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JANUARY 1958

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- New Amplifier With KT88's

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JANUARY, 1958

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ON THE COVER
(For details see page 32)
An obstruction by our art director, Sol Shieich, from an original design by Robert G. Middleton, illustrating "The Strange World of Color Vision."

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"SEEING AIDS" FOR THE BLIND may be possible as a result of experiments on direct stimulation of the brain with voltages from photocells. A New Jersey volunteer, Miss Betty Corstorphine of Newark, reported seeing flashes of light as she turned a photocell towards windows and other light sources. The photocell currents were conducted to the optic centers of the brain by fine wires, which were inserted through tiny holes drilled in the skull. Three-way cooperation made the test possible. Dr. John C. Button of East Orange, N. J., an osteopath devoted to nerve study, originated the idea. A team of physicians at Rochester (Minn.) State Hospital mapped the brain areas concerned and Dr. Tracy Putnam of Los Angeles performed the actual operation.

RADAR CONVICTION in Westchester County (N. Y.) of an alleged speeding offender was reversed by Judge Hugh S. Coyle after hearing an electrical consulting engineer, J. Kelly Johnson, testify that "even the rustling of leaves on a tree" or the "jangling of a radar patrolman's car keys" could cause inaccuracies in the radar equipment used to determine the speed of a passing vehicle.

In further testimony Mr. Johnson said that the transfer of a patrolman's revoler to another pocket, the metal on his gun belt, the patrol car's short-wave transmitter, a loose license plate on the car being timed or even vibration from the car itself could upset the radar receiver's accuracy.

In reversing an earlier decision, Judge Coyle said that evidence showed that the device in question "is accurate to the extent that it tells the existence of a moving target in proximity to the instrument but that its use for any additional purpose, such as measurement of speed of the vehicle, is subject to grave possibility or probability of error."

RADAR PATENTS are now coming out of hiding. Following close on the granting of the fundamental radar patent to Col. Wm. R. Blair (Radio-Electronics, November, 1957) comes news that a patent has been granted to P. F. M. Gloeas, a French scientist who developed the plan position indicator (PPI) radar while working in the Paris laboratories of the International Telegraph & Telephone Corp., now assignees of the patent.

The original patent application was filed in France in 1937 and in the United States a year later. PPI is the type of radar that, using a radial sweep, "paints" a rough map on the C-R tube screen, making it possible to see the distance and direction of individual objects directly. For that reason it is now the common type of radar used in surface and aerial navigation applications.

COLOR TV TAPE RECORDER was demonstrated by RCA recently at a closed-circuit demonstration. The new system uses tape 2-inches wide, which moves at 15 inches a second, on which the signal is impressed nearly crosswise by rapidly rotating heads. In this respect it is like the black-and-white system used by Ampex with which RCA has cross-licensing agreements. Ampex has not so far announced a tape recorder for color, although they have stated that they will market a conversion kit for their black-and-white recorder. Both the RCA unit and Ampex adapter are expected to be available to broadcast stations sometime in 1958.

The head mechanism consists of four separate recording (or reproducing) elements. The disc carrying the heads rotates at 14,400 rpm, so that each head crosses the tape 240 times per second. During each traverse a single head records information corresponding to slightly more than 16 lines of a color TV picture. A 1-hour program can be recorded on a 12½-inch reel.

Calendar of Events
Fourth National Symposium on Reliability and Quality Control, Jan. 6-8, Statler Hotel, Washington, D. C.
High-Fidelity Music Show, Jan. 16-12, Dinkman Hotel, Minneapolis, Minn.
High-Fidelity Music Show, Jan. 17-19, Hotel Antlers, Indianapolis, Ind.
Hi-Fi Music Show, Jan. 24-25, Hotel Statler, Buffalo, N.Y.
High-Fidelity Music Show, Feb. 7-9, Hotel Cosmopolitan, Denver, Colo.
TSA Midwest Electronic Forum, Feb. 8-11, Hotel Statler, Detroit, Mich.
Institute of High Fidelity Manufacturers Show, Feb. 26-3 Mar. 2, Hotel Biltmore, Los Angeles, Calif.

DR. ELMER ENGSTROM, color TV pioneer was granted the 1958 medal of the Industrial Research Institute. It will be presented to him at the institute's annual meeting in May. The medal is awarded for "outstanding accomplishment in leadership in or

(Continued on page 10)
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JANUARY, 1958

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8. Gershwin Hits—Percy Faith
9. Sinatra—Adventures of the Heart
10. Ambassador Satch
11. Firebird, Romeo and Juliet
12. Day By Day—Doris Day
13. Johann Strauss—Waltzes
14. Lure of the Tropics—Kostelanetz
15. Ports Of Call
16. Oklahoma!
17. Levant First Gershwin
18. The Elgar Touch
19. The Great Melodies of Tchaikovsky
20. Suddenly It’s The Hi-Lo’s
21. King of Swing—Benny Goodman
22. Brahms: Symphony No. 3
23. The Merry Widow
24. Wonderful, Wonderful—Mathis PE-1
management of industrial research which contributes broadly to the development of industry or in the public welfare."

Dr. Engstrom is senior executive vice president of the Radio Corporation of America, which he joined in 1930. He has been active throughout his period of service in the development and improvement of color television transmission and reception techniques.

**JUMP IN FM** receiver sales and an upswing in the number of FM stations on the air has focused the attention of FM broadcasters on protecting the 88-108-mc band. (See also p. 98) High-fidelity manufacturers are also concerned about the possibility of a cutback on the FM band to allow for more TV stations and industrial facilities.

One FM receiver manufacturer, Gruno Quarz, states that it has increased its 1957 production of FM receivers by 30% over the previous year.

**FACSIMILE SIGNALS BOUNCED** off meteor trails cover a distance of almost 1,000 miles without relays.

Announced by RCA, preliminary tests between the National Bureau of Standards in Havana, Ill., and RCA Labs in Riverhead, L. I., New York, have been completed. These points are 910 miles apart.

For the experiments the material to be transmitted was recorded on 35-mm film and was scanned to produce a signal similar to that used in transmitting television films.

The signals were projected by a highly directional antenna into the earth's atmosphere where they hit ionized meteor trails and are reflected back to earth to be picked up by another directional antenna.

The system was developed for the Cambridge Research Center of the Air Research and Development Command. The three principal scientists on the job were Warren H. Bliss, R. J. Wagner, Jr., and G. B. Wickizer. All are employees of RCA.

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<thead>
<tr>
<th>Name and Address</th>
<th>License</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walter Eggers, Pacific Grove</td>
<td>1st</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Paul Reichert, West Salem, Ohio</td>
<td>2nd</td>
<td>10 weeks</td>
</tr>
<tr>
<td>Harold Phipps, La Porte, Indiana</td>
<td>1st</td>
<td>28 weeks</td>
</tr>
<tr>
<td>John H. Johnson, Boise City, Okla.</td>
<td>2nd</td>
<td>12 weeks</td>
</tr>
<tr>
<td>James Faint, Johnstown, Pa.</td>
<td>1st</td>
<td>26 weeks</td>
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</tbody>
</table>

James Glen:
When Jim enrolled, he was a temporary employee of the City of Tacoma, Washington. In the space of 14 months, he completed the Master Course and received his first class license. He is now installing and maintaining mobile and microwave equipment.

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NEWS BRIEFS (Continued)

than the commercial aluminum itself. It is not even necessary to remove rolling-mill oils or the surface oxide from the surface to be soldered.

The new technique, which was developed by G. M. Houton and P. R. White of the Bell Telephone Laboratories, uses an already available alloy sold under the trade name of Zamak 3 for making zinc castings. It contains aluminum, copper, and magnesium as well as zinc. The soldering technique is equally effective for joining galvanized surfaces without a flux.

TV LIBRARY at the University of Virginia now permits students to read books by remote control, without even entering the main buildings where the stacks are kept. Students may phone their requests from either of the two library branches and have the book of their choice placed in view of the TV camera. After having finished a page at the remote viewer, they can turn pages with a remote control device. A considerable saving in time and energy may result, since the books can be made available to students on the other side of the 510-acre campus without any delay.

HI-FI TRAPS WILDLIFE. Sportsmen have discovered that recordings of geese and ducks while feeding makes an effective lure to draw game within range of the hunter. Recorded with high-fidelity equipment, the sounds are played back by portable tape recorders or record players and are amplified and beamed in the proper direction with directional speakers. One such device helped bring down 1,265 geese during the last hunting season.

The Interior Department's Fish & Wildlife service (FWS), worried over the effectiveness of this equipment, plans to ban these devices. Canada has already put such a ban into effect. When the United States ban goes into effect, it is expected to apply only to the use of recordings to attract game birds.

RADIO STREET-LAMP CONTROL was declared a success under New York City traffic conditions after a Fire Department test of the new equipment. Temporary radio-controlled portable signal lights were mounted at three intersections. The lights were controlled by FM transistor radio units in the cabs of two fire trucks. At the approach of a fire truck the flashing signal came on. The light continued to operate until the truck had passed. The system is adaptable to use by all emergency vehicles.

TV IN JAPAN has shown a tremendous growth in the 4½ years since the first station went on the air transmitting to 366 registered receivers. Today there are 68 stations on the air and 629,595 licensed receivers. This number is increasing by 40,000 a month. All programs are monochrome, but color is expected. Present price of a TV receiver is about $200 for a 14-inch screen, high for the average Japanese, but only half of its cost a year ago. END
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Big headlines say: "Stop fiddling with fine tuning now brings you Electronic Self-Tuner." The ad continues: "You just touch a button and the next channel comes on with a sharp-tuned picture... It's automatic—for you pre-tune each channel individually the day you get your set."

LET'S TAKE THE WHISKERS OFF!
The fact is that Zenith has had pre-tuning—called BULL'S EYE TUNING—since the first Zenith Television Set ever marketed in 1948! Now, it appears to be new because someone else thinks he has discovered it and starts using it.

IMITATOR NO. 1 further says in the same ad
"Now remote control is truly practical."
And also says that its consoles "include remote control—at no extra cost."

LET'S TAKE THE WHISKERS OFF!
The fact is that what they are talking about is a "one-half" imitation of Zenith's "Lazy Bones" remote control which Zenith put on the market in 1950, and which changes stations in either direction. The one being advertised currently by our imitator is merely a wired contraption that changes stations in one direction—it is as obsolete as the covered wagon, because now, Zenith's Space Command Remote TV Tuning Control turns the set on and off, changes stations in either direction, and cuts off long, annoying commercials while the picture remains on the screen. And, Space Command Tuning uses no wires, no flashlights, no batteries.

QUALITY BY
Zenith

14
At Zenith we are growing weary of inventing and introducing new, novel and different television improvements—only to see them imitated years later by competitors who boast that they brought them to you or by competition disguising their imitations in new terminology and then claiming them in advertising as new—as exclusive—as their inventions.

IMITATOR NO. 2 says in an advertisement in LIFE magazine

"One touch changes channels and fine-tunes picture and sound electronically!"
It says . . . "EVEN BLINDFOLDED, YOU GET PERFECT TUNING."

LET'S TAKE THE WHISKERS OFF!

The whiskers on this one have a nine-year growth dating back to 1948, when Zenith first introduced one-knob automatic station selection. New Zenith sets then, and now, are pre-tuned!

IMITATOR NO. 2 also claims discovery of remote TV control

This same ad in LIFE magazine also claims: "FIRST TRUE REMOTE CONTROL!" . . . lets you change channels and soften sound . . . "No wire stretching to set!" "No batteries!"
What they don't tell is that this gadget has to have wires running to the electric light line, and even then it will not turn the set "on" and "off" and will not completely mute the sound of long, annoying commercials while the picture remains on the screen as does Zenith Space Command Tuning.

LET'S TAKE THE WHISKERS OFF!

These whiskers sprouted seven years ago! In 1950 Zenith introduced, as mentioned above, "Lazy Bones" remote control. . . and since that time Zenith researchers and engineers have worked to develop and introduce the one remote TV control that obsoleted all others. This is Zenith Space Command Television, introduced to the public in 1956. With Space Command Tuning you can tune TV from anywhere in the room by "silent sound". . . without wires, cords, batteries, transistors or flashlights!

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The Royalty of
RADIO, TELEVISION, HIGH FIDELITY AND HEARING AIDS
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THE RIGID-CONE SPEAKER

Dear Editor:

Mr. Klipsch pays me a handsome compliment in his October article, but is rather unkink in calling me an elder statesman (Bernard Baruch or Winston Churchill type?)! Damn it all, I'm not that old and I still feel full of energy and ideas. I cannot reply at length to his article at this moment. I had promised you a new analysis of speaker performance and this is being prepared; but perhaps I may suggest, with a sly grin, that Mr. Klipsch hasn't completed his course in hermeneutics. He is still being fooled by those carefully checked figures. He hasn't appreciated that they do apply only to speakers with paper cones.

My data, referred to in my first letter, was taken with Bakelite cones; hence the disagreement. The letter from Mr. Harold Luth (September) was, in my opinion, of great importance; what he wrote was what I believed. I have just returned from seeing what he is doing and all he has found confirms what I found—the paper cone is a dead dog.

It requires no great technical knowledge to understand that for a given size a rigid piston will push air in a very different manner. A paper cone is a flexible piston, when driven hard by the voice coil it sets into action. It has a certain extent and to the low end of cone displacement the air is not influenced by the cone. However, the cone confines the air in the cone and around the paper cone, but certain undesirable properties and that led me to revert to the paper cone, but treated in various ways to make it a better paper cone material. This approach was demonstrated by the Hartley 217.

That speaker is well liked by a lot of people but it never satisfied me. Some said it had insufficient bass because it was too small. I believed it had insufficient bass because the cone wasn't stiff enough. The 217 speaker has a cone in which the paper is converted into something quite different, much more rigid, and without any other change in the speaker the undistorted output at very low frequencies went up more than 100%.

Luth revealed to me the fundamental principles of the work he has been doing. He proved to my satisfaction that, if one wholly rejects conventional notions of cone design, it is possible to achieve the most striking results. If a cone, a piston, does not distort in...
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JANUARY, 1958

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Yet, the C-60 will easily drive all modern preamplifiers, and is ruggedly suitable for any record changer or arm. Only the C-60 has all these advantages:

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**magnificent!**

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An example is the ESL MC-1 pictured above. This superb omnidirectional microphone will easily meet the most exacting professional requirements for music and speech, yet it lists for only $50 complete with base.

- Frequency range 50 cps to 15,000 cps ±3 db
- Internal impedance 200 ohms
- Output level — 47 db re 1 mv/10 dynes/cm²
- Size 4¼" x 1½" x 1½"
- Weight 8 oz.

A catalog of the entire line of ESL moving coil microphones and accessories may be obtained free upon request.

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**Electro-Sonic Laboratories, Inc.**

Dept. E • 33-54 Thirty-sixth Street • Long Island City 6, N.Y.

**CORRESPONDENCE (Continued)**

shape when driven by the voice coil, there will be no distortion in the sound created by the moving air. This was an endorsement of the sort of thinking that has been in my mind for a long time, yet I did not allow myself to be fooled. I had to be convinced before I would go along with him. I was convinced.

Even so, Mr. Klipsch is right in his first statement: "Much air must be moved to radiate appreciable power at low frequencies." What he has not appreciated is that we are not bound to accept a paper cone as the only device to move the air. We might as well criticize the performance of an automobile after running it on kerosene. Adopt a rigid cone and the size of the speaker is not important, so long as enough air is moved. The Hartley-Luth 220 speaker introduced at the New York High Fidelity Show is a demonstration of the thought processes of its designers. The public can judge if we are crazy or not.

H. A. HARTLEY

New York City

**WHOSE SATELLITE MODEL?**

**Dear Editor:**

Attached is an article which appeared in the Chicago SunTimes on Saturday Oct. 12, 1957.

This article states that the Soviet Journal Young Scientist of 1957 featured a cutaway diagram of a Russian satellite, and reveals that the picture originally appeared in the January, 1956, issue of Popular Science and that the full-color version of Allied Radio’s 1957 Catalog. Many Chicago residents saw the plastic model in December,
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"NRI changed my whole life. If I had not taken the course, probably would still be a fireman, struggling along. Now Control Supervisor at WRCA-TV." J. E. Melini, New York, N. Y.
1955, when it was on display at the Chicago Museum of Science and Industry.

The photographs show the Soviet version and the Allied Radio Catalog cover, which was photographed from the displayed model.

J. W. Rubin
Allied Radio Corp.

(The original model which was displayed in Chicago, weighed 25 pounds. It was built at a cost of $150 by Herbert R. Pfister, associate editor of Popular Science.—Editor)

**DOPPLER DISTORTION**

**Dear Editor:**

The latest round shows the complete state of superstition existing in some minds. Mr. Luth ("More About Speakers", page 18, September, 1957) implies a different cone material will eliminate doppler distortion. It must be pointed out, repeated and emphasized that doppler distortion is a function of a moving sheet of air, not a fault of a speaker. Regardless of how the air is moved, with a plutonium diaphragm or just some more air, the fact that it is in motion produces the frequency modulation. Thus the solution lies in reducing the amplitude and velocity of motion by increase in area. Obviously — or is it obvious when everybody seems to want to belabor the point — if the distortion is due to air in motion, the diaphragm material cannot affect this form of distortion, be it either paper, glass, lead or Styrofoam.

To reiterate, doppler frequency distortion is a function of the air in motion, regardless of how it is caused to move.

For the late readers, this is about the frequency modulation of one frequency by another. A sheet of air, as moved by a cone speaker, for example, or by any other means, carrying simultaneously some low frequency (like 50 cycles) and some higher frequency (like 500 cycles) will produce a frequency shift of a higher frequency in the form of a flutter at the lower frequency. A motion of .06 inch of the sheet of air at 50 cycles will produce about 1% peak-to-peak frequency shift or flutter, an amount which is plainly audible.

The obvious remedy is to increase the area so a given amount of energy can be radiated at a lower energy density per unit area. The pressure-velocity transforming function of a horn is useful in accomplishing this. In well designed horns the diaphragm needs to move through only a slight excursion; and the virtual diaphragm at the horn mouth (simply a sheet of air) can be several square feet in area and transmit up to an acoustic watt or more with negligible distortion, even at very low frequencies.

Hope, Ark.

Paul W. Klipsch

*END*

**NEW**

**New AM-FM Tuner puts wide band FM, wide range AM within your budget!**

Completely new in styling ... in engineering ... in performance ... the H. H. Scott model 300 AM-FM tuner embodies many new engineering features found nowhere else.

- Selectivity is superior to conventionally designed tuners because of the wide-band detector.
- Circuity is completely drift-free ... without the need for troublesome AFC.
- Cross-modulation is minimized so strong local stations do not appear at several points on the dial.
- A. M. section features wide-range circuitry. Reception is so good on fine A.M. stations you'll think of them as FM.

When you tune the H. H. Scott 300 to a weak FM station next to a strong one, it stays in tune perfectly. Ordinary tuners using AFC rather than Wide-Band, wander from the weak station to the strong, making it impossible to tune to weak stations. Smooth acting slide-rule dial is extra-long giving better band spread, so stations are easy to separate.

Famous musicians like Metropolitan Opera singer Jerome Hines choose H. H. Scott components for their own homes.

**Additional Technical Information — Model 300**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM sensitivity</td>
<td>3 microvolts for 20 db of quieting</td>
</tr>
<tr>
<td>Selectivity</td>
<td>±7 db at 3000 cycles</td>
</tr>
<tr>
<td>AFC drift</td>
<td>±1 cycle/sec</td>
</tr>
</tbody>
</table>

Precision-ray tuning eye makes it simple to tune precisely on both AM and FM.

Wide-band FM circuitry eliminates co-channel and adjacent channel interference — makes tuning drift-free.

The new 300 is a perfect match to H. H. Scott's best Buy Amplifier ... the famous "99". This 22 watt complete amplifier is only $199.95. This means that for only $29.95 you can have a complete H. H. Scott system.

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that Grantham Students prepare for F.C.C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

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<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>License Wks.</th>
</tr>
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<tbody>
<tr>
<td>Douglas Moore</td>
<td>5102 Flambeau Rd., Madison, Wisc.</td>
<td>1st 11</td>
</tr>
<tr>
<td>Bernard Kirschner</td>
<td>504 E. 5th, New York, N.Y.</td>
<td>1st 12</td>
</tr>
<tr>
<td>Albert D. Meelem</td>
<td>Box 136, Etrama, Pa.</td>
<td>1st 12</td>
</tr>
<tr>
<td>Dan Breese</td>
<td>Station KOVE, Lander, Wyo.</td>
<td>1st 12</td>
</tr>
<tr>
<td>Richard Meelan</td>
<td>166 Jerome St., Brooklyn, N.Y.</td>
<td>1st 10</td>
</tr>
<tr>
<td>Leo Bishop</td>
<td>37 Calle Contenta, Flagstaff, Ariz.</td>
<td>1st 12</td>
</tr>
<tr>
<td>Carl Deare, Jr.</td>
<td>P. O. Box 467, Jeanerette, La.</td>
<td>1st 11</td>
</tr>
<tr>
<td>Jackson York</td>
<td>1029 N. Quincy St., Arlington, Va.</td>
<td>1st 15</td>
</tr>
</tbody>
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ELECTRONICS IN SPACE

The Space Age Will Bring Many Electronic Changes

The Space Age, ushered in on Oct. 4, 1957, by the first man-made satellite, served a sharp and poignantly notice on all technologists that henceforth their thinking must embrace a new viewpoint—outer space.

Since the dawn of humanity, man has been confined to the very bottom of a vast protective ocean—the atmosphere. Now he is venturing far into airless space and into a vacuum far more perfect than any vacuum tube he has ever produced on earth. At the same time, he will be exposed to the fierce interstellar cold, far not from absolute zero (when screened from the sun), and, as if this were not sufficient, to an array of dangerous radiations ranging from cosmic to X-rays. Man's leap into space is certain to be far more exciting and have far greater consequences than Columbus' discovery of the New World.

A whole new and vastly complex space technology is now in the making. It affects every technician, whether he is a chemist, a metallurgist, a mechanical, electrical or electronics technician. All must revise their thinking if they do not wish to be left hopelessly behind.

Take such a comparatively simple space object as the Russian sputniks. Consider the electronic gear, the transmitter and receiver. Then reflect that while they are in the sun for 45 minutes, they become fiercely hot from solar radiation. Then for 45 minutes they travel in the earth's shadow, when if they remained there they would cool to below -200° Fahrenheit! Fortunately, the satellite traveling at 18,000 miles an hour will acquire a mean temperature after a few revolutions around the earth. To further this, the Russians pumped an inert gas into their sputnik to keep the inside temperature from fluctuating too violently. Nevertheless, the transmitter's and receiver's components often undergo greater temperature stresses than on earth and must be engineered accordingly.

Much of this changes once we leave the warming rays of the sun. Suppose that—as will soon happen—a technical crew is working on the dark side of the moon. Here the night lasts for about 14 (earth) days. The temperature goes down to around -400° F, soon after sundown. What will then happen to an exposed radio transmitter and receiver? You wouldn't, for instance, install electrolytic capacitors; they would cease operating long before the -400° freeze. One must also consider the fact that at extreme low temperatures various electronic components become extremely brittle and have a tendency to fall apart. Batteries? The Leclanché carbon–manganese–zinc type is probably the most efficient in cold weather. At 70° we have a 100% capacity (output); at 20°, 48%; at 0°, 27%; at -20°, 6%; at -400°? Long before that point is reached, they would have burst open. Hence, in the dark of interplanetary space we must have to use a different means of current supply, such as hand- or foot-operated generators or, more likely, in the near future, atomic batteries.

Curiously, too, as the temperature falls, our electronic circuits improve vastly—the colder it gets the lower the electrical resistance of a conductor. Finally, a few degrees above absolute zero (-459.22° F), many conductors lose all resistance—they become superconductors. On earth we already have superconductive circuits in which an induced electric current has been kept going without stopping for many months without any outside current supply!

If you ponder this statement—space-wise—you will appreciate what electronic revolutions are coming in the future. This does not mean that we will get electrical energy for nothing, but rather that we will get energy for less effort, at incredible efficiency.

In outer—or even nearby—space, the electronic technician will find other surprises. You do not need a vacuum tube—space will be far in space, as far without the glass envelope. This holds true only if the tube is out in open space; it is not true within a pressurized spaceship.

Transistors, too, work efficiently at lower temperatures. They have been operated routinely by scientists down to -40° F, where they perform quite well. What about transistors at near-absolute zero in the superconductivity region? We suspect that at such temperatures there will be some more electronic surprises—but right now this is strictly hush-hush information.

What about the comparatively new semiconductor, the solid-state solar cells? These cells are now being used increasingly in space rockets and will be used in most man-made satellites, replacing the old type dry-cell batteries. We talked about this with Bell Laboratories' Dr. D' M. Chapin, one of the inventors of the solar cell. On earth on a clear day, the average output of the cell is about 10 milliwatts per square centimeter. Above the atmosphere in airless space, there is 30% to 35% more radiation and at least part of this increase is in useful frequencies. Also the voltage of the solar cells increases as the temperature decreases. Thus, in space, the solar cell's output will be up considerably, generally speaking. This, then, means that future spacecrafts equipped with a bank of efficient solar-cell batteries will obtain much of their electrical energy directly from the sun.

At this point we should qualify some of the above statements regarding solar radiation. They hold true only in the vicinity of the earth's orbit. Near Mars, the solar energy from the sun is only 0.44 (earth is 1.00), while near Venus it is up to 2.04. Near Saturn's orbit, it is only .01. Finally, in the orbit of the outermost planet, Pluto, solar cells would be almost completely useless.

Nor would it be simple to communicate with a spaceship in the vicinity of Pluto. It would take an average of 6 hours and 25 minutes for a radio message to bridge the distance between Pluto and earth, or 12 hours and 50 minutes for a short two-way conversation.

Weightlessness in space, as far as humans are concerned, has never been explored except for short periods up to 30 seconds at a time. The first manned satellite will have at least one human completely wired with all sorts of electronic gear, from electroencephalograph to cardiac, to study human physical and psychic behavior during extended states of weightlessness. From what we already know, zero gravity will probably benefit most individuals. Extended periods of the weightless state may even cure or ameliorate certain ailments and diseases.

H.G.
The strange world of color vision

By ROBERT G. MIDDLETON
TELEVISION CONSULTANT

Color is by no means simple—it is often incomprehensible and always tricky; but its apparent inconsistencies make compatible color television possible.

CHILDREN and simple folk suppose that the colors they see really exist in nature and scoff at the idea that colors exist only in the mind.

Physicists explain that the colors we see correspond to waves of electromagnetic energy from 4 to $8 \times 10^4$ cycles per second. Electromagnetic waves used in radio and television transmission have longer wavelengths.

Of course, light waves are not color, any more than radio waves are color. Physicists do not attempt to explain further and physiologists cannot. Psychologists are baffled and philosophers offer various theories which cannot be proved or disproved.

In spite of the unsatisfactory state of our knowledge concerning color vision, many interesting laws have been discovered, upon which the technology of color television rests. Some of these laws are well known while others are familiar only to specialists.

Trichromatic vision

Of all our body's organs, the eye is most remarkable. Loss of hearing is a personal tragedy but loss of sight is a calamity—our eyes provide us with more information concerning the external world than any other organ.
It was once supposed that the eye is a frequency-sensitive organ because we see various colors when electromagnetic waves of various frequencies enter the eye. As shown in Fig. 1, a wavelength of 475 mµ (millimicrons) causes us to see blue, 520 mµ green, 578 mµ yellow and 700 mµ to see red.

Fig. 1 shows in a limited manner the information given in Fig. 2. The chromaticity diagram (Fig. 2) shows around its border the wavelengths of light corresponding to the common colors. Note that there are colors along the base of the diagram to which no single wavelength of light corresponds. This is a rather unexpected fact which is discussed later in the article.

In view of such experimental data, it is reasonable to conclude that each color we see has a corresponding frequency or wavelength. However, there are difficulties which make this conclusion unacceptable.

When we mix red light with green light, we do not see either of these two colors. Instead we see a new color: yellow. On this basis, we must abandon the definition that yellow corresponds to a wavelength of 578 mµ, since yellow is also produced by a combination of two other wavelengths.

In fact, investigation has shown that the many thousands of colors which we see can be obtained by mixing only three colored lights—red, green and blue—in various proportions. Color television operates upon this law, the law of trichromatic vision. Fig. 3 illustrates how the primary colors of red, green and blue combine by pairs to form the complementary colors of yellow, cyan and magenta. Fig. 4 shows how the three primary colors combine to form white.

To obtain compatible operation of black-and-white and color TV receivers, wavelengths of light are transmitted as various phase angles of a color sub-carrier. This is shown in Fig. 5. Burst is taken as the reference frequency. Red, which has a wavelength of 700 mµ, is transmitted as a phase angle of 76.5°. Magenta, which is a combination of 700 mµ and 475 mµ, is transmitted as a phase angle of 119°.

The colors seen in the spectrum of a prism are 100% saturated. They are pure colors. Saturated colors are vivid. Desaturated colors are pale—they have a pastel shade. The wavelength of a desaturated color is the same as the wavelength of the same saturated color. However, white light is mixed with a saturated color to make a desaturated color.

In Fig. 5, the relative voltages of the saturated colors are shown by the lengths of the vectors. Now, if we shorten the length of the red vector to half that shown in Fig. 5, we transmit pink—a desaturated red.

It is no mystery that hues are transmitted in terms of phase, and that saturations are transmitted in terms of voltage. These values are easily calculated throughout. We encounter the unknown only when we attempt to understand how a color such as yellow is seen when the eye is viewing a mixture of red and green lights. Perhaps we shall never know.

Producing color
White is a mixture of red, green and blue. Black is the absence of visible electromagnetic wave energy. As white can be produced from colors, conversely, colors can be produced by suitable arrangements of black and white. For example, when we mount the disk shown in Fig. 6-a on the shaft of a variable-speed motor, we see an arc of color in the rotating pattern. As the speed of the motor is varied, the hue of the color changes accordingly. A disk which produces red and yellow is shown in Fig. 6-b.

It is thought that there may be three types of color receptors in the retina.
of the eye, with peak responses to wavelengths in the regions of red, green and blue. These color receptors are not sharply tuned but have overlapping responses or considerable bandwidth. Furthermore, when these color receptors are simultaneously energized by white light which is then suddenly stopped, the response of the color receptors does not fall to zero at once, but requires a small time interval to decay to zero.

Because the color receptors have differing decay times, a residual unbalance of response occurs from the receptors during the decay time so that we see color in the black-and-white whirling pattern, which attacks the eye with sudden changes from black to white and vice versa. The disk should be rotated counterclockwise at a speed on the borderline of persistence of vision, and the level of daylight or artificial light adjusted to produce the maximum intensity of color in the whirling pattern. Thin, fairly intense red rings, blue tails and yellow fields will appear under suitable conditions.

The known facts of "color blindness" also support the theory of three color receptors in the retina, responding in the regions of red, green and blue.

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FIG. 8—Optical filters use resonant electrical circuits which are provided by nature in the electronic orbits of the atoms comprising the filter glass. A color mixture, whereby any desired color can be synthesized by a suitable mixture of the three primary colors.

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FIG. 9—The brightness of a white bar, like that of a color bar, is equal to the sum of the brightness of its components.

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FIG. 10—The brightness of a color is equal to the sum of the brightness of its components.
magnetic energy recognized by us as a given color. There is no basic difference between an optical filter and a wave trap except that the wave-lengths used in the optical filter are shorter.

Color can be specified on a technical basis in terms of brightness, hue and saturation. Fig. 9 shows that the brightness of a white bar is equal to the sum of the brightnesses of its components (red, green and blue). The brightness of red, as seen on a black-and-white picture tube, is 30%; the brightness of green is 59%; the brightness of blue is 11%—hence, the brightness of white is 100%.

Fig. 10 shows that the brightness of a color is equal to the sum of the brightnesses of its components. Yellow has a brightness, as seen on a black-and-white picture tube, of 89%. Yellow is comprised of green which has a brightness of 59% and of red which has a brightness of 30%—hence, the brightness of yellow is the sum of these brightnesses, or 89%.

The brightness of a color, as transmitted from a color TV station, is given by the level of the Y (black-and-white) signal component, as shown in Fig. 11. To this brightness signal level is added a 3.58-mc chroma signal. The chroma signal specifies hue and saturation. Fig. 12 shows how the voltage of the chroma signal specifies the saturation (vividness) of the color. We have already seen how the phase of the chroma signal specifies color (hue).

This particular (NTSC) signal arrangement has been established to provide compatibility in black-and-white and color TV reception. Fig. 13 shows how a succession of red, green and blue bars is transmitted as a series of video levels at 59%, 50% and 11%. This is the only part of the complete color signal which is seen by a black-and-white TV receiver.

The chroma signal has a relatively high frequency (3.579545 mc) which is largely filtered out in the if and video amplifier of a black-and-white TV receiver. In a color TV receiver, however, the chroma signal component is not rejected, but is processed through the chroma circuits of the color receiver.

The color receiver responds to the phase of the chroma signal by displaying a corresponding hue; it responds to the voltage of the chroma signal by displaying a corresponding color saturation. This is how we get compatibility.

DEFINITIONS

A translator picks up vhf or uhf signals, both audio and video, amplifies both and then retransmits them on one of the upper vhf channels.

A booster (or reflector) is simply a rf amplifier.

A satellite is, according to some sources, a booster or translator operated by a TV station itself to reach a "shadowed" area. Others refer to satellites as any amplifier that rebroadcasts a signal that it does not originate itself.

Three-tube-plus-rectifier Ultra-Linear job delivers 20 watts with excellent quality from a 1.8-volt signal input.

The how and why of the new Westinghouse AFT circuit.

Want to check on the noise level in home, factory or office? This highly portable instrument will do the job.

Albert Johnson, Moscow, Idaho, radio-TV repair man at work on modern TV receiver.

REPAIRING complex modern electronic circuits is a long step from keeping crystal radios in good repair, but that is the span of work covered by Albert Johnson of Moscow, Idaho, during his 24 years as an electronic technician.

Injured in an automobile accident and confined to a wheelchair, Johnson gives Milo T. Means of the State Vocational Training Department the credit for starting him on the road to success.

In 1934, after a period of training, Johnson rented a store and began to repair radios. He has had a store in several different locations before settling at his present place of business.

Now, there are five full-time employees working for him, servicing and selling radio and TV sets. Johnson's comment on his success, "I've been awfully lucky."
An illustrated discussion of retrace blanking, vertical peaking and yoke-damping defects

By CHARLES J. GARRETT

more about auxiliary circuits

The last time we got together we talked about those deep dark corners of a television receiver’s horizontal circuits. This time, let’s take a look into a few more ignored spots in the receiver’s circuitry. The vertical output stage should be a good place to begin.

Retrace blanking defects

The vertical output circuit contains a simple network that in its many forms has been used more and more in the last year or two. This network for retrace blanking is shown in Fig. 1-a.

In normal operation it supplies a vertical retrace pulse of the proper polarity and spike shape to the picture tube to cut it off during the vertical retrace period. Photo A shows the scope pattern of the blanking pulse applied to the picture tube. It is during this interval that slanting horizontal lines (retrace lines) can form on the screen. Photo B shows retrace lines caused by reversed polarity of the blanking pulse.

The values of the circuit components are chosen and arranged to pass only the quicker retrace pulse and very little of the actual vertical sweep voltage which would harmfully affect screen brightness.

Troubles in retrace-blanking circuits are usually caused by one or both of the capacitors developing leakage or a direct short. A short or leakage in capacitor C1 (circuit 1-a) can reduce vertical size as well as allowing retrace lines to form. A shorted or leaky C2 can black out the screen because it injects practically the full vertical sweep voltage into the picture tube. An open component in this circuit will be indicated by the presence of retrace lines and the absence or distortion of the retrace-blanking pulse.

Vertical peaking

When the sawtooth capacitor in a vertical blocking oscillator opens (Fig. 2-a), the condition shown in Photo C develops. If the resistor shorts or loses resistance, vertical interlace is destroyed and double the number of retrace lines form. Photo D shows a normal number of retrace lines. Photo E shows the result of a shunted resistor in the sawtooth-forming network.

The sawtooth capacitor in a combination vertical-multivibrator-vertical-output circuit (circuit 2-b) can produce vertical-sweep distortion, like that shown in Photo F, when it opens. When the resistor in this network goes down in value, severe nonlinearity, like that seen in the spacing of the cross-hatch pattern in Photo G, occurs. Waveforms at the input plate in this circuit are similar to those in vertical-blocking oscillators except that a sharper square wave is formed when the sawtooth capacitor opens as in Photo H.

Yoke damping defects

The two 560-ohm resistors across the vertical yoke coils (circuit 1-b) have a purpose similar to that of the damper tube in the horizontal output transformer’s secondary. The damper tube loads down the circuit, making it difficult for any transient oscillations to exist.

A similar condition exists in the vertical output transformer and yoke coils but, because vertical retrace is slower, transient oscillations are of much lower amplitude and duration and a damper tube is not needed. These two shunting resistors provide sufficient loading so that transient oscillations cannot exist. They also damp out any voltage peaks or spikes that might be picked up from the horizontal yoke coils.

Abnormal operation may not always be apparent—with these resistors disconnected, many older sets will still perform normally—it depends on the yoke efficiency or Q. On modern high-efficiency yokes, if these resistors are removed or open, ripples will form on the left edge of the screen that are
indistinguishable from those caused by an improper-size horizontal yoke capacitor (see Photo I). Direct substitution is the best test in this case.

A shorted resistor can cause vertical raster keystoning like that produced by a shorted yoke coil (see Photo J). Therefore, an ohmmeter check of these vertical yoke-shunting resistors should be made before replacing a yoke for vertical keystoning.

The small capacitor across the high side of the horizontal yoke coils (Fig. 3) has somewhat of a damping action, also. Ripples on the left side of the screen can also be due to interaction or crosstalk between the vertical and horizontal deflection coils.

The basic purpose of this capacitor across the top half of the horizontal deflection coils, the half farthest from B plus, is to balance the capacitance of both horizontal yoke coils (with respect to ground). Thus any coupling to the vertical deflection coils from the horizontal coils is equally out of phase. Interaction and crosstalk can thereby be nullified.

However, even on many new sets, some ripples are evident on the left edge of the screen. Assuming that the vertical yoke resistors are not defective in these sets, an adjustment of the value of the horizontal yoke capacitor can correct or improve this condition.

A mica trimmer adjustable from 10 to 100 μf can be temporarily substituted for the original yoke capacitor and adjusted for best results. When the best setting is found, the capacitor can be carefully removed and measured. The indicated value will be correct for the horizontal yoke capacitor for that particular yoke and set.

Another common trouble that can be caused by this capacitor is horizontal keystoning when it shorts out. This defect is shown in Photo K. Incidentally, a replacement horizontal yoke capacitor should be rated at 1,500 volts or more due to the high spike voltage present in yoke circuits.
HAVE I still got a job?” asked Fuzzball anxiously, as he sat down beside Red at the counter.

“Take it easy,” Red replied.

“Old Fatpants is late himself this morning—he don’t even know that you didn’t show.”

Fuzz’ hand shook visibly as he reached for the cup of coffee. “So where you been, anyhow?” Bess asked curiously.

“It worked out to be sort of a lost weekend for me,” Fuzzball explained. “I took one too many and…”

“There are times,” Red chuckled, “when Fuzz lives in a world of his own.”

“There ain’t no such world,” Bess snorted, and flounced off.

“There was a good reason for me falling off the wagon though,” Fuzz said in self-defense.

“Always is,” Red agreed. “What’s yours?”

“It’s that installation out on the South Side,” said Fuzz. “Line voltage drifts up and down so much that I can’t converge the picture tube for sour apples.”

“That’s easy,” replied Red. “All you got to do is put in an automatic line-voltage regulating transformer.”

“That’s easy?” Fuzzball asked. “This guy won’t even buy an outdoor antenna. I can’t get him off my back.”

“Lord have mercy,” Red breathed. “The penny-pinching public again.”

“What can I do?” Fuzzball asked helplessly.

“Ignore him,” Red advised.

“Suppose he calls up Old Fatpants and complains?”

“Let him. I’ll talk to Fatpants. I been on these hey-rube runs before.”

“Red.”

“What now?”

“Can you cash me a check?”

“The answer is no. Here’s a fin I’ll give you. That way nobody’s kiddin’ nobody.”

“Thanks, Red. I dunno what I’d do without a buddy like you.”

“I know what you’d do—and so do you.”

**A shortcut?**

“Not to change the subject, but I got a new way to converge a picture tube that I like better.”

“What’s that?”

“When I start making the vertical dynamic, I kill the red gun and line up the green dots with the blue dots.”

“Nothing wrong with doin’ it that way, if you want to.”

“The way you started me out,” explained Fuzzball, “I left the red gun on. It’s less complicated to adjust the green by itself.”

“At the beginning, yes,” Red agreed.

“But it’s a sure bet that after you get some more experience, you’ll be leaving the red gun on.”

“I suppose you’re right,” Fuzzball replied.

“Right now, it see is easier to work with two colors at a time.”

“After you get experience,” Red explained, “you’ll learn to pay no attention to the colors you’re not working with. It will just be a bother to you, then, to be turning guns off and on.”

“I see what you mean,” Fuzzball replied.

“Tell me this,” said Red, “do you keep the green and blue dots converged in the center?”

“I took your hint before, I did. I use crosshatch to start the job and I found it’s easier that way.”

“Thought you would.”

“But I don’t keep the green and blue lines converged at the center unless I’m working in a real dark room.”

“You’re learning fast.”

“Hope so,” Fuzzball replied. “I found that when there’s light shining on the screen, it’s easier to judge if the green and blue lines are straight with each other if I keep them separated a little bit.” (See Fig. 1.)

“Most techs would agree with you on that one,” Red assured him.

“One thing the set manufacturers have done that really helps on this convergence, though.”

“Namely?”

“They are either mounting the dynamic controls on the front of the set or on a box that you can bring around to the front.”

“You can say that again. It’s cut convergence time just about in half.”

“OK. I will say it again,” Fuzzball grinned.

“You’re a real character,” Red replied disgustedly. “But what are you doing after you line up the green and blue vertically?”

“Well, then I kill the green gun and turn the red gun back on.”

“That’s OK.”

“I adjust the red beam magnet or the blue lateral corrector to separate the red and blue lines a little bit.”

“What next?”

“Just like the green. I adjust the red vertical amplitude and tilt controls to make the red and blue lines straight with each other up and down the
screen." (See Fig. 2.)

"I hope you mean you are watching just the vertical center column on these vertical adjustments," Red interjected.

"What do you think I am? Stupid!" Fuzzball asked.

"I'd rather not answer that question yet," Red observed. "Then what next?"

"That's when I turn the green gun back on and check to see whether the green light is still straight." (See Fig. 3.)

"A little green touchup might be in order," Red agreed.

**Finishing up**

"Finally, I adjust the beam magnets and the lateral corrector to bring the three color lines together and make a white line."

"How's your luck running?"

"Sometimes there's a little tattle-tale color showing at the top or bottom," Fuzzball admitted.

"You'll never get it 100% perfect," Red reassured him. "We discussed that before."

"But you can't see it very far back from the set," Fuzz said.

"Better hadn't, at viewing distance anyhow."

"It's a funny thing," Fuzzball mused. "When there's a little color showing at the top of the white line, the dynamic adjustments will shift the color fringing to the bottom of the line, or to the middle. But you got to leave a little fringing somewhere."

"You're getting hep," Red remarked.

"And just where do you leave the fringing?"

"Does it make a difference?" Fuzz asked innocently.

"Sure does. You'll have lots less complaints if you leave the fringing at the bottom."

"But why should that be?" asked Fuzz.

"Simply because programming usually carries the action above center screen—that's where John Q. Public looks the most."

"I got to admit it makes sense," Fuzzball agreed.

"Now what next?"

"That's when I switch over to white dots and work on the blue amplitude and tilt controls."

"You can keep on with the crosshatch if you want to," Red advised.

"How would you do that?"

"Well, the crosshatches on the hatch give you the same use as dots."

"I guess they would, at that."

"So you can look up and down the vertical center line, and see how the crosshatches are doing."

"It always looks OK at the center of the screen," Fuzzball reminded him.

"That's right. The static adjustments make it easy to bring the center in."

"But the crosshatches are pretty cruddy at the top and bottom of the screen."

**Now the blue**

"Right again. So you should open up the blue vertical amplitude control wide and adjust the blue vertical tilt to get the same blue separation at both the top and bottom of the screen."

"You get away from the dot routine on this deal," Fuzzball remarked.

"Naturally, because you're working with a different type of pattern."

"Well, after I get equal blue line spacing at the top and bottom, where do I go from there?"

"Next thing you do is turn down the blue amplitude to get equal blue line spacing all the way up and down the vertical center column."

"But I might have to touch up the blue tilt adjustment," Fuzzball suggested.

"Only a miracle could save you," Red agreed. "There's quite a bit of interaction."

"And, then, when the blue lines are spaced exactly the same amount from the yellow lines all the way up and down the center column, the static adjustments should give final vertical convergence."

"Fuzzball, there are times when you are so bright you dazzle me," Red said effusively. "Permit me to buy you another cup of coffee."

"That's coffee?" Fuzzball exclaimed, ducking agily as Bess heaved a creamer at him.

"We can use crosshatch all the way on the horizontal dynamic convergence too, if we want to," Red added.

"How about giving me a rundown?" Fuzzball suggested.

"Well, you started off by telling me how you kill the red gun when you start the vertical. So you can start the horizontal the same way, killing the red gun."

"Makes it easier to remember that way," Fuzz observed.

"Then," continued Red, "turn the green horizontal amplitude and the green horizontal phase at the same time and get the green crossovers on the same side of the blue crossovers. Get the crosshatches the same, all the way along the horizontal center line."

"Guess I might need to hit the beam magnets or lateral corrector a little to separate the green and blue," Fuzzball suggested.

"But definitely," Red agreed, "and positively if there is much light in the room."

"So after I get the green crossing all on the same side of the blue crosshatches, where do I go from there?" Fuzz asked.

"Then you get down to fine points," Red explained. "Look at the spacings between the green and blue crosshatches. You'll find it's dollars to doughnuts that the spacings aren't all exactly equal amounts."

"So I suppose I got to touch up the green amplitude and phase to make all the crossovers sag the same."

"Positively. Then, you do exactly the same thing for the red crossovers. Kill the green gun and turn on the red gun. Adjust the red amplitude and phase to get equal crossover spacings, with all the red crossovers on the same side of the blue crossings."

"That makes a pretty good routine for remembering," Fuzzball remarked.

"What do I do next?"

"Turn the green gun back on. Both the red and green crossovers will be pretty near even from the blue crossovers. A little touchup on the red and green controls should do it about right."

"What about the blue horizontal dynamic?" Fuzz asked.

"I'm getting to that," Red replied.

"But, first, you want to make sure you are satisfied with the job so far. Get on the static adjustments and make the pattern white in the center of the screen. Then, you might want to do just a little more touching up to get real good crossovers at the same points all along the horizontal center line."

"Then I go to the blue horizontal controls?" asked Fuzz.

"Absolutely. Now we straighten up the blue line and bring it in with the yellow line."

"So far, I've always been resonating the blue phasing coil," Fuzz ventured.

"Saves time," Red agreed. "You should do it on this all-crosshatch routine also. Open up the blue horizontal amplitude and adjust the blue horizontal phasing coil for a peak, smack in the center of the screen."

"That's just like we were using dots."

"Right. Then, back off on the amplitude until the blue line is as near parallel with the yellow as possible."

"But I'll probably need to touch up the blue phasing here."

"You're reading my mind," Red stated. "The touchup will give the parallel spacing you're looking for between the blue and yellow."

"And the static controls will give me final overall convergence," Fuzzball suggested.

"Just about," Red agreed. "But there are a couple of little points to keep in mind."

"Such as?"

"Look carefully at the vertical convergence. You might have knocked it out a trifle, and need to touch it up a wee bit."

"Anything else?" asked Fuzz.

"Yep. Check the corners of the screen. There's no adjustment here, but sometimes if you see a little fringing in the corners, you can compromise a little to improve it, without hurting other parts of the screen noticeably."

"Whooh!" exclaimed Fuzzball, blowing hard. "And I took up television for a living. I could of had a job in a putty-knife factory and nothing to worry about."

"Maybe you could get a job as a pilot on a rocket to the moon," Bess suggested.

Fuzzball rose to his feet. "Give the girl her money, Red, and let's get out of this booby trap."

Bess banged another creamer on the door behind the fast-moving Fuzzball's back.

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**Television Station List**

**Compile by Muriel Schiller**

<table>
<thead>
<tr>
<th>State</th>
<th>City</th>
<th>Call Letters</th>
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<td>Alabama</td>
<td>WVTB</td>
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<td>New York</td>
<td>WNYW</td>
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**List includes all United States, Canadian and Mexican stations.**

Correct to Dec. 2, 1957.
TELEVISION

for 1957

By ROBERT B. COOPER, JR.

In seven years of active television dxing, I have seen the coming and going of many dx-rs, not a few of whom had top-notch potential in their day. The average life of the red-hot dx-r seems to run to about three years, and then, suddenly, dxing takes a back seat to other interests.

With the number of television stations presently operating, a station total of 150 is not too much of a task for a diligent dx-r in a year's time, provided he lives east of the Mississippi River, where station concentration is high. In the Mountain States or along the West Coast, 100 stations may prove to be a formidable task when 80-90 of these must come via some form of skip reception. But, given time, even the Western dx-r can reach the 150-station mark.

With the dyed-in-the-wool dx-r working hard at his hobby. Make no bones about it, dxing throughout a 4-hour session of fast-changing E-skips conditions can be tiring both physically and mentally. Yet, there must be a reason or reasons for a person perfectly sane in most other respects to spend a whole weekend at the dials of his (or her) television set, continually flipping the dials, rotating the antenna and keeping a written record of everything seen. Do you know what reason is? If you don't, you must be a dx-r. If you do, then I suggest that you find out. Come on in, the water's fine!

'57—Good in spots

The year 1957 proved very interesting to all long-distance television fans. Generally speaking, the summer Eskips conditions over the North American continent left much to be desired. For the first year in many, very few existing dials were broken, indicating that even the limits of TV dxing have almost been reached. However, some of the new records set this year may only be stepping stones to better things to come in 1958.

The end of the post sunspot cycle, the world's record for television dxing was pushed out to 10,800 miles with the reception of England's BBC channel 1 in various parts of Australia. (See TV Dx Column, RADIO-ELECTRONICS, March, 1957.) Here in the Western Hemisphere, the high-band (channels 7-13) television dx record was extended to approximately 2,300 miles on Aug. 2.
Robert Seybold displaying photos of some dx TV stations he has logged.

1957, at 1900 CST, with the logging of the YVLY relay on channel 9 from Maricabo, Venezuela, by dx-er Bobby Grimes in Little Rock, Ark. Two hours later, an old pro, Bedford Brown of Hot Springs, Ark., logged the channel-9 station, along with reception from Venezuela on channels 2, 4 and 5; Brazil on channel 2 and Argentina on channel 3.

A triple-hop channel-5 E-skip logging is noted in the report of Mrs. Doris Johnson of Longview, Wash. She reports a verification in writing for her reception of WORA, channel 5, Managua, Puerto Rico, at 1514 PST, on July 21 of last year—the distance, a neat 3,550 miles. Being a West Coast dx-er, I checked my log for this date and found a weird notation for 1720 hours on channel 3—a Japanese movie with Spanish subtitles! What you don’t run into during a hang-up opening!

Total champs

Hitting closer to home, we find that the magic number of 800 stations logged has been achieved by two dx-ers. 1956’s feature dx-er, Bob Seybold of Dunkirk, N. Y., now rests at 312 stations logged, after 5 years of tireless efforts and fighting local stations on channels 2, 4, 6, and 12 plus many grade-B signals on all vhf channels in most every direction. Bob’s location may be fine for watching any number of different programs, but all those locals don’t do much for dxing!

Our second over-300 man is the fellow who has been pushing Bob Seybold the greater part of the way, Bedford Brown, of Hot Springs, Ark. Bedford has made history by logging up to 76 stations in a single 24-hour period. Last year, July 24, 1956, to be exact, Bedford broke all existing short-term dx records by logging 89 skip stations and a total of 116 stations in a mere 24-hour period! Bedford’s new station total is 326 TV stations logged in 5 years of dxing from Hot Springs. Perhaps nothing stands out more than the fairly constant number of members in the Over 50 TV Dx Club.

You would think that, with television dxing always on the rise as a hobby of dx-ers, the number of contractors would increase by leaps and bounds each year. Unfortunately, dx-ers get a little careless and not interested to keep me informed on current totals. So, if you have a station total of over 50 and are actively engaged in dxing and why not get into the regular monthly reporting habit (using RADIO-ELECTRONICS report forms, of course) and join the Radio-Electronics TV dx group.

In studying the dx reports for last spring, I noticed a tendency on the DX-ers for long-distance E-skip in northern latitudes during the heavy aurora sessions. The signals usually have violent fading rates, with multipath characteristics evident in the video. Dx-ers should be on the lookout for such E-skip openings during aurora disturbances in detail any observations.

We are in the middle of the winter E-skip season. This season’s

...a can be ground. occurring after

...the first fourth few best for.

...appeared Western weeks of the roughout through

...Bob Seybold’s receiving and raised to about 60 feet above

...vides several good opening for the most part in the

...noon and early evening in past three years, and the first

...days of February have B E-skip openings.

...During October, E-skip with three good openings on areas during the first thr

...the month. This may indicate level of E-skip will be high the winter period (Oct 3 March).

Over 50 TV Dx Club

<table>
<thead>
<tr>
<th>Observer</th>
<th>Station Total</th>
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<tbody>
<tr>
<td>Bedford Brown</td>
<td>326</td>
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<tr>
<td>Bob Seybold</td>
<td>312</td>
</tr>
<tr>
<td>Art Collins</td>
<td>260</td>
</tr>
<tr>
<td>B. H. Rauch</td>
<td>239</td>
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<tr>
<td>Ed Bourgeois</td>
<td>230</td>
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<tr>
<td>Jerry Don Burch</td>
<td>196</td>
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<td>Frank Hill</td>
<td>167</td>
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<td>Ron Brown</td>
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<td>King Schaefer</td>
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<td>Carl Lupton</td>
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<td>John K. Bettersworth</td>
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<td>Bob Cooper</td>
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<td>B. J. Bingham</td>
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</table>

Bedford Brown leads the TV dx list (326 stations).

Francis E. DeGroot
Norman Ernt
Al Caldwell
Larry Vehorn
W. J. Owen, Jr.
Walker Ray
Billy Moers
R. H. Gordon
Dibrell Ingram, Jr.
Perry Cox
Bobby Grimes
Grant D. Ross
John Parrilo
J. W. Collier
Bob Martin
Carlton Bowling
George Leach
Doris Johnson
Dick Mason
John Comstock
Kann Cooper
Dennis Smith
Morris Poste
John Goanworth
Ed Hepa
Eddie Albright
Wayne Pincott
John Black
Gary Ochsenschlager
Bob Seaman
Al Kope
Ray O’Rea
Benjamin Tobin
Dan Samuels
A. Reise
Benjamin Bichier
Jim Dillon
Ronald Boyd
Dan Davis
Arthur Cordts
Deana Ouel
Carl-Richard Kassabian
Michael Holley
Ghislain Girard
J. W. Collier
Richard Gagnon
George S. Dunvani

Salamanca, N. Y.
Kenmore, N. Y.
Brockton, Mass.
Speedway, Ind.
Springfield, Ohio
Kewanee, Wis.
Baton Rouge, La.
La Grange, Ky.
Harrisburg, Pa.
Canyon, Miss.
Visalia, Calif.
Little Rock, Ark.
Coralville, Oio.
Kildonan, Va.
Girard, Pa.
Uniontown, Ohio
Tampa, Fla.
Longview, Wash.
Menasha, Wis.
W. Liberty, Va.
Shellville, Ind.
Provo, Calif.
Warren, Ohio.
Millwood, Va.
Bedford, Va.
Tonto, Ariz.
Medford, Ore.
Bedford, Va.
Lizoth, Wash.
Mantua, Mass.
Mt. Vernon, N. Y.
St. Louis, Mo.
Toluca, Okla.
Regina, Sask.
Turco, Nova Scotia
Champaign, Ill.
Northville, Va.
Tucson, Ariz.
Reedley, Calif.
Geneva, Ill.
Arvida, Quebec
Mexico City
Fancy Farm, Ky.

TV dx report forms

Once again the TV dx column of RADIO-ELECTRONICS offers free of any change TV dx report forms for use in reporting TV dx loggings to the column. You may obtain your set of forms by merely sending your name and address to TV Dx Column, Radio-Electronics, 154 W. 14 St., New York 11, N. Y.

COLOR BLIND?

By Jeanne DeGood

It’s often been said
(And I guess it is true)
That roses are red
And violets blue.

But roses are blue
When they’re seen on my screen,
For my color TV
Installer was green.
I HAVE received many inquiries asking "What color-bar generator should I buy?" This question cannot be answered with "Buy the new Super Chromonometer, it does everything." So rather than tell you which to buy I will describe the features of four types of color bar generators and leave the selecting up to you.

1. The simplest color signal generator is a sidetone instrument operating at 3.57045 mc minus 15,750 cycles. In the simplest instruments, the sidetone oscillator and the picture-carrier oscillator are free-running. In spite of the simplicity and lack of accuracy of such instruments, certain color servicing jobs can be done quite well with them. Adjusting the quadrature transformer is one of these jobs. However, in numerous other tests, such a generator leaves much to be desired.

2. The next more elaborate and expensive type of color generator is a sidetone oscillator with crystal control. Horizontal sync pulses are provided. These features greatly improve the accuracy of the instrument and make additional practical applications possible. This type of instrument is often packaged with white-dot and cross-hatch facilities. Thus, the instrument is sufficiently complete for installation work, and is compact and portable. However, it leaves something to be desired for bench work. As in the case of 1, the color pattern is a color-difference spectrum, comprising hues which gradually merge from one tone to another. The display is dominated by reds, greens and blues. All the hues are dim and bluish with respect to true saturated colors. One color may possibly be made normal, in some cases, by careful adjustment of the brightness control.

This type of instrument is useful in some types of bench work, such as adjustment of quadrature, check of chroma-channel gains and adjustment of the afc balance control, etc.

3. Keyed sidetone generators are also color-difference generators, though usually referred to as color bar generators. They are similar to 2, except that a multivibrator is used to key up the rainbow pattern into a number of bars (usually 10). The instrument is often called a color simulator. The signals are crystal-controlled, and accurate with respect to frequency. Each of the 10 bars is an approximation to an NTSC chroma phase, such as (R - Y), (B - Y), (G - Y), I, Q, etc. However, these are only practical approximations as the sidetone signal is changing from point to point. It is for this reason that such instruments are also referred to as linear phase sweeps. The keyed patterns make the instrument much more useful in bench work, because the chrominance axes can be identified with practical accuracy. Conclusive tests of synchronous detection and matrixing can be made with a keyed rainbow pattern. This type of generator often provides a sound sideband and an overload check, which makes it a runner up to the complete color generators.

4. The NTSC type of color bar generator—which provides 100% saturated true colors, with provision for saturation control and signal selection—is the most useful generator for general color service work. This type is expensive, but it also provides a large variety of basic color signals, either separately or in combination. A simultaneous display of the primary and complementary colors with white and black is useful in overall receiver checks as well as for checking delay lines, matrixing, color-subcarrier traps, cross-talk, burst gating and chroma detector operation (see Fig. 1). Individual color-difference signals with accurate phases are also provided, such as I, Q, (R - Y), (B - Y), and others. The (R - Y) and (B - Y) signals are usually available in combination, as well as separately. The bar widths are made unequal to provide identification during signal-tracing procedures. However, you will find that bar type of elaborate generators provide signals which are within the NTSC specifications, lower-priced instruments in this category may provide individual color fields in which the brightness component is constant for all colors. This simplifies the generator's construction, but does not provide signals within the NTSC standards of hue or saturation.

Still more elaborate color bar generators are available for laboratory use, but their price is prohibitive for most service shops.

Larger screen
I have an Emerson 686B with a 17CP4 metal picture tube. I would like to replace the 17CP4 with a glass tube such as a 16EP4 or a 19JP4. High voltage measures approximately 18,500.


As your first step, make sure you have enough room for the larger tube in the cabinet. I would choose the 19JP4 as a better replacement for a 17CP4 than a 19EP4. The 19JP4 operates at a lower voltage, and your high-voltage value of 12,500 would be marginal for the 19EP4. The ion trap from the 17CP4 can be used on the 19JP4 and the flyback transformer will not have to be replaced. The 19JP4 is 2 inches longer that 17CP4, and the yoke will have to be moved back 2 inches. The same yoke can be used however. The mask, of course, will have to be replaced.

Horizontal pulling
I have a converted RCA 630TCS chassis in the shop that shows horizontal pulling whenever straight vertical lines are present in the background. If there is a closely spaced horizontal line at a horizontal pulling straightens out and the lines are no longer wavy. Voltages and resistances check OK. I have replaced several coupling capacitors in the sync circuits. Do you have any suggestions?


The condition of the large electrolytic capacitors in this receiver should be checked. Measure the capacitance values and power factors to see if they are up to par. Don't forget also to check for leakage between sections of the multiple units. Replace any substandard capacitors, and the horizontal pulling will probably clear up.

![Fig. 1 — Video waveform from an NTSC type of color bar generator which provides 100% saturated colors. This is the waveform of the simultaneous bar display.](image-url)
suspect that you will also observe that interface is poor and a vague and poorly defined tracery shifts through the background of the picture. It is caused by cross-talk among receiver sections, due to failing common elec-

tronics.

Sync buzz
I have been working on a Philco 22B1402, code 140, r.e.n. 194, with sync buzz. Tubes, sound if alignment and video were checked. By varying the volume control midway, the buzz can be heard very easily. When the control is advanced, the buzz increases.

—J. S. T., Brooklyn, N. Y.

This trouble is evidently due to an overload in either the ff or video ampli-

fier. You may have a marginal age fault in the ff system. This can be checked by operating the receiver from a battery and potentiometer dc bias source. If the receiver does not Buzz when the if amplifier is operated from fixed bias, look for age trouble. This difficulty may also be due to a leaky coupling capacitor in an if stage. There is a lesser possibility that the charging capacitor in the sound detector circuit does not have sufficient capacitance.

Burning flyback
The high-voltage section of the flyback in a Sylvania 533-2 has burned out and, since a replacement could not easily be obtained, it was rewound. The resistance of the rewound portion is 500 ohms, as per the schematic. But 3 minutes after the set was turned on, this section began to overheat. I get a picture even though the flyback is smoking and have run the set 2 hours with an electric fan at the back. The picture is short 2 inches in width and the width control has no effect.

—A. L. G., Manila, P. I.

Rewinding the high-voltage section of a flyback transformer is a tricky job. The winding must be arranged to minimize the distributed capacitance of the coil and to avoid stray resonances. The smoking which you observed is probably caused by excessive circulating current in the winding due to stray resonance. Part of the winding is probably tuned by stray capacitance to 15,750 cycles and operates like a tuned secondary coupled to a primary coil—the circulating current is as many times greater than the line current as the Q of the section is greater than unity. The fact that the picture is short 2 inches means that the output voltage from the winding is excessive (which causes the electron beam in the picture tube to become "stiffer"), or it may mean that you have one or two shorts in the winding, which consume power. Resonant effects can result both in a resonant rise of voltage and excessive power consumption due to losses in the section with heavy circulating current, as the width control has no effect on picture width, it would seem that the portion of the winding across which the control is connected contributes little to the power output—this again could easily be caused by disturbed coupling and stray resonances in the rewinding job. It would be advisable to wait for a re-

placement transformer from the factory.

There is also the possibility that there is nothing wrong with the high-

voltage winding and that whatever caused the original winding to burn out is affecting the one you have wound. If current through the flyback is ex-

cessive (over 100 ma, measured at the cathode of the horizontal output tube), even a new factory-built flyback may not fix the set and you should look for trouble elsewhere.

Vertical-retrace blanking
Please show a basic circuit for adding a vertical retrace blanking circuit that will be usable on most TV receivers.—V. A. MacR., Franklin, N. Y.

A retrace blanking pulse can be obtained from the yoke, vertical output

and tube substitution will not correct the trouble.

The set owners did not wish to have the chassis pulled because they figured that, as long as the receivers are work-

ing, there is nothing to worry about. What do you suggest?—J. T., East Chi-

cago, Ill.

In response to your inquiry, the most likely cause of overheating of the plate in a horizontal output stage is too low bias on the grid of the tube. Low bias can result from a leaky coupling capaci-

tor to the grid of the tubes, and it can also result from insufficient drive to the grid. Insufficient drive can result in overheating of the plate because most, if not all of the grid bias for the hori-

zontal output tube is signal-developed bias. In other words, the sawtooth sig-

nal overdrives the grid into grid current and the drop of this current through the grid leak provides the neces-

sary grid bias.

The service notes for the receiver will usually give the correct grid-bias volt-

age, and you can easily make a check with a vtvm to determine whether the grid bias is up to par.

Correction
The conversion described in the Sep-

tember issue of RADIO- ELECTRONICS is quite timely. I have an RCA T120 on

my bench which has been converted to a pentode tuner. Two tuners have failed to give satisfactory operation, probably because the impedance match-

ing was not observed. In regard to the instructions noted above, why do you add a third 27.25-me trap? Was that a misprint, and did you intend to add a 19.75-me series trap?—W. L. J., Pas-

adena, Calif.

I congratulate reader W. L. J. on his 20-20 vision. The trap marked 27.55 me in Fig. 1 should have been marked 19.75 me. This is my error. The im-

pedance of the plate output circuit of the tuner must be approximately the same as the input impedance to the grid of the first if amplifier, or energy transfer will be inefficient. An im-

pedance match can be obtained with somewhat simpler conversions than shown. However, the if response will suffer more or less in bandwidth, which lowers the quality of picture reproduction. The RCA T120 is a wide-band re-

ceiver, which is capable of reproducing fine picture detail when the if response is properly maintained. In providing instructions to our readers, we always assume that the customer demands top performance from the receiver.

Tel

ELEcTRONICS

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VARICAP CAPACITOR, a tiny electronic component, no larger than a teardrop, can automatically observe and maintain color fidelity in a color TV picture and perform many other functions. It is made by Pacific Semiconductors, Inc., Culver City, Calif.

The unit is a member of the solid-state device family, which includes transistors, semiconductor diodes and rectifiers. Its capacitance is varied by changing an applied bias voltage.

In one application the Varicap, a resistor and a mica capacitor replace 24 components. The photo shows a comparison between the Varicap and a standard variable capacitor which it might replace.

FLAT TV TUBES are foreshadowed by these transparent-screen types already in pilot production for experimental military use. Invented by William Ross Aiken, these follow the same fundamental principles as the flat tube described in this magazine, March, 1957. The electron beam, instead of starting at the back and curving up again behind the face, is injected at the bottom edge. It travels along the bottom, which is coated with a row of deflection plates. By controlling the voltage on these plates, it can be deflected up at any point. Another (transparent) set of plates on the back wall turn the rising beam ahead against the screen at the desired point. These two sets of plates sweep the beam as did the deflection plates in early TV receivers, or the coils in modern ones.

According to officials of the Kaiser Aircraft and Electronics Corp., which developed the tube, refinements in the glass envelope may be all that is needed to make picture-on-the-wall TV a reality, though they feel it is still "a long way from commercial application. One of the photos shows a standard rectangular tube and a transparent-phosphor model which fits into an airplane's windshield. The other is a pictorial prediction of the two-sided TV set of the future.

TOROID TRANSISTOR POWER SUPPLY simultaneously delivers 225 and 450 volts dc from a dc input of 12 or 24 volts. Its maximum output power is 90 watts (transistor intermittent operation), 40 watts continuous. The compact unit fits into a 2 x 2 x 4-inch case and could move the amateur's power supply from the trunk to the glove compartment.

The completely silent electronic operation is a boon to those irritated by the annoying whine of a dynamotor or hum of a vibrator.

The unit is designed around a special toroid transformer built by Sunair Electronics Inc., Ft. Lauderdale, Fla., (who also developed the circuit). The diagram shows the circuit, which uses two Delco power transistors and eight of the new Sarkes Tarzian cartridge rectifiers. The photos show the parts layout.

All rectifiers are mounted on one side of a bakelite board. On the opposite side are placed all other competents. Transistors are mounted on brass heat dissipators. The Sunair model uses a printed-circuit board, but it is not a must.
The completed distortion analyzer.

**Fig. 1 — Block diagram of harmonic distortion test setup.**

**Fig. 2 — Notched filter response:**
- a — Wien-bridge with feedback amplifier
- b — Wien-bridge without feedback amplifier

**By L. B. HEDGE**

To measure harmonic distortion three instruments are needed. An audio oscillator (see “Extended Range Audio Oscillator,” page 36, December, 1957), an audio vtvm (see “An Amplifier-Rectifier Vtvm for Audio Testing,” page 53, October 1957), and a distortion analyzer. An oscilloscope will help, but is not absolutely necessary.

A single-frequency signal from the oscillator is fed to the amplifier under test. The analyzer is connected to the amplifier’s output, and the audio vtvm is connected to the output of the analyzer (see Fig. 1). The signal from the generator is amplified and the amplified signal fed to the analyzer, along with any harmonics produced in the amplifier. In the analyzer the fundamental generator signal is removed. The remaining signal, consisting of harmonics of the input signal, passes through the analyzer and is measured with the ac vtvm (and oscilloscope if one is available).

The distortion analyzer is basically a tunable filter. While many tunable filters are easily built, they tend to attenuate the harmonics of the filtered frequency as well as the fundamental frequency, which is exactly what we don’t want to do. However, the notch in the filter’s frequency response can be sharpened by building the filter network into the feedback loop of a high-gain high-negative-feedback amplifier. Fig. 2 shows the relative response of the network used in the Wien-bridge analyzer described in this article. Curve a shows its response with a feedback amplifier and curve b shows response without a feedback amplifier. The difference is obvious.

The analyzer circuit is shown in Fig. 3. It consists of two high-gain amplifier circuits (V1-a, V2-a), a phase-inverter-driver (V1-b) for the Wien-bridge filter with a switch (S2) for selecting the filter or the (filter) free channel for the circuit, and a cathode-follower output and feedback coupling stage.

Fig. 4 is a simplified diagram of the Wien-bridge filter circuit used in this analyzer. It represents the filter circuit with S1 of Fig. 3 in the position shown. When the bridge is balanced for some particular frequency, say 100 cycles, only signals whose frequency is above or below 100 cycles will be passed by the filter network. When a Wien-bridge is at resonance, the output at the resonant frequency is zero.

Precise balance of the filter requires that the ratio between E1 and E2 be accurately adjusted. (E1 is the output

---

from the plate of V1-b; E2 the output from its cathode.) As it is not practical to make this an automatic adjustment, coarse (R10-R11) and fine (R12), balance controls are provided to control E1. The adjustment range is wide enough to correct for minor capacitor (C3, C4) tracking error and resistor (range-resistor) mismatch.

Design demands

Designing the analyzer to provide a satisfactory filter notch and a minimum of distortion within the analyzer, requires a high-gain amplifier loop and large negative feedback so that the product of the loop gain and the feedback factor will be much larger than 1.2

The triode-amplifier stages (V1-a, V2-a) provide a gain of approximately 200, and with the feedback factor

\[ R17 \cdot \frac{R3 + R4}{R17 + R3 + R4} = 10,000 + 8,500 = 0.55; \]

the analyzer's overall gain—when S2 is in the FREE position, or in the FILTER position with the input frequency an octave or more away from the filter's balance frequency—is approximately 1.8.

The one R-C coupling (R6-C2) in the feedback loop provides a minimum phase shift, which is further reduced by the secondary feedback loop, R7 between V1-a and V1-b. This combination makes the unit inherently stable and insures low distortion in the analyzer.

Since distortion above 20,000 cycles is of little importance in audio amplifiers, this unit is designed to operate between 15 and 10,000 cycles. (Harmonics of signals above 10,000 cycles are higher than 20,000 cycles, the extreme upper limit of human hearing.)

Values for the R13, R14, etc., range resistor series are selected to provide substantial tuning-range overlaps.

Mounting the twin capacitor on standoffs insulators—to keep it as far as practical from the chassis and cabinet—reduces tracking errors due to variable stray-capacitance effects.

Range resistors should be matched in pairs as accurately as possible. If a bridge or other resistance balancing equipment is not available, precision resistors (2% or better) should be used. The exact values of these resistors are significant only in determining the frequency ranges, but close matching of the corresponding pairs is a real factor in providing satisfactory performance. This may not be immediately obvious, in view of the balance adjustment included in the analyzer, but it should be noted that, if the E1/E2 ratio changes from say 2.0 to 2.4 between two values of \( f_n \), this will move in the direction of E1 rather than E2 as the unit is tuned from the first to the second frequency. Since E1 is 180° out of phase with E2, this will reverse the feedback phase, and oscillation will start! Close matching of resistors.
Power-line leads must be kept away from the analyzer's amplifier loop circuit, and voltage-supply leads to the tubes should be twisted, laid close to the chassis and well spaced from the signal circuit elements. The bias network (R19-R20) places the heaters at higher potentials than the cathodes of the tubes, thus reducing heater-cathode hum leakage. R21 can be adjusted to minimize any hum which may get into the amplifier.

Final adjustment

When the analyzer is completely assembled, its tuning scales can be calibrated and its performance checked by connecting the oscillator to its input and its output to a vtvm (Fig. 1, input connection, amplifier and load omitted). Set the oscillator at a frequency in one of the analyzer tuning ranges, set S2 on the FREE position and adjust the LEVEL control (R1) to give a 1-volt reading on the vtvm. Switch S2 to the FILTER position and adjust the tuning capacitor to give a minimum voltage reading. Next adjust the coarse balance control for minimum voltage reading and then readjust the tuning capacitor for minimum voltage. Next adjust the fine balance control for minimum voltage and then again adjust the tuning capacitor for minimum voltage.

As these adjustments progress, the voltmeter range switch should be set to keep the meter needle somewhere in mid-scale, permitting accurate adjustment of the tuning and balance controls. When settings of the tuning and balance controls are reached which provide a voltmeter reading which increases with any change in either tuning or balance, the voltage reading will be 1/100 the percentage of harmonic content of the oscillator output (0.1 volt = 1%; 0.06 volt = 0.6%). and the bridge will be tuned to the fundamental frequency (f.) of the oscillator output.

R21 can be accurately adjusted by setting the oscillator to a frequency a few cycles off 60 cycles, and adjusting the analyzer tuning and balance controls as indicated above. If any hum is present in the output, the vtvm will show a fluctuating reading and R21 should be adjusted to reduce this fluctuation to a minimum. If the fluctuation cannot be eliminated by this adjustment, the hum may be present in the oscillator output and this setup can be used to check the heater potentiometer of the oscillator if it has one.

The calibration procedure should be repeated over a series of frequency values to provide calibration reference points on the tuning scales of the tuning capacitors.

A complete tuning-scale calibration is of little use since the scale is used only to provide an approximate initial setting of the tuning capacitors and final adjustment is made, as in the calibration procedure, to provide minimum voltage output reading with a given signal. On this analyzer I have five calibrated points on each range.

In application for checking harmonic distortion in an audio amplifier, connections are made as shown in Fig. 1. Provision should be made, as indicated, for connecting the analyzer input to the input and to the output of the amplifier. The harmonic content of the input and output signals should be checked without changes in the amplifier, amplifier load or oscillator adjustments between the two checks. The oscillator distortion is then determined, under the conditions and at the oscillator frequency of the test, as the difference between the percentage harmonic content of the output signal and the percentage harmonic content of the input signal.

If an oscilloscope is available, it may be connected across the output of the oscillator—in parallel with the vtvm—where it will be of some help in reaching a quick balance and tuning adjustment of the analyzer. Specific applications of the oscilloscope to audio amplifier tests will be covered later in this series but, at any stage in these tests, observation of waveforms involved will be worth while. An oscilloscope provides a kind of visual perspective which is always helpful in interpreting the measurements and effects involved in the various tests and test procedures.

With the analyzer, oscillator and vtvm available, the first three basic tests of af amplifiers—amplification (voltage and power gain), frequency response (amplitude distortion) and harmonic distortion—can be made directly. The changes in connections among the various units involved are, however, somewhat complicated. The next article of this series will cover the design and construction of a master control unit which will provide all of the necessary interconnections of the vtvm, oscillator, distortion analyzer and the amplifier under test. It will also include connections and controls for additional test units—an oscilloscope and an electronic switch—which will complete the test set up. Construction of the electronic switch and modifications to simple oscilloscopes to provide improved response, will be covered in future articles, which will also include a detailed analysis of test procedures and performance standards and specifications applicable to audio amplifiers.


BLIND DATES don't always work out the way you hope!

Neither does buying tubes by mail — except when you buy through advertisements in RADIO-ELECTRONICS. Since January, 1956, the publishers of RADIO-ELECTRONICS have insisted that mail-order advertisers either state that their tubes are new and unused or say specifically that they are substandard. There's no "blind dating" in RADIO-ELECTRONICS. You always know just what to expect. It may not be fun—but it's safer!
Fix That Rotator

By Homer L. Davidson

This "trained control box" makes rotator checking easier

The instrument described in this article may be built with parts from an old rotator control box and will check at least 90% of all rotator motors.

When a service call comes in for a rotator repair, the technician picks up his tool kit, several rotator control boxes (if he doesn't know just which type is needed) and takes off. The customer usually doesn't know what kind of rotator she has or if it is an automatic or manual type. The technician must localize the trouble. Is it in the motor or the control box?

The old way to check a rotator is with a continuity tester such as an ohmmeter. With this rotator checker you can check cable continuity and the motor, and you can even turn the motor. Provision for checking the meter rheostat in the motor while in operation is included. If the rotator is the automatic type, the pulse relay switch and return lead can also be checked.

In a regular rotator hookup (see Fig. 1) the control switch is turned in the desired direction. This places an ac voltage across the power transformer's primary and completes the secondary circuit through an ac capacitor and one winding of the rotator's motor, causing the motor to turn in one direction. When the switch is pushed in the other direction, the transformer's output is applied to another winding in the motor and the rotator turns in the other direction. To indicate the direction in which the rotator is turning, a rheostat is placed in the motor housing so that its resistance varies with the position of...
the antenna. A meter in the control box is wired into the circuit and provides a visual record of the direction in which the rotator and antenna are turning.

The rotator checker is essentially the same as the control box of an ordinary rotator. (See Fig. 2.) Since a meter is used in manual rotators and a relay assembly in automatic units, the tester employs a pilot light which serves as an indicator for both types. When checking we are not particularly interested in which direction the rotator is turning. We only want to know if it is turning. This job is handled best by the pilot lamp.

A No. 49 lamp is used. It is picked instead of the common No. 47 or 51 because it draws only 60 ma and will not cause the rheostat in the motor to run hot. Two 5-watt resistors, 200 and 75 ohms respectively, are connected in series to drop the voltage for the pilot lamp. By using the plain and black alligator clips on the checker, the pilot light becomes part of a continuity tester.

Rotator tests

When testing a rotator either in the home or on the workbench, the checker is hooked up according to a chart fastened to its case. (See Table I.) For example, when testing a Cornell-Dubilier-Radiant (C-D-R) TR-11 motor, the red clip is connected to terminal 1, yellow clip to terminal 2, plain clip to terminal 3 and the black clip to terminal 4. Turn the switch in one direction and, if the motor turns, the trouble lies in the control box. If the motor does not turn in either direction, it is defective. If the motor turns and the pilot lamp doesn't light, the trouble is in the rheostat in the motor, or the return cable from the rotator.

If the motor being tested is an automatic type, the pilot light will click on and off, according to the pulse switch in the motor. In fast-pulsing motors (as in the C-D-R automatics) the light will be as bright as in a slower-pulsing motor. This is due to the difference in switching-time duration.

The tester's construction is very simple. A complete unit can be built into almost any type of case. Alligator clips are used for connections to motor terminals. The clips should be insulated to avoid shock hazards and shorts. Indicated colors do not have to be followed as long as there is some distinction between clips. If you use different colors, be sure to make corresponding changes in Table I.

This little unit has been used, tried and tested in the field where it has successfully licked many rotator problems.

The most common failures in antenna rotators are a defective rheostat in the motor assembly, wind breakage and poor automatic timing. When the control-box indicator (meter) does not work, the fault is usually an open rheostat in the motor unit. Run a continuity test to make sure the unit is defective before pulling the motor. Pulling a motor is usually a lot of work so when it is unnecessary it should be avoided.

After the motor has been pulled, another test should be made before taking the unit apart. Replacement rheostats can be obtained from most jobbers or directly from the factory.

The motor assembly doesn't cause much trouble unless damaged by wind or struck by lightning. These small motors are practically trouble-free, though they can be burned out because of a defective control box. Whenever a motor is burned out, be sure that the control box has been checked.

Wind, customers, lightning

Wind is the most common cause of damage to rotator motors, especially if the unit isn't properly installed. Too large an antenna with a lot of wind resistance will strip the rotator's gears in a wind storm. A thrust bearing should be used to help support the antenna's weight and to prevent damage from constant rocking.

Many troubles are caused by the customer. He will almost invariably get an automatic control head out of time, but with a little instruction (the service technician's job) he can learn how to lock the unit in step. If this instruction is given when the unit is installed, you may save an unnecessary service call.

Occasionally a rotator will stick, bind or move slowly while turning. This is generally caused by a misaligned thrust bearing or a binding floating guy ring. It should be promptly repaired as the added strain may damage the rotator's motor. Simply place a ladder alongside the rotator and align the unit while someone operates the control box.

There are times when the rotator cable causes trouble. The wind may break a wire or the wires may become grounded when the unit is installed. When placing the cover over the motor unit's terminals, be sure the rotator wire is in its proper place. Otherwise, the cover will bite into the wire and eventually short the motor unit. Another point to remember is never place a strap standoff over the rotator cable to hold it in place. The strap will cut into the cable insulation and eventually

Table I

<table>
<thead>
<tr>
<th>Alliace Tenno-Rotor</th>
<th>TII2</th>
<th>U99, U113</th>
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<tr>
<td>Chambers-Master Golden Rotator</td>
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<td>Cornell-Dubilier-Radiant TR-11, AR-1, AR-22</td>
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<tr>
<td>Crown GAR44A</td>
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<tr>
<td>JFD RT100, RT1000</td>
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<td>La Pointe VEE-D-X</td>
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<td>M5S</td>
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<td>6</td>
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TABLE I

| RED | 1 |
| YELLOW | 2 |
| BLACK | 3 |

Fig. 1—Circuit of a typical rotator. Control and rotator units are shown.

Fig. 2—The rotator checker can be made of parts from old rotator control boxes. The wind is the most common cause of damage to rotator motors, especially if the unit isn't properly installed. A large antenna with a lot of wind resistance will strip the rotator's gears in a wind storm. A thrust bearing should be used to help support the antenna's weight and to prevent damage from constant rocking.

Many troubles are caused by the customer. He will almost invariably get an automatic control head out of time, but with a little instruction (the service technician's job) he can learn how to lock the unit in step. If this instruction is given when the unit is installed, you may save an unnecessary service call.

Occasionally a rotator will stick, bind or move slowly while turning. This is generally caused by a misaligned thrust bearing or a binding floating guy ring. It should be promptly repaired as the added strain may damage the rotator's motor. Simply place a ladder alongside the rotator and align the unit while someone operates the control box.

There are times when the rotator cable causes trouble. The wind may break a wire or the wires may become grounded when the unit is installed. When placing the cover over the motor unit's terminals, be sure the rotator wire is in its proper place. Otherwise, the cover will bite into the wire and eventually short the motor unit. Another point to remember is never place a strap standoff over the rotator cable to hold it in place. The strap will cut into the cable insulation and eventually

"You're pulling in a strong station from Australia, mam."

RADIO-ELECTRONICS
A DIRECT-READING audio-frequency meter is worth its weight in gold when you have to measure unknown audio frequencies, test or calibrate audio oscillators, or measure audio beat notes. In addition, you can plug a microphone into the meter and check the frequencies of pitch pipes, tuning forks, piano strings, sirens or any other single-frequency sound-producing device. For greatest convenience, add portability and eliminate the need for supplying external power. The result is a valuable tool for audio-frequency testing, outdoors, in the shop or in the lab.

This all-transistor unit fills the requirements of portability, low battery drain, accuracy and sensitivity. It covers the entire audio spectrum in three ranges: 20 to 200, 200 to 2,000, and 2,000 to 20,000 cycles. It responds to 1 volt of audio signal, making it usable for most applications where low-level audio signals are measured.

Nominally priced, noncritical parts are used throughout. The entire instrument is self-contained and rugged enough for the roughest servicing use.

Circuit description

The circuit, shown in Fig. 1, uses four CK722 transistors operating in pairs. The first two, V1 and V2, are limiting and shaping amplifiers. They convert the incoming audio sine wave (Fig. 2-a) into sharply peaked trigger pulses (see Fig. 2-b). In addition, this transistor pair saturates and keeps the amplitude of the output pulses from V2’s collector at a constant voltage level regardless of amplitude or frequency variations in the input sine wave. The net result, at the collector of V2, is an output which does not vary in amplitude, but whose frequency is identical with that of the input. A pulse is produced for each cycle of frequency. If the input frequency increases, the number of trigger pulses increases. If the incoming signal decreases in frequency, the number of pulses from V2 also decreases.

The second pair, V3 and V4, is arranged in a one-shot multivibrator circuit. This is a familiar resistance-coupled amplifier with feedback from V4’s collector to V3’s base. V3 is normally biased to cutoff and does not conduct until a pulse arrives from V2 to trigger the circuit and overcome the bias. V3 then conducts heavily and the resulting pulse is amplified by V4. When the pulse ends, V3 goes sharply back into cutoff and V4 stops conducting. The circuit is ready for the next pulse from V2.

The output from this pair is a series of amplified current pulses (see Fig. 2-c). The number of pulses is propor-
TENSIONAL to the frequency of the incoming audio sine wave at V1's input, and V4's collector current through the meter will deflect the meter needle higher for more pulses (a higher sine-wave frequency) and lower for fewer pulses (a lower sine-wave frequency). If you feed a known audio frequency into the unit and log the meter reading, you'll wind up with a standard by which unknown audio frequencies can be measured.

Since the circuit operates on a change of frequency, the coupling capacitor between V3 and V4 must be changed to allow the multivibrator circuit to operate over the 20-20,000-cycle frequency range. This is done with the RANGE switch. The unknown audio frequency's input level to V1 is controlled by the GAIN potentiometer.

Power requirements vary from 7 volts at 3 ma to 11 volts at 7 ma. The lowest range, 20 to 200 cycles, uses the highest voltage and current. A 15-volt battery pack, made from two series-connected 7.5-volt batteries, is used as the power supply and appropriate voltage-dropping resistors are selected by the RANGE switch to provide the correct voltage for each range.

A CALIBRATION potentiometer is inserted in series with the battery to compensate for battery voltage drop due to aging and use. This provides long service for a set and, because the CALIBRATION potentiometer is adjusted to compensate for battery age. When battery voltage drops below 11, the pack must be discarded.

Construction hints

There is nothing critical about building this test unit. The usual precautions must be observed if the transistors were soldered directly into the circuit. Keep soldering-iron heat away from the transistors by using long-nose pliers to hold the leads between the iron and the transistor body. Wire the GAIN potentiometer in the usual hookup, so its variable resistance decreases as the control shaft is turned counter-clockwise.

Any type of wood, metal or plastic chassis and case can be used. I used a Plexiglas block on which several terminal strips were mounted for the chassis. All resistors, capacitors and wires are soldered to the terminals before the transistors are wired into place. The panel is cut, drilled, painted and all parts mounted before the chassis is attached. The final hookup is completed and the batteries are fastened inside the wood cabinet with metal straps.

If you desire, a large milliammeter (square or round) can be used, as long as its movement is connected. If movement is not moved, it will be necessary to get an extra slider for R16. Two sliders are needed because the wirewound unit is used to drop the voltage for two ranges.

After construction is completed, connect the batteries (observe proper polarity!) and throw the switch to ON.

The meter should indicate about 0.1 ma.

If no reading is obtained or a much higher reading is noted, something is wrong. Check the wiring, V3 and V4. The 0.1-ma reading is normal, static current. If everything seems to be in order, calibration can begin.

Calibrating the meter

An accurate signal generator is needed to calibrate the transistorized test set. The final accuracy of the frequency meter depends upon the accuracy of the calibrating audio generator.

Be sure it is a good one. They are not as hard to find as you may think for most well-equipped service shops or schools have them. Arrangements can be made to bring the test set in for calibration. If you're in an area where these facilities are not available, try the local telephone-system maintenance shop. The shop supervisors are friendly people and most of them have good audio generators on hand. My unit was calibrated in a telephone maintenance and repair section.

If all else fails, you can use a less-accurate generator, a scope and Lissajous figures, but this method is extremely tedious and should be used only as a last resort. Normally, with a good audio oscillator, calibration takes from 15-30 minutes.

First switch the RANGE selector to range 1, 20 to 200 cycles. The GAIN control should be turned to its farthest counterclockwise position (toward the grounded end). Feed a 200-cycle 2-3-volt audio signal to the input jack and slowly rotate the GAIN control clockwise. The meter reading will slowly increase, then suddenly jump toward full scale. Further clockwise rotation of the GAIN control will not result in any further increase of the meter reading. Back the GAIN control down and reset it about a quarter turn after the needle has jumped toward full scale. Do this two or three times and you'll find it easy to reach this point. This procedure sets the best input level for proper operation of the test set.

Observe the meter reading. It will probably be a little below the full-scale 1-ma level. Adjust the 2500-ohm CALIBRATION potentiometer for exactly 1 ma with a 200-cycle input. Calibrate the rest of the range by decreasing the calibrating generator's frequency until the meter needle drops to the 0.1-ma mark. Log the frequency on the audio oscillator dial.

Go down to the next mark (0.8 ma), log the frequency and continue this procedure until you hit 20 cycles. This frequency will probably produce a reading somewhat around 0.2 ma, so the 0.1 static-current reading will not be within the frequency range. Several of these test sets have been built and none of them read appreciably below 0.2 ma for the lowest frequency in each range.

When range 1 is calibrated, switch the RANGE selector to range 2, 200 to 20,000 cycles. Feed 200 cycles into the frequency meter and recheck the setting of the gain potentiometer. Move slider 1 (nearest the connected end) of R16 up or down the resistor for a full-scale reading of 1 ma at 2,000 cycles. When this reading is obtained, tighten the slider permanently and proceed with lowering the frequency and logging the meter readings all the way down to 200 cycles.

Finally, turn to range 3, 2,000 to 20,000 cycles, set the calibrating oscillator to 20,000 cycles and recheck the GAIN control setting. Adjust the slider farthest from the connected end of the R16 for a full-scale 1-ma reading at 20,000 cycles. After this, lower the frequency of the calibrating generator and log the readings versus frequency until 2,000 cycles is reached.

The chart on the test meter in the photograph shows the meter readings and frequencies. The readings will vary between one test set and another because transistor gains vary, even among the same type and manufacturer. However, the variation will not be large. Type the chart, cover with cellophane tape or plastic and fasten it to the instrument's panel. Calibration is com-

www.americanradiohistory.com
Simple Signal Generator

Most experimenters and home constructors occasionally need an rf signal generator, but the need is seldom great enough to warrant purchasing one. Fig. 1 shows the circuit of a simple rf signal generator made from inexpensive or junkbox parts. The circuit originally appeared in The Short Wave Magazine (London, England).

The author used two banks of five coils selected by range switches S1 and S2 to cover from a few kc up to 250 mc. You can select coils to fit your needs and may replace S1 and S2 with a single switch having one position for each tuning range. Coil winding data was not given. It is recommended that coils be obtained from junked receivers and similar sources. Coils in the rf range can be windings from 132-, 175-, 262- and 455-kc if transformers. For lower frequencies try TV linearity or width coils in various inductance ranges. For the broadcast and shortwave bands you can use the tuned windings of antenna, rf and oscillator coils designed for the desired frequencies. Above 18 mc or so you can wind coils experimentally, cut sections of B & W Miniductors or use CTC (Cambridge Thermionic Corp.) 20- and 60-mc slug-tuned coils and check them with a grid-dip meter or on a receiver. Above 30 mc we sug-

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BIBLIOGRAPHY


"Three New Transistor Circuits," by N. Hoki-

The question most often asked, when the possibility of a new stereophonic system of disc recording is mentioned, is “Does it use one or two styli?” Often surprise is expressed that it should be possible to use a system with only one stylus. Of course, the Cook “binaural” record has been available for some time. It uses two pickups spaced a certain distance apart, so each plays a separate section of the record. But many people seem to visualize two stylus quite close together and probably in the same pickup, either playing adjacent grooves or following each other in the same groove.

This idea probably arises from the present systems of stereophonic tape which employ two tracks and consequently require two playback heads. Systems for stereo on tape have been suggested employing magnetization at different angles on only one track. Separate playback heads, mounted at the correct angle for the program information in each channel, could then play the same magnetic track (Fig. 1).

But disc is quite a different proposition. For one thing there would be the difficulty of making sure that each stylus is in the correct groove. If the arm and head of the pickup are mounted correctly so the stylus are theoretically in line with the groove at all positions across the record, the compliance of any modern pickup must be so large that the stylus can move a distance representing several grooves without appreciable opposition. Consequently it would still be very easy to lower the pickup in such a way that the two styli would settle in grooves two or three rotations apart instead of in the same groove. In fact it would become difficult to lower the pickup so that the two styli would rest in the same groove — and even more difficult to lower them so they rested correctly in adjacent grooves, if such a system should be used.

The great prospective advantage of stereophonic recording on disc is that it will be as easy to play as LP’s are today. Consequently an arrangement that involves great precision in lowering the pickup to the record would invalidate its advantage. It would become no easier to handle than tape. So the only prospective system for stereophony on disc that represents an economic and utilitarian advantage is one where a single stylus is used.

**Vertical-lateral**

The idea of using vertical-lateral recording is not new. It has been experimented with for a long time, and good pickups for the purpose were developed in the ‘30’s. At the moment, two completely different systems, both using vertical and lateral movement of the stylus, are being proposed for high-fidelity reproduction of stereophonic sound.

One comes from England (the London Record Co.), employing vertical for one channel and lateral for the other channel of stereophonic sound. The second is a system recently developed by Westrex, which employs 45° movement one way for one channel and 45° movement at right angles to the first for the other channel. This new system claims several advantages over the vertical-lateral system. Whether these advantages are real or theoretical remains to be proved.

One question encountered with both should first be resolved. When any system of moving the stylus both vertically and laterally is discussed, someone invariably asks won’t it be difficult to press recordings of this type. The implication seems to be that it must involve some undercutting in the groove.

Stereophonic disc recording is a prospect for the immediate future. Not so long ago, during the Audio Engineering Society’s convention in New York City, *two systems* of stereophonic disc recording — both using a single groove and single stylus — were demonstrated. Comments of manufacturers and engineers left little doubt that commercially practical disc stereo has arrived, and it is confidently expected that major record manufacturers on both sides of the Atlantic will start producing stereo discs this year.
walls. The argument usually begins, "If the stylus moves sideways when it is at the bottom of a vertical cut . . ."

In answer to this, note that both vertical and lateral recordings use a cutter and stylus whose disposition to the record is vertical (Fig. 1). When the same cutter is used to cut vertical and lateral, or the same stylus to play it back, it is still vertical. So there can be no undercutting at any point. In fact, London Records has pressed a quantity of these recordings in their standard machines used for LP's, and demonstrations were given with these pressings. We are assured that stereo discs need cost no more for the same playing time than LP's. This, surely, is the economic answer for stereo.

To explain the principle on which these systems work, Fig. 3 shows a simplified arrangement for a magnetic pickup (or cutter) for use on each. In the vertical-lateral (London) (Fig. 3-a) vertical motion of the armature attached to the stylus alters the magnetic field between the vertical pole pieces and produces vertical output from these coils. But the movement is parallel to the lateral pole pieces and thus produces no output. For lateral movement, the reverse is true.

The so-called 45/45 (Westrex) works in exactly the same way by rotating the pole-piece portion through 45° (Fig. 3-b). Each 45° motion is at 90° to the other so the same separation of outputs works just the same. Obviously the physical arrangement shown in Fig. 3 could not be used because the stylus could never touch the record in the position shown—the magnetic assembly would get in the way. These are simplified drawings to show how it works. Nor is the principle limited to magnetic pickups. The same separation can be achieved with moving-coil, crystal, capacitance, etc., or with combinations of them.

The first and biggest advantage claimed for the 45/45 is that vertical recording has always been accompanied by a greater amount of distortion than lateral recording. This is because depression of the cutter requires a greater force than lifting it. Because of the triangular shape of the cutter, depressing it by, say, 1 mil, increases the amount of recording made by much more than lifting it by 1 mil reduces the quantity removed (Fig. 4). Force required is approximately proportional to material removed. Consequently, vertical recording (or hill-and-dale, as it was called in old days) is accompanied by second-harmonic and similar forms of distortion.

For a long while this has been the reason given for the preference for lateral recording where the cutter removes a constant amount of material from the master disc, and consequently there is no inherent distortion in the cutting operation. The argument for 45/45 is that both movements involve the same proportion of vertical and lateral components (Fig. 5); consequently the quality is equal on both channels. The distortion contributed by the vertical component is not all on one channel but distributed equally between both channels.

**Compatibility**

The second claim for 45/45 is that it gives better compatibility both ways. Before going any further, let's define a little more precisely what we mean by compatibility. Complete compatibility would mean the system is capable of the following combinations:

1. A new type stereo pickup should be able to play and give satisfactory reproduction from an LP record recorded nonstereo, and
2. A nonstereo pickup and single-channel high-fidelity system should be able to play the new stereo disc with quality equivalent to reproduction from a good LP.

Compatibility in the first sense is achieved by either system. The second sense involves two further considerations. If it is possible to play the stereo disc with a nonstereo pickup and achieve high-fidelity reproduction, it would seem that the record manufacturer does not have to put out two types of discs for the same program. But there is another factor.

If the stereo disc is played with an LP type pickup, it may give satisfactory high-fidelity reproduction but still ruin the stereo disc for subsequent playing on a stereo pickup. The great majority of high-fidelity pickups today have much less vertical than horizontal compliance. In fact, one well known pickup, having a reputation among the best, has virtually zero vertical compliance. If such a pickup were used to play any stereo disc, it would completely wreck the vertical component of the stereo recording and the disc would then become useless for playing as anything but an LP.

While the hi-fi pickup would blow out most of the vertical material, it would not completely eliminate it. Consequently, whether vertical-lateral or 45/45 is used, if this disc were subsequently played on its appropriate stereo system, it would sound extremely distorted because of the damage to the vertical component. In a vertical-lateral recording one channel would get all the distortion, while the other would remain at its normal high fidelity. But with a 45/45 recording, both channels would be equally distorted.

Either way—and this is the vital factor about whether compatibility should be claimed by either system—the user is scarcely likely to blame...
his trusted high-fidelity pickup for the damage. He is much more likely to conclude either that the record was no good in the first place or that his stereo pickup is no good, and thereby form a bad initial impression of the system.

For this reason, it would seem advantageous, whichever system is used, not to make any endeavor to claim the second form of compatibility. In their own interests, the record companies should continue to issue both types of recording, whichever system of stereo disc is ultimately chosen.

The man who goes for stereo disc will buy a stereo pickup and thereafter, because of its compatibility in the first sense, he will be able to play his mono LPs with his stereo pickup. This is possible with both systems.

Further, it seems that with either system the user should be advised to keep his stereo disc to be played only with a stereo pickup and should be warned that an anachronistic high-fidelity pickup is likely to ruin the record. It's true that some hi-fi pickups may not ruin the record if they happen to have a high vertical compliance. But high vertical compliance is not inherently connected with the quality of an LP pickup. Consequently it would not seem advisable to differentiate between high-quality LP pickups with and without high vertical compliance. This will only be something that would confuse the consumer still further.

It would be best to play safe and recommend that stereo discs be played only with a stereo pickup, adding the warning that an ordinary pickup, which may give satisfactory high-fidelity reproduction, is likely to ruin the disc for playing over a stereo system.

Having settled (I hope) this question, let's investigate the comparative merits of vertical-lateral or 45/45, playing as a stereophonic system. First, let's look into this matter of distortion.

**Distortion**

The implication has been made that the 45/45 distributes the distortion equally between both channels. This tacitly assumes the vertical distortion is inevitable. "So we have to live with it, let's make the best of it" by putting it equally in both channels instead of having it all in one.

This seems a rather unsatisfactory attitude in view of the fact that stereophonic reproduction is intended to be a step forward from high fidelity. In high fidelity we have worked hard to eliminate or minimize all possible causes of distortion. So it seems to be a retrogressive step to provide two-channel recording at the cost of accepting a greater amount of distortion than we would tolerate with single-channel system.

The question arises "Do we really have to put up with this distortion on vertical recording?" The idea that distortion is inherent to vertical recording dates from the days before feedback cutters were invented. Any attempt to produce vertical-lateral recording with a "straight" cutter, without the use of feed back would undoubtedly involve considerably more distortion in the vertical than in the lateral cut.

If this were applied to a two-channel system, with the lateral for one channel and the vertical for the other, the vertical channel would have much more distortion than the lateral channel.

Whether such a cutter or one designed for the purpose were employed to produce the 45/45 system, both channels would have much more distortion than LPs using the simple lateral type of cut.

Fortunately, some very good feedback cutters have been developed, and a signal on both channels that would result in an ultimate push forward on both loudspeaker diaphragms moves the stylus to the left, the next half-cycle moving it to the right. We can call this a lateral-dominant movement.

Changing the phase of one of the cutters will make the same in-phase combination from the microphones move the stylus up and over the other words a vertical-dominant movement. A lateral movement in this case would correspond with pressure at one microphone and rarefaction at the other, or in playback would result in one speaker pushing when the other pulls. This phasing can result in certain economies in groove spacing but has disadvantages from the compatibility point of view. Playing an ordinary LP with a 45/45 stereo pickup so hooked up would result in the speakers being out of phase, which produces a rather unpleasant kind of reproduction.

If the vertical-dominant connection were selected for the 45/45 system as a standard, the system would be compatible for playing LP's only by arranging a phase changeover switch in one channel.

The vertical-lateral system is also compatible. If the stereo pickup is used to play an LP disc without changing connections in any way, the whole program will seem to come from one speaker. This is, of course, obvious to the user and it is a simple matter to provide this system with a paralleling switch to feed the output from the lateral coils of the pickup to the input of both channels. This would enable both speakers to get the same program in phase.

The question of possible cross-talk is one that ties in with two other factors: the way the recording is made — that is, the kind of microphone placement needed combined with the results of future developments in cutters and pickups which, at the present stage, are difficult to predict.

It would seem at present that it would be simpler to provide precision isolation between two movements at 90° to one another when one of these is vertical and the other lateral than when both are at an angle. Deviation of either angle of movement from a perfect 45° will result in some breakthrough onto the other channel's sound.

A recent demonstration given by London Records for the benefit of the industry, using the vertical-lateral arrangement, proved that it is possible to record vertically with as high a quality as laterally. This particular recording made claims of going no higher than 12,000 cycles. But neither did the lateral.

The important thing here is that distortion in the vertical was no higher than distortion in the lateral, due to the excellent compensation by the feedback cutter.

This, then, eliminates the distortion comparison issue from the relative merits of the two systems. So we are left with two main factors to consider. One is the claim of compatibility already mentioned. The other two are the possible problems involved in achieving an adequate cross-talk ratio, and a space utilization factor of the recording medium which will involve the relationship between playing length and dynamic range that can be achieved as compared with the regular LP.

There are two possibilities about the phasing of program material in the 45/45 system (Fig. 6). These principally affect the low frequencies which are responsible for the greater amplitude movement of the stylus in both directions. If the phasing is such that

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**Fig. 6 — Two possible ways of phasing stereo program in 45/45 system; a — dominantly lateral; b — dominantly vertical.**

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**Fig. 7 — Provided axes of movement are at precisely 45° in the cutter, cross-talk will be limited only by how well the cutter and pickup are made; distortion of these axes (dashed lines) at some stage of the process will cause increased cross-talk.**
because the two movements will no longer be at exactly 90° to one another. Academically, of course, both methods are equally possible of as good separation of talk ratio: technically it seems that the vertical-lateral arrangement would offer less problems in manufacture and also offer the greater potential for future development in cutter and pickup design. If anything at all should disturb the vertical-lateral proportions of the recording during processing, this would produce deterioration as cross-talk (Fig. 7).

As against this, the claim for the 45/45 in this respect can be based on the use of symmetry—the fact that the two drives can be arranged in symmetrical manner, like a V-8 motor, which is not so readily possible with a vertical and lateral arrangement.

London Records demonstrated with a pickup whose cross-talk was reputed to be 25 db and they reported that a prototype has just been developed that gives a cross-talk ratio of 55 db, which is more than adequate and would seem to allow plenty for production deviation.

Price range?

In the initial development stage, the crystal transducer did not produce as good a cross-talk ratio as the other types but it was still adequate for use in a low-cost stereophonic disc system—a very important consideration for the mass market.

The tape people lay claim to the potential for highest possible quality because their playback heads have no moving parts. Of course they have magnetic circuits which can introduce their own troubles. But pickups have moving parts which make it more difficult to produce a uniform frequency characteristic. So, basically, it would seem that tape stereo offers the best possibility for those really interested in absolute top quality—a view that is underscored by the fact that, at present, all mass market recordings are made on tape, later to be dubbed on disc.

The obvious advantage of the stereo disc is its simplicity in use. It can be handled exactly the same as the present LP's. If a visitor steps in and you want to impress him with your latest recording, you can lower the stylus onto the particular passage you want to play and then, if he is further interested, play the whole disc. This is quite different with tapes because you cannot find the particular spot in a recording as quickly.

This and the ease of putting the stylus on the record and taking it off again will presumably result in greater popularity of stereo disc with the mass market. In fact, I would go for stereo disc in preference to tape myself, for the same reason. This being the case, we have to consider not only the possibility, but the very high probability, that stereo discs will be applied in the extremely low price range, comparable with present record players. At the same time it should be possible to produce at an economical price a system having quality comparable with the best LP reproduction of today.

The final matter for comparison is the space factor. With both the London and Westrex systems, maximum groove width is greater than on standard LP's. This greater width is caused by the need for the cutter to go deeper into the record to record the vertical component properly. As the cutter is chisel-shaped, the deeper it goes the wider the groove.

In theory the modulation area for the 45/45 is the same square cross-section of possible movement as for the vertical-lateral, but it is turned up on its corner so that room has to be found in the material of the disc for a spiral modulation area of square section wound corner-on as it were. This results in less economical utilization of the space for a spiral wound so the flat surfaces of the modulation area lay one beside the other.

But there is another factor that brings up two possibilities. If the in-phase components result in lateral movement, the out-of-phase components, which will invariably be considerably smaller in amplitude, will result in less demand on the vertical excursion of the cutter and playback stylus. This enables the unwanted distortion we mentioned earlier—and which may be true only of academic interest at this stage—to be minimized.

On the other hand, if the in-phase operation produces a vertical resultant, the principal movement of the stylus with a 45/45 system now becomes vertical and the grooves can be cut much closer together, allowing a longer amount of weight for material to be squeezed into the same space but requiring much deeper vertical cut. This may either result in greater distortion or, by reducing the vertical excursion permitted, will considerably reduce dynamic range.

So, on the score of both compatibility and dynamic range, the 45/45 should be phased so in-phase program produces lateral-dominant movement. This is, in fact, the phasing standardized by Westrex in their system.

Recording techniques

A further factor that should be mentioned before we leave this subject is the effect of recording techniques. Systems developed in Europe independently, the Stere-Novac and the German MS systems, both employ dominantly intensity differences in the program content of the two channels rather than time differences which are more dominant in most American stereophonic systems. A possible advantage of the intensity-dominant channel differences is that it makes cross-talk relatively unimportant as both channels contain exactly the same program information at the same time, but with different proportions of it in each channel for different sections of the orchestra. Thus the only effect of possible breakthrough is that the directional effects intended will be slightly muddled. There will be no undesirable echo or distortion products due to intermodulation from one channel to the other, such as can occur where there are time differences as well as intensity differences.

Adaptation of these recording techniques might utilize a vertical-lateral arrangement, with wide-range lateral and limited-fidelity vertical. This would offer additional possibilities for rumble reduction with low-quality turntables.

The London people, however, adopt the attitude that, in view of the improved quality in the vertical channel they have already succeeded in achieving on a production basis, this is an unnecessary limitation on the medium. Without such a limitation, it is possible to have the flexibility so that both channels can contain stereophonic information with either intensity or time differences equally well.

Sometimes stereophonic recordings deliberately contain out-of-phase components in the low audio frequencies to gain specific effects that are not obtainable with simple single-channel LP presentation. Use of a modified stereophonic or MS system would preclude this type of presentation and other possibilities of exploiting the new stereophonic medium to the utmost. Consequently, it is good to see that the vertical-lateral presentation has achieved a standard of recording and reproduction such that two high-quality channels can be provided.

The next question is shall we have both systems or only one, and, if so, which one. This is a matter for the record industry to decide. Obviously it is impractical to use both systems because, although each is compatible with single-channel LP's in its own way, neither the company that made it without a conversion switch to sum- and-difference combination to convert the output from the pickup from one form to the other. It would be impractical to use such a system as this because the user would never know which kind of disc he had and whether he was playing it correctly.

Consequently it would seem vital to select one system or the other and make this the standard for the industry. (Proponents of both systems agree that it is unlikable that two incompatible systems should co-exist, and it is likely that they will agree on one of the systems before starting to make stereo discs.) From the foregoing discussion, it is evident that both systems have their possibilities and probably the decision will rest on the one that is developed so far with each system and the quality it produces. This does not say the system with the inherent best possibilities will win. More likely it will be the one whose technological development at the time the decision is made has reached a higher order.

JANUARY, 1958

END
The KT88, British big brother to the popular KT66, is now available in this country and is expected to appear in a number of commercial amplifiers in the near future. The KT88 is very similar to the American 6550 and can be used in most circuits which call for the 6550, if the bias is adjusted for the KT88. However, the new tube has some advantages which add to its utility.

The KT88 permits the use of large grid resistors (up to 120,000 ohms in fixed-bias applications), which leads to simpler driver circuits. Screen voltages as high as 560 may be used, which means that screen and plate can both be maintained at high potentials, as in triode arrangements or screen-loaded circuits, thus simplifying the power supply.

Specifications of the KT88 indicate that its operating characteristics are not critical. Primary impedances of 4,000 to 5,000 ohms match the tube for most operating conditions. According to GEC (Britain's General Electric Co.), manufacturers of the tube, screen taps of 20% to 50% give uniformly excellent performance with equal dc potentials on both plate and screen. This wide latitude differentiates the KT88 from many other beam tetrodes which exhibit the Ultra-Linear effect of maximizing performance at a relatively critical screen tapping point.

The KT88's noncritical impedance matching is a decided advantage as the shifts in reflected impedance which accompany the use of a loudspeaker load have relatively little unfavorable influence on performance. The normal variation of speaker impedance with frequency has less detrimental effect on performance with KT88's than with tubes in which matching conditions are more critical.

These desirable attributes have led to experiments using the KT88 in several types of circuits. One of the avenues of exploration led to using the tube in a 60-watt variation of the circuit used commercially in Dynakit amplifiers. This is shown in Fig. 1.

The KT88's are used with a Dynaco A-491 transformer, which has 4,300-ohm primary impedance with screen taps at 33% turns (11% of the primary impedance). Each tube draws 70 ma of cathode current with a 475-volt supply. Fixed bias is used and is adjusted by setting for 1.56 volts across the 11.2-ohm common-cathode resistor. Since an ordinary type-D flashligh cell, when fresh, reads close to 1.56 volts, this can be used as a reference standard when setting the bias.

The small unbalanced common-cathode resistor causes degeneration in the stage for signal components which are not canceled in the push-pull output stage. True push-pull cancellation requires accurately balanced operation under dynamic conditions. Slight deviations in driving signals or in output tube characteristics cause an unbalance which is not corrected by the push-pull action. These deviations cause a signal voltage to appear across the common-cathode resistor, and the resulting degeneration lowers distortion as per Fig. 2.

The correction for unbalance obtained by using this resistor is not that which is obtained by dc balancing of the output stage. The dynamic correction is one in which ac signal voltages are involved—not the static plate currents, which have little effect on performance in this particular case.

Distortion figures

Under these operating conditions, the KT88 can deliver as much as 75 watts at less than 1% distortion if the B-plus supply voltage does not fall off. However, in economical power supply arrangements, there is a drop in the B-plus, and a decrease in power output results. With a typical capacitor input supply, it is practical to obtain 60 watts of output, with very little distortion in the output stage.

The typical KT88 requires about 56 volts bias for these operating conditions. This in turn requires almost 40 volts rms each side from the driver. This amount of drive is normally obtained with a push-pull driver stage; but with the high supply voltage available and proper choice of tube type, a single-envelope pentode-triode can handle the job. The 6AN8 has direct coupling between pentode voltage amplifier and cathodeyne phase splitter—somewhat similar to the configuration popularized by Williamson. This one tube will furnish 120 volts peak grid...
to grid, enough for the KT88's, at an intermodulation figure of about 2%. Distortion is reduced in the amplifier by negative feedback. With 20 db of feedback, the driver output stage combination delivers 60 watts at about 0.5% IM. The actual distortion figure varies slightly, depending on the tolerances in components and tubes. With matched resistors in the phase-inverter circuit, the tolerance of other components will cause distortion to range from about 0.5% to 1.0% at full output. At lower levels, distortion decreases and is well below 0.1% at the 1-watt level. Measurements below 0.1% are difficult to make because of limitations of measuring equipment and because noise levels obliterate the residual distortion.

**Feedback circuit**

Several circuit features are included to maintain stability under feedback conditions. The most important of these are the capacitive feedback loop from the screen of one output tube to the first cathode, and the relatively small screen bypass capacitor. The capacitive feedback loop improves high-frequency stability while the choice of screen bypass improves low-frequency stability. If this screen bypass is significantly increased or decreased in size, there will be a bump in the low-frequency response around 5 cycles, which is a symptom of incipient instability under transient conditions. The selected value gives critical damping of the low end. High-frequency stability is suitable for all types of speaker loads including the newer electrostatic types.

The feedback compensation reduces the total bandwidth slightly since it produces rolloff in response below 6 cycles and above 60 kc. However, within the 20-20,000-cycle range this is flat response at any power level up to a maximum of 60 watts. Even more important than flat response at high power is that total harmonic distortion is kept below 1% over the audio spectrum at powers up to 48 watts. The advantage of being able to handle large amounts of power cleanly at low frequencies shows up on speaker systems in which there is significant impedance variation below 100 cycles. These variations result in effective reduction of undistorted power output in the amplifier through the condition of mismatch (this type of mismatch is not corrected by variable damping circuits) brought about by a rising impedance characteristic. However, if there is a large amount of power available, the loss due to mismatch can be tolerated since sufficient undistorted reserve is retained to handle most operating conditions.

The power supply is conventional, using a GZ34 rectifier with capacitor input and choke filtering. A tap with a separate rectifier is used to obtain bias voltage. One feature of interest is the grounding of the heater center tap through a .02-µF capacitor. The inherent heater-cathode leakage of the 6AN8 causes a small charge to build up across this capacitor, automatically biasing the heater string to the lowest noise condition. If a preamp is powered from the same heater supply, its heaters should not be grounded or the benefits of the amplifier arrangement will be destroyed. If the preamp has a hum pot or other device which requires grounding, it should be grounded through a capacitor to obtain an ac ground only so that the floating effect of the power amplifier arrangement is not removed.

This circuit has been constructed in several physical arrangements without any difficulty, provided normal good construction practice is followed. In the commercial kit, a printed-circuit board is used for all audio components up to the grids of the KT88's. This gives complete reproducibility of layout, but is not required to duplicate the circuit's characteristics. The photographs show the printed-circuit board and illustrate the essential simplicity of the entire amplifier.
HE first article of this series discussed a number of pickup arms when vertical and horizontal pivots are spaced appreciably apart. A second major category includes arms which have their vertical and horizontal pivots essentially at the same point. (As in the preceding article, we will consider the vertical pivot to be the one which lets the arm move vertically and the horizontal pivot the one which lets the arm move horizontally.)

This type of arm design is the most common and is familiar to most people since virtually all record-changer arms are so designed. Perhaps its major disadvantage is that its inertia is the same in both vertical and lateral planes. High lateral inertia (mass) is desirable, to keep arm resonance below the audible range, while low vertical mass tends to minimize record wear, particularly when playing warped records. In this type of arm design, a compromise is usually necessary between these conflicting requirements.

Most (though not all) arms of this type are not laterally balanced, which makes careful leveling a necessity. Even when they are laterally balanced, the high vertical mass makes the arm rather sensitive to groove jumping when it is jarred unless viscous damping is used on the vertical pivots.

Rek-O-Kut A-120/A-160

The photos show the Rek-O-Kut A-120 arm. The A-160, designed for use with 16-inch records, is similar in appearance. This tubular aluminum arm has a removable die-cast cartridge shell, and a die-cast counterweight threaded on the rear of the arm. The pivot structure is the gimbal type, with ball bearings in both vertical and horizontal pivots.

The stylus tracking-force adjustment is unique, simple and foolproof. No external gauge or scale is needed to set stylus force accurately. With the cartridge plugged into the arm, the counterweight is adjusted by screwing it on the rear arm extension until the arm is perfectly balanced. When the counterweight is then rotated clockwise, a net downward force is exerted at the stylus. On the A-120 arm, each 1/4 turns add 1 gram to the tracking force while on the A-160 arm each 1/2 turns add 1 gram. A self-locking thread is used so set-screws are not needed to keep the counterweight in position after adjustment.

Although the arm body appears to be a single tube, it is actually divided into two portions. The division is visible as a line around the tubular arm body, just behind the pivot gimbals. This line is a thin piece of acoustical damping plastic which joins the front and rear sections of the arm. Its purpose is to damp the arm resonance, which is usually between 13 and 16 cycles, depending on the cartridge employed.

The interchangeable cartridge shells are solidly constructed and are secured to the arm by a threaded locking ring. The front of the shell is open, permitting easy cuing of the stylus in the desired groove. This also permits the use of turnover cartridges which are rotated by a knob protruding from the front end. The pivot assembly may be moved vertically to adjust the height of the arm to the turntable.

Pickering 194D

The Pickering 194D (Unipose) pickup is shown in the photos. It is an integrated pickup design in which simplicity is the keynote. Indeed, it would be hard to imagine an arm simpler in construction or easier to install. The entire arm is pivoted on a single needle point, just as a compass rose is supported. The needle is made of hardened steel, and the cup into which it fits has a conical hole to receive the needle point. The needle passes through a slot in the arm and in contacted on both sides by a thin rubber membrane slitted to pass the pivot needle as the arm is raised or lowered. This membrane is intended to damp arm resonance somewhat.

Stylus tracking force is adjustable between 1 and 6 grams by sliding a knurled knob, located under the arm, toward the front of the arm to increase force or toward the rear to decrease the force. The white dots on the side of the arm correspond to the various settings of this knob. Each dot represents approximately a 1-gram change of stylus force from the adjacent dots. Most of the weight of the arm and cartridge is counterbalanced by the rear counterweight, which is designed so it also forms a part of the pivot assembly.

In next month's installment, Julian D. Hirsch will discuss the characteristics of the ESL/BJ Super-Go tangential arm, the Orthosonic V/4 radial arm and Audio Specialties AS-30 radial arm.
The Leak dynamic pickup. Note the single-hole mounting.

In Pickering 194D rear counterweight forms a part of the pivot assembly.

Installation of the Pickering 194D is further simplified by the single-hole mounting of its base. A 1 1/16-inch hole is drilled in the motor board at any convenient point 8 inches from the turntable center. The pivot is fastened in this hole with a single wing nut which also holds, below the board, a bracket with a standard phono connector. Pickup height is adjusted by merely screwing the pivot needle up or down in the base. Since the pivot point is located well above the arm's center of gravity, it is self-leveling within a range of a few degrees. Therefore the only leveling operation necessary is to be sure that the turntable surface is truly horizontal.

The arm rest also mounts in a single hole. A small adjustable brush forms an integral part of the rest. This brush may be adjusted so the stylus is cleaned of lint each time the arm is returned to the rest. Although the rest merely supports the cartridge body, the magnet in the pickup is strongly attracted to it and there is no tendency for the arm to fall off the rest accidentally.

The Pickering 194D is noteworthy in that it goes one step beyond other integrated designs. The cartridge structure does not plug into the arm—it is a permanent part of the pickup. The styli are mounted in small T-shaped plastic bodies which may be slid in or out of the cartridge without difficulty. A small plastic box with a rack which holds up to eight styli assemblies is furnished with the arm. Pickering manufactures styli in 0.5-, 1.0- and 2.7-mil radii (diamond), as well as a 2.7-mil sapphire stylus. Changing and storing these small stylus assemblies is certainly simpler than the usual practice of plugging in a different cartridge for each stylus size.

Leak dynamic pickup

The arm designed by H. J. Leak & Co. Ltd. (see photos) for their dynamic pickup is very similar in pivoting principle to the Pickering 194D. Fig. 1 is a cut away drawing of the Leak arm, showing the pivoting. The arm rotates in both planes on the point of an upright needle, resting in an inverted conical depression. The arm base mounts in a single hole and the pivot needle is adjusted vertically by loosening a setscrew. Vertical rotation of the arm is limited by a slot in a curved metal cover surrounding the needle. The pivot makes contact with a damping material as it passes through this slot. Lateral rotation of the arm is restrained to an angle of less than 90° by a projection from the side of the needle which strikes the sides of the pivot housing at the limits of arm rotation.

The pickup's tracking force is adjusted by loosening a setscrew and sliding a counterweight along the projecting rear portion of the arm.

The arm is a straight tube which receives the plug-in Leak cartridge only. The required offset for minimum tracking-single error is built into the cartridge.

As with any arm pivoted in this manner, the Leak arm is relatively insensitive to small leveling errors. Since it is not laterally balanced, accurate leveling of the turntable surface is important, however.

ESL type 310

The Electro-Sonic type 310 tone arm, shown in the photos, is designed solely for use with ESL Professional series cartridges. Like several other arms already described, it is of simple tubular-aluminum construction. The pivots are the gimbal type, using precision ball bearings in both vertical and horizontal pivots. The pivot assembly may be adjusted vertically to adapt the arm to turntables of different heights by loosening a single setscrew. No provision is made for leveling the arm, but its design is such that minor leveling errors should not cause trouble.

The ESL 310 is unique among the pickup arms discussed in this article since it is the only one which is balanced in the horizontal plane. The counterweight is factory-set to counterbalance exactly the mass of the arm and cartridge forward of the vertical pivot. Because of this, exact leveling of the arm is not critical. To obtain a downward stylus force, a spring (which can be seen in the photo) is connected between the counterweight and the gimbal assembly. The tension of this spring may be adjusted by a knurled screw at the rear of the counterweight to set the stylus force. A calibrated scale is engraved on the counterweight, and the stylus force may be set between 0 and 30 grams.

Although the ESL 310 is carefully balanced and may operate with very low stylus forces, it has considerable vertical mass. In fact, the vertical and lateral masses are essentially the same. Because of this, the arm is quite sensitive to jarring effects and must be installed on a heavy well-mounted motorboard.

The front of the arm contains a socket into which the ESL Professional series cartridges are plugged. A knurled locking ring fastens the cartridge to the arm.

This arm does not have any damping provisions. However, its mass is considerable (it is a 16-inch arm) and this factor, combined with the high compliance of ESL cartridges, reduces the arm resonance to well below 10 cycles.

Weathers

The Weathers pickup arm is unique in several respects. It is made of a lightweight wood rather than the more usual metals used in other arms. It is designed for and may be used only with the Weathers FM capacitance pickup cartridge. The Weathers pickup arm is shown in the photos.

The base of the arm is made of a soft rubber and has small rubber feet extending above and below each of its mounting holes. When permanently installed, the mounting screws exert little or no pressure against these feet or the base, but serve merely to keep the pickup in its proper position on the motor board. The rubber feet and base isolate the arm from turntable and motorboard vibration.

The mass of the arm and cartridge is

(Continued on page 78)
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.

(1) Connect a .005 µf disc capacitor from socket C4 (NS) to IF transformer Q3 (NS).
See Figure 8.
(2) Connect a .005 µf disc capacitor from socket C4 (NS) to 1F transformer Q4 (NS).
(3) Bend socket lug C5 and IF transformer lug Q3 toward each other until they make contact and overlap slightly.
Solder the connection securely. (1).
(4) Bend socket lug C9 and IF transformer lug Q3 toward each other until they make contact and overlap slightly.
Solder the connection securely. (1).
(5) Install a .005 µf capacitor from socket (NS) to ground lug C9 (NS). Dress the capacitor close to chassis, under the capacitor previously installed.

Read the step...perform the operation... and check it off—it's just that simple. These plainly-worded, easy-to-follow, steps are combined with pictorial diagrams to take you through every phase of assembly. Let our experience be your teacher!
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-diode rectifiers, which are noted for their very long life, and yet are smaller than a house fuse. Frequency response at 1 watt is ±1 db from 5 cps to 80 kc with controlled hf rolloff above 100 kc. At 70 watts output harmonic distortion is below 2%, 20 to 20,000 cps and IM distortion below 1%. 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-6M: Consists of W-6M kit, plus WA-P2 preamplifier. Express only. Shpg. Wt. 59 lbs. $109.95

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 warmup. Features broadbanded circuits for full fidelity, and better than 10 db sensitivity for 20 db of quieting, to pull in stations with clarity and full volume. Employs a high gain, cascade 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

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 band-width, 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. 8 lbs.

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 ±1/2 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: $19.75

An amplifier you will be proud to own

HEATHKIT BROADBAND AM TUNER KIT

Selects and controls sound to your taste

HEATHCOMPANY A Subsidiary of Daystrom, Inc. BENTON HARBOR 20, MICH.

JANUARY, 1958

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HEATHKIT ADVANCED-DESIGN 25-WATT HIGH FIDELITY AMPLIFIER KIT

Designed especially to satisfy critical audio requirements, the W-8M 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 1% at 25 watts, with IM distortion less than 1% at 20 watts. Hum and noise are a full 99 db below rated output, assuring quiet, hum-free operation. Output taps are 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
$59.75

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 1% and IM distortion is less than 1.3% at 20 watts. Hum and noise are 88 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
$49.75

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 output. 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 1.8% 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, and 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
$39.75

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 1% at 3 db below rated output. Push-pull 6L6 tubes are used, with output transformer tapped at 4, 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

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BY DAYSTROM
bring you the lasting satisfaction of personal accomplishment!
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 within ±5 db, in a specially-designed ducted-port, bass reflex enclosure. Impedance is 16 ohms. Cabinet measures 11½" H x 23" W x 11½" 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 ±5 db from 35 to 16,000 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, ¾" thick. Easy to build! Shpg. Wt. 80 lbs.

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 tele-metering and pulse work, and checking audio, video and hi-fi amplifier response. Frequency response is ±1½ db from 20 CPS to 20,000 CPS. 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 oscillators are built in. VTVM ranges are 0-1, 0.01, 0.001, 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. 13 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 in only the most expensive speaker systems available today. The listening experience it provides approaches the ultimate in aesthetic 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, ¾" 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.
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 through 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 0-0.03, 0.01, 0.03, 1, 3, 1.3 and 10 volts RMS. "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 is less than .1 of 1% between 20 and 20,000 cps. Total range is 10 cps to 100 kc. Shpg. Wt. 6 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
$49.50

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 150 kc. Stability is excellent and calibrated grid sweep 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 size, 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

HEATHKITS...

are well known for their high quality and reliability.

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 stage. It emphasizes stability, broadband 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 0.01, 0.03, 0.1, 3, 10, 30, 100 and 300 volts. Db ranges cover -92 db to +62 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
$29.95
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 "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, retrench 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 100 kc in five steps, five times the usual sweep obtained in other scopes through the use of the patented Heath sweep circuit. Etched-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. $69.50

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 rates. 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. $29.95

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 sharp square waves. Output frequency is approximately 1000 CPS. Fixed outputs selected by panel switches are: .03, .1, .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. $12.50

HEATHCOMPANY A Subsidiary of Daysstrom, Inc. BENTON HARBOR 20, MICH.
JANUARY, 1958
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 hyotron miniatures, and pilot lamps. Tube condition indicated on 4½" meter with multicolor "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 $29.90

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 $17.95

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 tubes 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 $24.95

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 VT-4 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, 400, 1400 and 4000. Resistance ranges provide multiplying factors of X1, X10, X100, X1000, X10k, X100k, and X1 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 VT-4 $24.95

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, 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 X1, X100, X10,000, 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 $29.95

Heathkits...
by Daystrom
let you fill your exact needs from a wide variety of instruments

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. MODEL SF-6 $19.50

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. MODEL LG-1 $48.95

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, .1 mfd, .1 mfd full scale. Not affected by hand capacity. Shpg. Wt. 7 lbs. MODEL CM-1 $29.50

HEATHKIT "IN-CIRCUIT" CAPACITOR CHECKER 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 short or "short" in the circuit. Fast and easy—to save your valuable time in the service shop or lab. Detects open capacitors from about 50 mmf up, so long as the capacitor is not shunted by excessively low resistance value. Will detect shunted capacitors up to 20 mfd (not shunted by less than 10 ohms). (Does not detect leakage.) Employs 60 cycles and 10 megohm test frequencies. Electron beam "eye" tube used as indicator. Compact, easy-to-build, and inexpensive. Test leads included. Shpg. Wt. 5 lbs. MODEL CT-1 $7.95

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, .05 mfd, 50 mfd and 1000 mfd. Also measures resistance from 100 ohms to 5 meghms in two ranges. Checks paper, mica, ceramic and electrolytic capacitors. Selection of five polarizing voltages. Shpg. Wt. 7 lbs. MODEL C-3 $19.50

HEATHKIT VISUAL-URAL 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. MODEL T-3 $21.50
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 100,000, inductance from 0.1 mh to 100 h, dissipation factor (Q) from 0.002 to 1, and storage factor (Q) from 0.1 to 1000. A 100-1000 uA meter provides for null indications. The decade resistors employed are of 1% tolerance for maximum accuracy. Completely self-contained, Has been in production, 1000-cycle generator, and vacuum-tube detector. Special two-section CRL dial insures convenient operation. Instruction manual is 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 amperes on 6 volt range or up to 7 amperes 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 milihenry, "Q" on a scale calibrated up to 250 full scale, with multipliers of 1 or 2, and capacitance from 40 mmf to 450 mmf = 3 mmf. 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, 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 filament. 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.
HEATHKIT DX-20 CW TRANSMITTER KIT
The Heathkit model DX-20 "straight-CW" transmitter features high efficiency at low cost. It uses a single 6DQ6A 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.

MODEL DX-20
$35.95

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 1625'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.

MODEL DX-100
$189.50

Heathkits...
are designed by
licensed ham-engineers,
especially for you

HEATHKIT DX-40 PHONE AND CW TRANSMITTER KIT
A most remarkable power package for the price, the new DX-40 provides both phone and CW facilities for operation on 80, 40, 20, 15, 11 and 10 meters. A single 6146 tube is used in the final amplifier stage to provide full 75 watt plate power input on CW, or control carrier modulation peaks up to 60 watts for phone operation. Modulator and power supplies are built right in and single knob bandswitching 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. A 4-position switch provides convenient selection of three different crystals or a jack for external VFO. The crystals are reached through access door at rear of cabinet. You can build this rig yourself and be proud to show it off to your fellow hams.

Get your DX-40 now for many hours of operating enjoyment. Shpg. Wt. 25 lbs.

MODEL DX-40
$64.95

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.
JANUARY, 1958
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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 reactivates the transmitter. Incorporates a heavy-duty six-ampere relay, a thyratron tube to activate the relay, and its own built-in power supply. A neon lamp shows that 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—headphone 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.
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 160 meters through 2 meters. Input and output impedances for 50 or 75 ohm 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 impedances between exciters or RF sources and grounded grid amplifiers. Power losses between transmitter 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.

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 75 or 300 ohms impedance. Design of the bifilar wound balun coils 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 5" 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.

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 application. Each unit provides 260 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 capacity, hash filter, and output filter capacitor. Shpg. Wt. 4 lbs.

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 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 hisCO 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.

Heathkits... are the answer for your electronics hobby.

Heath Company A Subsidiary of Daystrom, Inc. BENTON HARBOR 20, MICH.
JANUARY, 1958

$15.95
$19.50
$8.95
$7.95 Each

$895
$95
$1.5

www.americanradiohistory.com
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 wave form 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 setting of dwell-time percentage for the points. An important feature of this instrument is its ability to check dynamic performance, with the engine in operation (400 to 5000 RPM). It will show the complete engine cycle, or only one complete cylinder. Can be used on all types of internal combustion engines where breaker-points are accessible. Use it on automobiles, boats, aircraft engines, etc. 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 0-0.1, 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/hr 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...

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
$115.00

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 enough current from the battery to reveal its true condition. Simple to operate with "good-walk-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
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 serve 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.

MODEL CR-1 $7.95

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 5½" 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.

MODEL BR-2 $18.95

HEATHKIT TRANSISTOR PORTABLE RADIO KIT

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Steelcore Put-Ups & Prices

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Audio—High Fidelity

(Continued from page 61)

counterbalanced by a weight in the rear portion of the hollowed-out wooden arm. See Fig. 2 for a detailed view of the base, pivot assembly and counterweight.

The Weathers arm uses viscous damping on both vertical and horizontal pivots. Fig. 2 clearly shows the vertical pivot which has two washers (appearing to be nylon or Teflon) between the rotating cylinder attached to the arm and the U-bracket attached to the horizontal pivot. The space between these washers and the rotating cylinder is filled with a silicone grease which provides viscous damping in the vertical plane. Enough damping is used so that the arm's descent is always gentle, even if it is dropped in handling.

The horizontal pivot employs a cylinder of the same plastic material used in the vertical pivot. It is surrounded by the damping grease and provides a viscous drag when the arm is moved laterally. Extended use of this arm has shown that there is no appreciable tendency for the grease to leak out or lose its damping properties.

The stylus force of the Weathers arm is set at the factory by adjusting the counterweight visible in Fig. 2. Since this arm is used only with the Weathers pickup, there is no need to adjust the tracking force from its normal setting of 3 grams.

Although the Weathers arm is not balanced laterally, it has little tendency to jump grooves and is stable even when considerably off level. This is due to the stabilizing and damping properties of the viscous material in the pivot bearings.

The only height adjustment on the Weathers arm is a rubber ring of the same diameter as the base and about ¼ inch thick. If the turntable is unusually high, the ring may be installed under the arm base as a shim. Since the Weathers pickup is not unduly critical as to the angle the arm makes with the record surface, this rather crude method of height adjustment is adequate.

In the final article of this series, I will describe several arms of unconventional design, representing different approaches to the problem of reducing tracking-angle error. TO BE CONTINUED
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Here seem to be two reasons for wanting to dispense with output transformers—they cause distortion and they are the principal obstacles to reducing distortion due to other causes. Both reasons are open to discussion.

To get a little perspective on the problem, let's examine the amounts of distortion involved and where they come from. The contention that the output transformer causes distortion is somewhat out of date. Modern high-quality output transformers may run into saturation at the low-frequency end of their response. But—provided the saturation region is not encroached upon—maximum distortion caused by the transformer at the lowest operating frequency falls between 2 and 5%. Very often it is considerably less. By using operating conditions that produce a high damping factor, the effective distortion produced by the output transformer can be reduced far below this.

But, anyway, this distortion figure (2–5%) is for a frequency between 20 and 60 cycles. At middle frequencies (600 to 1,000 cycles), distortion introduced by the transformer, before feedback is employed to reduce it, is down to less than 1/10 that figure. So the maximum basic distortion a transformer is likely to produce ranges from 0.25 to 0.5% over the greater part of the audio spectrum. Compared to this, output tubes have distortion figures, over the whole of the audio range, between 2 and 5% at maximum output.

Thus it is evident that the output tubes are a greater source of distortion than the output transformer. This brings us to the second objection to output transformers—they restrict the measures that can be taken to reduce distortion. This is true.

An output transformer introduces two extra stability criteria (or should it be instability criteria?) for feedback at the high-frequency end and seriously complicates design attempts to increase feedback to reduce distortion due to output tubes. Overall feedback around an amplifier using an output transformer can seldom exceed 20 db. A few types raise the feedback to 26 db, while some employ no more than about 14 db. This means the reduction in distortion permitted in an amplifier with an output transformer is between 5 to 1 and 20 to 1. A distortion figure of 5% can be reduced to between 0.25 and 1%.

By contrast, some of the OTL's (Output TransformerLess amplifiers) use as much as 40-db feedback, which reduces distortion by a factor of 100 to 1. These are the facts; unfortunately this is not all there is to it. To get a true assessment of the relative merit of different circuits, we must consider several factors besides how much distortion the tubes give and how much feedback we can use to reduce it.

Another basic factor is cost. While some hi-fi addicts may be fortunate enough to pursue quality regardless of cost, economy has to be considered by most of us.

**Notch distortion**

Where the need is to produce a higher power output economically, tubes must be operated more efficiently. First we step from triode to pentode and finally to class-B push-pull. These steps toward better tube utilization introduce further complications into transformer design. A good, fat, output transformer that would perform very well with simple class-A push-pull operation might be pushed into service for class-B triode operation and still give passable performance. But when we use pentodes (or beam tetrodes) in class-B push-pull, or even class-AB push-pull, we run into such things as the well known notch distortion.

This should not be confused with crossover distortion, caused by over-biasing the output tubes. It sometimes occurs when maximum output is slightly exceeded, due to grid current on the positive excursion biasing the tubes further back and causing a short period during which both tubes are cut off. Waveforms of notch and crossover distortion are shown in Fig. 1.

**Fig. 1-a—Notch distortion; b—crossover distortion.**

**Fig. 2—The components in an output transformer responsible for notch distortion in class-B pentode operation.**
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load impedance for the output tubes. It is relatively easy to wind speaker voice coils with impedances of 1 to 16 or even 40 to 50 ohms but complications arise if we try to exceed 400 to 800 ohms. The wire gauge becomes extremely fine, causing difficulties in assembly.

The alternative is to find some way to reduce the load needed for the output tubes. Push-pull operation using a transformer provides parallel feed from the supply circuit to the plate (Fig. 3) but operates the two tubes effectively in series. That is, the windings of the transformer primary are basically in series rather than in parallel—from the viewpoint of audio signal—because the two audio voltages are additive.

The single-ended push-pull arrangement of operating tubes (Fig. 4) reverses this combination. Plate supply for the tubes is in series, but the audio signal action of the tubes may be regarded as in parallel. Suppose we use a couple of tubes that require a plate-to-plate load (in normal push-pull operation) of 8,000 ohms. Using the same tubes in single-ended push-pull reduces the required load to 2,000 ohms, which is a 4-to-1 improvement. If we use tubes with a plate-to-plate load requirement of 3,200 ohms, the single-ended push-pull arrangement reduces the required load to 800 ohms.

This is getting much nearer to what we really need. In the Philips amplifier (NG5200), two UL84’s are used in both positions. In normal push-pull they have a plate-to-plate nominal load of 3,500 ohms. So this arrangement reduces the optimum load to 430 ohms—a considerable improvement. As two UL84’s operated in push-pull are rated to supply 15 watts in class AB, we should expect the four-tube single-ended push-pull arrangement to deliver better than 25 watts into a speaker load of about 400 ohms. Actually this circuit has to be kept practically class A, so the Philips amplifier is rated to give only 12 watts for the four tubes.

This assumes we work the tubes as pentodes, so the supply circuit must be arranged so each tube works effectively as a pentode. Such a circuit, used by the Philips arrangement, is shown in Fig. 5. This circuit can be used with as much as 36-db feedback and Philips says that distortion is reduced to about 0.1%.

Working backward, if feedback is reducing distortion by a factor of 62 (36 db) and finishes up at 0.1%, the distortion provided by the output tubes must be about 6.2%.

The tube manual lists push-pull tubes of this type as delivering the same output with 3.5% distortion, so even operating the tubes into their correct plate load, the single-ended push-pull method of operation tends to cause about twice as much distortion as the normal push-pull method before feedback is applied.

Unequal drive

At this point another fact should be linked in because it is closely related to the distortion-producing properties of the single-ended push-pull output circuit. Output grid tubes require very unequal drive for single-ended push-pull. Assume that the voltage across each tube is 200 (using a 400-volt supply) and that the

alternating voltage at maximum output is 150 (peak), which requires an output grid swing of 20 volts peak. On the lower tube the required grid swing is 20 volts each way, while on the upper tube it is 20 volts for the grid, plus a 150-volt plate–cathode swing at the output. So we require a phase-splitting arrangement that delivers 20 volts to the lower grid and 170 to the upper grid. This is not all...

We have considered ideal conditions where the output load is a pure resistance, so the voltage for a given grid swing comes out accurately according to calculations. Assume we use a speaker load. (Is this unusual in a hi-fi system?) Then the output voltage will not be the same as that with a resistance load, but will differ in two ways. There will be a degree of phase shift in the drive to the two grids due to the reactance load and the voltages will be different. Suppose we continue to drive the upper tube with 170 and the lower tube with 20 volts on its grid. Now, when the output voltage is, say, 200 volts, at a phase angle considerably different from that on the grid of the upper tube, we may end up with the upper tube getting a total swing of 100 volts or more. Yet the lower tube is still getting the same 20 volts.

The lower tube will continue delivering its proportion of the power, relatively undistorted, while the upper tube will run into all kinds of distortion. Of course, the presence of overall feedback in bucket loads will cut down the input and minimize this distortion. The actual effect of loading on this type circuit depends on whether the output tubes are triodes, as in the Stephens amplifier and basic Peterson-Sinclair circuit (Fig. 6) or pentodes operated as triodes or whether they are pentodes, as in the modified Peterson-Sinclair circuit, as used in the National Horizon amplifier (Fig. 7).

With triode tubes, the difference in voltage output due to different loadings is not so large, but with pentodes the voltage change is almost in direct proportion to the load impedance and consequently the difference can be serious. A number of circuits, such as the Futterman (Fig. 8) and the Coulter (Fig. 9), use feedback arrangements to compensate the drives to the two tubes. Now, each one continues to deliver a corresponding proportion of the total load.

Some single-ended circuits

The Futterman circuit can be understood by regarding the drive stage as the normal split-load pentode inverter-—equal halves—which feeds each output stage with a signal from plate to grid instead of the more normal cathode to grid. In the Coulter circuit the upper tube is fed directly while an inverter is used for the lower tube. The inverter has two inputs, one at the grid, adjusted for balance with normal output loading, and one in the cathode to compensate for different loading effects.

The Stephens circuit is quoted as having 0.4% distortion with 40-db feedback. This sounds very good until we realize the implication that without the feedback distortion would be 40%. If...
full correction over a wide range of different impedances. Consequently, the distortion obtained under practical conditions is still considerably larger than with the corresponding push-pull arrangement.

With push-pull operation the modification due to incorrect loading is symmetrical between the two tubes. Therefore, the tendency is not for one tube to provide all the output while the other one provides all the distortion. With a normal pentode type output using overall negative feedback, a higher-than-correct value of load impedance results in increased voltage feedback, which cuts down grid drive, so the output voltage is very little more than it would be into the correct load. True, the distortion does rise slightly since the tube is not operated under quite such linear conditions. But neither of the tubes operates into a saturation region and causes excessive distortion, which is what can easily happen with the single-ended push-pull arrangement.

All this trouble to get rid of an output transformer seems to be due to the desire to use a large amount of feedback to minimize distortion, which we can more easily avoid by using a circuit that does not distort too readily in the first place.

Class-AB or class-B pentode operation produces notch distortion. Working the tubes as triodes avoids notch distortion, but drops the efficiency-power output for given tubes way down. Using an intermediate condition, like Ultra-Linear, has its problems, because it involves extremely tight coupling arrangements between each plate and the corresponding screen. Otherwise we get a much-amplified version of the notch-distortion problem, with little parasitic oscillations appearing at all kinds of odd points on the waveform. This means that Ultra-Linear operation requires extremely careful attention to the output transformer design.

### Unity-coupled circuit

Another form of operation that takes full advantage of the pentode method of working with tubes is the unity-coupled circuit (Fig. 10). It puts half the load on each tube in its cathode circuit and the other half in the plate circuit. The tubes can be operated in class B and still maintain good output, provided coupling between the cathode and the screen section of the winding is extreme. Each tube then operates truly as a pentode and so full degeneration due to cathode coupling is achieved. This eliminates the notch distortion of class-B-operated pentodes because the relative impedance of the respective windings in the tube circuit is divided by four and the cathode's degeneration reduces the effective source resistance presented by the tube to a fraction of the load resistance. Consequently, any tendency to produce notch distortion is reduced to a small fraction of triode-coupled output circuits, which never produce notches unless a very poor transformer is used. This circuit uses the output tubes as pentodes to make maximum power available.

The McIntosh method of achieving the necessary tightness of coupling consists of bilobar winding of the transformer's primaries. There is only one disadvantage to this and that is the increased cost of the transformer. McIntosh's solution is to make the transformers under the same roof as the amplifiers and in an integrated production line. As the company makes only bilobar-wound output transformers, they have the facilities for doing so at a lower cost than a regular transformer manufacturer could. They also eliminate the middle handling cost that occurs in most other types of transformer output amplifiers. Although this method of producing a transformer is normally not an economic proposition, their particular application produces a unit that is competitive with many other am-
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Fig. 11—Basic circuit of the Circlotron amplifier requires two floating high-voltage supplies.

That is most of the story on OTL vs transformer outputs. Maybe the OTL, with special tube types, has an edge costwise (which is not the usual reason for the choice) but a good transformer output, of which we have several, still holds the lead for quality. But the last chapter has not yet been written. Transistors are slowly but surely creeping into the picture. Here too we meet the no-transformer advocates. Transistors are a natural for matching voice coil impedances without transformers. But a lot more work must be done, in developing both transistors and circuits, before such a clear picture emerges as we now have with tubes.

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Comparable to the best in Hi-Fi—at far less cost! Deluxe features include: Linear-deluxe Williamson-type circuit for flawless response; equalization for all records within ½ db of recommended accuracy; 2 exclusive new printed circuit switches in preamp section (no complex wiring to do); 3 printed circuit boards for time-saving, error-free assembly; separate, continuously variable Level and Loudness controls; use of premium 12AY7 tube for low noise and hum; DC on all filaments of preamp tubes; exclusive A-AB-B speaker selector switch (use speakers of mixed impedances without mismatch). 8 inputs: Tape Head direct; G.E. and Pickering cartridges; Ceramic cartridge; Microphone; Auxiliary; Tape Preamp; Tuner (with separate Level Set control). Power amplifier response, ± ½ db, 15-100,000 cps at full 30 watt level; distortion—harmonic, 0.55% at 30 watts—1M, 0.74% at 20 watts. Separate Bass and Treble controls; rumble filter switch; variable damping. Output, 8 and 16 ohms. With smart French-gray cabinet, 4 x 15 x 15". Ready for easy, money-saving assembly. Shpg. wt., 32 lbs.

Model Y-752. 30-Watt Hi-Fi Amplifier Kit. Net only. $76.95

Here is top value in creative engineering, impressive hi-fi performance and distinctive design—a tuner you’ll be proud to build and own. Covers the full FM band, 88 to 108 mc. Features Automatic Frequency Control (with disabling feature) to “lock-in” stations and prevent drift; Inertia Flywheel Tuning for velvet-smooth, accurate station selection; pre-adjusted RF coils; pre-aligned IF's; cascode broad-band RF amplifier; drift-compensated oscillator; neon bulb pointer. All critical wiring is already done for you in the form of a printed circuit board—assembly is simple. Sensitivity is 4 microvolts for 20 db of quieting across entire band; output, 2 volts at 1000 microvolts input; IF bandwidth, 200 kc; response, 20-20,000 cps. with only 0.6% distortion. Output jacks for amplifier and tape recorder; cathode follower output. Ideal for use with the K-NIGHT amplifier, or any amplifier with phono-tuner switch. Features custom-styled case in French-gray, with tapered chrome-finished feet, 4 x 13 x 8". Includes all parts, tubes and step-by-step instructions for easy assembly. Shpg. wt., 12 lbs.

Model Y-751. Hi-Fi FM Tuner Kit. Net only. $38.95

**knight-kit Deluxe 3-Way Speaker System Kit**

Model Y-937

- Pre-Finished “Quik-Craft” Corner Enclosure
- Klipsch Designed and Licensed
- Famous Knight 12’ 3-Way Speaker
- Easy to Assemble—Top Hi-Fi Quality
- Choice of Enclosure Finishes

Deluxe quality high fidelity speaker system at a money-saving low price. Easy to assemble—all you need is a screwdriver. System includes knight “Quik-Craft” corner-type folded-horn enclosure kit, and the famous-value knight 3-Way 12-inch speaker. Just assemble the enclosure—no finishing required—all surfaces are finished in hand-rubbed Korina blonde, mahogany or walnut. The speaker is the new 3-way type: 12’ woofer cone for bass (full 154 pound woofer magnet); conical radiator for mid-frequencies, built-in compression-type tweeter (with wired level control and calibrated dial) for highest frequencies. Unexcelled enclosure efficiency and superb speaker performance combine to cover the whole spectrum of audible sound for true hi-fi response from 35 to 15,000 cps, ± 3 db. Kit includes 12’ 3-Way speaker, prefinished enclosure panels, grille cloth, hardware and instructions. Specify Korina blonde, mahogany or walnut when ordering. Shpg. wt., 44 lbs.

Model Y-937. 3-Way Speaker System Kit. Net only. $89.50

**knight-kit 10-Watt Hi-Fi Amplifier Kit**

Y-753

$23.50 Low-cost, authentic hi-fi amplifier. Response, ± 1 db, 20,000 cps. Input for crystal phono or tuner; chrome-plated chassis is punched for preamp kit below, to permit use of magnetic phone. Only 0.3 volt drives amplifier to full output. Separate bass and treble controls. Only 1% harmonic distortion. Matches 8-ohm speaker, 7 x 13 x 6". With all parts, tubes and instructions. Shpg. wt., 13 lbs.

Model Y-753. Net only. $23.50

Y-235. Preamp Kit. $ 3.10

Y-757. Metal Cover. $ 3.95
Sensational Hi-Fi design at amazing low cost. Provides precise record equalization guaranteed within 1/2 db of recommended accuracy—more accurate than all but the most expensive factory-built preamps. Includes exclusive new KNIGHT-KIT printed circuit switches for easy, error-free assembly; 2 printed circuit boards eliminate all other wiring, except for power supply and control leads—so easy to build. Has built-in power supply; includes premium 12A7 and ECC82 tubes. Frequency response, ± 0.5 db, 10-50,000 cps. Has 8 inputs: Tape Head; G.E. Phone; Pickering Phone; Ceramic; Microphone; Auxiliary; Tape Preamp; Tuner. Level adjustment for tuner input. Includes separate Bass and Treble controls; separate Level and Loudness controls; Rumble Filter switch; DC on all tube filaments; cathode follower output; 2 extra AC outlets. You get every advanced hi-fi feature in this easy-to-build preamplifier at the lowest possible cost. Includes beautiful custom-styled French-gray case, with tapered chrome-finished legs, 4 x 13 x 8". With all parts, tubes, step-by-step instructions; ready for easy assembly. Shpg. wt., 12 lbs. Model Y-754. Hi-Fi Preamplifier Kit. Net only $39.95

Here's superb Hi-Fi performance at less than half the cost of a comparable commercially-assembled unit. Williamson-type linear-deluxe circuit delivers over 25 watts of virtually undistorted reproduction. Ideal for use with the KNIGHT-KIT preamp at left. Includes printed circuit board for simplified, error-free assembly. Remarkable hi-fi response, ± 0.5 db, 10-120,000 cps at 20 watts. Harmonic distortion, 0.15% at 30 watts; 0.4% at 20 watts. Hum level, 85 db below 25 watts output. Output impedances, 4, 8 and 16 ohms; output tubes, 2-5881. Includes balance control for precise matching of the output tubes; variable damping control for maximum performance with any speaker system—prevents low-frequency distortion from overdamping or underdamping. Very attractive black and chrome styling, 8 1/4 x 14 x 9". An outstanding engineering achievement in a basic hi-fi amplifier, delivering performance equal to the finest commercially-assembled units. Includes all parts and tubes; with step-by-step instructions, ready for easy assembly. Shpg. wt., 25 lbs. Model Y-755. 25-Watt Amplifier Kit. Net only $44.50

BIG SAVINGS—assemble your own quality KNIGHT-KIT 2-way speaker system—it's quick and easy! The cabinet is pre-finished in full-grained, high luster blonde or mahogany—you just assemble 7 pieces, mount the speaker components and enjoy rich, thrilling hi-fi sound—at incomparably low cost. Special Jensen-engineered baffle features "ducted port" construction to bring out the full beauty of bass notes, perfectly matching the Jensen woofer and compression tweeter; genuine L-pad control is rear-mounted to permit adjustment of tweeter for best tonal balance. Impedance, 16 ohms. The assembled unit delivers a frequency response of 45 to 14,000 cps. Enclosure measures 28 x 19 x 14". Beautifully styled to blend in any room. Kit includes Jensen 12" woofer, Jensen compression-type tweeter, prefinished wood parts (with grille cloth installed), acoustic material, glue, hardware and step-by-step instructions. Absolutely no furniture finishing required. Specify blonde or mahogany finish when ordering. Shpg. wt., 33 lbs. Model Y-759. 2-Way Speaker System Kit. Net only $49.95

knight-kit Hi-Fi is available on easy terms to fit your budget
Fascinating ALLIED knight-kits FOR EXPERIMENTERS AND HOBBYISTS

**knight-kit 2-Transistor Pocket Radio Receiver Kit**

Model Y-262
- Loud, Clear Local Reception
- Newest Printed Circuit Board
- Complete Kit—Nothing Else to Buy

It's fun to build this pocket-size two-transistor radio—and you'll enjoy its crystal-clear local broadcast reception wherever you go! Fits in your pocket, or with its button-down flap, can be worn from your belt. Completely self-contained with built-in ferrite loopstick antenna—no external antenna needed. Extremely efficient reflex type 2-transistor circuit actually does the work of 3 transistors! Printed circuit board reduces building time to about one hour. Has one-diode variable capacitor for easy, accurate station tuning. Operates for months and months on long-life alkaline battery supplied. Sensitive miniature earpiece provides crystal-clear tone. Handsome tan carrying case, plastic-impregnated, is styled to resemble leather; only 4 x 3½ x 1½". Kit includes all parts, transistors, earpiece, battery and case. Shpg. wt., 1½ lbs.

Model Y-262. Not only $14.65

**knight-kit "Trans-Midge" Transistor Receiver Kit**

Model Y-767
- Tiny, cigarette-pack-size one-transistor radio kit—fascinating to build—so low-priced. This novel miniature receiver will provide endless listening pleasure the moment assembly is completed. Covers the local AM broadcast band with exceptional sensitivity and selectivity. Special features include: Efficient, slug-tuned coil for excellent station separation; external knob for easy station tuning; low-drain transistor operating for months from single penlight cell supplied; hinged-back, red plastic case. Kit includes all parts, transistor, battery, compact case and easy-to-follow instructions for quick assembly. (External antenna and headphones required.)

Shpg. wt., 8 oz.

Model Y-767. Not only $2.45

149. 4000 Ohm Headphones. 1 lb. $2.15

C-100. Antenna Kit, 1½ lbs. $1.03

**knight-kit 5-Transistor Superhet Personal Portable Radio Kit**

Model Y-766
- Sturdy to Equal the Finest
- Push-Pull Audio Drives 3½" Speaker
- Printed Circuit for Easy Building
- 200 Hour Battery Playing Life

Beautiful, easy-to-build transistorized personal portable with every ultra-modern design feature: 5 Texas Instrument Co. transistors; latest printed circuit chassis for easy, error-free assembly; bigger-than-average 3½" speaker; class B push-pull audio output; built-in high-gain ferrite loopstick antenna; plus phone jack output for private listening. Provides sensitive reception of the AM broadcast band with exceptional tone quality. Ultra-smart high-impact ivory plastic case has handsome gold trim with ebony accents; includes pull-out handle; only 7¾ x 3½ x 1¼". With all parts, transistors, 9 volt transistor radio battery, carrying case and instructions anyone can easily follow. Shpg. wt., 2 lbs.

Model Y-766. Not only $29.95

**knight-kit 10-Circuit Transistor Lab Kit**

Model Y-299
- Sensational experimenters' transistor kit—an electronic marvel! Perfect for experimenter, student or hobbyist. Assemble basic parts once, then complete project after project (10 in all), by simply plugging leads into proper jacks on printed circuit board—no wiring changes needed. You learn how transistors operate by "plugging in" to make any one of the following circuits: AM radio for strong headphone reception; 2-stage audio amplifier; wireless broadcaster; code practice oscillator; electronic timer; electronic switch; electronic flasher; photoelectric relay; voice-operated relay; capacity-operated relay. Includes all parts, 2 transistors, battery, headphones, circuit leads, relay, photocell, special guide cards for each project, explanation of each circuit. 3 lbs.

Model Y-299. Not only $15.75

**1-Transistor Radio Kit**

Model Y-765

Model Y-765. Not only $3.95

**Wireless Broadcast Kit**

Model Y-705
- Play music or make announcements through your radio set—no connection to set required! Lots of fun—easy to build. Works up to 50 feet from set. Shpg. wt., 3 lbs.

Model Y-705. Not only $9.50

**Crystal Set Hobby Kit**

Model Y-261
- Entertaining, educational. Delivers clear headphone reception of local broadcast stations. With all parts, ready for easy assembly. (Antennas and headphones required.) Shpg. wt., 1 lb.

Model Y-261. Not only $2.15

**"10-In-One" Electronic Lab Kit**

Model Y-265
- Famous experimenters' kit. Builds any of 10 fascinating projects, including broadcast receiver, wireless phone oscillator, code practice oscillator, signal tracer, relay, etc. Shpg. wt., 5 lbs.

Model Y-265. Not only $12.65

**"6-In-One" Electronic Lab Kit**

Model Y-770
- A favorite with beginners. After basic wiring is completed, you make circuit changes without soldering. Builds any of six favorite projects, including radio, wireless broadcaster, etc. Shpg. wt., 3 lbs.

Model Y-770. Not only $8.45

ORDER FROM ALLIED RADIO 100 N. WESTERN AVE. • CHICAGO 80, ILL
**Fun to Build...Instructive...Latest Circuits for Top Performance**

**Widest Choice of Quality Hobbyist Kits**

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**Knight-kit Photoelectronic Relay Kit**

**Model Y-702**

- $13.50
- Advanced-design, ultra-sensitive photoelectronic relay—build it yourself and save! Dosen of uses: for automatic control of lights, door annunciator, burglar alarm, counting devices, etc. Provides dependable operation up to 250 feet with white light, up to 125 feet with “museum” light (red filter) from Light Source Kit listed below. Selectable operation, with “trip” for burglar alarm to provide continuous ringing of alarm; and “auto” if relay is to operate each time beam is broken (for counters, counting devices, turning on lights at darkness). Has SPST relay operated from thyatron; 6.3 v. terminals provide power for circuitry. For 105-120 v. 50-60 cy. AC use. 6 lbs.

**Model Y-702, Relay Kit. Not only...$13.50**


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**Knight-kit “Ocean Hopper” All-Wave Radio Kit**

**Model Y-740**

- $11.95
- This top-performing regenerative receiver puts a world of listening pleasure at your fingertips. Tuning range (using coils listed below) is virtually world-wide, covering 105 ke to 35 mc. including every type of radio transmission: AM broadcast, marine, aircraft, distress channels, direction-finding, Amateur, frequency standard, foreign broadcast, and police. With broadcast-tune. For use with headphones or 3-4 ohm PM speaker. Kit is supplied with standard broadcast band coil and all tubes and parts. (Less extra coils, headphones, speaker and cabinet.) Shpg. wt., 5 lbs.

**Model Y-740, Not only...$11.95**

- Y-746, Cabinet for above $6.50. Net $2.90
- Extra coils available: Long Wave Coil (155-470 kc), Net 79c. Short Wave (1.65-4.1 me; 2.9-7.3 me; 7-17.5 me and 15.5-35 me). Each 65c.

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**Knight-kit “Space-Spanner” Bandswitching World-Wide Radio Kit**

**Model Y-243**

- $15.95
- Broadcasting...Short Wave Reception
- Sensitve Regenerative Circuit
- Convenient Bandspread Tuning
- Built-In Loudspeaker

Imagine the thrill of hearing overseas broadcasts on a precision receiver you’ve built yourself—and then, at the flip of a switch, being able to tune to your favorite local broadcast station! Bandswitch selects exciting short wave, including foreign broadcasts, amateur calls, aircraft, police and marine radio on the 6.5 to 17 mc range, as well as standard 440-1700 kc broadcasts. Features highly sensitive regenerative circuit. Includes built-in 4” PM speaker and beam-power tube for strong volume and clear tone. Headphone connectors are available for private listening; switch cuts out speaker. Controls: Bandspread, Main Tuning, Antenna Trimmer, Bandswitch, Regeneration, Volume. Y-246. Easy to build from step-by-step instruction manual. For 110-120 v., 50-60 cy. AC or DC. (Less cabinets.) Shpg. wt., 5 lbs.

**Model Y-243, Not only...$15.95**

- Y-247, Cabinet for above. Shpg. wt. 2 lbs. Net $2.90

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**Knight-kit 2-Way Intercom System Kit**

**Model Y-295**

- $14.75
- Low Cost—Easy to Assemble
- High Gain—Clear Tone
- Handsome Metal Cabinets
- Includes 50-Foot Cable

Easy to build at lowest cost—ideal for home, office, shop or school. Consists of Master unit and Remote unit. Remote unit may be left “open” for answering calls from a distance, for “baby sitting”, etc. Remote also may be set for “private operation” cannot be “listened-in on”, but it can be called and can originate calls. Master unit includes high-gain 2-stage amplifier, combination volume control and on-off switch, pilot light. Each unit has 4” PM dynamic speaker. System responds to a whisper. Handsome Antique white cabinets, each 4½ x 6½ x 4¼”. With all parts, tubes and 50-ft. cable (up to 200-ft. may be added). For 110-120 v., AC or DC. 8 lbs.

**Model Y-295, Master and one Remote. Not only...$14.75**

- Y-296, Extra Remote Station Kit. 3 lbs. $3.75

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**Phono Amplifier Kit**

- $9.45
- Build it yourself—and save! Ideal for use in a portable phonograph—just add record player and 3-4 ohm speaker. 1½ watt output. Inverse feedback circuit. Easy to assemble. Shpg. wt., 3 lbs.

**Model Y-790, Not only...$9.45**

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**Electronic Photoflash Kit**

- $28.50
- Ideal for color or black and white photography. 1/700th-of-a-second flash, 50 watt-second output. Synchronizes with any camera with X or O shutter. (Less battery.) Shpg. wt., 4 lbs.

**Model Y-244, Not only...$28.50**

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**Code Practice Oscillator Kit**

- $3.95

**Model Y-239, Not only...$3.95**

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**Phono Oscillator Kit**

- $5.85
- "Broadcasts" recorded music through any standard radio set up to 30 watts. No direct connection to set required. Easy to build—fun to use. Shpg. wt. 2 lbs.

**Model Y-760, Not only...$5.85**

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**Finest Electronic Equipment in Easy-to-Build Money-Saving Kit Form**
### knight-kit Low-Cost Tube Tester Kit

**Model Y-143**
- With 16 Filament Voltages
- 600 Latest Tube Types Listed
- Easy-to-Read 4½" Meter
- Tests Series-String TV Tubes

**$29.75**

Expertly designed for complete, up-to-date coverage of tube types. Tests series-string TV tubes; tests 4, 5, 6 and 7 pin large, regular and miniature types, tubes, tubes, 9-pin miniatures and pilot lamps. Tests for open, short, leakage, heater continuity and performance (by amount of cathode emission). Big 4½" square meter has clear "GOOD-7-REPLACE" scale. With line-voltage indicator and line-adjust control. Choice of 16 filament voltages from 0.63 to 117 volts to check virtually all receiving tubes; blank socket for future type tubes. Universal-type selector switches permit selection of any combination of pin connections. Single-unit, pre-assembled-10-level function switch simplifies and speeds assembly. Up-to-date illuminated roll chart lists over 550 tube types. Counter in case, 5 x 14 x 10". Easy to build, 14 lbs.

**Model Y-143. Net only**
**$29.75**

**Y-142. Portable Case model. 15 lbs. Net**
**$34.75**

**Y-141. Picture Tube Adapter. 1 lb. Net**
**$4.25**

### knight-kit RF Signal Generator Kit

**Model Y-145**
- Build this wide-range, extremely stable RF signal generator—save two-thirds the cost of a comparable wired instrument! Large, semi-circular dial is clearly calibrated; range is covered in 5 separate bands for close accuracy in setting individual frequencies. Ideal for aligning RF and IF stages in radio and TV sets and for troubleshooting audio equipment. Delivers output on fundamentals from 160 kc all the way out to 170 mc; useful harmonics to 224 mc. Has built-in 400-cycle sine-wave audio oscillator for modulating RF; audio is also available externally. Features high-stability Colpits circuit. Convenient jack for external modulation. Maximum audio output 2000 volts; RF output 1 volt on all ranges. Step and continuous-type attenuator controls. Supplied with precision wound coils that require no adjustment.

**$19.75**

### knight-kit Vacuum Tube Voltmeter Kit

**Model Y-125**
- 200 mV Movement, 4½" Meter
- Includes AC, Peak-to-Peak
- Balanced-Bridge, Push-Pull Circuit
- 1% Film-Type Resistors

Top buy in extremely stable, highly accurate VTVM. Easy to assemble—entire chassis is printed circuit board. Perfect for radio-TV service work, lab and Amateur use. Features low-leakage type switches; 1% film-type precision resistors; balanced-bridge, push-pull circuit (switch to any range without readjusting zero set); zero center scale and direct-reading db scale; polarity reversing switch. Ranges: Input Resistance, 11 meg; DC and AC mains, 0-15-50-150-300-1000; AC Peak-to-Peak, 0-4-14-40-140-1400-10000; Response, 30 cycles to 3 mc; Ohms, 0-1000-10K-100K and 0-10-100-1000 meg; db -10 to +5. Includes all parts, tubes, battery, test leads and portable case, 7½ x 5½ x 4½". Easy to assemble, Shpg. wt., 6 lbs.

**Model Y-125. Net only**
**$24.95**

**Y-126. Hi Voltage Probe; extends DC to 80,000 v.**
**$4.75**

**Y-127. Hi-Frequency Probe; extends AC to 250 mc.**
**$3.45**

### 6V-12V Battery Eliminator Kit

**$32.95**

High current rating; continuously variable filtered output; delivers 18 amps at 6 volts, 10 amp at 12 volts. May be used as battery charger. Two meters provide simultaneous current and voltage readings. Shpg. wt., 18 lbs.

**Model Y-129. Net only**
**$32.95**

### Capacitor Checker Kit

**$12.50**

Tests capacitors whithin the circuit! Has widest range—20 muf to 2000 mfd. Exclusive circuit for cancelling lead capacitance. "Magic Eye" indicator. Saves 60% over factory-wired units. 5 lbs.

**Model Y-119. Net only**
**$12.50**

### Sweep Generator Kit

**$43.75**

Extreme linearity on a par with costly lab instruments, fundamentals to 250 mc; output flat within 1 db; electronic blanking. Easy, money-saving assembly. Shpg. wt., 16 lbs.

**Model Y-123. Net only**
**$43.75**
ADVANCED-DESIGN INSTRUMENTS FOR SERVICE, INDUSTRIAL AND RESEARCH USE IN EASIEST-TO-BUILD, MONEY-SAVING KIT FORM

Knight-kit 20,000 Ohms/Volt VOM Kit
Model Y-140 Outstanding quality and performance at money-saving low price. Features 1% precision multipliers; 4½" meter accurate within 2% of full scale deflection; 50 microamp sensitivity for 20,000 ohms/volt input resistance on DC; front panel "Zero adjust"; single switch to select function and range. 32 ranges: AC, DC and output volts, 0-2.5-5-10-25-100-500-2500-10000-50000; Resistance, 0-20000, 20000 ohms and 0-2000 microamps; DC ma, 0-0.1-1-10-100; DC amps, 0-0.1-0.1-0.1-0.1-0.1-1.0-10.0. Moisture-resistant film-type resistors for extreme accuracy. Carefully engineered circuit design achieves high sensitivity and extremely versatile application. Kit includes all parts, battery, test leads and black bakelite case with highly legible white markings: size 6½" x 4½" x 3½". Easy to assemble. Shpg. wt., 5 lbs. Model Y-140. Net only ............ $29.50

Knight-kit High-Gain Signal Tracer Kit
Model Y-135 A remarkable value in an easy-to-build instrument which permits visual and aural signal tracing of RF, IF, video and audio circuits. Has highest gain in its price class. Traces signal from antenna to speaker. Reproduces signal at plate or grid connection of any stage. Identifies and isolates "dead" stages. Features: usable gain of 0.1,000; "magic eye" with calibrated attenuators for signal presence indication and stage-by-stage gain measurements; built-in 4" PM speaker; combination Z-position probe, one for RF (6 mmf. input), the other for audio. Provides noise test: built-in watt-meter calibrated from 25 to 1000 watts; provision for external scope or VTM. Binding posts provide output transformer and speaker substitution test, plus external 280 volts B+. With all parts, tubes and probe, 7½x5½" 12 lbs. Model Y-135. Net only ............ $26.50

Knight-kit 5" General-Purpose Scope Kit
Model Y-146
- Phantastron Linear Sweep
- 25 mv/inch Sensitivity
- Printed Circuit Board
- Retrace Blanking Circuit
- Voltage Calibrator Kit
- Resistance Substitution Box
- Capacitance Substitution Box
- Audio Generator Kit
- R/C Tester Kit

$42.00

Only $4.20 down Feature for feature the world's best oscilloscope kit value. A stand-out in its class with all these fine features: Phantastron circuit wiring and laced harness for quick, error-free assembly. Phantastron Sweep Circuit for high linearity of sweep from 15 to 150,000 cps. 85 Millivolts Per Inch Sensitivity —3 times that of similarly priced scope kits. Calibration Voltage—1 volt peak-to-peak square wave, fully regulated. Vertical Amplifier—frequency response ± 3 db, 3 cps to 1.5 mc (± 6 db to 2.5 mc). Includes: Directly coupled positioning controls; retrace blanking circuit; extremely-compensated vertical input attenuator; positive and negative internal sync; high 2-anode voltage for high-intensity trace; input capacity, 45 mmf. Kit includes CRT. 9½ x 13¼ x 17¼". 26 lbs. Model Y-146. Net only .......... $42.00

Voltage Calibrator Kit
Model Y-136 Net only .......... $12.75

Resistance Substitution Box
Model Y-139 Net only .......... $5.95

Capacitance Substitution Box
Model Y-138 Net only .......... $5.95

Audio Generator Kit
Model Y-137 Net only .......... $31.50

R/C Tester Kit
Model Y-124 Net only .......... $19.50

EASY TERMS AVAILABLE
Take advantage of the most liberal Easy Pay plan in electronics. On Knight-Kit orders totaling $45 or more—just 10% down; small monthly payments thereafter. Low carrying charges—no "red tape."
A sensational communications receiver value with all the selectivity, sensitivity and features of high-priced commercial units. Uses printed circuitry throughout, including the exclusive new KNIGHT-KIT printed circuit bandswitch, for remarkably easy assembly. Covers 540 kc to 31 mc in 4 ranges; calibrated, electrical bandspread on 80-10 meter Ham bands; slug-tuned Hi-Q coils; continuous, VR tube-regulated B+ applied to HF oscillator; lets you switch from standby to receive with no drift; built-in Q-multiplier peaks desired signal or nulls interference; delayed AVC; provision for crystal calibrator (below). Sensitivity, 1.5 microvolts for 10 db signal-to-noise ratio. Selectivity: variable from 300 c/s to 4,500 c/s at 6 db down. Exalted BFO injection. Controls: Main tuning, bandspread, band selector, Q-multiplier selectivity, VFO-tune, null-off-peak, BFO pitch, RF gain, AF gain, BFO-MVC-AVC-ANL, off-stby-rec-cal, antenna trimmer, and phone jack. Cold-rolled steel chassis. Handsome metal cabinet, 19 x 10 x 10-1/4". (Less phones, 8-ohm loudspeaker and S-meter.) 25 lbs.

Model Y-726. Amateur Receiver Kit. Net............ $104.50

knighit-kits FOR THE RADIO AMATEUR

knighit-kit All-Band Amateur Receiver Kit
Model Y-255
- Ideal for the Novice
- PI Antenna Coupler
- Bandswitching—80 to 10 Meters

$38.95

There's exceptional value in this very popular bandswitching transmitter kit. Compact and versatile, it's the perfect low-power rig for the beginning novice as well as the seasoned veteran. Has bandswitching coverage of 80, 40, 20, 15 and 10 meters. Rated at 50 watts—actually operates at up to 60 watts on 80 and 40 meters. Oscillator is efficient 6AG7, final 807. Crisp, clean cathode keying of oscillator and final. Built-in pi coupler permits use with random length antennas. Has highly effective TVI suppression. Other features not usually found in transmitter kits at this low price include: Ceramic-insulated final tank capacitor; pre-assembled switches; pre-wound parasitic chokes; ceramic coil forms; coax connector. Ready to addictive equipment. Meter reads either plate or grid current of final. Takes crystal or VFO without circuit changes. Cabinet interior and chassis are copper-enameled. Size, 8½ x 10½ x 8½". With tubes and all parts for easy assembly. (Less crystal and key.) Shpg. wt., 19 lbs. Net only ............... $38.95

Model Y-255. 50-Watt Transmitter Kit. Net only ............... $38.95

knighit-kit Self-Powered VFO Kit

Model Y-725

$28.50

Complete with built-in power supply! Careful design and voltage regulation assures high stability. Excellent oscillator keying characteristics for fast break-in without clicks or chirps. Full TVI suppression. Has plenty of bandspread, separate calibrated scales for 80, 40, 20, 15, 11 and 10 meters; vernier drive mechanism. 2-chassis construction keeps heat from frequency determining circuits. Output cable plugs into crystal socket of transmitter. Output: 40v on 80, 20v on 40. With Spot-Off-Transmit switch for spot frequency tuning. Extra switch contacts for operating relays and other equipment. Attractive metal cabinet, 8½ x 6 x 6". Ready for easy assembly. Shpg. wt., 8 lbs. Net only ............... $28.50

Model Y-725. VFO Kit. Net only ............... $28.50

knighit-kit Amateur RF "Z" Bridge Kit

Model Y-253

$5.85

Measures standing wave ratio (SWR) and impedance of antenna systems; ideal for adjusting antenna systems for optimum results. Measures impedances from 20 to 400 ohms up to 100 mc; SWR to 150 mc. Any VOM may be used for null indicator. With coax input and output connectors. Meters both input and bridge voltage. Calibrated dial gives true and accurate readings; includes 1% precision resistor for precise calibration adjustment. With all parts and handy plasticized SWR chart (less meter). 2½ x 3 x 4½". Shpg. wt., 1½ lbs. Net only ............... $5.85

Model Y-253. "Z" Bridge Kit. Net only ............... $5.85

ORDER BLANK

ALLIED RADIO
100 N. WESTERN AVE., CHICAGO 80, ILL.

ALLIED RADIO, Dept. PF, 100 N. Western Ave., Chicago 80, III.
Ship me the following KNIGHT-KITS:

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Part 1—How transistor sets differ from the familiar tube circuit; a detailed look at rf, mixer, oscillator and if stages

By JACK DARR

The experienced technician will not run into many problems in servicing transistor auto radios, aside from the difficulties common in all auto-radio work. Of course, a bench power supply with good regulation and filtering, is a must. I use a pair of standard 6-volt storage batteries, with a small trickle charger and a switch to select either 6 or 12 volts for the set being serviced. This gives almost perfect voltage regulation. (Except for the times I forget to add water to the batteries!)

An ac-powered battery-eliminator supply can be used, if it has good regulation and a very low hum level. The voltage should be adjustable over a fairly wide range as there is a wide variation in the current demand, especially in signal-seeking tuner sets. On tube sets, the current used by the solenoid, tuner mechanism, etc., represents only a small part of the 10 amps or so drawn by the set. With the much-lower-drain transistor sets, if the voltage is set for the small drain, 2 amps or so, the added drain of the tuner may cause an excessive voltage drop unless the power supply has excellent regulation. Delco recommends setting the bench power supply to 16 volts when testing automatic tuner type sets to avoid binding of the solenoid or better still, floating a 12-volt battery across the line to improve regulation.

When bench-testing the hybrid sets using low-voltage tubes or sets using these tubes throughout, excessive hum in the power supply can cause trouble. Floating a battery across the power supply eliminates this difficulty by smoothing out variations in voltage.

All-transistor sets tend to be quite compact. Set designers have taken advantage of transistors to reduce the size of the cases. However, heat-radiating fins and power transistors take up some room, although the whole thing is still quite a bit smaller than a tube set. Many recent sets are removed from the front, coming out through the dash, rather than the old familiar down-and-back method. One precaution should be observed, however. Because there is a voltage on the case of the power transistor, the set should never be removed from the dash before disconnecting the power leads, or with the power on. If the transistor’s case is shorted to ground during removal, the transistor may be damaged. Also, when replacing the set after servicing, be sure that the choke cable, speedometer shafts and other bare metal objects under the dash are cleared away from the transistor’s case to prevent grounding it.

While the familiar vibrator buzz is gone, there are still a few indications that make for convenience in the car tests. Even in the hybrid sets, using transistors only in the output stages, there will be a slight thump in the speaker when the switch is turned on. These sets require the normal warmup time, 30-60 seconds, while all-transistor sets will begin to play almost immediately. Otherwise, diagnosis and testing in the car is exactly the same as with older sets.

Noise problems

The same assortment of noises that plagued the old sets will cause the same troubles in the newer ones. One additional headache may cause trouble. With tube sets using low-voltage tubes, a high level of generator ripple may be fed through into the audio input stage, causing noise in the speaker. This can be reduced or eliminated entirely by additional filtering in the supply circuits and by servicing the generator and voltage regulator. If the car’s battery is not up to par, the increased internal resistance under heavy charging rates may cause an increase in the noise level. This would also be true with transistorized sets. So, if an unexplained noise persists, check the car’s battery very carefully.

Tube testing in the low-voltage series may present a problem. Although I have not had the courage to try it, it is quite likely that potentials present in the average tube tester, especially the transconductance type, will prove far above the maximum allowable voltages for these new tubes. Therefore, tube testing should be limited to substitution, at least until a set of test settings has been developed. With the very close spacing between elements, necessary in these tubes to achieve the needed transconductance, flashovers may occur even in perfectly good tubes, until the high potentials used on short tests. It is probably possible to build up a plug-in adapter for any standard tube tester, which will reduce voltages for these tests.

Troubleshooting techniques

The technician encountering his first all-transistor auto radio will find that basic procedures differ little from those used in the past. The old reliable method of locating a defective stage by performance checks and analysis is still valid. He will find himself using a signal generator for stage-to-stage tests far more than he has been accustomed to! Some basic differences will feel very peculiar to him, after many years of servicing tube sets—voltage measurements, for example.

First, most important and most likely to be overlooked is the matter of battery supply polarity when hooking a set up on the bench. THE BATTERY SUPPLY MUST HAVE THE SAME POLARITY AS THAT USED IN THE CAR!! Failure to observe this will result in immediate damage to the transistors! The technician who has been doing two-way radio work or the old-timer who remembers the days of the synchronous vibrator will soon become accustomed to checking this point. The newer crop of technicians, who have never seen anything but interrupter type vibrators with rectifier tubes, may have to post warning notices over their benches (on the face of the battery eliminator in an effective spot)! This will avoid expensive transistor replacements!

Some of the old quick-checks used by...
service technicians can lead to trouble in transistor sets. For instance, the practice of grounding the grid of a tube to produce a click in the speaker cannot be used with transistors! Delco issues a strong warning against this in their Testing Type.

In the transistor output circuit of Fig. 1, a p-n-p 2N278 is used. With a negative battery-ground connection, the transistor has a normal forward bias of 0.2 volt (from emitter to cathode). If the base (the grid) is grounded, this bias is changed to 11.2 volts, and the transistor burns out in a matter of a few microseconds!

Therefore, when testing for signal continuity in a transistor circuit, touch the base with a fingertip or a small screwdriver, being very careful not to let the screwdriver short to ground, and listen for the pop. Taking voltage measurements using a vtm will probably produce enough pop in the speaker to assure that the stage is working. Touching the audio amplifier (driver) stage's input will produce enough buzz or hum for a positive test, just as it should in the tube. An audio signal generator, set at a fairly low output level (2 or 3 volts), with a small blocking capacitor in the input lead, will be very useful. Most shop signal generators have a 400-cycle af output; use this for making stage-to-stage tests, if necessary.

Another precaution, this one familiar to PA men and most hi-fi addicts, is the need for loading the transistor output at all times. The transistor is a very-low-impedance device—the impedance from collector to emitter is relatively low, especially as compared with the plate resistance of a vacuum tube. A large increase in this impedance, such as would result if the secondary of the output transformer were suddenly opened, causes collector voltage to rise to a very high level. If this happens and the voltage rise should exceed the collector's maximum rating, the transistor is instantly and severely damaged. So before turning on the radio, be sure that the speaker is connected. If it is left off and a signal passes through the set, the resultant burst of voltage may severely damage the output transistor. Conversely, if the speaker voice coil should open, as often happens in auto-radio work, look for a defective output transistor if the radio has been operated with the speaker open.

Voltage and current

Perhaps the strangest thing of all to the vacuum-tube technician will be the very peculiar voltage measurements found in transistor sets. Up till now, he has always found voltages on the plate or output element, negative voltages on the grid and positive voltages on the cathode. His high voltage has been running from 150 to 200, especially in auto-radio work. Now, he's in for a rude shock: he will find only 8 to 12 volts at what he is sure is the plate, the same voltage at the grid, and possibly no voltage at all at the cathode. In some circuits, he may be worse off. In the grounded-emitter circuit used for so many power output stages, he will be quite disconcerted to find only 1 volt at the collector, which can be either positive or negative, 11.8 volts on the emitter, and 12 volts at the base! Until he can force himself to orient his thinking to the lower voltages and peculiar polarities found in transistor circuits, he's in for some trouble.

Seriousness speaking, the technician who tries to go directly from tube circuits to transistors will find himself confused unless he has taken the time to prepare himself thoroughly for it. This is not difficult or expensive. Practically all major set manufacturers have made transistor and transistor-circuit data available through parts supply houses and other sources, mostly free, or for a very nominal sum. Delco, G-E, Motorola, Philco, RCA and many others have this material, and it can usually be had for the asking. Therefore, I will not attempt to cover in this limited space any basic transistor theory. It is available in so many other places that it should be unnecessary. I will try to give some idea of the differences between tube and transistor circuits, and some of the things you can expect to find when the transistor sets begin to show up on your workbench.

Actually, there is no difference in the primary function of tube and transistor radio receivers! Each picks up an rf signal, amplifies it, converts it to af, then feeds it to a speaker. The common circuits are all there. They may be in slightly different forms, but the functions are present.

Parts values differ radically and very few parts, outside of resistors and capacitors, are interchangeable between tube and transistor sets. Resistors will be much smaller, because of the lower voltages, and capacitors will be much larger, at what seem to be ridiculous working voltages: 6, 12, 15, etc. Transformers are different because of the low impedances found in transistor circuits. Rf and if transformers are very much different, sometimes consisting of only a tapped coil of a few turns. Output transformers also differ; the autotransformer is found here, too.

Rf gains of up to 100 per stage are quite common in tube sets. Because of lower gain, at present at least, transistor sets are unable to achieve this efficiency, so more stages are used, especially in the radio's if strip—the Cadillac set has three if amplifiers, for example.

Oscillator circuits are conventional: with feedback from collector to base, coupled through a transformer. The mixer stage functions like a common tube circuit, the cathode-coupled type. The input rf signal is fed to the emitter, while the oscillator signal is fed to the base. The two signals combine inside the transistor in the normal manner. The external coil if output is selected by the action of the input if transformer, just as it is in tube type radios.

The rf stage, as used in Decco sets (see Fig. 2) uses a 2N150, connected in a common-emitter circuit. A matching transformer couples the high impedance of the antenna to the low input impedance of the 2N150, with a stepdown in the transformer. The base is returned to the junction of the two resistors, which form a voltage divider across the 6.5-volt line. This places a 2.5-volt forward bias on the base. This positive voltage at the base attracts electrons from the emitter and causes collector current to flow. If the collector current and a small base current return through the emitter circuit, the 2,700-ohm resistor in the circuit causes a small voltage drop. In a tube circuit, this is the equivalent of self-bias, with a bias resistor in the cathode circuit. Although the emitter is positive with respect to ground, it is negative with respect to the base, a 0.4-volt forward bias being placed on the input diode. Age bias voltage is also applied to the emitter, regulating the stage's gain.

In Fig. 3, a 2N149 transistor is shown connected in a tuned collector...
circuit. It uses a tickler winding for base feedback. Forward base-emitter driving current is picked up from the tap on the voltage-divider resistors, 6,800 and 1,200 ohms, across the 6.8-volt line. Tuning is set by the collector tank. This one has a slug-tuned coil. The 560-ohm self-bias resistor in the emitter circuit has a degenerative effect since the drop across it tends to cause the emitter to go positive on the conducting half of the cycle. This prevents excessive collector current flow and avoids tank-circuit loading for better stability.

Oscillator voltage is capacitance coupled to the mixer from a low-impedance point on a capacitance divider across the tank. This provides the proper impedance match for the input to the mixer stage's emitter, also a low impedance point.

The mixer (Fig. 4) is roughly equivalent to a triode mixer. The input or rf signal is fed to the base of the 2N149, and the oscillator signal is fed into the emitter. The by now familiar voltage-divider arrangement provides the necessary forward bias. The emitter circuit uses a 1,000-ohm resistor to stabilize collector current. Oscillator signal voltage, fed in at this point, will produce additional emitter voltage. This is an ac signal which drives the mixer into conduction on the positive swing, supplying a rectified emitter voltage which keeps the mixer operating near the class-B point for best non-linear detection characteristics. If the oscillator is not working, then the emitter voltage in the mixer stage will be less than the base voltage, an easy point to check.

Actual mixing of the signals takes place inside the transistor. The resultant if is selected by the tuned circuit of the primary of the first if transformer. It is then fed on through the if stages to the detector and audio section.

The if stages

It is not possible, as yet, to obtain a gain per stage from the transistor to equal that obtainable from tubes. Therefore, the designer of the transistor set uses one more transistor. Most transistor sets have a total of three if amplifiers, instead of the conventional one or two. Fig. 5 is a typical if stage. A 2N149 is used in a common-emitter circuit. Conventional appearing if transformers are used. The major difference is the low-impedance windings to match the transformers.

Agc, as in the mixer and rf stages, is applied to the emitter through a 4,700-ohm resistor. Three of these stages form the if strip.

Next month we will continue to tour the transistor auto radio. The detector, age control, age amplifier, audio preamp and audio output stages will be discussed. Methods of testing transistors, what to do while servicing in the car and how to cure auto noises will also be described. TO BE CONTINUED...
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Rediscovery of FM

Once almost down and out, FM is on the upswing again

By DAVID LACHENBRUCH

This year, for the first time since the very early 1950's, you'll see FM radios displayed by nearly all major manufacturers—and a greater assortment of imported and minor-brand FM sets than ever before.

This spring or summer, you're likely to see the first AM-FM automobile radios bearing the imprint of top U. S. car radio manufacturers.

Is it for real this time? Is FM going to catch on after 10 disappointing years?

It's still too early to tell. But this much is apparent—FM is experiencing a very definite boost in popularity which seems sure to accelerate in 1958.

It's a small increase, but it shows up at both the broadcasting and the receiving ends of the business. The downward trend in number of stations on the air and in production of receiving sets has halted for the first time since early 1956. If the signs of FM's health were plotted on a graph, 1956-57 would show up as the beginning of a small upward bump (see Fig. 1). The new signs of FM life bear close watching by everyone whose livelihood—or interest—is geared to radio.

A sick industry

Ask almost any broadcaster and he'll tell you that FM is still a very sick industry, a far cry from the virile newcomer who seemed destined to knock AM radio out of the spectrum after World War II—until television came along.

The number of FM stations on the air began tapering from its peak of 730 late in 1949, dwindling to 536 by early 1956. Then the casualties virtually stopped, and the number of operating stations even increased slightly to 544 by September, 1957.

Then, last summer, the FCC's normally quiet FM section was stunned by a comparative avalanche of applications for new stations. During a single 8-week period, the commission received a total of 24 applications—an average of 3 a week, compared with fewer than one a week in the same period the preceding year. Applications on file for new stations now total about 50.

For the first time in years, the FCC has more applications than available channels in some big cities—making it necessary to hold hearings among applicants for contested frequencies.

In the New York City area, where 16 FM stations are operating or authorized, there are 6 applications for the 2 vacant channels. In Los Angeles, where 17 are on the air with 1 more ready to start, 5 applicants are vying for 2 remaining channels. In Philadelphia, 7 are operating and there are 4 applicants for the 4 available assignments.

These cases are exceptions, of course. In most locations—even big cities like Chicago—FM channels are going begging. But these illustrations are indications of the broadcaster's current reappraisal of FM's possibilities.

Independent programming

There were other signs of a renewed interest in FM in 1957. Westinghouse Broadcasting Co. ended the repeater status of its FM outlets in Pittsburgh, Pa., and Portland, Ore., programming them separately from their AM companions—with classical music exclusively. Westinghouse also applied for a new FM station in Boston to replace the one it took off the air 2 years ago, and ordered brand-new transmitting equipment for its Cleveland FM outlet.

Both of these will also be independently programmed with serious music.

A few other large-network-affiliated outlets began programming their FM stations independently from AM—Washington's WMAL is an example. And NBC applied for a new FM station in Philadelphia as a companion for its AM and TV stations there, but currently has no plans for separate FM programs.

Many FM-only stations, and independently programmed FM's, report a definite increase in the amount of mail received from listeners—generally considered a reliable indication of a pickup in audience size.

During the long years of FM's post-1949 famine, one question frequently asked in the broadcasting industry has been: If FM is dead, why won't it lie down? Why did considerably more than half of the peak 730 stations stay on the air, when official FCC figures show only a handful of them making a profit from FM operations?

The National Association of Radio & Television Broadcasters, in a recent questionnaire to FM broadcasters, asked each one to give its own reason. The most recurrent answers were:

1. By duplicating AM programs on the FM transmitter, it costs virtually nothing to stay on the air.

2. FM listeners are a loyal bunch,
Telefunken Opus covers FM, AM and shortwave bands.

and it would be poor public relations to turn the station off.

3. FM gives daytime-only AM stations an opportunity to provide some nighttime coverage.

4. Duplicating programs on FM extends the coverage of low-powered AM stations.

5. Local sports events, carried on FM only, have a big following.

6. The possibility of future developments in the FM band makes it worth while to keep a foot in the door.

It's impossible to estimate just how many FM dials are actually being twisted. About 8,000,000 sets have been produced since FM started up after the war, but how many have been scrapped or are standing idle, nobody knows.

There aren't even any current statistics on FM receiver production or sales. The industry's record keeper, Electronic Industries Association (formerly RETMA), stopped keeping track several years ago when manufacturers' interest in FM approached the vanishing point.

Before EIA (or RETMA as it was then) stopped counting, it estimated 1,175,000 sets were produced in 1947, peaking to a high point of 1,600,000 in 1948 (see Fig. 2). Then came the drop, with annual output dipping to a little over half a million by 1952. In subsequent years, production probably fell to about 200,000 annually, reaching this lowest ebb in 1964.

A turning point came in 1955. That year, it's estimated that production of sets and tuners increased to 275,000. The uptrend continued in 1956, with sales climbing well over 400,000, and an educated guess would put 1957 sales somewhere above half a million. Not a boom by any means—but a step up.

Hi-Fi and FM

What did it? All of the probable answers revolve around high fidelity and the education of the American ear.

Though audio aficionados had been hooking up components for best possible musical reproduction for years, their purchases of FM tuners (made by nearly 20 small manufacturers) never comprised a numerically important factor for nation-wide FM. But their enthusiasm was so contagious that by 1955 it had spread to some important manufacturers, who decided that hi-fi might become a magic word for the mass market.

Pilot's FM-530, FM tuner.

The time was ripe. Phonograph records had attained a quality far beyond the ability of the average phonograph to reproduce. The natural companion to hi-fi recordings was hi-fi radio—FM.

But in 1956, the first big year for packaged hi-fi, most of the 500,000 units sold under the hi-fi label did not contain FM. The number doubled in 1956 and a greater proportion of them had FM tuners. In 1957, it's estimated that some 1,700,000 packaged hi-fi units were sold. It's improbable that anywhere near half of them had FM, but the proportion increased again.

Distributors in some cities now report that it's practically impossible to sell packaged hi-fi units without FM.

At least some of the credit for America's recently renewed interest in FM is due the Germans. In Germany, where FM has virtually replaced AM because of the crowded broadcast band, manufacturers with such jawbreaking names as Grundig, Telefunken and Blaupunkt began exporting their generally excellent FM-AM-SW sets to the U.S. The Germans are believed to have sold as many as 50,000 here in 1956 and perhaps 75,000 in 1957. American manufacturers sat up and took notice.

More American Sets

During the long FM famine, only one major U.S. manufacturer—Zenith—continually produced FM receivers in quantity. Late in 1954, just before the FM upturn began, a small American manufacturer—Granco Products, Inc.—experimentally turned out a 330 FM-only set with a circuit based on the design of its uhf TV converter. This clicked, and Granco claims its sales of FM sets and tuners hit 100,000 in 1956, and even more in 1957.

Other American manufacturers have decided to try again. For their 1958 lines they have announced not only hi-fi sets which include FM tuners, but such items as FM-AM clock radios and table models. Among those now offering or planning to offer FM sets are: Motorola (its first since 1952), Admiral (first since 1954), RCA (which will import a specially made set from Germany), G-E, Philco, Arvin, Columbia, Magnavox, Stromberg-Carland and Olympic. British radio manufacturers are also hoping to crack the 1958 U.S. markets with their FM sets. At least one Japanese manufacturer plans to export FM tuners to this country.

RCA International receiver, European made, has FM, AM, 2 shortwave bands.

Also from Germany, along with German-made automobiles, came FM auto radios. Again, U.S. manufacturers plan to follow suit. It's understood that both Motorola and Philco have FM car radios on the drawing boards for introduction this spring or summer.

Last summer, the FCC asked for the TV industry's comments on a proposal to facilitate highway FM reception with standard buggy-whip auto antennas by permitting FM stations to use vertical polarization in place of the traditional horizontal polarization. Commenting on this proposal, some FM stations pointed out that the FCC rules already permit circular or elliptical polarization which could produce the same effect without any changes in the rules. (However, no station is currently using circular or elliptical polarization.) Other stations expressed the view that present transmissions can be picked up satisfactorily by conventional auto radio antennas, that if there is any reception problem at all, it will be in areas far distant from FM stations.

All of these signs point to a definite increase in public awareness of FM. But FM station operators have their eyes on another development which they hope will permit them to keep serving a small and loyal public audience, and make money too.

This is multiplexing (see "Multiplexing and You," Radio-Electronics, October, 1957)—now permitted by the FCC on a regular basis. The commission has more than 50 applications by existing FM stations who want to begin this service, and a number of them have already started.

Stations plan many ingenious uses for the multiplexing technique. Among them are background music for stores, factories and offices; specialized programs beamed to schools; special home-study courses, etc.—all to be offered simultaneously with, and in addition to, regular FM broadcasts. Equipment has already been developed for binaural radio using a single FM channel. Some day soon, multiplex FM receivers may well be a companion to binaural tape players in the home. Which way FM? The signs of renewed activity in the 8-108-mc band are not of boom proportions. But there is more hope today than at any time since 1949 that this superior form of radio finally will take its well deserved place under the audio sun.

JANUARY, 1958

www.americanradiohistory.com
Faster Radio Repairs

By JOHN B. LEDBETTER

If you have deserted the field of radio servicing for TV, stop a moment and reconsider, even if you are "snowed under" with TV repairs. Radio servicing not only helps to pay your bills, it keeps you in closer contact with radio owners who in most cases will be prospects for TV receivers, antennas, converters and other accessories.

Since time is your most valuable asset, these notes have been selected to help you save it. Some troubles may sound routine, but they can result in quite a waste of time if you are not prepared for them.

1. Oscillation, usually appearing as birdies or squeals, evenly spaced throughout broadcast band.

   a. Radiation from second detector. If the set is not ac-dc, pull out the oscillator or converter tube. If the oscillation stops, trouble is probably caused by radiation from the second detector back to the front end (usually through the loop antenna or poorly shielded rf or converter stage.) If the set is ac-dc, check the same possibilities by shorting the converter tuning capacitor with a small screwdriver. See that all leads from the second detector are as short as possible and are dressed away from if, rf and antenna leads. In some cases, a copper or aluminum sheet installed between the loop antenna and the set (grounded to the chassis) will cure radiation trouble and may improve performance. Also try increasing spacing between antenna and chassis by 1 inch or so.

   b. Feedback from if strip. If radiation in either of the above cases continues after the oscillator or converter has been disabled, the trouble is originating in the if section. Check all decoupling bypass capacitors in these stages. They are sometimes open or become intermittent, and in some cases have changed value enough to produce resonance or feedback at the intermediate frequency. Check for gassy if tubes (instability and resultant oscillation from this cause is fairly common). Check each stage for correct alignment.

   c. Feedback from wiring. Check ac (heater) leads and dress away from grid circuits keeping as close to the chassis as possible. Keep maximum separation between grid and plate circuits. Check cathode and screen bypass capacitors for opens, changed values or a cold-soldered joint.

   d. Capacitive coupling between tube elements. If the set is designed to use metal tubes, see if they have been replaced with glass types. If designed for glass, use a GT instead of the G (these reduce microphonic tendencies and keep internal capacitances at a minimum). Keep all wiring as short as possible and be sure coupling capacitors are not crowding adjacent terminals on the tube socket. If a particular stage is critical even after these precautions, try a metal tube or check operating voltages for abnormal readings.

2. Oscillation or squeals from about 700 kc to lower end of band.

   Image interference from stations on high end of band. This is the result of poor selectivity or low Q in antenna and rf tuned circuits. About the only remedy (outside of adding an rf stage) is to shift the intermediate frequency slightly so images of higher-frequency stations will not beat with the desired low-frequency stations. Adding a broad-tuning rf stage to most midget sets is impractical, but you may be surprised at how effective this will be on some of the older (and larger) receivers.

3. Oscillation occurring only at low end of band.

   Sometimes caused by blocking or undesirable coupling from antenna or rf stage. Check alignment of receiver and realign at proper if frequency. Check for undesirable line-cord radiation by bypassing each side of the ac line to ground with a 0.02- to 0.1-μf molded capacitor.

4. Turntable hum.

   Most common causes, especially in ac-dc receivers, is insufficient capacitance in the ac line-to-ground bypasses. Often .01 μf is used, and in some cases this is not enough. Replace with .05 or .1 μf.

5. Intermittent reception.

   a. Defective paper coupling capacitor in second detector, first audio or output stage. Try replacing with .01- to .05-μf 800-volt molded units.

   b. Leaky coupling loop. This loop is used in many small and old-model receivers to couple the rf and oscillator, or antenna and converter grid coil (Fig. 1). The insulation sometimes absorbs moisture and makes these wire loops a hard-to-locate source of low gain or intermittent trouble.

6. Noisy tuning capacitor.

   a. Collection of dirt, grease, etc., in bearings or on wiper contacts. Clean with carbon tetrachloride. Apply a small amount of Lubriplate or similar noncorrosive lubricant.

   b. flakes or dirt between tuning capacitor plates. This is a common fault in older sets which used plated capacitors. If the receiver uses a transformer power supply, remove the rectifier tube, unsolder the grid connection from the stator of the tuning capacitor and apply high-voltage ac from one of the rectifier plate pins to the stator with a test probe. Rotating the capacitor will burn out the flakes in short order. (In some receivers, it may be necessary to straighten the plates to prevent rubbing.)

7. Microphonic howl in home; OK at shop.

   a. Low line voltage at customer's home. A tube which may operate satisfactorily in your shop can be microphonic in the customer's home under certain line-voltage conditions. (This is particularly true with three-way portables which use 1.4-volt tubes.) You can catch most of these offenders with an isolation transformer with a variable tap, or with a 115-volt bulb (20 to 60 watts) in series with the secondary (see Fig. 2). Low emission and drifting oscillator conditions will show up (along with a few other troubles) if the set is given a test run at reduced line voltages.

8. Sound comes on suddenly after set has warmed up; is sometimes accompanied by microphonics or "pinging" noise.

   Defective oscillator or audio tube. 12SA7, 12SQ7 and similar types are frequent causes of this trouble.

   If the above notes seem too simple in this complex business of servicing, remember—it is the simple things which trip you up! Nine times out of ten, you will remember the most difficult or time-consuming jobs as those which were caused by a simple or too-obvious defect. As the time-worn axiom states, we sometimes "can't see for lookin'."
Track the US satellites with this simple two-tube 108-mc converter, which also has other uses

By RICHARD GRAHAM

TUNING in our own Vanguard satellite promises to be one of the thrills of this year. However, because the frequency of radio transmissions from the Vanguard is beyond the tuning range of most receivers, many will miss out on this event. But you won't miss out on this or the satellites to follow, if you build this Vanguard 108 converter.

Basically, the converter is a device that translates the 108-mc transmissions from the satellite to a frequency of 8 mc which can be heard on your shortwave receiver. The receiver will read frequency directly if you mentally add 100 to the reading on the dial. For example, 8 mc on the receiver dial corresponds to 108 mc and 7 mc to 107 mc.

Since the transmitted power output from the US satellite will not exceed 0.1 watt, the converter has to use low-noise high-gain circuitry which must be adjusted for peak efficiency for satisfactory results. The ability to receive the satellite satisfactorily depends almost entirely on the converter's gain and noise figure. The receiver, if it is of average quality, plays a relatively minor part. (At vhf frequencies, the receiver's ability to detect a signal is limited only by the noise generated in the antenna resistance and the front-end tubes.)

The Vanguard 108 combines reasonably high gain and low-noise circuitry at a reasonable cost. It uses standard TV tubes, which are inexpensive and readily available. Some improvement in the gain and noise figure could be obtained by using some very special and very expensive Western Electric types. This is fine for those actually engaged in satellite tracking, but for the casual but interested observer the economic difference is worth the small sacrifice in performance.

Circuit description

The Vanguard 108 has only two tubes and its circuitry (see schematic) resembles that of many TV and FM receiver front ends. The converter uses the popular cascode circuit for the rf amplifier. This is followed by a mixer oscillator using a dual-purpose pentode-triode.

The converter can be generally described as a broad-band fixed-tuned type. This means that all of the tuned circuits are "fixed" and do not require adjustment while the converter is in use. All necessary tuning is done with the receiver only. This is possible because the converter's tuned circuits are broad enough to permit tuning over ±2 mc around the center frequency of 108 mc without any significant change in performance.

The signal from the antenna is applied to tapped coil L1. This is adjusted to resonate with capacitor C1 and the input capacitance of the tube to 108 mc. This drives the grid of the cascode rf amplifier. This stage uses a 6BZ7 dual triode which is the latest in a series of tubes designed specifically for this purpose. The cascode amplifier is noted for its low noise characteristic. It is equivalent to a single grounded-cathode triode with zero plate-to-grid capacitance, and with a mutual conductance and noise resistance equal to that of the first triode tube in the circuit.

A glance at the circuit shows that effectively the two triodes of V1 are in series. The first triode functions as a grounded-cathode and the second as a grounded-grid amplifier. The cathode of the second triode is driven instead of its grid, which is placed at ac ground by by-pass capacitor C3. The output of this second triode is untuned and is capacitance-coupled to the grid of the pentode half of the 6U8 which serves as the mixer.

L2 acts as a neutralizing coil. In practice, this coil is not too critical and therefore needs no adjustment. However, the purist who wants the most from the converter and who has a way
Another look inside the unit. Short leads are used on all components.

to measure noise figure, can adjust it for a minimum noise figure.

The triode half of V2 is an oscillator of the Hartley variety. It is adjusted by L4 to operate at a fixed frequency of 100 mc. The oscillator signal is coupled to thepentode mixer by stray capacitances in the tube and wiring.

The oscillator operates 8 mc lower than the incoming signal rather than 8 mc higher, because in this way the receiver reads an exact 100 mc below the actual incoming signal.

The difference frequency of 8 mc in the plate circuit of the mixer is selected by the tuned circuit consisting of the adjustable inductor L5 and fixed capacitor C5. A link (L6) wound over coil L5 provides a low-impedance output for coupling to the receiver's antenna terminals. To insures stability, the plate and screen circuit of each stage is decoupled with a 4,700-ohm resistor and a bypass capacitor.

The power supply uses a Stancor P-6181 power transformer which is intended for TV booster service. This supplies the 150 volts necessary for proper operation of the cascode amplifier. It also allows the use of the more economical resistance type of power supply filter. Otherwise the circuit is a conventional selenium halfwave transformer-fed power supply.

Construction hints

The Vanguard 108 is built into a 5 x 3 x 2-inch Minibox which acts as a shielded chassis. This avoids any possible interference with FM sets in the immediate vicinity. The general layout of the components can be seen in the photographs. I strongly suggest, unless you are fairly familiar with vhf circuitry, that the layout shown be used.

As can be seen in the photographs, lead length in rf circuits, particularly those performing rf bypass functions, is practically nonexistent. Short leads to a good ground connection go a long way toward preventing oscillation and birdies.

The rf output should be coupled to the receiver's antenna terminals with a short length of coax. Neither type or length of the cable is particularly critical. I used a piece of RG 59/U, 20-inches long. Keep the unshielded connection at the receiver end of this cable as short as possible. Sensitive receivers do not need much of an antenna to pick up objectionable signals directly at 8 mc. These might mask the desired converted signal at 108 mc.

If your receiver picks up signals in the vicinity of 6 to 10 mc with the antenna terminals shorted, it is a sign that the receiver needs additional shielding or power-line filtering is needed where the line comes into the receiver chassis.

Alignment

Alignment of the Vanguard 108 is quite simple and straightforward. It requires a source of 108 mc, which can be in the form of a signal generator.
or a grid-dip meter. After the unit has been completed and visually checked, it is ready for alignment. The first step is to set up the Vanguard 108 with the antenna, just as it will be used in practice. Set the receiver to 8.0 mc. If you have selected a frequency that will correspond to a received frequency of 108 mc with the Vanguard 108, turn the converter on and set the grid-dip meter to 108 mc. If a signal generator is used, connect a small antenna (12 inches or so) to the generator’s output terminal. Now adjust oscillator coil L1 until a carrier is heard. It can be identified as a grid-dip meter or signal generator simply by turning off the instrument being used. Next, adjust output coil L5 for maximum signal from the receiver by watching the receiver’s meter or output meter across the speaker voice-coil terminals. Now adjust coil L1 for maximum signal. The type of antenna and transmission line may make a slight modification of input coil L1 necessary. If it does not peak up, squeeze or spread the turns, as necessary, until it is in range of the tuning slug of L1.

At this point, check the oscillator frequency to insure that it is below the incoming signal. As stated earlier, adjust the oscillator to 100 mc. Then it is necessary only to add 100 mc to the receiver frequency reading to obtain the true received frequency. As you recall, from superhetrodyne theory, the chosen 8-mc frequency can be obtained as follows: oscillator frequency is at either 100 (106 mc minus the 6 mc) or at 116 (108 mc plus the 6 mc). However, it is only when the oscillator frequency is read by adding 100 mc that the frequency is correct.

This can be checked by adjusting the frequency of the signal generator or grid-dip meter upwardly until the frequency is 110 mc. Now tune the receiver to approximately 10 mc. The carrier from the generator should be picked up if the oscillator is on the correct frequency. If it isn’t heard, tune to 6 mc. The carrier should now be heard, which will indicate that the converter’s local oscillator is on the wrong frequency and L4 should be readjusted to a lower frequency. Once again, due to wiring differences, some spreading or squeezing of the turns may be necessary to get the inductance of the coil within the proper range.

Of course the accuracy of the equipment used to align the Vanguard 108 will determine the frequency accuracy of the converter receiver system. One way of checking the accuracy of the system and perhaps make the final touchup on the Vanguard 108 local oscillator is by using local FM stations around the high end of the FM band. For example, if a local FM station is at 106.5 mc, then, by properly connected to the Vanguard 108 converter should pick up this signal at 6.5 mc. The signal will appear quite broad. However, the center or carrier frequency will be the point where the least audio garble is heard.

Another method, available to those not so fortunate as to have a convenient FM station on the high end of the FM band, is simply to use an FM tuner of known calibration accuracy to check the oscillator’s frequency.

It’s worth making sure that the oscillator frequency is precisely set at 106 mc. Since this will help to insure that, when the satellite goes up, you won’t miss it by having to fool around with converter adjustments. As we all know, the thing travels fast and won’t be heard long enough or often enough to permit much adjustment.

The antenna used should come under careful consideration. With a transmitter power of 0.1 watt, the signal will inevitably be very weak and receiving equipment must be in top operating condition. A good antenna, one that is directive and hence has high gain, and is rotatable will give the signal a welcome boost. Even a rotatable TV antenna has something to offer in this respect.

One aspect of building this converter should be noted. Vhf is a busy world these days. Once the thrill of satellite hunting has subsided, the unit can always be converted to a host of other uses, either by simple realignment or by adding or taking turns from the coils. Removing one turn from L1 and L4, plus squeezing, will bring the 144-mc ham band within your tuning range. Similarly, police, fire, taxi, aircraft and other community and industrial services abound, requiring only minor modification to bring them within your tuning range.

END

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Nothing like the Russian Satellite.” Review by Roger L. Easton, QST, April, 1957.


“Precision Steering at 18,000 M P H,” by Otto Berg, Radio and TV News, September, 1957.


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"I always wanted to be an electronics engineer," Tim says, "ever since I first tinkered with hi-fi in my high school days. But my formal education ended when I entered the Marines in 1953. In spite of the excellent radar training I received in the Service, I still had doubts as to how far I could go in my chosen field without a degree."

HEARS ABOUT IBM—AND SAGE
A few months prior to his discharge, Tim began to look into the opportunities for a civilian career. He heard about IBM, learned that IBM was willing to invest thousands of dollars training the right men to assume engineering responsibilities in the Project SAGE program. "Could I do it?" Tim asked himself. To be brief, Tim could—and did. Two months later Tim reported to Kingston, N. Y., to begin training as an IBM Computer Units Field Engineer.

SAGE—PROJECT OF NATIONAL SIGNIFICANCE
SAGE—for which Tim was trained—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 perimeter. At the heart of this system are giant electronic computers, built for the project by IBM. These computers receive data from Texas towers, picket ships, reconnaissance planes, ground observers—analyze the data for action by the Strategic Air Command and other defense units. "These computers are the largest in the world," Tim points out. "Each contains 58,500 vacuum tubes plus 170,000 diodes."

BECOMES FIELD ENGINEER
"My five months' training at Kingston were a revelation," Tim remembers. "Here were top-notch courses in advanced electronics, taught by instructors who really knew their business—and had a personal interest in your progress. We had classroom lectures in which we learned about basic computers, logic, programming, general machine operation—how everything worked together. Instead of a lab, we worked in actual test areas, along with the regular test area personnel. Incidentally, IBM went out of its way to make our stay at Kingston pleasant. They helped us with housing accommodations and we received a living allowance over and above salary during our training period."

INSTALLS WORLD'S LARGEST COMPUTER
His training completed, Tim was assigned to the Project SAGE site at Newburgh, N. Y. "The giant computer was ready for installation," Tim recalls, "but before it could be moved into its new building, 300 miles of cable had to be laid. Then we made interconnections and brought in the power. Next came the testing phase—a long procedure, as you may imagine for a computer of this size. Then we set
up the auxiliary equipment. Finally, when everything was ready, the Air Force ran its acceptance tests—a stiff trial with no if’s, and’s or but’s permitted. I’m happy to say we got an unqualified OK.

"My present work," continues Tim, "is in the Tape Section of the computer. I’m responsible for the maintenance of the Central Computer Tape System which includes eight tape drives (a means of storing information) and two tape adapter frames which adapt information for admittance into the Central Computer. A Computer Units Field Engineer like myself works about three months in each of the computer’s three sections, giving him a chance to learn the whole computer."

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"IBM has proved to me," Tim says, "that a degree is not the only measure of a man’s ability, or the only indication of what he can do when given the opportunity. Around me at the site I see a lot of men who were once considered ‘just technicians’—men who have had a new engineering dimension added to their careers—all because IBM will spend time and money to train technicians for engineering responsibilities. I know this better than ever, now that I’m on the job. I’m on the Education Committee at the Newburgh site and I see what IBM will do to train men. My job on the committee is to find out what the men want. Then, IBM supplies courses, instructors, classrooms—everything that’s needed."

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The Tiny-Tran doesn’t shackle you to an antenna or ground. You don’t have to hold a lead and let your body serve as an antenna either. Here’s an example of Tiny-Tran’s performance: I live 15 miles from the nearest radio stations (in Dallas and Fort Worth); Tiny-Tran in my shirt pocket picks up eight stations without any external antenna and I can listen comfortably while walking.

I’ve wanted a radio as small as this for a long time. I’ve tried to miniaturize transistor audio amplifiers, use regenerative transistor detectors and, on occasion, I’ve even resorted to “odd ball” body-mounted antenna schemes. The results, though they seemed good at the time, are rather dismal, now that I’ve used Tiny-Tran.

The experimenter bent on extreme miniaturization for pocket radio operation has, until recently, faced almost insurmountable odds. Although transistors are small and other components have been miniaturized, he has still been hampered by resistor dimensions and space requirements for making electrical (non-short-circuiting) connections.

Two recent developments have changed the picture. These are manufacturing as well as engineering breakthroughs:

1. The packaged, printed-circuit, four-stage transistor amplifier manufactured by Centralab and designated the TA-11. Dimensions: 1.175 x 0.665 x 0.25 inch!

2. The miniature flat ferrite-strip antennas such as the Miller 2004. Q: 500 at 790 kc! Dimensions: 2 3/8 x 3/4 x 3/8 inch, when removed from its masonite mounting board!

Tiny-Tran’s small size (2 3/8 x 1-3/16 x 1 inch) and excellent performance are possible because of these components. The TA-11 subminiature transistor amplifier is expensive—about $35—but (to me at least) the compactness that it affords and the simplicity it lends to the Tiny-Tran more than compensate...
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108 RADIO - ELECTRONICS

Opening the case shows parts placement.

for the expenditure. Other miniature parts are also essential, but these have been available for some time.

The circuit

The circuit of the Tiny-Tran is straightforward (see diagram). The high-Q antenna provides adequate selectivity in a diode detector circuit. The extreme sensitivity of this high-Q circuit also accounts for the radio's good station pickup characteristics.

The rectified signal at the output of the detector is not strong enough for direct headphone operation without an external antenna. To eliminate the need for an antenna, considerable audio amplification is required. The TA-11 furnishes this amplification. Its gain is better than 73 db. That's a voltage gain of approximately 4,500!

Volume is controlled by a miniature volume control between the second and third transistor amplifier stage. A spot switch on the volume control turns the set on and off. The energy source controlled by this switch is a penlight cell.

Several of the amplifier's characteristics are of particular interest. Current drain ranges from 3.6 to 4.1 ma, input and output design impedances are 1,000 ohms and power output is 1 mw maximum with 15% distortion. At 0.36 mw, distortion is only 2%. Frequency response is within 5 db from 250 to 20,000 cycles. Not hi-fi, but certainly listenable.

Now build it

It won't take very long to make your Tiny-Tran. The first time I worked with the TA-11 amplifier, I breadboarded the basic circuit in less than 10 minutes. After I forced myself to stop playing with this simple setup that produced such intriguing results, I undertook the more tedious task of packaging the circuit. Even this can be done in less than 30 minutes. Here's a suggested procedure:

1. Drill the plastic case. Make starter holes with a small drill for the volume control and tuning capacitor shafts. Then ream the holes out to size. This precaution prevents cracking the case. My reamer wasn't large enough to make the volume-control hole, but I managed to melt the hole to size with a soldering gun. The small holes for fastening the tuning capacitor and the volume control are drilled directly. Notches at the top of the case (for the antenna) and at the bottom (for the headphone lead) are cut out with a soldering gun.

2. Mount the components as shown in the photos.

Remove the antenna coil from its Masonite mounting strip. This is done

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by loosening the tape which holds it in place. Trim the tape to a length to go just around the antenna and protect the end turns. Use cellophane tape to fasten the loop to the case.

3. Proceed with the wiring. Wire the ferrite-loop antenna, tuning capacitor and diode detector combination first. Take the usual precautions in soldering semiconductor leads and in handling Litz wire.

Next place the TA-11 inside the front half of the case and fasten the earphone lead temporarily in place with cellophane tape. Wrap the TA-11 output lead (numbered 7) around one phone lead tip. Wrap all the lead length you can around this tip, but don't put tension on the TA-11 lead. Do not solder this connection! With cellophane tape, fasten the phone tip securely to the side of the case.

Now connect leads 5 and 6 to the volume control. By running the leads up the side of the case and bending them back on themselves you can avoid cutting them. There's enough space and the leads are stiff enough to prevent short circuits. If you wish, slip fine spaghetti over these leads. Connect lead 1 to the volume control and the ground side of the tuning capacitor. Lead 2 is brought up around the variable capacitor and connected to the diode. Lead 3 connects to the switch. The other side of the switch is connected to the plus side of the battery. Put a piece of thin plastic spaghetti (may be stripped from plastic-covered hookup wire) on lead 4 of the TA-11 and wrap the end of this lead around the second phone tip. Do not solder this connection. Solder the end of this phone tip to the negative end of the battery. The phone tip and battery should be cleaned with a file prior to soldering. Secure the phone tip and battery with cellophane tape.

Finally, solder the antenna wire and tape it in place. I used 12 inches of No. 18 silk-covered wire. If you are going to use your radio in a city speckled with radio stations, the antenna is unnecessary. (Perhaps some reader will come up with a small telescoping antenna that will handle any eventuality.)

**Make it smaller**

Examination of the Tiny-Trans layout will probably prompt many experimenters to ask why I didn't make the radio smaller. The question is a fair one because it is quite apparent that it can be miniaturized further. There's plenty of space in the case and the tuning capacitor's shaft can be shortened. A smaller battery could be used. By taking advantage of these space-saving possibilities, Tiny-Trans' size can be cut in half. I didn't resort to these measures because the wiring would have been more difficult. Besides, with the usual experimenter's initiative to do more things with new gadgets, I'll probably expand Tiny-Trans to a Speaker-Trans by next issue. **END**
SENSITIZE RELAY CIRCUITS

Eight circuits that will increase the usefulness of your relay control

By EDWIN BOHR

TRANSISTORS can multiply the sensitivity of conventional control circuits by tens, hundreds or thousands of times. Transistor relay control circuits are excellent for extending the sensitivity of photoelectric devices, garage-door openers, radio remote control, carrier-current circuits and the like.

Most of the popular crystal diode circuits can be souped up and given new vitality. Just select a suitable transistor relay from this article and you're in business. Transistor relay control circuits can be used in hundreds of ways. But several limiting factors enter into any consideration of dc transistor amplification.

Sensitive relays

Very sensitive relays are expensive and fragile, and the contact adjustment is always delicate. Except for moving-coil types, the contact movement is exceedingly small. Armature movement is almost invisible on many types.

With these conditions, vibration sensitivity and contact sticking from the slightest overload are real headaches. Such troubles, however, disappear when relays are used and adjusted to operate from signals larger than 25 mw.

A specific example is the Sigma type 4F relay with an 8,000-ohm coil. This relay, adjusted to operate with a coil current of 2 ma, is reliable despite large inductive contact loads (the type usually found in model control circuits), vibration, temperature changes and dust.

This relay also operates pretty well on 1.5 ma if the armature air gap and spring tension are carefully adjusted. But, attempts to increase this relay's sensitivity further take it out of the good old "idiom-proof" category and place it in the "apologetic" group.

You know what we mean. An apologetic component is one with just enough margin of satisfactory operation to operate perfectly until we want to boast or demonstrate performance to someone important. Then it falls. Of course we can make a hurried screwdriver adjustment and get it to work. But, somehow, the sweetness of the moment is lost.

A Sigma 4F relay, adjusted for 30-mw operation, plus transistor amplification, will replace almost any special sensitive relay including polarized types. And there are many advantages in such an arrangement. Relay operation time—in most instances—is greatly improved; the cost is less and the complete unit is more immune to vibration, dirt, and contact wear. The characteristics of these two devices, the transistor and mechanical relay, are mutually complementary.

Typical circuit

For some time, transistor circuits for driving relays have appeared in popular technical magazines. Unfortunately, many of them have suffered from misapplication and poor design. Before going further, let's look at one of these circuits.

Fig. 1 shows a typical transistor relay circuit. The relay coil is simply connected in the collector circuit of a grounded-emitter stage. Current supplied to the base is amplified and operates the relay.

Fig. 3—Improved circuit eliminates heat and leakage problems: (a) for p-n-p transistors; (b) for n-p-n types.

This circuit is usable only with good-quality low-gain transistors at very moderate power levels. Preferably, the collector potential should be limited to 6 volts or less and the collector current to a couple of ma. These limitations hold two serious defects to a minimum.

The first defect results from leakage and temperature-induced transistor currents. These currents, in the grounded-emitter circuit, are amplified by the transistor—just like an input signal would be.

At temperatures of 90°F and higher, currents of this type are troublesome. High-gain transistors amplify these currents enough to keep the relay closed, even when there is no input signal. This condition becomes worse with higher collector currents and voltages.

The second defect is circuit-imposed. When the relay is energized, magnetic energy, of course, is stored in the coil windings. If the transistor input signal is suddenly removed, the magnetic field collapses and throws a high flyback voltage across the transistor. The flyback from a Sigma type 4F, for example, is enough to cause early transistor failure.

Experimental circuit

If you have a transistor and a few spare minutes, a simple experiment clearly shows these first effects of leakage and temperature.

Set up the circuit shown in Fig. 2. A multimeter with a current range of less than 1 ma is ideal for the collector indicator. The 470-ohm collector resistor is a safety, current-limiting device. Initially, the collector can be at about 6 volts.

Any handy transistor will do if it is an alloy-junction type. (Many of the more common transistors are alloy-junction types. Among them are the CK721, CK722, 2N77, 2N104, 2N105, 2N107, 2N109, 2N109, 2N186, 2N229, 2N233, GT14 and OC70.) Fig. 2 shows battery polarity for a p-n-p type. If an n-p-n alloy transistor is used, reverse the collector battery polarity.

Before starting the experiment, short the transistor base directly to the emitter. Then connect the collector battery and read the current. It should be no more than 50 or 75 ma. Now increase the base-to-emitter resistance Rb and notice the rising collector current. De-
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pending upon the individual transistor's characteristics and the room temperature, the collector current may climb to more than 1 mA with 500,000 ohms resistance between base and emitter. Lower values decrease the current.

Grasp the transistor between your fingers. Added heat from your body will cause the current to rise also. Cool the transistor, if you wish, with a small piece of ice held in Saran Wrap and collector current will drop tremendously.

Increasing collector voltage at room temperature causes an increase in the reverse current. Reduce collector voltage and the current decreases. These effects are more pronounced with high-gain transistors. Prove it to yourself. If you have high-and low-gain transistors, try both kinds.

If a silicon transistor were subjected to these experiments, it would show no effects. The initial collector current under any conditions would probably be too small to read on the microamp meter range.

This experiment shows us that ambient temperature is not a problem, as long as the base-to-emitter resistance is very low. Temperature effects are reduced by using low collector voltages. High-gain transistors amplify temperature effects even more, with resulting larger indications.

With these facts in mind, let's improve transistor relay performance by circuit modifications.

Improved circuit

The circuits in Fig. 3 eliminate the difficulties just mentioned. The elements responsible for this improvement are back bias and relay coil damping.

Diode D2 is a silicon unit, a type SG-22 Stabistor (Transistor Electronics Corp., 168 Albion St., Wakefield, Mass.), that maintains an essentially constant drop of 0.5 volt in its forward direction. This 0.5 volt bias effectively swamps out temperature currents by preventing them from flowing through the emitter.

Resistor Rb returns the base to ground. The lower the value of this resistance the more effective the bias. Even for very-high-gain transistors, 2,000 ohms should be low enough—10,000 ohms may be satisfactory for low-gain units.

Resistor R1 supplies the bleeder current through diode D2. For a collector supply voltage of 22, R1 should be about 27,000 ohms.

D1, across the relay winding, acts as a damper to short out the flyback voltage but not the actuating signal. If the diode were wired in backward, the relay would not operate. This diode is a general-purpose germanium unit such as the 1N34.

Notice that the maximum available relay current is the collector voltage divided by the coil resistance (8,000 ohms) for about 15 volts. A few extra volts of margin are always necessary. So 22 volts is about right. More voltage will exceed the conservative ratings of most transistors. If a 4,000-ohm relay were used, the collector supply voltage could be cut in half but the driving current, of course, would be doubled. A collector supply of 12 volts is satisfactory for a 4,000-ohm coil. Resistor R1 is changed, for this condition, to 15,000 ohms.

Circuits similar to those in Figs. 3-a and -b appear in a Transistor Electric Corp. application note titled "Transistor Relay Circuits."

Fig. 3-a is specifically for p-n-p transistors and Fig. 3-b for n-p-n types. Grown-junction transistors, the 2N170 for example, are not suitable because of their low rating.

These circuits are sensitive to input signals of only one polarity. Fig. 3-a responds to negative signals and 3-b to positive signals. The bases (inputs) of these two circuits can be connected, forming a polarized two-way relay. Thus each of the two relays would respond only to a specific input-signal polarity.

Battery-bias circuit

Figs. 4-a and 4-b are almost identical to the previous circuits. However, separate batteries supply the bias rather than constant-voltage diodes. One or more additional dry cells are necessary.

For a single 1.5-volt bias battery and a high-gain transistor, Rb should be roughly 6,000 ohms. For 3 volts of bias, double this value. The advantage of increased bias voltage and resistance is reduced input shunting. Otherwise, the results are the same as for reducing temperature effects is concerned.

If maximum gain is necessary, the value of the resistor Rb is selected to hold the collector current down to about 0.25 ma at the highest operating temperature. This means using fairly high values of resistance, about 47,000 ohms for a 1.5-volt bias. Using a transistor like the 2N43, it is possible to obtain current gains of 60 under these conditions.

Figs. 5-a and 5-b provide us with the ultimate in a simple, ultra-reliable, low-cost, transistor relay circuit. This circuit separates the functions of current amplification and relay driver. Two transistors are used. The relay driving transistor is connected with its base grounded. There are a couple of advantages in using a grounded-base transistor driver. First, because this circuit provides no current gain—only power gain—temperature and leakage currents are reduced and inconsequential. Second, the grounded-base circuit is electrically more robust. It can withstand higher collector voltages and currents. Grounded-base circuits absolutely cannot be damaged from thermal runaway.

This relay driving transistor (V2) should be a low-priced unit since a high-priced, high-gain transistor in the grounded-base connection gives no better performance than a low-gain unit.

The input transistor (V1) provides the current gain and functions at a very low collector voltage. Since the burden of supplying power has been removed to a grounded-base circuit, this input transistor operates at near optimum for minimum temperature and

Fig. 5—Two-transistor circuit provides additional gain. a—keyed by positive inputs; b—keyed by negative inputs.

Fig. 6—Ultimate relay control circuit uses three transistors: a—keyed by positive inputs; b—keyed by negative inputs.

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leakage effects. Grown-junction transis-
tors like the 2N78, 2N150, 2N165, 
2N168A and 2N203 (or any low-power 
transistor) may be used in this input 
stage.

One of the transistors must be p-n-p 
and the other n-p-n. Because of the re-
versed characteristics of these two 
classes of transistors, amplified current 
from the input transistor flows from 
its emitter into the emitter of the 
grounded-base transistor. Fig. 5-a is 
sensitive to positive input signals and 
Fig. 5-b to negative signals.

The optimum working conditions for 
the first stage obviate the need for 
reverse bias, unless the temperatures 
are high or the transistor very poor in 
regard to leakage or $I_{BC}$ temperature 
effects.

If a reverse bias is needed—indicated 
by high relay coil current with no input 

![Image](image-url)

Fig. 7—Simple circuit protects transis-
tors against excessive input.

signal—it can be taken from the relay 
collector supply through resistor $R_c$ 
shown in dashed lines. $R_c$ should have 
a value of about 10,000 ohms per volt of 
relay collector voltage.

A small resistor is in series with the 
input transistor’s collector. It protects 
the transistor from excessive collector 
current, caused by input-signal over-
loads.

Very-high-gain circuit

Tacking on another current amplifier, 
we come up with the high-gain ampli-
ifiers of Figs. 6-a and 6-b. Depending 
upon the gains of the two current-
amplifying transistors, these circuits 
give current gains from about 75 to 
over 2,000.

Usually a reverse bias is necessary 
for these high-gain circuits. Use the 
values given for $R_c$ in the preceding 
circuits (10,000 ohms). Or, and this is 
even better, connect a 100,000-ohm 
thermistor such as the VEO 512 in 
pair with $R_c$ and connect it to a tap on 
the relay collector battery that will 
reduce relay current to say 50 ma. 
A tap of 3 or 4.5 volts, from the relay 
collector battery, would be typical.

Fig. 7 is a circuit to protect the input 
transistors from accidental burnout due 
to excessive input signals. Use the 
same diode type as D1 in the preceding 
diagrams. This circuit is used when 
more than 10 ma of input signal could 
exist. Grown-junction transistors have 
a delicate base lead that is faster than 
the fastest fuse. This circuit protects 
your transistor by offering a high re-
stance to large signals, but little re-
stance to small signals.

These circuits are useful for ampli-
fying the outputs of self-generating 
selenium photocells, the CdS or new 
CdSe photocells, thermistor thermo-
meters, small dc signals from radio con-
trol circuits, and for innumerable indus-
trial applications. I have shown you 
some first-class transistor-relay circuits.
Now let’s see what you can do. END
POWER FAILURE ALARM

A robot reporter that calls attention to even momentary interruptions.

By GEORGE P. PEARCE

The Robot Reporter hooked to its external battery.

The most satisfactory setup is that which—when power fails—operates a small relay arrangement that instantly switches on a warning light. This type of indicator is very satisfactory, for the light promptly catches the eye. Power for the light is supplied by a small storage cell. The cell is constantly charged by rectifying the small current required to energize the relay.

Fig. 1—Circuit of the handy indicator, and passing the direct current the same as a trickle charger does.

Fig. 2—Adding reset button to relay.

failure. In these cases, the pilot lamp may be replaced by a buzzer or bell and the battery voltage raised to the level needed to operate the alarm.—Editor.)

A very simple and dependable design is shown in the photos and Figs. 1 and 2.

How it works
This little robot can be plugged into any standard circuit that requires a continuous check. It is designed so that the instant the circuit is energized, the
ELECTRONICS

NE-51 gloes. As long as it is glowing, you know that the power is on. Suppose, some time during the night a power failure occurs. The neon lamp goes out, the relay drops out and the No. 41 warning lamp is switched on. The Edison cell will keep the warning lamp lit for about 4 days. This provides ample reserve, even over weekends.

Power may come back in a second or perhaps not for several hours, but the warning light will immediately signal the first person who approaches that there has been a power failure. The engineer in charge can check promptly all parts that may have been affected. After the check, a slight tap on the plunger (white button) closes the relay armature, cuts the warning light out of the circuit and starts the storage battery on its recharging cycle.

The alarm advises the operator when any of the following events occur:

1. No power failure. Indicated by the neon lamp burning and the warning lamp out.
2. Power failure was corrected; power restored. Indicated by the neon lamp and the warning lamp being lit.
3. Power failure; power still off. Indicated by the neon lamp being out and the warning lamp lit.

When the alarm is not in use, the warning lamp must be loosened in its socket or the storage cell disconnected. Otherwise the lamp will burn until the battery runs down. This is a good arrangement for, when the alarm is next used, the warning lamp should light before power is switched on and the plunger pressed down to lock the armature. Thus, the cell and lamp are automatically checked. The life of the lamp is unusually long in this service because it is designed for 2.5 volts whereas the cell gives only 1.2 volts. If a brilliant light is desired use a power voltage lamp.

It is important to note that the amount of current through the relay is controlled by resistor R2. This current must be strong enough to hold the armature closed after it has been shut off by pushing the plunger. The current must not be strong enough to attract the armature automatically to its closed position. The relay 1 used has a 300-ohm coil and requires 45 ma to close automatically. But 25 ma is enough to hold it closed. Thus, if a 25- ma current is flowing, as soon as the armature is manually closed, it stays closed until power fails.

Resistor R2 was selected to permit only 25 ma to flow with a 117- volt line potential. The current flowing is not too critical and it is not necessary to measure it with a milliammeter. A little experimenting with various resistors is all that is required. First use, say 5,000 ohms. If it does not hold the relay closed, use smaller resistances until it is large enough that will pass enough current to hold the relay closed and yet not enough to cause it to automatically close when it is connected to the monitored circuit.

END

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Sensitive Photocell

By I. QUEEN
EDITORIAL ASSOCIATE

THE cadmium sulphide (CdS) photocell is far more sensitive than previous cells and compares well with germanium phototransistors. Photocells have been used for two general purposes: for control, as with a relay, and for measuring light intensity. The CdS cell can be used for both since it can supply a 1-ma output where required, yet its sensitivity is low enough to be useful at low illumination. It is sensitive to X-rays, gamma rays and infra-red.

The cadmium sulphide cell has one disadvantage and one big advantage when compared with the popular selenium cell with power supply; the cadmium type must be supplied with either ac or dc up to about 200 volts. This is not an important problem, since the needed power is very small. The big advantage is sensitivity. A typical selenium cell puts out 15 µa at 100 foot-candles. The type CL-2P Clairex (cadmium sulphide) cell puts out 100 µa at 2-foot-candles. This comparison is made with cells having approximately the same diameter (¾ inch).

Because of its small size and high sensitivity, the CL-2P and similar cells may be pinpointed directly on a luminous target. Also, it may be hidden in a convenient location or made inconspicuous. For extremely high sensitivity, it is a simple matter to rig up some sort of optical or focusing system to increase the illumination on the cell.

Although the CdS cell requires a high voltage to excite it, the current input is fortunately very small. Therefore a transistor oscillator and diode voltage doubler is sufficient. The diagram shows such a power supply which puts out 60 volts or more for a photocell. This circuit is described in more detail in Radio-Electronics for December, 1955, page 61. Briefly, the transistor oscillates at a frequency which is stepped up and then rectified by the diodes. The penlight cells must supply only about 3 ma so they will have long life. When size AA cells are used, this represents an operating cost of about 94 cent per hour.

Just what do we mean by high sensitivity? Well, here are typical measurements made on the photocell powered by a transistor oscillator.

An output of about 100 µa through 100,000 ohms (that is, about 10 volts) is available from the following sources of illumination: a 14-watt fluorescent lamp at a distance of 2 feet; the beam from a two-cell flashlight at 5 feet; a clear sky through a window, even after sunset. A supersensitive relay will easily operate on this output. For example, a Barber-Colman type O high-impedance relay operates on about 100 µa at 1 volt.

The above output is by no means the maximum obtainable from the circuit. It may be increased by applying greater input power to the transistor oscillator. One method is to reduce the base resistance. Alternatively, three or four cells may be used to power the oscillator, to increase the output voltage and power.

As examples of weaker light measurements, the following sources provide about 10 µa output through 25,000 ohms: a pair of 40-watt incandescent lamps at a distance of 8 feet or a pilot lamp (No. 47) at 6 inches. A lighted match deflects the meter to 6 µa at a distance of 6 inches.

The optimum load for the photocell is such a critical value that it lies between 10,000 and 50,000 ohms.

Many practical applications suggest themselves for this circuit. Any weak sources of illumination may be compared, measured or calibrated. For example, one common method of measuring rf power is to measure its heating effect on a filament. The brilliance of the filament is compared with that of a known lamp fed from a known source. For example, if a lamp gives the same illumination as that of a 25-watt lamp fed from the line, rf power is 25 watts.

The density of filters, films or paper may be measured and compared. For example, a filter may be placed between the cell and a standard source of illumination, and the meter will indicate the amount of light transmitted. The small window of the cell (¾-inch diameter) permits accurate measurements.

Even the light reflected from a dark wall or other surface will give readings of several microamperes. With suitable calibration the instrument becomes a photographic exposure meter.

The angle from which light can fall on this photocell is easily controlled. The cell is fitted into a polystyrene tube whose inner diameter is ¾ inch. This makes a neat fit. The tube should be painted black. As the cell is pushed deeper into the tube, the shield becomes more effective and the angle more limited.

Power supply used with the photocell.
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--- NEW RECORDS ---

MONITOR

It has always been the purpose of this column to review new record releases that are of real interest and with the accent on the technical and aural excellence achieved by each record. For our purposes, the fidelity of a recording is just as important as its musical and aesthetic excellence, if not more so. In the past, we have restricted ourselves principally to the review of long-playing discs. However, high-fidelity reproduction now includes another important recording medium: presereved tapes.

The potential of pretrained tape rests in stereophonic recordings. A good reason is that in less than 10 years the stereophonic reproducers will replace the present long-playing record in popularity. We say this confidently because a practical dual-channel, high-fidelity stereo phon LIP is certain to be developed and perfected during the next decade.

Some stereo playback systems incorporate a third speaker placed midway between the outer two and connected so that it produces an output which is the sum of both stereo channels. This "bride" speaker is sometimes helpful for minimizing the "hole-in-the-middle" effect which is present, to some extent, in present stereo recorders. This is because the two stereo microphones are a considerable distance from the musical instruments on the center of the stage and the sides of the instruments are recorded at lower volume than they are actually performing. Our playback, the lower volume of these center instruments is heard like an apparent volume "hole" midway between the two outer speakers. We did not include a bridge speaker in our setup for review, but the evaluation of the "hole in-the-middle" effect present in these stereo tapes, an important indication of the quality of the recording technique used.

A new year is beginning. For our new tape and disc column, 1955 is full of promise, with new review and recording developments in the offing. We will share with you each month in our expanded column.

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Place an unusually large orchestra in front of two Telefunken U-47 capacitor mikes, add a gifted conductor, choose the right music and you’ve got the ingredients for hi-fi excitement. In Rhapsodero the mikes are close and the sonic impact of biting brass and percussive bass drum contrasted with soft solo guitar realistically recreates the impact so characteristic of Latin American music. The full fidelity of clarinet and powerful bass at almost unbearably high power levels, so typical of the “living presence” technique, is thrilling in all quick-tempo rhythms. On the other hand, the lush, swaying lift of South American sensuous rhythms is also faithfully captured. Besides Rhapsodero, there’s My Hopeful Heart, Cordoba, Tropical Merengue, Maria-Le-O, Caminito, La Compana, I Won’t Stand in Your Way and Amor Que Basta. Only in the enormous realm of stereo can this chanteuse, Cuban portrait be fully appreciated.

Demonstration Tape No. 3: Highlights From Best Sellers of Various Artists

Concert Hall BX-37 (stacked or staggered) 
7-inch, playing time—31 minutes 
$4
Through experience we have come to expect little from demonstration tapes of this type. This one’s different. Concert Hall’s refreshing approach produces a notable demonstration tape that contains seven selections from their stereo

NEW RECORDS (Continued)

STEREOPHONIC RECORDINGS

Barbirolli conducting Halle Orchestra

Music for Hi-Fi Bags

Petie Bugalo and Orchestra (Stacked only) 
Mercury MDSS-3

Mercury continues its issue of stereophones that really show this medium off. The first two hit the Olympian dynamic range which can be achieved so impressively on tape. Neither of these is as spectacular as previous Mercury tapes reviewed here, but the Adventures with its rather small sound and in-turn presentation of various sections of the orchestra is especially good in the directionals, while the Strauss, presenting a big orchestra in big sound, is sure to impress.

The first Mercury pop is also excellent, with fine drums, very good string bass and lots of highs. Multiple miking produces a rather conceived but excellent stereo effect.

Chicago-New York Audio Show Stereophonic Demonstration Tape 
(Stacked or staggered) 
7-inch, playing time—14 minutes 
$9

It was interesting to note how the New York Audio Fair’s top stereo demonstration tape fared in the living room. The effect is not as impressive at home. First, the Audio Fair setup used four speakers, two outer stereo, a center bridge and monaural, and a rear effect. When relocated to two stereo speakers, without the lighting effects used at the Fair, most of the impact is lost. The tape impressed those who have never heard stereo before but has little lasting value. The announcements are tirking with repetition. The musical selections are too

short; before you settle down with a selection, it’s over. However, because of this brevity, there’s plenty of variety here—rivers, spirituals, elephants, Christmas carols, four-engine bombers, bowling alleys and, oh yea, full symphony orchestras. The fidelity and stereo effectiveness are very good and typical of Sterotape stereo quality. Not recommended for continued listening, but good for showoff material for stereo’s power.

Havana in Hi-Fi

Richard Hayman and his Orchestra

Mercury MDSS-2 (stacked only) 
7-inch, playing time—33 minutes 
$12.95

Place an unusually large orchestra in front of two Telefunken U-47 capacitor mikes, add a gifted conductor, choose the right music and you’ve got the ingredients for hi-fi excitement. In Rhapsodero the mikes are close and the sonic impact of biting brass and percussive bass drum contrasted with soft solo guitar realistically recreates the impact so characteristic of Latin American music. The full fidelity of clarinet and powerful bass at almost unbearably high power levels, so typical of the “living presence” technique, is thrilling in all quick-tempo rhythms. On the other hand, the lush, swaying lift of South American sensuous rhythms is also faithfully captured. Besides Rhapsodero, there’s My Hopeful Heart, Cordoba, Tropical Merengue, Maria-Le-O, Caminito, La Compana, I Won’t Stand in Your Way and Amor Que Basta. Only in the enormous realm of stereo can this chanteuse, Cuban portrait be fully appreciated.

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JANUARY, 1958
NEW RECORDS (Continued)

best sellers, and most of the excerpts are complete. Missing is the almost inevitable announcement with the long-winded sales pitch that made previous demonstrators annoying at first and unbearable in subsequent hearings. No 2-second samples here, but a full 31 minutes of music. Sam Price and his Kansas Stompers play Down Whales Again from HX-16, the Varieton Concert Orchestra plays Waldrous's España in its entirety from HX-27, Sleepy La-

gan by Marco Greco's Orchestra is taken from HX-44, followed by an excerpt from HX-

41, Ravel's La Muse L'Oiseau with the Pasadena Symphony Orchestra. The delightful Labor Merry Widow (HX-17) is featured, followed by an excerpt of Beethoven's Symphony No. 2 in D with the powerful Frankfurt Opera Orchestra (HX-39), and, finally, the last movement of Gershwin's Concerto in F displaying the talent of pianist Sonda Bianca (from HX-30).

IBERT: Escalés (Parts of Call)
Charles Munch conducting Boston Sym-

phony Orchestra

RCA Victor ACS-57 (stacked only) (7-inch, playing time—15 minutes) $6.95

Ibert's score for Escalés calls for an unusually elaborate percussion section—military drum, four kettledrums, tambourine, bass drum, cymbals, xylophone, triangle, gong, castanets and celesta. This is ideal, for the fame of the Boston Symphony rests in its percussion section and its drama. This charming work is rich with contrasts that show off this powerful orchestra and stereo to best advantage. The climax of the Valencia section is a truly excellent experience with snare drum, tambourine, kettle drums and strings on the left and brass and more percussion on the right, filling the entire room with sound. The transients are sharp, yet the orchestra is poetically smooth and silty. The performance is excellent, too. Good, relaxed stereo listening.

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

GERSHWIN: Concerto for Piano in F

Rhhapsody in Blue

Eugene List, Piano

Hanson conducting Eastman-Rochester Symphony Orchestra

Mercury MG-50138

The opening of the Concerto on this disc offers one of the most spectacular demonstrations of rich fidelity you are likely to find, with terrific drums and his cymbals in near-life-sized dynamic peaks. Plenty of fireworks later on as well, and an excellent piano, too. The popularity of the music should make it all the more in demand. Though the peaks on this seem even more Olympian than usual for Mercury, they are also cleaner: their sound is less likely to overload pickups, except on the inner grooves. The performance seems to me to be top-notch and attained by utilizing Mercury's acclaimed version of this music for me, both artistically and sound-wise.

Landmarks of a Distinguished Career

Stokowski

Capitol P-8399

For the third of its Stokowski recordings, Capitol has produced a concert of six popular classics. These are his very fine orchestral transcriptions of Bach's Toccata and Fugue in D Minor, Claire de Lune and Afternoon of a Faune by Debussy, Finlandia and Swan of Tuome-

y by Sibelius, and Blue Danube Waltz. Unless you have definite and sophisticated ideas about music, this cannot fail to please, both for music and sound. The recording is the very high standard set by the previous two in this series—bright, clean, well-balanced and exceptionally well-defined despite the license. Between them the works give a sampling of every variety of sound from the restrung to the brass, and show off the orchestra's beautiful, bold in tutti and solo the instruments are very natural, especially the string basses.

*Bonus information to the PTM offered only by Triad.

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MET" Catalogs.

LMB, 1011 Venice Blvd., Los Angeles 15, Calif.
This month brings a 12-volt automobile radio tube, a 30-mc tetrode transistor, a 250-mc drift transistor and selenium replacements for the 6AL5.

**12DL8**
A multiunit tube of the 9-pin miniature type containing two diodes and a high-perveance power tetrode. It is intended for use in hybrid automobile receivers in which tube and transistor electrode voltages are obtained directly from a 12-volt storage battery. In these

sets the diode units are used for AM signal detection while the tetrode section acts as the driver for the transistor at power output stage.

Announced by both RCA and Sylvania, typical operating characteristics of the 12DL8 are:

- $V_{hr}$ (approx) (ma) = 12.6
- $I_{hr}$ (ma) = 550
- $V_{o}$ (by rectification through 2.2-megohm resistor) = -2
- $V_{p}$ (peak af from 100,000-ohm source) = 2
- $I_{p}$ (ma) = 12.5
- $I_{0}$ (zero sig) (approx) (ma) = 40
- (max sig) (ma) = 8
- $R_{on}$ (ohms) = 75
- Total harmonic distortion R (5%) = 10
- Max Sig power output (mw) = 40
- $R_{m}$ (max) (megohms) = 10
- Maximum ratings each diode
- $P_{o}$ (ma) = 5

**2N384**
A hermetically sealed drift transistor of the germanium p-n-p type, designed primarily for military and industrial use as an oscillator up to 250 mc or as an rf amplifier in compact mobile communications equipment. The 2N384, announced by RCA, features a base region in which the impurity distribution is carefully controlled to produce a built-in accelerating field.

Maximum ratings for class-A rf amplifier service are:

- $V_{bn}$ = 30
- $V_{ds}$ = 0.5
- $I_{e}$ (ma) = -10
- $I_{r}$ (ma) = 10
- $P_{e}$ (at 25° C) (mw) = 120
- (at 55° C) (mw) = 70
- (at 71° C) (mw) = 35

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**NEW TUBES & SEMICONDUCTORS**

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70-31 84th Street, Glendale 27, L. I., N. Y.

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Export: 458 Broadway, New York 13, New York


JANUARY, 1958
To demonstrate how well Mallory "Gem" tubular capacitors resist moisture, we put some in plastic tubes filled with water. Months later, their internal resistance remains unchanged...proving there has been no moisture absorption.

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Get your stock today from your Mallory distributor. He carries them in all popular ratings for by-pass and coupling applications.

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### NEW TUBES & SEMICONDUCTORS (Cont.)

Basing is the same as the 2N274 (New Tubes and Semiconductors RADIO-ELECTRONICS, October, 1957).

3N32, 3N33, 3N34

These grown-diffused silicon tetrode transistors are especially designed and tested for amplifier applications at frequencies up to 30 mc.

**3N32, 3N33, 3N34**

Made by Texas Instruments, the maximum ratings of these units are:

- **Vc**
  - (ma) 30
  - (ma) 10
  - (ma) 5
  - (ma) 5

- **Total power dissipation**
  - at 25°C (mw) 125
  - at 100°C (mw) 50
  - at 125°C (mw) 25

- **Ic** (Ve = 20, Ic = 0)
  - (max µa) 0.2
  - (min) 30

- **BVco** (Ic = 10 µa, Ic = 0)
  - (min) 30

- **Power gain, common emitter**
  - (Vo = 20, Ie = -1 ma,
    - Ie = -0.3 ma)
  - (min db) 20 18 16
  - Frequency (me) 4.3 12.5 30

17BWP4

Another addition to the line of 110° picture tubes, the 17BWP4 is a 17-inch rectangular glass tube made by Sylvania. It has a spherical faceplate, aluminized screen and a straight gun design which needs no ion trap. Its 6.3-volt 600-ma heater has an 11-second warmup time.

**Maximum ratings are:**

- **Ultron voltage**
  - 17,600
  - 1,000
  - 550
  - 550

- **Vc** (neg value)
  - 154
  - 220
  - 0
  - 2

- **Peak heater-cathode voltage** (htr neg with respect to cath)
  - (15-sec warmup) 450
  - (after warmup) 200
  - (htr pos with respect to cath) 200
NEW TUBES & SEMICONDUCTORS (Cont.)

2N297
A p-n-p alloy junction germanium power transistor designed for use in high-current switching and audio-frequency power amplifier applications.

Announced by Clevite, the unit’s maximum ratings are:

- $V_{ce}$: 60 volts
- $I_e$: 9 amperes
- $I_s$: 5 amperes
- Total power (watts): 15
- Junction temperature (°C): 85

Selenium replaces 6AL5
Selenium rectifiers, designed to replace 6AL5’s in TV circuits have been released by G-E and Bradley Labs (illustrated).

The G-E assembly is center-tapped by connecting the two cathodes together. It is rated to handle a forward current of 0.5 ma at 2.0 volts dc, reverse current of 5 ma at 20 volts dc.

The Bradley Labs unit can be used where the peak inverse voltage does not exceed 40. Specifications are:
- Maximum applied voltage, 26 rms
- Maximum dc output voltage, 20.

2N341
A grown-junction, p-n-p silicon transistor designed for use in audio or servo amplifier stages requiring medium power output, this Texas Instruments transistor has a welded case with a glass-to-metal hermetic seal between case and leads.

Maximum ratings at 25°C case temperature are:

- $V_c$: 125 volts
- $I_c$: 40 ma
- $P_r$: 1,000 watts
- at 100°C: 400 watts
- at 125°C: 200 watts
- Power gain ($V_{ce} = 67.5$, $I_s = 10$ ma) (min db): 30

Other types
A xenon thyratron, type 7086, has been announced by RCA for use in welding and X-ray tube operation. The 7092, a radiation-cooled high-power industrial triode for applications in ultrasonic, induction or dielectric heating equipment, has been presented by Amperex.

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NEW YEAR’S RESOLUTIONS
1. To treat my customers with the greatest respect.
2. To give as prompt service as possible.
3. To pay my bills promptly and get the discount.
4. To buy wisely, knowing discounted merchandise can be the most expensive.
5. To buy from distributors who recognize our mutual problems.
6. To try to obtain new members for my association.
7. To work in my association for the promotion of the service fraternity.
8. To work when I work and try to have time for more relaxation.
9. To improve my technical knowledge and skill.
10. To charge enough to make a reasonable profit, but not enough to the unfair.
11. To expand my business by more aggressive advertising.

HOT-CHASSIS PROTECTION

The safety committee of the National Alliance of Television & Electronic Service Associations (NATESA) has recommended that all members take immediate steps to protect themselves on all cases involving hazards caused by "hot TV chassis service."

According to the council, as reported in NATESA Scope, such a set be serviced, the last serviceman could be held responsible. It is suggested that a statement similar to that below be made part of the delivery ticket.

"This TV set is of the 'hot-chassis' type. We have exercised all possible precaution to eliminate danger in handling. However, since the set is outside our control, we can assume no responsibility for electrical shock and other hazards." (Editor)

This statement may save you from damage claims.

$5 SERVICE CHARGE

Service dealers in Queens, N.Y., have increased their service charge to $5. One dealer, France’s Radio & Refrigeration, feels that customer acceptance of the increase is excellent. At the time the rate was raised the firm discovered that the customer who turned to another dealer for service was the individual who would have complained no matter what the price.
The Guild News, published by the Radio Television Guild of Long Island, reports that the movement has been under way for about eight months.

The paper also stated that “dealers, by charging $5, are at last realizing the cost of their overstand and a reasonable amount for themselves. The dealers who have been ostriches and maintain $2 and $3 service charge have not recognized the value of their own labors.”

TORONTO TECHNICIANS UNFIT?

Edward Reale, director of the Toronto Radio Electronics Technicians Association, Toronto, Canada, has said that of the 1,200 "so-called" television and appliance service technicians, less than half are qualified to work on TV sets. The statement was made at an association meeting held to develop ways of eliminating dishonest and incompetent technicians from the group.

Mr. Reale was strongly criticized for his stand, but the 71 members at the meeting agreed that fewer than 100 technicians in the area could measure up to the standards the association has set for its members. A resolution requiring all members to pass a tough examination within a year was passed. Grades of technician proficiency were set and a list of operating standards was proposed.

ESFETA OPPOSES PAY TV

The Empire State Federation of Electronic Technicians Association, New York, has strongly opposed any attempt to charge high fidelity and tape recorders to be disseminated through a series of two-day clinics in the area. Mr. Reale pointed out that the officers of the RCA Service Co. E. C. Cahill, executive of the company, stated that they would be held in most of the major centers of the nation. A booklet describing methods of training equipment, each of the four products demonstrated is given to each service technician attending.

THE REAL MEANING

A number of cliches seem to be universal with the electronics service customer, according to The Raster, official service publication of the Electronic Service Council of the nation. A few are listed with what we believe is the real meaning.

"It's just a bad tube." It's a 24CPA.

"I don't think there is much wrong." He's been working on the set.

"It won't take you a minute to fix it." I don't want to pay for more than a minute's work.

"The bill is too high." Fifty cents would be too high.

"There's not much wrong, it just quit." It's a dog.

"I could have fixed it myself if I had the right tools." I tried to fix it with the screwdriver I had.

"I don't want to spend much on this radio, but I want it fixed up good. It's a keepsake, been in the family a long time." IT SURE HAS!
...it's here!

1958 RADIO-ELECTRONIC MASTER (22nd edition)

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THE RADIO-ELECTRONIC MASTER 60 Madison Avenue, Hempstead, N.Y.

128

RADIO-ELECTRONICS

Patents

SKIN DIVER'S TELEPHONE

Patent No. 2,798,902

Daniel Richard Karwoski, Philadelphia, and Sig-

mund P. Rosen, Plymouth Meeting, Pa.

Skidivers and swimmers can now commu-

nicate- directly and without restriction. This

new transceiver can be made compact and

portable.

For transmitting speech, S1 is in the position

shown, and the solid line shows the signal path.

A balanced modulator receives two signals, one

from a microphone, the other from a fixed-

frequency oscillator. The fixed frequency itself is

balanced out, and the filter passes only the upper

sideband. When the speech frequencies are 250

to 3,000 cycles, this sideband ranges from 8.3 to

11.1 kc. It is amplified and transmitted through

the water by a conventional underwater trans-

ducer.

To receive, S1 is thrown to its other position.

The same transducer acts as pickup. The under-

water vibrations cause it to generate a volt-

age, at frequencies from 8.3 to 11.1 kc. Below the

dashed line in the diagram, this sideband is

amplified and noise is removed by the filter. Now

it beats against the fixed 8.1-kc frequency in the

transmitter, resulting in speech frequencies from

200 to 1,600 cycles, the original signal.

Both the receiver and microphone can be fitted

into a skidiver's mask. Transmitting power of

0.6 watt generates sufficient signal to be heard

at a distance of 2,000 yards. S2 is a test switch. When

closed, a fixed-frequency signal is transmitted.

INSTANTANEOUS ACC

Patent No. 2,782,368

William E. Ayer, San Carlos, Calif. (Assigned to

United States of America as represented by Secre-

tary of the Navy)

It is difficult to design a device for a radar receiver,

because the signal is pulsing. Acc must be quick-

acting. Further, it must operate on both positive

and negative pulses. This diagram shows a

video store using a new age circuit.

The gate may be half a 12AT7. Normally

both D1 and D2 conduct due to the large nega-
tive potential at their cathodes. Then when signals are weak, capacitor C effectively bypasses the grid resistor and gain is at a maximum. When a strong searesig i pulse arrives, the tube's cathode current drops. The cathode goes sufficiently negative to block D2. For all practical purposes, C no longer bypasses the grid capo-degeneration, gain drops quickly and is considereable. A strong positive pulse drives the cathode more positive, blocking D1. Again the cathode resistors is unbypassed and gain is low. In each case the strong pulse (positive or negative) instantly removes the bypassing effect of C so there is no time lag.

**SPEECH BRIGHTER**

**Patent No. 2,799,734**

Glen D. Camp, Chey Chace, Md. (Assigned to Melpro, Inc., Alexandria, Va.)

Most speech sounds carry fairly steady power over an interval of time, but a few (notably the multiplier) tend to rise and fall during the instant. This means that strong sounds of speech are nearly the same, pass through the bandpass filter and do not appear at the output. Output from the auto-correlator is ave for the amplifier. Thus gain is maintained by the maximum presence of noiselike components, and these are essentially higher frequencies which cannot pass through the bandpass filter and do not appear at the output. This makes the speech.

The second time delay equalizes for the time reading of a signal to pass through the auto-correlator.

**IMPROVED ELECTRONIC FLASH**

**Patent No. 2,775,718**

William Dobler, New Rochelle, N. Y.

This well-known inventor discloses an improved flashlamp for photographic purposes. It can be made at low cost and has long life. The side view of Fig. 1 shows that it has two main electrodes, A and B. Also, there is an auxiliary electrode C which extends from B. The front of the bulb is a Fresnel lens with a number of convex sections. The rear has a reflective surface and carries a conductive layer which connects one pin to the upper electrode A. Electrode B is tied to the other pin.

The camera shutter release operates in two steps. First, it closes battery switch S1 (Fig. 2). This charges capacitors C1 and C2. The "ready" light is a small gas tube which indicates when the battery circuit has been switched on. As the charge nears completion, current through R1 drops off and the "ready" light is extinguished. This indicates that the speed light is ready to be flashed.

When the shutter release is activated further, it closes S2. The flash switch C2 sends a high-voltage high-frequency pulse through T. This initiates an auxiliary discharge at electrode C. The main discharge follows at once, and C1 delivers its full power across A and B. Resistor R3 dissipates any voltage still remaining across capacitor C1, and the flashlamp is ready for the next cycle of use.

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This well-known inventor discloses an improved flashlamp for photographic purposes. It can be made at low cost and has long life. The side view of Fig. 1 shows that it has two main electrodes, A and B. Also, there is an auxiliary electrode C which extends from B. The front of the bulb is a Fresnel lens with a number of convex sections. The rear has a reflective surface and carries a conductive layer which connects one pin to the upper electrode A. Electrode B is tied to the other pin.

The camera shutter release operates in two steps. First, it closes battery switch S1 (Fig. 2). This charges capacitors C1 and C2. The "ready" light is a small gas tube which indicates when the battery circuit has been switched on. As the charge nears completion, current through R1 drops off and the "ready" light is extinguished. This indicates that the speed light is ready to be flashed.

When the shutter release is activated further, it closes S2. The flash switch C2 sends a high-voltage high-frequency pulse through T. This initiates an auxiliary discharge at electrode C. The main discharge follows at once, and C1 delivers its full power across A and B. Resistor R3 dissipates any voltage still remaining across capacitor C1, and the flashlamp is ready for the next cycle of use.

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**Patent No. 2,799,734**

Glen D. Camp, Chey Chace, Md. (Assigned to Melpro, Inc., Alexandria, Va.)

Most speech sounds carry fairly steady power over an interval of time, but a few (notably the multiplier) tend to rise and fall during the instant. This means that strong sounds of speech are nearly the same, pass through the bandpass filter and do not appear at the output. Output from the auto-correlator is ave for the amplifier. Thus gain is maintained by the maximum presence of noiselike components, and these are essentially higher frequencies which cannot pass through the bandpass filter and do not appear at the output. This makes the speech.

The second time delay equalizes for the time reading of a signal to pass through the auto-correlator.

**IMPROVED ELECTRONIC FLASH**

**Patent No. 2,775,718**

William Dobler, New Rochelle, N. Y.

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**SOLDERING-IRON REST**

Are you always misplacing that soldering-iron rest carried in your toolbox? Here's one that is always there when you need it—it's attached to the iron! Cut a length of heavy wire from a wire clotheshanger, bend the rest to shape around your iron's barrel and bend out the ends to form feet. If the rest fits loosely, pinch the coiled section lightly with pliers.

There's no danger of accidentally burning the customer's carpet with this soldering-iron rest!—John A. Comstock

**STANDOFF FOR SLOPING ROOFS**

On a long roof run of antenna lead-in I had to get the wire tied down to keep it from blowing around. The customer insisted that he would tolerate no screw holes through his shingles. I finally devised a method that would leave no marks or cause any leaks. A block of wood is fastened to a strip of tin (see diagram). The standoff is screwed into the wood block. The remainder of the metal strip goes under the shingles, where it is nailed down.—A. Zanelli

**MERCURY-CELL MOUNT**

With the ever growing popularity of transistors, the need for mercury cells has also increased. Since soldering leads to a mercury cell is somewhat difficult, mounting the cell and making good electrical contacts is a problem.

One way to beat this is to fasten a standard capacitor mounting clip (a) (one which holds the cell snugly) and a piece of copper with a 90° bend (b) onto a thin strip of wood or some
TRY THIS ONE (Continued)

other insulator. Place solder lugs under the mounting screw. Slip the mercury cell into the clip and push it forward (c) until its negative post makes contact with the copper strip. The clip will hold the cell in this position. Now you have a simple mount that provides for easy and rapid replacement of dead batteries.—Leonard Lyons

PIPE-CLEANER HEAT SINK

A moistened pipe cleaner makes a good thermal shunt when soldering transistors, diodes, small bantam electrolytics, etc. Simply wet the pipe cleaner and give it a twist or two around the wire lead to the transistor, etc., as shown in the photo. The pipe cleaner adds a safety factor to a pair of tweezers or pliers also used for a similar purpose. You don't need an extra hand to hold the pipe cleaner in place either.—A. R. Clawson

KNOB FROM TOOTHPASTE-TUBE CAP

Subminiture ferrite coils with micrometric screws are a big improvement over the earlier hard-to-tune types. Yet tuning is still very difficult because the shaft's diameter and the screw slot are very small. I have found that toothpaste-tube caps make ideal knobs for these coils. Drill a hole in the cap slightly smaller than the shaft's diameter. Then cover the end of the shaft with a good grade of multipurpose

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Robert L. Edwards, 343 Morn-

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mobile communications systems, 6, calibrated direct-reading scales cover 25-54, 140-175, 400-470, and 800-960-μc bands. Each range calibrated to 0.5%. Signal is stable to within 0.01%. Output voltage variable from 0.1-100,000 volts—Motorola Inc., Dept. SG, 4901 W. Augusta Blvd., Chicago 51, Ill.

TUBE TESTER KIT, model T-69. Checks AM-FM-TV tubes, including series-string types, 5-inch meter. Illuminated roll chart. Accessories include picture-tube test cable and 110° adapter—Paco Electronics Co., Inc., 70-31 84th St., Glendale 27, N.Y.

GRID CIRCUIT TESTER, model GCT-5. Checks condition of control grid of vacuum tubes for control grid emission, gassy tubes, and internal shorts.—Sears Manufacturing Co., 5015 Penn Ave. S., Minneapolis, Minn.

TRANSISTOR CHECKER, model TRC1. Tests for opens, shorts, current gain and leakage on all transistors and forward-reverse currents on crystal diodes and rectifiers.—Service Instruments Corp. (Sencore), 171 Official Rd., Addison, Ill.

REPLACEMENT FLYBACKS, HVO-76 exact replacement for Sylvania 241-0019; HVO-70 for Bendix NH 26601-1, 2; HVO-71 for Spartan PC-70010 and PC-70012; HVO-72 for Spartan PC-70012; HVO-71 for Spartan PC-70015; HVO-71 for Spartan PC-70025.—Merit Coll & Transformer Corp., 427 N. Clark St., Chicago 40, Ill.


METALLIZED CAPACITORS, type KLR. Metalized Mylar case unit. For potted assemblies, military and commercial applications.—Atron Corp., 250 Grant Ave., E. Newark, N.J.

SILICON RECTIFIERS. For radio, TV, and other electronic equipment. Screws onto the chassis or plugs into a holder. Typical unit ratings, 750 ma at 400 volts. Other values for commercial purposes range from 5 to 1,000 ma at between 100 and 400 volts.—Audio Devices Inc., Rectifier Div. 620 E. Dyer Rd., Santa Ana, Calif.


INDOOR TV ANTENNA, Vi-Fl. VHF and uhf models. Tuner designed for single or dual antennas. Includes transformer. All mounting hardware supplied.—Telco Electronics Mfg. Co., 400 S. Wyman St., Rockford, Ill.

TV ANTENNAS, Colortronics. Gold-anodized aluminum. Impervious to staining, spotting, tarnishing, fading and corrosion. Includes all helix and single orientation needed. All mounting hardware supplied.—Telco Electronics Mfg. Co., 400 S. Wyman St., Rockford, Ill.

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JANUARY, 1958
NEW DEVICES (Continued)


PIX TUBE REJUVENATOR, Rare-All. For parallel or series circuits. Claimed to cure open-cathode and heater-cathode shorts; control grid shorts, slow heating or low emission. Base design fits all TV picture-tube sockets without adapters.—Anchor Products Co., 2712 Montrose Ave., Chicago 18, Ill.

PORTABLE RADIO, all-transistor Trans-Oceanic, 8 bands with electronic handscrew to stretch distance between stations on dial. 13 lbs., including batteries. Ordinary flashligh batteries power set up to 300 hours.—Zenith Radio Corp., 6001 W. Dickens, Chicago 39, Ill.

TRANSISTOR RADIO KIT, model TR-II-K-1, 4 transistors and a diode. Flat ferrite antenna, printed circuit board and 2½-inch speaker.—Superex Electronics Corp., 4-6 Radford Place, Yonkers, N. Y.

CABLES. Full line with molded-on connectors. 10 to 72 inches with various combinations of phono pin plugs and jacks, alligator clips, spade lugs and phone jacks. Transparent plastic envelopes.—Walseo Electronics Manufacturing Co., 100 W. Green St., Rockford, Ill.

PRINTED-CIRCUIT SOLDERING KIT, 4 interchangeable tips fit this manufacturer's regular model 250k soldering gun. Tip No. 5209 designed for removal of circuits in straight line. No. 5208 for multiple connections requiring simultaneous removal.

No. 5207 for removing all standard sockets from printed-circuit boards; No. 5206 for removal of difficult connections like cans.—Gregg Electric Corp., 26 S. Broadway, Lawrence, Mass.

TUBE CADDIES, Pacemaker TC-100 (left). With meter and tools, holds 202 tubes or less.

Pacemaker Jr. TC-200 (right), 143 tubes or less.—Argus Products Co., 310 Main St., Geneva, Ill.

SOLDERING AIDS, miniaturized, two types. Specifically designed for printed-circuit applications.—Available from CBS-Hytron tube distributors.

CAPACITOR, type RQL. Mylar metallized in a hermetically sealed case. Reliable at temperatures up to 125° without derating.—Astron Corp., 225 Grant St., E. Newark, N. J.

TURNTABLE, G. I. Special. 33 ½ rpm. 50- or 60-cycle operation by shifting the drive belt to one appropriate step on the turntable's pulley.—Components Corp., Denville, N. J.

All specifications given on these pages are from manufacturers' data.

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Technotes

MOPAR 821X AUTO RADIO

After the set blew a replacement 14-amp fuse, I pulled it out of the car for a check. Not having 6-volt power at the bench, I checked for opens, shorts and in-betweenes.

Tubes, vibrator, buffer and filter capacitors appeared normal, but the B-plus filter resistor, a 2,200-ohm unit, was cooked down to around 300 ohms and indicated a dead short in the B-plus line.

A check of all components failed to locate the short until the spark-plug assembly was suspected. It was dismantled by filing and punching out the rivets. A small hole burned in the insulation between plates 1 and 2 proved to be our trouble.

The spark plugs were reassembled with a layer of electrical tape backing up the defective insulation. And, with the set reinstalled, the total damage amounted to one 2,200-ohm 2-watt resistor, two fuses and a lot of valuable time.

The moral of all this? Spark plugs are not as rugged and dependable as they appear.—Paul B. Lavalle

FLYBACK SINGING

Flyback transformer “singing” is a high-pitched whine occurring at 15,750 cycles and is caused by an inherent mechanical resonant condition. The core is usually the vibrating medium although a loose lead connected to the transformer or a loose turn of wire within the transformer itself is also often responsible for this condition. Singing is usually objectionable and sometimes nerve-racking to those whose hearing is acute at high frequencies. (Most people can’t hear it.)

To eliminate or minimize this condition, tighten and dress all leads; tighten all screws on the terminal board and mounting bracket, being careful
not to crack the transformer core or terminal board. Pack insulating wax or carbon compound between the core and terminal board and between the core and mounting bracket. If the difficulty still persists, as it sometimes does in more stubborn cases, mount the flyback transformer with rubber shock mounts and tighten the mounting screws securely. Also try readjusting the horizontal drive, width, and horizontal linearity controls.—Warren J.

Smith

**SNIVET CURE**

A General Electric 9-inch portable (model 9T001) had dark smudges on the right-hand side of the picture. A bypass to ground at the screen grid of the horizontal output tube reduced the intensity of the smudges (the snivets) somewhat but not enough to be considered a cure. As the accompanying schematic shows, a filament choke was installed in series with the 135-volt B-plus feed to the output tube's screen grid to finish the job.

**Can you think... faster than this Machine?**

Control panel of GENIAC set up to do a problem in high-speed research.

This filter prevented radiation of the disturbances at the horizontal output's screen grid all over the set via the 135-volt B-plus bus.—James A. McRoberts

**NO B — Y, BLUE SCREEN**

We have had a couple of sets come in with this trouble. An RCA CTC5 came in with a complaint that the screen had a predominant blue tint on monochrome programs. A check of the circuit showed no B-Y signal applied to the color picture tube. Further work pinned it down to L702. The coil had opened, cutting off the signal to the picture tube. The coil was replaced and the blue tint disappeared.—L. Warren

**TV PICTURE TUBE CONVERSION KIT**

Complete conversion kits for replacing metal tubes with glass tubes. Kit contains everything except the picture tube. Average conversion less than one hour.

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**RADIO-ELECTRONICS**

140
THE FUND REACHES $12,294.37
HELP - FREDDIE-WALK FUND

As we enter 1958, the Help-Freddie-Walk Fund, through the generosity of our readers, has collected almost $12,500 for little Freddie Thomason, son of a radio technician of Magnolia, Ark., and born without arms or legs.

We have not heard from the Thomasons for some time but, believing that "no news is good news," we are certain that Freddie is making steady progress in his fight to adjust to the normal life of a 7-year-old.

It goes without saying that we are sincerely grateful for all donations, no matter how small, but at this time we would like to say a special "thank you" to John Stefanuk of New York City, who has contributed $50 to the fund, and to Walter C. Hieber, Jr., radio and television technician of Maracaibo, Venezuela, who wrote us at length congratulating us on our efforts in Freddie's behalf and enclosed his check for $25. We would also like to thank Mr. Walter G. Sturt, assistant to the Meridian TV Service of Washington, D. C., who for several months have sent in almost-weekly donations.

Won't you send in your contribution as soon as possible? All donations are acknowledged by letter and are forwarded to Magnolia, where they are allocated according to Freddie's needs.

Make out all checks, money orders, etc., to Kiwanis Club of Magnolia, Ark. Send all contributions to: Help-Freddie-Walk Fund c/o RADIO-ELECTRONICS 154 W. 14 St., New York 11, N. Y. RADIO-ELECTRONICS Contributions are of July 16, 1957. $11,691.87 FAMILY CIRCLE Contributions: 602.50 Anonymous, Philadelphia, Pa. 1.00 Norman Fletcher, Toledo, Ohio 1.00 Cdr. Gant, USN, Seattle, Wash. 5.00 Walter C. Hieber, Jr. Maracaibo, Venezuela 25.00 Clayton Loyd, Oneda, Tenn. 15.00 John Stefanuk, New York, N. Y. 50.00 TOTAL CONTRIBUTIONS as of Nov. 11, 1957. $12,436.47

CORRECTIONS
There is an error in the coil table for the 108-inch common water described in the article "Tracking U.S. Satellite" on page 45 of the December issue. L4 is listed as 19 turns of No. 16 wire. It should be 9 turns as specified in the schematic.

Transformer T5 in the "7-Transistor Pocket Radio", November, 1957, is a Lafayette type MS-341. An error in the manufacturer's original specifications led us to list its primary impedance as 18,000 ohms. It is 25,000 ohms.

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**TV DIAL LAMP CONTROL**

Dial lights on TV sets are often too dim, or contrariwise, bright enough to distract the viewer. Patent No. 2,743,433, issued to B. S. Parment and assigned to Motorola, describes a system that turns on the dial lights when the viewer approaches the set to adjust its controls. The circuit is shown with typical resistance and capacitance values. Tube types were not specified in the patent drawing. Experimenters may try typical voltage-amplifier type triodes in the amplifiers and half of a 6AL5, a germanium diode or a similar rf detector diode in the rectifier circuit.

Coil L1 is tuned to a harmonic of the horizontal sweep frequency by C1 and C2, and L2 is tuned to the same frequency by C3. C1 is the capacitance between a metal control escutcheon and the chassis or ground. The .01-rf capacitor in series with L1 helps to insulate the escutcheon from the chassis.

When the set is operating, a harmonic of the flyback pulse is picked up by the escutcheon and a sine-wave signal is fed to the grid of V1. The variable grid capacitor combines with the input capacitance of V1 to form a capacitive voltage divider. It is adjusted so the signal applied to the grid drives V1 just to the point of saturation.

The amplified output of V1 is applied to the plate of rectifier V2. The grid of the dc amplifier (V3) is biased positive by a connection through R2 and R1 to a voltage divider consisting of 10,000 ohms from B plus and 47,000 ohms to ground. V2 rectifies the signal applied to its plate and develops a voltage across R1 that opposes the positive voltage on V3's grid. The negative voltage on V3's plate and V3's grid overcomes the positive bias and drives V3 to cutoff.

When the viewer's hand approaches the controls, the capacitance of C1—the capacitance between the escutcheon and ground—changes, detuning the input circuit and reducing the signal applied to V1. The rectified voltage developed across R1 drops, reducing the bias on V3's grid and permitting it to conduct. R3 draws plate current through R2 and develops a voltage drop across it. This voltage is applied to the neon or gaseous type pilot lamps through a 100,000-ohm limiting resistor. V3 cuts off and the lamps go out as soon as the viewer's hand moves away from the control escutcheon.

---

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COLORADAPTOR, 1708 Santa Cruz, Monta Park, Calif.

RADIO-ELECTRONIC CIRCUITS (Continued)

Optimum values for L1, C2 and L2 may be determined experimentally. L1 and L2 may be tapped TV linearity or width coils such as the J. W. Miller type 6323 with an inductance range of approximately 0.5 to 5 mH. C2 can be an adjustable mica paddler with a maximum capacitance of around .001 μF.

SURFACE-BARRIER SUPERREGEN

This circuit, although quite simple, has great sensitivity. I proved this to myself one night while tuning across the bands. Using a 4-foot test lead as an antenna, I picked up WWV on 15 mc, and a local ham. I could even hear the California ham he had contacted on 10 meters. (I'm in Belleville, Ill.)

I use tapped capacitance feedback, which eliminates the need for a tapped coil. For L you can use a Cambridge

Thermionic L5 — 5, 10- or 30-mc coil, depending on the desired operating range.

Quenching action takes place in the transistor's base circuit, with R and C1 determining the quench frequency. Variations in the values of R and C1 are left to the builder, but be careful not to make R too small and exceed the transistor's current rating.

Values of C2 and C3, which form part of the tank circuit, may be changed to obtain the desired operating range, but take care to maintain the proper ratio of these two capacitors. If this ratio is not maintained, oscillation will not occur. The earphones can be replaced with a transformer, and a transistor audio amplifier added. — Donald S. Belanger, KoHGT

END

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143
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- Input: 115 Volts 50/60 cycles
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- Less than 0.002% at full output

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**CAPACITORS.** Subminiature electrolytics are described in Engineering Bulletin TE-350; Mylar-metallized capacitors in RM-300; flat and round miniature Mylar dielectric types in RM-125; and metallized Mylar units in RM-375. — Astron Corp., 255 Grant Ave., New York, N. J.

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**OK METHODS MANUAL C4** gives detailed advice on how to assemble and use many of this manufacturer's connectors. Single- and multiple-contact units are listed in the manual's 44 illustrated pages. — Amphenol Electronics Co., 1830 S. 54 Ave., Chicago 50, III.

**TEFLON INSULATED WIRE**, Bulletin 8050. Military specification wire, standard and Teflon-insulated are listed along with their specifications in an illustrat-
ed 4-page pamphlet.—Belden Manufacturing Co., 4647 W. Van Buren St., Chicago 44, Ill.

ALL ABOUT FM ANTENNAE and their installation by L. F. Carini is a handy booklet about types and characteristics of various FM antennas. An 8-page directory, listing commercial FM stations in the United States, and their frequencies is included.—Apparatus Development Co., Inc., Wethersfield 9, Conn. 25c.

AMATEUR RADIO EQUIPMENT is described in this colorful 24-page catalog No. 557. Viking transmitters and accessories are presented, Circuit diagrams of many items are also shown.—E. F. Johnson Co., Waseca, Minn.

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MANUFACTURER'S SWITCH CATALOG offers complete specifications for this firm's complete line of rotary, slide and lever switches. This new catalog, available to interested parties, presents switches capable of handling power from a kilovolt to a microvolt.—Centralab, 900 E. Keefe Ave., Milwaukee, 1, Wis.

ELECTRONIC CONNECTOR, a 4-page quarterly publication, announces the firm's recent product developments and, specifically, designs in electronic connectors.—H. H. Buggie, Inc., Box 817, Toledo 1, Ohio.

MIT LINCOLN LABORATORY's fundamental research program and other activities are covered in an illustrated 12-page booklet. Subjects includes the SAGE system, heavy radar, memory devices, transistor digital computers, scatter communications and systems analysis.—MIT Lincoln Laboratory, Box 24, Lexington, Mass.

SPEAKER CATALOG. An attractive, descriptive folder outlines the complete line of Wigo speakers.—United Audio Products, 202 E. 19 St., New York 3.

INDICATOR LIGHTS, Form L-159. Subminiature indicator lights that incorporate the NE-2D neon glow lamp are described and illustrated in this 4-page catalog. The units shown are designed for panel mounting.—Dialight Corp., 60 Stewart Ave, Brooklyn, N.Y.

REGULATED DC POWER SUPPLY is described and illustrated in Bulletin 256. Specials, too, are presented for this laboratory unit.—Quad Electric Co., 69 Murray St., New York.

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ages for its silicon rectifiers. The Kit Pak's hold 20 M-500 TV conversion kits or 20 M-150 radio replacement kits.
University Loudspeakers, White Plains, N. Y., is participating with Fred Waring and his Pennsylvanians in a 10-week National Hi-Fi Holiday Tour. University developed an elaborate sound reinforcement system to improve listening in theatres and auditoriums where the concerts will be held. Photo shows engineer testing the system.

Lawrence Le-Kashman, widely known in the h-f, radio and television industries, has resigned as vice president of the David L. Bogen Company & Presto Recording Co., Paramus, N.J., to rejoin Electro-Voice, Inc., Buchanan, Mich., as vice president in charge of sales. Prior to joining the Bogen organization in 1956, Mr. Le-Kashman had been vice president of Electro-Voice for four years, and previously had been associated for several years with the RCA Tube Division, Harrison, N.J., resigning as advertising manager to join Electro-Voice.

Frederick H. Guterman was elected a vice president of Allen B. Du Mont Labs., Clifton, N. J. He is general manager of the Industrial and Military Equipment Div. He came to Du Mont some months ago from American Bosch Arma Corp.

Daniel P. Knowland, Jr., was promoted to assistant general manager of Health Co., Benton Harbor, Mich. He had been comptroller and assistant secretary.

Lester A. Bogen, president of Bogen-Presto, Paramus, N. J., division of the Siegler Corp., announced a new alignment of the sales department.

Mortimer Sumberg who was distributor sales manager of David Bogen Co. becomes responsible for all commercial sales to distributors for both Bogen
and Presto. Thomas L. Aye, who joins the organization, will manage the sales of professional products and David E. Pear will continue as advertising and sales promotion manager. Mr. Aye was formerly sales representative for Presto in the New York Metropolitan area and prior to that was a partner in Henry Geist & Co. Mr. Bogen reports that sales for Bogen products for the third quarter of 1957 were up 45% over last year and Presto’s sales up 15%.

A. L. (Al) Pezman was appointed sales manager of Trio Manufacturing Co., Griggsville, Ill. He has been associated with the firm for four years in executive post and prior to that had wide sales and advertising experience.

Donald T. Lucas was promoted to manager of receiving tube sales for Raytheon Manufacturing Co. Paul R. Keeler (below left) was named manager of Government relations and C. W. Duncan, sales engineer of receiving tubes, TV picture tubes, transistors and semiconductor diodes. Lucas who has been with Raytheon since 1948, will also work out of the Franklin Park, Ill., plant, Duncan, who has had 11 years’ experience as a TV design engineer, will work out of Franklin Park. Keeler will maintain his office in Newton, Mass.

Lee Gunter, Jr., (left) and Robert Troxel were named chief development engineer and chief products engineer respectively, of Shure, Bros. Inc., Evanston, Ill. Both have been with the company for more than 12 years.

Obituary

Gerard Swope, former president of the General Electric Co., died at the age of 84. Mr. Swope, who started with G-E in 1895 as a helper at $1 a day, became its president in 1922 and remained in that position until his retirement in 1939 at the age of 67. He was also a director of the National Broadcasting Co., RCA Photophone Co., RCA Victor, RCA Radiotron Co., and 14 other companies in the electric, electronics and power fields.

END
TV AND RADIO TUBE SUBSTITUTION GUIDE, Harry G. Csin, Amagansett, N. Y. 5¼ x 8¼ inches. 22 pages. 50c.

The 1957 edition of this handy booklet lists direct replacements for many common types of vacuum tubes. Saves the need of a second trip when you're out on a job and don't have the tube you need. All tubes listed fit into the same socket without any wiring changes. A chart of 600-ja series-string tubes with controlled warmup is also presented. In a separate section is a TV picture tube substitution guide. As practical as the first section, it emphasizes substitution rather than conversion. Many of the recommended substitutions can be made without changes of any kind.—LS


Written for students and engineers, this book goes into considerable detail to explain what a semiconductor is and why it behaves as it does. Transistors, rectifiers, photocells and 100 pages. $9.95.

Electricity is a fascinating subject, and according to the author, its study is more important than that of any other scientific subject. Certainly it is well explained here, and written so that all may understand. The reader learns how to experiment with electricity, to wire doorbells and automatic alarms and even how to wire a house safely. Motors, magnets and transformers and their applications are described. Except for simple Ohm's law, there is no math.

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Electronic Periodicals, Inc. 2775 S. Moreland Blvd., Cleveland 20, Ohio. 8" x 11½ inches, 495 pages, $10.

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The Lafayette LG-50 is a factory-wired and calibrated precision instrument for full alignment of IF and RF stages of TV and FM receivers. A new, linear sweepable sweep system covers 3MC-126MC and 146MC-260MC. Sweep width continuously variable 0-12MC; sweep time (variable): 50MS-2000MS, linear sweep. Marker covers 3MC-225MC in 4 ranges. Combination of crystal and variable markers allows complete flexibility of external marker. The built-in 100,000 microfarad high efficiency bearing having negligible drift. Ranges: 0-500µ, 0-1000µ, 0-225MC, and continuously-variable fine adjustment trimmers. Output impedance 50Ω, unilateral and controlled. Sweep input 0.001Ω, unilateral and controlled. Single knob control. Sweep head, dial and finish are on front panel. Marker Amplifier, RF Attenuator, Sweep Range Selector, Marker Range Selector. Crystal control. A very accurate and sensitive VOM. This Multimeter is a complete instrument (not a kit) with high quality and sensitive 160 micrometer magnet; 2000 ohm per volt on both AC and DC. Single selector switch to auto/manual ranges. 5½ meter. Features extreme versatility, accuracy and ruggedness. In attractive plastic plastic front, metal bezel for ruggedness and shielding. Fine easy range range. Output 10 volt AC source. Scale 4½" x 3½" x 1½". Complete with test leads and batteries. Shipping weight 2 lbs.

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NEW POCKET AC-DC VOM MULTİTESTER

2300 ohm volt sensitivity. Flexible for AC & DC. 160 v 3 METER 1% PRECISION RESISTORS

SILVER CONTACT SELECTOR SWITCH

FULL SCALE RANGE

D.C. Volts: 0-10; 0-50; 0-500; 0-1000; 0-5000; 0-10,000 Vols—A.C. Volts: 0-100; 0-500; 0-1000 Vols—D.C. Current: 500 mA and 5000 mA—Resistance: 0-10Ω, 0-100Ω, 0-1000Ω, 0-10KΩ, 0-100KΩ, 0-1MΩ—Capacity: 100µμF and 10mμμF—Inductance: 10mμμH and 100mμμH—Frequency: 50-60C—Temperature: 0-60C. Model MT-95...

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BW-30A

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LOOK AT THESE FULL SCALE RANGES

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with BINAURAL CHANNEL AND DUAL VOLUME CONTROL.
- Self-Powered
- DC On All Filaments
- 24 Positions of Equalization
- Tape Head Input, High Impedance
- Dual Cathode Follower Output Stages

This is not only the finest hi-fi preamp characterized by unmatched features, but it has been functionally designed to keep pace with the conversion of your present hi-fi system to binaural (stereophonic) sound. Incorporates an extra channel and dual volume control for binaural reproduction. Features include DC on all tube filaments, negative feedback in every stage, dual cathode follower output stages and latest techniques in circuit design. 4.5% IM distortion and less than 0.07 harmonic distortion at 10V. Hum and noise level better than 80 db below 30V. Uniformity flat frequency response over entire audible spectrum. 7 Inputs for every hi-fi and phone, tuner or tape. Tasteful styling, brilliantly executed. Size 13½” x 4½” x 3½”. Shpg. wt., 10½ lbs.

KT-300—Lafayette Master Audio Control Kit Complete with cage and detailed assembly instructions. Net 39.50

LT-30—Same as above completely wired and tested with cage and instruction manual. Net 59.50

DLUXE 70 WATT BASIC AMPLIFIER
- Conservatively Rated At 70 Watts on Tape Head Feedback
- Variable Damping
- Metered Balance And Bias Adjust Controls
- Available In Kit and Wired Form

Here’s ultra-stability in a 70 watt basic power amplifier employing highest quality components conservatively rated for long life. Features include R8’s and wire general Chicago output transformer, variable damping control, meter for bias and balance and 100”, 651, 100”, 5150, 500”, 10”, 10 db. Hum and noise 90 db below output, IM distortion less than 1½% at 70 watts, less than 0.3% below 10 watts. Harmonic distortion less than 2% at 70 watts output. 15 watts output power, 15 watts output. Has built-in antennas for both AM and FM as well as provision for outdoor antenna. Finished in attractive dark maroon and gold. Small 14½”, 11”, 7½” including cage and knobs. Shpg. wt., 40 lbs.

KT-400—Lafayette 70 watt Deluxe Basic Amplifier Kit complete with cage and detailed assembly instructions. Net 69.50

LA-70—Same as above completely wired and tested with cage and instruction manual. Net 94.50

Lafayette CUSTOM HI-FI “MUSIC MATES” STYLE MATCHED TUNER AND AMPLIFIER
MODEL LT-40 “MUSIC MATE” DELUXE FM-AM TUNER
- ARMSTRONG CIRCUIT
- AFC DEFEAT
- FOSTER-SEELEY DISCRIMINATOR
- TEMPERATURE COMPENSATED OSCILLATOR
- MEETS FCC RADIATION REQUIREMENTS

A sensitive, selective, stable FM-AM tuner. Temperature compensated oscillator and AFC assure drift-free performance and “locking-on” of static-free performance. 100”, Armstrong circuit eliminates Foster-Seeley discriminator uses 6 tubes, a rectifier and 2 long-life matched germanium diodes. Superior frequency response, hum and distortion specifications assure client maximum satisfaction. Has built-in antennas for both AM and FM as well as provision for outdoor antenna. Finished in attractive dark maroon and gold. Small 13½” 12” x 5½”. Shpg. wt., 10 lbs. Available with cage for shelf use or without cage for custom mounting.

Lafayette LT-41—FM-AM Tuner (Less Cage) Net 64.50

Lafayette LT-40—FM-AM Tuner (With Cage) Net 67.50

MODEL LA-40 15 WATT “MUSIC MATE” AMPLIFIER
- 20-20,000 CPS ± 10K
- TAPE HEAD AND RECORD EQUALIZATION
- LESS THAN 1% DISTORTION
- PUSH-PULL EL84 OUTPUT TUBES
- RUMBLE FILTER
- INPUT CHANNELS
- LOUDNESS CONTROL

Brilliantly engineered, beautifully styled and moderately priced, this deluxe amplifier matches the tuner in both quality and performance. Utilizes new premium quality EL84 tubes. In push-pull. In addition to separate bass, treble and volume controls, has 3 position loudness switch to retain correct tonal balance. 5 inputs, full名人, Ceramic Phone, Magnetic Phone, Tape, Tuner and Aux. A hum adjustment control minimizes subsidiary hum. Rumble filter switch to eliminate motor vibrations. Speaker and tape output. Output Impedance 4, 8 and 16 ohms. Has all of the prerequisite features for a fine hi-f1 system. Size 12½”, 11”, 5½” D = 5½” H = 7½” Shpg. wt., 12 lbs.

Lafayette LA-41—Amplifier (Less Cage) Net 43.50

Lafayette LA-40—Amplifier (With Cage) Net 46.50

NEW “DYNA-SLIM” MICROPHONE
- HIGH IMPEDANCE — 50,000 OHMS
- ON-OFF SWITCH
- “QUICK-SLIP” ADAPTER

New dynamic, high output microphone with all the features of "slim" costing 3 times Lafayette’s price. Output level 55db. Smooth response from 60 to 10,000 cycles. Omnidirectional head. External on-off switch. Slips on or off stand adapter in a wink. Standard 5/8” — 27 adapter permits fitting mikes for multangle use. Satin black and chrome finish. Complete with detachable cable and connector. 8” long, 1½” max. dia. tapered panel. Shpg. wt., 2 lbs.

PA-43 Net 6.95
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100,000 BTU self-contained heater. Model H-1 ideal for Scouts. Simplest, most practical method of providing warm air for emergency use. Entire unit can be carried by one man. Heats air uniformly. Can be used for any heating or cooling. Ideal for scouts, campers, or emergency use. Entire unit can be carried by one man.

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See Nov. 1944 Electronics for further details

This is a survey instrument for automatically drawing a map of the terrain over which the jeep or other vehicle to which it is attached travels. These Odographs are made by the Calculating Machine Co. and sold in quantities up to 100 units. Each unit purchased is delivered to the buyer by the company. These Odographs are made by the Calculating Machine Co. and sold in quantities up to 100 units. Each unit purchased is delivered to the buyer by the company.

LEEDS & NOURTHROP MICROMAX RECORDERS

Price $95.60 ea.

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New Torque Amplifier Only $7.95

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Low-Bass Section Employing an advanced principle of folded corner-horn loading, the new Patrician IV utilizes high-fidelity's only 18-in. low-frequency driver, Model 18WK. The taper rate has been extended to 35 cps. The first three octaves, to the first crossover point at 200 cps, are reproduced by a tremendous bass driving section . . . the largest, most highly developed ever designed for 1021 cps. Very-High Section

Treble Section, the horn presently only with the Patrician IV utilizes high-fidelity's only exclusive Electro-Voice high-frequency driver. Again the exclusive Electro-Voice direct radiation and employment of low crossover-frequency allows exploitation of the sealed cavity feature, assuring more than one full octave of added bass with unprecedented efficiency, providing direct front radiation of higher frequencies and musical balance.

Mid-Bass Section A separate horn employed as an indirect radiator with its two complementary Model 828HF driver units takes over for only the next 1½-octave range to 600 cps. Because no metal horn presently developed satisfactorily reproduces down to 200 cps, the horn load for the intermediate bass drivers is fabricated of wood and the A8419 phenolic tubes of the Mid-bass speakers.

Treble Section, The vital "presence" range—from 600 to 3,500 cps or the next 2½ octaves, the Electro-Voice Model T25A treble driver exhausts into a 600-cycle Model 6HD diffraction horn. This diffraction horn is another exclusive Electro-Voice design. The principles of optical diffraction are employed to disperse high frequencies far more uniformly than possible with conventional cellular type horns.

Very-High Section The range above 3,500 cps, extending beyond the range of hearing, is reproduced by the new Model T350 Super-Sonax very-high-frequency driver. Again the exclusive Electro-Voice diffusion horn is used. Through the Model T350, the remaining octaves of the upper audible octave are completely accomplished with practically no measurable distortion.

Crossover Network To allocate the various portions of the spectral energy to the respective driver units, the Model X2635 crossover network divides the amplifier power into four separate portions, and eliminates upper harmonic and intermodulation distortion from one driver in the region covered by the next.

Completely Engineered for the Ultimate in Sound Reproduction!

Now you can own an acoustically correct Electro-Voice high-fidelity, folded-horn speaker enclosure for your home music system and save up to one half! Build it yourself . . . seven models to choose from . . . wall types . . . corner models . . . for full-range loudspeakers . . . for separate two, three and four-way systems. Everything is ready to assemble . . . all parts pre-cut, shaped and drilled. Simply follow the easy, step-by-step instructions included.

Model KDL PATRICIAN IV Interior Assembly

For those desiring the utmost in reproduced music, the bass section design extends the lows and uses room walls as extensions of the exponential horn air load. Indirect radiation and employment of low crossover-frequency allows exploitation of the sealed cavity feature, assuring more than one full octave of added bass with unprecedented efficiency, providing direct front radiation of higher frequencies and musical balance.

Size: 57½" high, 34½" wide, 26½" deep.
Shipping weight: 135 lbs. Net: $118.00

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