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Editorial

Would you expect to hit the bullseye if you aimed a gun with your eyes shut?

No, you wouldn't—it even sounds ridiculous. Yet many people display such carelessness with their own lives—and with far more serious results.

Let's suppose we gathered together a group of elderly men and asked them this question: If you had your life to live over, would you make any changes? Most of them would say—"Yes, if I had only known what I know now. . . ."

As months and years pass, we see changes. People find new and better ways of doing things. True, no one can forecast the future with any great degree of certainty. For example, a man could spend the best years of his life in a job which he thought held out much promise, only to find out too late he was at a dead-end. But is uncertainty an excuse for failure?

J. E. Smith

Why are some men eminently successful, and others, who try very hard, end up as failures? When it comes to giving the *why* for failure, many just side-step a simple truth. The reason many people don't get what they want out of life is because *they don't know what they want!* They drift—they're carried along on the tide—they settle for whatever comes along. They refuse to set their sights, aim carefully.

A man can be pretty much what he wants to be. But he's got to decide what his goal is. Then, concentrate his thoughts,

(*Continued Page Two*)

Christmas Is Closer Than You Think!

Every year, as the holiday season approaches, we get many letters from students, graduates—their friends and relatives—who want to buy equipment from the NRI Supply Division as Christmas gifts. There are useful tools, instruments and accessories available to fit any pocketbook regardless of whether you're a beginner, hobbyist, part-time or full-time technician.

To assist you in making a selection (and in dropping hints), this issue of NRI News (page 16) and the December-January issue feature a complete listing of available equipment. If you have a particular item in mind and it's not listed in this issue, watch for it in the next.

A relative or friend may order any item for you—we'll ship to any address designated. But as a suggestion, place Christmas orders early. Mail moves much slower during the holiday season. You can be sure NRI will help in every way possible to speed things along—and help you have a truly merry Christmas.

Jules Cohen and Frank Skolnik are candidates for President of NRIAA

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In the matter of learning, time is our best friend and mellowest teacher. Even though the world fairly races along and jets span entire continents in hours, education still requires patience and long thoughtful resolution.

To achieve new heights of better understanding, of finer skills, of wider knowledge, of greater character, we must continue to move forward with determination. Respect time set aside for self-improvement as a priceless friend; use it wisely.

(Editorial—from page one)

his energies, his actions toward that objective.

As an NRI student or graduate, you have an advantage over thousands of other men. You *know* what you want. In short, you've defined your objective. You have a goal and you're working toward it now through self-improvement.

Keep a clear picture of this objective; work hard to reach it. Make the most of your hours, days, *your life*, and in later years, you'll look back on a job — well done.

J. E. Smith
Founder

From The Mailbag . . . .

"I am now working for RCA as a technician. When I applied for this job, the service manager informed me that they were not hiring at that time, but asked me what training and experience I had. After telling him I had taken the NRI course and had my business, he agreed to give me a test.

They looked over the results of this test the same day and told me to report for work the first of the week. I took the test on Friday so just two days lapsed before getting employment. I owe this entirely to the training I received from NRI.

There are many chances for advancement and I plan on staying with RCA for a career. Bought a brand new Chevrolet station wagon and paid for it cash.

All in all, right now I'm sitting on top of the world. If I hadn't spent the small cost of my NRI course, I'd still be at the bottom of the ladder just grubbing for a living. If anyone asks me (and they have) whether they should take your course, I tell them to hop to it and quit wasting time. My original investment has made me thousands. Boy, if that isn't proof NRI can improve a man, I'd like to know what is. Thanks again. I'll always be indebted to NRI."

Richard Latno
Daly City, Calif.

"I would like to take this opportunity to summarize my personal benefits and observations while taking the Radio and TV Communications Course.

As you know from past correspondence, I'm in the Air Force and have been for a number of years. I suddenly became interested in electronics and applied for your course after talking to an individual who was already a student of yours.

As a man who didn't know the first letter in this field, I found the lesson presentations amazingly interesting and simple, yet each new paragraph was filled with a pack of informative and advancing information. As I progressed through the course I can't say the lessons were as "simple" as at first; however each topic and lesson was thoroughly explained and I had little or no difficulty in comprehending the majority of the presentations.

After studying your material for about 12 months I decided to apply for an Air Force Electronics School and was subsequently accepted into the Ground Communications Repairman Course, a length of six months duration. Here is where I really found the quality in your school.

You may quote me when I say that your course covered every single phase of the AF school, plus many other subjects. When I ran into trouble in school, I had only to look up the subject in one of your presentations to find a simple yet professional explanation of the question.

I was not the most outstanding pupil at the AF school but solely due to the NRI material, I was one of the top graduating students. I must say that I have not ceased to reference my NRI presentations. I now work on light ground to air and point to point VHF and UHF transmitters and receivers plus a complex Data Link system and I constantly refer to your course material. I just can't explain to you how much your school has done for me and my future.

What about the future? Well next week the AF is sending me to Keesler AFB, Miss. to attend a special short course in Scatter Proprogation. After completing this course I will be sent to Iceland for a year where I will be working on Microwave equipment. When I return from there I will look forward to a new location and probably more new equipment. When I return from Iceland I would like very much to take another course from your school. Thank you very much for your course and your help."

S/Sgt. Arthur D. Jones
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How Amplification Is Obtained With A Transistor*

by

J. B. Straughn

Chief, Consultation Service

J. B. Straughn

Many students, and old timers, who thoroughly understand the operation of the vacuum tube are just as thoroughly confused by transistor action.

This sad state of affairs is the result of attempting to think of transistor operation in the light of their tube knowledge and by the fact that most transistor theory has come from the mind of the research engineer directly, without the necessary transition to the type of thinking done by the technician. In this article we will attempt to bring out the facts which you, as a technician, must know in order to see how amplification with a transistor takes place. Here we will not attempt to give a complete story of the inner workings of the transistor or of all transistor amplifiers, but we will try to show what makes amplification possible.

Our prime purpose is to tell how a transistor gives an increased signal voltage and an increase in signal power.

First, let's consider a few known basic facts about voltage, current, and power. Voltage is equal to current x resistance. If the current remains constant and the resistance is increased, the voltage drop across the resistance is increased.

** Written especially for those who have learned how amplification can be obtained with a vacuum tube, and who have a good understanding of Ohm's Law.*

Power is equal to current x current x resistance. If the current remains constant and the resistance is increased, the power present in the resistor is increased.

Ohm's law tells you that if the current remains constant and the resistance is increased the source voltage must increase. With a transistor this fact is sidestepped and as you will see, we accomplish this desirable result without increasing the original source voltage.

If we can switch a current from a low

(Continued Page Four)

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resistance low voltage circuit into a high resistance high voltage circuit without an appreciable change in the value of the current, we will automatically get an increase in voltage and an increase in power across the load resistor. This is just what is done in one type of transistor amplifier. To show how this seemingly impossible fact is possible it will be necessary to review current and see what it is and how it flows through a circuit.

In a metallic conductor such as copper you know that the current consists of a movement of free electrons through the wire. The technician generally thinks that moving electrons are current. Actually the current is a moving charge, which is part of the electron. Current does not necessarily have to be a movement of electrons. In a gassy vacuum tube we have positive charges (an ion with a missing electron) moving from positive to negative. This too represents a flow of current, and if the ion current bridges the gap between two metallic objects kept at a difference in potential by an external circuit, the number of electrons that will flow in the external circuit assuming the voltage is quite high, is governed entirely by the number of ions that bridge the space between the conductors rather than the exact value of the applied voltage. If we had some way of injecting a controlled number of ions into the gap between the conductors we could control the current in the external circuit.

The production of ions in a vacuum is a rather haphazard affair and cannot be controlled. However, a different situation exists in certain semi-conductors, particularly specially prepared germanium. Two types of germanium are used, one which has positive charge carriers and one which has negative charge carriers.

In a germanium diode, as in any rectifier, we can get a large current flow when voltage of the correct polarity is applied, the positive and negative charge carriers working together. If the voltage is reversed no current will flow because a small area of the two materials forming the junction of the diode are swept clear of current conductors. These conductors or carriers are free electrons and holes. A hole is somewhat like a gas ion—a germanium atom with a missing electron.

This atom cannot float around in the germanium crystal structure like a gas ion. What happens is that a "fixed" electron from another atom may jump into the hole and the atom from which this electron was attracted now has a hole in its structure. Thus the hole position will move through the germanium towards the negative side of the external circuit, passing electrons towards the positive side of the circuit during its drift. The hole will cease to exist on reaching the negative side of the circuit, but a new hole will be formed at the positive side of the crystal and the process will be repeated. When the applied voltage is of the wrong polarity (reversed bias), to permit current flow, the holes are repelled from the junction as are the free electrons, so there is nothing to carry current from one of the diode materials to the other.

However the reversed voltage across this diode is "raring to go" and wants to force current around the circuit, but the complete path is blocked by the non conductive region which is barren of current carriers.

HOW TO MAKE A REVERSE BIASED CIRCUIT CONDUCT

It is possible to inject or emit a controlled number of current carriers into this barren region and then current will flow through the external circuit and through all of the parts in this circuit.

Because the external voltage is high it can sustain any practical current that is injected into the barren region. If current carriers for 5 ma are injected then 5 ma flows in the external circuit. If 20 ma worth of carriers are injected then 20 ma will flow. Let's see how these controlled current carriers can be emitted into the carrier-free area of a transistor.

A typical transistor in block form is shown in Fig. 1. There are three leads from the transistor, the Emitter lead E, the Base lead B, and the Collector lead

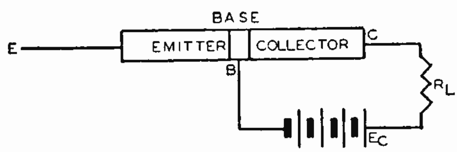

Fig. 1. A transistor in block form. The emitter and the collector are made of germanium which contain negative carriers (free electrons) and is therefore called N material. The base is made of material containing positive carriers (holes) and is for that reason called P material. The base is only a few thousandths of an inch thick. When the materials are arranged in this manner the resulting transistor is called a NPN type.

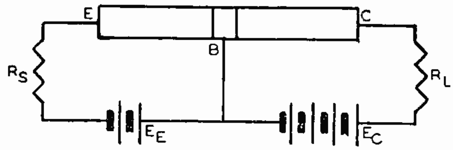

Figure 2. Here the emitter is biased in a forward direction and since current carriers are available at the junction of the emitter and the base current can flow from the emitter into the bias.

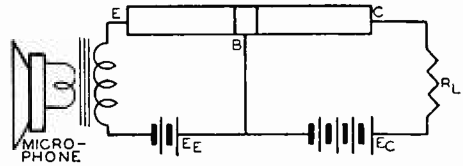

Figure 3. Signal currents from the low resistance microphone transformer will flow through the high resistance load R_L producing a large signal voltage.

C. The collector and base are reversed biased and the junction of the base and collector have been swept clean of current conductors. For this reason no current flows through load resistor R_L and the collector is hungry for current carriers.

In Fig. 2 we have completed the emitter circuit by connecting a small resistor and battery between the emitter and the base. The emitter and base are biased in a forward direction so electrons flow from the negative terminal of E_E through R_s, and into the emitter. You might expect an equal number of electrons to flow out of the base and back to E_E. This however does not occur. The base is made of material so thin as to be porous; and when current carriers are injected into it by the emitter, these carriers are snapped up (collected) by the collector, flow through load resistor R_L, source E_0 and are then returned to E_E.

An important point is that changing the value of R_L will have little effect on the current flowing through it. Because of this R_L may have a much higher resistance than R_s. Therefore since the current through R_L is essentially the same as the current through R_s the voltage and power across R_L is greater than the voltage and power across R_s.

If we replace R_s with an ac signal source such as a microphone the signal voltage will alternately add to and subtract from the bias voltage E_E. This will vary the emitter current, the injection of current carriers into the base, and the voltage across R_L. Thus the transistor will provide amplification.

The internal action of a transistor is a study in itself as are the various circuits which can be used. In every case, however, current carriers which complete a potentially high current circuit are emitted into the collector and essentially the same current flows in a circuit with more resistance than the source. As a result a gain in voltage and power occurs.

Now let's go a step further. The "block" diagram circuit in Fig. 3 is reproduced schematically in Fig. 4. There are two important facts which should be realized about this circuit. These are:

1. The emitter to which the signal is fed draws considerable current from the signal source.

2. The base current is equal to the emitter current minus the collector current. Therefore the collector current is always less than the input current. This means the circuit results in a current loss although it will provide both a voltage and power gain due to the high value of R_L.

One fact to bear in mind is that when a small current flows in the base circuit a much larger current will flow in the emitter and collector circuits. Let's rearrange the circuit in Fig. 4 to take advantage of this fact.

The new circuit is shown in Fig. 5. We have done away with forward bias battery E_E and are making the base .02 volt positive with respect to the emitter by means of voltage divider R_1 and R_2. However the collector is still highly positive with respect to the base and hence the collector base is reversed biased while the emitter-base is forward biased. Most of the electrons forced into the base by the emitter are snapped up by the collector and flow through R_3. When an ac signal is developed by the microphone the base current will vary slightly due to the slight variation in emitter—base voltage. This causes a very large change in both the collector and emitter currents. Now we have a circuit which gives not only

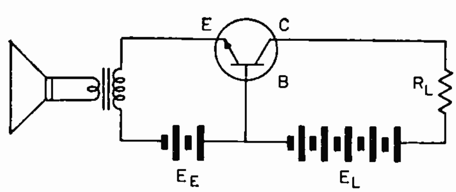

Fig. 4. Simplified common base circuit.

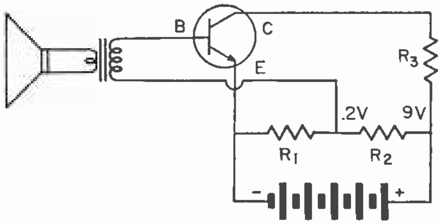

Fig. 5. Common emitter circuit using a single battery to provide forward bias for the emitter base and reverse bias for the collector base.

voltage and power gain but also current gain.

Since the current demands of the base are so low this means the load resistance on the secondary of the transformer is high. Therefore we say that this circuit has a high input impedance. The circuit in Fig. 4 on the other hand is known as one with a low input impedance due to the high current drawn from the source.

Fig. 4 is called a common Base circuit while Fig. 5 is what is known as a common emitter circuit. You will most frequently encounter the common emitter type circuit in the transistorized receivers now making their appearance in ever increasing quantities.

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Hi-Fi Corner

by John G. Dodgson

PRODUCT REPORT: EMPIRE 108 STEREO-MONO CARTRIDGE

QUICK LOOK: This is a new moving-magnet-type stereo cartridge from the Audio Empire division of Dyna-Empire, Inc. Like its predecessor, the Empire 88 cartridge, and the very excellent Empire 98 tone arm, the Model 108 was designed by Herb Horowitz, Empire's Director and Chief Engineer.

Listing of the cartridge as "stereo-mono" instead of just "stereo" is significant and implies, of course, that the 108 was designed to be used in monophonic as well as stereo systems. Even more significant is the Model 108 advertising: ". . . probably the finest stereo-mono cartridge ever developed . . . sets a new standard . . . outperforms the finest monophonic cartridges previously available . . ." These are strong words, particularly from a company that modestly advertised its first cartridge (the Model 88) as ". . . will contribute to superior reproduction. . . ."

MANUFACTURER'S SPECIFICATION: Frequency Response: 16 cps —30 kc, ±2 db; Output: 8.0 mv per channel; Compliance: 6 x 10^{-6} cm/dyne; Tracking Force: 1.5 to 5 grams; Price: $34.50.

TESTING: I first heard a Model 108 a short time before it hit the market when Mr. Horowitz was in Washington and brought one with him. It sounded good enough to be a hand-made "special" although Herb assured me it was not. As soon as the 108 hit the market a production model arrived and was tested.

The Empire 108 is constructed along the

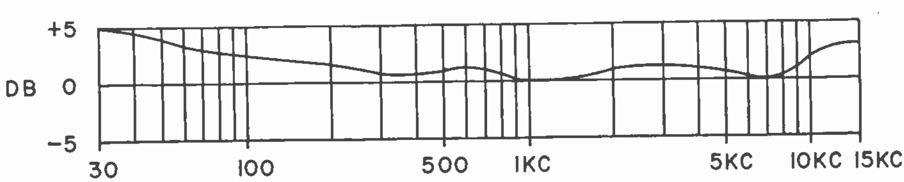

Fig. 1. Frequency response of the Empire 108 stereo-mono cartridge. See text.

same lines as the older 88 with the exception of a mu-metal shield completely surrounding all but the replaceable stylus mechanism. This previous Model 88 was a good cartridge except that it was susceptible to induction hum—I never reviewed it for that reason. The Model 108 is completely free from hum. As a bonus, it boasts 8 millivolt output per channel, further improving the signal-to-noise ratio.

Tracking of the Model 108 is astounding—note that it is advertised at 1.5 to 5 grams. At one gram, the 108 will not track; at 1.5 it will track almost every musical selection I tried. At 2 grams the Model 108 tracked everything, including maximum level glide tones and the most demanding inner record grooves. At 5 grams it tracked with equal ease and no audible difference. These tracking tests were carried out with the 108 mounted in an Empire 98 arm on a Fairchild 412 turntable.

The frequency response of the Empire 108 is shown in Fig. 1. Response tests of any cartridge are extremely difficult to make because of the record accuracy—the record surface noise doesn't help either. The curves shown in Fig. 2 are the results of eight different tests, two each on four different records. This is necessary because of inaccuracy of some of the bands on the records. Also, the compliance of the record material affects the response—particularly the high end. Similarly the mass of the tone arm along with the compliance of the cartridge affects the low end response.

All in all, the value of frequency response curves of any cartridge is limited until the curves are compared to other cartridges tested on the same records. Despite its moderate price, the response curves of the Model 108 are superior to any cartridge yet tested, particularly in its smoothness and high end response. Only one other cartridge tested approached the high end response of the 108, and it lacked bass, resulting in a shrilly texture.

Of course all the frequency or tracking tests prove nothing by themselves. How a cartridge performs on musical reproduction is the proof of the pudding. Careful listening tests were carried out for over two weeks on all types of music, on different labels, at all volume levels. The model 108 was tested against five other top-drawer cartridges, both by me and by others, so that I didn't know which would be played. The texture of the 108 was carefully examined on speech and singing, both by male and female voices, on sweeping orchestral selections (a la Mantovani), on powerful symphonic finales, like Berlioz' "Fantastique," on sharp transients, particularly the plucked strings and staccato drums of the new Command records. In other words, the 108 was subjected to every possible test I could think of. In all instances it came through with flying colors. Despite its very extended high end it never sounded shrill—although I heard some highs on older records that I didn't know were there! It did show that some of the newer stereo records (several were purchased for the tests) are surprisingly excellent.

In conclusion, it must be honestly admitted that in all measured and listening tests the 108 outperformed all other cartridges previously tested. The Empire 108 cartridge (mounted in an Empire 98 arm) sets a new standard in record reproduction that, in my opinion, will be hard to beat at any price.

PRODUCT REPORT: THE EICO HF-81, STEREO AMPLIFIER

QUICK LOOK: This HF-81, a 28 watt complete stereo preamp-amplifier, was one of the first such units on the market. Since its introduction it has met with consistent approval and praise from dealers and critics.

MANUFACTURER'S SPECIFICATIONS: 28 watts continuous power output, 14 watts per channel; IM distortion—2% at 14 watts, .5% at 10 watts; Harmonic dis-

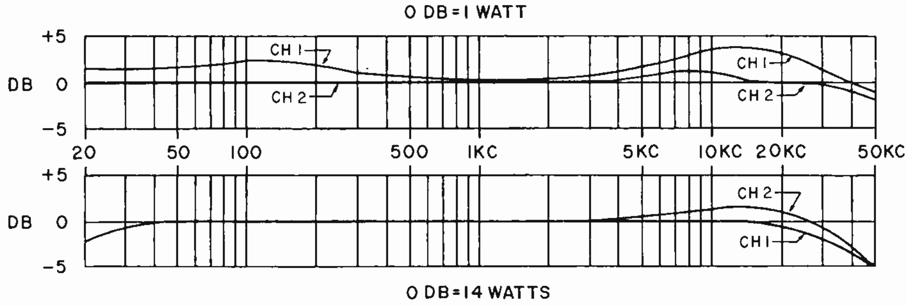

Fig. 2. Frequency response of the EICO HF-81. The top curve shows the response at 1 watt output per channel; the bottom curve shows the response at full 14 watt output per channel. See text.

tortion—less than 1% from 30 cps to 10 kc at 16 watts, less than 1% from 40 cps to 10 Kc at 28 watts.

CONSTRUCTION: The HF-81 is available in kit form for $69.95 and factory built for $109.95. A kit was obtained and constructed strictly according to the EICO instructions. As usual, they were complete and without error. The assembly was not difficult but don't expect to complete the HF-81 in just a few evenings. I would roughly judge the assembly time to be a minimum of 25 hours. No trouble was encountered in installing components—all were of good quality. There are a few terminals that require special attention because of the necessity of soldering four or more leads together.

TESTS

Frequency Response: After construction the HF-81 was immediately hooked up and turned on. A quick check showed one channel considerably less sensitive than the other—the result of a weak tube. This is the first defective component in over a dozen EICO units recently checked. Replacement of the tube, of course, cleared up the trouble.

The frequency response of both channels is given in Figure 2 at two different power levels. All tests were carried out with 0.5 volt input fed to the tuner inputs with the amplifiers set for normal stereo operation and the tone controls in their "flat" position.

It is evident that at 1 watt output the frequency response of channel 1 rises at both the low and high end as compared to channel 2. The bass rise is not audible; the treble rise is audible but is correctable by the channel 1 treble control. At high levels there is no audible difference between channels.

Square wave response of channel 2 was exceptionally fine for an amplifier in this price range—very fast rise time with almost no trace of ringing. Channel 1 showed a peak on the leading edge as might be expected from the sine-wave response curve. This peak could not be controlled, that is, reduced, as was evident from listening tests.

The channel frequency response difference of the EICO HF-81 is not unusual in stereo amplifiers. In fact, I've seen much worse. Just how important this is in judging the quality of an amplifier depends on the amplitude of the difference in response and, more important, where it occurs.

Notice that the peak in the EICO response occurs between 10Kc and 20 kc—the top end of the treble control range. Reducing the treble control brought the channel response within ±0.8 db of each other from 5 kc to 30 kc. No doubt this original difference is due to the fact that the mechanical "flat" position of the control is not the electrical "flat" position because of the control tolerance.

However, if this peak in response had centered at 5 kc instead of 15 kc, the treble control could not have compensated for the peak without completely wiping out the high end response.

HUM: Hum is inaudible with normal signal level (.5 to 1 volt) fed to the tuner or auxiliary inputs using medium efficiency speakers. Hum trouble was not encountered with average output cartridges like the Shure M3D or Empire 108; no overload problem with high output cartridges in the Pickering 380 class. Very low level cartridges like the Grado will benefit from their step-up transformers even if used with high efficiency speakers. These last tests with magnetic cartridges, of course, used the magnetic input jacks.

The HF-81 transformers do seem to put out a rather strong field, at least from the one I checked, and this could induce hum in some cartridges if the HF-81 is not placed at least a foot or more away.

EQUALIZATION: The RIAA phono equalization was not checked since the HF-81 uses the same circuit as the HF-85 stereo preamp. This latter unit was found to be entirely satisfactory when checked previously.

The HF-81 features tape equalization with a front panel selector for 15-7½ ips or 3-4/4 ips tape speeds. This circuit, too, is the same as the HF-85 and was previously found acceptable.

VOLUME CONTROL TRACKING: The volume controls of each channel are ganged and operated together—labeled "level" on the front panel. This convenient arrangement brings up another problem—tracking. When the control is advanced so that, say, one channel puts out one watt, the other channel should also put out one watt. If it doesn't, the difference is the tracking error.

I checked this by adjusting the output of one channel to ¼ watt intervals from ¼ watts to 14 watts (at 1 kc) and then measured the output from the other channel and computed the difference in db.

Maximum tracking error occurred at 5 watts where it was 1.4 db. It dropped to 0.3 db at 14 watts and 0.4 db at .25 watt. This is quite satisfactory, of course, since even the maximum error at 5 watts would be inaudible on music reproduction.

MISCELLANEOUS: Separate tone controls are provided for each channel—an excellent feature, particularly if there is any difference in the frequency response of the channels, or if different speakers are used in each channel.

A balance control, labeled "focus," increases the gain of one channel about 7 db while reducing the other about 3 db—it works well.

The input and functions switches, the same as on the HF-85, provide extreme flexibility; probably more than would ever be used.

There are several other features. For example, both power amplifiers can be combined and operated by one preamplifier while the other can be used to control a separate power amplifier. Thus, the present mono amplifier need not be discarded to step up to stereo. To help with this, 32 ohm taps are provided on the output transformer so that the parallel amplifiers can correctly match a 16 ohm speaker.

All in all, there are more inputs, outputs, and miscellaneous features than would ever be used. The only gadget missing is "loudness" compensation.

COMPLAINTS: First, the on-off switch is located on the treble control. It should be separate since it requires resetting the treble every time the unit is turned on. In addition it also increases the wear of the treble control.

Next, the HF-81 features an accessory power outlet on the back apron. This is fine but the outlet is not controlled by the on-off switch and this, to me, negates its usefulness since it doesn't do any more than would be done with an ordinary extension cord.

Finally, and this is rather minor, I think EICO could improve their sales with a better looking enclosure. The present design, although strong and functional, does not compliment the excellent engineering.

CONCLUSION: My first impression of the HF-81 was its similarity to EICO's HF-85 stereo preamp and HF-86 stereo power amp. The HF-85, HF-86 pair cost $13.95 more than the HF-81 in kit form and $29.95 more factory built. The HF-85, 86 is technically superior and more versatile and, in my opinion, worth more than the under $14 kit price difference. The factory built $30 difference, of course, is substantial.

The HF-85, 86 does not provide a single compact package which could be a disadvantage if space is a problem. The HF-81 is also easier to use since it eliminates interconnecting cables and additional level controls.

Ignoring this, the EICO HF-81 must be classed as one of the best, if not the best, amplifiers in its class. It performed better than any other amplifier in its power class that I have yet checked—including some selling for $30-$50 more. It was particularly superior in its frequency response and switching and input and output facilities.

MANUFACTURER'S COMMENTS: Your report on our HF-81 stereo amplifier is, in the opinion of our Engineering Department, complete and accurate and we have nothing to add or detract from same.

Servosystems

by Art Widmann

NRI Editorial Staff

Servomechanisms, or servos for short, are an important part of industrial machines. Servos are the muscles of machines. The servomechanism performs a controlled task such as opening a valve, positioning a ship's rudder, dumping a bin, moving a pen on a recorder, or any one of hundreds of jobs that require a machine to provide mechanical movement in response to a control signal. The mechanical movement may be accomplished by an electric motor, a solenoid, a hydraulic piston, or a hydraulic motor, but the control function nearly always includes electronic devices.

Servosystems are the backbone of remote control and automation. The servo can be thought of as a servant that performs the work in response to an order from a computer or programmer. The servo system accepts the control signal and performs the mechanical work. Usually the control signal is electrical and requires electronic circuitry in the servo system.

The electronic portion of a servosystem need not be complicated. Many systems have only the equivalent of a couple of audio amplifier stages. However, that doesn't mean that the servosystems are a cinch to troubleshoot. Similar trouble symptoms can be caused by either a faulty electronic section or some mechanical part in the system. Before you can intelligently troubleshoot the electronic portion of a servosystem you need to understand the operating relationship between the parts of the system. A lousy time to learn the operation is when the system breaks down. However, that is often what happens. The electronic technician is expected to work on the electronic section even if he has never seen the system in operation. And he can if he comes to the job knowing the principles of servosystems. A glance at the print of the system he must work on will enable him to identify the parts in this system that are used to perform functions that he knows must be performed by any servosystem. Once you understand how the system works, troubleshooting and repairing the electronic portion is usually quite simple.

Let's examine the operating principle of a typical servosystem. Then we will relate the operation of this system to general functions that are performed by any servosystem.

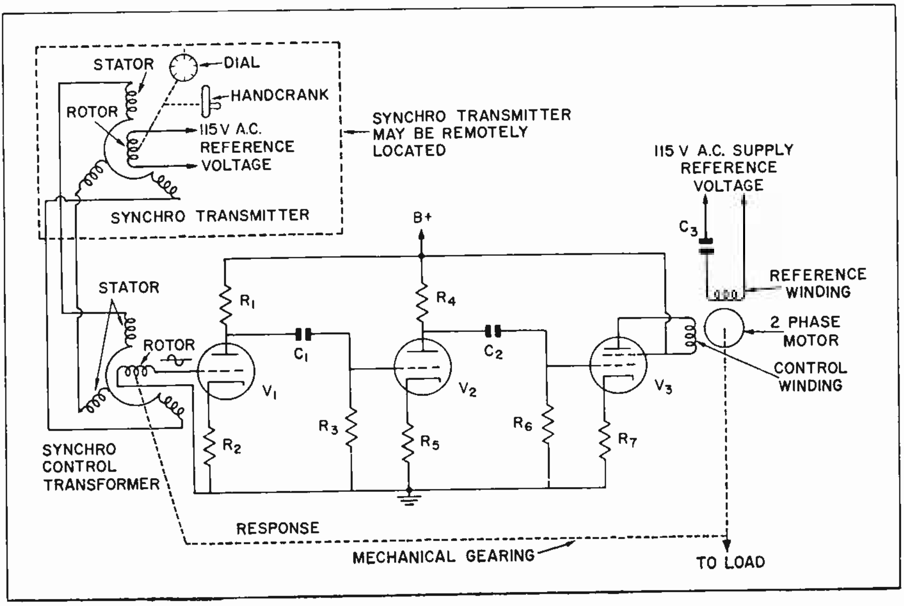

Fig. 1. A simple positioning servo.

TYPICAL REMOTE POSITIONING SERVO

Servos that drive motors of 1/10th hp or less are often called instrument servos. These small servo systems are used to position pens on recorders, drive inputs to data processing machines, and position computing mechanisms in computers. While they are designed to drive only light loads, they operate on the same principle as the large servosystems that may be required to move loads weighing several tons.

Fig. 1 shows the schematic for a small positioning servo that would fall in the instrument class. This servo includes a synchro transmission system that allows the load to be positioned from a remote location. At the remote location, a handcrank is shown mechanically connected to a dial and to the rotor of the synchro transmitter. The handcrank sets the dial and rotor to the desired position. The synchro transmitter converts the mechanical position of the rotor into an electrical signal in the stator windings of the synchro transmitter. These stator windings are connected to the stator windings of the synchro control transformer at the servo. The electrical signal from the synchro transmitter sets up a magnetic field in the control transformer. If the rotor winding is at right angles to this magnetic field, no voltage is induced in the winding. If the magnetic field is displaced either clockwise or counterclockwise from the rotor winding a voltage is induced in the rotor.

Error Signal. The voltage on the rotor winding of the control transformer is called the error signal or error voltage. This error signal indicates both the direction and amount that the load must be driven to correspond with the ordered position. The amplitude of the error signal indicates the amount the load must be driven while the phase of the error signal indicates the direction that the load must be driven.

Fig. 2 illustrates how the error signal is developed on the rotor winding of the control transformer. The position of the magnetic field depends on the position of the synchro transmitter rotor. With the synchro transmitter rotor on zero, the field of the control transformer is in the position shown in Fig. 2A. The magnetic field in the control transformer is at right angles to the rotor windings. In this position the error signal is zero because no voltage is induced in the rotor winding. In Fig. 2B, the magnetic field has been rotated clockwise by moving the rotor of the synchro transmitter clockwise. In this position, a voltage is induced in the rotor of the control transformer. This error voltage signal is in phase with the reference voltage. The reference voltage is the 115 volts AC supply voltage that is supplied to both the rotor of the synchro transmitter and the reference field of the two-phase AC motor.

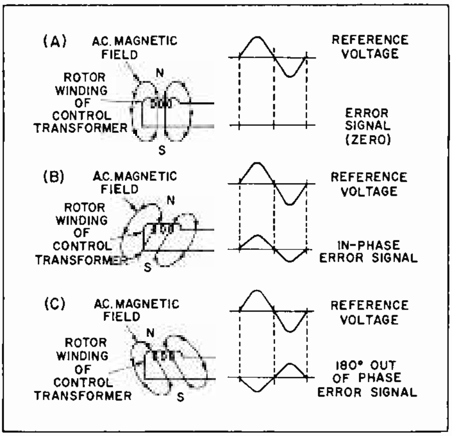

Fig. 2. The rotor winding of a synchro control transformer develops a zero error signal (A); an in-phase error signal (B) and a 180° out-of-phase error signal (C).

In Fig. 2C the magnetic field has been displaced counterclockwise. In this position the voltage induced in the rotor of the control transformer is 180° out-of-phase with the reference voltage.

The in-phase error signal tells the servo to move the load clockwise while the out-of-phase signal tells the servo to move the load counterclockwise. Notice that the error signal in 2B and C could be made zero by repositioning the rotor of the control transformer until it is at right angles to the magnetic field. For example in Fig. 2B, if the rotor winding is moved clockwise the error voltage would get smaller and smaller and finally be zero when the field and winding are at right angles. If the rotor is moved farther clockwise the error signal would again increase only now it would be 180° out-of-phase with the reference voltage so the conditions would be similar to those in Fig. 2C. Thus, the amplitude and phase of the error signal depends on the relative position of the magnetic field and the rotor winding of the control transformer. Now let's see how this electrical error signal is used to control the movement of the load.

Amplifier. The error signal is too small to control the drive motor directly so the signal is amplified. In Fig. 1, V1 and V2 are voltage amplifiers while V3 is the power stage. The error signal from the rotor of the control transformer is applied directly to the grid of V1. Resistor R2, in the cathode circuit of V1 biases the tube class A. The amplified signal appears at the plate of V1 and is coupled through C1 to the grid of V2. Triode V2 is also class A biased. The amplified signal at the plate of V2 is coupled through C2 to the control grid of V3. The power pentode V3 is class A biased by the drop across R7. Notice that the self-bias cathode resistors, R2, R5, and R7 are not bypassed. This produces degenerative feedback in all stages. While this arrangement decreases the gain of each stage, it cancels distortion produced in the stage. Thus the signal appearing across the motor control winding in the plate circuit of V3 will be almost a perfect sine wave. The waveshape of this signal is important to the proper operation of the motor.

The Motor. The two-phase induction motor (Fig. 1) provides the mechanical motion for positioning the load. In order for the motor to drive, the field set up by the control winding and the field set up by the reference winding must be 90° out-of-phase. This constant phase shift is accomplished by capacitor C3. This capacitor shifts the phase of the current in relation to the reference voltage. Thus the current in the reference winding leads the reference voltage. Since the magnetic field is the result of current flowing in the winding, the reference field leads the reference voltage by approximately 90°. The field set up in the control winding is either in phase of 180° out-of-phase with the reference *voltage*. Therefore, the control field either leads the reference field by 90° or lags the reference field by 90°. These magnetic fields combine to form a single rotating magnetic field.

The rotating magnetic field induces a field in the rotor of the motor. The field in the rotor is attracted to the rotating magnetic field causing the rotor to turn. The torque produced by the turning rotor depends on the amplitude of the signal to the motor windings. The motor stops when the voltage to either winding is zero. Thus when the AC voltage across the control winding is zero, corresponding to a zero error signal, the motor is stopped.

The direction of rotation of the motor depends on whether the control field leads or lags the reference field. When the control field leads the reference field, the motor rotates in one direction and when the control field lags the reference field, the motor rotates in the opposite direction. In this way the error signal at the input to the amplifier controls the direction and speed of the motor. An in-phase error signal drives the motor in one direction while an out-of-phase error signal drives the motor in the opposite direction.

The speed of rotation depends on the amplitude of the error signal. A small error signal drives the motor slowly while a large error signal causes the motor to develop more torque so it turns rapidly.

The Closed Loop. Up to this point, we have discussed only the simple conversion of an electrical signal to mechanical motion. Now let's see how mechanical feedback makes the servosystem in Fig. 1 a closed-loop control system. Suppose an error signal from the control transformer causes the motor to drive the load. As the load moves, a mechanical connection to the rotor of the control transformer repositions the rotor causing the error signal to decrease to zero. With a zero error signal, the motor stops driving and the load is in the ordered position. Rotating the handcrank at the synchro transmitter orders the load to be moved to a different position. This order is in the form of an electrical signal to the control transformer. The electrical signal causes the field in the control transformer to rotate to this new ordered position. This displaces the field in relation to the control transformer rotor winding. Since the field is no longer at right angles to the rotor winding, an error signal is induced in the rotor winding. This error signal is amplified causing the motor to start driving. The motor moves the load in the direction of the ordered position. As the load moves, the mechanical gearing from the load to the rotor of the control transformer rotates the control transformer rotor. The rotor is moved in a direction that causes the error signal to become smaller. When the motor drives the load to the ordered position, the field and rotor winding of the control transformer are again at right angles and the error signal is zero.

The mechanical gearing for the system in Fig. 1 is represented by dashed lines connecting the motor to the load and to the rotor of the synchro control transformer. The gearing between the motor and the load is usually a step-down gear ratio. That is, the motor must make many revolutions to drive the load

Genius is the ability to evade work by doing something right the first time it has to be done.

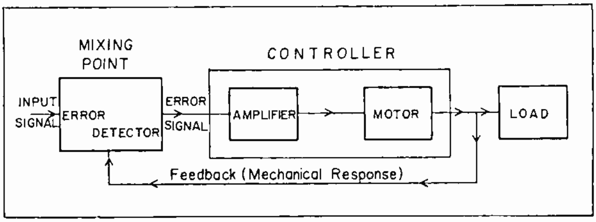

Fig. 3. Elements of a servosystem.

through its full travel. The gearing between the load and the rotor of the control transformer, called mechanical response, has a ratio to 1 to 1. Thus the position of the rotor of the control transformer is the same as the position of the load.

The servosystem in Fig. 1 will position the load rapidly and accurately to any ordered position from the transmitter. Since the amplifier has high gain, only a small error signal is needed to cause the motor to drive. Therefore, the load will follow closely any changes in the ordered position.

ELEMENTS OF SERVOSYSTEMS

Now that you have seen how a particular servosystem operates, let's consider the functions that must be performed by any servosystem. A study of these general functions will give you a pattern to work from. Knowing this pattern should enable you to fit the parts of any servosystem into this pattern. This will enable you to figure out how almost any servosystem works.

A servosystem functional block diagram is shown in Fig. 3. Each block is labelled with the function that must be performed by some part of the servosystem. These functions will be performed by physically different units in different systems. Let's consider each function and the kinds of units that are used to perform the functions.

Input Signals. The input signal to a servosystem is the order that tells the servo which direction and how far to drive the load. This input signal may be electrical or mechanical. In the positioning servo previously described, the electrical signal from the synchro transmitter to the synchro control transformer is the input signal. Other electrical input signals can be the voltage output from transducer circuits. Any device that produces an electrical signal can provide the input signal for a servo. For example, a temperature sensing device produces a voltage proportional to the measured temperature. This signal voltage can be used by a servo to drive an indicator and/or recorder. The servo must have a properly designed error detector so it can accept the signal and compare the signal with the actual position of the load.

Mechanical inputs are sometimes used for the input signal to a servosystem. In this case the servo usually operates as a power amplifying device. For example, power steering on a car is one example of a servo using a mechanical input signal. The mechanical input is the rotation of the steering wheel. This mechanical motion controls a hydraulic system that positions the front wheels. The force applied to the wheels is much greater than the force required to turn the steering wheel.

Servos with mechanical inputs are used in some analogue type computers. The weak mechanical output of a computing mechanism is used as the input to the servo. The output of the servo is then used to position another mechanism in the computer. When mechanical inputs are used, the error signal is usually converted to an electrical signal so it can be amplified. After amplification, the motor converts the electrical signal back to mechanical motion for positioning the load.

Error Detector. As shown in Fig. 3, the error detector is the mixing point where the input signal is compared with the position of the load. The error detector compares the ordered position (input signal) with the actual load position (mechanical response) and produces a difference signal (error signal). In the positioning servo in Fig. 1, the error detector is the synchro control transformer. The difference between the electrical signal to the control transformer and the position of the load (position of the control transformer rotor), causes the rotor winding to produce the error signal.

Error detectors may be electrical, mechanical, or electromechanical. The device always has two inputs, the servo input and response. The single output is the error signal. The synchro control transformer is one example of an electromechanical error detector. Another electromechanical error detector is the E-coil differential transformer shown in Fig. 4. This type of error detector is useful where the mechanical input signal moves only a small distance. The device consists of a movable core shaped like the letter E and a movable armature. The

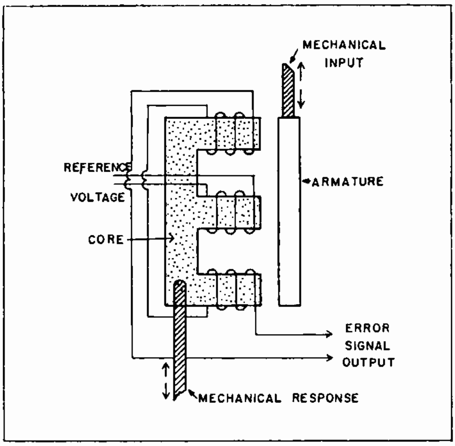

Fig. 4. E-coil differential transformer used as an error detector.

winding on the center leg of the core is supplied by the servo reference voltage. The windings on the end cores are wound in series opposition. When the armature is centered, as shown, the voltages induced in the end core windings are equal. Since these voltages oppose each other the error signal output is zero. When the armature is displaced up or down, the induced voltages become unbalanced and an error signal is produced. The phase of the error signal depends on the direction the armature is displaced while the amplitude depends on the amount of displacement. The error signal is cancelled by moving the core of the E transformer. Mechanical response repositions the core of the E transformer so the armature is again centered in relation to the core. This drives the error signal to zero.

Another common electromechanical error detector uses a pair of potentiometers. Fig. 5 shows two potentiometers used as an error detector. The servosystem reference voltage is applied across both potentiometers. The shaft of potentiometer P1 is driven by the mechanical input order signal. Mechanical response drives the shaft of potentiometer P2. The voltage between the potentiometer arms is the error signal. When both arms are in the same relative position, the error signal is zero. If the arm of P1 is moved up an error signal is produced and the servo must cause mechanical response to move the arm of P2 to the same relative position to cancel the error signal.

Some error detectors are entirely electrical. The error signal is produced by comparing two electrical signals to obtain a different voltage for the error signal. For example, the position of the load (response) is represented by the amplitude of one DC voltage while another DC voltage is the servo input signal. These two voltages are compared in a resistive network to produce a difference voltage. The difference in the two voltages in the error signal input to the amplifier.

Still other error detectors are completely mechanical. A mechanical differential compares the mechanical servo input order signal with mechanical response. The difference in these two signals is a mechanical error signal. Fig. 6 shows a schematic representation of a mechanical differential used as an error detector. Input shaft No. 1 couples the input signal to the differential. Input shaft No. 2 couples mechanical response to the differential. The output shaft couples out the mechanical error signal.

The mechanical error signal from the differential is converted to an electrical signal that can control the servo amplifier. Some systems use a simple contact arrangement. When the differential output shaft rotates clockwise, it closes contacts that cause the motor to drive in one direction. When the output shaft rotates counterclockwise, it closes contacts that cause the motor to drive in the opposite direction. When the error signal is zero, both sets of contacts are open and the motor is at rest.

Many other types of error detectors are used in servosystems. Many of them are variations of the types discussed above. In all cases the error detector performs the same function of comparing the ordered position with the actual position to produce an error signal.

The Controller. The part of the servosystem that amplifies the error signal and positions the load is called the controller. You will also hear the controller referred to as the servodrive. As shown in Fig. 3 the controller consists of an amplifier and a motor. This is usually an electronic amplifier and electric motor. The motor

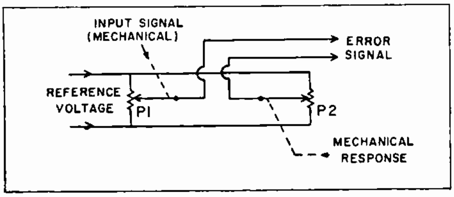

Fig. 5. Error detector using a pair of potentiometers.

may be AC or DC and the amplifier is selected to produce the necessary power to drive the motor. The AC motors are usually two-phase induction motors. Some DC motors are very small and have permanent magnetic fields. Others are large heavy-duty types having separately excited fields. These large DC motors are often driven by thyratron drive circuits.

In some servo systems the output of the amplifier drives a solenoid. The solenoid positions a hydraulic valve which controls a hydraulic system or hydraulic motor. Hydraulic servodrives are found on heavy equipment where high torque is needed to position the load. Some servosystems use pneumatic controllers. Air, under pressure is controlled in much the same way as oil in a hydraulic system.

Response. In servosystems, there is always a feedback path from the output (load) back to the input. This feedback feature makes the servo a control system. The response of the load becomes a part of the input to the system. Response enables the servo controller to adjust its driving force to the load condition. Thus if the load is increased, the motor finds it more difficult to drive the load to the ordered position. This condition is reflected at the input to the controller through the response connection. If a heavier load prevents the motor from keeping the load in the ordered position, the difference between the ordered position and response becomes greater. This produces a larger error signal and the motor produces more torque. In this way, servosystems are able to adjust, within limits, to changing load conditions.

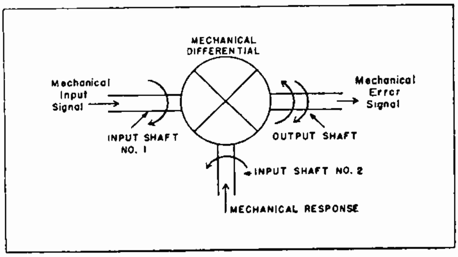

Fig. 6. Schematic diagram of a mechanical differential used as an error detector.

Stabilizing Devices. Servosystems with high gain amplifiers have a tendency to be unstable. That is, when the load approaches the ordered position rapidly, the inertia of the load tends to carry the load past the ordered position. If the system did not have some kind of damping to stabilize the motion, the servo would oscillate. The instability might be a simple overshoot of the ordered position. On the other hand the load might swing back and forth across the ordered position several times before it settled on the ordered position. This type of instability is called damped oscillation. If the load vibrates rapidly back and forth at the ordered position the instability is known as "jitter." If the load oscillates continuously back and forth across the ordered position, the instability is usually described as "hunting." There is one other form of instability known as "runaway." When the servo is energized, the load drives rapidly in one direction or the other to its limit of travel and stops. This runaway condition is usually caused by improper wiring.

Oscillations are produced in undamped servosystems in the following way. The error signal causes the load to approach the ordered position rapidly. After the error signal drops to zero, the inertia of the load causes the load to coast past the ordered position. Mechanical response to the error detector drives the error signal through zero and causes the error detector to produce an error signal calling for the servo to drive the load in the opposite direction. When the servo responds to this reverse error signal, the load is again driven past the ordered position. Thus even with the input to the servo stopped, the load would oscillate back and forth across the ordered position.

The amount of damping required to stabilize a particular servosystem depends on many factors. The time lag between the application of the error signal and the movement of the load is one factor. The inertia of the load, motor armature and gearing is another. These and other factors are taken into consideration when the system is designed. The damping or stabilizing device may be a simple friction damper or a complex electro-mechanical network. For example, the positioning servo in Fig. 1 relies on the friction of the load, gearing, and motor bearings to provide enough friction damping to stabilize the system. This damping is sufficient because the servo is designed to drive only a light load having very little inertia.

One common method of stabilizing servosystems is to use a tachometer generator. The tachometer generator, also called a rate generator, is a small generator connected to the drive motor shaft. The rate generator produces an output

(Continued Page 20)

Christmas Suggestions

This issue of NRI News and the next feature a complete catalog of items available through your Supply Division. As a final reminder, **be sure** to place Christmas orders early and avoid the disappointment of delayed shipments. Should you have any specific questions about a particular instrument, time-payment arrangements, etc., please feel free to write us for further information. Order by letter or coupon—**page 19**.

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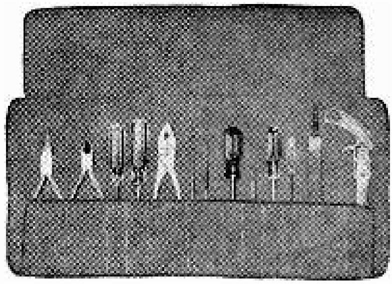

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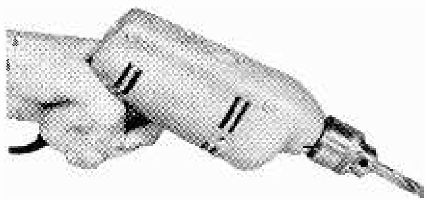

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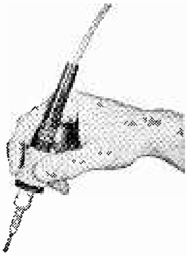

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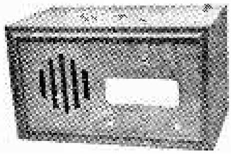

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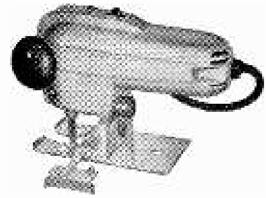

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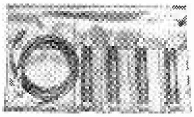

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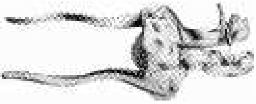

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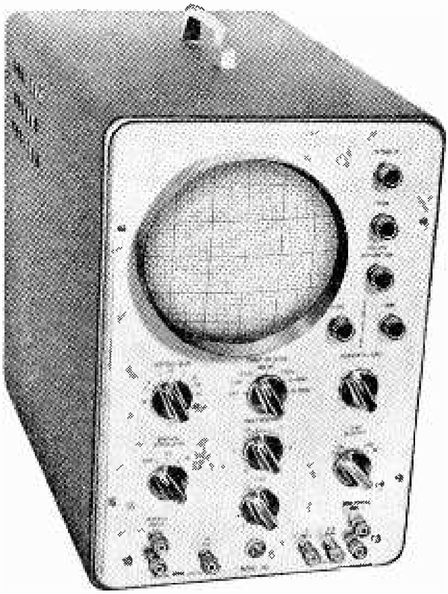

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RUGGED CONSTRUCTION; built to last. Truly professional appearance.

WIDE BAND RESPONSE. No wave distortion transients. Actually shows 3.58 color burst.

USES PHASE INVERTER TUBES in horizontal and vertical push-pull output stages.

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ACCURATELY MEASURES RIPPLE OUTPUT of any power supply. Check auto radio vibrators dynamically.

VERTICAL AMP RESPONSE—flat 13 cps to 2.5 mc down 1.5 db at 3.58 mc.

SWEEP RANGE—10 cycles to 500 kc. Uses special NRI linearity circuit.

PLENTY OF BRIGHTNESS. No need to turn off or dim lights to see trace. 2400 volts on CRT.

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AVAILABLE ON LOW MONTHLY TERMS.
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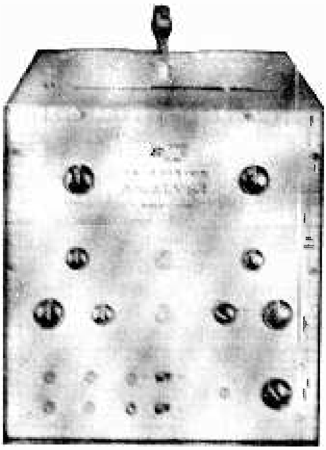

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(Note: The Model 1075 is not a "beginner's" instrument. It is a practical instrument for the experienced TV technician and well-advanced student only.)

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R.F. Supplies complete r.f. and i.f. signals with video and audio modulation to quickly troubleshoot each stage in each of the sections of the TV receiver. Enables you to check the r.f. sensitivity and AGC settings of TV receivers.

VIDEO Reproduces a complete test pattern on the screen of the TV picture tube and injects signals into each video stage of the receiver for fast, visual trouble-shooting and correction—anywhere, anytime. Easy to check bandwidth, resolution, shading and contrast capabilities of the TV set.

SYNC Provides composite signal, positive and negative.

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Generates white dot and crosshatch patterns on TV screen for convergence adjustments.

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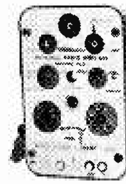

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(Servosystems—cont'd.)

voltage proportional to its speed of rotation.

The output of the rate generator is fed to the input of the amplifier to oppose the error signal. The rate signal is subtracted from the error signal. Thus when the servo is driving rapidly in response to a large error signal, the rate signal is also large. This large rate signal subtracts from the error signal and limits the maximum speed of the servo. When the load approaches the ordered position, the error signal gets very small. If the motor is still driving rapidly, the rate signal is larger than the error signal. Since the rate signal is the opposite of the error signal, the resultant signal to the amplifier is a signal telling the motor to reverse its direction of rotation. Thus the motor brings the load to a halt at the ordered position without overshoot.

Fig. 7 shows a partial schematic of a servo with a rate generator to stabilize the operation. The rotor of the rate generator is connected to the shaft of the servomotor. Thus whenever the motor turns, the rotor of the rate generator turns also. This rate generator is a type that is sometimes called a distortion generator. The reference field of the rate generator is excited by the 115 volt reference voltage. The signal field is wound 90° to the reference field. With the rotor at rest, no voltage is induced in the signal field. When the generator rotor is turned, it distorts the field and causes a voltage to be induced in the signal winding. The rate generator signal is always the same frequency as the reference voltage. The phase of the rate signal shifts 180° when the direction of rotation of the rate generator is reversed. A phase shift capacitor, C_1, in the reference field of the rate generator provides a constant 90° phase shift. Therefore the output of the rate generator will always be in-phase or 180° out-of-phase with the error signal.

The output of the rate generator is connected to a resistor network in such a way that the rate signal opposes the error signal. As shown in Fig. 7, the error signal is applied across potentiometer R_2 while the rate signal is applied across potentiometer R_1. The potentiometers are connected through their sliders. The total input signal to the amplifier is the resultant of the rate signal and the error signal. Trace the grid circuit of V_1 from the grid of V_1 to the top of R_1, through part of R_1 to the slider of R_1, from the slider of R_1 to the slider of R_2, and through the lower part of R_2 to ground. By adjusting R_2, the error signal input to the amplifier is adjusted. By adjusting R_1, the amount of stabilizing voltage is adjusted. Increasing the error signal improves the speed of response but this tends to cause instability. Increasing the rate signal improves stability but slows the speed of response.

Both dc and ac rate generators are in common use in servosystems. AC rate generators can be made lighter (less inertia) and since they have no brushes, they require less maintenance. Some servosystems do not use rate generators. Instead, a resistor network is placed in the motor circuit. A voltage is developed across the resistors that is proportional to the speed or torque of the motor. This voltage is then fed back to the amplifier to stabilize the servosystem.

—n r i—

If you would get along with others:

1. *Communicate with them.*
2. *Make them feel important.*
3. *Develop yourself mentally, physically, socially, emotionally.*

After all, the only thing wrong with the world is people—we have succeeded in improving everything but them. And that means you and me; that's where the genuine improvement has to begin.

Keep in mind—society pays its greatest homage—industry pays the highest salaries—to those who have mastered the secret of getting along with others.

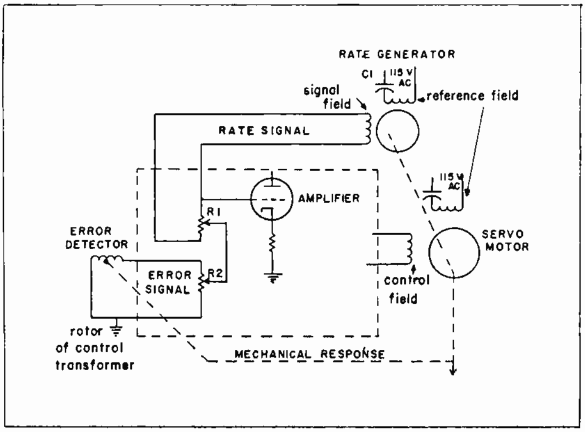


Fig. 7. The rate generator signal is fed to a resistor network at the input of the amplifier.

When to Check Electrolytics In TV Receivers

by J. Schek
NRI Consultant

A TV set has many varied types of capacitors used in a large number of applications. However, to completely discuss the one type of capacitor that has been a prime cause of many TV service headaches, this article will cover only the troubles caused by faulty electrolytic capacitors.

Electrolytic capacitors were developed to make available a low-cost, compact, high-capacity capacitor to filter or bypass low frequency signal and power supply ripple frequencies.

To filter or bypass these low frequencies effectively, a high value of capacitance is necessary. TV circuits use values of from 10 to 300-mfd at 150 to 450 working volts. With the advanced manufacturing methods used today, the size of a .25-mfd, 400-volt paper capacitor, is almost equal to a dual electrolytic 16-mfd, 450-volt unit. The obvious advantage in physical size is therefore made very apparent.

To provide suitable filtering, the reactance of a bypass capacitor must be kept very low. A .25 capacitor at 100 cycles has a capacitive reactance of about 7000 ohms. On the other hand, a normal 20-mfd electrolytic capacitor has a capacitive reactance of only about 10 ohms at the same frequency. Hence, the enormous superiority of using high-value capacitors is clear.

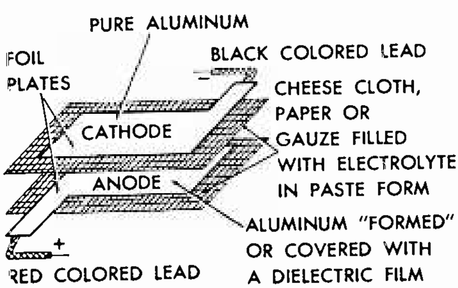


FIG. 1. How dry electrolytics are made.

CONSTRUCTION

A dry electrolytic is made of two plates with an electrolyte in paste form placed between the two plates as shown in Fig. 1. The anode plate is treated chemically before the capacitor is assembled to produce a coating of aluminum oxide on the surface of the plate. The aluminum oxide then acts as the dielectric.

INSTALLATION

All electrolytic capacitors are polarized. This means that they can be used only in circuits with a dc or pulsating voltage. The plate called the anode must always be connected to the positive side of the voltage source and the plate called the cathode must always be connected to the negative side of the voltage source. To make it easy to identify the leads, they are color coded and the code of the lead is marked on the case of the capacitor. If a metal case is used, the case is the negative terminal.

If an electrolytic capacitor is connected backwards, it will act as a low dc resistance and excessive current will flow through the capacitor, destroying it.

DEFECTS

Dry electrolytic capacitors deteriorate when not in use either in the receiver or on the shelf. This is why suppliers specify that their capacitor stock is "fresh." An electrolytic capacitor that has been unused for six months or more should be "formed" before the capacitor is put into service.

Forming is done by applying a low dc voltage of the correct polarity to the capacitor leads. The positive side of the source voltage connects to the positive capacitor lead. Then the voltage is gradually raised until it is equal to the rated working voltage of the capacitor.

If an electrolytic capacitor which has just been sitting around unused in a set or at a parts dealer, has full voltage applied to it without first being formed, the chances are that its dielectric will break down causing the capacitor to pass excessive current. The capacitor will be destroyed and at the same time possibly damage other parts such as the rectifier or power transformer.

An ideal and convenient way of not only obtaining the variable forming voltage but also to test the operating condition of the capacitor is to have on hand the NRI Professional Capacitor-Resistor Checker. This outstanding TV servicing

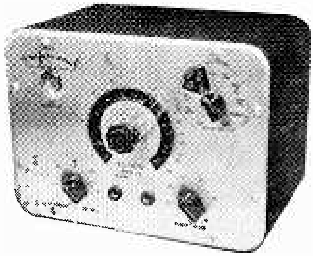


FIG. 2. NRI R-C Tester.

instrument is illustrated in Fig. 2. The "leakage test" voltage is gradually increased each time the eye indicates normal leakage current. The operation is stopped when the voltage applied equals the voltage marked on the capacitor and the eye tube shows normal leakage.

Electrolytic capacitors also deteriorate with use. The moisture in the paste electrolyte will slowly escape from the capacitor. When a good deal of moisture evaporates, the capacitor will have lost most of its capacitance and will be considered "open." Electrolytic capacitors also develop leaky or shorted conditions which causes excessive current flow through the capacitor, greatly increasing its operating temperature.

Any capacitor not near a heat source which feels quite warm or hot to the touch should be checked without delay. In normal operation there is some leakage through an electrolytic capacitor and this will cause the capacitor to become warmer than surrounding chassis hardware. However, if you notice that an electrolytic is getting very hot, it is a sign that the leakage is entirely too high and the capacitor should be replaced before it shorts completely and damages the parts.

The operating efficiency of electrolytic capacitors will depend largely upon its dielectric contact resistance—the lower the better. However, even a high internal resistance that will not cause trouble in low frequency circuits can prevent normal operation in rf circuits because the loss across a resistance in series with the diaelectric will go up as the frequency goes up.

To provide adequate rf filtering or decoupling along a single B+ circuit, a paper or ceramic type capacitor can be shunted across the electrolytic.

The series resistive losses in a capacitor is expressed in terms of "Power Factor." The power factor of a capacitor shows the percent of applied electrical power that is wasted by the internal series resistance of the capacitor. It is usually expressed in per cent. A perfect capacitor would have a power factor of zero, while one with a high loss would have a fairly high power factor. To measure the power factor a professional RC Tester such as the NRI model should be used. The normal power factor for an electrolytic condenser in good condition is below 10%. In general, capacitors should be replaced when the power factor rises above 15%. In some cases, however, you will find that a capacitor with higher power factor will do the job satisfactorily in some circuits. If the power factor is shown to be greater than 15%, however, it would probably be well for you to replace the capacitor to reduce the chance of trouble in the near future.

So much for a general discussion of the whys and wherefores of electrolytics. Now let's see what operating trouble symptoms they can cause when faulty and how the defects can be analyzed.

POWER SUPPLY

A TV set with one or more open or shorted electrolytic capacitors in its low-voltage power supply section will cause undesirable operating conditions. The performance of a low voltage power supply must be satisfactory since the way it functions affects all of the stages in the receiver.

Although there are some variations in TV power supply circuits, they can be classified in three basic popular arrangements. In Fig. 3, we have one type of power supply, employing a power transformer and vacuum tube rectifier, plus of course the filter system C1, C2 and L1. In this hook-up, we will generally find electrolytics with capacitance values from 20-mfd to 80-mfd, and dc working voltage ratings of from 300 to 500 volts. The electrolytics C1 and C2 are used in conjunction with filter choke L1 to form an effective filter, producing smooth dc with

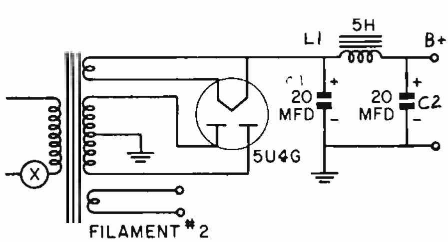


FIG. 3. A typical power supply using a transformer and full-wave rectifier.

a peak-to-peak ripple of less than two volts. (An oscilloscope is an ideal test instrument for checking ripple content in B+ circuits.)

Since the full-wave rectifier circuit of Fig. 3 conducts on each negative and each positive ac alternation, the ripple frequency will be twice the line frequency or 120-cps. However, the rise in ripple voltage will be much greater—although the B+ will not change appreciably—when the output capacitor (C2) loses its effectiveness to filter this ac component, present in the rectifier output.

This will adversely affect set performance by causing trouble symptoms such as hum in the sound, dark bars across the screen, vertical roll and horizontal pull.

On the other hand, a sharp drop of 30 to 75 volts, in B+ voltage will take place

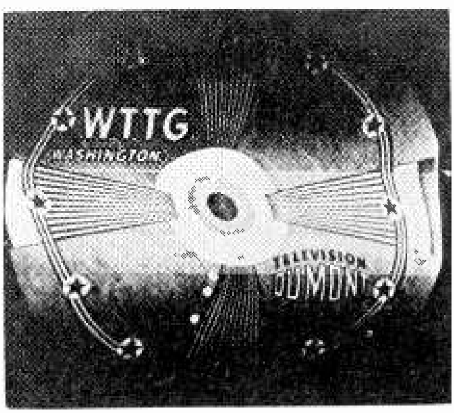


FIG. 4. 120 cycle hum in the sweep.

when the input capacitor (C1) loses capacitance or develops a high power factor.

If the B+ voltage should drop excessively, a complete loss of high voltage will result due to the reduced voltage at the plates of the horizontal oscillator tube.

The symptom shown in Fig. 4 is typical of the way the picture is affected by excessive ripple in the B+ line. Note the two dark hum bars and the "S" pull in the picture. Two bars indicate 120-cycle modulation, showing the source to be the full-wave power supply.

The particular electrolytic that loses its capacitance and is regarded as "open" can quickly be isolated by using an oscilloscope to examine the amount of

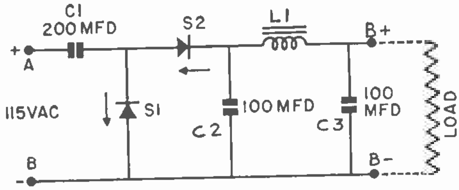


FIG. 5. A voltage-double circuit similar to circuits used in many TV sets.

ripple across each capacitor in turn added circuit connections and noting which capacitor shows abnormal ripple voltage.

Remember the ripple across the input capacitor (C1 in Fig. 3) is normally many times that across the output capacitor (C2 in Fig. 3). A highly leaky or shorted power supply electrolytic can cause both sound and picture to disappear. This B+ to B— short will demand far more current than the rectifier or power transformer or any other component, such as the filter choke—can pass. Hence, permanent damage can be caused by one shorted electrolytic capacitor, requiring replacement for not only the capacitor itself but the other overloaded parts as well.

Electrolytic capacitor shorts of this kind can quickly be located by resistance measurements taken across the capacitor connections. Another power supply hook-up used in many TV sets is shown in Fig. 5. This circuit may use, instead of vacuum tubes, solid rectifiers S1 or S2, which may be either of the selenium, silicon or germanium types. The schematic symbol for all solid rectifiers is the same.

Electrolytics C1 and C2 work with the rectifiers to produce an output B+ voltage about twice the input ac line voltage. Here is how this takes place:

The voltage across C1 produced during the first half cycle combines with the line voltage and is applied to C2 and S2 during the second half S cycle causing C2 to be charged at the line frequency rate to about twice the line peak voltage.

The voltage developed across C2 will be about 265 volts, which is the usual value indicated in TV receiver service data. Capacitor ratings in voltage doubler power supplies will range from 100 to 300-mfd. These high capacitance values are necessary to secure satisfactory regulation of the output voltage during periods of momentary heavy current drain on the power supply. If the voltage regulated is good (voltage varies little if any) the filtering will also be good.

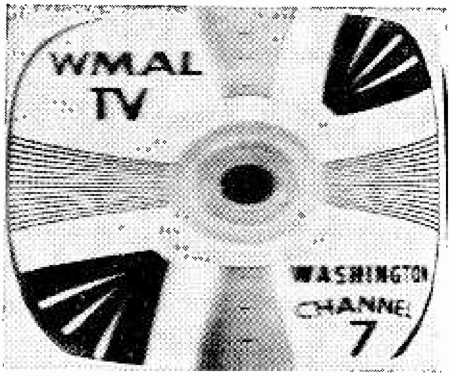


FIG. 6. Loss of brightness and size in raster.

An electrolytic capacitor that is leaky or open can sharply decrease the output B+ voltage to the extent that the high voltage and sound circuits will fail to operate. Frequently, however, the trouble symptom illustrated in Fig. 6 will be encountered. The raster will lack normal brightness, width or height. When checking the power supply to locate the faulty component, do not overlook the rectifier.

An additional tell-tale symptom indicating that the fault originates in one or more electrolytics is the appearance of a dark hum bar across the picture. Portable TV receivers occasionally use a relatively simple low-voltage supply with a half-wave rectifier as shown in Fig. 7. Because only half of each line voltage cycle is used to produce current flow through the rectifier, the ripple frequency will be equal to the 60-cycle line frequency. As checked with a scope, the output ripple amplitude should not exceed one to 1.5 volts peak-to-peak for this type of power supply.

Modulation of the video signal by excessive ripple will result in a strong hum bar through the picture. We can see this trouble symptom in Fig. 8. In addition the set may also have horizontal and vertical sync instability. A service technique that is widely used to pinpoint the defective electrolytic is to shunt with

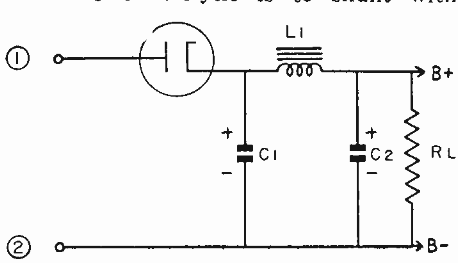


FIG. 7. Half-wave power supply.

another electrolytic, with the same working voltage or higher, each power supply electrolytic in turn until the trouble symptoms clear up.

To provide various values of both negative and positive voltages to different sections of the receiver. a resistive voltage-divider network is frequently used. A simplified power supply circuit showing this arrangement can be seen in Fig. 10.

Individual electrolytics C3, C4, C5, and C6 are used as filters for each separate branch. When the trouble indications are relatively minor and not affecting all receiver functions, this could mean that only a single branch electrolytic is open or leaky rather than one of the main filters, C1 and C2.

AUDIO OUTPUT STAGES

Let us now investigate the sound output section of a typical TV receiver and ex-

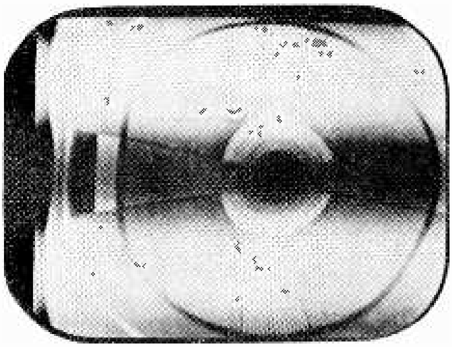


FIG. 8. Strong 60 cycle hum bar.

amine those electrolytics used in the circuits. In almost all cases at least two electrolytics are employed in the audio output stage using a cathode bypass (C1) and decoupling capacitor (C2) is illustrated in Fig. 10A. In this particular circuit, C1 usually have a value of 10-20-mfd and a working dc voltage rating of 25 to 50 volts. When this capacitor becomes open, leaky or shorted, the sound will become weak, slightly distorted or highly distorted in the order of the troubles given above. Capacitor C2 decouples the audio output stage plate circuit from its B+ line. Should this electrolytic open the audio signal, can reach the plate circuits of the Video stages and cause sound bars to appear in the picture as shown in Fig. 11. Other operating faults can include buzz, weak audio, distorted sound or a feedback howl when C2 opens up. A shorted condition in this electrolytic will cause R2 which usually has a value

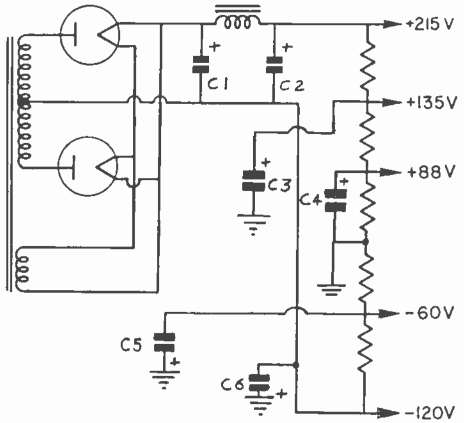


FIG. 9. Simplified circuit of a low-voltage power supply producing both positive and negative voltages.

of 330 ohms, to burn up and the sound will be dead.

A very popular audio output hook-up is shown in Fig. 10B where the internal resistance of the tube is used as a voltage divider. The low B+ 125 to 150 volts line formed at the cathode connects to the plate supply circuits of the sound and video i-f stages. Sync stages as well as the screen grid of the horizontal output may sometimes operate from this low B+ line.

The B+ voltage dividing arrangement across C1 and C2 permits use of capacitors with working voltage ratings considerably less than the total B+ voltage which is from 250 to 325 volts. Hence, C1 and C2 will be rated at 150 volts. The capacitance values of these electrolytics will usually be around 100-mfd. Although failure of C1 and/or C2 will produce the results similar to those mentioned previously for Fig. 10A, additional trouble symptoms will be present due to other circuits being connected to the 125-150-volt line.

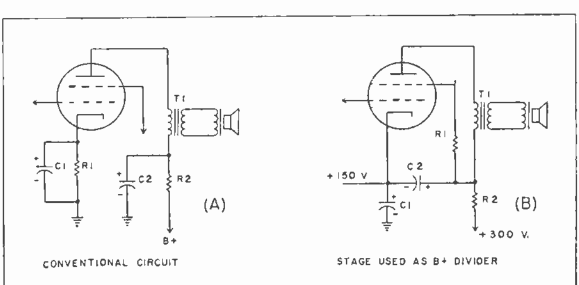


FIG. 10. Electrolytics in audio output stages.

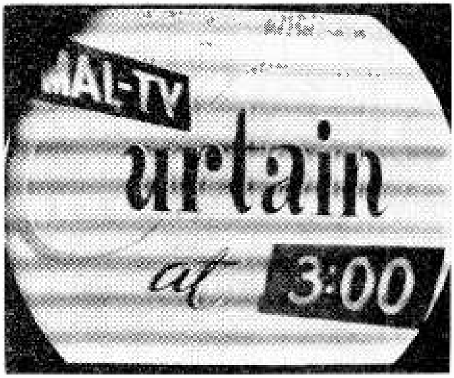


FIG. 11. Sound bars in video.

All ratio-detector stages use an electrolytic across the dc load as shown in Fig. 12. This capacitor (C23) functions as a stabilizer, removing amplitude variations caused by noise changes in the signal. A low-frequency (60-cycle) tunable buzz will be heard as a very typical trouble symptom when the vertical sync signals cause sound variations in the ratio-detector due to this electrolytic stabilizing capacitor opening up.

A quick and effective test for a fault of this nature is direct substitution.

VIDEO SECTION

Electrolytics are used with audio amplifier stages in their cathodes and screen grid circuits to control stage degeneration at low frequencies. Electrolytics in the plate load circuit increase the load at very low frequencies and boost the gain of the amplifiers at these frequencies. These are shown in the typical video amplifier section illustrated in Fig. 13.

An open electrolytic will decrease stage gain and upset sync stability. Possible causes for weak sync can be difficult to localize unless a careful check of the electrolytics related to the video amplifier or stages is made.

You should be on the alert to consider and check for leakage between sections of a multi-unit electrolytic block, since unusual trouble-indications can result from this faulty condition. Only when testing for open electrolytics can paralleling suspected units be done. If an electrolytic is leaky, it must be first disconnected from the circuit and a substitute test capacitor connected. If leakage between sections of mul-

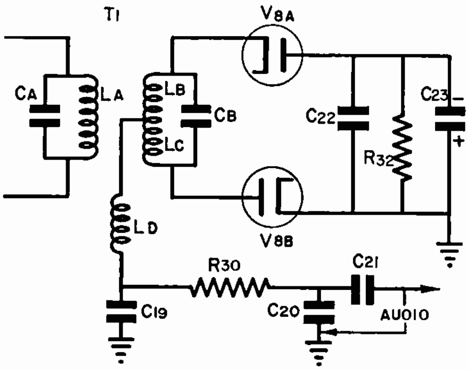


FIG. 12. The ratio detector.

tiple electrolytics is suspected all positive leads must be disconnected at the same time and substitute capacitors connected.

VERTICAL SECTION

In vertical sweep circuits, electrolytics are used almost exclusively in the output stage. The typical vertical sweep system in Fig. 14 shows that electrolytics C407A and C438 are used in the output stage cathode and plate circuits. An open cathode capacitor will greatly decrease height and introduce non-linearity in the vertical deflection signal.

However, the linearity control will have some effect on the sweep. On the other hand, a shorted cathode bypass electrolytic can be quickly spotted since a fault of this nature will prevent the linearity control from having any effect on the vertical scan.

An open coupling capacitor (C438) will not only squeeze the top and bottom of the raster but will produce inter-stage coupling due to the strong 60-cycle deflection signal entering the common B+ line. One operating trouble symptom is unstable horizontal sync due to the 60-cycle interference. Another is a distinct non-tunable buzz in the audio output; also caused by modulation of the common B+ line by the vertical sweep output signal.

HORIZONTAL SWEEP SECTION

Electrolytics are used as filtering, bypass and decoupling components in the horizontal sweep system.

The horizontal oscillator stage, for example, will utilize an electrolytic in its plate circuit as shown in Fig. 15A to decouple any sound and vertical sweep signal that may be present in the B+ or boost lines. When this unit opens or becomes excessively leaky, the operating frequency is very likely to change and the picture will show loss of horizontal sync. A completely shorted C1 capacitor will kill the raster. From the trouble-shooter's point of view, the shorted capacitor can quickly be pinpointed by the obvious burn-out of R2.

In the output stage—Fig. 15B—C1 serves as an electrolytic capacitor bypass for cathode resistor R1. If this capacitor opens, degeneration (loss of gain) in the horizontal output stage will take place and the width will suffer.

An electrolytic capacitor is frequently used in the B+ boost line as shown in Fig. 15C. This capacitor functions to both eliminate ripple in the B+ boost line and to isolate the flyback system from other B+ boost branches. When a boost filter fails, horizontal sweep signal decoupling is not present and the picture elements which are connected to the

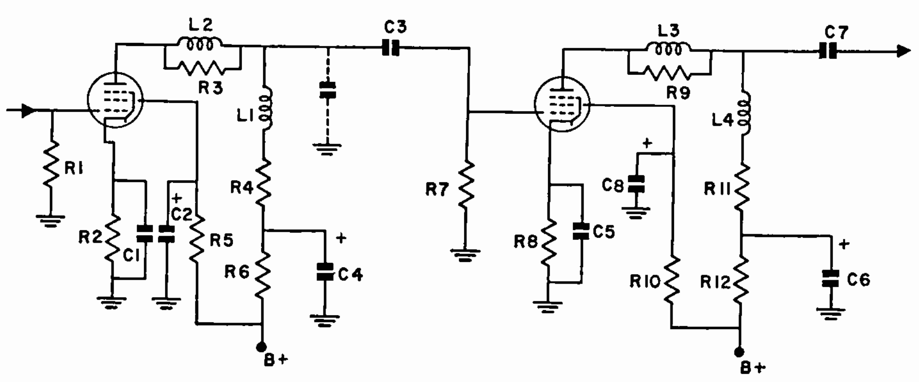


FIG. 13. Electrolytics in video amp. stages.

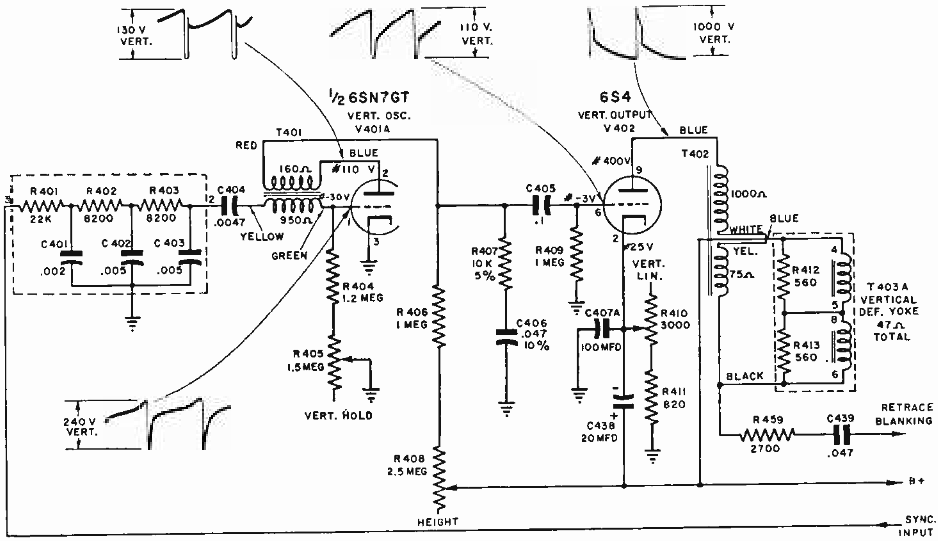


FIG. 14. The vertical sweep system of a typical TV receiver.

regular boost lines receive the sweep signals resulting in modulation of the picture tube beam. This causes a sizeable portion of the screen to appear dark.

AGC CIRCUITS

Electrolytic capacitors with low voltage and capacitive ratings are frequently used in agc systems. Fig. 16 shows a typical agc system with a 4-mfd (C2) capacitor serving to filter the pulsating voltage present in the plate circuit of the agc tube. The current pulsates through the agc tube due to the nature of the horizontal sweep voltage reaching the plate in the form of pulses. These are obtained from the agc horizontal output transformer winding and when the plate of the agc tube is made more positive than the cathode, plate current flows through the resistors between the plate and +150 volts, developing the agc voltage. Failure of the agc electrolytic will prevent the formation of agc voltage, causing sync signal clipping and compression due to i-f amplifier overloading.

CHOOSING REPLACEMENT ELECTROLYTICS

Thanks to the conscientious efforts of the capacitor manufacturers, there are hundreds of different values available singly or in multiple section form. This permits the technician to use a replacement of the original value in place of the faulty factory installed unit. Also since most set manufacturers maintain a replacement parts stock, their distributors can furnish exact duplicate electrolytics.

Because of the superior performance and longer operating life of aluminum or can electrolytic types, they should not be replaced by paper cased tubulars. If you find one section of a multiple capacitor defective, either open or shorted, always replace the whole unit for long-lasting satisfactory results.

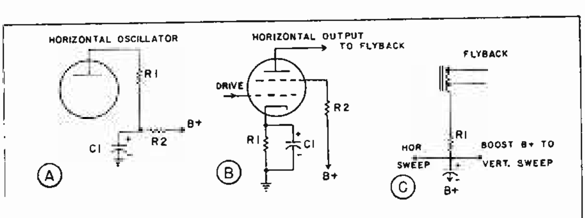


FIG. 15. Where electrolytics are used in hor. sweep stages.

Working voltages of electrolytics used in power supply and B+ lines have dc working voltages ratings of from 150 to 450 volts. Carefully check this rating in the original unit and install a replacement of equal or higher voltage rating.

CAPACITOR CHANGES

While it is true that a suspected electrolytic or any other type of capacitor is

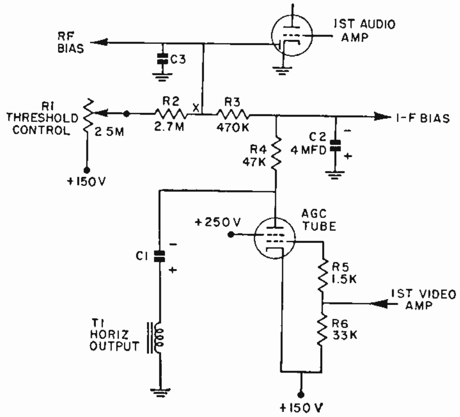


FIG. 16. A typical keyed agc system.

best tested by direct substitution, the professional service technician will find a resistance-bridge checker such as the NRI R-C tester, of great help, since you can measure power factor and leakage as well as the capacitance. You will tame many "tough dogs" by using the service information presented in this article to track-down sick electrolytic capacitors.

"We've invented a transistor so small it can barely be seen by the naked eye and now we can't find it."

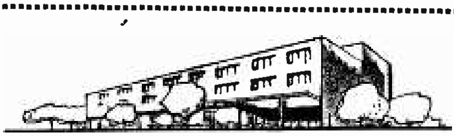
Courtesy Bell Telephone

Among the Christmas gems was the story about the little boy who approached Santa in a department store with a long list of requests. He wanted a bicycle, a wagon, a chemical set, a cowboy suit, a set of trains, a football and roller skates.

"That's a pretty long list," Santa said sternly. "I'll have to check my book and see if you were a good boy."

"No, no," the youngster said quickly. "Never mind checking. I'll just take the roller skates."

NRI ALUMNI NEWS



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

Jules Cohen and Frank Skolnik are Candidates for President of NRIAA

Current Vice Presidents Heavily Favored As Candidates For Re-Election

Jules Cohen of Philadelphia and Frank Skolnik of Pittsburgh are the candidates for President of the NRIAA next year.

The very popular Jules Cohen, elected a Vice President for 1958 and again for 1959, is now making his bid for the top office. Officially Secretary of the Philadelphia-Camden Chapter continuously for the last eight years, he has been one of the most outstanding and industrious leaders that this Chapter has had in the past decade. Cohen would unquestionably make a strong President.

Frank Skolnik is a former Chairman of the Pittsburgh Chapter, has been and is now one of the Chapter's most dependable members for getting things done. He would also make an able President.

It would appear that Alumni Association members in Pennsylvania are participating in this year's election more strongly than ever, since both candidates for the Presidency are from that state. One thing we already know, therefore, is that the next President of the NRIAA will be a Pennsylvanian.

The votes for candidates for a Vice Presidency followed the not-unusual pattern of heavily favoring the current VP's: Earl Oliver of Detroit, John Babcock of Minneapolis, Roland Tomlinson of San Francisco and Howard Smith of Springfield, Mass. But none of the present office holders can again be candidates for Vice President for at least three years, because of the adoption of the recent amendment to Article VI, Section 2 of our Constitution and By-Laws.

An odd situation occurred this year among the candidates for a Vice Presidency. In three instances there are two members from the same chapter. The runners-up to the more heavily favored candidates are John Berka, former Chairman of the Minneapolis-St. Paul Chapter (among his opponents is current Vice President John Babcock of the Minneapolis-St. Paul Chapter); Frank Cattalano and James Eaddy, both of whom are members of the New York City Chapter; and J. Arthur Ragsdale, Chairman of the San Francisco Chapter, of which current Vice President Roland Tomlinson, who has been nominated for re-election, is also a member.

Only members of the NRI Alumni Association are eligible to vote in these elections. Members are to vote for *one* man for President and *four* for Vice President, by means of the ballot on Page 30. The polls will close at midnight on October 25. Ballots must be mailed in time to be delivered to National Headquarters by then in order to count. The winners will be announced in the next issue of the NRI News.

Chapter Chatter

SAN FRANCISCO CHAPTER devoted an entire meeting to assembling a power supply. Anderson Royal, Chairman of the Program Committee, explained the different parts employed in the unit and drew a schematic diagram on the blackboard. All the members participated in assembling a section of the power supply. After it was assembled it was tested on an oscilloscope furnished by Edward Persau, and it was found to work satisfactorily. All the members present enjoyed working on this project.

Continued study of power supplies was planned for future meetings, this study to be accompanied by actual practice on power supplies.

LOS ANGELES CHAPTER tried a novel stunt at one of its meetings. An informal discussion was held among the attending members on what they had done in Radio-TV-Electronics since graduating from NRI. Two of the most interesting reports were Nibaldo Figueroa's, who became an inspector for Packard Bell Radio and Television Corporation and that of Jessie Davis, who teaches Electronics and other subjects to mental patients at a Veterans Administration Hospital in Sepulvedo, Calif.

One of the enjoyable features of the Chapter's meetings is the entertaining and instructive films that it features. At one recent meeting films were shown on plastics, one about volcanos and how they start, and several travel films.

Frederick Tevis and Julio Solis were elected to fill the posts of Vice Chairman and Treasurer, respectively.

A pot-luck picnic was scheduled to be held in September, to which all members and their families were invited.

All members please note: meetings will hereafter be held at a new meeting place, 4415 Santa Monica Blvd.

NEW ORLEANS CHAPTER, despite the heat and humidity in that part of the country, nevertheless maintained its regular schedule of meetings right through the summer. This speaks a great deal for the earnestness and determination of the members of this chapter.

FLINT (SAGINAW VALLEY) CHAPTER is also one of the local chapters of the NRIAA which does not hold meetings in July and August. Regular meetings have now been resumed, however, and the Chapter is looking forward to a busy season.

MINNEAPOLIS - ST. PAUL (TWIN CITY) CHAPTER planned to devote its September meeting to the B & K Television Analyst, then to line up a tour of one of the area TV stations for its October meeting. Such tours have been very popular wherever local chapters have been able to arrange for them.

The Chapter hopes to have a film on transistors at one of its meetings soon. Most of the time at the regular meetings is taken up with the tough dogs brought in by members. This, of course, is one of the important benefits of membership in a local chapter of the NRI Alumni Association.

CHICAGO CHAPTER is continuing to devote a good part of its meetings to transistors.

Mr. Oakley was scheduled to give the members a demonstration on his transistor checker but was unable to do so because of a broken finger. However, he promised to bring the checker to the next Service Forum and give the members the long-awaited demonstration. He also promised to leave the checker at the Chapter's meeting place for several months so that it would be on hand whenever it was needed at the meetings.

The members also continue with roundtable discussion on servicing at the meetings. At one of these discussions Mr. Oakley gave the members a few good pointers that he had picked up on the scope.

MILWAUKEE CHAPTER, following its suspension of meetings in July and August, has now resumed regular meetings.

Students and Graduates in the area who have never attended a meeting but who may be interested in doing so will likewise be interested to learn that S. J. Petrich's Radio-TV shop, where the meetings are held, is extensively furnished with the professional test equipment used in Radio-TV work. Mr. Petrich, in addition to providing the Chapter's meeting-place, also generously permits this equipment to be used at the meetings when required for demonstrations.

DETROIT CHAPTER, like several other local chapters, follows the practice of suspending meetings for the summer and looks forward to celebrating the new season with a stag party, usually held in October. At last report the stag party was scheduled for early in the same month again this year.

SPRINGFIELD (MASS.) CHAPTER is one of several local chapters of the NRI Alumni Association which do not hold meetings in July and August. Now that the summer is over the Chapter is again holding its twice-a-month meetings, one a regular meeting and the other a shop meeting.

The presentation of a 16MM film showing advanced technology in the field of Electronics was planned for the first meeting of the new season. Members have been sent forms which they were asked to fill in to indicate their preferences concerning the various fields of Electronics they were interested in for the Chapter's meetings.

(Page 31, Please)

Election Ballot

All NRI Alumni members are urged to fill in this ballot carefully. Mail your ballot to National Headquarters immediately.

FOR PRESIDENT (Vote for one man)

- ☐ Jules Cohen, Philadelphia, Pa.
- ☐ Frank Skolnik, Pittsburgh, Pa.

FOR VICE PRESIDENT (Vote for four men)

- ☐ F. Earl Oliver, Detroit, Mich.
- ☐ Howard Smith, Springfield, Mass.
- ☐ John Babcock, Minneapolis, Minn.
- ☐ John Berka, Minneapolis, Minn.
- ☐ J. Arthur Ragsdale, San Francisco, Calif.
- ☐ Roland Tomlinson, San Francisco, Calif.
- ☐ James Eaddy, New York, N. Y.
- ☐ Frank Catalano, New York, N. Y.

SIGN HERE:

Your Name ....

Your Address ....

City ....State ....

Polls close October 25, 1960. Mail your complete Ballot to:

T. E. ROSE, Executive Secretary

NRI ALUMNI ASSOCIATION

3939 Wisconsin Ave.

WASHINGTON 16, D. C.

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.

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: George Rashead, 338 E. Marengo Ave., Flint, Mich.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER meets 7:30 P.M., second Thursday of each month, North Hagerstown Senior High School, Hagerstown, Md. Chairman: J. Howard Sheeler, 300 Walnut St., Shippensburg, Pa.

LOS ANGELES CHAPTER meets 8:00 P.M., second Friday and last Saturday of each month, 4415 Santa Monica Blvd., 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: Kermit Olson, 5705 36th Ave., S., Minneapolis, 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, 436 Forbes St., Pittsburgh. Chairman: Thomas D. Schnader, R.D. 3, Irwin, Pa.

SAN FRANCISCO CHAPTER meets 8:00 P.M., first Wednesday of each month, Palm Ave. & Geary 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 John Alves, 57 Allen Blvd., Swansea, Mass. Chairman: Arthur Hubert, 1566 Pleasant St., Fall River, 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: Norman Charest, 43 Granville St., Springfield, Mass.

PHILADELPHIA-CAMDEN CHAPTER customarily holds two meetings a month, a regular meeting and a Service Night. During July and August the regular meetings were dispensed with and only the Service Night meetings were held. But the two-meetings-a-month schedule is now in effect again.

The October Service Night meeting was slated to be held at the shop of a member of the Chapter, Henry Whelan, who recently moved to a larger establishment where he has more room for his growing auto Radio business.

The Chapter always has a heavy schedule of instructive and entertaining programs. Any students and graduates in the area who plan to join the Chapter should do so now in order to get the full benefit of all these fine programs for the coming season.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER, as in former years, suspended meetings for July and August but is now maintaining its regular schedule for once-a-month meetings. As we go to press a banquet has been planned to be held in October.

PITTSBURGH CHAPTER has admitted three new members: William Sames, Edgar Lowther, and Walter Payne, all of Pittsburgh. Congratulations, gentlemen!

Vice Chairman William Lundy delivered a talk and demonstration on the servicing of horizontal troubles in a TV, using a defective set that had horizontal pulling at the top of the picture. As a result of this, the members requested more demonstrations on using the scope to troubleshoot the various defects in a TV or Radio receiver.

Howard Tate, who is also a Vice Chairman of the Chapter, gave a talk on the general operation of the cathode-ray oscilloscope—methods of testing resistors and condensers separately and in networks to show the spikes and waveforms produced on a scope, also how to test selenium rectifiers with a scope by hooking directly to the vertical plates in the scope.

Still more work with the scope and the Chapter's enlarged transistor Radio, which has been built up so that different defects can be introduced into it, have been scheduled for subsequent meetings.

NEW YORK CITY CHAPTER, after having taken a vacation in July and August, is once again maintaining its regular schedule of two meetings a month.

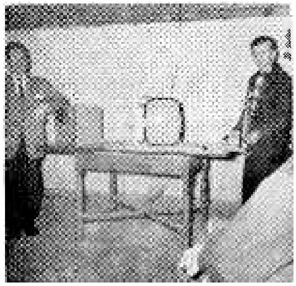
On the meeting nights many members come early to participate in the "ham sessions" conducted by Ralph Pincus prior to the regular meetings.

At the regular meetings the Chapter has many fine speakers who keep the members up to date on the latest in Electronics. Among these are Tom Hull, National President of the NRIAA for the current year, and Jim Eaddy, who makes many excellent talks on the theory of transistors and transistor circuits, and the various methods of troubleshooting these circuits.

Frank Zimmer is the Chapter's Hi-Fi man who recently officiated at an open form on Hi-Fi, during which he treated the members to an enjoyable evening of music appreciation.

The Chapter is off to a splendid start for the new season and will continue with its many fine talks and demonstrations on Radio, TV, and the latest developments in Electronics.

SOUTHEASTERN MASSACHUSETTS CHAPTER was honored to receive Graduate Carl Frohn of Philadelphia as a guest. Mr. Frohn demonstrated yoke and flyback testing with his newly-built NRI Model 250 Oscilloscope. He took the "chassis" out of the cabinet to show to the members—and a neat wiring job it was, too. This scope drew a lot of interest and members were seen reluctantly pulling away, giving many favorable comments.



Two stalwarts of the Southeastern Massachusetts Chapter, Manuel Souza and Walter Adamiec, giving a demonstration at a meeting.

John Alves spoke on picture tube boosters. He then touched on a method of determining the unknown polarities of unmarked silicon and selenium rectifiers with a VTVM. In this demonstration he was assisted by Manuel Souza, a full-time TV serviceman, who like John is considered an authority on these subjects.

The speaker certainly has the attention of his audience at this meeting of the Southeastern Massachusetts Chapter.

The Chapter's annual banquet was scheduled to be held at "TV Hangar's" in Acushnet. It was to be stag, with the Chapter footing most of the tariff. No report on the banquet has been received up to the time we go to press, but it is presumed that the banquet was held and was enjoyed by all who attended.

Mr. John Callahan has been admitted to membership in the Chapter. A warm welcome to you, John.

——— *n r i* ———

As soon as you have done a thing better than *you* have ever done it before, you are becoming great.

As soon as you have done a thing better than it has ever been done before, you have become great.

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