every one of my prizes. Some produced neither raster nor sound; some made with fearful planing-mill noises. Others were inhabited by gremlins or some of the many ailments common to TV sets. Sad cases every one, but you don't learn TV repairing by working with sets in good order. Assuming a receiver hasn't suffered a major burn-up (sniff well before buying), and hasn't been robbed of tubes, then the worse its condition the better for the student seeking experience.

The actual, hard-rock experience I gained in repairing those boxes was only part of the program. My next step was to twist every nonoperating control I could find, with the idea of getting everything as far out of kilter as possible. Then I restored everything to normal, sometimes repeating the process several times. The further I progressed the bolder I became; the deeper I dug into my clonkers. I introduced defects and observed the symptoms. I practiced signal-tracing and alignment, to mention just a few of my earlier experiments. Then, after I'd milked a chassis dry of information I sold it down the river, as detailed a little later.

In one corner of my over-sized garage I fought first one piece of junk back into working order and then another—and another. A v.t.v.m. with a couple of probes, a tube tester, and some early printings by Rider and Photofact made up my equipment, plus the usual hand tools.

It's no fun—not at the start. Not for the

student completely on his own, with not a soul to give him a lift when he gets stuck in the mud, which is often. It's not the most efficient method in the world, either; it involves frustrated hours of doing things the wrong way, stupid mistakes, wrong approaches, errors of both omission and commission. There were times when I'd have sold out for a fraction of the inventory.

But you can say this about the method—it works! It produces real, valuable experience. Moreover, it sticks with you, as does anything acquired the hard way. Another advantage is that you have neither employer nor impatient customer breathing down your neck—a handicap which can make even an experienced mechanic sometimes black out.

I started out in my garage loaded with theory but inclined to go numb from the neck up the moment I removed the back of a defective TV set. The first time I pulled one out of a cabinet and turned it over I recall sitting there for half an hour, just gawking, with a gone feeling at the pit of my stomach, wondering why I'd ever started this. The first few times I compared a schematic with a chassis I got lost so fast it was worse than pitiful. No fun at the start.

Little by little, however, stage by stage, I acquired competence and confidence, a backlog of experience. I discovered head-on attacks don't pay off in TV repairing. Strategy is the key to the jackpot; knowing when to attack a repair job via the dynamic approach, checking a.c. components with a v.t.v.m. or scope, and knowing when to use the static approach, routinely checking socket voltages, capacitors or resistors. It means knowing when to use a tube-tester and when to rely entirely on substitution. The difference between the strategic and the head-down approach is the difference between minutes and hours in wrapping up a repair job.

The strategist is always changing pace. He hangs onto an idea or a deduction just so long, then if it fails to pan out he drops it. This is an attitude of mind to be cultivated. Let me illustrate the disadvantages of not having this attitude, by using a hypothetical Joe Doakes. Confronted with a fairly tough case of TV trouble, Joe looks the situation over and makes a quick deduction as to the probable cause. So far so good. However, Joe's test gear promptly reports that everything is under control in the suspected area. This is where real trouble starts.

Instead of changing pace and developing a second deduction, Joe stubbornly makes another pass at the original target. When this gets him nowhere, he promptly goofs off. Two hours, three hours later you may find him still working over the same group of components. Meanwhile in the process of checking and re-checking it's quite possible Joe's test gear has indicated the cause of the trouble. But because Joe is operating strictly under Condition Gooff, he pays no attention to what the test gear tells him. He ignores it, knot-headedly continuing his original line of attack.

After lunch or possibly the next day, he'll come to, kick himself, and proceed to repair the TV set in a normal manner. I goofed off like this more than once. Others far more competent than I have done exactly the same thing.

The calm, cool, and collected attitude is about twenty-five percent of the top-drawer technician. It increases output and accuracy, it inspires that precious gem, customer confidence. Move slowly and deliberately; it will reduce the number of chassis unnecessarily pulled, and the number of 6AU6's popped by forgetting to return the filament knob on the tester back from 12.6. In short, the less haste the more speed.

I once pulled a chassis and fought with it for an hour, trying to discover the reason for nonsound. I was knee-deep in gear and half-strangled with test leads when I noticed at long last that the record-player switch had somehow been snapped over to PHONO.

Then there was that memorable Philco on which I wasted more than half a morning trying to find out why the over-all bandwidth had decreased to about 2 megacycles. (Yes, I checked and rechecked the tubes.) The trouble, it eventually developed, grew out of the fact that a 12AU7 and a 12AV7 were planted side by side in the front end—and someone had swapped them! Later I discovered the owner had taken some of his tubes downtown for testing before calling me in, which shows to go you—never take anything for granted.

When nothing produces results within a reasonable time, start taking wild shots in the dark. I am reminded of a certain series-filament conglomeration wherein all

Service to a just cause rewards the worker with more real happiness and satisfaction than any other venture of life.

Carrie Chapman Catt

the symptoms of an open grid circuit in the C-R tube were produced by a heater-to-cathode short in the damper! Then there was that frightful case of horizontal nonlinearity which was caused by trouble in a 6SN7GT horizontal oscillator which checked perfectly in my tester. In this case and as an added unattraction, the horizontal drive capacitor had insanely taken over the function of a horizontal centering control!

Anyway, and as I started to say some time back, little by little, stage by stage, headache by headache, I acquired competence and confidence at my garage workbench. If I've made it sound rough, I can only say it is indeed rough—at the start.

In the end, I no longer crept timidly up to each sour TV set, wondering whether this one would be my Waterloo as I began to probe its innards.

Oh, sure you get thrown for a loss every so often by some box tougher than you, but repairing the vast majority of TV sets is so simple—even for a halfway competent technician—that it sometimes seems a shame to take the money(?).

I bought a lot of clonkers, but my actual inventory at any one time was seldom more than one TV set. As soon as I milked one dry, it was promptly sold.

I'd have a really good story here if I could say these transactions showed a nice profit, but not so. I had to price those boxes low enough to insure prompt disposal, and I had to get cash. The prices I got were anything but fancy. Considering the cost of advertising, mileage, replaced tubes and components, I lost something on every deal—around \$7.50 per box.

Holding on for higher prices could have showed a profit possibly, but I wasn't necessarily trying to make money; my objective was getting experience. Keeping a constant supply of TV cadavers coming my way was the all-important item.

I started my project with a v.t.v.m. and a tube-tester; eventually I acquired a scope, sweep and marker generators, 1,000-kc crystal marker oscillator, grid-dip meter, wattmeter, capacitance-bridge, short wave receiver to monitor WWV, complete set of service manuals, and trimmings. You don't have to be a big dealer to do this. I bought my gear one item at a time. Moreover the purchases were spread out over a considerable period of time.

Slow work? Well, acquiring electronic know-how is a slow process. The TV student in a hurry is licked before he starts; never less than a year and often two years must elapse before he gains enough ground to tackle general repair work.

Also pretty well licked before he starts is the TV student who expects to draw a salary while he gets his practical experience. Students pay considerable sums to acquire theory, and without protest. However, the thought that practical experience must also have a price tag is something which seldom occurs to them. But that's what it amounts to when the inexperienced technician—sharp though he may be in theory—tries to hire out in Slowblow's TV shop.

Apprentice training works out well enough in some occupations, where other services may be rendered while the student learns. Simply observing a TV repairman at work is of little value to the novice, assuming the repairman is not doubling as instructor. Ninety-nine per cent of the effort is quite invisible, consisting of mental processes involved in diagnosing the trouble.

If Slowblow takes him as a bona-fide apprentice or learner, the novice will be in Slowblow's way for a long time; he's only half a technician. Slowblow would be forced to make up his deficiencies. Slowblow must spend many hours teaching the novice the techniques he needs; inevitably the novice will make numerous and sometimes expensive mistakes. In short, he'll be a student drawing wages for being instructed!

The only practical way Slowblow can hire the student is on the basis of shop helper. Most of the time he will put up aerials, pull chassis, act as general man-of-all-work. Thus the student earns his wages, but acquiring experience is strictly hit-or-miss, at a woefully slow rate.

Hence, unless he's exceptionally lucky, the average Joe must buy his experience—and the only visible method is along the general route I've been outlining.

Even if the student does not plan to go into business for himself, buying this test gear is actually a necessity. Considering the strong economic position enjoyed by the experienced, competent TV service technician, the money represents a trivial investment indeed.

Financial statistics prove the best time to buy anything is a year ago.

Awning Art, Pawtucket, R. I.

THE PRICE OF SUCCESS



OFTEN wonder what it is that brings one man success in life, and what it is that brings mediocrity or failure to his brother. The difference can't be in mental capacity; there is not the difference in performance. In short, I have reached the conclusion that some men succeed because they cheerfully pay the price of success, and others, tho they may claim ambition and a desire to succeed, are unwilling to pay that price.

AND THE PRICE IS

TO USE all your courage to force yourself to concentrate on the problem in hand, to think of it deeply and constantly, to study it from all angles, and to plan:

TO HAVE a high and sustained determination to put over what you plan to accomplish, not if circumstances be favorable to its accomplishment, but in spite of all adverse circumstances which may arise—and nothing worth while has ever been accomplished without some obstacles having been overcome.

TO REFUSE to believe that there are any circumstances sufficiently strong to defeat you in the accomplishment of your purpose.

Hard? I should say so. That's why so many men never attempt to acquire success, answer the siren call of the rut and remain on the beaten paths that are for beaten men. Nothing worth while has ever been achieved without constant endeavor, some pain and constant application of the lash of ambition.

THAT'S the price of success as I see it. And I believe every man should ask himself: Am I willing to endure the pain of this struggle for the comforts and the rewards and the glory that go with achievement? Or shall I accept the uneasy and inadequate contentment that comes with mediocrity? Am I willing to pay the Price of Success?

And the Time to Begin to Pay is Now

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