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STEREOPHONY as the dominant trend in the audio–radio field was evidenced at the Annual Audio Engineering Society Convention and High Fidelity Show held in New York City early in October. One complete session of the convention (Friday afternoon, Oct. 11) was devoted to stereophonic sound, highlighted by the demonstration of the Westrex discs. (See page 8.) Part of another session dealt with stereo FM transmission.

At the show, the dominance of stereo was even more pronounced. In addition to the manufacturers exhibiting stereo equipment, the majority of exhibitors demonstrating amplifiers, speakers or other apparatus used a stereophonic setup. Unfortunately the extremely high volume levels traditional at audio shows masked out the stereophonic effect in most cases, but could not conceal the conviction of the manufacturers that stereophony is the next big thing in the audio field. Some expressed the fear that the prospect of stereophonic discs might have a deterring effect on stereo tape similar to that color television is alleged to have had on the sale of black-and-white TV receivers but an equally large group insisted that disc and tape would help each other to promote stereo.

PHONE CABLE TO HAWAI, the world's longest and deepest, provides 36 circuits between the United States mainland and the island of Oahu, where 80% of Hawaiian telephones are located. The distance between cable terminal points is 2,000 miles. At some places the cable is 83 miles below the surface of the Pacific Ocean. The cable was built by American Telephone & Telegraph's Long Lines Department and the Hawaiian Telephone Co.

Amplifiers, needed to boost the strength of signals when they reach the fading point along the cable, were developed by Bell Telephone Laboratories. They are built into the cable at 44-mile intervals and are designed to withstand the pressures encountered on the ocean floor. They amplify voice currents 1 million times and are expected to operate without attention for at least 20 years.

It is now possible for operators on both the mainland and the island to dial directly, rapidly completing calls that span the Pacific.

TV SERVICING IN 1966 will be a vastly larger field than today, according to a recent survey made by Frank W. Mansfield, Sylvania's marketing research director. He shows a dollar volume of $447 million in 1948, $2.55 billion in 1957 and an expected $3.97 billion by 1966.

An interesting sidelight is the predicted drop in number and total value of receiving tubes. This is due to the increased use of transistors and the expected reduced price of tubes because of competition from transistors.

Mansfield's survey is based on six service calls a year for color TV sets, three a year for black-and-white sets, one a year for home radios and 0.5 a year for auto radios. Growth in the number of TV sets is also expected. Color sets from 160,000 now to 18,840,000 in 1966, and black-and-white sets from 42,580,000 now to 53,760,000. The number of service technicians for this year is listed as 122,070. Predicted growth at a rate of 5% per year should bring this to 206,640 by the beginning of 1966.

Calendar of Events
1957 Eastern Joint Computer Conference, Dec. 3-7, Sheraton-Park Hotel, Washington, D. C.
EIA Conference on Maintainability in Electronic Equipment, Dec. 18-19, University of Southern California, Los Angeles, Calif.
Fourth National Symposium on Reliability and Quality Control, Jan. 6-8, Statler Hotel, Washington, D. C.

THYRISTOR, a new high-frequency switching transistor, can switch substantial currents from one circuit to another in periods as short as 1/50,000,000 second. It is switched from on to off and vice versa by applying low energy pulses of the proper polarity to the base circuit. Announced by Dr. Irving Wolff, vice president of RCA's research department, it is described as a modified alloy-junction transistor. A novel feature is a new form of collector contact which makes the high-speed switching action possible. The Thyristor may be operated as either a bistable switching element or a more conventional high-frequency transistor, either in switching or amplifying circuits. The device is still under development and is not yet commercially available.

Similar units announced by Philco are a new class of field-accelerated transistors made possible by a Micro Alloy Diffused-Base Transistor (MADT) process. MADT's are available in various voltage and frequency specifications for use in transistorized equipment through the entire vhf and part of the uhf spectrum. These transistors feature a maximum frequency of 250 to 1,000 mc. Typical gain is 10 db.
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NEWS BRIEFS (Continued)

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A logical outgrowth of MADT is the development of a super-high-speed switch. Engineers now discuss switching time in light feet instead of inches. Typically the MADT will switch on or off in 10 light feet. No type number was given for these transistors nor was unit price revealed. The unit is now in production.

STEREO DISC RECORDS were demonstrated by two companies during the recent Audio Engineering Society convention in New York City. Westrex, a subsidiary of Western Electric Co., demonstrated one system at the convention. The other, not shown at the convention itself, was demonstrated by London Records at an outside location. Opinion seemed to favor the London demonstration, though conditions surrounding the Westrex audition caused some to wonder if the records might not be somewhat better than circumstances permitted them to sound.

The London system—originated in England by London's parent company (British) Decca Records—combines vertical (hill-and-dale) and lateral recording. Vertical motion of the stylus produces one of the stereophonic channels, while lateral motion produces the other. The American system records the two channels on opposite sides of a 45° groove. Thus each of the two stereophonic signals is a combination of vertical and lateral movement of the stylus.

It was generally understood that manufacturers were ready to agree on a single standard before beginning to mass-produce records. Once agreement on the system to be used is reached, there need be little delay in putting stereophonic discs and cartridges on the market. The would-be stereophonic listener could use his own pickup arm and cartridge, and his amplifier—speaker system would furnish the sound for one channel. It would then be necessary to obtain only one additional preamp, amplifier and speaker system, which many feel need not be of the extreme quality required in a single-channel true high-fidelity system.

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X-RAYS FROM TV SETS

Dear Editor:

"Hot Words on Boosters" (page 16, October issue) hit a point close to home. Therefore, I am writing this to correct what seems a gross misunderstanding of a rather vague subject.

Since I am a radiation physicist, one of the very first things I found myself doing was measuring the X-rays that emanate from picture tubes and other high-voltage tubes to find out if they would be strong enough to be harmful.

Using a Victoreen R-meter, which is commonly used in X-ray laboratories for measuring X-ray strength, I empirically determined that very little radiation emanated from the face of a TV picture tube. So little, in fact, that the readings were barely indicated on the R-meter. With the TV set in the cabinet, no reading was available, indicating that the strength of X-rays was way below the sensitivity of the meter.

Around the neck of the picture tube, where the glass is rather thin, a definite reading was indicated. However, this reading (of the usual voltages in black-and-white TV sets) was so low that a person would have to spend 6 or 8 months near the neck of the picture tube (or inches from it) to get enough radiation to pass the minimum safe requirements (100 milliroentgens per week) of the Radiological Safety Conference.

There is, however, a more serious danger point. That is at or near the 1B3, 1X2 and 1V2 tubes used as rectifiers. Here, X-ray dosages were such that a long exposure of perhaps an hour, at 6 inches from these tubes, could cause an overdose of these soft rays. Fortunately, these tubes are usually enclosed in a metal can or placed under the chassis in which the X-rays are heavily absorbed. No reading of any value was available from sets in their cabinet or from sets where all the hardware was in place. My measurements were made within 6 inches since, frankly, I cannot see anyone getting closer than this to a "hot" high-voltage rectifier.

My conclusions from this were very definite:
1. A properly manufactured TV set gives off no appreciable radiation to the user or his family.
2. A properly manufactured TV set has sufficient protection so the service technician need not be worried.
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CORRESPONDENCE (Continued)

he does not allow himself to get close enough to high-voltage components to get sparkover to his body or hands does not have to worry about X-rays since he is usually far enough from their source or well enough protected from their source (by shields, etc.) that he is in no danger.

4. When replacing a TV set in a cabinet, technicians should at all times replace all hardware, especially high-voltage caps, and safety glass to insure his customers against possible low dosages of X-rays as well as to provide the security these devices offer from shock hazards.

The only tube (picture tube) that seemed a potential X-ray hazard other than the rectifiers was the 3-inch Philips projection tube when used, and only when used outside its housing. This tube, remember, has a rather thin glass window, uses some 39,000 volts (which is definitely in the X-ray range), and its cathode is rather close to the screen (it being a short-neck tube).

Be careful when using this tube.

Unfortunately, I have not been able to obtain any X-ray measurements on color TV tubes at this time. However, I intend to do this as soon as possible.

CHARLES R. MADUELL, JR.
Consulting Physicist
New Orleans, La.

KLIPSCH VS. VILCHUR

Dear Editor:

I read with extreme interest the two sides of the speaker-distortion argument presented by Messrs. Klipsch and Villchur in October. B ut it seems to me that the issue, an extremely important one, has not been joined. Mr. Villchur speaks of harmonic distortion and Mr. Klipsch of intermodulation distortion.

Mr. Villchur shows an oscilloscope trace of a sine wave reproduced by an acoustic suspension system at 30 cycles with a 30-watt input. The waveform is clean to the eye, and this is remarkable. But the eye cannot discern harmonic distortion much below 5%. If harmonic distortion were, say, 3% or 4%, the eye could not tell but this might conceivably imply quite a high order of intermodulation distortion, perhaps as high as Mr. Klipsch indicates with a ½-inch cone excursion. I don't know, I can only guess at what is possible. The possibilities include that the relationship between harmonic and intermodulation distortion in a speaker resembles that in a tape recorder where, for example, only 3% harmonic distortion may correspond to 20 or 30% intermodulation distortion.

HERMAN BURSTEIN

Wantagh, N. Y.

A HI-FI PROBLEM

Dear Editor

An increasing number of customers are bringing back records with the
CORRESPONDENCE (Continued)

complaint that they are defective because "they skip" and are "scratched and keep repeating."

When this happens here, we immediately put the record on one of our players and it plays perfectly. Some people then realize that perhaps their own player can be corrected to play the record properly, too.

But the majority remain unconvinced because "the other side plays all right; all my other records play all right; it's a new hi-fi and I know that nothing could be wrong with it!". The statements are stereotyped; the phrasing, the emphasis, the attitude.

These individuals want one action only. They want "a fresh record." We know from experience that giving one to them is no solution. It also repeats in exactly the same places. This exasperates them till they think that we gave them still another "worn out record." Worse, these potential purchasers may lose interest in buying records.

Who is responsible for the state of mind of these customers and the conditions which cause it? Is the record dealer, who sold only the record and not the player? (We do sell recording equipment, and we are careful to sell only those we know and can guarantee will not skip or repeat.) Is it the record manufacturer? Is it the cartridge manufacturer? Is it the tone-arm manufacturer? Is it the stylus manufacturer?

This needless situation comes from the sale of certain players and records that are incompatible.

As a retail record dealer, I resent and protest against being the scapegoat and taking the resulting blame, ennui, and loss of patronage.

For the benefit of both the public and the industry, I ask that adequate standards of relationship between records and reproducers be established and thoroughly publicized.

The following statement is printed on our carry bags: Farrington's Record Store guarantees that every record is fresh and undamaged when it leaves our store. Records are not allowed out for home use.

We are not responsible for records damaged by recording equipment which "keeps repeating," "sticks in the greens," etc., regardless of whether "it's a new player," or "the other side plays all right."

The responsibility lies with those who sell such equipment.

We guarantee that any record player bought from us will not damage records by "sticking" or "repeating."

For the benefit of the public and the industry, I ask that adequate standards or relationships between records and reproducers be established and publicized. The prevalent passive acceptance of normal merchandise as "defective" is not a solution. Thousands of customers are still sore.

CHARLES W. FARRINGTON
Farrington Record Store
Arlington, Mass.

DECEMBER, 1957

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... Teleducation Can Safeguard Your Future ...

If you are convinced of the feasibility of MASS NATION-WIDE TELEDUCATION and its urgency, in view of the serious danger your country now faces, write or wire your Senators and Congressman calling their attention to this article. They have received copies.

The greatest accomplishment of the Russians was not their famed earth satellite, great as that feat was, but a deadly aroused United States, now awakening to its shocking peril.

For make no mistake, the Russian Sputnik is only a moving finger in the sky, writing out plainly Nikita Kuschev's recent threat to us: "We will bury you!" That threat is not an idle boast in Russia, a country that glorifies its men of science, technicians and inventors, while in the U. S. many politicians and others delight in ridiculing them. In Soviet Russia, boys with a scientific or technical bent crowd the large number of technical schools to such extent that there is no room for all who wish to attend. Why? In Russia, a scientist is a near-hero. In the United States, there is—and has been—a serious shortage of technical pupils on which our very future life depends. The result: The United States is now a very bad second runner in a world where science and technology are replacing the soldier, the regiments and the military divisions of former days.

What is the remedy in our perilous dilemma? It is far too late now for a crash program in technical education using our antique teaching methods. There are not enough good teachers to supply such a demand. And good teachers are not made overnight—it takes many years. What then is the answer? MASS NATION-WIDE TELEDUCATION.

In 1945, we were the first to broach the subject in a short article entitled "Television Teaching." We said: "Outstanding educators . . . lecture via (closed circuit) television from central Teleutoriums. . . . Thus one teacher can lecture and instruct hundreds of classes.

Since that time we have published a number of articles on this subject. A condensed version of this far-reaching plan is summarized thus:

1. The United States government to set up a nation-wide closed circuit educational television network, tying together all schools and colleges. The Government to finance and build the network, but to have no voice in the teaching. Schools, however, would have to agree to a specified amount of technical teaching hours per week.

2. We have a sufficient number of good teachers right now to teach 50,000 or 5,000,000 pupils or students. These teachers now are wasted, literally.

3. To be effective, science and technology must start with the 6-year-old child, in easy stages, to awaken his interest. Television has shown that simple science things fascinate youngsters and, if presented right, hold his interest. The marvels of science and the wonders still to come would always have to be emphasized, with the result that a large percentage of youngsters 10 years hence would be well on the way to fill our sadly lagging ranks of scientists and technologists.

4. So as not to confuse, we repeat that the proposed Nation-Wide Teleducation Network is to be strictly CLOSED-CIRCUIT—not broadcast. We have all the necessary technical means now to build it. On a crash basis, it could be working in a year or less.

5. Who will do the science teaching? This will be left to a National Science Instruction Board. For details, see "The Elements of Teleducation," in our May, 1956, issue.

Since we first broached the idea of teleducation in 1945, teaching via television has become a rather well established method of teaching. Old-fashioned orthodox pedagogues, skeptical at first, have now become enthusiastic supporters of the idea. Many schools and colleges now have become TV-integrated, and wherever funds are available, more schools are coming into the fold.

One of the most recent successful experiments was inaugurated in September, 1956, in Hagerstown, Md., where 6,000 children, in 6 elementary and 2 high schools, are now being educated experimentally via a local TV school closed-circuit network. The pupils receive televised lessons in English, geometry, art, music, history and social studies. It has been termed by a very prominent educator, Dr. Alexander Stoddard, who for 10 years was chairman of the Educational Policies Commission of the National Education Association, as "the most significant thing going on in America today."

The schoolrooms in Hagerstown today have an average of four 21- or 24-inch regulation TV receivers spotted around the class in strategic positions, so most of the students can get a good view of the proceedings.

We can foresee the day when a single large theater type wall-projection televiser will prevail instead of the box type receiver. The wall-projection type, when mass produced and consequently much cheaper than the comparatively few in use today, will give a better view for the entire class, particularly when the picture is in color, as it surely will be. Much later, it will also be a three-dimensional picture, rather than a flat one. This is most important for science teaching when during televised experiments instruments, apparatus and machines must be viewed from several angles by the student for better understanding.

In the meanwhile, it is understood that the many schools and colleges that are TV-equipped now can readily be integrated into a nation-wide closed-circuit network without difficulty.

Yes, as in all revolutionary new undertakings, there will be many squabbles by the various boards of education in cities and states as to methodology in teaching, procedure, curriculum and many other details. These we feel certain will and must be resolved speedily. They are not serious candidates to the life of our nation, which depends on a successful outcome of this plan.—H. G.
The VTVM...its care and repair

By RHYS SAMUEL

How to keep your vtvm at top efficiency

Fig. 1—Recommended test setup for aging tubes for vtvm's.

Fig. 2—Block diagram of typical vtvm.

The vtvm is such a reliable device that the technician gives it little thought until that inopportune moment when it breaks down. A defective vtvm should offer no special problems because it is basically a simple instrument. It uses two or three tubes, conventional parts and straightforward circuitry. For the experienced tech especially, troubleshooting should be a snap.

The best way to minimize vtvm down time is to prevent trouble in the first place by following the simple precautions and periodically making the brief checks described in this article. Although many of these points may seem academic, they are often overlooked by techs who should know better. Hundreds of defective vtvm's are returned to manufacturers and instrument repair shops yearly because of user carelessness or neglect.

Preventive maintenance

Probes and cables are a frequent source of trouble because they are subject to constant handling. Internal connections break or become intermittent. Detachable probes are often dropped. Check the condition of ohms probes and cables by shorting them together and flexing the leads while watching the meter pointer. Erratic changes of the meter reading indicate loose or broken connections. Voltage leads should be checked in a similar manner while connected to a test-voltage source.

When a vtvm is used in the shop, mount it securely so that an accidental tug on the test leads will not pull it off the bench or shelf and break the meter movement. Keep detachable probes in an out-of-the-way place or clamp them in fuse type clips on the vtvm case.

To check the condition of the ohms battery:

1. Set the FUNCTION SELECTOR to ohms.
2. Set the RANGE CONTROL to R × 1.
3. Rotate the OHMS ADJUST control to bring the pointer to full-scale deflection. If it is impossible to adjust the pointer to full-scale, replace the battery.
4. If OK as checked for full-scale deflection, short the ohms cable to ground for about 10 seconds.
5. Open the short circuit and observe the scale indication. Any appreciable deviation of the pointer from full-scale deflection indicates a weak battery.

If it is impossible at any time for the meter pointer to deflect to the full-scale point on ohms, it is advisable to replace the battery. Never leave exhausted batteries in the instrument. If any inspection reveals a battery that is leaking or corroded, replace it immediately and thoroughly clean out all chemical deposits inside the case and on the battery contacts. Before a new battery is installed in a holder with spring contacts, clean the contacts thoroughly and adjust the springs to insure a solid contact with low contact resistance. Be sure to observe correct polarity during battery installation.

Like the switches in TV tuners, vtvm switches should be checked and attended to periodically. Keep panel nuts tightened to prevent movement of the switch assembly, broken leads and shorted components. Take care during soldering to prevent overheating or scraping the resistors mounted on the switches. Excessive heat can permanently change the value of precision resistors and result in inaccurate meter readings. Avoid twisting or loosening the switch contacts.

Improper use of a vtvm is a major cause of failure and expensive repairs. While its design makes it almost impossible to burn out the meter movement, excessive and repeated overloads can cause other types of damage. Excessive inputs, which result from improper settings of the function and range switches, may change the value of the precision resistors in the divider networks or burn out the low-value resistors. Many vtvm's returned to manufacturers have damaged resistors in the ohms-divider network because the operator attempted to measure voltage with the function selector set to ohms.

Replacement parts

Whenever possible, exact replacement parts should be used. Most divider-network resistors have a ±1% tolerance, and many have special values obtainable only from the instrument manufacturer.

Individual replacement parts for meter movements generally are not stocked by the manufacturer. Defective meters are best returned to a repair shop which specializes in this work. Never attempt to check the continuity of a meter movement with an ohmmeter or general-purpose continuity checker. The battery voltage in the ohmmeter may be high enough to burn...
out the meter movement under test.

**Tube replacement**

Most vtvm's use tubes specially aged or selected to insure a low amount of gas and contact-potential current. Although tube-replacement requirements differ among instrument models, it is usually desirable to age replacement tubes intended for installation in bridge circuits and ac signal rectifiers. Unless a bridge-circuit tube has suitable operating characteristics and a low value of gas current, it may cause off-zero deflection of the meter pointer when the RANGE switch is changed from the lowest dc-voltage range to the higher ones. This condition requires that the operator replace the meter pointer whenever ranges are changed. Often a tube will prove unsuitable for installation, even after a lengthily aging period.

The acceptability of a tube for bridge-circuit use will depend upon the vtvm's design and the manufacturer's recommendations. Usually, a change of one or more divisions in the meter-zero setting as the RANGE switch is changed indicates that the tube requires more aging or is unacceptable for use in a vtvm. If several tubes are available, install them in the instrument one at a time, before aging, to determine which has the lowest value of gas. The tube which produces the least amount of off-zero deflection as the range is changed is the best tube to select for aging.

Single or twin diodes used in the ac signal-rectifying section may or may not require selection or aging, depending upon manufacturer's recommendations. The diode selected should provide a minimum amount of off-zero deflection of the meter pointer when the FUNCTION switch is changed from dc volts or ohms to ac volts, as well as the minimum amount of deflection when the RANGE switch is rotated. Many vtvm's have internal adjustments for differences between signal-rectifier tubes. Hence, tube selection and aging may not be critical.

A new tube may be aged by installing it in the vtvm and running the instrument for a number of hours or days. An alternative, and quicker method of aging diodes or triodes is to use the simple setup shown in Fig. 1. The grids and cathodes of triodes are tied to one side of the ac line and the plates to the other side. Heaters are operated at a normal voltage supplied by a transformer. Diodes are aged in the same manner except that no grid connections are required.

The aging period is from 24 to 100 hours. Aging by this method usually requires less time than aging in the instrument. Whenever a new tube is installed, the vtvm should be checked for calibration and accuracy. Recalibration may be needed to insure accurate ac and dc voltage measurements.

**Zero setting, accuracy**

When the vtvm is switched off, the meter pointer should rest at the left-hand zero mark. If the pointer comes to rest above or below this mark, the mechanical zero requires adjustment. This adjustment is accessible from the front of the meter case and may be a small setscrew or lever. On some vtvm's the adjustment screw is accessible through a hole in the front of the meter case. The hole may be covered with a small cap or screw plug.

With the power off, remove the cap or plug and adjust the setscrew to bring the pointer into line. On vtvm's with a lever adjustment, insert a small scriber or similar tool into the hole and move the lever right or left, as required. Take extreme care to avoid inserting the scriber into the movement. Always replace the screw plug or cap to seal the movement against dust and moisture.

The inside of plastic meter faceplates of vtvm's is often coated with a special antistatic solution to eliminate effects of static charges on the meter pointer. If this coating is removed, the meter pointer action may be erratic.

On plastic meter cases, therefore, do not rub the inside of the faceplate. If the antistatic coating is ineffective, apply additional antistatic solution to eliminate the trouble. A detergent soap, such as Gleem, may substitute for the solution. Use a medium amount in water, fill the inside of the case and pour out. Shake off any remaining solution and allow the meter case to dry.

When you suspect that changed-value divider resistors are responsible for faulty readings, check the resistor values on a resistance bridge, if possible. Because many resistors used in commercial vtvm's are accurate to 1%, conventional ohmmeters cannot be used to measure their values accurately. Factory-fresh flashlight cells are a fair substitute for a dc voltage standard. When new, one of these cells should provide 1.55 volts under the high-resistance load of a vtvm.

**Analyzing the trouble**

Like a television receiver, a vtvm has a number of individual sections and circuits which perform specific functions. In a vtvm, some circuits, such as the ac signal rectifier and the ohms-divider network, are imperative (disconnected) for all other functions. Others, like the power supply, bridge circuit and meter movement, are used for all operations of the vtvm.

A block diagram of a typical vtvm is shown in Fig. 2. The vtvm is built around a vacuum-tube bridge circuit and indicating meter. The function of the ac signal rectifier and the divider networks for ac and dc volts and ohms is to supply a fixed proportion of the input test voltage to the bridge circuit. During operation, a dc voltage is fed to the bridge from one of three sections.

On resistance measurements, a resistance-divider network in series with an internal battery furnishes a value of dc voltage in proportion to the value of the unknown resistance placed across the ohms network through the ohms probe and ground cable. On dc voltage checks, the voltage being measured is applied across the dc voltage-divider network which, in turn, applies a pro-
TEST INSTRUMENTS

Intermittent troubles can often be found by probing parts and wiring with an insulated tool.

Portionate part of the test voltage to the bridge circuit.

In ac voltage tests, the signal is rectified and the resultant dc voltage is applied to the bridge circuit. The input-divider networks for all three measurement functions are designed so that only a small part of the input voltage (1.5 to 3 volts) reaches the bridge circuit.

Voltage for ohms measurements is obtained from an internal battery; all other voltages are obtained from a built-in power supply. The compensating circuit for contact potential is used when the vtvm is switched to ac. The first step to be taken in localizing trouble consists of inspecting the instrument's performance on all ranges and functions. Set the function switch to the first position (— DC VOLTS, for example), and rotate the range switch through each of its range settings. Turn the function switch to its next position and again rotate the range switch through all its positions. Repeat this procedure for all remaining settings of the function and range switches and note the vtvm's performance at each new step.

Check probes and cables in some routine application while these checks are made. When a complete check has been made, you should have a complete picture of over-all performance. If the vtvm is imperative on all functions, look for trouble in sections or circuits common to all functions. If the defect occurs only on one or two functions or ranges, look for trouble in the corresponding sections of the instrument.

With some vtvm's, a single probe and cable are used for all voltage and resistance measurements. On other instruments, separate probes and cables are provided. Some common troubles and probable causes are given below.

General troubles
Instrument fails to operate on all functions; pilot light does not light.
Check the line cord and switch wafer section of the function switch for defects. Fuse may be open (if used) or perhaps primary winding of power transformer has opened. Check continuity with another ohmmeter.

Instrument fails to operate on all functions; tubes light.
Lead may be broken in ground cable or at ground connection inside case. There may be faulty tube in the bridge circuit, open or short circuit in bridge circuit, or faulty tube or component in the power supply. There may be an open or short in probe or cable, if the vtvm uses multipurpose probe and cable. Meter movement may be defective. Meter pointer sticks.
Jewel bearing in meter may be cracked or broken. Return meter to meter maker or repair shop. Scale plate of meter may be loose and striking meter pointer. Remove meter from case and tighten faceplate screws. Meter pointer hangs hard left or right, depending upon setting of function switch.

There may be open or short circuit in bridge network. Check parts mounted on switch wafers. Take continuity readings with another ohmmeter. Bridge tube may be defective. Intermittent operation on all functions.

Connection may be loose or broken in ground cable or in probe if multipurpose probe is used. Check as described under preventive maintenance. There may be a faulty wiper or contact in the switching section, or open or broken connection in bridge-circuit wiring. With power applied, check wiring, connections and components with an insulated probe. There may be a defective tube or component in bridge circuit or power supply.

Ohms-function troubles
Instrument fails to operate on ohms; works normally on ac and dc voltage measurements.
Battery may be dead or not making contact. There may be a loose or broken connection in ohms cable if separate cable is used. Contact on function switch may be defective. There may be open circuit in resistance-divider network. (Note: In some vtvm's this network is made up of series-added resistors. An open circuit can affect operation on two or more ranges. On other vtvm's, separate resistors are switched in when the range is changed. In these instruments, a defective resistor will cause inaccurate readings on only one range.)

Ohms adjusted control fails to give infinite readings on resistance scale.
Ohms battery may be dead. Ohms adjusted potentiometer may be defective. Bridge tube may be defective. Ohms readings inaccurate on some or all resistance ranges.
(Note: Manufacturers usually do not publish accuracy figures for ohms measurements. Generally, the vtvm should provide readings within 10% of the actual value. If readings of greater precision are required, use a calibrated resistance bridge.) One or more resistors in the ohms-divider network may have changed value. Excessive leakage in this network can also cause trouble. Check ohms range switch for dirt or damage. High humidity may cause leakage and inaccurate readings on high ohms scales. Bake inside of instrument with low-wattage light bulb. Check ground jack and cable for poor connection. Check for shorted wiring in ohms divider network.

Meter pointer moves off infinity mark when range switch is changed.
Replace bridge tube with new tube having a low value of gas current. (Note: A small deviation should be considered acceptable.) There may be a defective resistor in bridge circuit. Check by baking for several hours with light bulb. Do not overtighten and damage components.

Ac voltage measurement troubles
Instrument fails to operate on any ac voltage range; works normally on ohms and dc voltage ranges.

Ac signal-rectifier tube may be defective. Ac volts contacts on function switch may be defective. There may be open or short circuit in ac signal-rectifier circuitry. Check wiring and components with another ohmmeter.

Meter pointer may be off zero when ranges are changed.
Ac zero potentiometer may be out of adjustment. Adjust according to manufacturer's instructions. If this adjustment fails to correct trouble, replace the ac signal rectifier or bridge tube or both. Check resistance values in network around contact-potential bucking tube, if one is used.

Ac voltage inaccurate on some or all ac ranges; performance on ohms and dc voltage ranges normal.

Resistor network around ac voltage divider may be defective. There may be defective contacts or excessive leakage in switches. Ac signal-rectifier tube may be defective. Check for leaky capacitors or changed-value resistors in ac signal-rectifier circuits or in ac voltage-divider network.

Dc voltage measurement troubles
Instrument fails to operate on any range of +volts or —volts; works normally on ohms and ac volts.

Dc (isolating) probe may be defective. Check isolating resistor. Check all switch contacts used on dc voltage function.

Instrument fails to operate on any range of +volts but normal on volts, or vice versa; works normally on ohms and ac volts.

Check calibrating potentiometer in series with meter movement. Check for defective switch contacts or wipers in polarity-reversing circuit.

Voltage readings inaccurate on +volts, —volts, or both; ac voltage and resistance readings correct.
De calibrating potentiometers may be out of adjustment. Isolating resistor in dc probe may have changed value. Check cable and connectors. Check out resistors in the dc voltage divider network for changed values.
EVER wonder how you could double the usefulness of your field-strength meter? It's easy. Add a tuner test, as shown in the diagram, and your field-strength meter becomes as useful on the bench as it is in the field.

In making this modification an output is taken from the unby-passed cathode resistor of the first if stage in the instrument. At this point the if signal first becomes available at low impedance. A 72-ohm coax cable is used to bring the low-impedance if signal from the cathode resistor to a connector on the front panel of the field-strength meter. Some technicians may prefer to mount the tuner-test connector on the back of the instrument.

An output cable with a pair of alligator clips at the terminal end is made up for the tuner-test application. The output from the tuner-test cable is applied directly to the grid of the first if tube in the receiver under test. No disconnections are necessary in the TV receiver.

When the field-strength meter is tuned to a TV station, the output from the instrument is applied to the if amplifier in the receiver under test. A picture and sound output are obtained from the TV receiver, just as if the receiver were operating from its own tuner.

In this manner, a quick and decisive answer is obtained to the question: Is it the tuner or some other section which is causing the trouble? If it is the tuner, a normal picture and sound are obtained from the tuner test.

Of course, consideration must be given to the intermediate frequency used in the field-strength meter. If it is one of the older instruments, using a 21-mc if strip, the tuner test can not be used on the newer 41-mc TV receivers. But the newer field-strength meters are operated at 45 mc in many cases and these can be modified for a tuner test. Some new field-strength meters have a built-in tuner test.

The tuner test is useful to determine not only whether a TV receiver has a dead or a weak tuner but also whether certain types of interference are being generated in the tuner or elsewhere. For example, a set was brought in which had severe herringbone interference in the picture when the fine-tuning control was set for the best picture. It looked like it might be tuner oscillation but it could also have been if instability. The output from the tuner test of the field-strength meter was applied at the grid of the first if stage in the receiver and the tuner in the receiver was switched off channel. Normal reception was then obtained on the receiver, showing that the trouble was in the tuner and not in the if strip. Tuner replacement restored normal operation.

In the field it might be supposed that the presence of the tuner-test cable across the cathode resistor in the instrument might lead to difficulty. It is good practice to provide a terminal cap for the front-panel connector, with a 72-ohm terminating resistor, as shown. However, if this termination is omitted, in most cases there is no discernible change in the performance of the instrument, because the cable inside the instrument is only a few inches in length, a small fraction of one wavelength at the operating frequency. Furthermore, the cathode circuit is a low-impedance network, not as easily disturbed as a grid circuit, for example.

The user may object to the necessity of using two field-strength meters to check out 21- and 41-mc tuners. However, this is the case at the present time. Since the cost of field-strength meters is very modest, in view of their high utility, the average shop does not usually object to acquiring two.

Some field-strength meters have a uhf-vhf front end. Such instruments provide a uhf converter test in a TV receiver also—when the tuner test is applied a uhf antenna can be connected to the field-strength meter and the uhf converter (or receiver uhf tuner) bypassed and tested.

Dead, weak or unstable uhf converters and tuners can thus be quickly pinpointed by the modified field-strength meter. This test is often of great value, inasmuch as uhf test equipment is difficult to manipulate and an in-set performance test is usually preferred for a quick check.

This modification applies directly to the Simpson model 488 TV field-strength meter but it can be used with other units with low-value unby-passed cathode resistors in the first if stage. In the case of the 488, the bias filter capacitor should be changed from 100 to 500 µf to minimize the possibility of hum appearing in the picture.  

By R. M. CENTERVILLE

Diagram shows how tuner-test cable is connected in the meter for feeding an if signal into a receiver.

Modification permits if injection into television receivers.
EXTENDED-RANGE AUDIO OSCILLATOR

AUDIO-frequency tests for objective evaluation of characteristics of a hi-fi system and the correlation of these evaluations with characteristics of the system's components require, as a minimum of instruments, an adjustable signal source of high quality and wide frequency range, and a voltmeter capable of measuring the signal voltage at the system's input and output.

After obtaining a suitable voltmeter (described in RADIO-ELECTRONICS, October, 1957), the next instrument to be added to the af test setup should be an af oscillator. Some basic tests can be made with the meter and oscillator alone, and both instruments are essential in more elaborate tests which require additional equipment.1

Vfo's for audio use have been the subject of much development, analysis and evaluation during the past 20 years. The Wien-bridge, described by M. Wien in 18912 as a frequency-selective network for capacitive impedance measurement, was incorporated in oscillators as a frequency-selective feedback network by H. H. Scott3 in 1938 and by Terman, Buss, Hewlett and Cahill4 in 1939. Extensive study and experimental evaluation of these and other oscillator circuits have established the Wien-bridge as one of the simplest and least critical basic circuits for use where broad frequency range, low distortion and high stability of frequency and amplitude are required.5

The basic Wien-bridge oscillator circuit (Fig. 1) is named for the feedback network R1-R2-C1-C2-R3-R4, which, when R3 and R4 are adjusted to the correct ratio, provides positive feedback at a frequency determined by:

\[ f = \frac{1}{2\pi VR1R2C1C2} \]

with input in phase with the amplifier's output, permitting oscillation at this frequency. Any component of the output which differs in frequency from the value of f determined by the R1-R2-C1-C2 combination is reduced in amplitude and shifted in phase before being applied to the amplifier input. This provides a negative feedback for all spurious components of the amplifier signal (including noise, hum and harmonic distortion). The overall result is a high-quality sine-wave output with an accurately determined frequency.

Several variations of the bridge circuit, including widely differing combinations of values for and relations between R1-R2-C1-C2 and R3 and R4, are possible. The simplest is when R1 = R2 and C1 = C2, with frequency adjusted continuously with a variable capacitor for C1 and C2, or a dual potentiometer for R1 and R2, with switched fixed resistors or capacitance to extend the frequency range.

Amplitude regulation is usually provided by using a self-heating heat-sensitive resistor (incandescent lamp) attached to the oscillator circuit, including widely differing combinations of values for and relations between R1-R2-C1-C2 and R3 and R4, are possible. The simplest is when R1 = R2 and C1 = C2, with frequency adjusted continuously with a variable capacitor for C1 and C2, or a dual potentiometer for R1 and R2, with switched fixed resistors or capacitance to extend the frequency range.

Amplitude regulation is usually provided by using a self-heating heat-sensitive resistor (incandescent lamp) attached to the oscillator circuit.

This second of a series on audio testing describes a Wien-bridge oscillator that goes down to 12 cycles and up to 150,000 cycles.

By L. B. HEDGE

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**Fig. 1**—Basic Wien-bridge oscillator circuit.

**Fig. 2**—Complete circuit of the extended-range oscillator.

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1. As used in this context, a VFO is a voltage-controlled oscillator.

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RADIO-ELECTRONICS
Oscillator design

Based on these general considerations, the oscillator shown in Fig. 2 and the photos is designed to provide approximately continuous coverage from 20–150,000 cycles, with an extended low-frequency coverage of 12–20 cycles and a maximum output of about 15 volts. Output impedance is about 600 ohms. Since twin variable capacitors of about 10-to-1 capacitance range (30 to 365 μf) are readily obtainable, variable-capacitor tuning is used.

The general characteristics of tubes used in the Wien-bridge oscillator are not critical, but certain factors do require attention. High gain is desirable in the oscillator loop (V1-a–V1-b) since it permits a large negative feedback with improved output waveform. Cathode current in V1-a should be large enough to keep the lamp resistors LM1 and LM2 in their stable temperature region, and V1-b's plate-load resistor R12 should be small enough to keep the effective load impedance essentially constant at any position of the RANGE switch S2. A 7F8 was selected for the oscillator triodes (V1-a and V1-b) since it provides high gain without excessively low plate current.

Since the oscillator is very sensitive to hum pickup, particularly from heater–cathode leakage, voltage divider R23-R24 is arranged to maintain the heaters of V1 and V2 at about 50 volts above their cathodes, minimizing the tendency for heater–cathode leakage. Potentiometer R22 permits balancing such leakage, if it does develop, to a negligible value.

A few special construction points must be considered to provide accurate balance and uniform output over the oscillator's entire frequency range. Stray capacitance between the tuning capacitor and the cabinet or chassis is a problem since the common rotor is not grounded. A Masonite sheet was used as a mounting board in the chassis setup, with the capacitor mounted upside down to minimize changing stray capacitance effects as the rotor position changes with respect to chassis and cabinet. If a metal sheet is used for the chassis, it should be cut away under the capacitor to keep stray capacitance effects small. The capacitor's shaft must be well isolated from the panel for the same reasons. A 2-inch-long ¼-inch-diameter plastic rod placed between the capacitor's shaft and the panel dial or drive (a gear-reduction drive in the unit shown) will do the job well.

The trimmer (C3) balances the frequency control network at the high-frequency (low-capacitance) end of the
tuning scale, and it should be so arranged that it can be adjusted with the oscillator enclosed in the cabinet. Potentiometer R22 should also be mounted so it can be adjusted with the oscillator in its cabinet, and R9 is mounted on the front panel to facilitate final adjustment. It is provided with a screwdriver-slotted shaft and a shaft lock to prevent accidental changes in its setting. This is important since too much negative feedback will induce a kind of pulsed oscillation caused by thermal-overshoot time-delay characteristics of cathode lamps LM1 and LM2 and too little negative feedback will increase the harmonic content of the oscillator output.

Resistors R1 and R5, R2 and R6, R3 and R7, and R4 and R8 must be accurately matched pairs—the exact value of each resistance pair is not of great importance since small gaps between or overlaps in successive ranges will have little if any effect on the usefulness of the oscillator. Uniform output and low harmonic content will depend, however, on the precise matching of each pair. If a good resistance bridge is available, these pairs can be made up from ordinary 20% resistors connected in series-parallel combinations. If no resistance bridge is available, use precision resistors for these elements. Approximate values for the resistances used for each frequency range in the Wien-bridge network can be determined from the nomograph of Fig. 3. The low-frequency limit, using the maximum capacitance value for the variable capacitor elements, should be quite accurate, but the high-frequency limit will be somewhat lower than that shown in Fig. 3 or the equation because the stray-capacitance effects and the added capacitance of capacitor C2.

In addition to these details of design and assembly, the oscillator's general layout should be arranged to keep the fields of the power supply transformer and choke as far from the elements of the V1 circuit as possible to minimize further the possibility of stray hum pickup. The 60-cycle output terminal, connected to the second filament winding of the power transformer, is provided as a source for use in intermodulation distortion measurements. A polarized power plug (see R.F. articles in January, 1953; October, 1956) is necessary, or reversal of the plug will cause hum and other complications. The plug's wide blade attaches to the line lead that goes to the junction of C11 and C12.

Final adjustment

After building the oscillator, adjustment should be started with R9 set at its minimum resistance position during a warmup period of a few minutes. Connect an ac voltmeter, set for at least 30 volts full scale, across the oscillator's output and, if an oscilloscope is available, connect its vertical input across the oscillator output too. Turn the output control R15 to maximum output, set range switch S2 at the low-frequency (A-range) position, the extended range switch S1 at the ABCD position, and trimmer C4 at minimum-capacitance and the frequency control C4 at maximum-capacitance (minimum-frequency) position. After a few minutes' warmup:

1. Increase the feedback control slowly until oscillation starts. Adjust to the minimum value that will maintain oscillation.

2. Increase the frequency control gradually to maximum-frequency (minimum-capacitance) position, increasing the capacitance of the trimmer (C5). If necessary, to maintain oscillation as frequency increases.

3. Decrease the frequency control gradually, observing closely the ac voltmeter reading. If a position is reached where the voltage varies noticeably and regularly, leave the frequency control at this position and adjust hum potentiometer R22 to the position that reduces the output voltage variation to a minimum. (This effect will occur at a frequency near to the 60-cycle line frequency if hum is being picked up in the oscillator.) The mixture of oscillator output and hum will produce a beat at the output at a frequency equal to the difference between the oscillator and hum frequencies and, if this difference is small, the meter will indicate the beat-frequency voltage with changes in voltage reading. If a scope is used, the hum voltage can be observed as a distortion of the oscillator output waveform at low frequencies, and adjustment of R22 can be made to minimize this distortion. After the hum adjustment is complete, return the frequency control to minimum frequency position.

4. Set S2 to range B position.

5. If oscillation does not start immediately, allow a minute for it to start.
position, which

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—balance can usually be established by connection of a small resistor (approximately 1% nominal value) in series with one of the range resistors or a larger resistor (approximately 10 times the nominal value) in parallel with one of the range resistors. If the change made in one resistor requires increasing the feedback control to maintain oscillation, apply the correction to the other resistor of the pair. If more than one range increases requiring R9 to maintain oscillation, apply this corrective resistor-matching procedure to each.

The extended low-frequency range can now be adjusted. Set the extended range switch at the AX (closed) position, with the frequency control somewhere in mid-range, and adjust trimmer C1 to give the same output voltage as that produced with the frequency control in the same position and the extended range switch in ABCD (open) position.

Scale calibration

With the oscillator adjusted, calibration of the frequency scale is the next and final job. If a scope is available, calibration is easily and accurately accomplished. With a 60-cycle input to the horizontal amplifier, the 60-cycle point on the scale is located by adjusting the oscillator frequency to produce a circular or elliptical stationary pattern (Fig. 4-a), and multiples up to 300 cycles and submultiples down to 15 cycles are easily identified by Lissajous figures (Fig. 4-b). By switching the horizontal amplifier to internal sweep with the sync control at 0 and the oscillator at 300 cycles, the sweep frequency can be set at 100 cycles and the oscillator frequency checked at 100-cycle intervals up to 1,000 cycles (Fig. 4-c). By alternately stepping up the frequency of the scope sweep and the oscillator frequency, calibration can be extended to the top of the oscillator's range. As the scope's sweep frequency approaches its maximum, the flyback time of the sweep will take a larger portion of the sweep cycle time, and the resulting pattern will approach the Lissajous figure—at least to the extent that one or two cycles of the oscillator output may appear in the flyback trace and must be counted to determine the ratio between oscillator and sweep frequencies.

If a scope is not available, a speaker or headphone connected across the output of the oscillator may be used to give an audible tone which can be tuned to the pitch of a note from a piano or other musical instrument in the mid-frequency range of the oscillator, and a series of such calibrations covering one range of switch S2 can be extended to the lower and higher ranges by use of the Wien-bridge nomograph (Fig. 3). Frequencies of standard musical scale tones are given in the table. Calibration by comparison with musical tones should be quite accurate over the range of available reference tones, and extended calibration based on the Fig. 3 nomograph should be more than adequately accurate for audio test purposes since precise frequency values are seldom significant in these tests.

With calibration completed, the oscillator is ready for use, and with an ac vtm it comprises the basic af test setup. Frequency response curves for an amplifier are made with the oscillator and voltmeter connected as shown in Fig. 5. If a scope is available, it should be connected across the vtm and used to observe the input and output waveforms at frequencies and signal levels at which measurements are made. If the amplifier contains a volume control, it should be kept at its maximum output setting during tests, with the input signal level adjusted by the oscillator's output level control. Response measurements should be made with the input voltage constant at all frequencies at a level below the amplifier overload level to avoid overload distortion errors. Serious distortions can be detected on a scope as changes in the shape of the signal wave image. Measurements of distortion require the use of an analyzer which will be described in the next article of this series. The output of an amplifier under test should be connected to a resistance load of the value for which the amplifier is designed and of a power rating at least twice that of the power output of the amplifier. Output power of an amplifier under test may be computed from the formula:

\[ \text{Power (watts)} = \frac{E^2}{R} \]

where \( E \) is the rms ac voltage measured across the load resistor of \( R \) ohms.

BIBLIOGRAPHY


Table of Musical-Note Frequencies

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*To the nearest integral number of cycles. Based on A above middle C 440.

Dec. 1957
WHEN announcements of the Russian satellite (Sputnik) burst upon us not so long ago I immediately cranked up the old Super-Dopper receiver and began listening on the 20-mc channel. While considering the possibilities of monitoring Sputnik's second channel, I suddenly realized that while the shock was literally full of "all-wave" receivers of various vintages, not one could be tuned to 40 mc. Something had to be done. Technical magazines and handbooks did not come up with the circuit of a single converter operating around 40 mc that I thought would do this job satisfactorily.

Reports stressed the importance of using a receiving system with high sensitivity, good selectivity, and a good noise factor, so I decided to "engineer" a fixed-tuned crystal-controlled converter based on a cascode type front-end design like that used in many TV and FM sets. This should insure an acceptable noise factor and good sensitivity. Selectivity would be supplied by the receiver's antenna, mixer and IF circuits.

The old Super-Dopper was a little noisy; its image rejection was not good enough on 20 mc to prevent Voice of America and Mackay Radio transmitters (92 miles away) from breaking through and swamping weak signals.

I decided that a hot low-noise converter would give me a better signal-to-noise ratio on 20 mc and began thinking in terms of a converter to cover Sputnik's 20- and 40-mc channels. Since at the time of writing, reports were that the Russians were planning to release other satellites, such a converter may be also useful to you in tracking Sputnik No. 2.

Fig. 1 shows the block diagram of the converter. The 20-40 mc cascode rf amplifier will provide good sensitivity with low noise. A crystal oscillator was selected to provide good stability and to minimize calibration difficulties. The 32-mc oscillator in 12 mc above the 20-mc channel and 8 mc below 40 mc. The 20- and 40-mc signals will be received at 8 and 12 mc, respectively.

Thus the receiving system is comparable to a double superhet with the receiver acting as a tunable 8-12 mc first if and a 456-kc second if, detector and audio system. (The high first if provides adequate image rejection and the second if supplies the selectivity.)

Some converters do not provide enough signal output for good weak-signal performance and some receivers are relatively insensitive around 10 mc—my receivers are peaked on the centers of the ham bands—so I've incorporated a wide-band if amplifier with gain control to boost the overall sensitivity. The circuit of the converter is shown in Fig. 2.

The cascode rf amplifier is based on the FM front-end of the Bogen R750 AM-FM tuner. The inductors in the antenna and mixer grid circuits were selected to tune to 40 mc with a small capacitor or stray and distributed capacitances alone. Small trimmers are then switched in and adjusted so the circuits tune to 20 mc.

The mixer is the pentode half of a 6U8 in a circuit similar to that in some TV tuners. The oscillator, the triode half of the 6U8, is recommended by the crystal manufacturer (International Crystal Manufacturing Co., 18 N. Lee St., Oklahoma City, Okla.) for 10-60-mc operation of his third-overtone (FA-5 and FA-9) crystals. International assured me that the circuit will surely supply enough signal injection in this circuit for good mixer conversion.

(FA-5 and FA-9 crystals differ only in the design of the holders. They are not generally available on the open market, but can be obtained from...
the ground for monitoring our satellite. The mixer plate coil L3 may consist of a 1-inch-long close-wound coil of No. 28 enameled wire on the upper part of a National XR-91 form. L4 is a 10-turn coil of No. 28 wire over the cold end of L3.

Other frequencies between 20 and 40 mc can be used for the oscillator. The point where either channel comes in on the receiver will be the difference between the oscillator and signal frequencies.

Circuit alignment is comparatively simple. Pretune L1, L2, L3 and L5 with a grid-dip meter. Then, use a signal generator to align the if amplifier, mixer and if circuits in that order. If you don't have a signal generator, you may be able to align the circuits on WWV transmissions on 20 mc. Vary the values of resistance across the if transformer for relatively even response between 8 and 12 mc. Rig up a simple noise generator and use it to set the taps on L1 and L2 for minimum noise.

In bringing you details of this converter, we could not wait until the crystal arrived, and therefore had no opportunity to try it, before press deadline. So minor modifications may be needed when the converter is put on the air. For example, you may have to keep all leads as short as practical and use good vhf wiring and layout techniques.

Gonna try 108 mc?

The selection of a 32-mc crystal is a good idea if you plan a 108-mc converter for monitoring our satellite. You will probably be able to use the same oscillator circuit and components as in the 20-40-mc converter. The third-harmonic (96-mc) output of the 32-mc oscillator will probably be strong enough for good conversion to 12 mc. If the 96-mc signal is too weak, try a small coupling capacitor between mixer grid and oscillator plate. If this fails, insert a 35-40-mc tuned circuit in the oscillator's cathode return and connect the crystal directly between the grid and cathode. Tune the plate circuit to 96 mc.

END

all good wishes for a
MERRY CHRISTMAS
and
HAPPY NEW YEAR
from everyone at
Radio-Electronics
By JACK DARR

Part II—Printed-circuit boards, and some special circuitry found in auto radios today

LAST month we had a rundown of the new look in auto radios. These transistorized (in places) receivers have some interesting special features we will now examine.

As in many other types of electronic equipment, printed circuits have appeared in auto radios. Motorola uses Pla-Cir plated-wiring boards in several of the new sets, as does Philco. Delco is also using printed-wiring boards in quite a few sets. In the signal-seeking tuners, switch panels and station-selector tab boards are small plated circuits. Quite a bit of printed wiring is used in the Chevrolet, especially in the rf, oscillator and if stages (see Fig. 6).

Motorola's Res-Caps are actually small printed-circuit combinations of resistors and capacitors, similar to the Couplates and vertical integrators familiar to the TV technician. They are used, in various combinations of capacitance and resistance, in many parts of the sets. If one of the parts fails, it may be replaced individually, or the whole unit may be replaced.

Special circuits

A novel circuit is found in the Motorola 79MS, the set designed for Ford Thunderbirds. Fundamentally, the purpose of the circuit is to increase the radio's volume as the speed of the engine increases. With an increase in speed, wind and road noises get louder and the volume of the radio is automatically increased to compensate for this.

Specifically, volume is increased as the car's engine is speeded up. This is done by the circuit shown in Fig. 7. A special cable connected to the high side of the breaker points feeds noise pulses from the distributor to a 12AL5 dual-diode, through a .005-µf blocking capacitor C1. Negative pulses are shunted to ground by diode D1, as is any charge that may be built up in the blocking capacitor. Positive pulses are rectified and cause a voltage drop across cathode resistor R1. This positive voltage is coupled to the grid of the 12CR6 audio amplifier, through a filter consisting of R2, R3, R4 and C2. The amount of this voltage determines the gain of the pentode section of the 12CR6, directly controlling the receiver's volume.

The time constants of the circuit are such that the action will not be affected by normal rapid increases and decreases in engine rpm, which might occur when shifting gears, but will follow a gradual increase in speed. As the pulses become more frequent, the charge on C2 builds up and the added positive voltage on the grid causes an increase in the stage's gain. As the engine gradually slows down, the voltage across C2 discharges, allowing the volume to drop. These variations, of course, take place around the operating point of the tube, as selected by the position of the manual volume control R5.

Motorola also is continuing the use of their Volumatic age control circuit in their present line of auto radios. Replacing the conventional avc circuit, which is actually an age circuit as it has no effect on the audio section of the set, this circuit not only controls rf gain but directly controls the audio volume as well. The circuit uses a 6CR6 or 12CR6 diode-pentode tube and is shown in Fig. 8. Grid resistor R1 returns to the age bus instead of ground. This provides a variable bias that is in direct proportion to the amplitude of the signal picked up by the set. The bias controls the gain of the pentode section of the tube, the audio stage. Conventional age is also used, in a standard circuit, from the diode section. This added degree of control has proved successful in eliminating fading from changes in signal levels, due to movement of the car, that is so prevalent in auto radios. It also aids in the operation of automatic tuning devices. The output level variations between the various stations are smoothed out to the point where it is not necessary to adjust the manual volume control.

Fig. 7—Circuit increases radio's volume as car speeds up.

Fig. 6—Printed-circuitry used in the Chevrolet 987575.

Fig. 8—Volumatic circuit controls rf gain and audio volume.
Elitinoise circuit, from
reduces the amplitude
noise and input circuit
pass tuning.

A differentiating filter, of the high-
pass variety, is used in the antenna
input circuit to help eliminate high-line
noise and other electrical interference
(see Fig. 9). R1 and C1 values are
chosen to eliminate reception of the low
or prevalent noise frequencies. This
reduces the amplitude of 60-cycle pickup
from power lines and helps reduce the
ill effects of standing waves on the
antenna, resulting in a much cleaner
signal.

The transistor power supply
The versatile transistor, not only
replaces tubes, but has even been used
to replace the vibrator itself. This is
found in the Chevrolet Corvette radio,
Delco model 3725156. Conventional
tubes are used in all but the output
stage where a pair of 2N173 transistors
supply audio output. Power require-
ments are about 200 volts. This is
supplied by transistors.

A pair of 2N174 p-p power transis-
tors are hooked up in an oscillator
circuit (see Fig. 10). This is a relaxed
or blocking oscillator, very familiar
to all TV technicians. A frequency of
around 20,000 cycles is used, to elim-
nate hum and buzz and simplify filter-
ing problems. The frequency of oscilla-
tion is determined mainly by the
inductance of the power transformer
primary. This is a special unit with a
primary, high-voltage secondary and a
tertiary feedback winding.

As the first transistor conducts,
through the center-tapped primary, the
other is cut off. When the first tran-
sistor reaches saturation, the field
collapses, inducing a voltage in the
opposite direction in the tertiary wind-
ing. This voltage drives the second
transistor into conduction, then into
saturation, and the first transistor into
cutoff. Since the second transistor con-
ducts in the opposite direction, a square
wave is produced. Through the stepup
action of the secondary winding, the
voltage is raised to 200-250 ac. This
is rectified by the 12X4, filtered and
applied to the set. Filter components
are not nearly as large in the older
sets. The input filter is a 20-µf unit,
while the output filter is only 0.25 µf!
The ac voltage may be measured
across the secondary; if it is not pre-
rent the transistor may not be oscillating.
This could be caused by a defective
transistor, power transformer or by
excessive loading of the B-plus line to
the receiver. Tests for oscillation may
easily be made with a scope or by pull-
ing the 12X4 from the socket, remov-
ing the load and measuring the ac voltage.

The heat sink
Another new feature will be the heat
sink necessary for proper operation of
the power transistor. The technician
will be able to spot transistor sets by
the appearance of a set of fins on the
end of the set, on either side of the
small round object which is the power
transistor. Power type transistors, such
as the 2N173, 2N278, Philco's AR-5
and AR-6, etc., are all basically alike
in structure, although their individual
characteristics differ somewhat. All re-
quire some means of radiating the heat
generated during normal operation (see
Fig. 11).

Transistors of this type draw up to
900 ma during operation and generate
quite a bit of heat. The transistor must
not be allowed to get too hot, otherwise
a condition known as thermal runaway
may occur and the transistor will be
ruined. Therefore, the transistors are
mounted solidly to the end of the chas-
is, on a special plate which is insulated
from the chassis on many sets. In
others, the transistors themselves are
insulated with thin mica spacers which
allow heat transfer to the chassis but
prevent grounding the collector which
is connected to the case in most of the
common power types. Some use a cen-
tral stud and two flexible leads or lugs;
the stud is the collector connection
while base and emitter are connected
to the leads. Others use three flexible
leads, mounting the transistor by means
of small bolts through the ears of the
case.

When testing power transistors in
actual operation, they must be firmly
clamped to their heat sinks. Otherwise,
they may get too hot and become defec-
tive. Insulation must be perfect to pre-
vent grounding of the collector to the
chassis. Almost all circuits up to this
time use the common-emitter configura-
tion, which uses the collector as the
output element. While the collector
returns to ground through the primary
of the output transformer, grounding it
would cause trouble.

Control of the normal thermal in-
crease in collector current is ac-
complished in the design of the circuit.
Delco uses a small resistor (0.47 ohm)
in the emitter circuit. If the transistor
overheats, this resistor increases the
bias voltage, opposing the current in-
crease. Thermistors are also used in the
larger sets with push-pull output (see
Fig. 12) for the same purpose.

In addition to the 0.3-ohm emitter
resistor, a thermistor is connected
across the 4.7- and 39-ohm base voltage-
divider resistors. It changes the base-
emitter voltage to compensate for tem-
perature increases which would other-
wise cause much increased collector
current and possible thermal runaway.

This completes a full look at the new
line of transistor radios and their spe-
cial features. I'm sure you'll feel as I
do—there have been some changes
made. Next, we are going to discuss
servicing these sets.

Fig. 10—Transistorized power supply
replaces familiar vibrator.
while using the automatic tuner, search
tuner or other forms of automatic
tuning.

The transistor power supply
The versatile transistor, not only
replaces tubes, but has even been used
to replace the vibrator itself. This is
found in the Chevrolet Corvette radio,
Delco model 3725156. Conventional
tubes are used in all but the output
stage where a pair of 2N173 transistors
supply audio output. Power require-
ments are about 200 volts. This is
supplied by transistors.

A pair of 2N174 p-p power transis-
tors are hooked up in an oscillator
circuit (see Fig. 10). This is a relaxed
or blocking oscillator, very familiar
to all TV technicians. A frequency of
around 20,000 cycles is used, to elim-
ninate hum and buzz and simplify filter-
ing problems. The frequency of oscilla-
tion is determined mainly by the
inductance of the power transformer
primary. This is a special unit with a
primary, high-voltage secondary and a
tertiary feedback winding.

As the first transistor conducts,
DURING the winter and spring of 1957-58, the United States will launch a number of earth satellites into interplanetary space as part of our participation in the International Geophysical Year.

After launching via a multistage rocket, each satellite will circle the earth in an elliptical orbit at altitudes above 500 miles and at speeds of nearly 20,000 miles an hour. Purpose of the space voyage is to collect scientific data about the earth and the upper atmosphere.

In addition to special instruments, the metal sphere of each satellite contains a tiny radio transmitter weighing about 12 ounces. Various atmospheric data collected by the satellites are transmitted on a frequency of 108 mc, but with an extremely low power of less than 50 mw.

With appropriate ground-based receivers, this radio signal permits tracking of the satellite through most of its flight. Large and elaborate installations—known as Minitrack stations—have been installed by the Government to track and receive data from the satellites.

With a receiving system that's sufficiently sensitive, however, anyone can pick up the coded signals from a U.S. satellite. And with slightly more elaborate equipment, you can help directly in locating and tracking the satellites as they pass over or near your area of the country.

If you're a radio ham or dx fan with a yearning to contact stations in outer space, here's your chance!

A receiving system, based on the interferometer principle and similar to that used by the Minitrack stations, has been developed by the Naval Research Laboratory in Washington for tracking U.S. satellites.

In its simplest form (Fig. 1), the system requires (1) a set of two identical Yagi antennas on a single base line from 20 to 500 feet long, (2) a coaxial T junction centrally located on the antenna base line, (3) a frequency converter to shift the incoming 108-mc signal to a lower frequency acceptable to a standard type of communications receiver, and (4) an S-meter or visual recording device connected to the output of the standard receiver. The two Yagi antennas should have the same shape and spacing of elements, and should be mounted parallel to each other. The antenna base line should be as long as possible—preferably running in a somewhat east–west direction. A number of economical, commercial frequency converters will probably be on the market soon. But a conventional overtone crystal oscillator with a buffer amplifier can be used to convert the satellite signal to a clear frequency acceptable to the range of your communications receiver. Amateur receivers and converters intended for the 144-me band may also be modified for the lower frequency. The really ambitious constructor may wish to try the preamp–converter shown in Fig. 2. It was designed especially for the purpose of satellite tracking by the Naval Research Laboratory. The tubes are expensive—the GL-6299 lists at $56—and the layout and construction requires considerable experience with rf circuitry. (Construction details and design data on the equipment may be found in the article “A Low-Noise Preamplifier for Satellite Tracking” in the December, 1956, issue of QST magazine.)

Want to track our space satellite? Here's how to go about it

By JORDAN McQUAY

Fig. 1—Simple system for tracking satellite launched by United States.

Experimenters wishing to try a less expensive version of the circuit might substitute a 6Q4/EF80 in place of the expensive 6299. It is a low-noise tube whose characteristics are somewhat similar. The 5842/417A or a triode-connected E180F/6688 could also be tried, although they do not closely approximate the original tube.

Another approach would be to substitute the cascode rf amplifier described in the “Low-Noise TV Booster” (Radio-Electronics, November, 1957) for the portion of the circuit between the antenna terminal and the input to the mixer. Coils would have to be adjusted for the spectrum, of course. Further savings might be realized by using a 12AT7 for the 12AT7-WA and a 6AQ5 for the buffer.

When a U.S. satellite is expected over or near your area, you'll know about it from your local newspaper or radio or TV station. Then, at an appropriate time, fire up your converter and receiver, and tune carefully for a weak pulsed signal at or near 108 mc. It may be difficult to detect at first. If you fail
to receive signals, carefully recheck the calibration and tuning of your converter as well as the receiver. With good reception, you should get an indication on your S-meter of the signal from the satellite. This signal may fluctuate slightly, but will gradually rise as the satellite approaches your area. When the satellite passes directly over or relatively near you, the output reading on the S-meter will reach its maximum. Then, as the satellite continues in its orbit, the S-meter reading will gradually decrease until it finally disappears altogether.

If you fail to receive signals at 108 mc or if you want to track and record a more accurate indication of satellite positions with respect to time, you can make any of a number of modifications and improvements in the simple system described above: (1) A longer antenna base line, from 500 to 1,000 feet, can be used for better signal resolution. (2) The coaxial T junction can be replaced by a hybrid junction to feed two converter-receiver units. (3) All elements of the rf transmission line can be more accurately matched. (4) A low-noise preamplifier can be included in each of the two frequency converters to increase sensitivity. (5) A source of time, accurate to 10 milliseconds or better, can be included in the tracking system so that exact time is recorded simultaneously with signal intensity of the satellite. (6) The output indicator can be changed from a simple S-meter to a graphical or magnetic tape recording for permanent record.

A diagram of this improved tracking system, also developed by the Naval Research Laboratory, is shown in Fig. 3. A hybrid junction can be constructed to match the impedances of the two antennas with the inputs of the two preamplifier-converters. Suitable types of low-noise preamplifier-converters will soon be available commercially, but can be assembled around two grounded-grid amplifier tubes feeding a balanced mixer with a separate local oscillator. (See Fig. 2.) Outputs from the two standard communication receivers can be connected in parallel to any of several kinds of permanent visual recorders. Most desirable is the direct-writing type with a frequency response up to about 30 cycles. Galvanometer type photographic recorders may also be used. Paper speed for recorders should be at least 3 inches per second.

Improved tracking systems are usually sensitive—sometimes extremely sensitive—to satellite signals. As a result, the output device may often record fluctuations in intensity, at the same time recording gradual increases or decreases in average intensity. Other variations in intensity may occur as the result of polarization effects on the satellite signals. The frequency of some types of intensity variation is a measure of ionospheric refraction of radio waves from the satellite. Further refinements in the above tracking systems will result in improved reception and more accurate recording of satellite signals, and can be made by introducing additional sets of antennas, use of large broadside arrays and more precise recording devices.

By designing and building your own system for receiving and recording radio signals from the U.S. satellites, you'll get personal satisfaction from contacting and tracking stations in interplanetary space and you'll be making a direct contribution to this important phase of the International Geophysical Year.

Fig. 3—An improved satellite tracking system.

Dec. 1957
By GEORGE P. PEARCE

In hobby and experimental work there is frequently a need for a small ac or dc power supply—for example, in electroplating, generation of small quantities of oxygen and hydrogen, running miniature electric motors and models, charging storage batteries, rejuvenating dry cells, operating electromagnets, low-voltage lamps and innumerable experiments and tests where a low voltage is required.

To meet my own needs along this line and to avoid the annoyance of finding that my batteries are dead just when I want to use them, I set to work and built a compact electric power supply that provides trouble-free, reliable dc at 9 or 18 volts and ac at 3.15 or 6.3 volts with current up to 1 ampere.

The unit is built around a small filament transformer with 117-volt primary and a 6.3-volt secondary with center tap rated at 1.2 amperes. This transformer is a standard type and can be obtained from most radio supply houses. The outside terminals give 6.3 volts and either outside terminal to the center tap gives 3.15 volts ac. For dc I use a voltage-doubling circuit which gives me 9 and 18 volts.

The voltage doubler may be a pair of 1-ampere 26-volt (maximum ac input) half-wave selenium rectifiers or a 26-volt 500-ma full-wave bridge with the normal ac terminals strapped to provide two series-connected 1-amp half-wave rectifiers. Suitable 1-amp half-wave units are not readily available so you can use a full-wave bridge such as the Sarkes Tarzian A-2, Radio Receptor P1B1SIG and International JD507G.

Note that this voltage doubler actually produces 2.82 times the rms voltage on open circuit. The voltage drops as the current demand is increased. The amount of drop or the voltage regulation depends greatly on the size of the capacitors used. The larger the capacitors, the better the voltage regulation.

The circuit shown in the diagram was designed to use odds and ends I had in my junkbox except for the small steel cabinet which I bought for around $1.75. The photos show the completed unit ready to deliver dc or ac power up to 1 ampere.

Before attempting the design of the final assembly, I made a temporary hookup on a breadboard to test all components and be sure they were in proper working order. I then made the final design and arranged everything to fit into the 9 x 6 x 5-inch steel cabinet so they would be in good balance when carrying the unit.

In planning the design, these steps were taken to obtain the highest efficiency out of the materials on hand: The 1-ampere voltage-doubler rectifier was placed in an open space near the bottom of the cabinet where it would be surrounded with the coolest air available. The transformer was also located on the bottom and as far away from the rectifier as possible without getting the cabinet out of balance.

To get everything into the cabinet I had to make a double decker, but I was careful to cut vent slots in the shelf to permit free circulation of air. This has proven very effective and, since the entire steel cabinet acts as a radiating surface of approximately 250 square inches, there was no need to drill a grid of ventilating holes which let in dust and insects to cause trouble. It can be seen from the photos that nothing whatever is attached to the back panel, which is easily removed by taking out four screws. This provides quick access to the works for replacing a blown fuse or for repairs. The view also shows the inside arrangement.
Up to 400 feet of cable can be run between your pickup and this preamp without causing high-frequency attenuation.

**Phono-preamp compensates for cable capacitance**

By G. Franklin Montgomery

The completed preamp.

**Circuit action**

The circuit design is based on the following reasoning. Suppose the capacitor represents the pickup coil by L and the effective coil resistance by R. If the pickup is terminated in a capacitance C (the cable capacitance, for instance), L and C form a low-pass filter section. With practical values of L and C, the cutoff frequency of this filter can easily fall within the audio-frequency range and the pickup's output will become negligible at frequencies above this point.3

One solution to the problem is to provide a cathode-follower amplifier between the pickup and the cable.2 The drawback of this arrangement is the extra equipment and the need to supply power for it. The unit described here simply replaces the usual phonograph preamp so that no extra equipment is necessary and permits using a long cable. It has been designed particularly for the G-E series of magnetic cartridges RPX-050, 052, etc., although the amplifier's circuit constants can be worked out for use with a number of other high-impedance pickups.

![Equivalent circuit of a magnetic cartridge.](Fig. 1)

![Circuit of one-tube preamp.](Fig. 2)

![Solid line: RIAA characteristic, X indicates actual preamp frequency response; dashed line: preamp input impedance.](Fig. 3)
Fig. 4—Standard preamp circuit.

Underchassis view shows parts layout.

Connecting cable were terminated in a low resistance $R_0$. If $R_0$ were equal to the characteristic impedance of the cable, then the pickup would always be terminated in $R_0$, and its performance would be independent of cable length no matter how long the cable might be. Even if $R_0$ were made several times the characteristic cable impedance, it would still be possible to use a considerable length of cable before its capacitive reactance became equal to $R_0$ at the upper limit of the audio range, which with response, obtained characteristic.

Terminating the pickup in a low resistance produces high-frequency attenuation by itself, of course, but it is often difficult to predict and control. In addition, its slope with frequency is such that with minor modifications it can be used to compensate the pickup response for modern recording characteristics.

A simple resistive termination of this sort is impractical due to the low developed voltage of the usual magnetic pickup. To overcome tube noise and hum in the preamp, the amplifier input must be kept as large as possible and little or no attenuation of the pickup's output may be permitted.

We now recall two facts concerning feedback amplifiers: First, an amplifier's input impedance can be modified by feedback. Second, the application of feedback does not change the signal-to-noise ratio of an amplifier. These facts suggest that a phonograph preamp can be made that will load the cartridge cable with a low impedance and at the same time maintain the signal-to-noise ratio that exists when a short-circuited feedback is used.

Fig. 2 is a circuit for such an amplifier. The two sections of the 12AX7 are connected in cascade. Negative feedback is taken from the cathode of the second section and is applied through the network consisting of C4, C5, R3, R8 and R4 to the amplifier's input. If the network consisted only of R3, the amplifier's input impedance would be a constant resistance throughout the audio range. The purpose of the additional elements is to vary the input impedance with frequency and correct the output of the G-E cartridge in accordance with the RIAA playback characteristic. The RIAA characteristic is plotted in Fig. 3. The crosses on this curve indicate the measured amplifier output voltage for driving the unit from a signal source of 10 mv in series with a 330-ohm 500-mh impedance, which simulates the G-E cartridge.

Also shown in Fig. 3 is the magnitude of the preamp's input impedance. Note that at the high-frequency limit of the range, the impedance is a resistance of about 400 ohms. If an ordinary preamp were used with the G-E cartridge, a terminating capacitance of 200 $\mu$F would place the cutoff frequency at about 16,000 cycles. With a cable capacitance of 50 $\mu$F per foot, the cable should be no longer than about 4 feet. Using the feedback preamp, a capacitance of .02 $\mu$F is permissible for the same cutoff frequency and the cable may be up to 400 feet long.

Reducing input impedance by using negative feedback may seem curious, because we are accustomed to amplifiers in which the input impedance is raised by this means. The reduction will be less strange to readers who follow design advances in audio power amplifiers; it is now common practice to modify amplifier output impedance by a combination of positive and negative feedback. The output impedance is reduced by either negative voltage or positive current feedback, and increased by either positive voltage or negative current feedback.

In the preamplifier, the input impedance is similarly affected. The voltage fed back to the input is negative with respect to the source voltage, but it is applied in shunt with the source, thereby increasing the source loading, which is the same as reducing the amplifier input impedance. Had the feedback voltage been applied in series with the source, the source loading would have been reduced and the effective input impedance increased.

**Low distortion level**

The negative feedback used in the preamp helps reduce amplifier distortion. The circuit shown in Fig. 4, which corresponds to one used in many installations, was set up with a 1,000-cycle source in series with 3,300 ohms. With an amplifier output of 1 volt, the total harmonic distortion was 0.5%. The same test on the feedback preamp gave 0.1% distortion. Since the audio generator used in the measurements had inherent distortion of the same order, the actual preamp distortion may be less than 0.1%.

Total hum and noise in the preamp's output is over 60 db below 1 volt. This hum level was obtained only with selected 12AX7 tubes and with the usual arrangement of a hum-balancing potentiometer connected across the heater supply, as shown in Fig. 2. The feedback network C4, C5, R3, R8 and R4 has been determined only for the G-E series of cartridges. Other pickups, having different values of resistance and inductance, will require a different set of feedback circuit constants. The easiest way to determine these is by experiment. The procedure is to connect a low-impedance audio signal source (10 ohms or less) of rated pickup output voltage in series with the cartridge and amplifier input. An ac meter is connected to the amplifier's output. Curves of output voltage vs. frequency are then run for different feedback circuit values until the set is found that matches the RIAA characteristic or whatever characteristic is desired. Alternatively, a dummy network may be used in series with the generator instead of the pickup itself. The resistance and inductance of the dummy should duplicate the actual pickup constants. The accompanying table lists these constants for most high-impedance cartridges.

**TABLE OF PHONOGRAPH CARTRIDGE CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Manufacturer and type</th>
<th>R (ohms)</th>
<th>L (mh)</th>
<th>E (rated mv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio Hi-QT</td>
<td>575</td>
<td>700</td>
<td>20</td>
</tr>
<tr>
<td>Clarkslan 204</td>
<td>1300</td>
<td>350</td>
<td>10</td>
</tr>
<tr>
<td>G-R RPX-450, 952, etc.</td>
<td>340</td>
<td>520</td>
<td>10</td>
</tr>
<tr>
<td>Pickering 150</td>
<td>400</td>
<td>165</td>
<td>30</td>
</tr>
<tr>
<td>Pickering 260</td>
<td>750</td>
<td>130</td>
<td>30</td>
</tr>
<tr>
<td>Recoton-Golding 500</td>
<td>1500</td>
<td>550</td>
<td>30</td>
</tr>
</tbody>
</table>

These are the most common cartridges, used in the "Bookshelf Audio Amplifier" (RADIO-ELECTRONICS, April, 1957, page 32) and has turned in an excellent job.

References

THE vital role of the pickup arm in audio reproduction is not as widely understood as it should be.

The arm bears the same relationship to the cartridge as the speaker enclosure does to the speaker it houses. Most, if not all, of the extreme low-frequency reproduction of a phono system is dependent on the properties of the arm. Because its contributions are largely confined to frequencies below 40 cycles, they are not as audibly striking as those of a speaker enclosure which may influence the response for several octaves higher.

Apart from frequency-response considerations, pickup arms have a considerable effect on playback distortion. A poor arm may introduce large amounts of distortion or may even cause the pickup to fail to stay in the groove. Operating convenience must also be considered since, unlike the speaker enclosure, a phono arm is handled frequently and contains a rather delicate mechanism—the phono cartridge. An arm which is awkward to handle or is easily dropped may prove unsatisfactory even though its acoustical design be excellent.

A surprisingly large number of phono arms are offered for home use. In this series of articles I will describe most of the approximately 20 high-quality types, pointing out their unique features and essential design principles.

The arms may be classified according to several of their design characteristics. For example, some arms do not employ damping means, while others use various forms of viscous damping to eliminate or minimize the major resonance. From the standpoint of the user, perhaps the most obvious difference between various makes is the manner of pivoting the arm in the vertical and horizontal planes. (We will consider the vertical pivot as that which allows the arm to move vertically, although the pivot axis is horizontal. Similarly, the horizontal pivot is the one that allows the arm to traverse the record.)

In some designs, both pivots are located essentially at the same point, usually near the rear of the arm. In handling this type, the entire arm swings upward when it is lifted to or from the record. Other arms have the vertical pivot located well forward of the horizontal pivot. A large portion of the arm does not move vertically when the cartridge is lifted from the record. This type of construction allows a fairly large counterweight to be used. This gives the arm considerable lateral mass and a low resonant frequency, while the vertical mass is kept low for reduced record wear. A third type is actually the ultimate refinement of the second, in which the vertical pivot is at the front of the arm, immediately behind the cartridge. Such arms have little or no up and down movement in handling, and require the user to develop a special technique if he is accustomed to the more conventional designs.

Several unconventional arms have been designed to reduce or eliminate entirely the tracking error which is the inevitable result of playing a record made with a cutter which travels on a radius with an arm that rotates on a single pivot point outside the record diameter.

Other distinctions between arms include the degree of lateral balance, various types of leveling and height adjusting mechanisms, use of springs or counterweights for stylus-force adjustment and others too minor to consider. Obviously, to categorize the large number of arms for comparison purposes, it is necessary to make certain arbitrary decisions as to the basic design differences. Since the relative location of vertical and horizontal pivots directly affects the feel of the arm more than any other factor (except the presence of viscous damping, which is used on only a few types), we will use this as our basis for grouping the arms.

Separated pivots

The first two arms in this category are the Fairchild 280A/281A and the Audax KT-12/KT-16. Each has its vertical pivot located several inches forward of the horizontal one. Apart from this, they have little in common in the way of appearance or handling feel.

The Fairchild 280A. (Fig. 1) and 281A are of similar design, and are intended for playing 12- and 16-inch records, respectively. They are laterally balanced by the counterweight at their rear. Because of this, leveling is not critical and they are relatively insensitive to the effects of jarring. The vertical pivots are located about 40% of the way from the rear of the arm to its front.

The arm is constructed of extruded aluminum, of about 1-inch-square cross-section. This provides rigidity and minimizes torsional resonances which can occur in an arm. The weight of the forward portion of the arm and the...
cartridge is counterbalanced by a long spring which is adjusted with a thumb-screw under the arm. The pivot bearings are simple yet effective. Fig. 2 shows their construction. They are individually adjusted at the factory for optimum performance. The base of the Fairchild arm is fastened to the motor board by three screws and rests on rubber grommets. The screws may be tightened against these grommets to level the arm relative to the motor board. A single screw may be loosened to permit vertical adjustment of arm height to accommodate any turntable. Another adjusting screw enables the arm to be set so the stylus cannot strike the turntable if no record is on it.

Two unique features of the Fairchild arms are the absence of an arm rest and the plug-in drawers (or heads) for cartridges. A detent built into the base holds the arm in rest position without the need of mounting the usual separate arm rest on the motor board. The cartridge is mounted in a separate metal drawer which slides into the open front of the arm. It will accommodate practically any cartridge which mounts on standard 1/2-inch centers.

In the arm are a pair of springs which make solderless connections to the cartridge pins, for a wide range of lengths and spacings of these pins. When the drawer is removed, the springs short-circuit, preventing loud hum or noise when changing cartridges (and also safeguarding the speaker cone).

Audax KT-12/KT-16

The basic Audax arm has been on the hi-fi scene for many years and has enjoyed an excellent reputation. In the past, its usefulness has been limited by the fact that it would accept only Audax cartridges. But the new KT series has a removable shell which accommodates any standard magnetic cartridge as well. Fig. 3 shows the Audax KT-16 arm.

Perhaps the most novel feature of these arms is that they are sold in kit form at a saving of nearly 50% over their assembled prices. The arms can be assembled in less than 15 minutes, using only a screwdriver.

Unlike the Fairchild arm, the entire body of the Audax arm moves in the vertical plane. Only a small angular movement is possible vertically since the vertical pivots are 2 inches forward of the horizontal pivots and the rear of the arm strikes the base assembly when the arm is raised more than a few degrees.

The arm is made of light aluminum with a U-shaped cross-section. A heavy brass counterweight in the rear is adjusted by loosening a knurled screw, permitting a wide range of stylus-force adjustment with any cartridge. The vertical pivots are simply screws with conical ends which are threaded through the sides of the arm and fit into small dimples in the pivot casting. The adjustment for low friction and low play is easily made, after which protective caps lock the pivot screws.

The horizontal pivot, described by Audax as "compass-point pivoting," can be seen in Fig. 4. The entire arm mass is supported on a needlepoint, which provides low friction and has no adjustments or wearing parts. The slot, which covers a 90° arc in the base, is engaged by a screw in the pivot casting and prevents the arm from being rotated more than 90°. This is to keep the pickup from being placed on the wrong side of the record, which could damage the record grooves. The screw visible at the front of the pivot casting provides a stop to prevent the stylus from striking the turntable in the absence of a record.

The outstanding feature of the Audax design is its simplicity, since it has a minimum number of moving or adjustable parts. One minor disadvantage of this emphasis on simplicity is the need for shims to adjust arm height. Cardboard shims are supplied with the arm and are placed under the base as needed to fit the turntable height.

Pickering 190D

For many years Pickering 190-

series arms have held a unique place in the field. The entire arm is constrained in the vertical plane, and only the cartridge pivots vertically. Fig. 5 is a phantom view of the Pickering arm. The arm body has a rectangular cross section and is extremely rigid. It is counterweighted and is balanced about the horizontal pivots. Leveling the arm is completely noncritical, as it will track records with the motor board inclined 45° or more to the horizontal.

The arm’s height is adjusted by loosening a single screw and sliding the entire arm up or down on the upright rotating spindle which forms the horizontal pivot. This spindle contains two precision ball-bearing assemblies and has extremely low friction. The base mounts with a single screw passing through the motor board, and three adjusting screws permit the arm to be set parallel to the turntable surface. This is an important adjustment since the arm cannot move in the vertical plane.

At the extreme forward end of the arm is a small pivoted plate on which the cartridge is mounted. Needle bearings are used for the vertical pivots. A long stretched spring counterbalances the weight of the cartridge and its mounting plate, and a knurled wheel underneath the arm permits the stylus force to be adjusted conveniently.

Although the body of the Pickering 190D arm is straight, the necessary

Fig. 5 (Above) — Phantom view of Pickering 190D.

Fig. 6 (Right) — The Pickering arm in use. Notice the magnetic arm rest.
offset angle is provided by the orientation of the cartridge mounting. The arm is supplied with a mounting clip for the Pickering 350 Fluxvalve cartridge, but this can be removed and any cartridges having standard ½-inch centers can be mounted. The finger lift at the end of the arm merely lifts the stylus clear of the groove, and the arm is swung to the desired position without any vertical motion. This requires a somewhat different technique than any other arm does.

This design has the advantage that the cartridge is protected and cannot strike the center spindle of the turntable. The design of the finger lift also prevents the stylus from striking the turntable in the absence of a record, if properly adjusted.

The salient feature of the Pickering design is the reduction of vertical mass to a practical minimum, using conventional cartridges. Not only is the cartridge mounting plate as small and light as possible, but a spring counterbalance is used instead of a counterweight which would add to the vertical mass. The heavy counterweight at the end of the arm serves the dual function of balancing the arm laterally and providing a high lateral mass, resulting in an arm resonance well below the audio range.

Another novel feature of the Pickering 190D is the magnetic arm rest (Fig. 6). The arm is shown installed on a motor board and the magnet can be seen on the side of the arm. The arm rest (not shown) is an upright piece of steel to which the arm is held by the magnet.

The Pickering 190D is available only in a 16-inch model, but the stubby counterweight gives little overhang and it can frequently be installed in locations too cramped for other 16-inch arms.

Shure Studio Dynetic

The basic philosophy behind the design of the Shure Studio Dynetic arm is similar to that of the Pickering 190D, although there does not appear to be any physical resemblance between them.

Fig. 7 shows the Shure arm in playing position. It comes in 12- and 16-inch models. Notice the magnetic arm rest. Fig. 8 is a phantom view of the Shure pickup. The vertical pivot is located just behind the cartridge. Ruby jeweled bearings are used in both vertical and horizontal pivots. The arm is a slim streamlined device and can be adjusted vertically for turntable height by loosening a screw and sliding it up or down on the horizontal pivot spindle.

The cartridge mass is counterbalanced by a threaded weight, which is moved back and forth for stylus-force adjustment. The special Shure cartridge, an integral part of this arm, has a very low mass so the total vertical mass is still quite small. The arm itself is straight, with the offset angle built into the stylus assembly of the cartridge.

Like the Pickering 190D, the Shure arm does not move in the vertical plane. A unique system lifts the stylus from the record. A small plastic button on the top of the arm is pressed down to lift the cartridge and released to lower it to the record. Since the cartridge itself is never handled by the user, and the maximum downward force it can exert is only 2 grams, it is impossible to damage the record or stylus by accidentally knocking the arm across the record.

The Shure design incorporates a new and novel damping system, termed "dynamic damping." The weight at the rear of the arm balances it about the horizontal pivot's axis. It is connected to the body of the arm by a springlike suspension bar. The space between the weight and arm is filled with a plastic material. The physical and mechanical constants of the system are chosen so that at the arm's resonant frequency the plastic provides mechanical resistance which effectively damps the resonant peak. At other frequencies, the mechanical resistance has no effect so there is no possibility of a viscous drag which might introduce undesirable lateral or vertical forces when playing eccentric or warped records.


Like the preceding two, General Electric arms (see Fig. 9) have a wide separation between vertical and horizontal pivots, with most of the arm constrained in the vertical plane.

The main body is a rigid tube, mounted on a very-low-friction, horizontal pivot spindle. Its height is adjusted by sliding the arm up or down the spindle. The cartridge shell is removable for easy cartridge installation, though it is not a plug-in shell. The entire shell is offset for correct tracking.

The cartridge is counterbalanced by a sliding weight on a boom extending to the rear of the shell. This boom has a gram scale which reads the stylus force directly when using G-E cartridges or others of equal weight. The cartridge shell may be tilted upward 90° to inspect, clean, or replace the stylus.

There is almost no overhang to the rear of the horizontal pivot, so the arm can be installed in limited space, especially in its 12-inch version (A1-500). However, it is not laterally balanced and must be carefully leveled for proper operation.

The next article in this series will describe the large group of arms with vertical and horizontal pivots located close to each other. TO BE CONTINUED

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A number of readers have been writing me to ask about electronic channel separators. Circuits they have tried suffer from excessive noise, hum or distortion. Then, too, some want to adjust the crossover frequencies in different ways. To overcome all these problems I have developed a couple of universal channel-filter circuits, along with a design chart that indicates component values for any desired crossover frequencies.

The two circuits have been carefully designed so the amplification level does not run up into distortion or down into the noise region. Sometimes these problems occur because the channel separator provides extra gain and proper attenuation is not inserted at the right place. The circuits presented here have zero insertion loss—the input and output levels are the same. Also, considerable feedback minimizes distortion.

Both circuits can readily be added to existing equipment, an essential feature for our purpose, because the single tube for each channel filter requires less than 1 mA at 250 volts for its plate-screen supply. If existing equipment does not have reserve heater supply (6.3 volts at 300 mA for each channel), it can be obtained cheaply from an additional filament transformer.

Both circuits use a single 6AU6 for each channel. The difference between them is that the simpler circuit gives a 12-db-per-octave transition rate, while the more complicated one steps up the transition to an ultimate slope of 24 db per octave. As previous articles have pointed out, the shallower transition is usually recommended. But some readers have asked, “How can I make the transition more sudden,” so a circuit is included that gives the full 24 db per octave. However, circuit values are much more critical if the correct response is to be obtained. Various values around the circuit may have to be adjusted to get a smooth response, turning over at the correct frequency.

Simpler 12-db circuit

In the simpler circuit (Fig. 1), the effective dynamic range of the 6AU6 is designed so the amplification level does not run up into distortion or down into the noise region. Sometimes these problems occur because the channel separator provides extra gain and proper attenuation is not inserted at the right place. The circuits presented here have zero insertion loss—the input and output levels are the same. Also, considerable feedback minimizes distortion.

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VALUES FOR CIRCUIT OF FIG. 1.
VALUES FOR CIRCUIT OF FIG. 5.

CROSSOVER FREQUENCY - CYCLES

CAPACITOR RATINGS FOR ELECTRONIC CROSSOVER CIRCUITS

DECEMBER, 1957
is increased by using about 14 db of degenerative feedback through the 2,700-ohm bias resistor in the cathode circuit. Values of plate and screen feed resistors are such that the operating condition works the tube around the point where the curvature of plate and screen current is very similar (Fig. 2). This is important because the cathode resistor linearizes the total signal current. If the curvatures of plate and screen current differ, the feedback may well produce more distortion rather than less.

The cathode feedback gain reduction is not frequency-discriminating and leaves a highly linear amplifier with a gain of 30. The 1-megohm resistor from output to input reduces the gain, this time including the rolloff components, by a further 6 db, leaving the tube with a working gain of 15. The 220,000- and 820,000-ohm resistors in the grid circuit reduce this to 12. Finally, input and output resistor networks dissipate the rest of the gain, so the output voltage is approximately equal to that of the input.

The 6-db controlling feedback is dependent on the circuit being fed from a cathode follower with a source resistance of more than about 5,000 ohms. If the filters are fed from the plate circuit of a preamplifier tube, subtract the tube's plate resistance from 150,000 ohms for the input feed resistor R1.

The capacitors responsible for low-frequency rolloff are C1 and C3, while those for high-frequency rolloff are C2 and C4. For a section to feed a mid-range speaker all these capacitors will be needed. For the woofer unit C1 is not needed, and C3 can be a convenient value, .06 µf. Capacitors C2 and C4 are selected (using the chart) according to the crossover frequency desired from woofer to mid-range unit.

For the mid-range, C1 and C3 are determined for the crossover frequency between woofer and mid-range, while C2 and C4 are determined for the crossover from mid-range to tweeter. For the feed to the amplifier supplying the tweeter C2 and C4 are omitted and the chart supplies values for C1 and C3 to get the right low-frequency rolloff to match the mid-range unit according to crossover frequency.

For example, assume the desired crossover frequencies are 600 and 4,000 cycles (Fig. 3). For the woofer unit, C2 is .00185 µf and C4 .002 µf. This circuit is not highly critical and if one capacitor is a little higher and one a
little lower than the indicated value the result will come out about right. Both capacitors could be .002 nominal, and response would probably come pretty close to the desired performance.

For the mid-range unit, C1 is 170 μF and C3 is 260 μF. These are calculated using the 600-cycle design frequency. One at 150 and one at 270 or 300 μF will probably be close enough. Alternatively, both at 220 would also come pretty close. Capacitors C2 and C4 are calculated with the 4,000-cycle design frequency and come out to 280 and 300 μF, respectively. Capacitors of 270 and 300 μF will do nicely.

For the tweeter unit C1 and C3 are 26 and 40 μF, respectively. Thus, we have all the values to build up a three-way filter which can conveniently be fed from a preamp's cathode-follower output. The complete three-channel circuit is shown in Fig. 4.

24-db-per-octave roll-off

The more complicated 24-db circuit (see Fig. 5) uses 18 db of feedback from plate to grid and consequently does not need the cathode degenerative feedback employed with the simpler circuit. Now, the circuit has to be arranged to get the maximum possible gain out of the 6AU6, if we are to adjust circuit values to get a reasonable degree of independence in action.

The working gain of the tube, with the values shown, is 250. The output provides a voltage stepdown of 5 to 1. Feedback reduces the working gain by an effective 8 to 1. The grid circuit drops it by 5 to 4 and the input attenuation arrangement gets rid of the rest.

Correct response is dependent on feedback from a cathode follower. It would be difficult to allow the kind of latitude needed for plate-coupled circuits, with a 24-db-per-octave type. Outside the passband the rate of rolloff approaches 24 db per octave at each end.

As before, for the woofer unit, the odd-numbered capacitors can be omitted where they are not required for dc blocking purposes—only C5 is required, which can be some convenient value, like .05 μF. The capacitors with even numbers are selected (use the chart) using the low-Frequency crossover point.

With the same example of 600 cycles, the values required for the feed unit to the woofer amplifier are: C2, .0115 μF; C4, .0039 μF; C6, .0044 μF, and C8, .00145 μF.

For the mid-range feed, using the same frequency at 600 cycles to select the capacitors with odd numbers, we get: C1, .00195 μF; C3, 88 μF; C5, 125 μF, and C7, 210 μF. For the even-numbered capacitors in the mid-range feed the 4,000-cycle frequency is used, giving the following values: C2, .00172 μF; C4, 580 μF; C6, 660 μF, and C8, 210 μF.

For the tweeter unit, the odd-numbered capacitors are again calculated with 4,000 cycles: C1, 230 μF; C3, 13.5 μF; C5, 19.2 μF, and C7, 32 μF. For the tweeter unit, C2, C4, C6 and C8 are omitted. The complete three-channel circuit is shown in Fig. 6.

If the power amplifier's input capacitance in conjunction with the output resistances of these circuits produces a high-frequency loss on the tweeter unit (above 10,000 cycles), compensation must be provided. Use a small trimmer, about 5 to 30 μF, across the upper resistor of the output voltage divider. As shown at Figs. 4 and 6, that can be used to adjust the frequency response obtained in the tweeter unit.

Most feedback amplifiers have their gain control right in the input circuit. This will shunt the output of the filters, altering both gain and response. Using a 500,000-ohm input potentiometer in the circuit of Fig. 1 and a 250,000-ohm input potentiometer for the circuit of Fig. 5, the output circuits will be as in Figs. 7 and 8.

END
AST month we discussed the use of information presented in tube manuals for designing R-C-coupled pentode amplifiers. This month we shall cover triode circuits.

Let's use a 12AY7, a very good input stage for audio work. The RCA manual does not list this one. The Sylvania does; in fact it gives a table for it. But let's assume for the purpose of this article that we don't have the Sylvania book. It often happens that the tube we want is not in the book we have. But in one of those comprehensive tube data manuals that list every tube made, we find the following (ratings may differ in different manuals):

<table>
<thead>
<tr>
<th>Type</th>
<th>Heater</th>
<th>Plate</th>
<th>Grid</th>
<th>Plate</th>
<th>Grid</th>
<th>Plate</th>
<th>Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>12AY7</td>
<td>6.3</td>
<td>3.1</td>
<td>1.55</td>
<td>2.35</td>
<td>4.25</td>
<td>2.5</td>
<td>26.5</td>
</tr>
</tbody>
</table>

For a low-level input stage, we shall probably decouple so that the plate supply point is about 150 volts. With a plate resistance of 26,500 ohms, the coupling resistor should be at least three times this and, allowing for the increase of plate resistance at lower currents, 100,000 ohms would seem a good value. Assuming that the biggest part of the supply voltage will drop across this, we should have about 1 ma of plate current, with a plate voltage in the region of 50. For 150 volts on the plate, a 2.5-volt bias gives a plate current of 2 ma. Reducing everything to one-third, 50 volts on the plate should give a plate current of 0.67 ma with a negative grid voltage of 1.67. So 1 milliamp would require rather lower grid voltage, say 1.5. This means the cathode resistor should be 1,500 ohms.

For this kind of stage the following grid resistor could well be 47,000 ohms.

We will estimate the gain on this basis. As ratings are proportional to those listed we can assume that the amplification factor will still be about 40. But due to the drop in plate current, plate resistance will be higher. On the previous basis, as the current is halved, we would expect the g_m to be divided by about 1.6. The square of 1.6 is 2.56, and 2 is an approximate mean between 1.6 and 2.56. So the ac resistance will be multiplied by 1.6, to keep the same amplification factor, giving a value of 26.5 x 1.6 = 42,500. The 100,000-ohm plate resistor is parallel, ac-wise, with the 470,000-ohm grid resistor following, giving a plate load of about 82,000 ohms. So the stage gain is likely to approximate

\[ 40 \times \frac{42.5 + 82}{2} = 26. \]

Taking a peep at the Sylvania table, we find values for a plate supply of 150 and of 250 volts. By averaging the gain figures and bias values, it would seem that we may be a little conservative on the gain, and the bias and operating condition we hit about right. Using the tube characteristic as a check—which we have to get from the Tung-Sol book (Fig. 1)—we will get a gain of 27 with these values (cathode properly bypassed) and the plate current will be 0.82 ma, the bias 1.23 volts and the plate voltage 68. On the whole as good a guess as can be expected from the information we used!

To complete the stage design, we want suitable coupling capacitors. With a following grid resistor of 470,000 ohms, the reactance of the coupling capacitor must be less than 470,000 ohms down to 20 cycles. A .02μf capacitor satisfies this with 400,000 ohms, or a .05μf capacitor will give a better margin, with 160,000 ohms.

For the cathode bypass, we first calculate the gain without it. With a 1,500-ohm cathode resistor and a gain of 26 (taking our own figure) into 82,000 ohms, the gain from grid to cathode will be 26 x 1.5 = 0.475. This means that we need 1.475 volts in to get 1 volt from grid to cathode, without the bypass. This represents a gain reduction of almost exactly 3 db due to the 1,500-ohm cathode resistor. This means there will be a loss of 1.5 db when the reactance of the bypass capacitor is 1,500 ohms. A value of 5.5 μf gives a reactance of 1,500 ohms at 20 cycles. So anything above 10 μf should be OK.

The circuit for a two-stage amplifier developing a gain of 875 to 730 (according to whether you take the guess figure of 26 or the one from the tube characteristic, 27), is shown in Fig. 2.

Other design problems

Another job in R-C-coupled amplifier design that often sets problems is providing sufficient swing to drive the output tubes. The more straightforward circuits require only a relatively small swing but some need a very large one—for example, the cathode-follower output stage. None of the tabulated data gives a large enough swing for this purpose. How can we get more?

Increasing the B-supply voltage enables a stage to provide a larger output: the highest working voltage listed in the RCA manual is 300, and in some other manuals it is only 250, but supplies for output stages deliver as much as 450. Here's an example.

Looking through the RCA manual, the best triode tube for providing a large output swing is the 6SN7 group. If need be, we can work two in push-pull, which will help by cancelling the second harmonic, which is bound to predominate in any tube operating at this large swing. Suppose we are limited on the output tube grid resistors to 500,000 ohms. The table lists two combinations at 300 volts using a 470,000-ohm grid resistor R_g: one with R_c of 100,000 ohms, giving a noise figure of 100,000 ohms, and the other with R_c of 220,000 ohms, giving an E_b of 85. Obviously the latter arrangement fails to improve the output because the high resistance values are starving the tube of current and working it too far round the bend.

Fig. 3 shows the tube characteristics for one half of a 6SN7-GT, with load lines drawn for 100,000- and 470,000-ohm conditions. First the 100,000-ohm line is drawn by aligning 300 volts with 3 ma, and the operating point found from the cathode resistor given in the manual, 3,000 ohms. The operating point is 1.55 ma, -6 volts bias, from which the plate voltage is seen to be about 137. Now draw a load line through this point to represent the ac resistance of 100,000 ohms in parallel with 470,000 or 82,000 ohms. This can be done by aligning 5 ma and 410 volts with a straightedge and then drawing a parallel line through the found operating point.

We now have the limits of voltage excursion for a 6-volt grid swing each way from the -6-volt bias point: 33 and 225. This is a peak-to-peak swing of 192 volts, or a peak output of 96 volts, which agrees with the manual. Next we can see how much second harmonic we have.

The midpoint between 33 and 225 is 129 volts. But the operating position is
137 volts. So the swing is 8 volts off center in a peak-to-peak of 192. This represents a second harmonic of just over 4% (8/192).

Now let’s see what we can do with 450 volts of B plus: Drawing the 100,000-ohm line by aligning 450 volts with 4.5 ma, we select an operating point at about 200 volts. This would represent a bias of about 8.8 volts, so the total swing would go almost to −18 volts, which looks as if it is getting well into the curvature. Dropping a little, to 9.5 volts bias, the plate current is 2.5 ma so the bias resistor calculates to the convenient value of 3,200 ohms. Now we draw the 82,000-ohm load line through this point and note the voltages corresponding with 0 and −17 volts on the grid: 48 and 323. A peak-to-peak swing of 275, or E_0 = 137.5.

To estimate distortion, the midpoint between 48 and 323 is 185.5, while the operating point is 196. This is a difference of 10.5 volts in a peak-to-peak of 275, representing about 3.8% second harmonic, which is a little lower than the previous figure. We could use a little more bias and get a little more swing. Say we use 3,600 ohms, giving 9 volts bias with 2.5 ma. The relevant voltages will then be 48, 202 and 380, which works out to an E_0 of 166 volts with still less than 4½% distortion.

The chart in Fig. 3 comes from the Tung-Sol manual. If you have been following along in another book, you may not read exactly the same voltages. These curves differ slightly from one source to another.

But even allowing for differences, investigation has shown the trend on which we can base our “inspired guesswork” when the only data available are not enough. Going back to the table, we find that, using the same values of Rc and Ra, at the three voltages of 90, 180 and 300, E_c steps up by a slightly larger ratio than B plus each time. The first step is double, but E_c goes from 23 to 51, which is more than double—a ratio of 2.2. The second step, from 180 to 300, is a ratio of 1 to 1.67, but E_c jumps from 51 to 96, a ratio of 1 to 1.88. The third step, from 300 to 450, is a ratio of 1 to 1.5, but E_c jumps from 96 to 166, a ratio of 1 to 1.73. So the pattern is fairly consistent and should enable us to make a reasonable estimate. Notice what happens to the cathode resistor: In order, the values for 90, 180, 300 and 450 volts are: 4,800, 4,140, 3,900 and 3,600 ohms. Again a consistent trend.

There are some points that must be watched in pushing up the B plus. See that tube ratings—voltage or dissipation—are not exceeded. This is usually fairly safe, but a danger that may be overlooked is the condition during warmup. Single-ended tubes (plate connection at the base) have a maximum plate voltage rating that should be watched. If it is seriously exceeded during warmup, there is risk of internal flashover. Either get a special type in which allowance is made for this (such as the 6SN7-GTA, whose maximum plate voltage is extended from 300 to 450) or use a slow warmup rectifier to insure that the tube heater is “up” before B plus arrives.

Using a larger cathode bias resistor with the same plate circuit resistors will always increase the available swing before clipping occurs, but will also increase the curvature producing second harmonic. If you don’t need the full swing, operation will be better with a somewhat lower cathode resistor. This will reduce second-harmonic curvature and the operating plate voltage and plate dissipation, when high-value plate resistors are used.

In general we use a certain amount of guesswork unless we can get the tube characteristics and use the full method, based on load-line technique, which has been discussed elsewhere (RAIRO-ELECTRONICS, June, 1956; April, 1956). After a little practice, the guesswork becomes almost inspired!
PULLED your egg and forgot to wreck it," Bess apologized.

"Skip it," Fuzzball replied. "At least you didn't forget it entirely."

Turning with a hurt look to Red, he said, "Did you do me dirty the other day?"

"Did I?" asked Red noncommittally.

"Yes, you dog, you did."

"What now?"

"You told me that the blue lateral corrector moves the blue beam left and right on the screen, didn't you?"

"Sure did," Red replied.

"Then why doesn't it do what you say?"

"Maybe the blue lateral corrector was mounted in the 2 o'clock position on the picture tube's neck."

"You mean that makes a difference?" asked Fuzzball in amazement.

"Looks like you found out the hard way," Red observed. "Reckon I ought to have told you. There are two ways to mount the corrector magnet."

"Now you tell me," Fuzzball protested. "Here I am slowly going crazy trying to remember everything you said, and you didn't even say it.

Bess dropped the corner of her mouth open. "You've gone, boy, if you ask me."

"Nobody..." Fuzz started to say, as Red reached for the sugar and stuck his elbow in Fuzzball's mouth.

"Yes," continued Red, "on some sets you'll find the corrector magnet is not mounted directly over the blue gun. Instead, it's turned to the 2 o'clock position, if you call the blue gun 12 o'clock."

"Why?" Fuzz asked.

"Gives a little better purity, that way," Red explained.

Where's 2 o'clock?

"I see," Fuzzball said, nodding his head slowly. Then a crafty look crossed his face. "Do you mean 2 o'clock standing in front or behind the set?"

"Well, let's put it this way," Red replied, "just remember that the 2 o'clock position is between the blue and green guns."

"I guess that ties it down OK," admitted Fuzzball, "but will you or can you explain that crazy motion I was fighting on the blue dot?"

Red lit a fag thoughtfully, and then replied, "It is a little harder to get the color dots together, with a 2 o'clock corrector."

"You're the guy that's making it hard," Fuzzball protested. "Why don't you tell me these things before I go out on the job?"

"Look, Fuzz," Red replied evenly, "life is like that. Do you suppose I told me? Nobody, but nobody. It's lumps on the head."

"Excuse me for living," Fuzzball said resignedly, "but how does the blue dot move?"

"It moves in a sort of an ellipse. Here, Fuzz. Here is a drawing that I tore out of RADIO-ELECTRONICS, Glom on to that." (See Fig. 1.)

"Dig them crazy dots," Fuzzball remarked. "That's what makes it so rough—the red and green dots are like horse feathers—they're all over."

"But not so much," Red observed. "The blue dots move the most."

"It's a lot tougher to bring in a blue dot on an ellipse than on a straight line," Fuzzball bellyached.

Red exhaled a perfect smoke ring, making no comment.

"I'm just lucky I could stall on the job until tomorrow," Fuzzball continued.

"It is a little tougher to converge the blue dots with a 2 o'clock corrector," Red finally agreed. "But it's still a lot easier than making the dynamic convergence."

"Don't remind me," Fuzzball groaned.

"How did you make out on the purity?" Red asked.

"I fought it for a while, and finally ended up with the degaussing coil, and got it looking OK."

"Tell you what," Red remarked, "I was talking to Jack Darr, and he recommends that we should degauss picture tubes as a matter of course."

"Before we adjust the purity?"

"Yes. The way Jack puts it, you save time on the average. It makes a lot of sense."

"Are you going to follow Jack's advice?" asked Fuzz.

"Sure am," Red replied. "That's a shop rule from now on."

"How's Jack making out with this color racket?"

"Good enough, it seems," Red replied. "But he sure got hold of a weird dog last week, on black-and-white."

"What's the scoop?"

"Well, this was a Raytheon, last year's model—14AY21, or something like that. Had pix and no sound. On turning the volume control full up, it gave a fairly good picture. But, when the volume control was turned down, the picture quietly folded up in the middle, overlapped, pulled in from the sides, and the screen went black."

"What could cause that?" asked Fuzzball.

"Well, that's a good question," Red remarked. "I couldn't figure it, myself. He explained that a coupling capacitor had shorted from the plate line to the audio grid, so that it was grounded at one end by action of the volume control."

"Why did the screen go black?" asked Fuzzball with a puzzled look.

"Well," Red explained, "he pointed out that this grounded the 150-volt line which supplies plate voltage to the horizontal oscillator."

"That's the d....t symptom I ever heard of," Fuzzball said, shaking his head.

"Worse than the 2 o'clock lateral corrector?" asked Red with a grin.

"I hate to admit it, but the lateral
deal is a breeze compared to something like that," Fuzzball said mildly.

"How did you make out on dynamic convergence?" Red asked.

"Tell you the truth . . ." Fuzzball started.

"Do so, by all means," Red encouraged.

"I got so fouled up on the 2 o’clock corrector that I never got that far." "We all go through the same mill," Red advised him. "Dame History is a very old lady and likes to repeat herself."

Dynamic-convergence tips

"Can you give me some handy-dandy tips to save headaches on the dynamic convergence?" Fuzzball asked.

"I wouldn’t be splashed," agreed Red. "Just remember, No. 1, that you bear down on the vertical dynamic convergence before going to the horizontal."

"I won’t forget," Fuzz promised.

"And No. 2, it helps to start the job with crosshatch, instead of white dots."

"Why?" asked Fuzzball.

"Simply because we start the dynamic job by lining up the red and green columns to make them straight and parallel. Look, here’s a photo. (See Fig. 2.)" "You say it’s easier to start with lines than with dots?" Fuzzball persisted.

"My opinion is yes," Red asserted. "Maybe you wouldn’t agree, but take a look at this other photo showing the dot deal. See the difference?" (See Fig. 3.)

Fuzzball compared the photos carefully. "I would go along," he announced. "It’s quite a bit easier to size up the columns on the crosshatch pattern."

"Thank you, Mr. F." Red returned humbly. "I am greatly honored to have my own judgment confirmed by no less an authority than yourself."

"Cut the balderdash," Fuzz said. "Anyone would think I was a Ph.D. or something, trying to fix his own TV set."

"What’s a Ph.D.?" asked Red innocently.

Fuzzball looked sharply at Red, to see if he was joking. His face was blank. "For your information," said Fuzzball, "a Ph.D. is a degree from an institution—it means piled high and deep, or something like that."

"Do you notice anything about this photo (Fig. 2)?" Red asked.

"The blue line is out," Fuzzball suggested.

"Right," Red agreed. "You don’t have to cut off the blue gun, but look of guys figure it makes things less confusing to start."

"Tell me something, now," Fuzzball blurted. "OK."

"On this interaction business that drives me nuts, what effect do the blue vertical amplitude and blue vertical tilt have on red and green lines?"

"There’s some interaction," Red advised him.

"So if I get after I get the red and green lines straightened up, I can’t forget about them until after the blue has been brought in?"

"They’ll be giving you a gold star on your report card," Red remarked. "Just remember one thing, now. Set up the red and green lines with the crosshatch, like we’ve been saying. But bring in the blue gun on the dots."

"Any fool can see that," agreed Fuzzball. "I can see it."

"You might remember it," suggested Red, "by making it a rule to always start a job with crosshatch and always end with dots."

"By a job I guess you mean static convergence, vertical dynamic and horizontal dynamic—that would make three jobs?"

"You’re right in the groove, buddy," Red agreed.

Horizontal yoke balancer?

"There’s just one thing that’s got me in the dark," Fuzzball recalled, "and that’s a little coil on top of the deflection yoke. Motorola I worked on yesterday had it. There’s a slug can be slid up and down in the coil."

"Old Eagle-Eye Fuzzball," Red exulted, patting him on the back. "Yep, that’s part of the consistency line-up on that model. That, Fuzz, is a horizontal yoke balancer."

"OK, you joker," Fuzzball replied. "What’s a yoke balancer?"

"Well, on a color set, the yoke is very critical. If there’s a little more inductance in one coil than the other, edge convergence won’t come in right. The nearer the edge you get, the more serious it becomes. So, the yoke balancer is a gismo which lets you add or subtract a little inductance on one coil and throw it over to the other."

"What’s that got to do with the price of peas?"

"Well, you don’t worry about the yoke balancer until you get near the end of the horizontal convergence. Then, when you have the dots pretty well in, except for the ends of the pattern, youiddle with the yoke balancer."

"So I suppose I have interaction between the horizontal controls and the yoke balancer, already?"

"A little," Red agreed. "But it’s a small price to pay for the improvement in edge convergence."

"Next thing you know," Fuzzball predicted, "we’ll be having vertical yoke balancers too."

"We already have," Red advised him. "The 21-inch model has both horizontal and vertical balancers."

"Great gosh and little goldfish," Fuzzball exclaimed.

"Relax, man," Red suggested. "I realize that the yoke balancers and the dynamic controls make 14 adjustments to do with. But it’s like learning to play horsetail poker—you get kings and queens and aces and deuces and four colors instead of three. But I never saw you in no blind in horsetail poker."

"That’s different," Fuzzball protested. "But tell me, how long should I take to tame these little color dots?"

"The boss gives you three days on your first job," Red advised, "but he charges the set owner for a half hour of convergence time."

"You mean the shop’s losing money on me?" asked Fuzzball in an unbelieving tone.

Figs. 1 and 2—The red and green columns must be lined up straight and parallel with each other.
everybody's doing it!

FRANK PERKINS
Composer and arranger Frank Perkins listens attentively to his Decca hi-fi album "Music For My Lady" as its beautiful sounds are recreated with Heath high fidelity equipment. Music is a very important part of Frank's life, since his background includes composing and arranging musical scores for motion pictures, and for music publishers. Songs he has written include "Stars Fell on Alabama", "Emaline", "The Scat Song", "The Way I Feel Tonight", "After All These Years", and "Turn Back The Clock". Frank Perkins has discovered the beauty of Heath Hi-Fi sound... and the fun of "do-it-yourself" Heathkit construction. So, why don't you!

Heathkits
...fun to build and a thrill to own!

and here's why...
1. You get higher quality at lower cost by dealing direct, and by doing your own assembly.
2. You receive personal, friendly, service (before and after sale) for complete satisfaction.
3. You benefit from the latest in engineering designs because of our concentration on kit-form equipment only.
4. You may depend on performance as advertised—backed by Heath's world-wide reputation for quality.
5. You can take a full year to pay with the HEATH EASY TIME PAYMENT PLAN.

[Diagrams and drawings]
HEATHKIT EXTRA PERFORMANCE 70-WATT AMPLIFIER KIT

For really high performance, with plenty of reserve power, the W-6M is a natural. The full 70-watts output will seldom, if ever, be required. However, this reserve insures distortion-less sound on power peaks. The W-6M will loaf along at normal listening levels and yet is always ready to extend itself when program material demands it, without the least amount of strain. The output circuit employs 6550 tubes with a special-design Peerless output transformer for maximum stability at all power levels. A quick-change plug selects 4, 8 and 16 ohms or 70-volt output and the correct feedback resistance. A variable damping control is also provided for optimum performance with any speaker system. Extremely good power supply regulation is possible through the use of a heavy-duty transformer along with silicon-oxide rectifiers, which are not subject to the long life and yet are smaller than a house fuse. Frequency response at 1 watt is +1 db from 5 cps to 30,000 cps with controlled rolloff above 100 kc. At 70 watts output harmonic distortion is below 2% at 20,000 cps and IM distortion below 1% at 60 and 6,000 cps. Hum and noise 88 db below full output. In addition to high performance, its fine appearance makes it a pleasure to display in your living room. Proper layout of chassis insures ease of assembly by eliminating those cramped and difficult places to get at. Clear instructions—and top-quality components. Get started now and make this amplifier the heart of your hi-fi system. Shipped express only. Shpg. Wt. 50 lbs.

MODEL W-6: Consists of W-6M kit, plus WA-P2 preamplifier. Express only. Shpg. Wt. 59 lbs. $129.70

MODEL W-6M $109.95 (with cabinet)

HEATHKIT HIGH FIDELITY FM TUNER KIT

This tuner can bring you a rich store of FM programming, your least expensive source of high fidelity material. It covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures negligible drift after initial warm-up. Features broadbanded circuits for full fidelity, and better than 10 uv sensitivity for 20 db of quieting, to pull in stations with clarity and full volume. Employs a high gain, cascode RF amplifier, and has AGC. A ratio detector provides high-efficiency demodulation without sacrificing hi-fi performance. IF and ratio transformers are prealigned, as is the front end tuning unit. Special alignment equipment is not necessary. Edge-lighted glass dial for easy tuning. Here is FM for your home at a price you can afford. Shpg. Wt. 8 lbs.

MODEL FM-3A $25.95 (with cabinet)

HEATHKIT BROADBAND AM TUNER KIT

This AM tuner was designed especially for high fidelity applications. It incorporates a special detector using crystal diodes, and the IF circuits feature broad-bandwidth, to insure low signal distortion. Audio response is +1 db from 20 cps to 9 kc, with 5 db of preemphasis at 10 kc to compensate for station rolloff. Sensitivity and selectivity are excellent, and tuner covers complete broadcast band from 550 to 1600 kc. Quiet performance is assured by 6 db signal-to-noise ratio at 2.5 UV. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs, and built-in power supply. Edge-lighted glass slide-rule dial for easy tuning. Your “best buy” in an AM tuner. Shpg. Wt. 6 lbs.

MODEL BC-1A $25.95 (with cabinet)

HEATHKIT MASTER CONTROL PREAMPLIFIER KIT

Designed for use with any of the Williamson-type amplifiers, the WA-P2 has five switch-selected inputs, each having its own level control to eliminate blasting or fading while switching through the various inputs, plus a tape recorder output. A hum control allows setting for minimum hum level. Frequency response is within +1 1/2 db from 15 to 35,000 cps. Equalization provided for LP, RIAA, AES, and early 78's. Separate bass and treble controls. Low impedance cathode follower output circuit. All components were specially selected for their high quality. Includes many features which will eventually be desired. Shpg. Wt. 7 lbs.

MODEL WA-P2 $197.50 (with cabinet)
HEATHKIT ADVANCED-DESIGN 25-WATT HIGH FIDELITY AMPLIFIER KIT

Designed especially to satisfy critical audio requirements, the W-5M incorporates the extra features needed to complement the finest in program sources and speaker systems. Faithful sound reproduction is assured with a frequency response of ±1 db from 5 to 160,000 cps at 1 watt, and harmonic distortion is less than 1½% at 25 watts, with IM distortion less than 1% at 20 watts. Hum and noise are a full 89 db below rated output, assuring quiet, hum-free operation. Output taps are at 4, 8 and 16 ohms. Exclusive Heathkit features include the "tweeter saver", and the "bas-bal" balancing circuit, requiring only a voltmeter for indication. Years of reliable service are guaranteed through the use of conservatively rated, high quality components. KT66 tubes and Peerless output transformer are typical. Shipped express only. Shpg. Wt. 31 lbs.

MODEL W-5: Consists of W-5M kit above plus model WA-P2 preamplifier. Express only. Shpg. Wt. 38 lbs. $79.50

MODEL W-5M $59.50

HEATHKIT DUAL-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model W3-AM is a Williamson-type amplifier built on two separate chassis. The power supply is on one chassis, and the amplifier stages are on the other chassis. Using two separate chassis provides additional flexibility in installation. Features include the famous acrosound model TO-300 "ultralinear" output transformer and 5881 tubes for broad frequency response, low distortion, and low hum level. The result is exceptionally fine overall tone quality. Frequency response is ±1 db from 6 cps to 150 kc at 1 watt. Harmonic distortion is less than 1½% and IM distortion is less than 1.3% at 20 watts. Hum and noise are 89 db below 20 watts. Designed to match the speaker system of your choice, with taps for 4, 8 or 16 ohms impedance. A very popular high fidelity unit employing top quality components throughout. Shipped express only. Shpg. Wt. 29 lbs.

MODEL W-3A: Consists of W-3AM kit above plus model WA-P2 preamplifier. Express only. Shpg. Wt. 37 lbs. $69.50

MODEL W-3AM $49.50

HEATHKIT SINGLE-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model W4-AM Williamson-type amplifier will amaze you with its outstanding performance. A true Williamson circuit, featuring extended frequency response, low distortion, and low hum levels, this amplifier can provide you with many hours of listening enjoyment with only a minimum investment compared to other units on the market. 5881 tubes and a special Chicago-standard output transformer are employed to give you full fidelity at minimum cost. Frequency response extending from 10 cps to 100 kc within ±1 db at 1 watt assures you of full coverage of the audio range, and clean clear sound amplification takes place in circuits that hold harmonic distortion at 1.5% and IM distortion below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps on the output transformer are at 4, 8 or 16 ohms. Shipped express only. Shpg. Wt. 28 lbs.

MODEL W-4A: Consists of W-4AM kit above, plus model WA-P2 preamplifier. Express only. Shpg. Wt. 35 lbs. $59.50.

MODEL W-4AM $39.50

Heathkits...

BY D. A. STROM

bring you the lasting satisfaction of personal accomplishment

HEATHKIT GENERAL-PURPOSE 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model A-9C will provide you with high quality sound at low cost. Features a built-in preamplifier with four separate inputs, and individual volume, bass and treble controls. Frequency response covers 20 to 20,000 cps within ±1 db. Total harmonic distortion is less than 1½% at 3 db below rated output. Push-pull 6L6 tubes are used, with output transformer tapped at 8, 16 and 500 ohms. A true hi-fi unit using high-quality components throughout, including heavy-duty "potted" transformers. Shpg. Wt. 23 lbs.

MODEL A-9C $35.50
HEATHKIT "BASIC RANGE" HI-FI SPEAKER SYSTEM KIT
The extremely popular Heathkit model SS-1 Speaker System provides amazing high fidelity performance for its size. Features two high-quality Jensen speakers, an 8" mid-range woofer and compression-type tweeter with flared horn. Covers from 50 to 12,000 CPS with +5 db, in a special design ducted-port, bass reflex enclosure. Impedance is 16 ohms. Cabinet measures 11½" H x 23" W x 17½" D. Constructed of veneer-surfaced plywood, ½" thick, suitable for light or dark finish. All wood parts are precut and predrilled, for easy, quick assembly. Shpg. Wt. 30 lbs.

HEATHKIT "RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT
Extends the range of the SS-1 to the basic range extending kit includes CPS. Uses 15" woofer and super-tweeter both by Jensen. Kit includes crossover circuit. Impedance is 16 ohms and power rating is 35 watts. Measures 29" H x 23" W x 17½" D. Constructed of veneer-surfaced plywood ½" thick. Easy to build! Shpg. Wt. 80 lbs.

HEATHKIT "LEGATO" HIGH FIDELITY SPEAKER SYSTEM KIT
The quality of the Legato, in terms of the engineering that went into the initial design, and in terms of the materials used in its construction, is matched only by the most expensive speaker systems available today. The listening experience it provides approaches the ultimate in esthetic satisfaction. Two 15" theater-type Altec Lansing speakers cover 25 to 500 CPS, and an Altec Lansing high-frequency driver with sectoral horn covers 500 to 20,000 CPS. A precise amount of phase shift in the crossover network brings the high frequency channel into phase with the low frequency channel to eliminate peaks or valleys at the crossover point, by equalizing the acoustical centers of the speakers. The enclosure is a modified infinite baffle type, especially designed for these speakers. Cabinet is constructed of veneer-surfaced plywood, ½" thick, precut and predrilled for easy assembly. Frequency response 25 to 20,000 CPS. Power rating, 50 watts program material. Impedance is 16 ohms. Cabinet dimensions 41" L x 22½" D x 34½" H.

Heathkits...

BY DAYSTROM
let you save up to ½
or more on all types
of electronic equipment.

HEATHKIT SINE-SQUARE GENERATOR
The new AG-10 provides high quality, sine and square waves over a wide range, for countless applications. Some of these are: radio and TV repair work, checking scope performance, as a variable trigger source for telemetering and pulse work, and checking audio, video and hi-fi amplifier response. Frequency response is ±1.5 db from 20 CPS to 1 MC on both sine and square waves, with less than .25% sine wave distortion, to 20,000 CPS. Sine wave output impedance 600 ohms, square wave output impedance 50 ohms, (except on 10V ranges). Square wave rise time less than .15 usec. Five-position, band switch—continuously variable tuning—shielded oscillator circuit—separate step and variable output attenuators in ranges of 10, 1, and .1 volts for both sine and square wave, with extra range of .01 volt on sine wave. Both sine and square wave can be used at the same time without affecting either wave form. Power supply uses silicon-diode rectifiers. Shpg. Wt. 12 lbs.

HEATHKIT AUDIO ANALYZER KIT
The AA-1 is actually three instruments in one compact package. It combines the functions of an AC VTVM, an audio wattmeter, and an intermodulation analyzer. Input and output terminals are combined, and high and low frequency oscilators are built in. VTVM ranges are 0-0.1, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts (RMS). Wattmeter ranges are .15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w and 150 w. IM scales are 1%, 3%, 10%, 30% and 100%. Provides internal load resistors of 4, 8, 16 or 600 ohms. A tremendous dollar value. Shpg. Wt. 19 lbs.
HEATHKIT "GENERAL PURPOSE" 5" OSCILLOSCOPE KIT
The model OM-2 Oscilloscope is especially popular with part-time service technicians, students, and high fidelity enthusiasts. It features good vertical frequency response +3 db from 4 cps to over 1.2 mc. A full five-inch crt. and sweep generator operation from 20 cps to over 160 kc. Stability is excellent and calibrated grid screen allows precise, signal observation. Extra features include external or internal sweep and sync, 1-volt peak-to-peak calibrating reference, 3-position step-attenuated input, adjustable spot shape control, push-pull horizontal and vertical amplifiers, and modern etched-metal circuits. Easy to build and a pleasure to use. Ideal for use with other audio equipment for checking amplifiers. Shpg. Wt. 21 lbs.

MODEL OM-2 $42.50

HEATHKIT AUDIO WATTMETER KIT
The AW-1 Audio Wattmeter can be used in any application where audio power output is to be measured. Non-inductive LOAD resistors are built in for 4, 8, 16 or 600 ohms impedance. Five power ranges cover 0-5 mw, 50 mw, 500 mw, 5 w, and 50 w full scale. Five switch-selected db ranges cover -10 db to +30 db. All indications are read directly on a large 4½" 200 microampere meter. Frequency response is +1 db from 10 cps to 250 kc. Precision type multiplier resistors used for high accuracy, and crystal diode bridge for wide-range frequency response. This meter is used in many recording studios and broadcast stations as a monitor as well as servicing. A fine meter to help supply the answers to your audio operating or power out put problems. Shpg. Wt. 6 lbs.

MODEL AW-1 $29.50

HEATHKIT AUDIO SIGNAL GENERATOR KIT
The model AG-9A is "made to order" for high fidelity applications, and provides quick and accurate selection of low-distortion signals throughout the audio range. Three rotary switches select two significant figures and a multiplier to determine audio frequency. Incorporates step-type and a continuously variable output attenuator. Output indicated on large 4½" panel meter, calibrated in volts and db. Attenuator system operates in 10 db steps, corresponding to meter calibration, in ranges of 0.003, .01, .03, .1, .3, 1, 3, 10, 100, and 10000. "Load" switch permits use of built-in 600-ohm load, or external load of different impedance. Output and frequency indicators accurate to within ±5%. Distortion less than .1 of 1% between 20 and 20,000 cps. Total range is 10 cps to 100 kc. Shpg. Wt. 8 lbs.

MODEL AG-9A $34.50

HEATHKIT HARMONIC DISTORTION METER KIT
All sounds consist of dominant tones plus harmonics (overtones). These harmonics enrich the quality and brightness of the music. However, additional harmonics which originate in the audio equipment, represent distortion. Used with an audio signal generator, the HD-1 will accurately measure this harmonic distortion at any or all frequencies between 20 and 20,000 cps. Distortion is read directly on the panel meter in ranges of 0-1, 3, 10, 30 and 100% full scale. Voltage ranges of 0-1, 3, 10 and 30 volts are provided for the initial reference settings. Signal-to-noise ratio measurements are also permitted through the use of a separate meter scale calibrated in db. High quality components insure years of outstanding performance. Full instructions are provided. Shpg. Wt. 13 lbs.

MODEL HD-1 $40.50

HEATHKIT AUDIO VTVM KIT
This new and improved AC Vacuum Tube Voltmeter is designed especially for audio measurements and low-level AC measurements in power supply filters, etc. Employs an entirely new circuit featuring a cascode amplifier with cathode-follower isolation between the input and the amplifier, and between the output stage and the preceding stages. It emphasizes stability, broad frequency response, and sensitivity. Frequency response is essentially flat from 10 cps to 200 kc. Input impedance is 1 megohm at 1000 cps. AC (RMS) voltage ranges are 0-0.1, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover -52 db to +52 db. Features large 4½" 200 microampere meter, with increased damping in meter circuit for stability in low frequency tests. 1% precision resistors employed for maximum accuracy. Stable, reliable performance in all applications. Shpg. Wt. 5 lbs.

MODEL AV-3 $29.50

Heathkits... are well known for their high quality and reliability.
HEATHKIT COLOR BAR AND DOT GENERATOR

The CD-1 combines the two basic color service instruments, a Color Bar Generator and White Dot Generator in one versatile portable unit, which has crystal-controlled accuracy and stability (no external sync lead required). Produces white-dots, cross hatch, horizontal and vertical bars, 10 vertical color bars, and a new shading bar pattern for screen and background adjustments. Variable RF output on any channel from 2 to 6. Positive or negative video output, variable from 0 to 10 volts peak-to-peak. Crystal controlled sound carrier with off-on switch. Voltage regulated power supply using long-life silicon rectifiers. Gain knowledge of a new and profitable field by constructing this kit. Shpg. Wt. 12 lbs.

$59.95

HEATHKIT TELEVISION ALIGNMENT GENERATOR KIT

This fine TV alignment generator offers stability and flexibility difficult to obtain even in instruments costing several times this low Heathkit price. It covers 3.6 mc to 220 mc in four bands. Sweep deviation is controllable from 0 to 42 mc. The all-electronic sweep circuit insures stability. Crystal marker and variable marker oscillators are built in. Crystal (included with kit) provides output at 4.5 mc and multiplies thereof. Variable marker provides output from 19 to 60 mc on fundamentals and from 57 to 180 mc on harmonics. Effective two-way blanking to eliminate return trace. Phasing control. Kit is complete, including three output cables. Shpg. Wt. 16 lbs.

$49.95

HEATHKIT "EXTRA DUTY" 5' OSCILLOSCOPE KIT

This fine oscilloscope compares favorably to other scopes costing twice its price. It contains the extra performance so necessary for monochrome and color-TV servicing. Features push-pull horizontal and vertical output amplifiers, a 5UP1 CRT, built in peak-to-peak calibration source, a fully compensated 3-position step-type input attenuator, retrace blanking, phasing control, and provision for Z-axis modulation. Vertical amplifier frequency response is within +1.5 and -5 db from 3 CPS to 5 MC. Response at 3.58 MC down only 2.2 db. Sensitivity is 0.025 volts RMS/inch at 1 kc. Sweep generator covers 20 CPS to 500 kc in five steps, five times the usual sweep obtained in other scopes through the use of the patented Heath sweep circuit. Elched-metal circuit boards reduce assembly time and minimize errors in assembly, and more importantly, permit a level of circuit stability never before achieved in an oscilloscope of this type. Shpg. Wt. 21 lbs.

$69.90

HEATHKIT ELECTRONIC SWITCH KIT

A valuable accessory for any oscilloscope owner. It allows simultaneous oscilloscope observation of two signals by producing both signals, alternately, at its output. Four switching ratios. Provides gain for input signals. Frequency response ±1 db, 0 to 100 kc. A sync output is provided to control and stabilize scope sweep. Ideal for observing input and output of amplifiers simultaneously. Shpg. Wt. 8 lbs.

$20.00

HEATHKIT VOLTAGE CALIBRATOR KIT

This unit is an excellent companion for your oscilloscope. Used as a source of calibrating voltage, it produces near-perfect square wave signals of known amplitude. Precision 1% attenuator resistors insure accurate output amplitude, and multivibrator circuit guarantees good square waves. Output frequency is approximately 1000 CPS. Fixed outputs selected by panel switches are: 03, 0.1, 0.3, 1.0, 3.0, 10, 30 and 100 volts peak-to-peak. Allows measurement of unknown signal amplitude by comparing it to the known output of the VC-3 on oscilloscope. Shpg. Wt. 4 lbs.

$19.95

HEATH COMPANY A Subsidiary of Daystrom, Inc. BENTON HARBOR 20, MICH.

DECEMBER, 1957
HEATHKIT TUBE CHECKER KIT

Eliminate guesswork, and save time in servicing or experimenting. The TC-2 tests tubes for shorted elements, open elements, filament continuity, and operating quality on the basis of total emission. It tests all tube types encountered in radio and TV service work. Sockets are provided for 4, 5, 6 and 7-pin, octal, and loctal tubes, 7 and 9 pin miniature tubes, 5 pin hytron miniatures, and pilot lamps. Tube condition indicated on 4½" meter with multi-color "good-bad" scale. Illuminated roll chart with all test data built-in. Switch selection of 14 different filament voltages from .75 to 117 volts. Color-coded cable harness allows neat professional wiring and simplifies construction. Very easy to build, even for a beginner. Shpg. Wt. 12 lbs.

**MODEL TC-2**

$29.50

HEATHKIT HANDITESTER KIT

The small size and rugged construction of this tester makes it perfect for any portable application. The combination function-range switch simplifies operations. Measures AC or DC voltage at 0-10, 30, 300, 1000 and 5000 volts. Direct current ranges are 0-10 ma and 0-100 ma. Ohmmeter ranges are 0-3000 (30 ohm center scale) and 0-300,000 (3000 ohm center scale). Very popular with home experimenters, electricians, and appliance repairmen. Slips easily into your tool box, glove compartment, coat pocket, or desk drawer. Shpg. Wt. 3 lbs.

**MODEL M-1**

$14.50

HEATHKIT PICTURE TUBE CHECKER KIT

The CC-1 can be taken with you on service calls so that you can clearly demonstrate the quality of a customer's picture tube in his own home. Tubes can be tested without removing them from the receiver or cartons if desired. Checks cathode emission, beam current, shorted elements, and leakage between elements in electromagnetic picture tube types. Self-contained power supply, and large 4½" meter. CRT condition indicated on "good-bad" scale. Relative condition of tube fluorescent coating is shown in "shadowgraph" test. Permanent test cable with CRT socket and anode connector. No tubes to burn out, designed to last a lifetime. Luggage-type portable case. Shpg. Wt. 10 lbs.

**MODEL CC-1**

$22.50

HEATHKIT ETCHED-CIRCUIT VTVM KIT

This multi-purpose VTVM is the world's largest selling instrument of its type—and is especially popular in laboratories, service shops, home workshops and schools. It employs a large 4½" panel meter, precision 1% resistors, etched metal circuit board, and many other "extras" to insure top quality and top performance. It's easy to build, and you may rely on its accuracy and dependability. The V7-A will measure AC (RMS) and DC voltages in ranges of 0-1.5, 5, 15, 50, 150, 500 and 1500. It measures peak-to-peak AC voltage in ranges of 0-4, 14, 40, 140, 400, 1400 and 4000. Resistance ranges provide multiplying factors of X 1, X 10, X 100, X 1000, X 10k, X 100k, and X 1 megohm. Center-scale resistance readings are 10, 100, 1000, 10k, 100k, 1 megohm and 10 megohms. A db scale is also provided. The precision and quality of this VTVM cannot be duplicated at this price. Shpg. Wt. 7 lbs.

**MODEL V7-A**

$24.50

**Heathkits...**

*let you fill your exact needs from a wide variety of instruments*

**HEATHKIT 20,000 OHMS/VOLT VOM KIT**

This fine instrument provides a total of 25 meter ranges on its two-color scale. It employs a 50 ua 4½" meter, and features 1% precision multiplier resistors. Requires no external power. Ideal for portable applications. Sensitivity is 20,000 ohms-per-volt DC and 5000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 15, 50, 150, 500, 1500 and 5000 volts, AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are X 1, X 100 and X 10,000, with center-scale readings of 15, 1500 and 150,000 ohms. Covers -10 db to +65 db. Easy to build and fun to use. Attractive bakelite case with plastic carrying handle. Shpg. Wt. 6 lbs.

**MODEL MM-1**

$29.50

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**Priced low to fit your budget**

**ETCHED CIRCUIT VTVM**

**HANDITESTER**

**PICTURE TUBE CHECKER**

**30,000 OHMS/VOLT VOM**

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*High quality test gear you will be proud to own*
HEATHKIT RF SIGNAL GENERATOR KIT
Even a beginner can build this prealigned signal generator, designed especially for use in service work. Produces RF signals from 160 kc to 110 mc on fundamentals in five bands. Covers 110 mc to 220 mc on calibrated harmonics. Low impedance RF output in excess of 100,000 microvolts, is controllable with a step-type and continuously variable attenuator. Selection of unmodulated RF, modulated RF, or audio at 400 CPS, ideal for fast and easy alignment of radio receivers, and finds application in FM and TV work as well. Thousands of these units are in use in service shops all over the country. Easy to build and a real time saver, even for the part-time service technician or hobbyist. Shpg. Wt. 8 lbs.

HEATHKIT LABORATORY RF GENERATOR KIT
Tackle all kinds of laboratory alignment jobs with confidence by employing the LG-1. It features voltage-regulated B+, double shielding of oscillator circuits, copper-plated chassis, variable modulation level, metered output, and many other "extras" for critical alignment work. Generates RF signals from 100 kc to 30 mc on fundamentals in five bands. Meter reads RF output in microvolts or modulation level in percentage. RF output available up to 100,000 microvolts, controlled by a fixed-step and a variable attenuator. Provision for external modulation where necessary. Buy and use this high-quality RF signal generator that may be depended upon for stability and accuracy. Shpg. Wt. 16 lbs.

HEATHKIT DIRECT-READING CAPACITY METER KIT
Here's a fast, simple capacity meter. A capacitor to be checked is merely connected to the terminals, the proper range selected, and the value read directly on the large 4½" panel meter calibrated in mmf and mfd. Ranges are 0 to 100 mmf, 1,000 mmf, 0.1 mfd, .1 mfd full scale. Not affected by hand capacity. Shpg. Wt. 7 lbs.

Heathkits...
by Daystrom
are educational as well as functional

HEATHKIT "IN-CIRCUIT" CAPACITATION TESTER KIT
With the CT-1 it is no longer necessary to disconnect one capacitor lead to check the part. You can check most capacitors for open or "short" right in the circuit. Fast and easy—to save you valuable time in the service shop or lab. Detects open capacitors from about 20 mfd up, so long as the capacitor is not shunted by excessively low resistance value. Will detect shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). (Does not detect leakage.) Employs 60-cycle and 100 megacycle test frequencies. Electron beam "eye" tube used as indicator. Compact, easy to build, and inexpensive. Test leads included. Shpg. Wt. 5 lbs.

HEATHKIT CONDENSER CHECKER KIT
This handy instrument uses an electron beam "eye" tube as an indicator to measure capacity in ranges of .00001 to .005 mfd, 5 mfd, 50 mfd and 1000 mfd. Also measures resistance from 100 ohms to 5 megohms in two ranges. Checks paper, mica, ceramic and electrolytic capacitors. Selection of five polarizing voltages. Shpg. Wt. 7 lbs.

HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT
Although designed originally for radio receiver work, the T-3 finds application in FM and TV servicing as well. Features high-gain channel with demodulator probe, and low-gain channel with audio probe. Traces signals in all sections of radio receivers and in many sections of FM and TV receivers. Built-in speaker and electron beam eye tube indicate relative gain, etc. Also features built-in noise locator circuit. Provision for patching speaker and/or output transformer to external set. Shpg. Wt. 9 lbs.

HEATH COMPANY A Subsidiary of Daystrom, Inc. BENTON HARBOR 20, MICH.
DECEMBER, 1957
HEATHKIT IMPEDANCE BRIDGE KIT

The model IB-2A employs a Wheatstone Bridge, a Capacity Comparison Bridge, a Maxwell Bridge, and a Hay Bridge in one compact package. Measures resistance from 0.1 ohm to 10 megohms, capacitance from 100 mfd to 100 mfd, inductance from 0.1 mh to 100 h, dissipation factor (D) from 0.002 to 1, and storage factor (Q) from 0.1 to 100. A 100-0-100 ua meter provides for null indications. The decade resistors employed are of 1% tolerance for maximum accuracy. Completely self-contained. Has built in power supply, 1000-cycle generator, and vacuum-tube detector. Special two-section CRL dial insures convenient operation. Instruction manual has entirely new schematic that clarifies circuit functions in various switch positions. A true laboratory instrument, that will provide you with many years of fine performance. Shpg. Wt. 12 lbs.

HEATHKIT "LOW RIPPLE" BATTERY ELIMINATOR KIT

This modern battery eliminator incorporates an extra low-ripple filter circuit so that it can be used to power all the newest transistor-type circuits requiring 0 to 12 volts DC, and the new "hybrid" automobile radios using both transistors and vacuum tubes. Its DC output, at either 6 or 12 volts, contains less than .3% AC ripple. Separate output terminals are provided for low-ripple or normal filtering. Supplies up to 15 amps on 6 volt range or up to 7 amps on 12 volt range. Output is variable from 0 to 8 or 0 to 16 volts. Two meters constantly monitor output voltage and current. Will also double as a battery charger. Shpg. Wt. 23 lbs.

HEATHKIT ISOLATION TRANSFORMER KIT

The model IT-1 is one of the handiest units for the service shop, home workshop or laboratory. Provides complete isolation from the power line. AC-DC sets may be plugged directly into the IT-1 without the chassis becoming "hot". Output voltage is variable from 90 volts to 130 volts allowing checks of equipment under adverse conditions such as low line voltage. Rated for 100 volt amperes continuously or 200 volt amperes intermittently. Panel meter monitors output voltage. Shpg. Wt. 9 lbs.

HEATHKITS...

are designed with high-quality, name-brand components to insure long service life

HEATHKIT "Q" METER KIT

At this price the laboratory facilities of a Q Meter may be had by the average service technician or home experimenter. The Q Meter permits measurement of inductance from 1 microhenry to 10 millihenry, "Q" on a scale calibrated up to 250 full scale, with multipliers of 1 or 2, and capacitance from 40 mfd to 450 mfd ± 3 mfd. Built in oscillator permits testing components from 150 kc to 18 mc. Large 4½" panel meter is featured. Very handy for checking peaking coils, chokes, etc. Use to determine values of unknown condensers. Both variable and fixed, compile data for coil winding purposes, or measure RF resistance. Also checks distributed capacity and Q of coils. No special equipment is required for calibration. A special test coil is furnished, along with easy-to-follow instructions. Shpg. Wt. 14 lbs.

HEATHKIT REGULATED POWER SUPPLY KIT

Here is a power supply that will provide DC plate voltage and AC filament voltage for all kinds of experimental circuits. The DC supply is regulated for stability, and yet the amount of DC output voltage available from the power supply can be controlled manually from 0 up to 500 volts. At 450 volts DC output, the power supply will provide up to 10 ma of current, and provide progressively higher current as the output voltage is lowered. Current rating is 130 ma at 200 volts output. In addition to furnishing B+ the power supply also provides 6.3 volts AC at up to 4 amperes for filaments. Both the B+ output and the filament output are isolated from ground. Ideal unit for use in laboratory, home workshop, ham shack, or service shop. A large 4½" meter on the front panel reads output voltage or output current, selectable with a panel switch. Shpg. Wt. 17 lbs.

www.americanradiohistory.com
HEATHKIT DX-20 CW TRANSMITTER KIT
The Heathkit model DX-20 "straight-CW" transmitter features high efficiency at low cost. It uses a single 5D06A tube in the final amplifier stage for plate power input of 50 watts. A 6CL6 serves as crystal oscillator, with a 5U4GB rectifier. It is an ideal transmitter for the novice, as well as the advanced-class CW operator. Single-knob band switching is featured to cover 80, 40, 20, 15, 11 and 10 meters. Pi network output circuit matches various antenna impedances between 50 and 1000 ohms and reduces harmonic output. Top-quality parts are featured throughout, including "potted" transformers, etc., for long life. It has been given full "TVI" treatment. Access into the cabinet for crystal changing is provided by a removable metal pull-out plug on the left end of the cabinet. Very easy to build from the complete step-by-step instructions supplied, even if you have never built electronic equipment before. If you appreciate a good, clean signal on the CW bands, this is the transmitter for you! Shpg. Wt. 18 lbs.

Heathkits...

by Daystrom

are designed by licensed ham-engineers, especially for you

HEATHKIT DX-35 PHONE AND CW TRANSMITTER KIT
The DX-35 transmitter can be thought of as the "little brother" of the DX-100. It features both phone and CW operation on 80, 40, 20, 15, 11 and 10 meters. A single 6146 tube is used in the final amplifier stage to provide full 65 watt plate power input on CW, or controlled carrier modulation peaks up to 50 watts for phone operation. Modulator and power supplies are built right in and single knob band switching is combined with a pi network output circuit for complete operating convenience. The tight fitting cabinet presents a most attractive appearance, and is designed for complete shielding to minimize TVI. Back panel control provides convenient switch selection of three different crystals, reached through access door at rear of cabinet. A most remarkable power package for the price. Complete step-by-step instructions with pictorial diagrams to assure your success in assembly. Shpg. Wt. 24 lbs.

HEATHKIT DX-100 PHONE AND CW TRANSMITTER KIT
Listen to any ham band between 160 meters and 10 meters and note how many DX-100 transmitters you hear! The number of these fine rigs now on the air testifies to the enthusiasm with which it has been accepted by the amateur fraternity. No other transmitter in this power class combines high quality and real economy so effectively. The DX-100 features a built-in VFO, modulator and power supplies, complete shielding to minimize TVI, and pi network output coupling to match impedances from approximately 50 to 600 ohms. Its RF output is in excess of 100 watts on phone and 120 watts on CW, for a clean strong signal on all the ham bands from 10 to 160 meters. Single-knob band switching and illuminated VFO dial and meter face add real operating convenience. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 12AT7's. High quality components are used throughout, such as "potted" transformers, silver-plated or solid coin silver switch terminals, aluminum heat-dissipating caps on the final tubes, copper plated chassis, etc. This transmitter was designed exclusively for easy step-by-step assembly. Shpg. Wt. 107 lbs.

FUNCTIONAL DESIGN...
The transmitters described on this page were designed for the ham, by hams who know what features are desirable and needed. This assures you of the best possible performance and convenience, and adds much to your enjoyment in the ham shack.

HEATH COMPANY A Subsidiary of Daystrom, Inc. BENTON HARBOR 20, MICH. DECEMBER, 1957
HEATHKIT "AUTOMATIC" CONELRAD ALARM KIT
This conelrad alarm works with any radio receiver; AC-DC-transformer operated—or battery powered, so long as the receiver has AVC. Fully complies with FCC regulations for amateurs. When the monitored station goes off the air, the CA-1 automatically cuts the AC power to your transmitter, and lights a red indicator. A manual "reset" button reacts the transmitter. Incorporates a heavy-duty six-ampere relay, a thyatron tube to activate the relay, and its own built-in power supply. A neon lamp indicates the alarm is working, by indicating the presence of B+ in the alarm circuit. Simple to install and connect. Your transmitter plugs into an AC receptacle on the CA-1, and a cable connects to the AVC circuit of a nearby receiver. A built-in sensitivity control allows adjustment to various AVC levels. Receiver volume control can be turned up or down, without affecting alarm operation. Build a Heathkit CA-1 in one evening and comply with FCC regulations now! Shpg. Wt. 4 lbs.

HEATHKIT "Q" MULTIPLIER KIT
The Heathkit Q Multiplier functions with any AM receiver having an IF frequency between 450 and 460 KC, that is not "AC-DC" type. It derives its power from the receiver, and needs only 6.3 volts AC at 300 ma (or 12 VAC at 150 ma) and 150 to 250 volts DC at 2 ma. Simple to connect with cable and plugs supplied. Adds additional selectivity for separating signals, or will reject one signal and eliminate heterodyne. A tremendous help on crowded phone and CW bands. Effective Q of 4000 for sharp "peak" or "null". Tunes any signal within IF band pass without changing the main receiver tuning dial. A convenient tuning knob on the front panel with vernier reduction between the tuning knob and the tuning capacitor gives added flexibility in operation. Uses a 12AX7 tube, and special high-Q shielded coils. Instructions for connecting to the receiver and operation are provided in the construction manual. A worthwhile addition to any communications, or broadcast receiver. It may also be used with a receiver which already has a crystal filter to obtain two simultaneous functions, such as peaking the desired signal with the crystal filter and nulling an adjacent signal with the Q Multiplier. Shpg. Wt. 3 lbs.

HEATHKIT GRID DIP METER KIT
A grid dip meter is basically an RF oscillator for determining the frequency of other oscillators, or of tuned circuits. Extremely useful in locating parasitics, neutralizing, identifying harmonics, coil winding, etc. Features continuous frequency coverage from 2 mc to 250 mc, with a complete set of prewound coils, and a 500 ua panel meter. Front panel has a sensitivity control for the meter, and a phone jack for listening to the "zero-beat." Will also double as an absorption-type wave meter. Shpg. Wt. 4 lbs.

Low Frequency Coil Kit: Two extra plug-in coils to extend frequency coverage down to 350 kc. Shpg. Wt. 1 lb. No. 341-A. $3.00.

HEATHKIT ALL-BAND COMMUNICATIONS-TYPE RECEIVER KIT
This communications-receiver covers 550 kc to 30 mc in four bands, and provides good sensitivity, selectivity, and fine image rejection. Ham bands are clearly marked on an illuminated dial scale. Features a transformer-type power supply—electrical band spread—antenna trimmer—head-phone jack—automatic gain control and beat frequency oscillator. Accessory sockets are provided on the rear of the chassis for using the Heathkit model OF-1, Q Multiplier. Accessory socket is handy, also, for operating other devices that require plate and filament potentials. Will supply +250 VDC at 15 ma and 12.6 VAC at 300 ma. Ideal for the beginning ham or short wave listener. Shpg. Wt. 12 lbs.

Cabinet: Fabric covered cabinet with aluminum panel as shown. Part no. 91-15A. Shpg. Wt. 5 lbs. $4.95.

Heathkits...

are outstanding in performance and dollar value
HEATHKIT REFLECTED POWER METER KIT

The Heathkit reflected power meter, model AM-2, makes an excellent instrument for checking the match of the antenna transmission system, by measuring the forward and reflected power or standing wave ratio. The AM-2 is designed to handle a peak power of well over 1 kilowatt of energy and may be left in the antenna system feed line at all times. Band coverage is 180 meters through 2 meters. Input and output impedances are 50 or 500 ohms lines. No external power required for operation. Meter indicates percentage forward and reflected power, and standing wave ratio from 1:1 to 6:1. Another application for the AM-2 is matching impedences between exciters or R.F. sources and grounded grid amplifiers. Power losses between transmitter and output and antenna tuner may be very easily computed by inserting the AM-2 in the line connecting the two. No insertion loss is introduced into the feeder system, due to the fact that the AM-2 is a portion of coaxial line in series with the feeder system and no internal connections are actually made to the line. Complete circuit description and operation instructions are provided in the manual. Cabinet size is 7-3/8" x 4-1/16" x 4-5/8". Can be conveniently located at operating position. Shpg. Wt. 3 lbs.

MODEL AM-2
$15.95

HEATHKIT VARIABLE FREQUENCY OSCILLATOR KIT

Enjoy the convenience and flexibility of VFO operation by obtaining the Heathkit model VF-1 Variable Frequency Oscillator. Covers 160-30-40-20-15-11 and 10 meters with three basic oscillator frequencies. Better than 10 volt average RF output on fundamentals. Plenty of output to drive most modern transmitters. It features voltage regulation for frequency stability. Dial is illuminated for easy reading. Vernier reduction is used between the main tuning knob and the tuning condenser. Requires a power source of only 250 volts DC at 15 to 20 milliamperes and 6 3/4 volts AC at 0.45 amperes. Extra features include copper-plated chassis, ceramic coil forms, extensive shielding, etc. High quality parts throughout. VFO operation allows you to move out from under interference and select a portion of the band you want to use without having to be tied down to only two or three frequencies through use of crystals. "Zero in" on the other fellow's signal and return his CQ on his own frequency! Crystals are not cheap, and it takes quite a number of them to give anything even approaching comprehensive coverage of all bands. Why hesitate? The model VF-1 with its low price and high quality will add more operating enjoyment to your ham activities. Shpg. Wt. 7 lbs.

MODEL VF-1
$19.50

HEATHKIT BALUN COIL KIT

The Heathkit Balun Coil Kit model B-1 is a convenient transmitter accessory, which has the capability of matching unbalanced coax lines, used on most modern transmitters, to balance lines of either 50 or 200 ohms impedance. Design of the bifilar wound balun coil will enable transmitters with unbalanced output to operate into balanced transmission line, such as used with dipoles, folded dipoles, or any balanced antenna system. The balun coil set can be used with transmitters and receivers, without adjustment over the frequency range of 80 through 10 meters, and will easily handle power inputs up to 250 watts. Cabinet size is 9" square by 5" deep and it may be located any distance from the transmitter or from the antenna. Completely enclosed for outdoor installation. Shpg. Wt. 4 lbs.

MODEL B-1
$8.95

HEATHKIT 6 OR 12 VOLT VIBRATOR POWER SUPPLY KITS

These little power supply kits are ideal for all portable applications with 6 volt or 12 volt batteries, when you are operating electronic equipment away from power lines. By replacing the power supplies of receivers, small public address systems, or even miniature transmitters with these units, they can be used with conventional 6 or 12 volt batteries. Use in boats, automobiles, light aircraft, or any field applications. Each unit provides up to 250 volts DC output at up to 60 milliamperes. More than one power supply of the same model may be connected in parallel for increased current capacity at the same output voltage. Everything is provided in the kit, including a vibrator transformer, a vibrator, 6X4 or 12X4 rectifier, and the necessary buffer capacitor, hash filter, and output filter capacitor. Shpg. Wt. 4 lbs.

6 VOLT
MODEL VF-1-6
$7.95 Each

12 VOLT
MODEL VF-1-12
$7.95 Each
HEATHKIT ELECTRONIC IGNITION ANALYZER KIT

Previous electronic experience is not necessary to build this fine ignition analyzer. The construction manual supplied has complete step-by-step instructions plus large pictorial diagrams showing the exact placement and value of each component. All parts are clearly marked so that they are easily identified. The IA-1 is an ideal tool for engine mechanics, tune-up men, and auto hobbyists, since it traces the dynamic action of voltage in an ignition system on a cathode-ray tube screen. The waveform produced is affected by the condition of the coil, condenser, points, plugs, and ignition wiring, so it can be analyzed and used as a "sign-post" to ignition system performance. This analyzer will detect inequality of spark intensity, a poor spark plug, defective plug wiring, breaker-point bounce, an open condenser, and allow defective plug wiring, breaker-point bounce, will detect inequality of voltage of spark system. The dynamic action of the engine can be shown, and the points, condenser, and spark plug, etc., can be identified. The kit price includes batteries. Shpg. Wt. 18 lbs.

MODEL IA-1 $59.95

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

This Heathkit professional-type radiation counter is simple to build successfully, even if you have never built a kit before. Complete step-by-step instructions are combined with giant-size pictorial diagrams for easy assembly. By "building it yourself" you can have a modern-design, professional radiation counter priced far below comparable units. Provides high sensitivity with ranges from 0-100, 600, 6000 and 60,000 counts-per-minute, and 0-0.2, 0.1 and 10 miliroentgens-per-hour. Employs 900- volt bismuth tube in beta/gamma sensitive probe. Probe and 8-foot expandable cable included in kit price, as is a radiation sample for calibration. Use it in medical laboratories, or as a prospecting tool, and for civil defense to detect radioactive fallout, or other unknown radiation levels. Features a selectable time constant. Meter calibrated in CPM or mR/hour in addition to "beep" or "click" from panel-mounted speaker. Prebuilt "packaged" high voltage power supply with reserve capacity above 900 volt level at which it is regulated. Merely changing regulator tube type would allow use of scintillation probe if desired. Employs five tubes (plus a transistor) to insure stable and reliable operation. Kit price includes batteries. Shpg. Wt. 8 lbs.

MODEL RC-1 $79.95

Heathkits...

BY DASTROM

are supplied with comprehensive instructions that eliminate costly mistakes and save valuable time

HEATHKIT ENLARGER TIMER KIT

The ET-1 is an easy-to-build electronic device to be used by amateur or professional photographers in timing enlarger operations. The calibrated dial on the timer covers 0 to 1 minute, calibrated in 5-second gradations. The continuously variable control allows setting of the "on" cycle of your enlarger, which is plugged into a receptacle on the front panel of the ET-1. A "safe light" can also be plugged in so that it is automatically turned "on" when the enlarger is turned "off." Handles up to 350 watts with built-in relay. All-electronic timing cycle insures maximum accuracy. Timer does not have to be reset after each cycle, merely flip lever switch to print, to repeat time cycle. A control is provided for initial calibration. Housed in a compact plastic case that will resist attack of photographic chemicals. A fine addition to any dark room. Shpg. Wt. 3 lbs.

MODEL ET-1 $77.50

HEATHKIT BATTERY TESTER KIT

The BT-1 is a special battery testing device that actually "loads" the battery under test (draws current from it) while it is being tested. Weak batteries often test "good" with an ordinary voltmeter but the built-in load resistance of the BT-1 automatically draws current from the battery to reveal its true condition. Simple to operate with "good-weak-replace" scale. Tests all kinds of dry cell batteries within ranges of 0-15 volts and 0-180 volts. Slide switch provides for either 10 ma or 100 ma load, depending on whether you're testing an A or B battery. Not only determines when battery is completely exhausted, but makes it possible to anticipate failure by noting weak condition. Ideal for testing dry cell hearing aid, flashlight, portable radio, and model airplane batteries. Test batteries in a way your customers can understand and stimulate battery sales. Shpg. Wt. 2 lbs.

MODEL BT-1 $85.00

RADIO-ELECTRONICS

www.americanradiohistory.com
HEATHKIT CRYSTAL RADIO KIT
The Heathkit model CR-1 crystal radio is similar to the "crystal sets" of the early radio days except that it has been improved by the use of sealed germanium diodes and efficient "high-Q" coils. The sealed diodes eliminate the critical "cats whisker" adjustment, and the ferrite coils are much more efficient for greater signal strength. Housed in a compact plastic box, the CR-1 uses two tuned circuits, each with a variable tuning capacitor, to select the local station. It covers the broadcast band from 540 to 1600 kc. Requires no external power whatsoever. This receiver could prove valuable to emergency reception of civil defense signals should there be a power failure. The low kit price even includes headphones. Complete step-by-step instructions and large pictorial diagrams are supplied for easy assembly. The instruction manual also provides the builder with the basic fundamentals of signal reception so that he understands how the crystal receiver functions. An interesting and valuable "do-it-yourself" project for all ages. Shpg. Wt. 3 lbs.

HEATHKIT TRANSISTOR PORTABLE RADIO KIT
Heath engineers set out to develop a "universal" AM radio, suitable for use anywhere. Their objective was a portable that would be as much "at home" inside as it is outside, and would feature top quality components for high performance and long service life. The model XR-1 is the result of these efforts. Six name-brand (Texas Instrument) transistors were selected for extra good sensitivity and selectivity. A 4" by 6" PM speaker with heavy magnet was chosen to insure fine tone quality. The power supply was designed to use six standard size "D" flashlight cells because they are readily available, inexpensive, and because they afford extremely long battery life (between 500 and 1000 hours). Costs you no more to operate from batteries than what you pay for operating a small table-model radio from the power line. An unbreakable molded plastic was selected for cabinet material because of its durability and striking beauty. Circuit is compact and efficient, yet components are not excessively crowded. Transformers are prealigned so it is ready for service as soon as construction is completed. Has built in rod-type antenna for reception in all locations. Cabinet dimensions are 9" L x 8" H x 3 1/4" D. Comes in holiday gray, with gold-anodized metal speaker grille. Compare this portable, feature by feature, to all others on the market, and you'll appreciate what a tremendous dollar value it represents! Shpg. Wt. 4 lbs.

HEATHKIT BROADCAST BAND RADIO KIT
This table-model broadcast radio is fun to build, and is a fine little receiver for your home. It covers the standard broadcast band from 550 to 1600 kc with good sensitivity and selectivity. The 51/2" PM speaker provides surprisingly good tone quality. High-gain IF transformers, miniature tubes, and a rod-type built in antenna, assure good reception in all locations. The power supply is transformer operated, as opposed to many of the economy "AC-DC" types. It's easy to build from the step-by-step instructions, and the construction manual includes information on operational theory, for educational purposes. Your success is assured by completely detailed information which also explains resistor and capacitor color codes, soldering techniques, use of tools, etc. A signal generator is recommended for final alignment. Shpg. Wt. 10 lbs. Cabinet: Fabric covered cabinet with aluminum panel as shown. Shpg. Wt. 5 lbs. Part no. 91-9A. $4.95.

HEATHCOMAPNY A Subsidiary of Daystrom, Inc. BENTON HARBOR 20, MICH. DECEMBER, 1957

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HEATHKIT FUEL VAPOR DETECTOR KIT

Protect your boat and its passengers against fire or explosion from undetected fuel vapor by building and using one of these fine units. The Heathkit Fuel Vapor Detector indicates the presence of fumes on a three-color "safe-dangerous" meter scale and immediately shuts off if it is safe to start the engine. A red light on the front panel shows when the detector is operating, and it can be left on continuously, or just used intermittently. A panel control enables initial calibration of the detector when installed. Features a hermetically sealed meter with chrome bezel, and a chrome-plated brass panel. It is very simple to build and install, even by one not having previous experience. Models FD-1-6 (6 volts DC) and FD-1-12 (12 volts DC) operate from your boat batteries. The kit is complete in every detail, even to the inclusion of a spare detector unit. Shpg. Wt. 4 lbs.

HEATHKIT BATTERY CHARGE INDICATOR KIT

The Heathkit model CI-1 Marine Battery Charge Indicator has been designed especially for the boat owner, although it has found use in service stations, power stations, and radio stations where banks of batteries are kept in reserve for emergency power. It is intended to replace the hydrometer method of checking storage batteries, and to eliminate the need for working with acid in small, below-decks enclosures. Now it is possible to check as few as one, or as many as eight storage batteries, merely by turning the switch and watching the meter. A glance at the meter tells you instantly whether your batteries are sufficiently charged for safe cruising. Dimensions are 2-7/8"W x 5-11/16" H x 2" D. Operates on either 6 or 12 volt systems using lead-acid batteries, regardless of size. Simple installation can be accomplished by the boat owner in fifteen minutes. Shpg. Wt. 3 lbs.

HEATHKIT ELECTROLYSIS DETECTOR KIT

The Heathkit model ED-1 Electrolysis Detector indicates the extent of electrolysis currents between the boat's common ground and underwater fittings, except on boats having metal hulls. These currents, undetected, could cause gradual corrosion and deterioration of the propeller or other metal fittings below the water line. It is particularly helpful when installing electrical equipment of any kind, or to determine proper polarity when power is obtained from a shore supply. Easy to build, the model ED-1 consists of a hermetically sealed, waterproof meter, special sensing plate, and sufficient wire to install, including the necessary hardware. Mounts on instrument panel where it can be easily seen. Requires no power for operation, and gives instant warning to guard your boat for a lifetime. Shpg. Wt. 2 lbs.

HEATHKIT RF POWER METER KIT

The Heathkit RF Power Meter Kit is designed to sample the RF field in the vicinity of your transmitter, whether it be marine, mobile, or fixed. Output meter is merely placed in some location close to the transmitter, to pick up RF radiation from the antenna. Requires no batteries, electricity, nor direct connection to the transmitter. It provides you with a continuing indication of transmitter operation. You can easily check if power is dropping off by comparing present meter readings with past ones. Operates with any transmitter having output frequencies between 100 kc and 250 mc, regardless of power. Sensitivity is 0.3 volts RMS full scale, and a special control on the panel allows for further adjustment of the sensitivity. Meter is a 200 ua unit, mounted on a chrome-plated brass panel. The entire PM-1 measures only 3½" W x 6¼" L x 2" D. An easy way to put your mind at ease concerning transmitter operation. Shpg. Wt. 2 lbs.

Healthkits...

by D. A. STROM

now offer you completely modern marine equipment with outstanding design features
HEATHKIT TRANSISTOR RADIO DIRECTION FINDER KIT

The Heathkit Transistor Radio Direction Finder model DF-1 is a self-contained, self-powered, 6-transistor super heterodyne broadcast radio receiver incorporating a directional loop antenna, indicating meter, and integral speaker. It is designed to serve primarily as an aid to navigation when out of sight of familiar landmarks. It can be used not only aboard yachts, fishing craft, tugs, and other vessels which navigate either out of sight of land or at night, but also for the hunter, hiker, camper, fisherman, aviator, etc. It is powered by a 9-volt battery. (A spare battery is also included with the kit.) The frequency range covers the broadcast band from 540 to 1600 kc and will double as a portable radio. A directional high-Q ferrite antenna is incorporated which is rotated from the front panel to obtain a fix on a station and a 1 ma meter serves as the null and tuning indicator. The controls consist of: tuning, volume and power (on-off), sensitivity, heading indicator (compass rose) and bearing indicator (antenna index). Overall dimensions are 7¾" W x 5½" H x 5¾" D. Supplied with slip-in-place mounting brackets, which allow easy removal from ship bulkheads or other similar places. Shpg. Wt. 5 lbs.

Heathkits... by Daystrom
are sold only by direct mail, passing middleman profits on to you

Pioneer in "do-it-yourself" electronics

HEATH COMPANY A Subsidiary of Daystrom, Inc. BENTON HARBOR 20, MICH.

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DECEMBER, 1957

HEATHKIT RADIO DIRECTION FINDER KIT

use it for a radio-compass or as a portable radio

HOW CAN YOU MISS?
The Heath Company maintains a technical consultation service, should you experience some sort of difficulty in construction or operation. Although only a very small percentage of our customers ever have occasion to use this service (usually only beginners in electronics) it is still reassuring to know that technical help is available when needed. A service department is also available, should you wish a complete factory check of operation and alignment or repair. After you build your first Heathkit you'll realize how easy it is.

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The cartridge of tomorrow is HERE!

To ride in America's first jet airliner, you'll have to wait until 1959—but the cartridge of tomorrow can be yours today! The sensational new ESL C-60 electrodynamic cartridge, as advanced as tomorrow's jet and musical as a rare Stradivarius, is now at your audio dealer's.

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COMPARE THESE MINIMUM PERFORMANCE DATA:

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FOR LISTENING AT ITS BEST

Electro-Sonic Laboratories, Inc.
Dept. E • 35-54 Thirty-sixth Street • Long Island City 6, N.Y.

TELEVISION

(Continued from page 59) lucky. I harpooned it before it got up and ran off."

"Say, Red..."

"What now?"

"I hear they got a hoot-nanny out that you can plug on the base of the picture tube. It's supposed to have a switch that you use to turn on the red or blue or green by itself."

"Nothing wrong with your hearing," Red remarked. "Yep, what it does is to ground two grids at a time. The cathodes run positive in a color set, so that's the same as putting a negative bias on the grids."

"Seems like that would be real fine for checking field purity," Fuzzball suggested.

"It's a timesaver," Red agreed. "In fact we have half a dozen on order. We're going to use them on the bench, too."

"For what?"

"Well," replied Red, "it's got six other switch positions, too. You can switch a pair of binding posts into the different grid and cathode circuits of the picture tube for a quick voltage check all around."

"You connect a meter to the hoot-nanny?"

"Yep. Has a pair of binding posts for connecting the meter."

"What won't they think of next?" asked Fuzzball.

"Do you really want to know?" asked Red challengingly.

"Reckon I'll pass," Fuzzball replied.

"What other gimmicks should I know about for installation work?"

"Well, in case you are working on your own set sometime, where you are interested in doing a good job, you'll find a low-power pocket microscope is handy."

"A microscope?"

"M-I-C-R-O-S-C-O-P-E," Red spelled out emphatically.

"All right, you don't have to throw your weight around," Fuzzball grumbled; "what would I be doing with a microscope?"

"It's for checking field purity," Red explained. "It's a sort of head shrinker that reduces a swelled head real fast."

"How do I use it?" asked Fuzzball.

"Let's get into that one another time," suggested Red. "Bess is getting ready to throw us out."

END
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www.americanradiohistory.com
ONE member of our family could get no pleasure out of the TV set because he is hard of hearing. No matter how high the volume was turned up it did no good and of course there were others to consider. A hearing aid didn’t help much as it picked up too much noise from sources other than the TV set. A phono jack could have been used but the volume control then could be set only either for loudspeaker or phones.

Obviously, the answer was a separate amplifier and volume control. Preferably, the amplifier should be peaked at the higher frequencies for that is where most of the hearing range of the hard of hearing usually lies. (Many authorities believe that a flat response is more satisfactory to the usual hard-of-hearing person.—Editor)

This unit was the result. It is a simple two-stage amplifier (see diagram) and provides more than enough gain. No attempt was made at high fidelity, the only requirements being crispness and clarity.

The amplifier input is taken from the audio output tube so that there is always enough signal to drive the amplifier input section even though the speaker volume is turned down to the point where no one else can hear it. This makes it useful for late-hour listening when others are asleep, even for those whose hearing is not impaired.

I took the audio input from the plate (pin 5) of a 6A95. The B plus for the hearing aid came from the screen grid (pin 6). Pin 3 supplies the hot 6.3-volt side of the heater and ground return was made to the chassis. For other output tubes use the same system, connecting the leads to corresponding pins. The input lead should be shielded and the shield itself used for ground and heater return. Make all grounds to one point on the chassis. A word of caution: before wiring in the hot heater lead, check to see which is the ground side. If this connection is not properly made, it will short the 6.3-volt winding of the power transformer to ground and probably burn out your transformer.

The chassis is a sheet-metal angle and can be made any convenient size. It is held to the inside of the TV cabinet by screws and the necessary holes drilled in the front of the cabinet for the gain control and earphone jack. If it is not desirable to drill holes in the cabinet, the amplifier can be built in a small box and kept near the receiver.

The circuit shown in the diagram was designed for a receiver having its heaters in parallel. Series-string heaters will require some modification, especially if the chassis is transformerless. In such case a .01-mfd capacitor should be placed between the output jack and the lead to the TV chassis. This will isolate the phones from the ac line.

The 12AV7 draws 450 ma with its heaters in parallel. This may exceed the safe operating limits of the existing power transformer or make it difficult to use in series strings. The problem can be overcome by using a separate heater transformer or a tube such as the 12A7 which draws only 300 ma. If a 12A7 is used, the plate and cathode resistor values may have to be varied slightly to obtain maximum gain.

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TELEVISION

Understanding auxiliary TV circuits

By CHARLES GARRETT

TV RECEIVERS are spotted with a number of special circuits and circuit components that can be troublesome to the service technician unless he is thoroughly aware of their normal and abnormal operation.

Horizontal peaking

The largest group of auxiliary circuits (circuits and components may often ignored or left out when discussing or simplifying the TV receiver's main circuitry) is located in the deflection oscillators and their associated circuitry. Some of these networks are shown in Fig. 1. The networks labeled a, b, c and d are all sawtooth-forming circuits. As their fundamental operation is the same, only network a is detailed. It is the sawtooth-forming network for a horizontal multivibrator.

The output from a multivibrator cannot be used directly to drive the horizontal output tube and deflection circuits as it is basically a square wave and not the sawtooth usually thought of in its connection. Photo A shows the output of the horizontal multivibrator with the sawtooth-forming network removed. The sawtooth has to be formed from this “square wave” to obtain a linear raster.

In normal operation the capacitor (called either charging or discharging capacitor) prevents the horizontal plate voltage from rising sharply by storing the rapid voltage change during its steady charging period. It releases its charge when the horizontal oscillator fires during the horizontal retrace period.

The series resistor in this circuit, by slowing down the capacitor's discharge, forms a negative pulse following the capacitor discharge. Photo B is the square wave found at the junction of the capacitor and resistor in circuits 1-a, 1-c and 1-d. This waveform combines with the capacitor waveform to form a modified sawtooth wave. The resistor determines the size of the negative pulse the sawtooth waveform will have. The size of the negative pulse that is needed is determined by the type of horizontal output tube used, and the design of the output transformer and output circuit whose inductance has to be overcome before the sawtooth portion can produce a linear sweep and raster. Photo C shows the waveform at the horizontal multivibrator's plate, with the resistor in circuit 1-a removed and the capacitor going directly to ground. The modified sawtooth in Photo D appears at the plate of the horizontal multivibrator with circuit 1-a connected. This waveform is found in the older TV sets.

Photo E shows another modified waveform found at the plate of a horizontal multivibrator with circuit 1-a connected. This is the normal plate waveform in most modern sets.

Improper operation of this circuit is not always obvious. The symptoms are very similar to those that can originate in other circuits and components. For example, in many receivers, when the capacitor or resistor opens, the only symptom is a slightly nonlinear raster on the left half of the screen. In this case, the amplifier or linearity circuit would normally be suspected instead of the sawtooth-forming network. However, overdrive bars in the center of the screen or even complete loss of raster are the more common symptoms of an open sawtooth-forming network.

A shorted resistor or one that has decreased in resistance will cause the raster to narrow somewhat and be nonlinear near its center. But several other circuit defects or misadjustments can produce similar symptoms. In every case of stubborn nonlinearity or insufficient width or height, an oscilloscope check should be made of the waveform at test points TP in Fig. 1 to determine if the source of the trouble is in the sawtooth-forming network.

Circuit 1-b is the sawtooth capacitor in a pulse-width type of horizontal oscillator. When this capacitor opens, it so greatly upsets the characteristics of this circuit that it usually kills the raster. This is because the normal waveform at the tap on the oscillator or transformer is destroyed and the oscillator is thrown way off frequency. Direct substitution is the easiest way to check this capacitor.

Stabilizing circuits

Networks a and b in Fig. 2 are horizontal stabilizing or ringing coils. Their function is not vital to the receiver's performance—horizontal oscillators could function without them, though not without some sacrifice of picture stability. Photo F shows the effect of a misaligned horizontal ring

The tail ends you rarely hear about, but often cause trouble

their normal operation is as follows: When correctly tuned to the horizontal frequency of 15,750 cycles, they are shocked into sine-wave oscillation and this voltage combines with the normal circuit waveform.

This combined negative voltage (during cutoff) holds the second grid of the horizontal multivibrator or pulse-width oscillator more negative and more evenly negative until the tube is properly triggered by the positive-going sync pulses. Thus, positive noise pulses have to overcome an even greater negative voltage before they can maturely fire the circuit. Also, the positive half of the sine wave will properly trigger the tube into conduction even if sync pulses are temporarily absent.

The sine wave formed by this circuit is finally eliminated by the sawtooth-forming capacitor, as previously described.

Circuit 2-a is normally aligned with a voltmeter. A jumper is first placed across the coil and the negative voltage on the multivibrator input grid test point is measured and recorded. The jumper is then removed and the coil aligned by adjusting it until grid voltage returns to the value it had with the jumper in place.

If the coil is not responsive to adjustment, it may be open, contain shorted turns or its shunting resistor or capacitor may be defective.

Circuit 2-b is aligned with an oscilloscope. The slug of coil L2 is adjusted until a waveform like that in Photo G is formed. This waveform should be present at the tap on L1. Adjustment of L1's slug may be required to hold the picture in horizontal sync during alignment of L2.

The circuit can produce severe raster tearing when it approaches correct alignment. Photo H shows raster breakup due to incorrect adjustment of horizontal stabilizing coils. Therefore, once the proper scope waveform is obtained, some slight touchup may be required to keep the raster from breaking up within the normal horizontal hold range of the set.

That about closes the shop for this month. Look for more on accessory circuits in a future issue. Retrace blanking, vertical peaking and yoke damping defects will be discussed. END
Fig. 1—Sections of deflection oscillator circuits: a, b, c, and d are sawtooth forming networks.

Fig. 2—Horizontal stabilizing or ringing coils are found in horizontal oscillator circuits.
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## TELEVISION

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Our record books showed more than the usual number of calls for service, far exceeding the average for the fine set we had sold.

Finally we got the story from a disgruntled neighbor of the loud-mouthed brother. Unwilling to pay the legitimate price for a receiver like the one his brother had bought from us, the mouthy man had purchased an exactly similar one from a fly-by-night discount dealer at a substantial price reduction. He couldn't get service from the discountier, on the low price he'd paid. So, each time the set conked out, he'd cart it over to the brother's house and hook it up in place of the one we'd sold. Then the brother would phone us that his set was on the blink.

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We learned our lesson, and now we can identify any set we sell.—H. J. Miller

(The Miller concern has our sympathy, but not too much of it. We have always insisted that a service shop should have the serial number of every set that is repaired—Mr. Miller's experience is only one of the many reasons for that. For a dealer this precaution is many times more necessary than it is for a service technician.—Editor)

### CANCELLED!

This space was reserved for an advertiser who refused to state whether the tube he was selling by mail were new, unused and perfect, or in any way standard. The publishers of RADIO-ELECTRONICS have insisted on such a statement in all mail-order tube advertising since January 1956. This policy has lost us considerable advertising space—but it protects our readers.
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COLOR TV receiver can be a rather frightening object, when we go out on our first service call. All the confidence that we feel back at the shop seems to sort of ooze out of our pores as we turn on the receiver and begin to study the symptoms.

However, most color receiver servicing requires only replacement of defective tubes. Fig. 1 shows a partial block diagram of a color receiver. You can see that a faulty tube can sometimes be localized by observing the reproduction (or lack of reproduction) of chroma, black-and-white and audio signals. Even the noise reproduction has a definite story to tell about the receiver's circuits.

A complaint of no sound and no picture may indicate a faulty tube in the front end or in the if stages prior to the sound takeoff point.

A complaint of no color picture, but with black-and-white reproduction and sound OK, points to a faulty tube in the chroma or possibly in the color sync sections. For example, if the chroma bandpass amplifier tube is dead, no chroma signal can pass. In some cases, when the color afc tube is defective, the color signal rolls so fast on the screen that the colors produce a neutral gray, and the color drops out of the picture.

If the color picture is satisfactory but the sound is dead, the tubes in the sound channel should be checked, just as in a black-and-white receiver.

When the symptom is very poor definition, with colors dim and bluish, check the tubes in the Y channel between the color takeoff point and the picture tube.

Clear distinction must be made between raster colors and signal colors on the screen of the picture tube. Raster colors are present during black-and-white reception and in the absence of a signal. It is necessary to apply a color signal to the receiver before a check of the signal colors can be obtained. Signal colors appear superimposed upon the raster colors.

Raster colors are controlled by dc voltages on the cathodes, grids and screen grids of the color picture tube. Since modern color receivers often use dc coupling in the chroma channels, a tube fault which affects the signal may affect the background too. Here, the circuit diagram for the receiver is a valuable guide.

Blown fuses
A few days after an Olympic 24-inch set (chassis 4CG26) was installed, it started blowing the ½-amp 250-volt fuses. A replacement fuse would last only a couple of days. The factory advised me to return to the flyback transformer. However, it seemed to me that the filter choke was grounding out. I replaced the choke with a resistor, slipped in a new fuse and the set operated OK for another day or so.

Then the damper tube blew and something in the horizontal output circuit is shorting out and smoking. The set is dead. Where should I start to nail this one down once and for all?—J. E., New Jersey.

I would suggest that the initial trouble with this receiver was a defect in the flyback, which occasionally drew excessive current from the horizontal output tube. However, there is also the possibility that the B-plus drain is marginal due to an open filter choke, which you noted. I suggest that you check through all the B-plus circuits to find out which one is drawing too much current (which causes the smoke that you mentioned).

This check should lead you to the main difficulty. Even an ohmmeter check of the B-plus branch circuits should serve.

No sound
Complaint on a Crosley GC2iTOJ was "no sound dead." The picture was normal. I found at the grid of the 25L6 a voltage of 170 instead of 142. Why is this voltage high and killing the sound?—A. R., Hamilton, Ont.

Use a 01-m series capacitor with a pair of headphones as an audio signal tracer. Find out where the sound stops, and go to work at that point in the circuit. It is certainly true that a voltage of 170 on the grid of the 25L6 will kill the sound, if the cathode is running at the specified 150 volts. The 25L6 in this receiver is used as a voltage divider. If the receiver is operating normally except for sound, look for trouble in the divider resistors which bring the 280-volt supply down to 142 volts.

Dim raster
I am working on a G-E model 21C928U with symptoms that would seem to indicate a simple repair job. However, I have worked myself blue in the face and cannot come up with the trouble. It is a condition of intermittent dimming of the raster with insufficient vertical sweep. The a may be OK for a day or the trouble may occur when it is first turned on. All voltages and resistances check OK except the cathode of the 6V3 which reads 740 volts instead of 645.—R. R., Westerlyport, Md.

This intermittent trouble sounds very much like a bad electrolytic which is breaking down on occasion. The de- (Continued on page 93)
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- Pi Antenna Coupler
- Bandswitching—
  80 to 10 Meters

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TELEVISION

(Continued from page 84)

efective electrolytic would be in either the vertical sweep or vertical oscillator circuit. Check the electrolytics carefully and replace those that do not have full capacitance and good power factor. It would also be advisable to make an over-voltage check of the electrolytics by running the line voltage up 15%. A bad electrolytic will break down faster on this test. It will get hot after a while, and you can find the bad one by touching its case.

Ringing

A Pacific Mercury chassis 150 has a severe case of ringing, with numerous vertical bars on the left side of the raster. The manufacturer states that the flyback transformer is probably defective. I replaced the horizontal output transformer and found that the improvement was so slight as to be negligible. I then checked all components in the horizontal output and damper circuits but this did not help either. An oscilloscope check clearly indicates a periodic oscillation in and around the flyback circuit, but the trouble cannot be pinned down. Perhaps I should try another flyback transformer but I am convinced that this is not the fault.

Since all the components check good, I would like to know of some circuit modification that would cure the trouble. Otherwise, perhaps you can recommend some way to re-dress the critical wires in this circuit.—G. B. Cranson, R. I.

The manufacturer's recommendation of replacing the flyback was probably based on this trouble appearing in other chassis in this series. Modifying the circuitry would be merely shooting in the dark in this case, and re-dressing the wires could possibly make things worse. Because of the nature of the trouble, I feel that the most efficient way out of the trouble is to simply install an anti-ringng coil. (See Fig. 2.)

In installing this coil, you will have to remove capacitor C19, a 100-µF unit connected between terminals 7 and 3 of the high-voltage transformer. Then connect the anti-ringng coil in series with C19, with C19 tied to terminal 9 of the transformer and the coil to terminal 5. This will place the coil

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across a major portion of the flyback turns and choke off the ringing which is probably originating somewhere in the damper-yoke circuit. The antiringing coil should be approximately 3 µh. If you wind it yourself, use a 1-watt resistor as a form.

Be sure the solder joint between the coil and capacitor C19 is smooth and round. Also, dress the coil and capacitor close to the transformer, as far as possible from the chassis to avoid corona.

Vertical sync instability

The complaint in a Philco TV-350 chassis is intermittent vertical roll. A thorough check of the vertical oscillator and output circuits showed everything to be per manufacturer's specifications.

Fig. 3—Modification to increase sync stability of Philco TV-350.

The customer said that before moving here from a strong-signal area the set played perfectly. I then carefully checked the vertical integrator and the sync separator stage, but still without finding anything out of order. A few resistors were slightly off value, but replacing them did not help.

The horizontal sync on this set is extremely stable so I started replacing components in the vertical oscillator stage, and some in the sync stage, but could not improve the situation. Short of replacing all components in the set, I would appreciate any suggestions that you may have.—P. R., Poughkeepsie, N. Y.

There is a possibility that the vertical sync pulses are of lower amplitude than the horizontal pulses. The attenuation could be due to slight misalignment. However, if alignment does not help, you should try the following circuit changes to improve sync stability. Before doing this, however, be sure to replace the 12BY7 (Fig. 3). A gassy tube can deform the vertical pulse and produce rolling.

You can improve the low-frequency coupling to the video amplifier by changing C55 from 0.068 µf to 0.15 µf. Also, reduce the value of R71 from 1,000 ohms to 330,000 ohms. Improve the sensitivity and stability of the sync circuit by removing capacitor C58 and resistor R69 from the circuit, and connect capacitor C54 as shown. Next, remove the leads from capacitor C54 and resistor R64 to pin 7 of the 6CS6 sync separator.

Take the removed 330-µuf capacitor C58 and connect it between pin 7 of the 6CS6 and the leads going to R64 and C54. Finally connect a resistor of about 68,000 ohms in parallel with C58. On several of these chassis the above modification has proved highly successful. And if the trouble is due solely to a signal of less than normal strength, the change will provide good vertical and horizontal synchronization.

Excessive drive

In servicing a Sylvania 1-515 chassis I replaced the horizontal output transformer because of shorted turns. The replacement flyback, obtained from Sylvania, restored the faster but the brightness was excessive and there is a drive line that cannot be eliminated by varying the drive control trimmer. I checked all components in the horizontal output and damper stages, and everything is in order. I tried changing a few component values but, while some helped a bit, they also caused other undesirable effects. Do you think the transformer is defective or is some other component damaged by the original defect?—P. R., Lynn, Mass.

The Sylvania replacement flyback transformer for this and similar chassis will often develop excessive high voltage and produce a drive line which cannot be removed by the drive control. The solution is to reduce the drive to the grid of the horizontal output tube. This can be done by replacing the 470,000-ohm resistor that shunts the drive control with one of about 150,000 ohms. This done, the drive control has adequate range to eliminate any drive bar and restore normal high voltage.

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Of course you can buy an adapter for about $5—which theoretically will convert your standard tube tester into a picture-tube tester; or a neon type instrument which sells for a little more and is supposed to be "as good as", a metered instrument. Superior does not make nor do they recommend use of C.R.T. adaptors or neon gadgets because a Cathode Ray Tube is a very complex device, and to properly test it, you need an instrument designed exclusively to test C.R.T. Tubes and nothing else.

Tests ALL magnetically deflected tubes in the set... out of the set...

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Testing Tubes

- Employs improved TRANS-CONDUCTANCE circuit. An inphase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factors, plate resistance and crossovers are all correlated in one meter reading.
- NEW LINE VOLTAGE ADJUSTING SYSTEM. A tapped transformer makes it possible to compensate for line voltage variations to within 1% of the transformer's rating. The Extra Tube Tester has an added bonus, the one test is a general test for all tubes and electronic instrument transformers, providing a complete correlation of all factors, including tube-socket and circuit connection effects. The Extra Tube Tester is easily controlled for a given installation by the choice of transformer taps. The Extra Tube Tester is not limited to one tube at a time, but can be used to test all tubes in a set.
- SAFETY BUTTON—protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.
- NEWLY DESIGNED FIVE POSITION LEVER SWITCH ASSEMBLY. Allows application of separate voltages as required for both plate and grid of tube under test, resulting in improved Trans-Conductance circuit.

Extra Feature

Model TV-12 Also Tests Transistors!

A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

The Model TV-12 will accommodate all transistors, including NPN's, PNP's, Phototrons and Transistors, whether used in Germanium or Silicon, either point contact or junction contact types.

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Superior's New Model TV-11

STANDARD PROFESSIONAL TUBE TESTER

- Tests all tubes, including 4, 6, 7, Octal, Lockin, Hearing Aid, Thyatires, Miniatures, Sub-miniatures, Novals, Sub-miners, Proximity fuse types, etc.
- Uses the new self-cleaning Lever Action Switches for individual element testing.
- Because all elements are numbered according to pin-number in the R.M.A. numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with elements terminating in more than one pin are easily tested with the Model TV-11. All of the pins may be placed in the neutral position when necessary.
- The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is possible to damage a tube by inserting it in the wrong socket.
- Free-moving built-in roll chart provides complete data for all tubes. All tube ratings printed in large easy-to-read type.
- NOISE TEST: Phone-jack on front panel for plugging in either phones or external amplifier to detect microphonic tubes or noise due to faulty elements and noise internal connections.

EXTRAORDINARY FEATURE: SEPARATE SCALE FOR LOW-CURRENT TYPES. Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types. Housed in hard-rubbed oak cabinet...

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**7 Signal Generators in One!**
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- R.F. Signal Generator for F.M.
- Audio Frequency Generator
- Marker Generator
- R.F. SIGNAL GENERATOR: 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Kilocycles to 180 Megacycles on powerful harmonics.
- VARIABLE AUDIO FREQUENCY GENERATOR: Provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.
- BAR GENERATOR: Pattern consists of 4 to 16 horizontal bars or 7 to 20 vertical bars.
- CROSS HATCH GENERATOR: Pattern consists of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect.
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Complete with shielded leads.

Superior's New Model 76

**IT'S A CONDENSER BRIDGE**
**IT'S A RESISTANCE BRIDGE**
**IT'S A SIGNAL TRACER**
**IT'S A TV ANTENNA TESTER**

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- 4 Ranges: 0.0001 Microfarad to 0.005 Microfarad; 0.01 Microfarad to 0.1 Microfarad; 1 Microfarad to 5 Microfarads; 20 Microfarads to 100 Microfarads. Will also measure the power factor of all condensers from 0 to 1000 Microfarads.

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Complete with R.F. and A.F. probes and test leads.

Superior's New Model TV-60

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Includes services never before provided by an instrument of this type. Read and compare features and specifications below:

**FEATURES**
- Giant recessed 6½ inch 40 Microampere meter with mirrored scale.
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  - 10 to 15/75/100/150/200/300/500/750 Volts.
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- **RESISTANCE RANGES:** 10 to 10,000,000 Ohms
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do you do a MAXIMUM or MINIMUM job?

There's more to fixing a TV set than replacing one bad tube

By ART MARGOLIS

Fig. 1—The 500-µuf capacitor measured 700,000 ohms. It caused blooming by lowering the high-voltage output.

TELEVISION

The meter needle indicated REPLACE. Now she felt she was getting her money’s worth.

You walk in on a service call. The TV set has no sync. The picture is running in all directions at about 60 miles an hour. You take two screws off the top of the back, peel the fiberboard down and peep in. Right in the middle of the chassis, there is the sync separator, a 12A7, with only one light burning.

You reach in, pluck out the old tube and insert a new one. The picture snaps into place with a boing-n-g. Your repair is complete. Total time elapsed 3½ minutes.

The set owner says, "While you're here, would you check the TV over and make sure everything is okay?"

What is your next move? Wrinkle up your nose in annoyance and beg off or begin pulling the set apart for a lengthy check? With a combination of the pressure of waiting calls, our natural laziness and a feeling of let well enough alone working on us; the tendency is do the minimum job. But from both a business and technical point of view, it's just not the thing to do.

In our outfit we don't wait for the set owner to ask us to check out a set. With the exception of brand-new or just recently repaired TV's we ask the owner if he would like us to do a maximum job. We explain there is an additional labor charge plus any parts necessary. Here is what we give them.

The chassis is pulled out. The dust is wiped off, the controls lubricated, the tuner cleaned, the C-R tube face is cleaned. All the tubes are checked, resistors and capacitors visually checked, picture set for linearity and any trouble symptoms are traced and eliminated. Of course with the thousands of different makes and models the procedure is tailored to fit the individual set but, in general, that is what we term a maximum job.

There is quite a bit more to completing a maximum job to the customer's satisfaction than a minimum. There is more salesmanship needed, as the price of the repair rises. It has often been said that one of the reasons why people hate to have their TV fixed is that the repair seems to them a negative thing. Just a restoration of status quo, not a new hat or pair of shoes. It's up to the technician to make the repair a positive thing, to provide definite actions or objects so the consumer feels he has received something tangible for his money.

It's hard for a customer to appreciate the complicated repair techniques that flash through your mind. All they can understand are the things they can see clearly. Some of these positive things that satisfy are the labor you go through, a lineup of defective parts or a meter that says something they can understand.

With all its faults, a tube tester is a good customer satisfaction. I was servicing a 21-inch Sylvania. The complaint was no raster. I found the 6CD6 out cold. I replaced it and the picture came on. The set was very dusty and the screen filthy. I asked the customer, who happened to be a real estate agent, if she would like me to do a maximum job. She told me to go ahead.

After cleaning it all up, I began checking out the set. There were two weak if's that I changed. As I was adjusting the age I noticed a bad blooming condition had developed. I checked the two subminiature 5642 high-voltage rectifiers. They were both weak so I replaced them. The bloom cleared a little but there was still some left.

I dug into the high-voltage cage and measured the resistance of the two 500-µuf 10,000-volt capacitors. One of them measured 700,000 ohms (see Fig. 1). I replaced it. The blooming ceased. After that I made up the bill with the additional charges. The female land seller was naturally curious as to what she was paying for. I showed her how the capacitor measured 700,000 ohms on my ohmmeter. She looked at me blankly, completely snowed. I don't think she was too happy about not understanding either. I finally gave up that tack and demonstrated all the weak tubes, one by one on the tube tester. The meter needle sitting in the red REPLACE zone brought a satisfied smile. Now she felt she was getting her money's worth.

Sell each dollar separately

The majority of your customers will put up no argument and will go along with whatever you, the expert, advise. But, there are always the tough "I'm from Missouri" set owners who don't trust a soul. I have one such customer who is a bill collector. Maybe his job makes him that way, but anyway here's what we do with clients like him.

I arrived after an absence of close to 2 years. When I took the back off of his 21-inch G-E, I could see it hadn't been touched since I was there last. He growled, "The sound is reverberating in the picture."

Sure enough, he had sound bars in the video that could be varied with the volume control. After a few minutes of checking I found the cover can on the fourth if video detector was loose. As the volume control was turned up, the

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DECEMBER, 1957
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cabinet would vibrate, vibrating the can which modulated the video. Snapping the can into place cured the condition. Only about 5 minutes had elapsed. I advised the customer he could use a maximum job. He gave me the go-ahead, not missing a move. After the routine cleaning, I noticed the vertical sync was a little weak. The picture would roll every now and then. I mentioned this to the customer. He said, "It does roll sometimes but I adjust it back in."

I checked through the vertical circuits. After about a half-hour I found one of the line filters leading into the vertical B plus, a 40-µf electrolytic, was defective. It had evidently decreased in value, allowing some ripple into the vertical sync which rolled the picture (see Fig. 2). A new filter gave the vertical sync much better holding power. Before replacing it I showed my client a before-and-after on the vertical stability meter nodded OK.

The 6BQ7 rf amplifier read weak on the tube tester. I showed the customer a before-and-after on how some of the snow was cleared out of the video. The vertical output tube was weak. And I gave him a before-and-after on the additional vertical sweep that allowed a perfect linearity adjustment.

I tapped the damper, it started to arc. I called him over and asked him by saying, "OK, OK, I believe you. Do what you think it needs." I completed the maximum job. The only objection I received to the bill was a swallow.

Because you do check over the entire TV during a maximum job, you might gain the impression that your standard guarantee is now unconditional. You must make the point beyond any doubt that the guarantee is only on the actual labor performed and parts installed. You must let the set owner know that he is taking a part does not guarantee it. Only replacing it or reparing it carries some form of guarantee. I learned this lesson the hard way.

I was called by an old customer who has a 12-inch Emerson. His call came in early asking for service before noon. I arrived about 11:30. He had his hat and coat on when I arrived. He said, "It's in bad shape, fix it all up and Dad will pay you." With that he drove off, the only one left in the house besides me was his father, who was reading in another room.

There was no video and a four-sided shrunked picture. I changed a 12A7 video amplifier and the selenium rectifiers. That restored all. I cleaned and checked the set out, but I couldn't find another defective part. I made up a bill and his father paid me. About a week later he called again, patient but annoyed, "The picture is much better but it still doesn't work right." I went over on the double. The set was the intermittent erbiment on my hands. He described the symptoms, but his words had little meaning. I did manage to make out there was no audio or video, just a shrunked raster. I pulled the chassis.

After the usual waiting, checking and heartache a red dot appeared. The sound and video left and the picture developed extreme horizontal foldover. I changed the damper, the condition cleared. I reinstalled the old damper, the condition reappeared. An open cathode in the damper was converting the sawtooth waveform into a sine wave. I had it.

That was until I presented the set owner with another bill. He legitimately said, "I thought you'd given me a 90-day guarantee on that overhauling job you did for me."

Since I hadn't made the conditions absolutely clear, he had a leg to stand on. I swallowed this time and chalked it up to overhead. A few words of clarification before he left the house in the beginning would have avoided this loss.

Catch the little things

If you do a maximum job for a set owner, he naturally expects perfection. There are always many tiny details about his TV that have been annoying the viewer. These faults have not been major enough for the set owner to call you for these annoyances alone. But while you are there, if you can catch these tiny faults, you will really leave a satisfied customer.

Lots of them are so minor to you that you're not even aware of them. They might be dead picture bulbs, springs missing from knobs, a dead Mosquito under the glass face, some TVI you can eliminate or explain away, or an actual trouble symptom. The only way you can get at these minor complaints is to interrogate the set owner.

I was repairing a 17-inch G-E. The original complaint was no raster. I found this was due to no high voltage. Regular tube checks proved fruitless so I pulled the chassis on the floor. There was no B plus on the horizontal output tube. I found the 4,700-ohm 4-watt screen resistor open. I changed it and the raster returned.

I said to the set owner, "While I have the chassis on the floor, would you like me to check it over?" She gave me the go-ahead. While I was tube checking, I gave her the third degree. I managed to pry loose that the contrast hadn't been as good as it was used to be. I resolved to check out the video circuits for defects.

About five were tubes were in dilapidated shape and they were nearly dead. I changed them all, cleaned the controls and went through the rest of my maximum-job procedure. Then I turned on the set. The picture was much clearer but the contrast level was down quite a bit. I checked voltages in the video amplifiers. On the plate of the first video amplifier there was supposed to be 75 volts. I measured about 40. I checked all the components in that plate leg. I found a brand new 40, but the measured 10,000 ohms (see Fig. 3). I changed it. You should have seen the contrast come up then.

She became very excited with the newly found contrast. She remarked, "The picture looks now like when the set was brand new. It's funny, but the restoration of the high voltage didn't face her one way or the other. That she took as her due. But the bringing back of the contrast that had been needling her for months and months, but, if in her estimation was really an achievement. It was something that she had accepted as having to be. Something she wouldn't have tried to have fixed.

Contrary to what you may think, doing a maximum job that costs so much more than a straight service call is not unpleasant to set owners. Sure, laying out the cash hurts them for a minute. But if they can feel that the TV is operating at peak performance, that's really what they want.

But the maximum job has to be done correctly. You have to make the repair a positive thing. Sometimes you have to remind them of the improvements one by one. Spell out whatever guarantee you are going to give and make sure you catch all annoyances, even the little ones.

After a maximum job your customers will get the idea that you are thorough. It is hard for them to remember exactly what you did but the main thing is you will get across the idea of completeness. This idea of completeness is important; don't underestimate it. Even if it comes back to you in a seemingly silly way. Like it did to me after I had done a maximum job on a 16-inch Philco.

A new 12A7 local oscillator brought back the high band. A new 6T8 cleared up the garbled sound. A new 6CD6 got rid of some black spaces on the sides. A screen cleaning restored a 50% brilliance loss. Each and every change was positive and made a whoa of a difference.

When I received a recommendation call from their neighbor, I was curious enough to ask the neighbor what the original customer had remembered about my repair. The answer, "She told everybody how you put all the screws back into the set."

Fig. 3—Low resistance short in the .05-µf capacitor lowered plate voltage and caused lack of contrast.

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For the best in entertainment tune to CBS
Simple photoelectric relay is an educational toy and practical robot

By JAMES A. McROBERTS

Closeup shows parts layout and wiring detail.

Circuit 1—Circuit of the automatic crossing control.

The train was stopped short of that tragedy by an automatic crossing guard (see photo above).

As an educational toy, this device furnishes many hours of enjoyment for Junior and perhaps Papa too. It was built breadboard style for this reason. Besides cutting off power to the train when the crossing is obstructed, it can be made to ring a bell, light a block signal, stop following train, ring a station bell, or do any one of a number of other things.

For practicality, build the unit into a metal or other sturdy container along with a self-contained power supply. The most obvious gainful use is as an annunciator service. Whenever light to the cell is broken, a chime rings, announcing the presence of a guest or customer. It will indicate the presence of unwanted visitors, too, such as burglars. To discourage the latter group, use the device to turn on lights automatically whenever night comes, with a second piece of apparatus for burglar or visitor alarm duty.

Fig. 1 shows the simple circuit which you can put together in an hour. And the closeup photo shows the parts layout and wiring details.

The cover picture demonstrates how a CL-3 Clairex photocell is illuminated by a small bulb whenever the crossing is not obstructed. As long as the crossing is clear, relay RY stays closed (energized), and power is supplied to the track's control section through the NC contacts. This circuit is normally open when coil is not energized. Interruption of the light beam reduces current through the relay, which opens, cutting the circuit from train transformer to track, and stops the train. Two or more sections of the track's middle rail (either rail in a two-rail system) may be insulated by pulling the connecting pins. Put a piece of tape over the ends to insulate the broken connection. As the train approaches an obstructed crossing, it stops but it will run on the remainder of the track. The number of track sections controlled depends on the track's speed and length. Two or three experiments quickly determine the required distance.

The CL-3 photocell is a conductive type whose resistance decreases in proportion to an increase in the light on it. When unilluminated, almost no current passes through the transistor's base circuit. Consequently little current flows in the collector circuit including relay RY. Increased light on the photocell increases the transistor's base and collector current. When the relay's pull-in point is reached, the relay closes, applying current to the track. Reverse action occurs as the light decreases, with the relay dropping out and opening these contacts.

For some purposes, the de-energized position activates the controlled circuit through the NC contacts. For this reason, the NC contact has been brought out to a lug on terminal strip TS3.

The light source may be a prefocused flashlight bulb operated below its voltage for the short distance by a single flashlight cell. Or it may be energized from hot contacts of the train transformer through a suitable dropping resistor. (Two flashlight cells driving a 2.8-volt bulb will pull in the relay at 8 feet. With one cell, the range is about a foot.)

Now build it

The board model, most instruc-
tive for Junior, takes about an hour to assemble. Parts placement is not critical and may follow the photo. Hidden beneath the batteries are two No. 2/56 screws holding the battery clip to the board. Cut off any extra screw length and cover the end with plastic tape to prevent scratching floors and furniture.

About a ¼-inch length of a 6/32 screw is needed for the relay. Cut off the excess with a hacksaw while a nut is on the screw. Unscrew the nut to clean the threads. Install carefully, checking to prevent this screw from digging into the relay coil. An extra nut is used, with the screw and nut forming the negative tie point. For convenience you can slip a soldering lug on the screw. Position the relay for easy wiring to TS3, TS2 and the negative tie point.

Cut the fiber insulation of the battery harness in half. One polarized end fits the negative terminal of the battery and goes to the negative tiepoint. This is the black lead. The red lead runs to the transistor's emitter. Do not reverse polarity to see if it works—it won't! The transistor probably won't work again either.

Two 0-volt batteries snap together to form an 18-volt power source. The battery clip (a spring type clip used to hold small tools) holds them rigidly in place. Simply unsnap the batteries or either lead to cut off power.

The light source is shielded with a piece of black tape in the photo. You can use a lamp cover for a neater appearance and some type of building could be placed over the relay unit if desired. A single cell will light a 2.8-volt prefocused flashlight bulb brightly enough to operate the relay from about 6 to 10 inches. Two cells and a reflector extend this distance to about 7 or 8 feet. A lens further increases the range, and can be used on either the light or photocell.

If you want to work the bulb from the train transformer, use a locomotive headlight bulb rated about 14 volts. A 12–14 volt bulb may also be utilized with a bell transformer as the light source. Do not overexpose the photocell by bringing the source closer than about 2½ inches or excessive current may be passed to the base of the transistor. Use just enough light to hold the relay on.

Some relays have to be adjusted to increase their sensitivity. This is done by decreasing the tension on the armature spring and possibly decreasing the spacing between the contacts. The tension-adjusting screw on the Sigma type 4F relay is indicated in the photo.

Less tension lets the relay close more easily. Relay RY will not drop out if spring tension is too weak. Clockwise turning of the adjustment screw increases tension; counterclockwise turning reduces it. Turn the adjustment screw a little at a time and note results.

If a voltmeter is handy, check to see that the relay pulls in with about 11 volts across its coil and drops out at about 6 volts. The circuit is designed for these normal relay operational points with an 18-volt supply. Do not use higher voltages.

Other uses

The locomotive's headlight beam can energize the relay. If the light is obstructed, the relay does not go on and the train stops. Here again the number of track sections controlled is determined by the speed of the train. Also take into account the intensity of the locomotive headlight. It must be bright enough to trigger the relay.

As an annunciator, interruption of the beam de-energizes the relay. This time, you would use the NC (normally closed) contacts instead of the normally open set used at the crossing. An auxiliary power supply rings the bell or chimes with the relay circuitry acting only as an electronic switch. Fig. 2 shows this type of operation.

To turn on houselights when it gets dark, place the photocell where it will be indirectly illuminated by daylight. The relay's NC contacts are used. Dropping light values allow the relay to drop out and actuate the auxiliary circuit. Up to 200 watts may be directly controlled by a Sigma 4F relay. For heavier loads, use an auxiliary relay.

The photocell's sensitivity may be too great in some applications. Whenever this becomes a problem, connect a 1-megohm potentiometer in series with the photocell and the negative end of the power supply. The added resistance lowers the photocell's sensitivity.

A somewhat similar arrangement makes the relay an electronic counter. The relay controls a circuit containing a stepper relay or a solenoid moving a mechanical counter. Objects that interrupt the light beam cause a count for each interruption. The count will be exact if some spacing exists between the objects being counted. Should two pass at about the same time, the photocell may see them as one only.

Power supply

Although less than 2 ma is drawn from the battery supply of the crossing relay circuit, you may prefer to use a batteryless power supply for continuous operation. Fig. 3 shows the circuit of such a supply. The bell transformer is stocked by most hardware stores. It is the higher voltage type delivering a nominal 12–14 volts instead of the more common 8–10 volts. Failing to secure such a transformer, use a low-current 12.6-volt filament transformer.

In wiring the power supply, take care that diode and electrolytic capacitor polarities are correct. Connect the negative terminal of the capacitor and diode.

If the same transformer also powers a lamp for lighting the photocell, its output voltage may be rather low due to the load. If this hinders relay action, simply adjust the relay for a lower pull-in point. Do not overdo it or the relay may not drop out. Make a check for drop-out after all such adjustments.

Caution

One side of the line may be connected to the relay frame in some of the circuit applications. Exercise care in touching the relay or allowing it to touch metal objects possibly grounded. A small plastic box placed over the relay and electrical tape over the mounting screws will offer added protection. If the unit is built on a metal chassis or into a metal box, keep the relay isolated from the box or chassis.
How Far Can You Go in Electronics Without a Degree?

Fred Gunther has no degree. Yet, today, at IBM, Fred is a Technical Engineer working on America's biggest electronics project. His story is significant to every technician who feels that lack of formal training is blocking his road to the top.

Let's go back to 1950 and watch Fred Gunther, at 18, as he goes about the business of determining his life's work. Fred spent almost a year trying his hand at various jobs. None of these turned out to be the one that Fred wanted to devote his life to. So, still undecided about his career, Fred entered the Navy for a four-year hitch.

Fred learned something very valuable in the Service, as have many other men who eventually discover the electronics field. His aptitude tests revealed him as an excellent electronics prospect, and he received ten months' training in electronics fundamentals and radar. Upon his discharge in 1955, he was an Electronics Technician, First Class.

Something even more important to Fred's career occurred during his Service hitch. He began to hear such terms as "automation" ... "data processing" ... "electronic computer." "Then, one evening, while glancing through the paper," he recalls, "I spotted a story about Project SAGE."
**What is Project SAGE?**

SAGE means Semi-Automatic Ground Environment. It is part of America's radar warning system—a chain of defense that will ultimately ring our country's entire perimeter. At the heart of this system are giant electronic computers which digest data filtered in from Texas towers, picket ships, reconnaissance planes, ground observers. The computers analyze this information for action by the Strategic Air Command and other defense units. These computers are the largest in the world. Each contains 58,500 vacuum tubes plus 170,000 diodes. They are built for the project by IBM.

**Fred joins IBM**

SAGE fascinated Fred, for it embodies the most advanced electronic concepts in giant computer work. And, when he learned that IBM would train him at full salary, plus a living allowance, to become a Computer Units Field Engineer, he seized the opportunity. Fred started his new electronics career in the IBM school, with twenty other technicians. He attended classes 8 hours a day. Courses consisted of some 20 subjects—computer circuitry and units, maintenance techniques—everything he would need to become a full-fledged Computer Units Field Engineer.

**Assigned to McGuire AFB**

His training completed, Fred was assigned in May, 1956, to McGuire Field, where the first of the giant SAGE computers is located. Here he assisted in the cable installation for this vastly complicated electronic giant. He helped to set up the computer, interconnect its many sections, check it out and make it ready for operation. Fred spent five months at McGuire Air Force Base, but his education was not yet completed.

**Becoming a Computer Systems Engineer**

"I like to think it was due to my interest and grade of work," Fred says, "but at any rate, last October I was invited to return to Kingston for further training—to become, in fact, a Computer Systems Engineer. Naturally, I was proud and pleased, for this training would give me a much greater range of understanding... make me more valuable to the company and myself... and give me a chance to assume actual engineering responsibility." Fred completed the Computer Systems course. After several months of outstanding work in his new capacity, he received a third promotion—to Technical Engineer—in a field engineering liaison group.

**What does the future hold?**

What does the future hold for Fred Gunther, now that he has become a Technical Engineer? "It's hard to even set a goal in a field as rapidly moving as this," Fred says, "but with my IBM training back of me, the future sure looks good. I've advanced from Radar Technician to Computer Units Field Engineer to Computer Systems Engineer to Technical Engineer in two years—and received a valuable electronics education besides!"

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Military Products Division
IBM Corp., Kingston, N.Y.

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**How about YOU?**

Since Fred Gunther joined IBM Military Products and the Project SAGE program, opportunities are more promising than ever. This long-range program is destined for increasing national importance, and IBM will invest thousands of dollars in the right men to insure its success.
The completed timer.

Top view of the timer chassis, showing subchassis assembly.

Rear view of the chassis. Note the compact layout.

This timer is easy to use, even in complete darkness

By ALVIN F. RYMSHA

PROBABLY hundreds of circuits have been published illustrating as many different approaches to an electronic timer. The majority have been designed for darkroom use, for timing enlargers and contact printers. As an amateur photographer, I have found one failing common to all. They cannot be seen in the dark! Unless the user has considerable dexterity, the lights must be turned on to change the time setting. The timer described in this article overcomes this fault because it doesn't require sight for its setting. Any delay from 1 to 165 seconds can be set by touch alone. The timer will repeat its setting each time it is tripped, and the setting may be "read" by the fingers in total darkness. The entire unit is encased in a plastic meter box and measures only 6¼ x 3¾ x 2 inches.

Starting with a circuit which is simple and reliable (used in the Heath-kit timer), several changes are made. First, the socket for the safelight is eliminated, since there seems to be no need to turn it off in the first place. Second, the variable resistor type of control is replaced by a step-resistor bank. It is this change that increases the convenience of operation. A group of fixed resistors are connected in series across the timing capacitor to change its discharge time and thereby the "on" time of the enlarger. Each resistor is
The Electronics diagram shows a circuit with labeled components. The text discusses the calibration control (R1) being adjusted so the clock indicates exactly 10 seconds movement. Fine adjustment can be made by inserting the 4-megohm resistors at once, obtaining a total resistance of 16.5 megohms results in a 165-second delay. Circuitry is shorted by a slide switch, permitting any combination to be inserted. The values of the resistors are determined by a binary series: 100,000 ohms across the 4-µf timing capacitor results in a 1-second delay. Therefore, 200,000 ohms produces a 2-second delay; 400,000 ohms, 4 seconds; 800,000 ohms, 8 seconds; 16,000,000 ohms, 16 seconds, and so forth. If all except the 100,000-ohm resistor are shorted, a 1-second delay results. By placing any other resistors in the circuits, the delay is increased by a factor of 1 second for each 100,000 ohms. The 100,000- and 400,000-ohm resistors are inserted. One minute would be obtained by inserting the 2-megohm (for 20 seconds) and the 4-megohms (for 40 seconds) resistors. By inserting all the resistors at once, a total resistance of 16.5 megohms results in a 165-second delay. The slide switches are connected so that in their "up" position the associated resistor is out of the circuit. Sliding it down inserts the resistor. With only eight switches, it is a simple matter to code-set the desired time and to feel the positions of the switches to read their setting. In addition to its other advantages, the unit's calibration is extremely simple. No dial needs hand calibration. After constructing an electric clock with a second hand is connected to the enlarger terminal, the switches set for 10 seconds and the timer started. The calibration control (R1) is then adjusted so the clock indicates exactly 10 seconds movement. For fine adjustment a longer time (perhaps 120 seconds) may be set up and the final "touchup" given the calibration. If the resistors are sufficiently precise, they will all fall exactly in line and no further adjustment is necessary. For the sake of economy, 5% 1/2-watt carbon resistors can be used, in series combinations shown in the parts list. A more precise and reliable unit will result if 1% deposited carbon or boron-carbon resistors are used. One word of caution: use care when soldering the resistor in place. If possible, leave the leads fairly long and do not overheat the resistors as a permanent change in value may result. **Construction details** An aluminum panel cut to fit the meter case and a small subchassis support the components. If the parts are laid out beforehand, possible interference (or downright lack of space) will be avoided. The timing capacitor, filament transformer and relay are the largest components and should be selected for the smallest size available. To conserve space, timing capacitor C1 should be metallized-foil type and need not be over a 200-volt rating. For the transformer, any 6.3-volt unit rated at 1/2 amp will do. Lay out the slide switches, lever switch, ac connector, timing capacitor and the relay on the front panel. The capacitor is mounted on the subchassis stand-offs behind the power switch and connector. Bend up a subchassis shelf to support the tube socket and transformer. The calibrating potentiometer may be mounted either on a separate bracket or the bent-over end of the subchassis. This also applies to the tube. In the prototype, the slide switches were secured by machine screws but smooth-headed rivets would retain the "feel" of the unit better. After all panel drilling, cutting and filing is complete, mount the slide switches and ac connector. Wire the switches in series and solder the resistors in proper order across the switch terminals. Keep the parts snug against the panel as other components will be mounted adjacent to them. Mount the tube socket on the subchassis and install the subchassis, timing capacitor, lever switch and transformer. Complete as much of the wiring as possible, leaving wire ends for the relay and calibrating potentiometer. Wire the potentiometer and the relay (with its capacitor) and install them, the relay going in last. The power cord is fed through a hole in the side of the plastic case. The unit is a fairly tight squeeze into the box. Due care should be taken to insulate any parts which may touch. The relay-calibration potentiometer area should be particularly watched. You can lose a 6DJ through carelessness here. (I know!)
LAST month you took a close look into the workings of drift and Uni-junction transistors. You also learned how some alloy and diffusion types are made. Now, the discussion of manufacturing techniques is continued, covering additional types.

An interesting variation of alloying produces bonded or bonded-barrier transistors. Here the material to be alloyed in, instead of being in the form of a dot, is plated or otherwise attached to the end of a wire. The necessary heat is produced by passing a surge of current through the wire.

A bonded transistor looks much like a point-contact (or coaxial) unit, except that it is truly a junction transistor, the emitter and collector regions being produced by alloying, not electro-forming.

Micro-alloy transistor

Here the material to be alloyed in as collector and emitter is produced by plating it directly on the surface of the germanium. The slab of germanium (see Fig. 1) is etched, with a jet spray, till very thin, just as for surface-barrier transistors. The emitter and collector are then plated on the surface, also like surface-barrier transistors. However, now the device is heated and alloying takes place, giving a very shallow alloyed region.

The only advantage of the surface-barrier transistor, remember, is that special etching techniques are used to get a very thin base. Micro-alloy transistors have the same advantage. There are also subtle advantages in micro-alloying one or both of the contacts. The disadvantage is that the base is made so very thin that maximum collector voltage is very low.

Because of the low voltages, the micro-alloy transistor is severely limited in power and its only advantage is good frequency response.

Grown transistor types

Germanium and silicon for transistors must be in the form of a single crystal—one very large array of precisely arranged atoms. About the only practical way to obtain these crystals is to grow them. The Czochralski technique, by which a small single crystal is slowly pulled out of a vat of molten germanium, is generally used. The melted germanium crystallizes in exactly the right order on the single crystal or seed. The photograph shows a germanium crystal being pulled. The coils, wrapped around the outside, are for heating the molten germanium, and only the top of the ingot is visible through the quartz tube which encloses the apparatus. The technician is using an optical pyrometer to read the temperature of the melt.

If the material in the melt is pure germanium, then intrinsic type germanium will be pulled. But if there are more donors than acceptors, the n-type will result, and vice versa.

Using this idea, grown-junction transistors are made by starting off with n-type material. At a certain point a small pellet of acceptor material is dropped into the melt, and p-type germanium is grown. After a short while, a pellet of donor material is added which more than balances the acceptors present.

The result is an n-p-n sandwich in the pulled crystal (see Fig. 2, which has suitable properties to be a transistor. The finished ingot is cut up after

By PAUL PENFIELD, JR.

Part II—Manufacturing techniques used to make bonded, micro-alloy, grown-junction, rate-grown, grown-diffused and meltback transistors are discussed.

Fig. 2—Growing a single germanium crystal.

Fig. 1—Micro-alloy unit uses same shape germanium as surface barrier types.
the junctions are located, and many transistors are cut from the sandwich. Unfortunately, it is rather difficult to locate and make a connection to the p-type base. And only a limited number of transistors can be made from each pulling operation. The scrap germanium must be purified before it is used again. The base region can be made quite thin, meaning fairly good high-frequency operation. Also, the collector capacitance is rather small.

An interesting technique exists for making several grown junctions in one ingot. This is done by growing the crystal from three reservoirs of molten germanium, each doped appropriately for one of the three regions. When it is time to change the doping, one reservoir is moved away and the other shifted into place, leaving the crystal always in contact with a germanium surface. This is done by mounting the reservoirs on a turntable with narrow channels between them. The turntable is rotated while a clever gate system keeps the three melts from mixing. This technique allows many sandwiches to be made from each pulling.

**Rate growing**

Another way to get n-p-n sandwiches in a grown ingot is to use the rate-growing method. Here a nearly equal mixture of donors and acceptors is put into the melt. Whether we get n-type or p-type depends on the delicate balance between donors and acceptors, which is affected by the rate of pulling and the temperature. Thus slow rates of pulling yield p-type, and fast growing gives n-type.

Fig. 3 shows an ingot with n-p-n sandwiches made by merely slowing down the growth rate for a minute. This can be cut apart and each sandwich yields many transistors. Dozens of sandwiches can be obtained from each melt.

If the growth rate and temperature are adjusted correctly, the growth rate may actually be negative for a while—the crystal melts back. When the positive growth rate appears again, a very thin p-region results, and the junction formed is abrupt. Both factors help raise the frequency response.

With or without meltback, the rate-grown transistor compares with the grown-junction model in high-frequency response. Both types are available commercially.

It is possible to combine the effects of growing a junction with diffusion techniques to get very small base regions. If the materials and their densities are just right, it is possible to get a p-p junction in a grown bar—either by rate growing or by adding pellets. The p-p junction (one side of which has more of both acceptors and donors than the other side) is not itself useful, but, if the ingot is heated, some of the donors diffuse, giving a very small n-region right where the p-p junction was. By locating these junctions and cutting up the bar of germanium, a grown-diffused transistor is made.

All the grown type transistors have the advantage of a small base region, but have a rather high cost. Partly this is due to the difficulty of locating the junctions in the completed transistor, and of soldering a connection to the extremely thin base region.

**Meltback types**

If a piece of germanium is placed between a hot and a cold temperature, it will melt back partially, remaining partly molten, partly solid. Now if the temperature is reduced, the germanium will refreeze as a single crystal, but with a changed impurity distribution. By properly using a delicate balance of donors and acceptors, it is possible to start with a p-region, refreeze it as an n-region for a short distance, and then change over to a p-region. This produces a p-n-p sandwich (Fig. 4) which can be cut apart for meltback transistors.

It is difficult to control the base width accurately this way. So an improved method is used to make the meltback-diffused transistor. Correct doping is provided so that after meltback a p-p junction, of the type discussed in the grown-diffused transistor, is formed. The two sides of this p-p junction are p-type but have different amounts of impurities. If correct doping is used, a gentle heating of the germanium will cause a diffusion of the donors, giving a very thin n-region at the location of the junction. The p-n-p sandwich can now be cut apart to make good high-frequency transistors.

**Tetrode transistors**

Transistor tetrodes (which have two base connections) are customarily made from a meltback or meltback-diffused sandwich, although in principle they could be made from any of the grown types as well. Furthermore, p-n-p hook transistors can be made by a slight variation of the meltback-diffused technique.

By cooling a meltback sample rapidly instead of slowly, melt-queen transistors are formed. The original bar may be p-type, and immediately after refreezing the material may be n-type. The refreezing is allowed to proceed only a small distance, however, and then the germanium is rapidly cooled or quenched. In effect, the impurities are trapped wherever they happen to be, and the quenched region is p-type again. Thus only a small controlled n-type region is produced. Melt-queen transistors are not yet available, and it is doubtful if they ever will be, because they offer no particular advantage over other high-frequency models.

The major difficulty with transistors is poor high-frequency response. It seems probable that future high-frequency transistors will be drift units made with the special jet-etching techniques used for surface-barrier types, which is used in the alloy-diffused transistor, and microalloy emitter and collector regions. Such a transistor should not be too expensive and is expected to go beyond 1,000 mc.

Techniques for making junction transistors that have been popular in the past, specifically the grown type methods, will be less important. Meltback techniques will never amount to too much because the base region is of poor quality.

Alloy transistors will continue to be the best sellers for ordinary applications. Power transistors may be silicon-diffused emitter-collector models. Diffusion techniques are just coming into their own, so expect good diffused transistors in the future.

---

**Fig. 2**—A grown n-p-n sandwich suitable for transistors.

---

**Fig. 3**—Many junctions can be rate-grown in one crystal.

---

**Fig. 4**—A meltback p-n-p sandwich.
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By A. R. CLAWSON

The humble neon lamp may be used in many circuit applications. Two such uses are found in the new G-E color receiver (21C700). In Fig. 1, the lamp acts as a switch in series with a resistor. In Fig. 2 it behaves like a voltage regulator. The neon may behave as a nearly perfect bypass capacitor, curing stubborn cases of unwanted feedback. To use the neon lamp in these varied applications, its unique characteristics must be understood.

Neon characteristics

A neon lamp acts like an open circuit or a switch until a certain critical striking (starting) voltage is reached. Then it conducts. Due to its internal resistance, it can be compared to a resistor in series with a switch. Once lit, the voltage must be decreased somewhat below the striking value to extinguish the lamp. Table I shows these characteristics for dc operation.

On ac, the tube is extinguished each cycle, and the values are slightly different than for dc. The maintaining voltage given in the table is just above the extinguishing point. (Individual bulbs vary considerably; these figures are an average.)

For the tube to act as a bypass it must be lit. This is also true if it is used as a voltage regulator (except for use as a surge suppressor). The bulb is used on voltages above the striking value in most instances, like the voltage regulator of Fig. 3. An external resistor (Re) is then needed to limit current if the tube does not have an internal resistor. It may be a rheostat, a fixed resistor or both. Table I lists the minimum resistance required to drop the voltage to the maximum safe
them in series for the voltage desired. Thus two 60-volt tubes would maintain an output voltage of 120.

The larger sizes of neon lamps are commonly used for this purpose (see Table II). The greater the drain of the neon lamp as compared to the load the better the regulation.

The lamp's current rating helps determine how much bypassing and regulatory action may be obtained. To maintain a relatively fixed bias on a grid the smallest lamp will do the job while for the example of Fig. 3 a larger one is needed to handle the larger current.

Most screw-base neon lamps are intended for use as dial lights or indicator duty directly from the line. They have a built-in dropping resistor. They can be used at higher voltages by adding the necessary external resistance in series. Table II gives wattage, type number, basking and value of any internal resistance for a number of popular types. Wire lead types are intended to be soldered into the circuit directly.

Applications

Use as a combined switch and pulse-height regulator is illustrated by the circuit in Fig. 1. The tube conducts on the flyback pulse and tends to regulate the pulse's height also.

In Fig. 2, grid voltage is maintained relatively constant by the neon lamp. The circuit is direct-coupled so the lamp may be shunted from grid to cathode. The video signal will also be limited if it is excessive.

Some TV sets have critical points where 10\% or better tolerance resistance are used. Fig. 4 shows such a circuit. A neon bulb was utilized to repair this set rather than experiment with precision resistors. A 1525-watt neon lamp regulated the B-plus supply to the vertical regulator, correcting a bad case of bounce plus height trouble with varying line voltage. Some slight changes were made in the circuit to allow for the added drain of the regulator. The lamp did another thing: too; it corrected some hook caused by blurs of the vertical pulse traveling along the B supply and being radiated into the horizontal sweep control circuit (the afo).

A neon lamp's nearly perfect bypass action is used, in Fig. 5, to eliminate pseudo-Barkhausen interference radiated by the screen-grid supply of a horizontal output tube. The screen resistor was removed first. Then its value was broken into two separate resistors whose total was a little less than the original resistor. The NE-17 neon lamp was added as shown. It bypassed the interference and regulated the screen voltage, too.

In a Du Mont RA-350 TV chassis, filter capacitor C296-B did not completely remove spurious sync pulses from the 150-volt B-plus line feeding the video if amplifiers. See Fig. 6. The neon lamp with its series resistor was added as illustrated. About 5 volts less B plus was available but this did not interfere with normal operation. If B plus is lowered unduly, the dropping resistor may be reduced in value. Here R306 is the dropping resistor.

The modification mentioned cured a bad case of horizontal jitter. Similar treatment alleviates or cures oscillation and regeneration caused by feedback along a B-plus line. A common case is that of feedback in the if stages of a car radio.

Neon lamps have other uses too. For example, they can serve as an ac voltage regulator on the input to experimental equipment. A resistor is placed in series with the line and the neon will pull more or less current in accordance with the demands of the load.

**TABLE II**

<table>
<thead>
<tr>
<th>Type</th>
<th>Purpose</th>
<th>Neighboring Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE-1</td>
<td>High-frequency audio</td>
<td>3000 kHz</td>
</tr>
<tr>
<td>NE-2</td>
<td>Low-frequency audio</td>
<td>30 kHz</td>
</tr>
<tr>
<td>NE-3</td>
<td>High-frequency radio</td>
<td>300 kHz</td>
</tr>
<tr>
<td>NE-4</td>
<td>Low-frequency radio</td>
<td>30 kHz</td>
</tr>
<tr>
<td>NE-5</td>
<td>High-frequency audio</td>
<td>3000 kHz</td>
</tr>
<tr>
<td>NE-6</td>
<td>Low-frequency audio</td>
<td>30 kHz</td>
</tr>
<tr>
<td>NE-7</td>
<td>High-frequency radio</td>
<td>300 kHz</td>
</tr>
<tr>
<td>NE-8</td>
<td>Low-frequency radio</td>
<td>30 kHz</td>
</tr>
<tr>
<td>NE-9</td>
<td>High-frequency audio</td>
<td>3000 kHz</td>
</tr>
<tr>
<td>NE-10</td>
<td>Low-frequency audio</td>
<td>30 kHz</td>
</tr>
</tbody>
</table>

Values may change slightly during first 20 hours of service, due to aging. Current is full rated current for the quoted voltage. Operating current is often below this value.

Fig. 4—Bypass action is combined with primary voltage-regulator action in this Olympic C21R D35 modification.

Fig. 5—Simple bypass action removes pseudo Barkhausen interference in an Emerson 120257-D.

Fig. 6—Neon bulb as a glow-lamp regulator cured a case of jitter in this Du Mont RA-350.
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A fine-operated battery eliminator with adjustable A and B voltages is handy when servicing portable radios. By dropping the output voltages below the levels required by the set you can spot erratic oscillator tubes and often isolate the causes of intermittent operation.

The circuit of a suitable eliminator is shown in the diagram. It can be used on most portables with parallel-connected 1.5-volt filaments. B voltage can be as high as about 120 with normal drain and A voltage can be adjusted to supply some sets requiring 3 volts. The eliminator can be improved by installing a 25-ma dc meter in the

formerly occupied by the batteries. The power transformer may be a Stancor PS-5415 or equivalent, the B-plus rectifier a Sarkes Tarzian model 50, the low-voltage rectifier a Mallory 18RE, and the A filter capacitors a triple section unit such as the Sprague TVL-3015 or individual units with values of 1,500 µF or more.

BOOSTING 152-162-MC SIGNALS

I have a Gonset model 3012 FM tuner for the 152-162-MC band. Its sensitivity is satisfactory for powerful base stations but not for low-powered mobile transmitters. I raised the overall sensitivity of the system to an acceptable level by replacing the ground-plane antenna with a high-gain omnidirectional type and adding a booster. The antenna is a vertical collinear array like that in Fig. 1. This is a three-element array with a gain of about 3 db and a feed-point impedance that provides a good match to 300-ohm transmission lines. The antenna will cover the entire band adequately when cut for 157 mc. The dimensions shown are for this frequency.

The gain of the array can be increased about 1 db for each half-wave element added to it but it is hardly worth while to add fewer than three. The feed-point impedance will approximately 100 times the number of half-wave elements. The two outside elements remain the same length. The added elements are inserted between the end ones and are each the length of the center element. One-quarter wavelength stubs like those shown in Fig. 1, are used between each half-wave element.

The antenna and phasing stubs are made from rigid rods or tubing. The array can be mounted by fastening the cold (shorted) ends of the stubs to a metal mast. Be sure the mast is grounded to provide protection against lightning.

Fig. 1 is the diagram of a single-stage neutralized rf amplifier similar to a simple TV booster. Tuning capacitors C1 and C2 are butterfly type midget units with capacitance of about 10 µF per section. You can use E. F.
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Pentron combines professional features and custom styling with building block flexibility. You buy what you want and add to your system when you desire—from the simplest monaural system to the all inclusive stereo systems.

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Simple single rotary control.

Four outputs plus two AC convenience outlets.

Mounts VERTICALLY, horizontally, or at any angle.

Speed change lever at front panel.

Removable pole pieces in heads, as easy to change as a phono needle.

Automatic self-energizing differential braking.

basic specifications

TM series mechanisms

COMBINATION HEAD:
Frequency response: 40,15,000 cps with proper equalization. Signals:
Noise: 55 db with CA units:
track width: 0.025", gap width: 1/2 mil; impedance of record section 6000 ohms; inductance of erase section 65 mH.

HEAD: track width: 0.055", gap width: 1/10 mil; impedance: 3500 ohms + FLUTTER: under 0.4%, all T.H.D. under 1% at 3 ips. + CAPSTAN DRIVE: idler driven 4-pole induction type, individually balanced + OUTPUTS: 4 standard pin jack outputs to accept shielded phone plug + CONVENIENCE OUTLETS: two auxiliary AC outlets controlled by mechanism power switch. Supplied with tamper resistant mounting brackets with shock mounts.

preamplifiers

CA-11

CA-13

CA-15

ALL CA UNITS HAVE SAME PHYSICAL DIMENSIONS AND REQUIRE SAME CUTOUT.

RADIO-ELECTRONIC CIRCUITS (Continued)

Johnson type 11M11 or equivalents. Neutralizing capacitors Ca are twisted-wire gimmicks or 0.5-μF tubular ceramic trimmers.

L1 and L2 each consist of five turns of No. 18 enameled wire wound in two sections of 2½ turns each. The sections are 1/4 inch in diameter and 1/2 inch apart with a tap at the center. The antenna input and output link windings are each three turns of No. 18 wire wound 3/4 inch in diameter and 1/4 inch long. The links are inserted between the halves of L1 and L2.

To adjust the booster, connect it between the antenna and tuner—for example, to match the tuner's 52-ohm using a balun or TV elevator transformer to match the tuner's 52-ohm input. Tune the tuner to a frequency in the center of the band and squeeze or spread the turns of L1 and L2 so the signal comes in. To neutralize the booster, disconnect the antenna lead-in and replace it with a 300-ohm resistor. Turn up the tuner's volume control and adjust the neutralizing capacitor for minimum noise.—Henry O. Maxwell

RE: PHASING EARPHONES

It is interesting to note that the technique of phasing earphones—described by Art Trauffer on page 40 of Radio-Electronics, June, 1957—can be elaborated to reproduce direction of sound origin.

For example, if one earphone is fed a tone which is constant in phase, while the other earphone is fed the same tone which passes through a phase-shifting circuit, the apparent direction from which the tone is coming moves about the listener as the operator varies the amount of phase shift.

A suitable demonstration arrangement is shown in the diagram. T is a conventional audio output transformer with its low-impedance winding connected to the audio oscillator. R2 operates as an ATTENUATOR and should be set to provide approximately the same level of sound in the right earphone as in the left. R1 is the PHASE-SHIFT CONTROL, and causes the apparent direction of sound origin to move around the listener as its setting is varied.—Robert G. Middleton
You get everything in a Sprague TVL! Every TVL for every voltage rating is made with the more expensive high-purity etched-foil anode construction using ultra-stable film formation techniques. Cathodes are etched to meet high ripple requirements. Sprague TVL's give maximum trouble-free service—NO HUM—as well as long shelf life. And they perform just as well in the cold North as they do in the sub-Tropics. Yet this premium quality costs you no more!

That's why Sprague Twist-Lok® electrolytic capacitors are the first choice of leading radio-TV set makers and independent service technicians alike. Insist on TVL's for more exact ratings... quality that meets original equipment specifications... and all the latest results of capacitor research. WRITE FOR NEW CATALOG C—612

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DECEMBER, 1957
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Ask your dealer for a demonstration, or send your name and address for full details.

Electronic Applications Division
SONOTONE CORPORATION
ELMSFORD, N.Y.

SONOTONE CORPORATION, Dept. L-E-127, Elmsford, N.Y.

NAME
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CITY         ZONE         STATE

New Tubes & Semiconductors

An all-glass color picture tube, a diode-tetrode designed for 12-volt automotive radios and some more transistor-characteristic abbreviations highlight this month's releases.

21CYP22

A directly viewed, round-glass, shadow-mask type picture tube for use in color television receivers, made by RCA. It is designed with an all-glass envelope which reduces high-voltage insulation requirements of the color receiver. It also has an external conductive coating which, with a portion of the internal conductive coating, forms a supplementary filter capacitor. This 3-gun tube has a 6.3-volt 1.8-amp filament.

The 21CYP22 is electrostatically focused and magnetically converged. Its maximum ratings are:

Ultor-to-cathode voltage† 25,000
Grid 3-to-cathode voltage† 6,000
Grid 2-to-cathode voltage† (of each gun) 600
Grid 1-to-cathode voltage† (Neg bias value) 400
(Pos bias value) 0
(Pos peak value) 2
Peak heater–cathode voltage† (hr neg respect cath) (during warmup, 15 seconds) 410
(after warmup) 180
†Between the ultor terminal and the high-voltage supply terminal, it is necessary to connect a 50,000 ohm resistor. The high voltage must be connected to the high-voltage supply terminal (G6–CL) —never directly to the ultor. †Of each gun.

12R5, 17R5

These seven-pin miniatures are beam pentodes designed for use as a vertical amplifier in television receivers. Both

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NEW TUBES & SEMICONDUCTORS (Cont.)

Filter tubes are identical except for heater ratings. The 12RF has a 12.6-volt 600-ma and the 17RF a 16-volt 450-ma heater. Both have controlled-warmup characteristics for use in series-string circuits.

Manufactured by Raytheon, typical operating characteristics are:

\[
\begin{align*}
V_T & = 110 \\
I_C (ma) & = 8.5 \\
I_A (ma) & = 40 \\
R_T (ohms) & = 3.3 \\
g_m (ohms) & = 12,000 \\
\end{align*}
\]

12DF5

A nine-pin miniature tube containing a cathode-fusing type full-wave rectifier. Its center-tapped heater can be operated at 12.6 volts, 450 ma or 6.3 volts, 900 ma. It is manufactured by Sylvania.

Typical operating characteristics are:

\[
\begin{align*}
V_T & = \text{rms ac supply to each plate} \\
V_C & = 325 \\
V_R & = 450 \\
I_F (ma) & = 40 \\
& = 10 \\
\end{align*}
\]

Effective plate supply resistance (ohms) 82
De output current at filter (ma) 100
De output voltage at filter 300

2N340

This grown-junction n-p-n silicon transistor is especially designed for use in audio or servo amplifier stages requiring medium power and output. The 2N340, made by Texas Instruments, will operate over a temperature range of -55°C to 150°C.

Maximum ratings are:

\[
\begin{align*}
V_T & = 85 \\
I_C (ma) & = 50 \\
P_T (mw) & = (at 100°C) 400 \\
& = (at 25°C) 900 \\
P_I (db) & = 30 \\
\end{align*}
\]

6DT8, 12DT8

General-purpose high-mu transistor type intended for use as an rf amplifier and as a combined oscillator-mixer in FM tuners. The 6DT8 has a 6.3-volt 0.3-amp heater. The 12DT8 is rated at 12.6 volts at 0.15 amp. Both are made by RCA.

The triode units are isolated by an internal shield having a separate base-pin terminal. Operating characteristics, when used in Class-A1 amplifier service are:

\[
\begin{align*}
V_T & = 100 \\
\mu & = 200 \\
g_m (ohms) & = 60 \\
R_T (ohms) & = 4,000 \\
I_C (ma) & = 15,000 \\
& = 10,990 \\
I_R (ma) & = 3.7 \\
V_R & = (at 10 µa) -5 \\
& = 12 \\
\end{align*}
\]

12EM6

A combined detector diode and a tet rode with a common cathode. The tet rode section is intended for use as a power amplifier where heater, plate and screen grid potentials are obtained di-

---

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"T - GUARD"

STYLUS

only with the

FLUXVALVE

PICKERING'S introduction of the truly miniature FLUXVALVE magnetic phonograph cartridge represents a new era in high fidelity cartridge design. This newest of PICKERING cartridges brings the music lover the most exciting and safest idea in a stylus assembly since PICKERING introduced the first lightweight high fidelity pickup more than a decade ago.

The "T-Guard" stylus assembly is a quick-change, easy to slip-in unit which eliminates precarious finger-nail fumbling. Its practical "T" shape provides a firm and comfortable grip for safe and easy stylus change.

The most flexible cartridge in the world... the FLUXVALVE is the only cartridge with the remarkable 1/2 mil stylus... exclusive only with PICKERING. The FLUXVALVE can be used with any one of five stylus, to meet any requirement or application... to play any record, at any speed.

If you are planning to buy a new cartridge—the fact that PICKERING developed this revolutionary stylus is important to you! All of the research, development and planning that went into the "T-Guard" stylus is conclusive proof of the superlative engineering skill in every FLUXVALVE model you buy.

NEW TUBES & SEMICONDUCTORS (Cont.)

rectly from an automotive battery.

Announced by Raytheon, typical operating characteristics of the 12EM6 are:

\[ \begin{align*}
V_{1C} & = 12.6 \\
I_{1C} (ma) & = 500 \\
V_{1T} & = 12.6 \\
V_{3C} & = 12.6 \\
V_{3C} (af) (rms) & = 1.0 \\
I_{3C} (ma) & = 2.5 \\
Power output (mw) & = 10 \\
Total harmonic distortion (%) & = 10
\end{align*} \]

Abbreviations

I_{CE}—Collector current when collector junction is reverse-biased and emitter is dc open-circuited.

I_{BE}—Emitter current when emitter junction is reverse-biased and collector is dc open-circuited.

I_{GC}—Collector current with collector junction reverse-biased and base open-circuited.

NF—noise figure.

G_{m}—Common-emitter power gain.

G_{p}—Common-base power gain.

P_{D}—Collector power dissipation.

I_{bb}—Common-base input impedance, output ac short-circuited.

I7CAP4

Another addition to 110° picture tubes, the I7CAP4 is a direct-viewed 17-inch rectangular glass type made by Sylvania. It has a spherical faceplate, aluminized screen and needs no ion trap. Its 6.3-volt 600-ma heater has a warmup time of 11 seconds.

Maximum voltage ratings for the I7CAP4 are:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{bb} (pos value)</td>
<td>1,100</td>
</tr>
<tr>
<td>(neg-value)</td>
<td>550</td>
</tr>
<tr>
<td>V_{bb} (neg bias value)</td>
<td>154</td>
</tr>
<tr>
<td>(neg peak value)</td>
<td>220</td>
</tr>
<tr>
<td>(pos bias value)</td>
<td>0</td>
</tr>
<tr>
<td>(pos peak value)</td>
<td>2</td>
</tr>
<tr>
<td>Peak heater–cathode voltage (htr neg with respect to cath)</td>
<td>450</td>
</tr>
<tr>
<td>(15-sec warmup)</td>
<td>200</td>
</tr>
<tr>
<td>(after warmup)</td>
<td>200</td>
</tr>
<tr>
<td>(htr pos with respect to cath)</td>
<td>200</td>
</tr>
</tbody>
</table>

Other types

A high-current medium-nu triode, the 6528, has been presented by the Chatham Electronics Div. of Tung-Sol Electric. It is intended for series regulator service in dc power supplies.

A 1,000-watt ceramic tetrode for single-sideband operation, the 4CX1000A, has been announced by Eitel-McCulough.
New Transcription-Type Tone Arm Makes Collaro World's First True High Fidelity Changer

The Turntable That Changes Records

From Collaro, Ltd., world's largest manufacturer of record playing equipment—comes the most significant development in the field in years—the new transcription-type tone arm.

This arm, exclusive with Collaro, literally changes the conventional record changer into a brand new instrument—a TRANSCRIPTION CHANGER—with features of the finest professional equipment.

The arm is a one-piece, spring-damped, counter-balanced unit which will take any standard high fidelity cartridge. It is free of any audio spectrum resonances. It permits the last record to be played with the same low stylus pressure as the first. Between the top and bottom of a stack of records there is a difference of less than a gram in tracking pressure as compared with 4 to 8 grams on conventional changers. Vertical and horizontal friction are reduced to the lowest possible level. These qualities, found only in the Collaro Transcription Changer, insure better performance and longer life for records and styli.

In its superb performance, the new Collaro Continental, Model TC-540, meets the rigid requirements for high fidelity equipment. Here, for the first time in a changer is professional quality at a record changer price. The Continental is $46.50. Other Collaro changers are priced from $37.50 up. (Prices slightly higher west of the Mississippi.)

In addition to the new tone arm, the Collaro Continental features include: 4 speeds, manual switch for turntable operation; wow and flutter specifications—0.25° RMS at 33 1/2 RPM—superior to any changer in the world; automatic intermix; automatic shut-off after last record; heavy duty 4-pole, shaded pole induction motor; heavy rim-weighted balanced turntable; muting switch and pop-click filter for elimination of extraneous noises; jam proof machinery; pre-wiring for easy installation; attractive two-tone color scheme to fit any decor; tropicalization to operate under adverse weather and humidity conditions; easy mounting on pre-cut board or base; custom testing at the factory for wow, flutter, stylus pressure and correct set down position.

FREE: Colorful new catalog describes complete Collaro line. Includes helpful guide on building record collection.

WRITE TO ROCKBAR CORPORATION
Dept. D-012
650 Halstead, Mamaroneck, N.Y.

Rockbar is the American sales agent for Collaro and other fine companies.

DECEMBER, 1957
OTHER MALLORY service-engineered products

MALLORY VIBRATORS to meet every service requirement

FOR THE VERY BEST IN PERFORMANCE...

Mallory Gold Label Vibrators are the result of over 27 years of vibrator pioneering and leadership. Employing the exclusive Mallory buttonless contact design, they eliminate problems of sticking contacts... insure positive starting... provide far longer life... are unbelievably quiet. For utmost dependability, and to build your reputation for service, make Mallory Gold Label Vibrators your standard of quality.

2 FOR ECONOMY JOBS...

The Mallory Highlander is a new line designed expressly for the jobs that must be done at a lower price. It delivers trouble-free service longer than any vibrator in its price class—second only to the Gold Label line. Ask your Distributor for the new Mallory Highlander—in the handy new 10-pack carton.

Technicians' News

OPPOSES PAY TV TESTS

The National Alliance of Television and Electronic Service Associations' (NATESA) executive secretary, Frank J. Moch, has expressed the organization's stand against any tests of pay TV "which would in any way encourage the acceptance of this system." This was in a letter to John C. Doerger, FCC chairman.

NATESA has asked the FCC and the House Interstate Commerce Committee to get all details of the workings of pay TV before permitting tests or authorizing it in any form.

Six points are emphasized by Mr. Moch. He states that approving pay TV will be a mortal blow to the independent service industry, since pay TV promoters would demand the right to maintain the sets. He continues that we (NATESA) have not been able to get assurances to the contrary.

He also states that approval would encourage the promoters to assume a utility attitude, and like the phone company would then supply the sets on a rental basis, thus raising havoc with the entire manufacturing, distribution, retail and servicing industries.

In explaining other points of the NATESA stand, Mr. Moch wrote that pay TV is opposed to historical concepts is not in keeping with the spirit of laws, like those authorized by the FCC; that despite its weaknesses, the present system of telecasting has been accepted by the public; that pay TV cannot guarantee elimination of existing shortcomings and that pay TV does not guarantee that commercial practices now distasteful to viewers will not be continued.

TECHNICIAN'S ADVERTISING

The National Alliance of Television & Electronics Service Associations (NATESA) now offers every member of every local affiliate an opportunity to participate in the NATESA National Advertising and Publicity Program, an article in the September issue of TESA (Missouri) News proclaims.

The program calls for ads in several top magazines, newspaper ads on a local level, radio and TV spots on a national level, listing in the yellow pages of the phone directory, Operator 25 service and use of direct-mail pieces.

Individual members of local affiliates will be franchised to participate, and window valences, truck decals, letterheads, bilheads, mailing pieces, etc., will be available at cost. The cost will be very low as advertising materials

www.americanradiohistory.com
URGES STRONG GROUP

Addressing the annual convention of the National Alliance of Television and Electronics Service Associations (NATESA), E. P. Atcherley, assistant manager of Sylvania's Electronic Products Distributors Sales Dept., said that, in his opinion, television service technicians require fewer, or one strong nationally known organization, to insure proper coordination of ideas and adequate interchange of technical information.

"To fulfill its role in electronics," Mr. Atcherley stated, "the service industry should have the equivalent of an American Medical Association or a National Association of Cost Accountants. At the present time there is no single organization equipped to fulfill the servicemen's needs and protect his interests."

HAZARDOUS ANTENNA

Those who believe TV repairing is a cinch were proved wrong again when Dr. Sidney Gaft, Bronx, N. Y., was killed while fixing a television antenna. Working on the roof of a 6-story building, Dr. Gaft slipped and fell off the roof to his death.

Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNBACK, Founder

Modern Electrics 1908
Wireless Association of America 1913
Electrical Experimenter 1919
Radio News 1920
Science & Invention 1927
Television 1930
Short-Wave Craft 1930

In December, 1923, Science and Invention (formerly Electrical Experimenter)

Loudspeaker Without Microphone, by Dr. Alfred Gradenwitz.
Broadcast Stations.
Multi-Wave Reinartz Receiver, by Kenneth Harkness.
How to Build a Rogers' Cage Loop, by Dr. James Harris Rogers.
Well Made Radio Cabinet.
Radio Oracle.

END

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Servicemen's favorites
in wire-wound controls

You're sure of giving your customers the best when you use Mallory wire-wound controls. The choice of servicemen and manufacturers everywhere, they have set the standards of the industry for value and performance.

They're conservatively rated—to assure you of cool operation without need for using over-sized units.

They're compact—fit readily into crowded chassis locations.

They're long lasting—give years of stable, dependable service.

They're uniform—made to strict specifications to meet or exceed original equipment requirements.

Mallory 2-watt and 4-watt controls are available in resistance values and tapers to match every replacement need. Your local Mallory distributor has a complete stock—see him today!
**ADJUSTABLE MULTIVIBRATOR**

Patent No. 2,788,419
Richard L. Bright, Adamstown, Pa. (assigned to Westinghouse Electric Corp., S. Pittsburgh, Pa.)

When this circuit is first switched on, BATT 1 and BATT 2 act in series through the load to charge C. A rush of current through resistor R2 produces a voltage drop that drives the junction of C, R2 and R3 negative and blocks V1. Absence of current through R4 keeps V2 non-conducting also.

As C charges, junction C-R2-R3 goes less negative. When the base voltage has dropped to about 1.3, V1 begins to conduct. Current flows through R4 to unblock V2 as well. C now discharges through R3 and saturates V1, and in turn V2. Thus, a second discharge path exists through R2 and V1.

At completion of the discharge, the cycle repeats. Voltage of BATT 1 has an important effect on the timing of the cycle, for it determines the instant V1 begins to conduct. Therefore this circuit is a pulse generator variable over a wide frequency range with but a single potentiometer control, R1.

**DOG-TRAINING DEVICE**

Patent No. 2,800,104
Robert E. Cameron, and John W. Hopkins, Jr., Lewes, Del., Delaware.

With this invention a dog's life can be made more miserable by remote control. The trainer carries an ultra portable transmitter (Fig. 1). A receiver is strapped to his dog within a harness, with a pair of electrodes touching the dog's shoulders. When the dog disobeys a command or fails to do something expected of him, the trainer presses a key to impart a "mild and unharsh, but effective" shock to his dog.

The radio detector may be superregenerative, with audio output fed to a relay (Fig. 2). This stage is biased to cutoff, so it conducts only when modulated by a tone. Normally the relay armature touches the upper contact, allowing C to discharge through the filament supply.

The relay is energized when the transmitter key is depressed. C discharges through the primary of step-up transformer. A high voltage

---

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**2-set coupler**

Model TV-42 is a 2-set coupler approved for color, UHF, VHF and FM. Matched resistive circuit with 12db interset isolation and flat response—0-500 megacycles. Another quality TV accessory engineered by B-Labs... $2.95 list

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**BLONDER-TONGUE LABS, INC. RE12 925 Alling Street, Newark 2, N. J. Please send me literature covering □ B-L TV Accessories □ Name... □ Address... □ City... Zone... State...”
appears across the secondary and the electrode. The inventors recommend subminiature tubes and tiny batteries. This is the least that can be done for the poor dog. Forcing him to carry heavy equipment would add insult to injury.

WIDE-BAND AMPLIFIER

Patent No. 2,781,423


Two separate amplifiers team up to provide flat response from dc to 10 mc. One amplifier (A) is effective from zero to 300 kc. The other (B) runs from 100 cycles to 10 mc. A crossover network smooths the overlap range for flat transition.

It is easy to maintain a constant gain through A, but B presents more of a problem because of the high frequencies. Therefore, its gain is regulated. A standard or pilot frequency (10 cycles) is fed to B. Some transmission occurs even though this amplifier is designed for high frequency. Initially, the pilot frequency output from B is made equal to that from the pilot oscillator. Any departure from this condition is the fault of B. An automatic control corrects its gain as needed.

There must be no coupling between A and the pilot generator. Also, the pilot frequency must not reach B directly from the input. Both purposes are accomplished by a rejection filter.

R1, C1 is a crossover unit. It reduces high frequencies from A and also low frequencies from B. R2 and C2 form a low-pass filter that transmits only the pilot frequency to V3. V3 is a difference amplifier that receives two signals, both of pilot frequency. One is the output of the pilot generator itself, connected by V1 and filtered. The other is the output from B, rectified by V2 and filtered. These signals appear at the grids of V2. When they are equal, there is no potential difference between the cathodes of V2. Therefore, no additional bias voltage is fed to B at this time. Any change in the output from the pilot generator has no effect on the bias, since it affects the grids of V2a and V2b equally.

If the 10-cycle output from B changes (without corresponding change from the oscillator), it must be the fault of amplifier B. For example, if the output increases, V2a receives more positive signal at its grid. Its cathode also goes more positive. As a result B receives a bias voltage that reduces its gain.

END
A complete range of TV equipment for hotels, motels and community systems.

SUPER 40—BROAD BAND AMPLIFIER
Completely new design—Four 75 ohm inputs, each self-controlled—Modified cascode input, giving extremely low noise figure—Most versatile amplifier for present day conditions. 
Total output up to 4 volts.  
$115.00

P. A.—SINGLE CHANNEL PRE-AMPLIFIER
The ultimate in end equipment—60 db input—Extremely low noise, full A.G.C. Exceptional results with signals as low as 50 microvolts.
$135.00

H. C. A.—VERY HIGH OUTPUT AMPLIFIER
Designed for all applications where a high output voltage is required. Capable of driving a low output signal through 2½ miles of K-14 type cable. 5 volts maximum output.  
$250.00

S. P. A. SINGLE CHANNEL PRE-AMPLIFIER
For head end of multiple systems, 40 db gain—built-in overload control. Low noise cascode input. Economically priced at $59.95

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

PROKOFIEV: Peter and the Wolf
SAINT SAENS: Carnival of Animals
Rodzinski conducting Philharmonic of London

Schuricht conducting Vienna State Opera Orchestra

Westminster XWN-18525

Few combinations of music present as delightful material for testing, demonstration and show-off (as well as listening) as these two. Westminster does its wonderful best, presenting marvelous drama and solo double bass and a brilliant and clean overall sound. Unfortunately, it undoes its work by an error which I cannot forgive in a company with so much hi-fi savvy. The commentary by Garry Moore, dubbed in after the recording of the orchestras, is at a level higher than the peaks of the orchestrations. It is impossible to set the volume to bring the musical portions to best effect without raising the voice to the level of a fog horn. I urge Westminster forthwith to rebud the job with the voice at least 6 db, and preferably 10 db lower. If it does so, it should have a best selling hi-fi hit. The solo bass in the Elephants of Carnival of Animals alone is worth the price. Here, at last, is a double bass not as big as life but as big as many hi-fi fans would like it to be, with fearsome capacity to rattle the loose china and window panes and to find any point of resonance in the system—or the house structure. Its rosy guttural is entirely natural, too. The drums, too, are both prodigious and natural. Other elements contribute to its superiority. As a dividend—which may annoy some—it includes the very awesomely natural sounds of the animals. The roar of the lion will especially delight those with a perfectly tuned speaker systems. It has the genuine thunderous omniousness. But, I repeat, as long as the voice is at its present ridiculous level, these virtues will either have to be hidden or paid for with headache and family strife.

HOLST: The Planets
Stokowski conducting Los Angeles Philharmonic

Capitol L-8389

This second release makes plain that the new association of Capitol and Stokowski is going to be a highly rewarding one for listeners with fine hi-fi systems. This music is extraordinary in its variety of tonal effects. Requiring a very augmented orchestra, it provides opportunity for almost every instrument to show off its particular forte and in several fearsome peaks produces a concatenation of orchestral sound which is hard to match. This recording does a superb job of bringing it all to the ear, with complete freedom from distortion, great faithfulness of tone and an extremely fine definition. It will take a really fine system to do it justice, but on such a system it is hard to imagine what advantage a live performance could have. For those who can learn to like the music well enough to become familiar with the detail, this would be a superlative test recording—particularly for distortion, definition and naturalness. And it would be a fine demonstration record for musicians or sophisticated listeners. For my money, the best recording Capitol has issued so far.

DVORAK: Slavonic Dances (Nos. 1–10)
Malko conducting Philharmonia Orchestra of London

RCA Victor LM-2096

DVORAK: Slavonic Dances (Nos. 11–16)
GRYEG: Lyric Suite
Same orchestra

RCA Victor LM-2107

Now that everybody has recorded Strausser in hi-fi, it appears that another cycle may be in the making with The Slavonic Dances. If so, it's a good idea, for these dances have a variety of music and tone coloring. This one is good enough musically, but the bass is rather vague for hi-fi demonstration. The Lyric Suite makes an excellent pairing. The surface of my copies were very noisy and nothing I could do would quiet them.

ROZSA: Jungle Book Suite
Thief of Bagdad Suite
Composer conducting Frankenland State Symphony Orchestra

RCA Victor LM-2118

The background music to the Alexander Korda filming of Kipling's The Jungle Book was recorded by RCA Victor with the voice of its hero for the narration before the war on 78's and proved very popular with the young fry. The music itself has been frequently performed in concert suite version. Here we have a new version, but with an adult voice in narration. The recording is far superior, being both clear and pleasing to those who have not been conditioned by the original recording. The same composer's music to the movie, Thief of Bagdad, also with narration, has the flail side. The balance of voice to music is excellent. Not remarkable in hi-fi effects but pleasant and clean.

BIZET: Carmen Suite
L'Astralienne Suite No. 1
Paray conducting Detroit Symphony Orchestra

Mercury MDS 5-3

KODALY: Hary Janos Suite
Dorati conducting Minneapolis Symphony

Mercury MDS 5-1

Mercury's entry into the stereo tape field is a welcome one. For one thing its Olympic recording technique with its wide dynamic range is particularly suited for showing off the advantages of tape reproduction. Whereas on the discs the peaks are very likely to overload even the best pickups, on tape they come through with a brilliant cleanliness. For another, the Mercury three-channel recording technique is a step toward but not a complete solution of the "holes-in-the-middle" effect of two-channel stereo reproduction. Finally, and perhaps best...

DECEMBER, 1957

NEW RECORDS (Continued)

of all, the initial offer includes present the spectacular type of material which makes the most vivid impression whether on stereo or single channel. This pair of tapes will present present-day stereo at its very best. The Sony Yarnas, especially, has some very satisfactory spots which, on the best stereo systems, will yield a most persuasive and brilliant presence. The more familiar Carmen Suite also has some very effective portions. The clare is high but pays for some of the very finest stereo tapes so far issued.

Dancing and Dreaming
Jay Norman Quintet
Concert tapes 24-2 (stereo)
456 (monaural)

There is nothing very demanding or spectacular about the music, but this tape is capable of bringing a five-piece supper club ensemble right into your living room. The high highs and percussives of the rhythm are extremely good, and the monaural version would be excellent for demonstrating really fine single-channel systems.

Russkaya
Dragon conducting Hollywood Bowl Orchestra
Capitol P-8384

Another of the excellent combination saluts in the Hollywood Bowl series which ought to find a very wide audience, especially among those who are just beginning to enjoy both classical music and high fidelity. This consists of a half dozen such proven Russian favorites as the Overture from Eugene Onegin and Livelice, Volga Boatsman, Dance of Hoffmann, Moscow Overture, Tchaikovsky's Melody and the folklore-based Meudowland. There is plenty of both hi-fi fire and melody. The recording is fully up to the high standards of this series—clean even in the biggest peaks, with a realistic balance of highs and lows, and a nice liveness. Nothing here to try a system severely, but much to make even a moderate system sound good: easy to listen to at low levels and refreshingly impressive for demonstration at loud levels, especially Meudowland.

Guitariana Espagnol
Richard Pick on Solo Guitar
Concert tapes 24-1 (stereo)
455 (monaural)

Recording a solo guitar in stereo looks like a silly performance and, in fact, sounds silly in spots. But few recordings communicate so high an immediacy—even in the monaural version. If you've never listened to a guitar at a distance of a few inches, this will give you the very same experience. The reproduction of the guitar transients is almost painfully real, and I recommend the monaural version as a demonstration piece with first-class single-channel systems.

Lena Horne at the Waldorf-Astoria
With Nat Brandwein's Orchestra
RCA Victor LOC-1028

On-the-spot recording of an actual performance. The recording of Lena is extremely intimate and her breathiness, etc., are very audible. There is not a mean strain effect, however, in the baritone when she opens up double F. To prevent over-loading, the engineer reduced gain of the close-up mike, which has the effect of seeming to make her move about 20 feet back during the last spot. Exceptionally clean for a pop. The audience was well disciplined except for one table whose enthusiasm is plainly audible on the flip side.

Tchaikovsky: Serenade for Strings
BARBER: Adagio for Strings
ELGAR: Introduction and Allegro for Strings
Munch conducting Boston Symphony Strings
RCA Victor LM-2105

Though we seldom pay any great attention to the quality of the strings in recordings, the fact is that it is not easy to record or reproduce massed strings with any great verismilitude. They seem able to find any discontinuity or resonant peak in a string system and indeed few tweeters really come through with flying
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NEW RECORDS (Continued)

The solo violin is not as easy to record and reproduce as some think, either. Two violinists have a special gift for enhancing its coloration, and pickups seem especially subject to becoming rattled by portions of highly-strung solo music. The string section of the Boston Orchestra, with its precision and excellent tone, is eminently suitable for an attempt at faultless reproduction and in this record RCA does a very good, though not yet perfect, job. With top-notch equipment, you should be able to reproduce it with no disquieting waverun, but with a bit audible string tone.

TCHAIKOVSKY: Violin Concerto in D
Heifetz, Soloist
Reiner conducting Chicago Symphony
RCA Victor L.M. 2129

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WEAK COLOR

We've come across what seems to be a fairly common trouble in the RCA 21-CT-663U set. The symptom is weak color, all washed out even with the chroma control turned all the way up. Circuit checks and voltage readings reveal low plate and screen voltage at V121-b, the bandpass amplifier. A positive voltage is found at the grid of V129, a demodulator driver. It seems to be disconnected from the set's speaker whenever the symptom occurred. The transformer was the only cure, and a quick one.—Joe Shone

INTERMITTENT OSCILLATION

An Emerson was brought into the shop with a complaint of occasional jellyfishing. The symptom would vary. Violent shaking was one type while complete loss of sync was another. A negative picture with smear was a third, even though the negative picture was not over the entire raster. The symptom could be excited by jarring and the set's speaker did the exciting while in the customer's home. The speaker was disconnected temporarily to prove this point of a loose contact somehow.

A meter on the scope indicated a rise whenever the symptom occurred. And the same increase in voltage was noted across the detector load resistance. As a result of this check, the trouble seemed to lie ahead of the video detector.

The voltmeter was left connected to
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TECHNOTES (Continued)

the detector load and the first if's grid was grounded with a jumper. The
chassis was shaken again and the rise of voltage defined indicated oscillation
in the if section. Successive grounding
and many tappings with shakes localized the trouble to one stage.

The photo shows the bottom view of this stage with a miniature tub as the
ampifier. Some previous repair work had been done. Evidently a resis-
tor had been replaced.

In so doing, the iron had heated the contact center of the tube socket. And
the lead to it was probably shaken while cooling. The result was a cold
soldered joint at the center contact. Resoldering cured the symptoms once
and for all.

The center contact is grounded to prevent undue capacitance between the
input and the output forming a small
shield. Stage gain was enough on weak
stations to force the set into oscillation
due to this added capacitance. Most of
the time the joint made good enough
contact to prevent the oscillation.—
James A. McRoberts

PHILCO CHASSIS 7L40

On these sets you will occasionally
run into a horizontal drive line which
cannot be eliminated. If all horizontal
tubes have checked good, take a look at
the 6DQ6's screen circuitry. The correct
hookup should include a 2,200-ohm and
a 4,700-ohm resistor as shown in a.

On several of these models, the circuit
had been changed so that a 6,500-ohm
resistor replaced the two shown in a.
FIELD COIL RESISTANCE?

When you run into a loudspeaker with a burned-out field coil and don’t know what the coil’s resistance is; relax, there is a way to find out.

Connect a 5,000-ohm variable resistor (R) in series with a filter choke (CH) across the field-coil terminals. Vary R until proper plate and screen voltages appear. Then turn the power off and measure the resistance between points A and B. Now just hook up a coil with the same value.—Stanley Clark

DU MONT RA-165

The complaint was no picture. I found a burntout 6BQ6 and replaced it. This restored the picture, but there was a slight horizontal displacement and critical vertical sync. I checked the sync video, if and tuner tube—all were very good. The customer said that the trouble had been there as long as she could remember and the chassis had received shop repairs without the difficulty being corrected.

This presented a challenge, so I convinced the customer to let me take the set to the shop. I set it up on the bench with a test tube and yoke. It performed perfectly. All waveforms and voltages were normal. After letting it cook for a few days, I returned it. The chassis was still there, but set still had a slight horizontal displacement and critical vertical sync. I pulled the chassis again, this time with the yoke and picture tube. Set up on the bench it played perfectly. I brought the cabinet to the shop and found the trouble would appear only when the set was in its cabinet. Further checking showed that the trouble started when the chassis was about two-thirds in the cabinet.

Several enjoyable minutes were spent pushing the chassis in and out of its cabinet and watching the trouble come and go. Then I checked the bottom of the chassis for parts which might be hitting the cabinet. I had absolutely no luck!

The only conclusion was that the trouble could not be happening. But it was! Then I noticed a blue lead running on top of the chassis to the local-fringe switch. The trouble would start when this lead was under the front of the picture tube. I removed the lead under the chassis and the trouble was permanently cured.

The picture tube was a glass 21-inch type with its outer coating grounded. There was only a fraction of an inch between the chassis and the front bottom of the C-R tube. Evidently the capacitance between the blue lead and the grounded C-R tube coating was enough to disturb the sync pulse.—Harry D’Otte, Terrace Radio & Television

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RADIO-ELECTRONICS

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NEW DEVICES (Continued)

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RECORD PLAYERS, portable hi-fi units. Model CV-11 (illustrated) permits continuous speed variations from 25-100 rpm, Model L-11 plays at 33⅓ and 45 rpm. Both use the A-120 arm.—REK-O-KUT Inc., 38-19 108th St., Corona 68, L.I., N.Y.


TAPE RECORDER, model 90, 40-15,000 cycles. Wow and flutter less than 0.01%.—Nortonics Co., 1015 S. 6 St., Minneapolis 4, Minn.

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STEREO TAPE HEAD. Recording and playback. Interchannel magnetic shield provides cross-talk rejection. Can be compensated to provide essentially flat response from 30-10,000 cycles.

...-Tancorde, Inc. 103 S. Jamaica Ave., Jamaica 38, N.Y.

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nal distribution in apartment houses, hotels, motels, housing developments, etc. Model ABB-2 (Illustrated) covers channels 2-6. ABB-4 covers channels 2-13. —Westbury Electronics Inc., 368 Shanes Dr., Westbury, N.Y.


BRIDGE KIT, resistance-capacitance-ratio, model C-40. Resistance ranges from 0.5 ohms-200 megohms; capacitance from

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- Type 40 TR: -40°C to 85°C
- Type 55 TR: -55°C to 85°C

CAPACITANCE TOLERANCES: Pyramid type TR units are made with commercial capacitance tolerances.

POWER FACTOR:
- TR units rated less than 15 working volts have a maximum power factor of 25% at 25°C and 120 cps.
- Type TR units rated 15 working volts and over have a maximum power factor of 15% at 25°C and 120 cps.

D.C. LEAKAGE:
- Leakage current limits for Pyramid type TR capacitors measured after the working voltage has been applied for 5 minutes may be determined from the following formulas:
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  - At 85°C: I = 0.35CV
  - At 100°C: I = 0.63CV
  Where: I = leakage current in microamperes, C = capacitance in microfarads, V = rated working voltage.

WORKING VOLTAGE:
- Pyramid type 20-85 TR can be supplied up to 450 working volts.
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SURGE VOLTAGE:
- The surge voltage rating of Pyramid type TR capacitors at 85°C and 100°C is 115% of the rated working voltage.

LIFE TEST:
- After 1000 hours at 85°C or 100°C, and working voltage applied, Pyramid type TR capacitors meet the following specifications at 25°C and 120 cps. The capacitance is within +10% of the capacitance measured before life test. The power factor is less than 150% of the power factor measured before the life test. The leakage current is within the limits specified above.

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HF61A-HF1 PREAMPLIFIER 111.11...

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HF51-HF1 PREAMP. w, power supply...

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HF40-HF1 AMPLIFIER 9-watt tube...

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DECEMBER, 1957

TELEPHONE Cortland 7-2359

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Sylvania Electric Products, Seneca Falls, N. Y., recently produced its 15 millionth TV picture tube. Shown on hand for this production milestone are, left to right, Donald W. Gunn, general manager of the Electronic Products Sales Department; Matthew D. Burns, vice-president; electronic tube operations, and W. Herbert Lamb, general manager of the Television Picture-Tube Division.

Weller Electric Corp., Easton, Pa., search and development, conducted the meeting and Jack Barnum, California representative, acted as host. Thirty people from 14 different firms attended.

Cleveland Institute of Radio-Electronics, Cleveland, Ohio developed an Employers’ Plan for training technical personnel while on the job. The plan helps employers relieve the two-way radio-microwave technician shortage without hiring new personnel. A book-let describing the service has been prepared by the school.

Weller Electric Corp., Easton, Pa.,
BUSINESS AND PEOPLE (Continued)

is offering electronic distributors a four-color three-dimensional sign featuring its soldering gun.

General Cement Manufacturing Co., Rockford, Ill., made a special price offer on its grille cloth. In addition, a wire display rack is offered with packages.

Vaco Products, Chicago, created a new display featuring its solderless terminals. The display also has slots for exhibiting the Vaco crimping tool and for holding descriptive literature.

Electronic Chemical Corp., Jersey City, N. J., is offering dealers two-color single cans for its volume control and contact restorer, and Tuner-Tonic products.

George Gemberling, former general district manager of Alliance Manufacturing Co., Alliance, Ohio, has been promoted to sales manager of the Consumer Products Division. Ray Buhman (right), advertising manager, was appointed assistant sales manager of the division as well as advertising manager.

H. F. Randolph continues as manager, receiving tube operations, of the RCA Electron Tube Division, Harrison, N.J., in a realignment of the staff of

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**BUSINESS AND PEOPLE (Continued)**

entertainment tube products. H. R. Seelen, manager, color kinescope operations, is now manager, kinescope operations. Right, M. J. Carroll former manager, cathode-ray and power-tube marketing, becomes manager, marketing. Roy A. Juusola joined CBS-Hytron, Danvers, Mass., as manager, marketing administration. He has over 15 years experience in electronics and comes to the company from Sylvania, where he was a plant manager.

John Pruton joined the capacitor sales section of Centralab Division of Globe-Union, Milwaukee, Wis. He has wide experience in the industry and was formerly associated with the P. R. Mallory Co. and Westinghouse Corp.

Henry Hadrick joined the engineering staff of Simpson-son Electric Co., Chicago, as chief field engineer—test equipment. He comes to Simpson from Admiral Corp. where he had been chief television field engineer.

George L. Long, Jr., president of Ampex Corp., Redwood City, Calif., was elected to the board of directors of Orradio Industries, Opelika, Ala.

Obituary

Robert Lee Stephens, a pioneer in electronics and high fidelity, recently in Iowa City, Iowa, following surgery for a chronic hip ailment. He founded Stephens Tru-Sonic Co., Los Angeles. Although he sold his interest in 1956, he was a consultant to the firm.

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**FIXED COMPOSITION RESISTORS, type BT.** Construction, characteristics, terminations, heat dissipation, color coding, power and voltage ratings are found in Catalog Data Bulletin B-12—International Resistance Co., 401 North Broad St., Philadelphia 8, Pa.

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**Technical Literature (Continued)**

A second booklet, Guide to Replacement, lists basic designation, tube class and various manufacturers’ type numbers of more than 1,000 industrial types.—Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

**Replacement Chart** shows part of manufacturer’s line of exact replacement power transformers, yokes, flybacks and vertical output transformers.—Merit Coil & Transformer Corp., 4227 N. Clark St., Chicago 40, Ill.

**Speaker Enclosures,** ready-to-use cabinets and prefinished types. A complete line is shown in this 1955 catalog.—Cabinart, 99 N. 11 St., Brooklyn 11, N. Y.

**Electronic Circuits** are outlined and employment opportunities with their requirements are presented in this handy brochure.—Cleveland Institute of Radio Electronics, 4900 Euclid Ave., Cleveland 3, Ohio.


**Linearity in Transmitter Tubes** is stressed in a 9-page bulletin entitled “Transmitting Tubes for Linear Amplifier Service.”—Penta Laboratories, Inc., 312 N. Nopal St., Santa Barbara, Calif.

**Control Guide. No. 5.** makes control replacement information available. Covers replacements for radio, TV, audio sets as well as audio equipment.—Centralab, Div. of Globe Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis., 20c.

**Electronic Phono Facts** is a 21-page booklet by Maximilian Weil which answers many questions about high-fidelity equipment. It covers subjects like stylus alignment, peaks and dips, tunable and removable cartridges—Rek-O-Kut Inc., 38-19 108th St., Corona, 68, L. I., N. Y. 25e.

**Fixed Composition Resistors, type BT.** Construction, characteristics, terminations, heat dissipation, color coding, power and voltage ratings are found in Catalog Data Bulletin B-12—International Resistance Co., 401 North Broad St., Philadelphia 8, Pa.

**New Book Circular** describes Beitman’s Additions to Servicing Information Manual. Also lists other helpful servicing literature.—Supreme Publications, 1760 Balsam Rd., Highland Park, Ill.

**Crystal-Filter Specifications.** Outline drawings, typical characteristic curve and circuit diagram are set forth.

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**Coloradaptor, 3471 Ramona, Palo Alto, Calif.**

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**LMB, 1011 Venice Blvd., Los Angeles 15, Calif.**

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TECHNICAL LITERATURE (Continued)


ELECTRONICS CATALOG, No. 170, lists over 27,000 items in its 404 pages. A complete line of hi-fi components and Knight kits are included. Industrial equipment is also shown.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

HIGH-FIDELITY CATALOG contains a listing of this manufacturer’s line of hi-fi equipment in kit and factory-wired form.—Electronic Instruments Co. (EICO), 84 Whithers St., Brooklyn 11, N. Y.

MAGNETIC TAPES for instrumentation recording are the subject of this illustrated booklet. Six tape types used in telemetering, computers and other instruments are detailed.—Minnesota Mining & Manufacturing Co., 900 Bush St., St. Paul 6, Minn.

CONSTANT-VOLTAGE TRANSFORMERS for 6.3-volt filament supplies are offered in circular CVF-269. Four informative pages describe the operation of these units.—Sola Electric Co., 4533 W. 16 St., Chicago 50, Ill.

AUDIO-FREQUENCY AMPLIFIERS are detailed in Catalog No. 15-C which stresses laboratory type units for scientific laboratories, tape or disc recording equipment and other purposes.—Ciriena Engineering, Div. of Aerovox, 1100 Chestnut St., Burbank, Calif.

TRANSPORT SPECIFICATIONS of this manufacturer’s line of alloy-junction types and an interchangeability guide are offered in a 4-page pamphlet.—Industro Transistor Corp., 649 Broadway, New York 12, N. Y.

PRECISION WIREWOUND RESISTORS are presented in this illustrated 2-color catalog. Axial, lug, printed-circuit and radial-lead versions are described.—General Radio Co., 557 E. 156 St., New York 55, N. Y.

MINIATURE PAN-I-LITES and Pan-I-Lite switches are shown in two illustrated spec sheets.—Alden Products Co., 117 N. Main St., Brockton 64, Mass. END

CORRECTION

There is an error in the text of the article “Hi-Fi Twin-Coupled Amplifier” in the November issue. In the second paragraph on page 44 the text states that R5 and C1 should be removed when using an electrostatic tweeter. The reference should be to R6 instead of R5.

Our thanks to Mr. L. R. Cartwright of Unionville, Mich., for reporting the error.

The author of “Build This Amplifier—Rectifier Vm for Audio Testing” (October, page 59) points out that capacitor C7 was erroneously listed as an electrolytic in parts list. C7 should be a paper type capacitor to minimize leakage and erroneous meter readings. A bath tub type capacitor was used in the original instrument.

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This newest volume of the TV Tube Locator starts where Vol. I stopped. Shows tube layouts of recent TV sets from 1055 models up to and including the newest 1957 sets. Each diagram gives the location and exact type number for every tube in the receiver and its function. A handy feature of the book is a table listing 155 common TV troubles caused by defective tubes. Series-string heaters and selenium rectifiers are indicated. If you've ever wondered which tube is the video output, this book can save you time.—LS

This work by the technical editor of the British periodical The Gramophone is billed on the jacket as "intended for the ordinary man in an inquiring turn of mind who wants to know something of the ideas behind this modern development of high-fidelity reproduction of sound." Mr. Williams presents the basic purposes of high fidelity, the conditions for achieving it and a summary of the means of arriving at it, clearly and free from personal prejudice or enthusiasm. The first four chapters comprise an excellent presentation of the ideas behind high fidelity. The several chapters on pickups, styli, arms and turntables, record wear, etc., are a little more advanced than the rest and should be of value to a somewhat more technical reader. Though specific references are

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RADIO-ELECTRONICS
to British equipment, this does not take away from the usefulness of the book to American readers.—JM

SERVICING AND CALIBRATING TEST EQUIPMENT, by Milton S. River, Howard W. Sams & Co., Inc., Indianapolis 5, Ind. 5 1/2 x 8 1/2 inches, 184 pages. $1.75.

A successful service technician really has two jobs: He must keep his own test equipment in good operating condition as well as keep his customers' sets in good repair. Unless the first requirement is satisfied, there is not much likelihood that his customers will be. Even the highest-quality meters, generators, scopes and probes do not remain reliable if they are not properly maintained and regularly checked.

This book shows how to take care of, calibrate and test various test instruments. It tells how to keep test records and the best methods of preventive maintenance. Typical service instruments are described with photos and schematics.—IQ


Four basic FM circuits are described in detail. They are the limiter, Foster-Sleeky discriminator, radio detector and gated-beam tube circuit. Theory and operation are given in each case, together with information for adjustment for optimum results.—IQ


Resonant circuits; combinations of L, C and R are found in many types of electronic instruments and radio devices. Presuming little previous knowledge.


Whether you admire the inventive genius in others or you yourself have a creative spirit, this book will be interesting. The author describes effects of environment, education and age on patent productivity. Case histories of many important inventors such as the superheterodyne radio, telephone and X-rays show how inventions may result from inspiration, curiosity, accident or sheer necessity.

Inventors will find suggestions for protecting, patenting and marketing their brain-children IQ

CORRECTION

The author of "Build This Amplifier: Rectifier VTVM for Audio Testing" (October, page 59) points out that capacitor C7 was erroneously listed as an electrolytic in the parts list. C7 should be a paper type capacitor to minimize leakage and erroneous meter readings. A bathtub-type valve was used in the original instrument.

This handsome new control unit gives crystal clear, noise-free reproduction from any modern program source. Its unique all feed back design limits cross over distortion to less than 0.05% at 300 cycles. Works with any number of circuits by merely connecting them to the output terminals, saving the expense of building or purchasing a new amplifier. Available at your HiFi dealer's for a low price of $34.95.

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This unique all feed back design limits cross over distortion to less than 0.05% at 300 cycles. Works with any number of circuits by merely connecting them to the output terminals. Available at your HiFi dealer's for a low price of $34.95.

* Unequaled performance

Actually less than 0.05% distortion under all normal operating conditions. Reposition 0.5 dB at 25 to 64 kh. Distortion and response unaffected by setting of volume control. Satisfactory square wave performance, and complete damping on any pulse or transient test.

* Easiest assembly

All critical parts supplied factory-mounted on XXX printed circuit board. Eased construction prevents damage to printed wiring. This type of construction cuts wiring time by 50% and eliminates errors of assembly. Open simplified layout offers complete accessibility to all parts.

* Lowest noise

Integral de heater supply plus low noise components and circuitry bring noise to less than 0.005% measured in 0.25 mV equivalent noise input by a 100 kh measurement. This is better than 76 db below level of 1 millivolt magnetic cartridge.

* Finest parts

15% components in equalization circuits to insure accurate compensation of record characteristics. Long life electrolytic capacitors and other premium grade components for long trouble-free service.

* High flexibility

Six inputs with option of extra phone, tape head, or mic input. Four AC outlets. Controls include tape, monitor switch, loudness with disabling switch, full range feedback tone controls. Takes power from Dynapak, Heathkit, or any amplifier with octal power socket.

* Outstanding appearance

Choice of bone white or charcoal brown decorator color and any size. Finished in indescribable vinyl coating with solid brass escutcheon.

* Best buy

Available from your HiFi dealer at only $34.95 net (slightly higher in the West), and yet the quality of performance and parts is unequalled at any price.

Description brochure available on request.

A

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* Patent pending

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† U.S. patent 2,650,012

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- automatically sets up socket connections, and all operating voltages such as heater, signal, plate and screen voltages, and bias (both fixed and cathode).
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- tubes, such as rectifiers, tested under heavy load currents up to 140 ma per plate.
- high-and-low sensitivity ranges for leakage tests.
- 12-volt plate and screen supply for testing new auto-radio tubes.
- meter protected against burnout.
- test card provided for checking instrument.
- 239 prepunched cards supplied with instrument cover 95% of currently active TV tubes. Pre-punched accessory cards available.
- active card magazine capacity—330; storage capacity—350 ... a total capacity of 700 cards.

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Neon Flasher, Low-Voltage
Oscillator, Audio
Phone-Tip Adapter
Panels
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Saver
Substitution
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Viscous Damped Transcription Tone Arm}

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SILVER CONTACT SELECTOR SWITCH
FULL SCALE RANGES
D.C. Volts: 0-10; 0-50; 0-500; 0-1000 Volts — A.C. Volts: 0-10; 0-50; 0-500; 0-1000 Volts. A.C. Current: 0-100; 0-500; 0-5000 mA — Resistance: 0-10; 0-100; 0-1000; 0-5000 ohms — Capacities: 0.01; 0.1; 1; 10 microfarads — Inductance: 0-1; 0-6; 0-30; 0-120 henrys — Voltage: 0-120; 0-250; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100; 0-500; 0-1000 Volts. A.C. Power: 0-100;
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<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Specifications</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 105E Deluxe</td>
<td>15-inch standard speaker system, wired and installed</td>
<td>33½&quot; high x 26¼&quot; wide x 19½&quot; deep</td>
<td>$359.00</td>
</tr>
<tr>
<td>The Duchess</td>
<td>Model 1178</td>
<td>15-inch standard speaker system, wired and installed</td>
<td>Mahogany Complete</td>
</tr>
<tr>
<td>The Empire</td>
<td>Model 1178</td>
<td>15-inch standard speaker system, wired and installed</td>
<td>Mahogany Complete</td>
</tr>
<tr>
<td>The Sheraton</td>
<td>15-inch standard speaker system, wired and installed</td>
<td>33½&quot; high x 37¼&quot; wide x 19½&quot; deep</td>
<td>Mahogany Cabinet Only</td>
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