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POPULAR ELECTRONICS

AUGUST 1959

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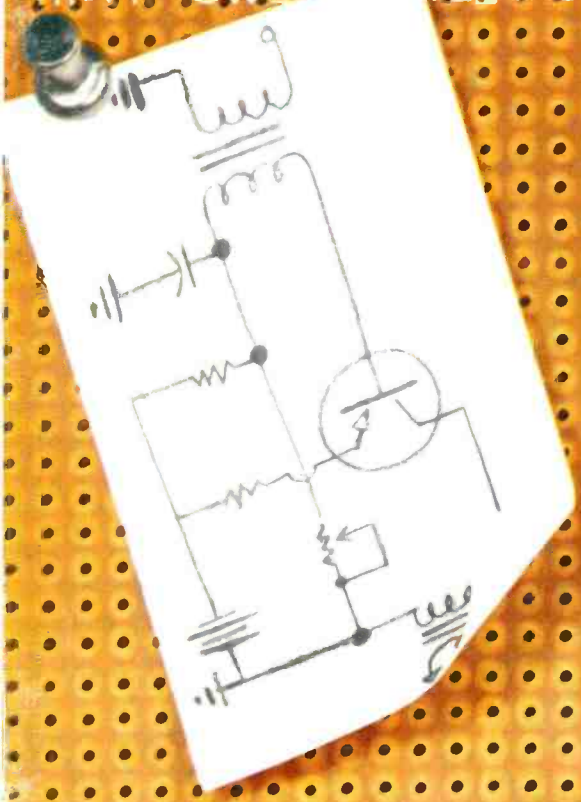

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But first other problems had to be solved: how to house the complex electronic equipment; how to assemble and test it at hard-to-reach relay stations way up in the mountains; and how to do it economically.

On-the-spot telephone company engineers had some ideas. They worked them out with engineers at the American Telephone and Telegraph Company and at Bell Telephone Laboratories. The result: a packaged unit.

The electronic equipment was assembled in trailer-like containers at convenient locations and thoroughly checked out. The complete units were then trucked up the mountains and lifted into position.

The system, now operating, keeps a watch on itself. When equipment falters, a relay station switches in stand-by equipment, then calls for help over its own beam.

The new Phoenix-Flagstaff link illustrates again how Bell System engineers work together to improve telephone service. Back of their efforts is the constant development of new communications systems at Bell Laboratories.

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POPULAR ELECTRONICS

AUGUST 1959

VOLUME 11 NUMBER 2

"Bonus" Feature

Electronic Construction Projects

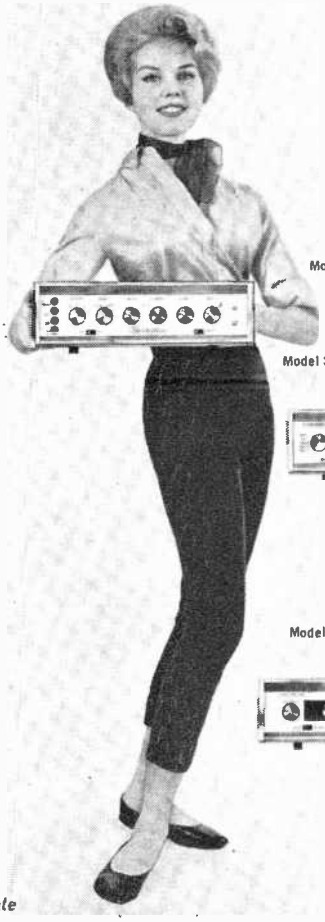
Audio and High Fidelity

Electronic Features and New Developments

Amateur and SWL

Departments

Discover for yourself why Sherwood is the most honored line of high fidelity components in the field. Sherwood Tuners (the first ever to achieve sensitivity under 0.95 microvolts) feature: Inter-Channel Hush, a noise muting system which makes FM tuning easier than ever • FM Multiplex Output • "Feather-Ray" Tuning Eye • Automatic Frequency Control • Flywheel Tuning. Combine these tuners with either of Sherwood's "mated" stereo amplifier choices; 20+20 watts or 36+36 watts. And only Sherwood offers all these features: Single/Dual Bass & Treble Controls • Mid-Range Presence Rise • Stereo-Mono Function Indicator Lights • Phase-Reverse Switch • Damping Factor selection. Sherwood also offers either 36 or 60 watt monaural amplifiers, FM Multiplex Adapters and a complete decorator-styled line of cabinetry and 3-way speaker systems —The Finest in High Fidelity, Sherwood Electronic Laboratories, Inc., 4300 N. California Avenue. Chicago 18, Illinois.



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COMING NEXT MONTH

(ON SALE AUGUST 20)

Keep your eyes open for the September cover—it will show a picture of a color TV show under way. This ties in with a no-holds-barred evaluation of color TV to date. See page 39 for details.

A whole batch of novel construction projects will appear in next month's POPULAR ELECTRONICS. Here is just a partial list: an electronic fish lure that really works; a completely transistorized stereo tape preamplifier to provide the best possible results from stereo tapes; and a pocket-sized three-transistor portable radio with a built-in loudspeaker.

Also coming are interesting and informative feature articles and, of course, all our regular features for experimenters, hams, SWL's and hi-fi'ers.

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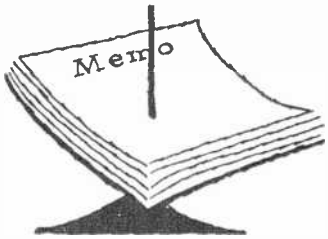


Notes from the Editor

TRANSISTORS. Some months back, included in our morning mail along with the usual bills, press releases, and notes from our readers, was a Yukon-postmarked manuscript typed on a code-copying typewriter. After wading through the mass of capital letters, we discovered that we had in our hands an explanation, in dialogue form, of how transistor circuits work, and how to design them by using Ohm's law and common sense.

This unusual manuscript so impressed us that we immediately got off a letter to the frozen north, asking the author, Jim Butterfield, to expand the article to the point where we could make a special feature out of it. After a series of conferences via trans-Canadian mail, Jim came up with "Understanding Transistor Circuits," which begins on page 67 of this issue. We think it's a pretty fine exposition of the transistor.

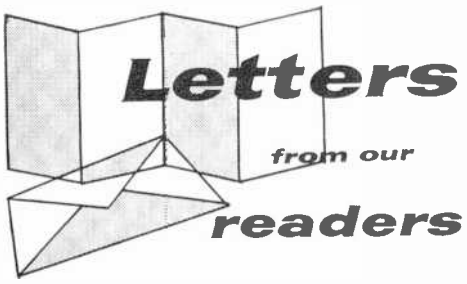
Unless you know your transistors cold, don't expect to absorb the whole story in one sitting. Take the three sections slow and easy, one at a time, and think over what you've read before going on to the next section. If you've been bogged down in textbook-style math or so "brainwashed" by vacuum-tube theory that the new transistor current amplification concepts have trouble getting through, you'll enjoy and appreciate "Understanding Transistor Circuits."

NEW COLUMN. Citizens Band radio has really gone over with a bang. Most manufacturers of Citizens Band equipment are in the frustrating but nevertheless happy situation of being unable to produce enough gear to satisfy the demand. Since our mailbag indicates a tremendous interest in this new service, we have arranged with Tom Kneitel, one of our contributing editors, to write a monthly column on the latest news and happenings on the Citizens Band. Tom's first column starts this month, on page 130.

CIRCUITS AND PROJECTS. Through the years, our reader mail has always indicated that a number of circuits were special favorites. In this issue we have assembled some of the most popular ones. Starting on page 83 is a four-page section which presents nine old standbys in "capsule" form.

Also in this issue are six other build-it-yourself projects which were requested by readers. If there are other projects you would like to see in the future, drop us a line. When we get enough requests for any particular item, we will publish complete plans.

Oliver Read



Perplexing Stereoplex

■ I want to build the "Stereoplex" amplifier which appears in your April issue, but am unable to find the output transformers. Could you please tell me where I can purchase these transformers?

S/SGT. BUDDIE BAILEY
APO 332, New York, N. Y.

The Stancor A-3872 can be ordered from any of the larger mail-order supply houses for $4.66 plus shipping charges. Incidentally, please note that capacitor C8 *in the Stereoplex is shown on the schematic with its positive end connected to ground—the negative end of* C8 *should go to ground.*

Ham Band Romance

■ My name appeared in Herb Brier's column in the November 1956 edition of POPULAR ELECTRONICS. At that time I offered my assistance to anyone who might need help in getting an amateur radio operator's license. One of the letters I received was from a girl in Lambertville, N. J. She and I soon found that we had a great many things

in common. One thing led to another; and to make a long story short, we will be married on September 25th. If it weren't for your magazine, we would never have met. Please accept thanks from both of us for the role that POPULAR ELECTRONICS played in bringing us together.

NATHAN J. SCHULMAN, K4OYG
Eau Gallie, Fla.

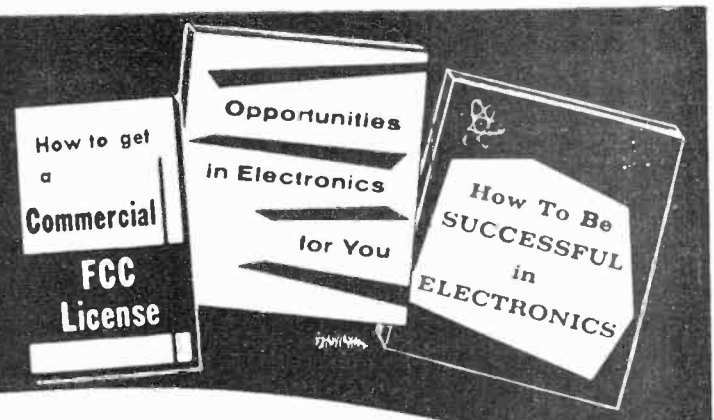
We're overwhelmed. We never thought we'd be playing Cupid. Anyway—congratulations and best wishes for a long and happy marriage.

Replace the Buffer, Too

■ Having serviced auto radios for several years, I enjoyed reading "How to Repair Auto Radios" in

Want To Double Your Pay

Get into Radio—TV-Electronics



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Charles C. Roberson
Cheyenne, Wyoming

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Letters

(*Continued from page 10*)

your May issue. However, the article failed to mention the buffer capacitor and the spark plate.

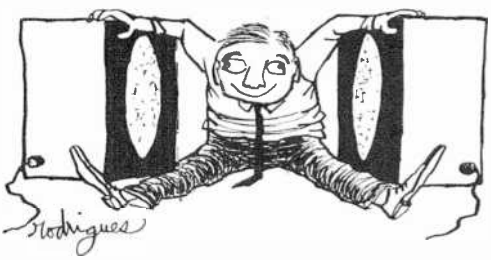
Many times the buffer capacitor shorts out as well as the vibrator. If a faulty vibrator is replaced with a new one and the buffer capacitor is shorted, the new vibrator can be damaged. In fact, many manufacturers guarantee their vibrators only if the buffer capacitor is replaced along with the vibrator.

BILL CARLISLE, USAF
Keesler AFB, Miss.

Although good service practice dictates replacing the buffer capacitor along with the vibrator, the primary aim of this article was to show how to get an inoperative auto receiver working again without removing it from the car. If the set is taken out of the car—or can be without too much difficulty—always replace the buffer capacitor.

Better Convert to Monophonic

■ Can you tell me if there is a device for shutting out sounds such as stereophonic music which can be placed over the ears (not inside the ears), and where I can secure this? Such a device could be



worn by one person who does not like stereophonic music without taking away that particular enjoyment from others who do.

MRS. ORRIS MCCARTNEY
Napa, Calif.

Have you tried the ear muff and ear plug manufacturers?

Correction on "Dice"

■ Just a note to let you know that I have heard from Ira Glickstein on his "Eight-Sided Dice" article, and that he was able to straighten out the trouble I was having. The dice work swell now and are great fun. The one thing you might correct for your readers is the listing of the push-button switch for this unit. It should be a Switchcraft 1009 and not a 9001 as shown in the parts list.

STAN FARMER
Grand Junction, Colo.

More on Contra-Polar Energy

■ Referring to Lawrence Jenkins' letter in the April issue concerning contra-polar energy, I would like to point out that although such matter—with positive electrons and negative protons—would be incompatible with our conventional matter, the particles which would make it up definitely do exist. A full report on the present status of the particles and anti-particles is contained in the

"HOW A 'CRAZY RUMOR' GOT ME PROMOTED!"

What I overheard one morning shook me right out of a rut!

"Company's getting ready to cut back . . . bound to be layoffs," I heard them say. "Just another crazy rumor," I told myself.

Just the same, I took quick stock of myself that night. Came up with four good reasons why the company would keep me on:

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Prompt and dependable

And four just-as-good reasons why they might let me go:

Making no real headway
Others better qualified
Still rated "semi-skilled"
Needs special training

I wasn't in trouble. But I sure wasn't "in solid" like I should be. That's when I made up my mind to enroll for training with I.C.S.

I picked I.C.S. because it's the oldest and largest with 259 courses. The training is quick and thorough. It's recognized by my company and accredited by the National Home Study Council. You study in your spare time and get personalized, practical instruction—know-how you can apply next day on the job.

That was a year ago. There have been two layoffs since then. While some of the others were just hanging on or being released, I was moving up. My I.C.S. training started something. Not only did it get me promoted (with a fat pay hike), but it put me in line for real advancement.

Don't wait for a "crazy rumor" to set *you* straight. Take out your "job insurance" right now. Mail the coupon and get full, free details on how I.C.S. has helped thousands, how it can help you. No obligation—and you get three valuable books *free!* (1) How to Succeed; (2) Catalog of opportunities in the field of your choice; (3) Sample lesson (math).

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Letters

(*Continued from page* 12)

March issue of "Scientific America." Further information on anti-particles can be found in Van Nostrand's *Scientific Encyclopedia*. Considering the dilemma faced by present-day physicists, it may just be that there *is* such a thing as a negative frequency!

BRICE L. WARD, JR.
U.S.S. Essex (CVA-9)

See "The World Within the Atom" on page 63 for more information on anti-particles.

■ In performing some basic research on the subject of contra-polar energy, I have uncovered some facts which may be of interest to your readers.

Everyone with a basic knowledge of electronics is familiar with the formula for finding the resonant frequency of an inductive-capacitive circuit:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

As the square root of a number can be either positive or negative, it follows that the square root of LC may be either positive or negative, which, in turn, would make f, the resonant frequency of the circuit, either positive or negative. Since the amount of current drawn by a circuit is equal to the voltage divided by the reactance, a negative reactance would make the circuit draw a negative amount of current.

Since contra-polar energy is itself negative, it changes electrons to positively charged particles or positrons, the anti-particles of electrons. As a result, positron flow is from positive to negative, and in this way power is produced.

When electrons pass through the filament of a light bulb, they collide with other particles and photons are emitted. However, when positrons flow through the filament, anti-photons are emitted. These anti-photons are the anti-matter particles of photons and, in effect, produce negative light. In daylight, anti-photons hit protons produced by the sun and the two types of particles neutralize each other, thus producing darkness.

When electrons flow through a resistance, heat is produced by the collision of electrons with positively charged protons. However, when contra-polar energy is applied and the electrons change their charge to positive, the movement of particles is stopped, thereby producing cold. Therefore, if a wire or resistance element is run through a tray of water and contra-polar energy is applied to it, the water will freeze.

Experimentation with devices using contra-polar energy has shown the following formula to be very helpful:

$$\frac{D^{0}n(T)}{\beta_{e}(1/)E_{v}^{e}}\sqrt{\frac{eV^{e}(R)^{\gamma}}{r(h')(N_{g})}}\,UC$$

VLADIMIR NEMEC
Brookfield, Ill.

Room for Improvement

■ Your magazine is one of the best we have ever read in this complex field of amateur radio and electronics. We have collected all but a few of the

Letters

(*Continued from page 14*)

back issues and plan on completing our collection in the near future. The past few issues have been much better than those of the first few years, but we would like to see more construction projects. How about a few construction projects on v.h.f.

converters? Actually, anything that is connected with the v.h.f. frequencies will help, as this is one of the most neglected parts of the ham program.

PHILIP W. KELLEN, K9POS
THOMAS D. MURPHY, K9POY
Chicago, Ill.

Help, Please!

■ I have searched through all kinds of radio books but cannot find instructions for winding base loading coils for a 10- to 80-meter vertical 21′ antenna. The vertical tubing is ½″ in diameter.

C. K. ESER
2304 Jefferson St.
Baltimore 5, Md.

Citizens Band Stations

■ I have been reading your articles on Citizens Band Class D radio and have enjoyed them very much. However, I wonder why you don't mention the fact that anyone who maintains such a station must have a first- or second-class commercial radiotelephone operator's license.

When I first heard of the new Class D band, I wrote the FCC asking about it. The answer I received said: "Installation tuning and maintenance work on Class D citizens radio transmitters may be performed only by the holder of a first- or second-class operator's license. If you do not intend to employ such an operator and desire to obtain your own license to do the maintenance work, you will be required to pass the necessary examination." In view of this reply from the FCC office in Chicago, I wonder if you might be misleading some hopefuls who believe they can do all the work themselves.

HORACE N. SMITH, W9PPD
Hagerstown, Ind.

If you do not hold a radiotelephone license, you may build a Citizens Band radio provided that all adjustments are made with a resistive dummy load connected to the antenna. The transmitter circuit must be the type approved by the FCC (as was the POPULAR ELECTRONICS *unit in the June 1959 issue) and the output frequency tolerance must be at least .005%.* —30—

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	License	Weeks
Ron Taylor, 29 S. Franklin St., Chambersburg, Pa.	1st	12
Bert Moore, P.O. Box 169, Opp, Alabama	1st	15
Donald R. Tatro, 270 Park Terrace, Hartford 6, Conn.	1st	12
Robin O. Okuniki, P.O. Box 175, Hanapepe, Kauai, Hawaii	1st	12
Billy R. Kirby, Route #3, Smithfield, N. C.	1st	9
J. H. Reeves, 10621 Rothelen, Los Angeles 47, Calif.	1st	12
Donald H. Ford, Hyannis Rd. (Cape Cod), Barnstable, Mass.	1st	12
James D. Hough, 400 S. Church St., East Troy, Wisc.	1st	12

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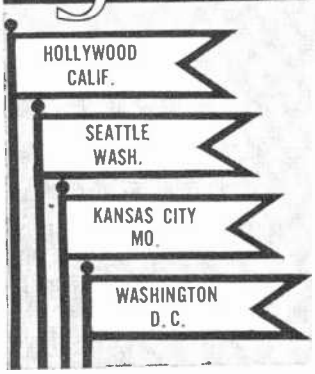

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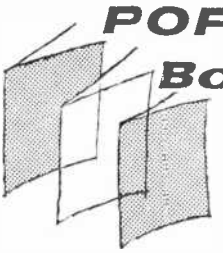

POP'tronics Bookshelf

"ELECTRON TUBES AND SEMICONDUCTORS" by Joseph J. De France. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. 288 pages. Hard cover. $8.00.

Here is a basic text written in a conversational style which presents theory discussions with a minimum of mathematics. Frequent use of illustrations, logical sequence of sub-topics, and illustrative problems all combine to make this book easy to follow and understand. A basic knowledge of high school algebra, trigonometry, and a.c. and d.c. fundamentals is required.

"DICTIONARY OF GUIDED MISSILES AND SPACE FLIGHT" edited by Grayson Merrill. Published by D. Van Nostrand Co., Inc., 257 Fourth Ave., New York 10, N. Y. 688 pages. $17.50.

As its name implies, this is a dictionary of terms used in the guided missile and space flight fields. Terms defined cover current and historical guided missiles and spacecraft, systems used in guidance and control, propulsion, armament, and launching, and all related terms from aerodynamics, astrodynamics, electronics, astronomy, and physics. This book is recommended for those working in the field and those who have a serious interest in guided missiles and space vehicles.

"MOBILE RADIO TELEPHONES" by H. N. Gant. Published by The Macmillan Company, 60 Fifth Ave., New York, N. Y. 125 pages. Hard cover. $4.50.

Now that new techniques have opened up the higher frequency bands (allowing greater space for channels of communication), and have succeeded in greatly reducing the size of the necessary equipment, mobile radio has become a natural aid to business and administration. Previous

Bookshelf

(*Continued from page* 18)

books on this subject have been written for the technicians—design, installation and maintenance engineers—but Mr. Gant, realizing that mobile radio is now so much the executive's responsibility, has written this book especially for those people who deal with and organize transportation. While it will present little new information to the qualified design engineer, it should provide common understanding for the layman user and the skilled technician responsible for the installation and maintenance of mobile equipment.

"FUNDAMENTALS OF DIGITAL COMPUTERS" by Matthew Mandl. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. 297 pages. $9.00.

At a time when digital computers are fast becoming an integral part of modern life, this book offers clear and accurate explanations of their design, operation, and maintenance. Topics include basic circuits, computer arithmetic applications, special circuits, calculation circuits, storage systems, commercial computers, maintenance factors, etc. If you're interested in the intricacies of digital computers, this book is a good choice.

"RECORD CHANGER MANUAL: VOLUME II" compiled and published by Howard W. Sams and Co., Inc., Indianapolis 6, Ind. $2.95.

This book provides a comprehensive coverage of 11 basic units used in 40 models of automatic record changers produced in 1957 and 1958. Exploded views, operational data, and detailed service instructions are included. The information presented here should be of great value to the service technician who is called upon to adjust and repair automatic record changers.

"FUNDAMENTALS OF HIGH FIDELITY" by Herman Burstein. Published by John F. Rider, Inc., 116 West 14th St., New York 11, N. Y. 144 pages. Soft cover. $2.95.

As its title suggests, this is another basic book on high fidelity; it differs from a num-

Bookshelf (*Continued from page 20*)

ber of its predecessors, however, in that it is written by a real expert thoroughly familiar with the field. In the main, this volume is concerned with spelling out the attributes of high-fidelity performance—that which distinguishes a high-fidelity system from a garden-variety radio-phonograph—and with clarifying certain major problems which arise in striving for the best possible reproduction of sound. Since it is a basic introduction to hi-fi, the author does not try to answer all possible questions about the audio art, but rather to assist the reader in new purchases of audio equipment and in the improvement of components already owned.

"PERFORMANCE-TESTED TRANSISTOR CIRCUITS" published by Sylvania Electric Products, Inc., Semiconductor Division, 100 Sylvan Rd., Woburn, Mass. 53 pages. Soft cover. 35 cents.

Thirty-six transistorized construction projects are featured in this book. It should provide the electronic experimenter with many hours of profitable entertainment. Included are various types of transistorized hi-fi equipment, household gadgets, darkroom accessories, and receivers. Each project is complete with circuit diagram, parts list, and an explanation of how the circuit works.

This book is recommended primarily for the electronic hobbyist.

Free Literature Roundup

Hams and experimenters can obtain a copy of an eight-page catalog on crystals from Texas Crystals, 8538 Grand Ave., River Grove, Ill. A number of crystal-controlled circuits are included. Catalog No. 759.

University Loudspeakers, 80 S. Kensico Ave., White Plains, N. Y., has available a new product catalog containing information, illustrations, and specifications on its current line of public address speakers and components. Hi-fi speakers and enclosures suitable for commercial installations are also covered. -30-

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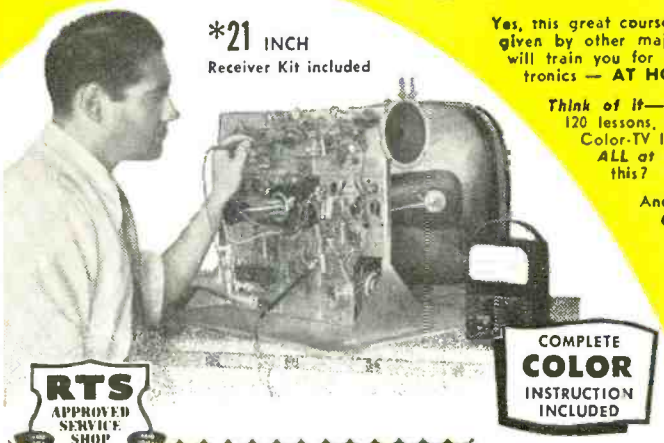

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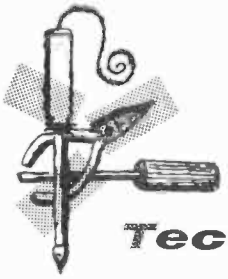
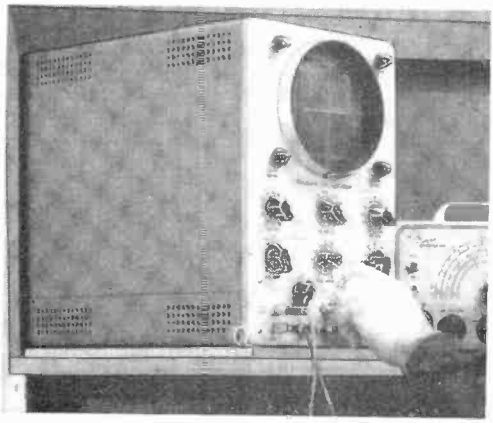


Tips and Techniques

ROTATING SHELF FOR SCOPE

Unlike other test instruments, the oscilloscope does not fit very well on the usual shallow shelf. Here's a good way to mount your scope on your workbench. Cut a piece of plywood the same size as the scope base and fasten it to the shelf with a bolt, using two nuts with a lock washer between them for safety. When the scope is placed on the plywood base, it can be turned to face in



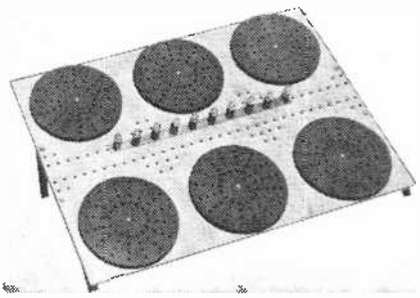
the most convenient direction. Make sure the base is fastened well enough to withstand being twisted and turned.—*Myron Bookwalter, Spokane, Wash.*

SUPPRESSING TV RADIATION

Most TV viewers have encountered some form of TVI at one time or another. Interference of this type results when the TV set picks up unwanted signals such as automobile ignition "noise." However, on occasions a TV set itself may radiate and interfere with radio reception. This condition might be dubbed "TVR."

Radiations emanating from a TV set can be suppressed by stapling ordinary household aluminum foil to the inside surfaces of the TV cabinet and grounding the foil to the TV chassis. If more shielding is necessary, staple metal window screening to the inside of the back panel and ground

Can you think faster than this Machine?



Control Panel of GENIAC set up to do a problem in space ship engineering

Be careful before you answer. GENIAC ® the first electrical brain construction kit is equipped to play tic-tac-toe, cipher and encipher codes, convert from binary to decimal, reason in syllogisms, as well as add, subtract, multiply and divide. Specific problems in a variety of fields—actuarial, policy claim settlement, physics, etc., can be set up and solved with the components. Connections are solderless and are completely explained with templates in the manual. This covers 125 circuits and shows how new ones can be designed.

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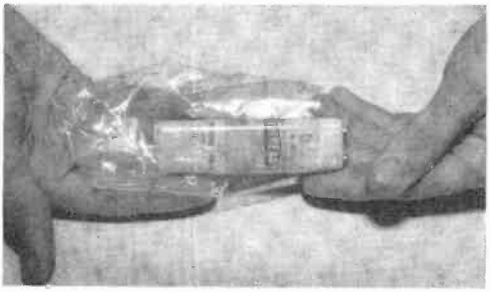
Tips

(*Continued from page 24*)

it to the chassis.—*Wm. B. Rasmussen, Prosser, Wash.*

BATTERY PACK SAFEGUARD

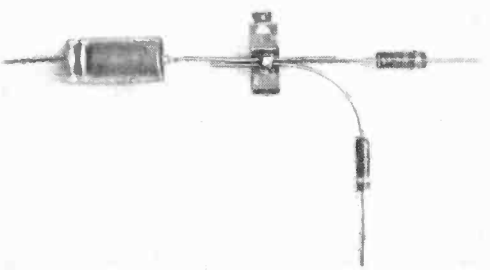
It's a wise safeguard to wrap battery packs in plastic food bags before installing them in portable radios or other portable electronics gear. Should a battery



pack develop a leak, the plastic bag will keep the corrosive acid from damaging parts mounted nearby.—*Jerome A. Cunningham, Chicago, Ill.*

FAHNESTOCK CLIP CONNECTORS

In experimental "haywire" hookups where the leads of resistors, fixed capacitors, coils, crystal diodes, etc., are continually being connected and disconnected, you can save time, and wear and tear on the leads, by using small Fahnestock clips as connectors. The clips need not be fastened



to the board, but can simply be used as clamps, where needed, to hold leads together.—*Art Trauffer, Council Bluffs, Iowa.*

DOT YOUR COLLECTORS

Many new transistors do not have in-line leads and it is not immediately apparent which lead is which. A person who is a bad guesser can kill many a 2N'er! A simple and efficient way to stop this needless slaughter is to paint a red dot on the col-

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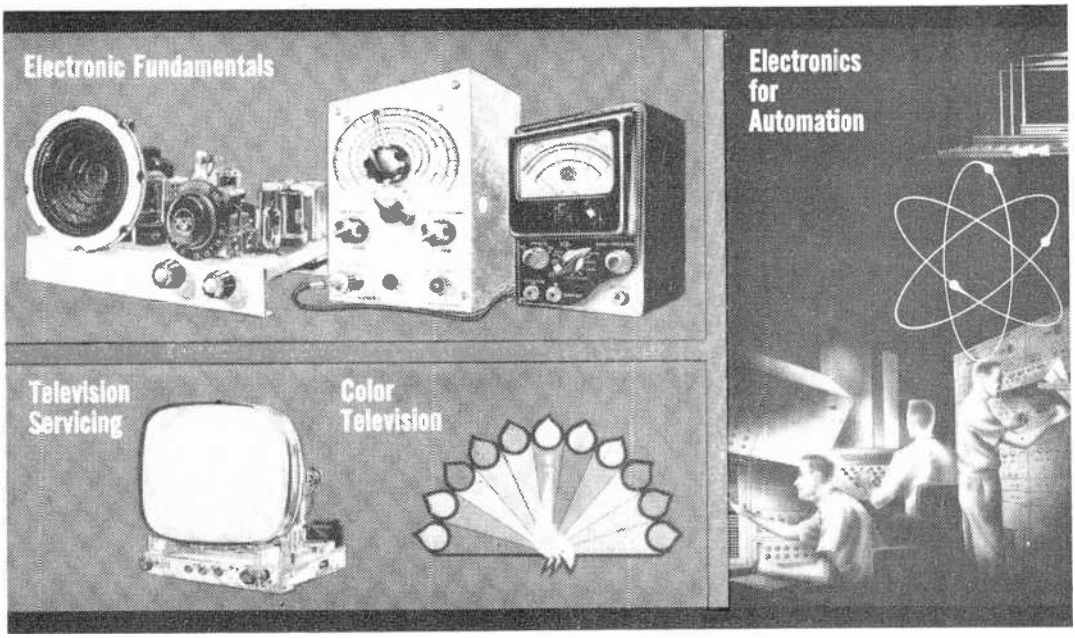

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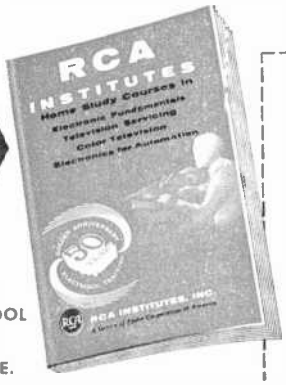

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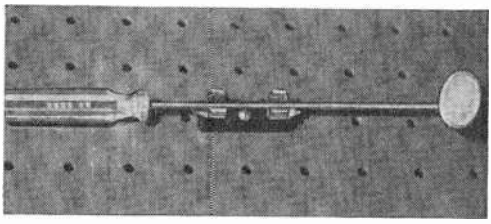
Tips

(*Continued from page 26*)

lector corners of all your transistors and all your transistor sockets. This method assures positive identification because the base is always in the middle and the emitter is the only unidentified lead.—*Stanley Tenen, Brooklyn, N. Y.*

INSPECTION MIRROR FUSE CLIP

Don't just toss your inspection mirror around the bench with other tools—they are liable to break it and you'll be destined to receive "seven years of bad luck." Instead, attach a fuse holder to your tool panel or bench and snap the mirror in place. You'll find it makes a perfect fit. —*Charles A. Lang, San Francisco, Calif.*

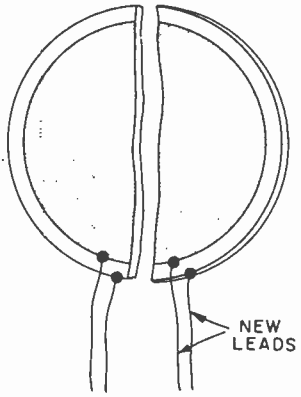


STYLUS INSPECTION

A home movie projector can be used for inspecting phono needles with amazing results. Just position the tip of the stylus near the light source where the film goes through the projector. A magnified image of the tip will be projected onto the screen and can be used to determine its condition. —*Gary A. Rork, Pueblo, Colo.*

DOUBLE SUN BATTERY VOLTAGE

It is possible to double, triple, or even quadruple the output voltage from sun batteries by dividing your present cells into several pieces and wiring them in series. Many sun batteries can be cut with a fine jeweler's saw or a very fine coping saw. After the surgery, the edges should be smoothed with a fine file and coated with a thin layer of clear household cement. Care should be taken not to chip the photosensi-



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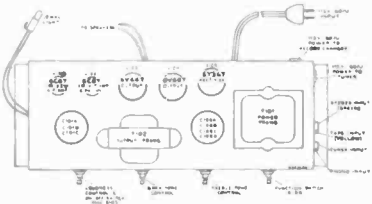
1B3GT	.79	5AN8	.86	6AN8	.85	6BQ6GT	1.05	6J5GT	.51	12AT6	.43	12SA7M	.86	25BQ6GT	1.11
1S5	.51	5AQ5	.52	6AQ5	.50	6BQ7	.95	6J6	.67	12AT7	.76	12SK7GT	.74	25C5	.53
1U4	.57	5AT8	.80	6AT6	.43	6BR8	.78	6K6GT	.58	12AU6	.50	12SN7GT	.64	25CD6	1.44
1U5	.50	5BK7A	.82	6AT8	.79	6BY6	.54	6L6	.84	12AU7	.60	12V6GT	.53	25CU6	1.11
1X2B	.82	5BQ7	.97	6AU4GT	.82	6BZ6	.54	6S4	.48	12AV6	.41	12W6	.69	25L6	.57
2AF4	.96	5CG8	.76	6AU6	.50	6BZ7	.97	6X4	.39	12AV7	.75	17AX4	.67	35C5	.51
2BN4	.60	5CL8	.76	6AU8	.87	6C4	.43	6X8	.77	12AX7	.63	17BQ6	1.09	35Z5GT	.60
3AL5	.42	5J6	.68	6AV6	.40	6CB6	.54	6Y6G	.65	12AZ7	.86	19AU4	.83	50B5	.60
3AU6	.51	5T8	.81	6BA6	.49	6CD6	1.42	8AU8	.83	12B4	.63	19BG6	1.39	50C5	.53
3AV6	.41	5U4GB	.60	6BC5	.54	6CF6	.64	8AW8	.93	12BD6	.50			50L6GT	.61
3BZ6	.55	5U8	.81	6BD6	.51	6CG7	.60	11CY7	.75	12BE6	.53				
3BY6	.55	5V6	.56	6BE6	.55	6CG8	.77	12A4	.60	12BH7	.73				
3CB6	.54	5X8	.78	6BF6	.44	6CM7	.66	12AD6	.57	12BQ6GT	1.06				
3CF6	.60	5Y3GT	.46	6BG6G	1.66	6CN7	.65	12AF6	.49	12BY7	.74				
3DT6	.50	6AB4	.46	6BH8	.87	6CS6	.57	6SK7GT	.74	12C5	.56				
3V4	.58	6AC7M	.96	6BK7	.85	6CU6	1.08	6SN7GT	.65	12CU5	.58				
4BN6	.75	6AF4	.97	6BN4	.57	6CY7	.71	6T4	.99	12CU6	1.06				
4BQ7	.96	6AG5	.65	6BN6	.74	6DE6	.58	6T8	.80	12DQ6	1.04				
4DT6	.55	6AH6	.99	6BQ/ CU6	1.25	6DG6GT	.59	6U8	.78	12F8	.66				
4BZ7	.96	6AK5	.95			6DQ6	1.10	6V6GT	.54	12K5	.65				
4CB6	.59	6AL5	.47					6W4GT	.57						
								6W6GT	.69						

Ask For Types Not Listed

SEND FOR NEW FREE BROCHURE OF TUBES AND PARTS

USE THIS AD AS YOUR ORDER BLANK



RCA RS-151B

HI-FI AMPLIFIER

BELOW DIST. COST

Convert Your Present System To Stereo!

COMPLETE, $22.95 ea.

Lots of 3 $20.95 ea.

- For Stereo System
- 3 Stages of Audio Amplification; Push-Pull Output
- 4 Inputs — tuner, phono, tape, left or right channel of stereo system
- Front Panel Control
- Separate Bass, Treble and Loudness Control
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10 Watts with less than 1½% distortion.

15W maximum. Frequency response 45 to 20,000 cycles.

2-6CG7; 2-6V6; 1-5Y3

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Est. 1945

55 Chambers Street
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Not Affiliated With Any Other Mail Order Tube Co.

TERMS: 25% dep. must accompany all orders — bal. C.O.D. All shipments F.O.B. Newark warehouse. NO HANDLING CHARGE WITH THIS AD. Subject to prior sale. No C.O.D.'s outside continental U.S.A.

Tips

(*Continued from page 28*)

tive surface while filing it. Leads can be soldered to the cell after the enamel protective coating is scraped off. Insulate your connections with household cement, connect your cells in series, and you have twice the voltage. If you decide you want the original voltage and current capacity back, just connect the cells in parallel.—*Stanley Tenen, Brooklyn, N. Y.*

TEST PROD SAFETY DEVICE

When you are measuring voltages around crowded tube sockets and the like, cut about a half inch of ⅛" "spaghetti" and slip it over the end of the test prod. This will reduce the possibility of touching nearby exposed leads. The spaghetti can be slipped off for less cluttered circuits. —*Arthur Fregeau, Bristol, Conn.*

INDOOR SHORT-WAVE ANTENNA

Gummed aluminum tape (used in store and bank windows for protection against burglars) makes an efficient, quickly installed indoor short-wave radio antenna. Simply run the tape around the ceiling of the room. It is so good-looking that you may even be able to convince your wife that you are decorating the room. If the tape is put up over wall paper, it should be fastened (with tacks or cellophane tape) at the corners of the room.—*Ira Glickstein, Brooklyn, N. Y.*

BIT AND TAP HOLDER

You will find it convenient to drill a block of wood to hold the tap, tap drill and body drill for the most-often-used sizes of machine screws. A good assortment of sizes includes: 5-40, 6-32, 8-32, 10-32 and ¼-20. —*Charles V. Bittner, Erlton, N. J.*

REMOVING ENAMEL FROM FINE WIRE

The enamel insulation on the hair-fine wire used in r.f. coils is very difficult to remove without breaking the wire. To remove the insulation from this tiny litz wire without breaking the strands, dip the wire in nail-polish remover. After the solvent has had time to soak in (this requires about five minutes), you can gently pull the enamel off with your fingernail. When you solder these

build this great new knight®-kit

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stereo hi-fi amplifier...save up to 50%

COMPARABLE IN EVERY WAY TO WIRED AMPLIFIERS COSTING TWICE AS MUCH

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never before such performance... such styling... such quality at so low a price...

knight-kit 20-watt stereo hi-fi amplifier

Newest complete Stereo high-fidelity amplifier at an amazing low $44.50. Incomparable value: Includes two built-in preamps for magnetic cartridges. Single switch selects phono, tuner or auxiliary stereo inputs, plus stereo reverse on each; also switches monophonic input to both amplifier channels. Bass and treble controls boost and attenuate. Special clutch-type concentric volume control permits individual channel balancing, plus overall volume control. Total output is 20 watts (10 watts per channel at less than 1½% distortion). Response, 20-20,000 cps, ± 1.5 db. Hum and noise better than 85 db below full output. Has four pairs of stereo inputs: magnetic cartridge, ceramic cartridge, tuner, auxiliary. RIAA equalized for stereo discs. Expertly designed push-pull output circuitry. Beautiful custom-styled case, 4¼ x 13¼ x 9". With case, tubes, all parts, wire, solder and instructions. Shpg. wt., 27 lbs.

Model Y-773. Knight-Kit Stereo Amplifier, F.O.B. Chicago... **$44.50**

EXCLUSIVE **knight-kit** MONEY-BACK GUARANTEE

Every KNIGHT-KIT meets or exceeds published specifications, or we refund your money.

ONLY **knight-kits** ARE CONVENIENCE ENGINEERED

for easiest building—no previous electronic experience needed...

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HI-FI KITS	HOBBY KITS	INSTRUMENT KITS	
Stereo Amplifiers	Short-Wave Radios	VTVM	Cap. Checker
Stereo Preamp	AC-DC Table Radios	VOM's	R/C Tester, etc.
Stereo Control	Clock-Radio	Tube Checkers	
Hi-Fi Tuners	Radio-Intercom	Oscilloscopes	HAM KITS
Hi-Fi Amplifiers	Transistor Radios	Signal Tracer	Receiver
Speaker Systems, and others	Electronic Lab Kits and many others	Audio Generator	Transmitter
		Sweep Generator	VFO, etc.

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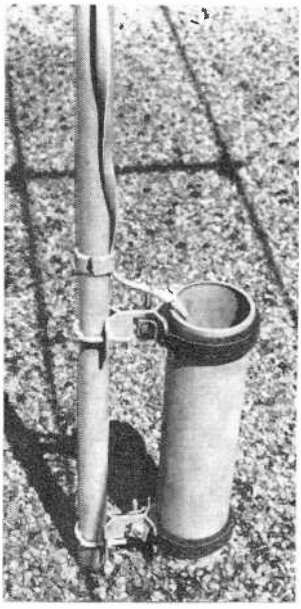
Tips

(Continued from page 30)

small wires, use flux and heat sparingly—excess heat will weaken the wires.—*James A. Clifford, Detroit, Mich.*

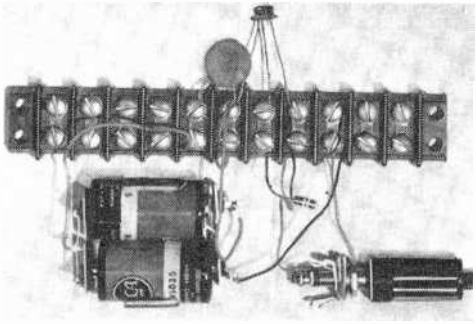
FELT PADS QUIET TV NOISE



Noise which is transmitted from a vibrating TV antenna can be eliminated by wrapping narrow strips of felt around the standpipe or other support. Metal bands are placed over the felt strips and then drawn tight in the same way an automatic radiator hose is clamped.—*Gale Foster, Hingham, Mass.*

USING BARRIER TERMINAL STRIPS

The electronic experimenter usually finds that he wastes a lot of time in soldering and unsoldering components. Also, after the same components have been employed several times, their leads frequently become broken. Both of these troubles can be eliminated by using inexpensive barrier terminal strips for hooking up experimental circuits. As many as six components can be connected to one set of terminals on the strip. Circuits can be assembled very rapidly, and if it is necessary to change components, a twist of a screwdriver does it. —*George Sollman, Cobleskill, N. Y.* —30—



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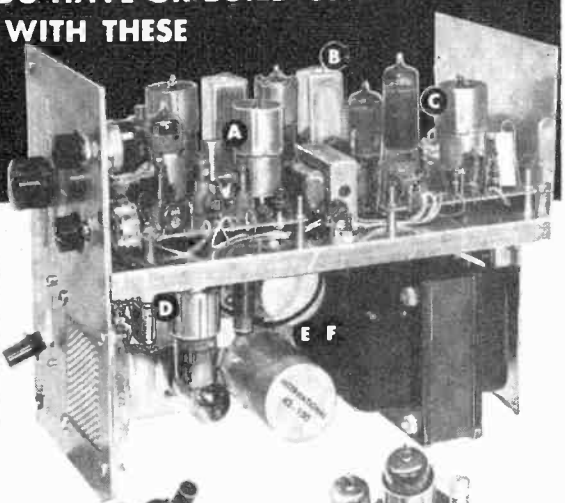
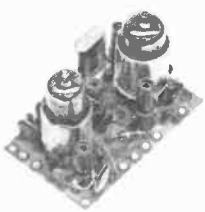
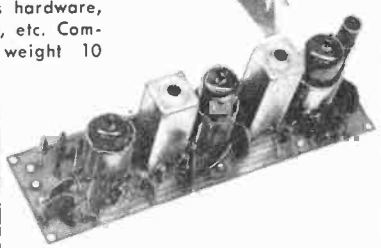
MAKE YOUR OWN!



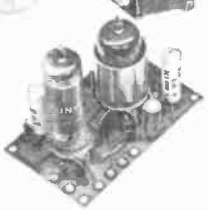
G Cabinet (all metal) includes hardware, switches, speakers, panel, case, etc. Complete instructions. Shipping weight 10 lbs. $20.00.



A RF Converter (printed circuit prewired), two-tubes, crystal controlled. Use with IF unit B. Shipping weight 2 lbs. $14.00.



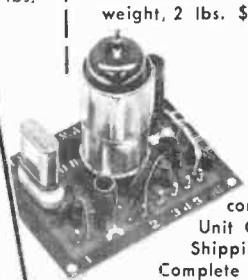
B IF Unit (printed circuit prewired) consists of mixer and tunable local oscillator feeding 262 KC IF stage. Includes noise-limiter and squelch circuits. Designed to work with units A and C. Makes dual conversion receiver. Shipping weight, 2 lbs. $16.00.



C Audio Unit (printed circuit prewired), speech amplifier for crystal or carbon microphone, first audio for receiver and power amplifier/modulator stage. Designed to follow unit B. Includes output transformer but not speaker. Shipping weight 2 lbs. $13.50.

E Power Supply 115 VAC (not prewired). All parts necessary to construct power supply to operate Units A, B, C and D. Shipping weight 10 lbs. $12.00.

F Power Supply 3-way 6 VDC, 12 VDC or 115 VAC (not prewired). Shipping weight 10 lbs. $20.00.



D Transmitter Unit (prewired and tuned) Oscillator and amplifier. Crystal controlled. Requires Unit C for modulation. Shipping weight 2 lbs. Complete with crystal and tube certified .005% tolerance. $14.50.

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For amateur or commercial uses. Send for free catalog. Write: Crystal Dept.

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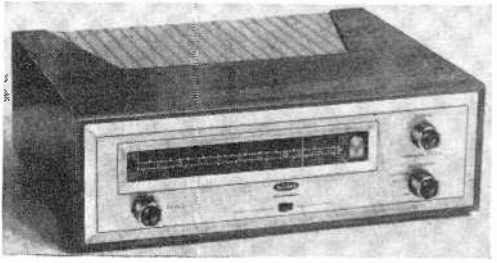
NEW products

AM-FM TUNER

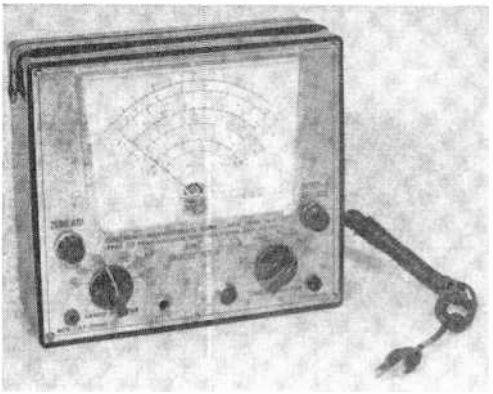
The FM sensitivity of Scott's Model 320 AM-FM tuner is 3 microvolts for 20-db quieting on 300-ohm antenna terminals. Circuit features include a 2-mc. wide-band FM detector to assure high selectivity, high-capture ratio and drift-free FM reception. The r.f. stage assures high sensitivity on



both AM and FM sections. Tape recorder and multiplex outputs are included. Write to the manufacturer for further specifications. $139.95. *(H. H. Scott, Inc.,* 111 Powdermill Rd., Maynard, Mass.)

VACUUM-TUBE VOLTMETER

All of the following measurements can be made with the new EMC Model 107A VTVM: peak-to-peak voltages from .2 volt to 2800 volts; a.c. r.m.s. voltages from .1 volt to 1000 volts; capacitance from 50 $\mu\mu$f.



to 5000 μf.; and resistance from .2 ohm to 100 megohms. The 107A is also capable of measuring inductance from 1.4 to 140,000 henries. Wired, $51.40; and in kit form,

BECOME A RADIO TECHNICIAN For Only $22.95

BUILD 16 RADIO CIRCUITS AT HOME

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- ★ CODE OSCILLATOR

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It is understood and agreed that should the Progressive Radio "Edu-Kit" be returned to Progressive "Edu-Kits" Inc. for any reason whatever, the purchase price will be refunded in full, without quibble or question, and without delay.

The high recognition which Progressive "Edu-Kits" Inc. has earned through its many years of service to the public is due to its unconditional insistence upon the maintenance of perfect engineering, the highest instructional standards, and 100% adherence to its Unconditional Money-Back Guarantee. As a result, we do not have a single dissatisfied customer throughout the entire world.

YOU DON'T HAVE TO SPEND HUNDREDS OF DOLLARS FOR A RADIO COURSE

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing. THIS IS A COMPLETE RADIO COURSE IN EVERY DETAIL.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester and the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 16 Receiver, Transmitter, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the complete price of $22.95. The Signal Tracer alone is worth more than the price of the entire Kit.

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment. Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are sixteen Receiver, Transmitter, Code Oscillator, Signal Tracer, and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, etc. in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator. In addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

FREE EXTRAS

- **SET OF TOOLS**
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- **ELECTRONICS TESTER**
- PLIERS-CUTTERS
- ALIGNMENT TOOL
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- HIGH FIDELITY GUIDE • QUIZZES
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- MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE • FCC AMATEUR LICENSE TRAINING
- PRINTED CIRCUITRY

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You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

J. Stabitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Troubleshooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

PRINTED CIRCUITRY

At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a Printed Circuit Signal injector, a unique servicing instrument that can detect many Radio and TV troubles. This revolutionary new technique of radio construction is now becoming popular in commercial radio and TV sets.

A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

Printed Circuitry is the basis of modern Automation Electronics. A knowledge of this subject is a necessity today for anyone interested in Electronics.

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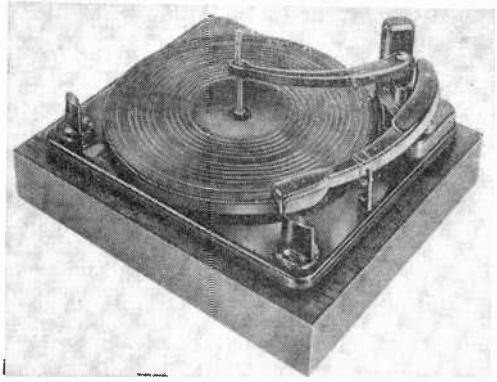
products

(*Continued from page* 34)

$36.50. For more information, write to *Electronic Measurements Corporation,* 625 Broadway, New York 12, N. Y.

STEREO CHANGER

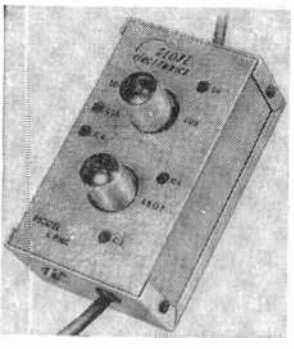
A new Collaro stereo changer has been announced by the *Rockbar Corp.,* 650 Halsted Ave., Mamaroneck, N. Y. The Model TC-99 Constellation features a non-magnetic 6½-lb. turntable which provides a 10-db reduction in magnetic hum pickup



as compared with steel turntables. Its heavy-duty precision-balanced four-pole motor is screened with triple interleaved shields to provide an additional 25-db reduction in magnetic hum pickup. The two-piece stereo transcription type tone arm comes equipped with a detachable five-terminal plug-in shell. Price, $59.50; slightly higher in the West.

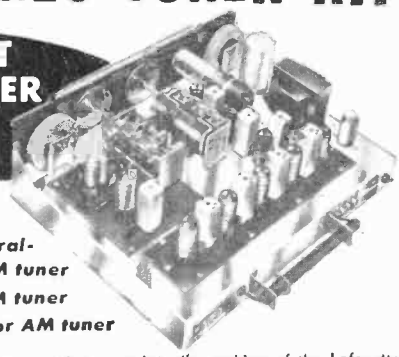
SIX-METER CONVERTER

Greater sensitivity with better signal-to-noise ratio is provided in the new, improved version of the Globe 6-meter converter. The Model 6 PMC has a cascode r.f. stage and bandpass coupling, and is available in a range of output frequencies. It may be used with all types of communications receivers as well as 6- or 12-volt auto radios. Wired, $29.95; in kit form, $21.95;



New! YEARS AHEAD! Lafayette STEREO TUNER KIT

THE MOST FLEXIBLE TUNER EVER DESIGNED



Use it as a Binaural-Stereophonic FM-AM tuner

Use it as a Dual-Monaural FM-AM tuner

Use it as a straight Monaural FM or AM tuner

- Multiplex Output for New Stereo FM
- 11 Tubes (including 4 dual-purpose) + Tuning Eye + Selenium rectifier Provide 17 Tube Performance
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- Dual Double-Tuned Transformer Coupled Limiters.

KT-500 IN KIT FORM

74.50 7.45 Down 7.00 Monthly

LT-50 COMPLETELY WIRED 124.50

12.45 Down—10.00 Monthly

More than a year of research, planning and engineering went into the making of the Lafayette Stereo Tuner. Its unique flexibility permits the reception of binaural broadcasting (simultaneous transmission on both FM and AM), the independent operation of both the FM and AM sections at the same time, and the ordinary reception of either FM or AM. The AM and FM sections are separately tuned, each with a separate 3-gang tuning condenser, separate flywheel tuning and separate volume control for proper balancing when used for binaural programs. Simplified accurate knife-edge tuning is provided by magic eye which operates independently on FM and AM. Automatic frequency control "locks in" FM signal permanently. Aside from its unique flexibility, this is, above all else, a quality high-fidelity tuner incorporating features found exclusively in the highest priced tuners.

The 5 controls of the KT-500 are FM Volume, AM Volume, FM Tuning, AM Tuning and 5-position Function Selector Switch. Tastefully styled with gold-brass escutcheon having dark maroon background plus matching maroon knobs with gold inserts. The Lafayette Stereo Tuner was designed with the builder in mind. Two separate printed circuit boards make construction and wiring simple, even for such a complex unit. Complete kit includes all parts and metal cover, a step-by-step instruction manual, schematic and pictorial diagrams. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 22 lbs.

The new Lafayette Model KT-500 Stereo FM-AM Tuner is a companion piece to the Models KT-600 Audio Control Center Kit and KT-310 Stereo Power Amplifier Kit.

KT-500.....Net **74.50**

LT-50 Same as above, completely factory wired and tested.....Net **124.50**

NEW! LAFAYETTE PROFESSIONAL STEREO MASTER AUDIO CONTROL CENTER

KT-600 79.50

IN KIT FORM

ONLY 7.95 DOWN

LA-600

COMPLETELY WIRED AND TESTED

134.50

Solves Every Stereo/Monaural Control Problem!

- **UNIQUE STEREO & MONAURAL CONTROL FEATURES**
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products

(*Continued from page* 36)

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Available as a kit or wired, the Eico Model 1020 serves as a power supply as well as a variable bias supply to bias transistors or vacuum tubes in circuit development or study. For service work it can be used to offset a.v.c. and a.g.c. voltages in the alignment of TV and radio receivers. It provides continuous variable output voltage monitored by a dual range voltmeter (0-6, 0-30 volts d.c.). Two type 2N256 power transistors are incorporated in the transformer-operated circuit. Up to 30 volts output is available. Kit, $19.95; wired, $27.95. (*Electronic Instrument Co., Inc.*, 33-00 Northern Blvd., Long Island City, N. Y.)

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The "Sound-N-Sight" radio code course published by *John F. Rider Publisher, Inc.*, 116 W. 14th St., New York 11, N. Y., utilizes long-playing records of code signals and the instructor's voice, as well as flash identification cards and an instruction book. The student advances in steps of one-word-per-minute per-day. Novice Course, (0 to 8 wpm), #REC-08, $9.50; Advanced Course, (9 to 20 wpm), #REC-920, $8.95; Complete Course, covering all licenses up to commercial (0 to 20 wpm), #REC-020, $15.95.

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(*Continued on page* 132)

NEXT MONTH IN POPULAR ELECTRONICS:

Should you buy color TV now?

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- INSIDE THE HI-FI TUNER
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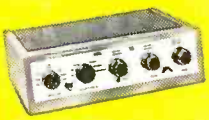

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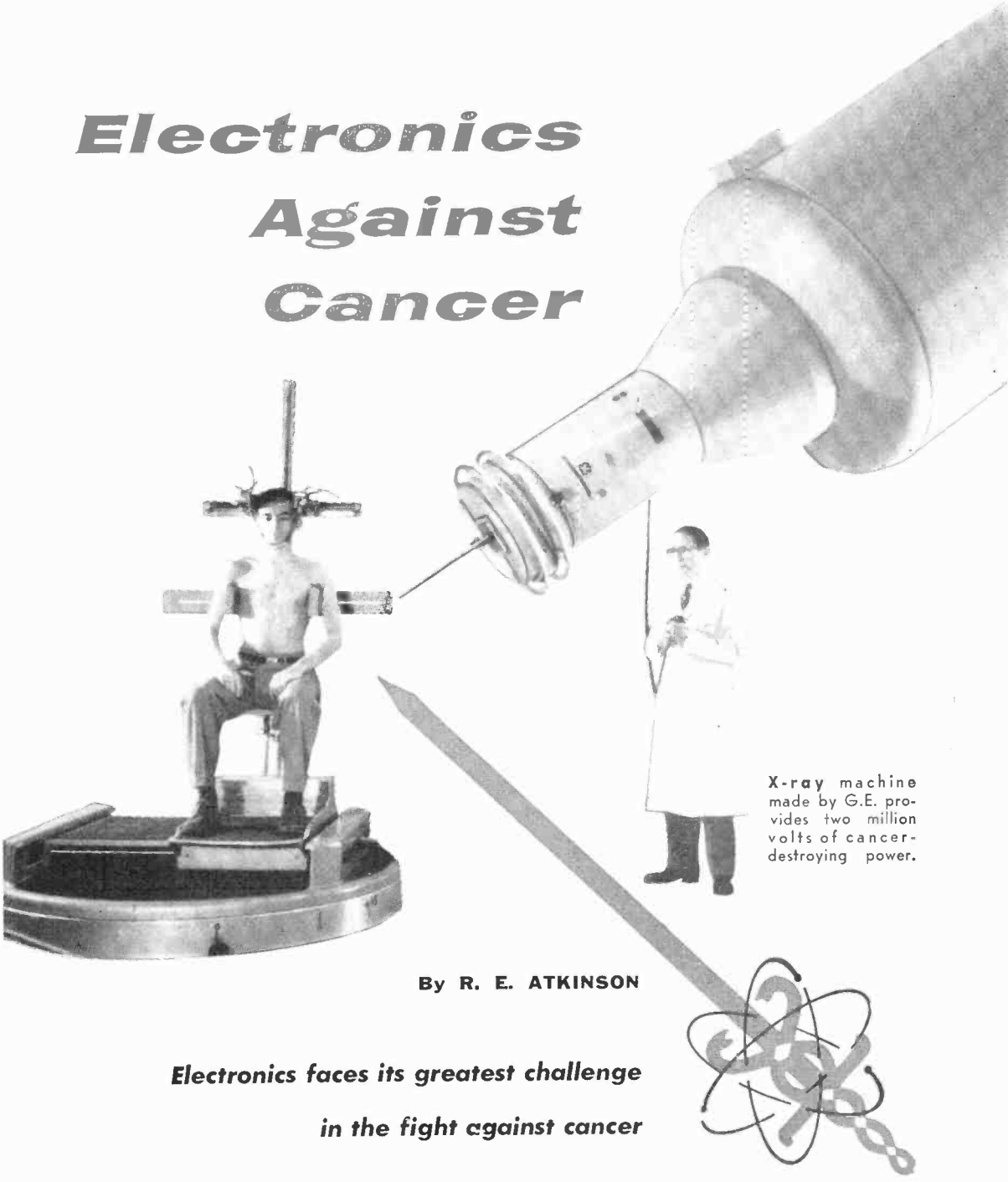
Electronics Against Cancer



X-ray machine made by G.E. provides two million volts of cancer-destroying power.

By R. E. ATKINSON

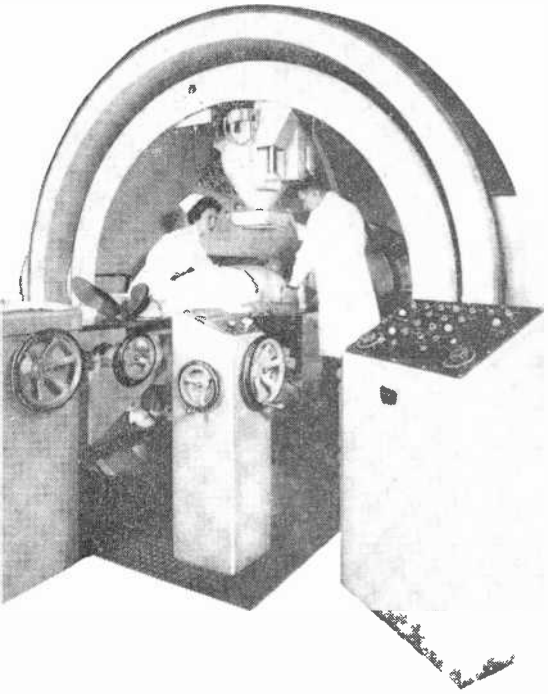
Electronics faces its greatest challenge in the fight against cancer

ONCE the word "cancer" was whispered. Now we say it firmly, as a challenge. People are learning to spot the signs of early cancer, and are seeing their doctors regularly; alert physicians are also detecting cancer in time to remove malignant growths before they can spread. The situation is far from hopeless. Statistics show that more and more people are being saved from cancer each year.

Dramatic examples of electronics being used to help mankind are found in the battle against cancer. Electronic de-

vices are invaluable in the diagnosis and treatment of cancer, and more important, they promise to provide the key which will open the door to an understanding of what causes normal cells to start multiplying wildly and grow into malignant masses.

In the field of cancer diagnosis, radioactive chemicals injected into the blood stream act as invisible bloodhounds which track down malignant tissue. In the treatment of cancer, atoms and electrons are used to destroy cancerous areas, even those deep within the body. Ultrasound, too, has been used to shatter malignant cells under the skin. Electric shock has been employed in a few cases to relieve pain, and cancer research leans heavily on electronic instruments such as the electron microscope.



Radioactive cobalt machines such as the one shown at left can produce radiations equal to those from a 3,000,000-volt X-ray. These radiations destroy malignant tissues.

Cancer Therapy. A big gun in our anti-cancer arsenal was unveiled this March at the Brookhaven National Laboratory, Long Island, N. Y. A uranium-powered 1000-kilowatt atomic reactor has been completed for use in medical research and treatment. The first reactor specially designed with medical uses in mind, the Brookhaven installation is integrated with a research center and hospital. Cancer is its chief target.

One of the experimental techniques that scientists at Brookhaven are working on is a treatment called "neutron capture." Boron, a chemical which "captures" a large number of neutrons, is carefully injected into the patient's blood stream. After the boron is carried by the blood to an area known to be cancerous, neutron particles from the atomic reactor are beamed directly at the tumor area. When neutrons strike the boron, the resulting radiation kills the tumorous tissue with little damage to surrounding healthy tissue. Treatment is promising, scientists report, but is still in the research stage.

Most powerful of all the weapons against cancer is a kind of X-ray machine called a "synchrotron." While X-ray machines used in cancer therapy in the past generated 250,000 volts, the University of California synchrotron generates an X-ray beam amounting to 70 million volts. The synchrotron's high power is equivalent to penetration power and is of value when a tumor is located deep within the body. Of course, brute force is not enough. The problem in treating cancer with X-rays is to destroy the cancer tissue and leave the adjacent healthy tissue undamaged. Consequently, although the synchrotron produces enormous power, its accuracy in focusing beams of cancer-killing X-rays is a marvel of engineering.

Cancer Can Be Cured. In the therapy of cancer with X-rays and other methods, the primary interest is in curing the patient outright. The Cured Cancer Congress, which met recently in Washington, D. C., is living testimony that cancer can be cured. To qualify as a member of the Cured Cancer Congress, a cancer victim must have had no sign of the disease for five or more years after treatment. This year 40 delegates represented almost one million Americans cured of cancer.

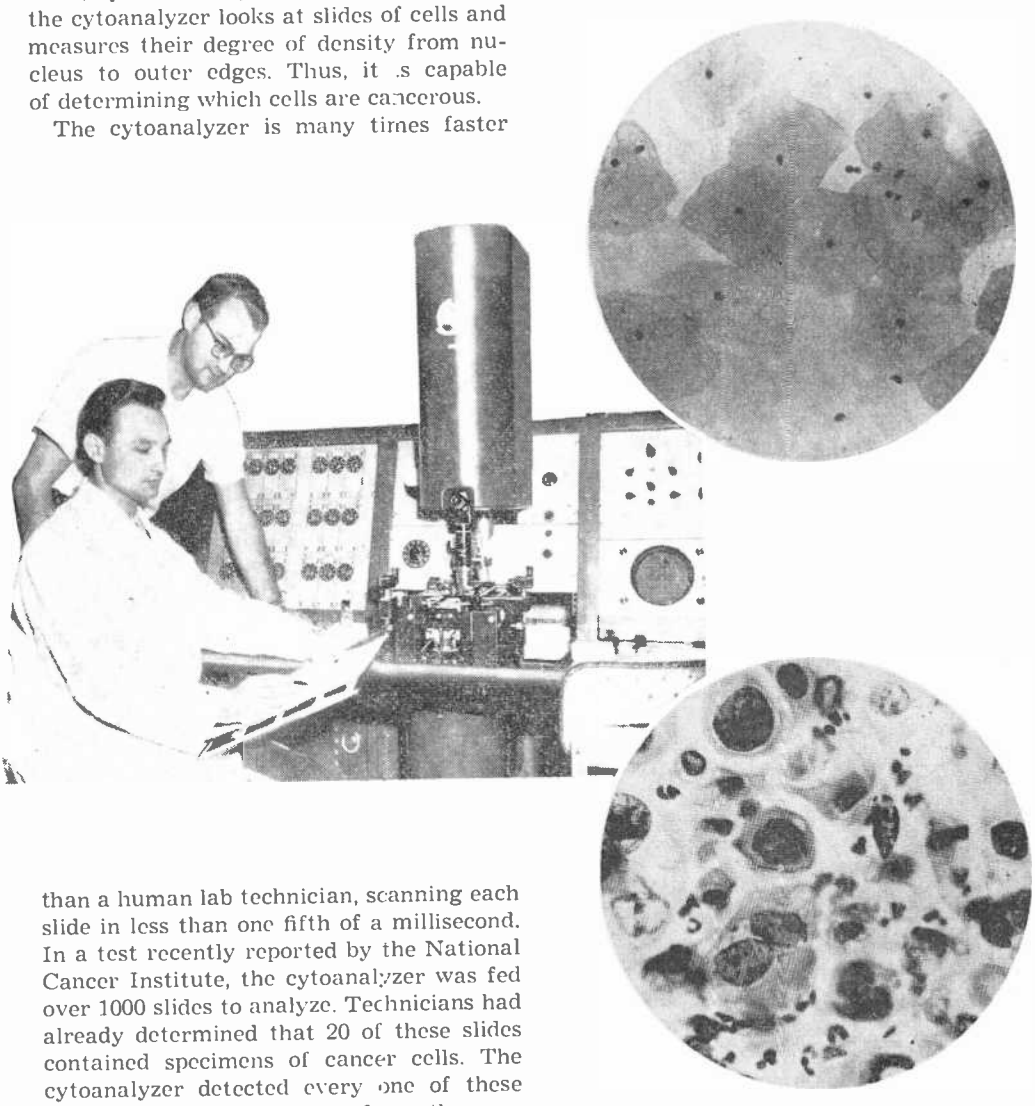
Many of these people would not be alive today if it weren't for medical electronics. For example, Mrs. Richard A. Flacco of Bellflower, Calif., received surgical treatment of an abdominal cancer after X-rays revealed it in time for early care; follow-up

radiation treatment finished the job. Mrs. Flacco leads a normal life today and two of her three children have been born since the surgery was performed.

Just as early and accurate diagnosis was so important to Mrs. Flacco, it is vital to the well-being of hundreds of thousands of people. One of the most promising electronic diagnostic devices is the "cytoanalyzer." Cancer cells have a peculiar center, or nucleus, by which they may be identified, and the cytoanalyzer looks at slides of cells and measures their degree of density from nucleus to outer edges. Thus, it is capable of determining which cells are cancerous.

The cytoanalyzer is many times faster

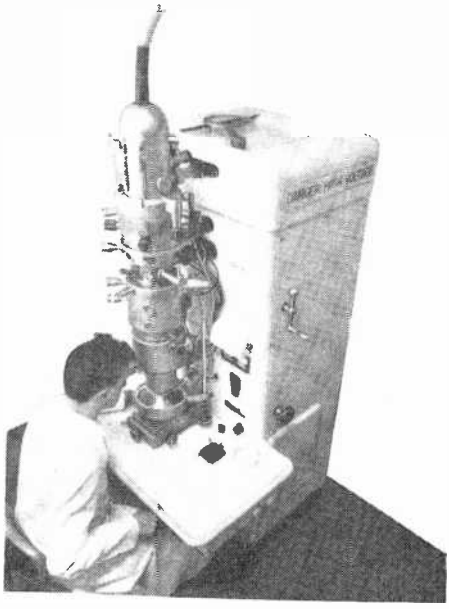
Examination of cells suspected of being cancerous is speeded by the use of the cytoanalyzer. This device can tell if cells are norma (upper circle) or cancerous (lower circle).



than a human lab technician, scanning each slide in less than one fifth of a millisecond. In a test recently reported by the National Cancer Institute, the cytoanalyzer was fed over 1000 slides to analyze. Technicians had already determined that 20 of these slides contained specimens of cancer cells. The cytoanalyzer detected every one of these slides, and also labeled a few others as "suspicious."

The radioactive isotope—another diagnostic aid—has been called a hitch-hiker with a walkie-talkie. If it finds cancer, it reports back to an isotope counter. Here's how it works. After scientists find chemi-

Photographs courtesy of American Cancer Society and National Cancer Institute



Electron microscopes enable researchers to see cell processes which are invisible to ordinary microscopes.

cals that are especially attracted to cancer tissues in certain parts of the body, they "tag" them with a small dose of radioactivity.

For example, thyroid tissue has a special thirst for iodine. If offshoots of thyroid cancer travel to any part of the body, they, too, attract more iodine than do other tissues. A patient thought to have thyroid cancer is injected with radioactive iodine and is then placed under a scanner—an isotope counter. As the patient is moved under the scanner, impulses from the radioactive iodine indicate the areas in which bits of thyroid cancer have begun to grow. Often, with early detection, it is possible to remove these stray growths.

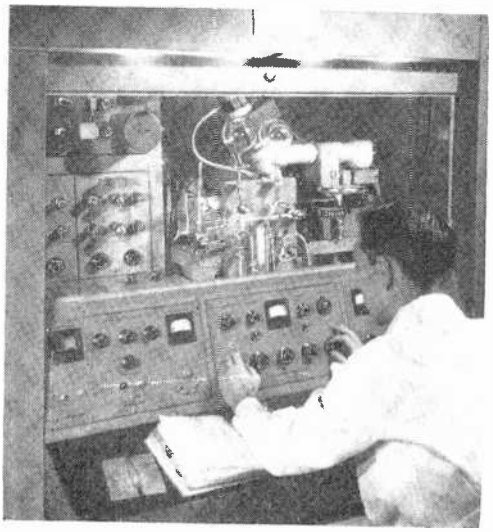
Cancer Research. Why does a cell go berserk and start multiplying wildly? Do germs upset the cell's own control centers? Does some chemical imbalance cause the cellular havoc we call cancer? In seeking the answers to these questions, the researcher would be almost helpless without electronic instruments to extend the limits of his perception. In addition to the many devices which are useful in detecting and treating cancer, electron microscopes and other electronically controlled instruments are now enabling us to study the structure of the cell itself. Such devices may turn up the clue which will lead to an understanding of the behavior of cancer cells.

POSSIBLE SIGNS OF EARLY CANCER

1. A lump or thickening in the breast or elsewhere.
2. Unusual bleeding or discharge from body opening.
3. Persistent indigestion or difficulty in swallowing.
4. Unexplained changes in bowel or bladder habits.
5. Persistent hoarseness or cough.
6. Changes in color or size of a mole or a wart.
7. Any sore that does not heal promptly.

Don't wait for symptoms to become painful; pain is not an early cancer sign. Have a complete physical examination at least once a year.

Research is also aided by the use of the mass spectrometer. It measures the relative weights of molecules by electronic means.



Progress in cancer-therapy techniques has already raised the life-saving rate from one in four to one in three. But it is possible even today, says the American Cancer Society, to save *half* of all the people stricken by cancer by early diagnosis and treatment. Eventually, we will find out exactly what cancer is, why it starts, and how to cure it. Until that time, medical electronics will continue to face its sternest challenge, the conquest of cancer. —30—

The Trans-Six Receiver

By **JOHN J. SURY,** K8NIC

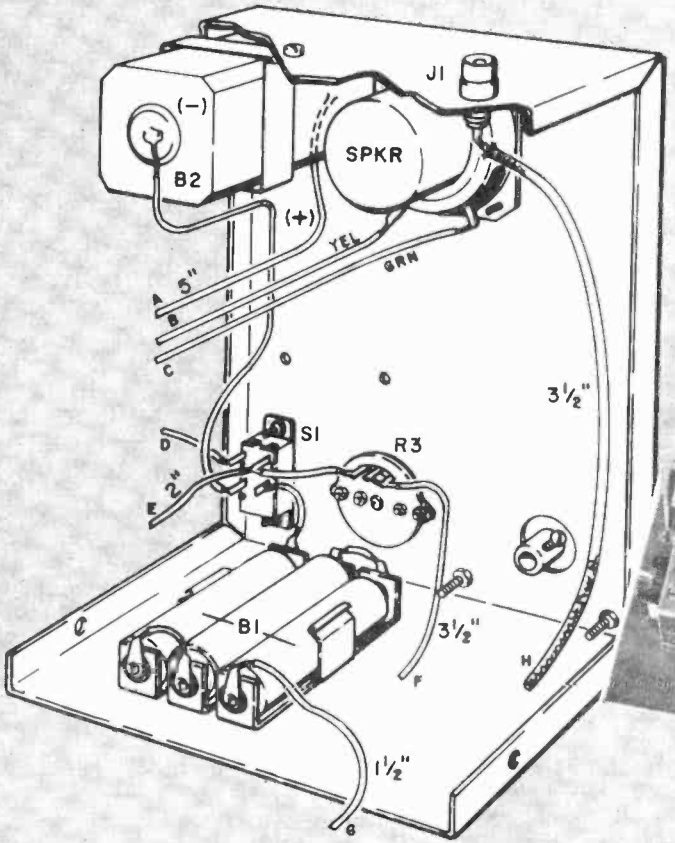
Transistorized superregenerator tunes 6- and 10-meter ham bands

HERE is a "hot" little superregenerative receiver designed for the ham or ardent DX'er. It includes an audio section with a push-pull output feeding a miniature speaker.

The tank circuit coil may be rewound for the 10- and 20-meter bands, and amazing pickup can be had with only a short whip antenna. The superregen pot does a fine job in separating stations in conjunction with the tank circuit.

Total cost of the project should be $16.00 or under, made possible by the introduction of the Philco 2N588 MADT transistor at less than $3.00.

Chassis and Cabinet. The subchassis is made from a piece of 3/32" fiberboard. A triangular file can be used to make the rectangular transistor socket holes. L-brackets of scrap aluminum mount the sub-



HOW IT WORKS

A Micro-Alloy Diffused-Base (MADT) Philco transistor (*Q1*) is employed in a superregen circuit. When *Q1* oscillates, a negative voltage charges *C4* and the transistor blocks. As *C4* discharges, conduction resumes. The periodic blocking results in background hiss. Choke *RFC1* in the emitter lead blocks the signal.

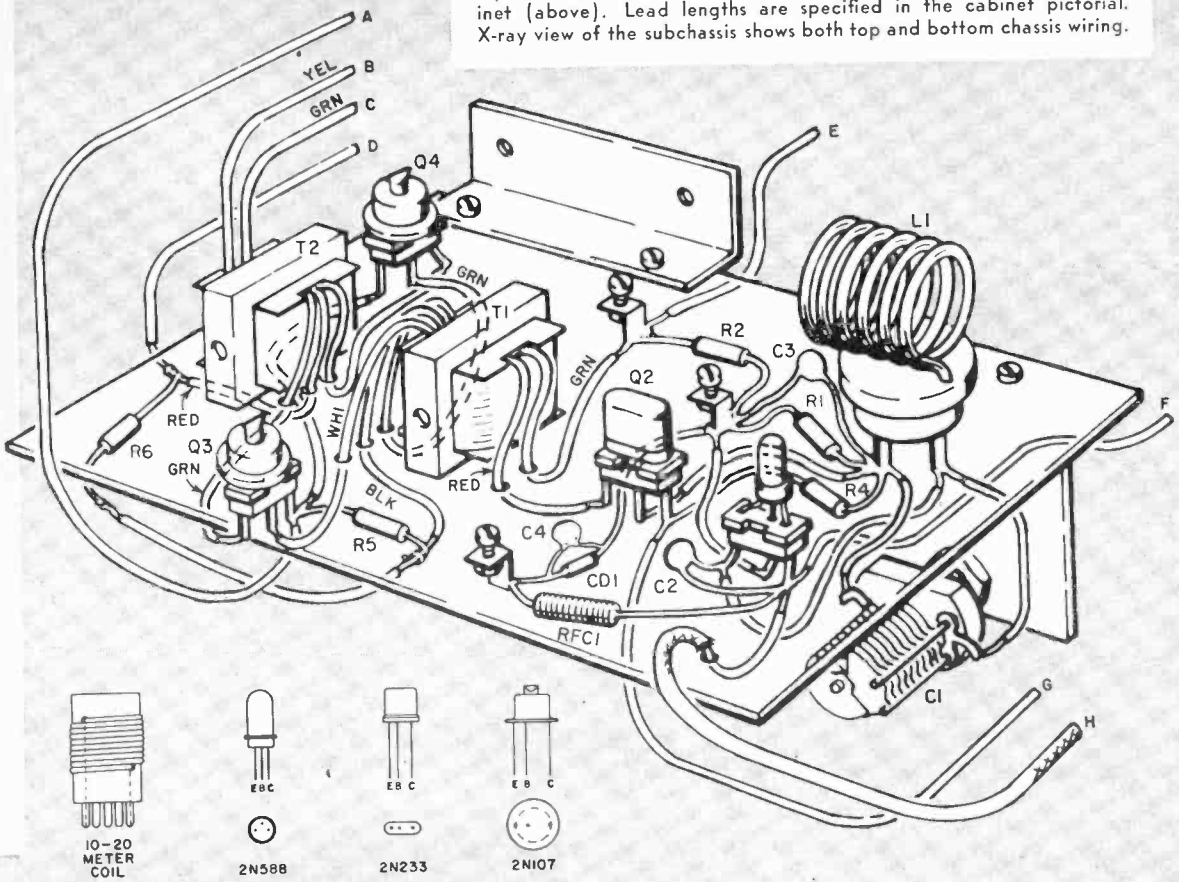
Diode *CD1* rectifies the signal and feeds back energy so that the superregenerator also amplifies at audio frequencies. The signal is then fed into the base of *Q2* which is coupled to driver transformer *T1*.

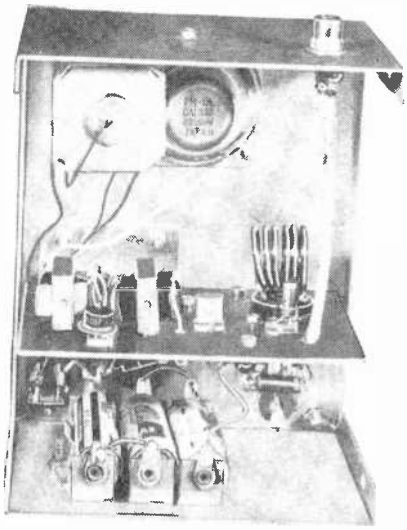
The push-pull stage consists of two *p-n-p* transistors (*Q3* and *Q4*) connected in Class B using the grounded-emitter arrangement. Two separate battery supplies are employed in this circuit for stability, as the supply voltage will not shift too greatly during heavy audio drive. Power output is between 50 and 100 milliwatts.

PARTS LIST

B1—4.5-volt battery (3 penlight cells in series)
B2—6-volt battery (Eveready 724)
C1—15-μμf. variable capacitor (Johnson 15M11)
C2—10-μμf. disc ceramic capacitor
C3, C4—.001-μf. disc ceramic capacitor
CD1—1N34A diode (or equivalent)
J1—RCA-type phone jack
L1—6 turns of #14 enameled wire, ¾"-diameter
Q1—2N588 transistor (Philco)
Q2—2N233 transistor
Q3, Q4—2N107 transistor
R1—18,000 ohms
R2, R6—2700 ohms
R3—5000-ohm miniature or standard potentiometer
R4—270 ohms
R5—150 ohms (All resistors ½ watt)
RFC1—32 turns of #28 wire close-wound on ⅛" form
S1—D.p.s.t. slide switch
T1—Driver transformer; primary 10,000 ohms, secondary 2000 ohms (Olson T-230 or equivalent)
T2—Output transformer; primary 500 ohms, secondary to match speaker voice coil impedance.
1—1½" - 3" speaker
1—5" x 4" x 3" Minibox
1—3½" x 2½" x 3/32"-thick fiberboard subchassis
1—Vernier dial (Calrad VD-36 or equivalent)
4—3-pin transistor sockets
1—Coil socket (Amphenol 78-S5S)

The letter-coded leads from the subchassis are connected to the equivalently coded leads shown in the pictorial diagram of the cabinet (above). Lead lengths are specified in the cabinet pictorial. X-ray view of the subchassis shows both top and bottom chassis wiring.





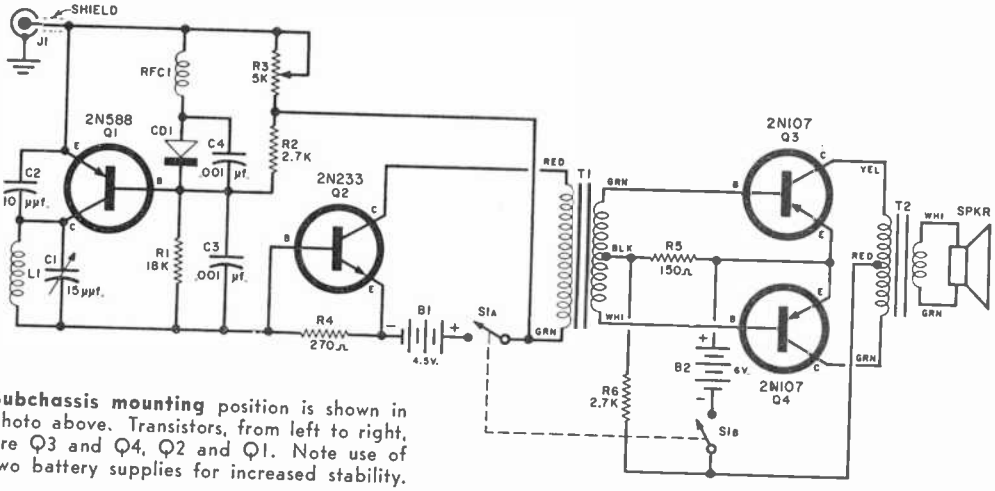
the cabinet. A ¼"-o.d. and $^{3}/_{16}$"-i.d. sleeve will be needed to couple the dial to the shaft of *C1*. Once the vernier dial is properly aligned with *C1*, drill the holes and mount.

Install the 6-volt battery that powers the amplifier with a small bracket. Then wire the battery into the amplifier circuit, carefully observing polarity.

For the antenna connection, use a piece of RG-58 A/U shielded cable and connect it from the emitter pin of *Q1* to the antenna connector *J1*. Do *not* ground the shield at either end.

Coil *L1* consists of six turns of ¾"-diameter #14 enameled wire, closely spaced. Tin the ends of the coil for better contact in the socket.

After you insert all transistors and *L1*



Subchassis mounting position is shown in photo above. Transistors, from left to right, are Q3 and Q4, Q2 and Q1. Note use of two battery supplies for increased stability.

chassis to the inside of the cabinet and *C1* to the subchassis.

Prepare the cabinet by drilling all holes except the ones that are to be used for mounting the vernier dial. To insure good alignment, don't drill holes for the vernier dial until the receiver is assembled.

Wiring and Mounting. Keep all wires in the superregen circuit as short as possible, using ground lugs as tie points. After subchassis wiring is completed, mount the chassis to the inside of the cabinet using an L-bracket and *4-40* hardware. Install the penlight battery holders in the cabinet beneath the chassis and wire to the superregen circuit.

Install the vernier dial on the front of in their proper locations, you will be ready to use the receiver.

Tuning and Operation. This is a very easy superregenerative receiver to tune. Hook a fairly good six-meter antenna to it, then turn the receiver on and adjust *R3* until a loud hiss is heard. Tune the vernier dial and adjust *R3* until you get the best reception.

The author had no problem in receiving hams on six meters. Also on the higher end of the band is TV Channel 2.

Additional coils may be made up for the lower ham bands, but use only a single wire antenna. With this little rig, the author has heard stations all over the United States and South America. —30—

SHOCKING But True

Ignorance of electrical safety rules could cost you your life

By **FORREST H. FRANTZ, Sr.**

MOST OF US have been "bit" at one time or another. If the shock was a mild one, we said "ouch" or "d--n" and that was that. We gave it no further thought. However, we *should* think about it. An appliance that in one situation may produce a slight tickle, in another may jolt us right into a hospital bed or worse. Each year electrical shock takes approximately 800 lives in this country, and these 800 executions are usually accomplished with less power than it takes to press a shirt!

Shocks are caused by a combination of two factors: voltage and current. The relationship between voltage and current can be compared to that of a gun with a bullet in its firing chamber, with *voltage* being the gun itself, and with *current*—the actual death-dealer—being the bullet. The current, or bullet, is harmless until it is "fired" by the voltage. Thus neither voltage nor current is dangerous until they exist in the proper relationship. This explains why a 50-volt jolt occasionally will cause death, while an automobile's ignition system—with its several *thousand* volts of shocking power—is rarely a killer.

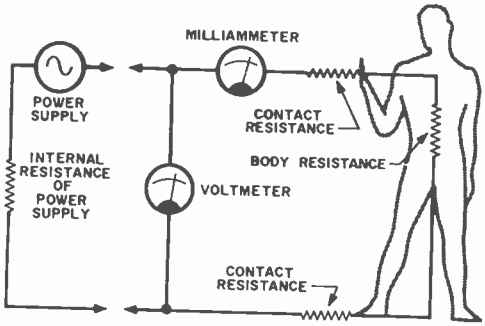
Watch That Current! The amount of current that flows depends on the amplitude and source of the voltage, the physical size of the individual who is shocked, the portion of his body through which the current flows, and the condition of the skin at the points of contact.

The amount of shock current can be calculated by ($I = E/R$). Assuming a voltage of 80 volts and an *internal* body resistance of 400 ohms, a fatal current of 200 milliamperes would flow. Fortunately, in addition to the internal body resistance, there is contact resistance between the voltage source and the skin. Dry skin contact resistance is between 100,000 and 600,000 ohms, but this figure decreases rapidly as the contact area increases and the skin becomes damper. A small amount of perspiration can lower skin contact resistance to 50,000 ohms or less, while complete wetting of the skin and increased contact area can reduce the contact resistance to between 500 and 1000 ohms.

Wet-body contact might involve a total resistance of about 1000 ohms from the right to the left side of the body. With a voltage source of only 50 volts, the current would be 50 ma., a deadly level.

After initial contact has been made, contact resistance decreases. If the decrease in contact resistance lowers the total resistance to 500 ohms, the current will rise to 100 ma.—enough to cause ventricular fibrillation, a heart condition that results in death.

Current-Limiting Factors. But what about the cases where several hundred volts from a Geiger counter battery or thousands of volts from an automobile spark coil or a laboratory high-voltage machine do not cause death? In calculating the effect of a 50-volt shock, it was assumed that no internal resistance existed within the voltage source and that current was limited only by body resistance. This is not always the case. Any electric battery or



The amount of current in a "shock" circuit is determined by the applied voltage in relation to the sum of the internal resistance of the power supply, the resistance of the body, and contact resistance at the points where the circuit is completed.

electric generator has an internal resistance. If this internal resistance is low in comparison to body resistance, total body resistance will determine the amount of current flow.

On the other hand, if the internal resistance of a battery or generator is almost as great or greater than body resistance, current flow is partially limited. If the internal resistance of the voltage source is many times the body and contact resistance, current flow is limited to an almost constant value. Thus, in a 1000-volt generator with an internal resistance of 100,000 ohms, the current could never exceed 10 ma.

Electrostatic generators such as Wimshurst machines or small van de Graaff generators can develop hundreds of thousands of volts. But, although these machines produce high voltages, their *power* output (volts x amperes) is small. When contact is made with a "hot" van de Graaff generator, the current flow is limited to a low value, as it is with automobile ignition systems. However, live experiments should be avoided because there *are* exceptions!

Effects of A.C. Shocks. Special physiological effects of electrical shocks are determined by the frequency of the voltage. While both d.c. and a.c. can cause burns, low-frequency alternating current—and this includes the standard 60-cycle house current—affects the nervous system.

At current values between 8 and 15 ma., a.c. shocks are painful, but most individuals retain enough control of their muscles to withdraw from contact. Currents between 15 and 20 ma. cause pain and loss of muscular control. The victim cannot voluntarily withdraw from contact. Unless the current is interrupted, the victim becomes exhausted and lapses into unconsciousness. When a.c. shock currents reach values between 20 and 50 ma., pain is very intense and paralysis of the breathing muscles will cause suffocation.

When a 60-cps alternating current of between 100 and 200 ma. is applied to the body, the frequency superimposed over the heart's normal beat can disrupt its timing. Since the heart is being told to pump at a rate of 72 times a minute by the nervous system, and, at the same time, it receives external stimuli from the house power supply at the rate of 60 per second, it becomes confused and begins to flutter aimlessly. This is ventricular fibrillation.

Currents greater than 200 ma. stop the heart's movements completely, rather than causing ventricular fibrillation. If exposure to the shock is not prolonged more than three or four minutes, however, the heart will sometimes resume its action.

Shocking Situations. The knowledge that it takes two contacts to cause a shock

Don't adjust your radio while taking a bath. This is an easy way to start a one-way trip to Paradise.

tempts some people to take foolish chances. Don't work on your house wiring until the power switch is turned off. Although you may have one of the wires completely taped up, if you happen to be working with the "hot" wire and then you back into a cold water pipe, zowie! If you're standing on damp ground or on a concrete floor, you can get a shock right through your shoes.

A number of people have been killed each year because they touched light fixtures, switches, or radios while standing in a bathtub. If you're taking a bath and you want

to change the radio station, *don't*—it's such an undignified way to leave this world. Switches are normally insulated from the a.c. line; but a defect in wiring, or an insulation breakdown, can cause a fatal accident. If these things seem unlikely, keep in mind the 800 Americans who die each year from "unlikely" shocks.

Portable electric tools are a "sneak-path" threat. To minimize the chances of sneak-path electrocution, most portable tool manufacturers provide a grounding wire con-

Always ground the third wire from a 3-wire portable electric tool. If the motor shorts out to the frame, the grounded wire will protect you from shock.

nected to the frame of the tool. If the insulation breaks down or a short from the motor to the frame occurs, current will return to ground through the grounding wire (*if* it's grounded, of course) instead of through the user. The short will usually necessitate the replacement of a blown fuse. This is small trouble, however, compared to what might happen otherwise.

The a.c./d.c. radio and other a.c./d.c.-operated electrical devices are additional sources of danger. In the earlier a.c./d.c. devices, one side of the line was connected directly to the chassis. If the line cord for one of these units is inserted so that the chassis is connected to the hot side of the line, body contact from chassis to ground (even though the equipment is not turned on) can result in electrocution.

At present, most a.c./d.c. equipment is manufactured with the chassis connected to one side of the line through a capacitor. But even this measure does not completely eliminate the shock hazard. At 60 cycles, a 0.5-μf. capacitor has a reactance of 5300 ohms, and a 0.1-μf. capacitor has a reactance of about 26,500 ohms. If the body is placed in series with a 0.5-μf. capacitor across the line, electrocution can occur. Although electrocution is unlikely from body contact to the a.c. line through a 0.1-μf. capacitor, a shock will occur. The experimenter should proceed with caution when working with a.c./d.c. equipment. If possible, isolate the equipment from the line with an isolation transformer.

Emergency Procedures. In any shock emergency, the circuit should be broken as quickly as possible, preferably with a switch. If you can't get to a switch, remove the victim from the circuit. *But take precautions to avoid becoming a second victim.* Remember, the victim is "hot," and if you simultaneously touch him and a good ground, you won't be in a position to help anyone.

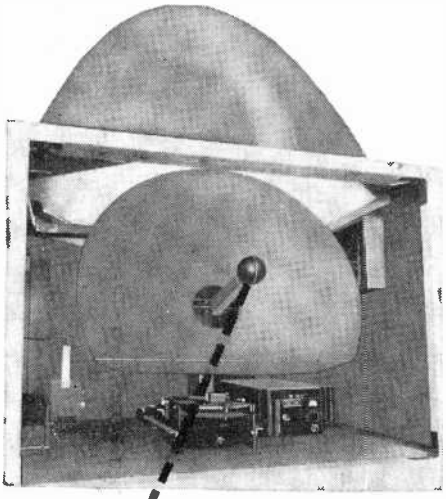
If the victim is not able to breathe after he is removed from the circuit, don't waste

Never touch electrical equipment while you are standing on a damp surface. If you do, you have a good chance of getting 117 volts through your body.

time calling a doctor. Apply artificial respiration immediately and keep it up until someone else brings a doctor.

With the observation of basic safety rules, electronics is *not* a dangerous hobby. But a complete knowledge of the "enemy" and his "tactics" is your best insurance against painful and possibly serious accidents. Don't take chances with house wiring, don't touch any electrical fixture when your hands or feet are wet, and don't work with a.c./d.c. equipment unless you are aware of its shock hazard. —30—

RADAR EYES for TV Weather Forecasts

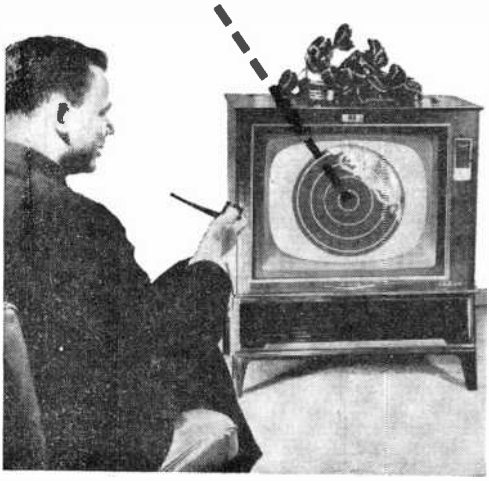


AS you're watching your favorite "weather girl" on television, she starts talking about a storm that's headed your way. While she is describing the storm, the image of a radarscope is suddenly superimposed over her weather map. You actually see the storm as it looks on radar. You watch its progress as it seems to crawl toward your city.

This type of "See It Now" weather reporting will probably become a reality in the near future, thanks to the development of a special ground weather radar system by Radio Corporation of America. Designed with the special needs of television stations in mind, the compact, easy-to-install unit can pick up approaching storms from as far away as 150 miles. It also provides "close-ups" of weather conditions within a 20-mile radius and a detailed view of the weather within 50 miles.

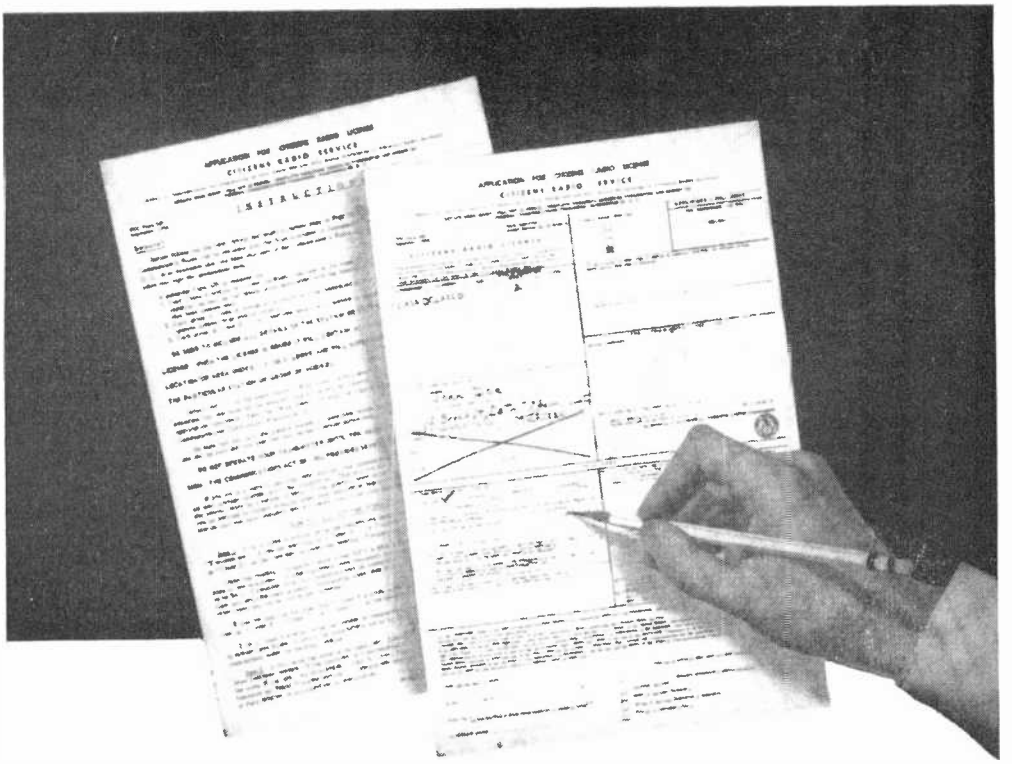
With this unit, television stations can do their own on-the-spot weather forecasting and fill in the blank spots of more general forecasts by giving their particular localities a detailed analysis of the weather that's in store for them. A little practice will even enable a telecaster to forecast the amount of rainfall by studying the presentation on the radar screen.

A disc-shaped antenna housed in a Plexiglas dome is the heart of the radar device. It can be mounted on top of the television station's transmitter antenna tower or on the roof of a tall building. The antenna rotates constantly, sending out pulses and receiving echoes from weather targets.



The pulses are fed to a simple control console equipped with a small radarscope. Here the broadcasters see the radar image. To show it to the viewing audience, they merely move up a studio vidicon camera of the type used to show motion pictures on TV and focus it on the radarscope. The radar presentation can be shown by itself or mixed with an image supplied by another camera. —30—

By ART ZUCKERMAN



Tips for Citizens Band Applicants

THE new 27-mc. Citizens Band has created considerable interest on the part of private individuals and businessmen. It is now possible for any U. S. citizen (over 18 years old) to obtain a license to operate a low-power radio station for voice communications purposes. The rules also permit youngsters who are at least 12 years old to operate transmitters for controlling model airplanes or for other radio control purposes. There are no stiff examinations or code tests. You just fill out a form, with four carbon copies, and mail it to Washington, D. C. It's as simple as that!

If you plan to use the Citizens Band, save this guide for filling out FCC Form 505

The form (FCC Form 505, September 1958) is used as an application for several classes of license, and the references to the rules and regulations may confuse some applicants. The simple 27-mc. voice communications license is called "Class D," and you are probably interested in this one. Radio control transmitters operating on 27-mc. frequencies are called "Class C." Be sure you understand the various classes.

Your Application. When you purchase a Citizens Band radio unit, you will probably find a license application packed in the

box. If you purchase two or more units, each package will have an application form, but you need only fill out one. A separate Form 505 is required for each group of Class C or Class D stations (use a separate form for each class) which is to operate in a separate geographical area.

If you do not receive an "Application For Citizens Radio License" with your radio, copies may be obtained by writing your *local* FCC office.

Before you attempt to fill out the application, send an airmail letter to the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. (include 10 cents in coin) and request Part 19, Rules Governing Citizens Radio Service. You *must* have a copy of Part 19; when you fill out the application, you have to swear under oath that you have read and understood these rules.

If you should ever be cited for operating your station improperly, you cannot plead ignorance of the rules!

Use a Work Sheet. After you have "digested" the rules, you are ready to "attack" the application form. You will note that the papers include a work sheet. This should be filled out in pencil. After you have filled it out, you can show this sheet to someone who has already applied, if you like, and make any changes that might be necessary. In this way, you can avoid messing up the sheets that you mail to Washington. The following is a guide to filling out the work sheet.

Item 1. Under the heading *Frequencies,* write "Class D." Under the heading *Emission,* also write "Class D." Write the number of transmitters you plan on using under the heading *Mobile.* For Class C or Class D do not write anything in the *Base* or *Fixed* columns (for an explanation of this, carefully read Item 1 in the Instructions). If you are filing for a 27-mc. radio control license, write "Class C" under *Frequencies* and *Emission,* and specify the number of transmitters you will use (usually one) in the *Mobile* column.

Item 2. Fill out your name, address, city, *county,* and state.

Item 3. Since your transmitters are listed as mobile units, this question need not be answered.

Item 4. Check the box marked *Class D,* unless you are filing for radio control on 27 mc., in which case you should check the box marked *Class C.*

Item 5. Write "In the vicinity of the city of ————————" (or names of counties or states in which you plan to operate). If you plan to operate outside of your registered area for longer than two weeks, you *must* notify the Commission Engineers in charge of the district you are leaving and the district you plan to operate in. Notification must be provided even if you will still be in the same district.

Item 6. Since *Item 3* was not answered, no answer is required in this space.

Item 7. Check the box marked *Individual* (or whatever other term applies).

Item 8. Check Box 8A if you own the equipment yourself. If not, check Box 8B. Ignore 8C.

Item 9. State briefly how Citizens Radio is to be used in connection with your business or personal activities. As an example: "For personal communication between husband and wife (no business application)." On a Class C application, you might say: "For controlling model aircraft." Use your own words, however.

Item 10. This space is used only for modifying your original license (change of address, new units, etc.).

Item 11. Check the box marked *Yes* if your transmitter is crystal-controlled.

Item 12. Since your antenna can be no higher than 20 feet above existing structures (see rules), no answer is required here.

Item 13. There are no fixed stations in Class C or Class D service, so no answer is required.

Item 14. If the commercial transmitter you purchase is crystal-controlled, no answer is required.

Although you are not required to answer several of the questions, it is always a good idea to "dash in" the appropriate space so it will be obvious that you did not overlook a particular question.

Mailing Procedure. When you have your work sheet completed to your satisfaction, type it up (do not use pencil or pen) along with the four copies. Read the small print above the signature space, and the conditions and warnings on the reverse side of the application. Take the application to a notary public and sign it exactly as you have typed your name in Item 2. Check the box marked *Individual Applicant,* and have it notarized.

Mail your application to the Federal

(*Continued on page* 140)

Build a SOLAR-Powered 40-Meter Transmitter

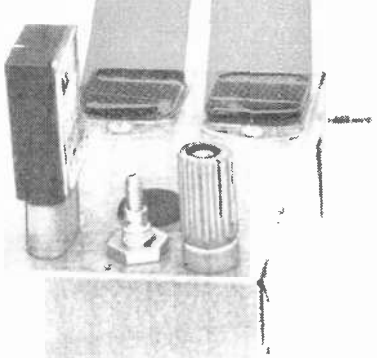
RADIO AMATEURS with privileges in the 40-meter band (7.0-7.3 mc.) can build this solar-powered transmitter to make local contacts. When connected to a 66' length of wire and a good ground, it is capable of transmitting several thousand feet. A test between WV6BGD and WV6BMI (about 1000 feet apart) produced an RST report of 569 in a heavily populated band. During the early morning hours, when 40-meter activity is low, the unit can be heard for even greater distances.

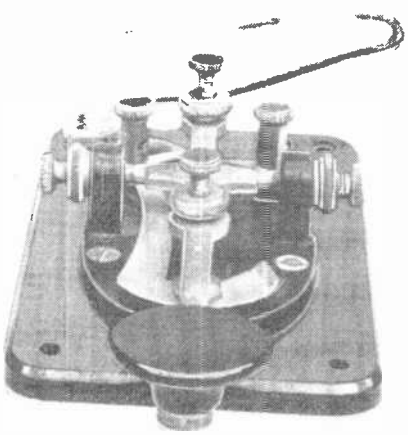
Simplicity is the keynote of this circuit. A single-transistor crystal-controlled oscillator is powered by two inexpensive silicon solar cells. The cost of all the parts will be less than $20.00. You can use the solar cells in other projects, too.

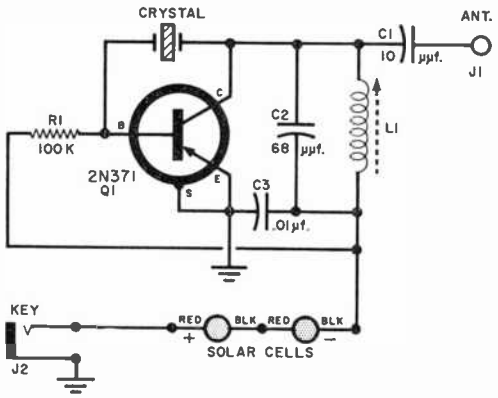
Construction. The unit is built on a 2¼" x 4¼" x 2½" chassis box. The r.f. components (transistor, crystal, coil, and antenna terminal) are located at one end of the chassis, while the key jack and the solar cells are at the opposite end. Two ⅜" holes are drilled below the cells for the red and black leads. A ⅜" grommet is installed near the center of the chassis and the transistor is shoved tightly inside; this mounting is rugged and free from shock and vibration. The transistor leads are soldered directly to the components. A fourth transistor lead (exactly in the center of the case) is a shield connection and should be grounded along with the emitter lead. All components are self-supporting and no terminal strips are used.

Wire the solar cells by connecting a red lead from one cell to the black lead of the other cell, and tape the connection. The remaining black wire is connected to the lug of *L1* nearest the chassis. The remaining red wire is connected to the ungrounded terminal of the key jack. When you mount the key jack, it is automatically grounded to the chassis through the frame. The collector of *Q1* should

By
DONALD L. STONER
W6TNS



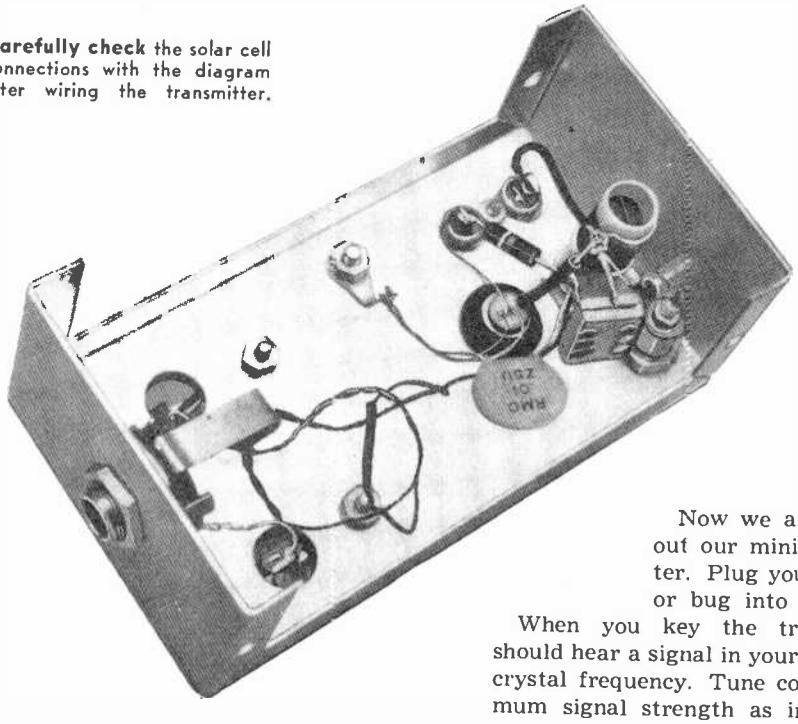




be connected to the lug of *L1* farthest from the chassis.

Adjustment and Operation. The transmitter should be connected to a good antenna-ground system. Insert a 40-meter crystal and hold a lamp bulb near the solar cells. *Caution*—do not put the bulb any closer than two or three inches from the solar cells, as excessive heat will damage the cells. Feel the cells occasionally to make sure they are not too hot. They work much better at lower temperatures.

Carefully check the solar cell connections with the diagram after wiring the transmitter.



Now we are ready to try out our miniature transmitter. Plug your standard key or bug into phone jack *J2*. When you key the transmitter, you should hear a signal in your receiver on the crystal frequency. Tune coil *L1* for maximum signal strength as indicated by an S-meter or with the help of a local ham. The adjustment is very broad and not very critical. The c.w. note should be "pure d.c.," with no sign of "chirp." After coil adjustment, the unit should operate with bright sunlight illuminating the cells.

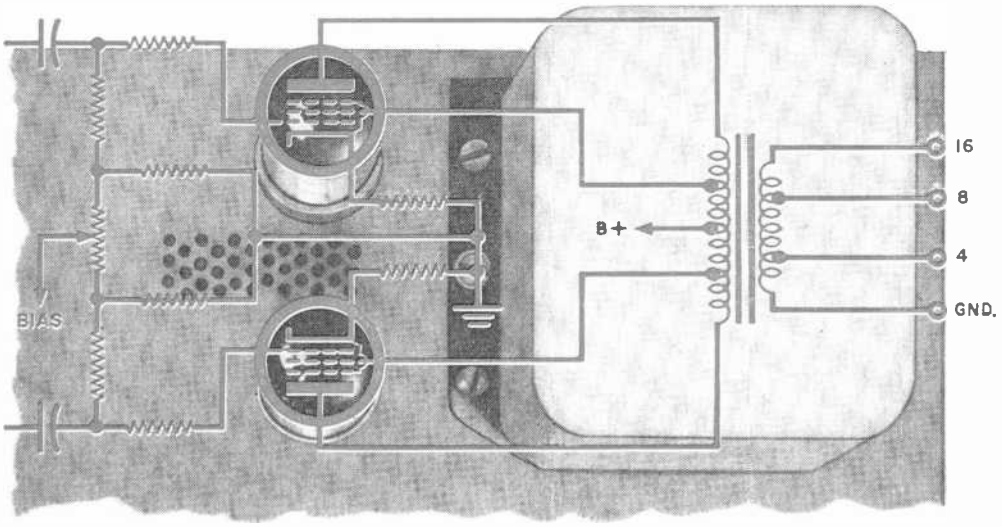
Power can be greatly increased by replacing the solar cells with two series-connected 1.5-volt penlight cells (don't use more than two). Connect the positive terminal to *J2* and the negative terminal to *L1*.

Keep in mind that although this is a "micro-power" transmitter, you still need an amateur license to put it on the air. It does not qualify for the so-called "phono oscillator rules." —30—

PARTS LIST

C1—10-μμf. ceramic disc capacitor
C2—68-μμf. ceramic disc capacitor
C3—.01-μf. ceramic disc capacitor
J1—Nylon pin tip jack
J2—Phone jack
L1—25 turns of #26 enameled wire, close-wound on 3/8" slug-tuned form
Q1—2N371 transistor
R1—100,000-ohm, 1/2-watt resistor
Solar Cells—Two 0.4-volt solar cells (Type SD-1020B, available from International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.)
1—Crystal, 7.0-7.2 mc. fundamental
1—4¼" x 2¼" x 2½" chassis (LMB #777)
Misc. #6 solder lug, 6-32 nut and bolt, 4-40 nuts (4), bolts and washers

INSIDE the



POWER AMPLIFIER

Part 2

The Power Output Stage

By JOSEPH MARSHALL

THE power amplifier's sole function is to produce the power to drive a loudspeaker. This seems simple enough, but as we have noted previously, it takes a lot of doing to get the job done right.

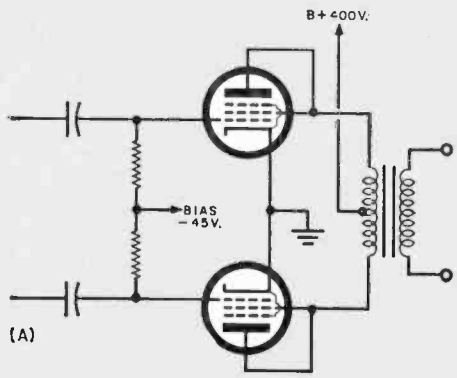
Power amplifier tubes differ from voltage amplifier tubes principally in the amount of current drawn. A voltage amplifier tube may pull 2 or 3 ma. of plate current; a power amplifier may draw well over 100 mils. For voltage amplification, we design tubes so that a given variation in the input signal will produce the largest possible voltage swing in the load. In a power amplifier, on the other hand, we need tubes that will produce the largest possible *current* variation for a given change in input signal.

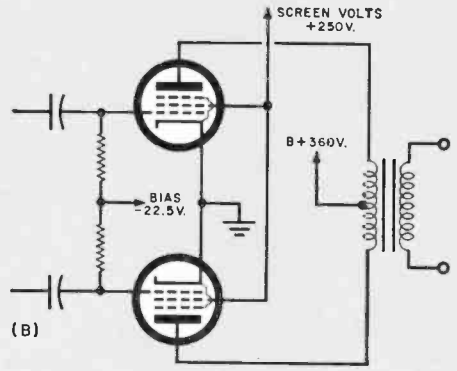
Clearly, voltage amplifier tubes are not suited for application in power output circuits. Consequently, an entirely different breed of tubes capable of handling high currents has been developed.

Probably more than 80% of the power amplifiers now being manufactured utilize EL84's (for power outputs under 20 watts) and EL34's or KT88's (for higher outputs). The other 20% are accounted for, in the most part, by the KT66, 5881, 6L6, 6V6, and the new 6973 and 7027.

Push-Pull Circuits. Power output stages in hi-fi amplifiers almost always operate in "push-pull." As one output tube grid is driven more positive, and thus draws more current, the other tube is driven more negative and it draws less current. Thus the current swing in the load is twice as great as that produced by one tube working alone.

Two conditions must be met for the push-pull output stage to operate properly. First,





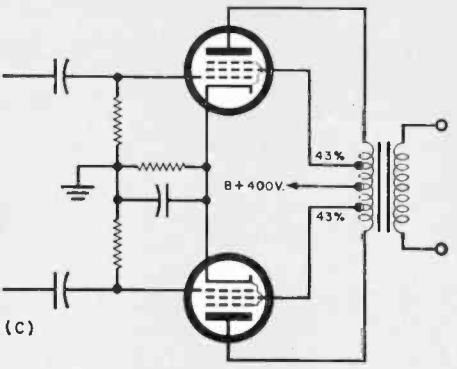


Fig. 1. The four most common power output arrangements: (A) push-pull triodes, (B) push-pull pentodes, (C) Ultra-Linear, or "screen-tapped" circuit, and (D) McIntosh's "Unity-Coupled" circuit.

the two tubes must be fed by identical but exactly out-of-phase signals. Secondly, the tubes must be balanced very closely so that one half of the output swings up as far as the other swings down. If the push-pull circuit is perfectly balanced, the even-order harmonic distortion cancels in the output transformer.

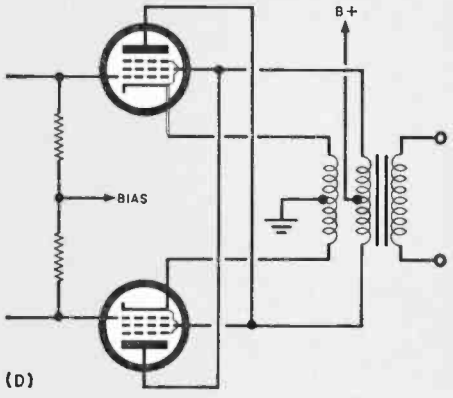
Because of this distortion-cancelling feature of the push-pull circuit, we can drive tubes in push-pull much harder than we could in a single-ended circuit. The distortion-cancelling feature enables far more usable power at low distortion from a push-pull pair than could be obtained from a pair of the same tubes in parallel.

Where one pair of tubes in push-pull does not deliver all the power required, we can use two more tubes in parallel with the first pair to double the power output. This operation is called "push-pull parallel."

Power Output Circuits. There is a great variety of circuits for push-pull operation, but practically all commercial amplifiers use one of the four circuits diagrammed in Fig. 1.

In Fig. 1(A) we have a push-pull triode pair. The tubes can be true triodes, though more often they are tetrodes or pentodes used as triodes by connecting the screen grids to the plates. Although power triodes were very popular at one time because of their low distortion characteristics, they have some serious disadvantages.

Triodes need about twice as much drive voltage as pentodes to produce the same power output; it is not easy to deliver these high signal voltages at low distortion and still keep the circuit simple enough to allow large amounts of feedback. Another dis-



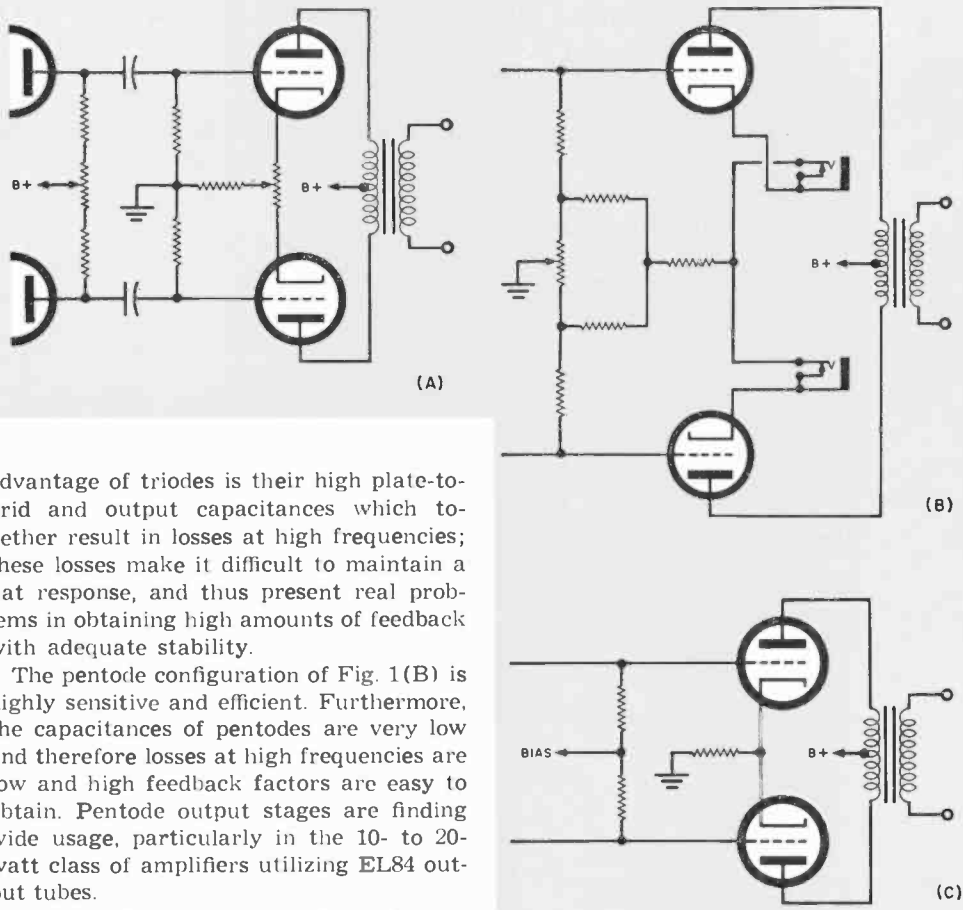


Fig. 2. Balancing arrangement shown in (A) uses a pot in the cathode circuit of the output tubes to provide d.c. balance. A pot in the driver plate circuits provides a.c. balance. The well-known Williamson balancing circuit is shown in (B), and (C) is the semi-automatic balancing circuit used for bias correction in the Dyna amplifiers.

advantage of triodes is their high plate-to-grid and output capacitances which together result in losses at high frequencies; these losses make it difficult to maintain a flat response, and thus present real problems in obtaining high amounts of feedback with adequate stability.

The pentode configuration of Fig. 1(B) is highly sensitive and efficient. Furthermore, the capacitances of pentodes are very low and therefore losses at high frequencies are low and high feedback factors are easy to obtain. Pentode output stages are finding wide usage, particularly in the 10- to 20-watt class of amplifiers utilizing EL84 output tubes.

Today's most popular circuit is the "screen-tapped" or Ultra-Linear arrangement in Fig. 1(C). This circuit is built around an output transformer with special primary taps which are connected to the screen grids of the output tubes. The result is a sort of hybrid operation somewhere between that of triodes and pentodes, combining the best features of each. Among other things, given good output transformers, it permits the use of very high feedback factors.

The fourth major output configuration—the "Unity-Coupled" circuit shown in Fig. 1(D)—is found only in the McIntosh amplifiers. This circuit is basically a "split-load" type, with part of the load in the plate circuit and part in the cathode circuit. The two loads are "unity-coupled" by winding the primaries side by side in bifiliar form. Also, the plates are cross-coupled in relation to the cathodes and screens.

The efficiency of the "Unity-Coupled" circuit is very high since the large amounts of negative feedback within the stage permit the tubes to be operated in Class B without incurring the penalty of high distortion.

Balancing Circuits. We have noted that when a push-pull stage is perfectly balanced, even-order distortion is cancelled. It is obviously advantageous to provide a means for balancing the output stage, and many amplifiers incorporate this feature.

One approach is to use a wire-wound pot (from 10 to 50 ohms) in the cathode circuit, as shown in Fig. 2(A). This pot permits adjusting the bias on the two output tubes

until the tubes draw equal current. Balance is usually indicated by connecting a voltmeter from one cathode to the other and is achieved when the voltage difference between cathodes is zero.

One of the most popular balancing systems was first used in the Willamson amplifier and is still employed by many amplifiers. See Fig. 2(B). Here we have a pot in the common grid and cathode return which is adjusted until the tubes draw equal current. This adjustment not only provides static, or d.c. balance, but also provides a slight adjustment of the input signal delivered to each tube, thereby allowing a degree of dynamic balance as well.

There is an increasing trend toward the use of more-or-less-automatic balancing arrangements. A typical circuit used in the Dyna amplifiers is shown in Fig. 2(C). Here a small (10- to 15-ohm) resistor is inserted

between the two cathodes and ground. This resistor provides bias correction on each tube and, in addition, acts as a feedback device.

The above-mentioned balancing methods are primarily for achieving *static* or d.c. balance. However, the output stage is not truly balanced unless the signal delivered to both grids is equal. Some amplifiers, notably the Marantz and the Acro, provide a means of balancing the input signal as shown in Fig. 2(A). Here, a potentiometer is inserted between the plate load resistors of the driver stage. This pot can be used to vary the plate loads until the two tubes put out equal signals. For lowest distortion, this type of dynamic balancing control is best adjusted while checking the amplifier with an intermodulation analyzer.

Several amplifiers have meters and switching arrangements to permit metered static and dynamic balancing. In these, an external voltmeter is usually connected from cathode to cathode of the output tubes. Small resistors are provided to permit measurements and are usually switched out of the circuit when the amplifier is in normal use.

Output Transformers. The last—and most important—element in a power amplifier is the output transformer. The transformer in your radio or TV set probably weighs a few ounces, cost a dollar—or less—and has a flat frequency response from 200 to 5000 cps. Hi-fi output transformers may weigh as much as 25 pounds and cost up to $50.00.

Transformer response at the extreme low end of the frequency range is limited by the size of the core and its magnetic properties. A flat response to 20 cps at 10 watts or more takes a lot of core, special expensive core materials, and complicated core structures.

There is a lot of wire in a transformer and obviously the windings produce not only inductance and resistance, but also capacitances. These capacitances limit frequency response at the high end by providing bypass paths for the high frequencies. Various clever and costly methods of winding transformers have been developed to minimize unwanted capacitances. Although the end product is expensive, output transformers with frequency responses to 100,000 cps or better are now available.

You may well ask, if transformers pose such problems and cost so much, why use them at all? And it is a good question. One of these days, when transistors are refined, possibly we will not need output transformers. But as long as we have to use vacuum tubes to develop high power outputs, we must use output transformers.

Optimum loads for power tubes run from a minimum of 500 ohms all the way to 10,000 ohms, with an average of around 5000 ohms. Loudspeakers have impedances of between 4 and 15 ohms. Since no power generator can deliver power efficiently unless it is matched to its load, the output transformer is required as an impedance-matching device.

In effect, the output transformer "steps up" the low impedance of the speaker until it seems to the tubes that they are working into their proper load. By proper design, we can obtain matching ratios as high as 2500

(*Continued on page* 128)

Build the Mark-A-Spot Frequency Standard

Printed-circuit board simplifies assembly

By DON LEWIS

ARE you having trouble determining the frequency of that new short-wave station accurately? Or, if you are a ham, do you park your VFO near the center of the band because you are not sure where the edge is? If the answer is yes, in either case, you need a frequency standard to calibrate your equipment.

The "Mark-A-Spot" frequency standard will generate a signal every 100 kc. ($\frac{1}{10}$th mc.) up to 30 mc. You can put it to work on 40 meters, for example, and the unit will generate a carrier on both 7.2 and 7.3 mc. to mark the edges of the phone band.

SWL's will discover that the 100-kc. markers are handy for checking the frequency of short-wave broadcasts. The frequency of a station between the 100-kc. markers can be estimated with great accuracy.

Construction. The Mark-A-Spot is built on a 5¼" x 3" x 1¼" aluminum chassis box with a small rectangle cut out for printed-circuit oscillator board mounting.

The rectifier used in the author's model snap-mounts into a $\frac{3}{16}$" hole but any small rectifier with any terminal arrangement may be used.

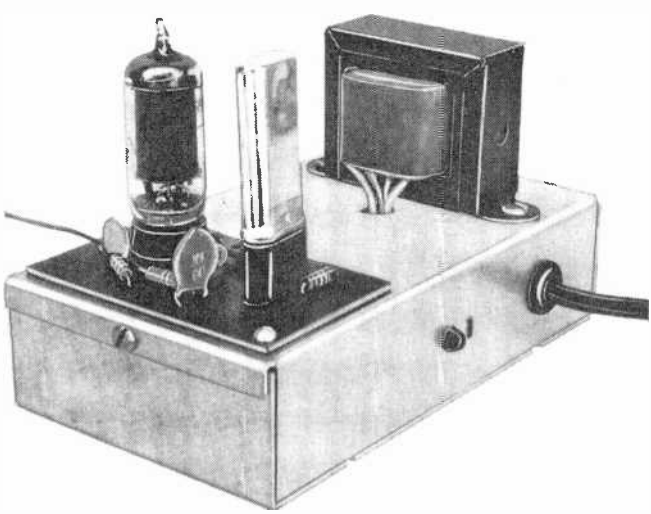
Wiring the unit should take about an hour. The printed-circuit board is wired according to the manufacturer's instructions.

Testing. Before applying power to the unit, check for 100,000 ohms resistance or more across *C1*. If your ohmmeter indicates less, try reversing the leads.

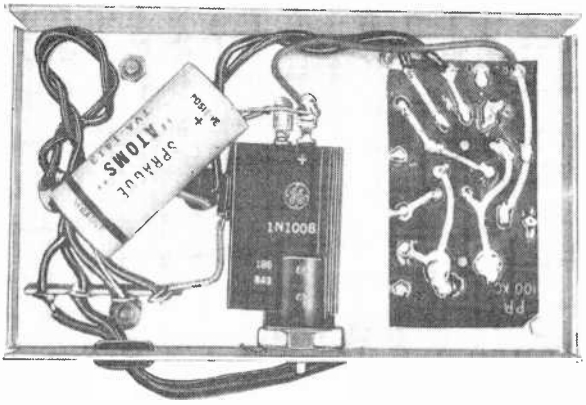
Connect a d.c. voltmeter across *C1* (negative lead to chassis) and set on the 200-volt (or higher) scale. Insert the 6BA6 tube and crystal and apply power. The meter should read about 150 volts instantly.

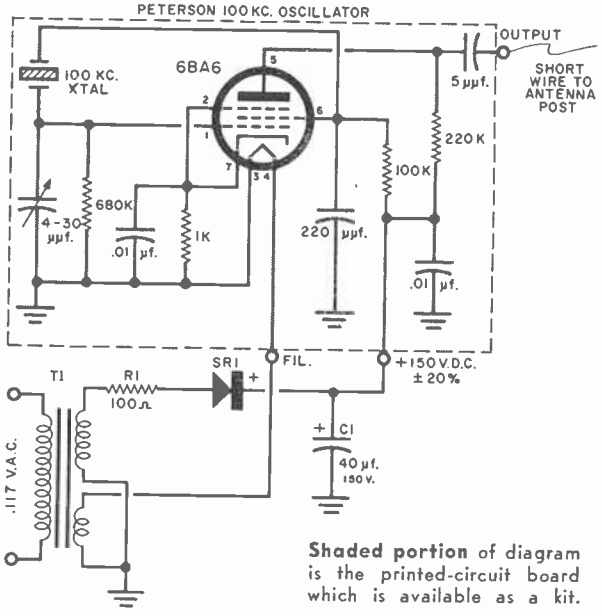
Connect the output wire to the antenna jack of your receiver. With the BFO on, you should be able to detect the oscillator signals each 100 kc.

Adjusting the Beat. A variable capacitor is provided to trim the crystal frequency and put it "on the nose." This adjust-



Chassis layout shown need not be followed exactly. Critical wiring is part of printed-circuit board.





Shaded portion of diagram is the printed-circuit board which is available as a kit.

PARTS LIST

C1—40-μf., 150-volt electrolytic capacitor
R1—100-ohm, ½-watt resistor
SR1—20-ma. (or higher) selenium rectifier
T1—Power transformer; secondary 117-130 volts a.c., 15 ma., 6.3 volts a.c., 0.6 amperes (Triad R54-X or equivalent)
1—6BA6 tube
1—100-kc. printed-circuit oscillator (Peterson Radio Co., 2800 Broadway, Council Bluffs, Iowa)
1—5¼" x 3" x 1¼" aluminum chassis (LMB #136)

HOW IT WORKS

When power is applied, the crystal is stressed and it begins to oscillate. These oscillations are fed to the control grid of the 6BA6 tube and are amplified. A few of the electrons, representing the amplified signal, strike the screen grid and are fed back to the crystal. The feedback energy from the screen grid circuit will "twang" the crystal each cycle, thereby continuing the oscillation.

The remainder of the electrons continue on to the plate circuit and are coupled to your receiver. The output circuit is coupled to the oscillator circuit only by means of the electron stream (hence the name "electron-coupled") which isolates the plate circuit connections from the oscillator.

ment is set in the following manner.

Warm up your receiver and the Mark-A-Spot for about an hour. Tune in WWV on 5, 10, 15 or 20 mc. and couple the frequency standard to the antenna terminal. During the WWV "silent period" just before the voice announcement, adjust the trimmer capacitor until you hear a whistle or "beat note" which is a harmonic of the 100-kc. fundamental. As you adjust the trimmer, the note will drop in pitch, go into the inaudible region, then rise to a high pitch.

The trimmer should be set so that the beat note is in the center of this region and is inaudible. If your receiver has an S-meter, you will note that in this inaudible region the meter needle pumps up and down very rapidly. You can obtain a much more accurate adjustment if you set the trimmer so that the needle moves at a very low frequency or not at all. This is known as "zero beat."

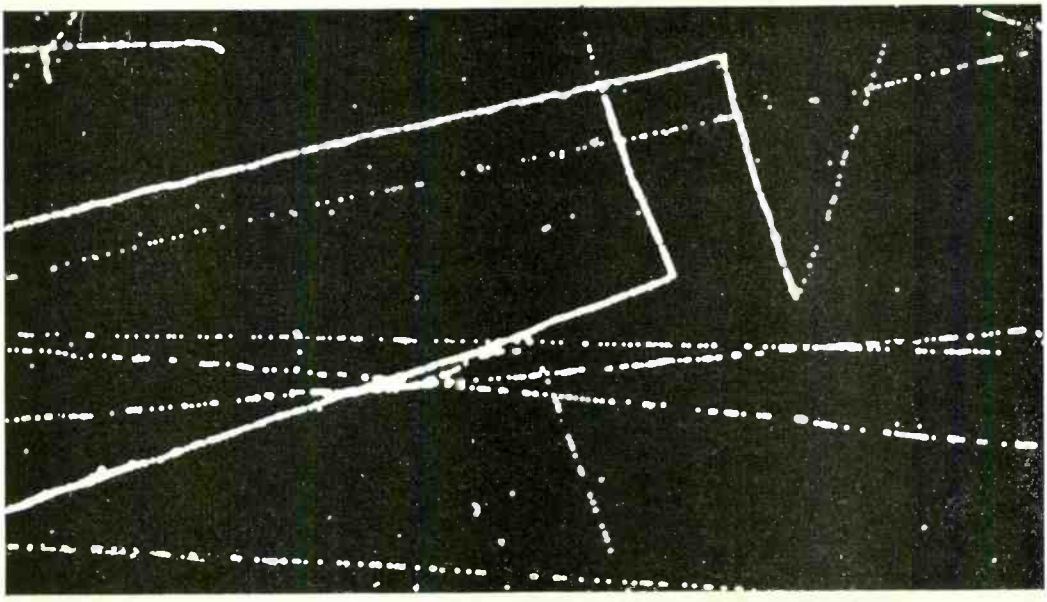
When the harmonic of the calibrator is "dead on" with our primary frequency standard, WWV, all other 100-kc. beat notes will have the same accuracy as the standard.

Operation. No power switch is included in the Mark-A-Spot for two reasons. The power consumed is negligible — less than the average "night light," and the oscillator will be more stable if left running. The components must be at the temperature they were when the unit was aligned to duplicate the frequency.

If you do not want to leave the unit on continuously, you can insert a toggle switch in one side of the line cord. It is also possible to connect the line cord across the primary transformer leads in your receiver. Then the frequency standard will come alive when you switch on the set. —30—

THE WORLD WITHIN THE ATOM

. . . an atomic detective story



Atomic cloud chamber "footprints" have shed new light on the inner world of the atom.

By SAUNDER HARRIS, WINXL

BELIEVE IT or not, our Atomic Age is over 2500 years old. It all started back with the ancient Greek philosophers. One in particular, named Democritus, suggested that a particle existed which was basic to all matter. This particle, he said, was invisible and could not be divided. The Greeks had a name for it . . .they called it the *atom*.

Early Atomics. This idea of a basic particle or substance was more hunch than scientific theory, and it took thousands of years before it could be put to test. Our present concept of the atom began with the work of John Dalton, an English chemist, who first described the laws of chemical compounds and elements in 1802. He separated matter down to its basic building blocks, the elements.

To visualize Dalton's discoveries, imagine that we have a basket of mixed citrus fruit. The complete basket with all the various fruits would be comparable to a chemical *compound*. If we took out the fruits and separated them into groups of lemons, oranges, grapefruit and so on, we would be breaking the compound down into its *elements*. Then, if we set apart one orange, for example, we would be isolating a single *atom*. The next step would be to peel the orange and take a bite of the fruit within. In the case of the atom, this first bite was taken by the English physicist, Sir Joseph J. Thomson, in 1897.

Discovering the Electron. During the middle years of the 19th century, scientists had discovered that if an electric current were passed between two electrodes placed at the ends of a partially evacuated glass tube, a visible beam of unknown nature

would travel from negative to positive electrode. Experiments indicated that this beam was negative in its electrical charge.

Sir J. J. Thomson, using the apparatus shown in Fig. 1, was able to compute the ratio of the charge of a single particle in the beam to its mass. In so doing he proved that the beam was composed of individual, negatively charged particles. This was the discovery of the *electron*.

In other experiments, Thomson tried using various gases in the tube, but in each case his results were the same. The particle was independent of the material from which it came. Thomson therefore concluded that the electron was a basic constituent of all atoms.

You can see that Thomson's apparatus

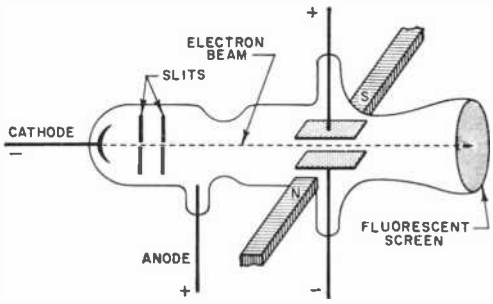


Fig. 1. Thomson was able to calculate the ratio of the electron's charge to its mass by bending the electron beam with known electrostatic and magnetic fields.

was similar to our cathode-ray tube. In fact, the picture tube in your TV set is a direct descendant of the one Thomson used. If you take a strong magnet and place it against the face of the tube while the set is on, you will see a distortion caused by the magnetic field bending the tube's negative electron beam. This is essentially the same effect that led Thomson to identify the electron.

The Proton. The discovery of the electron was only the first step in the exploration of the inner world of the atom. Since the atom was known to be electrically neutral, the physicist now began to search for the positive particles which would balance out the negative charge of the electron.

In 1914, another English physicist, Sir Ernest Rutherford, found such a positive particle and called it the *proton*. The elec-

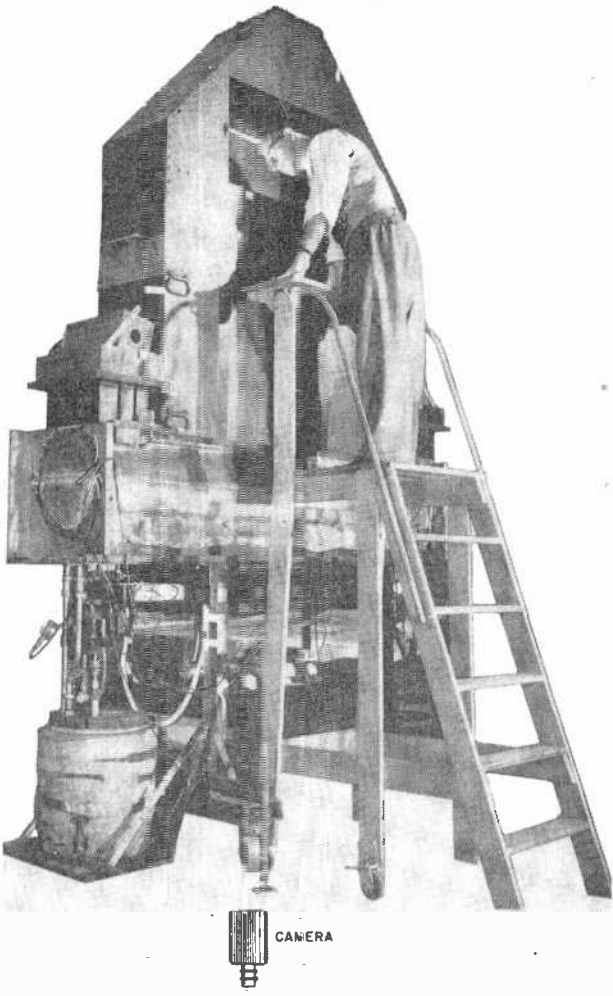
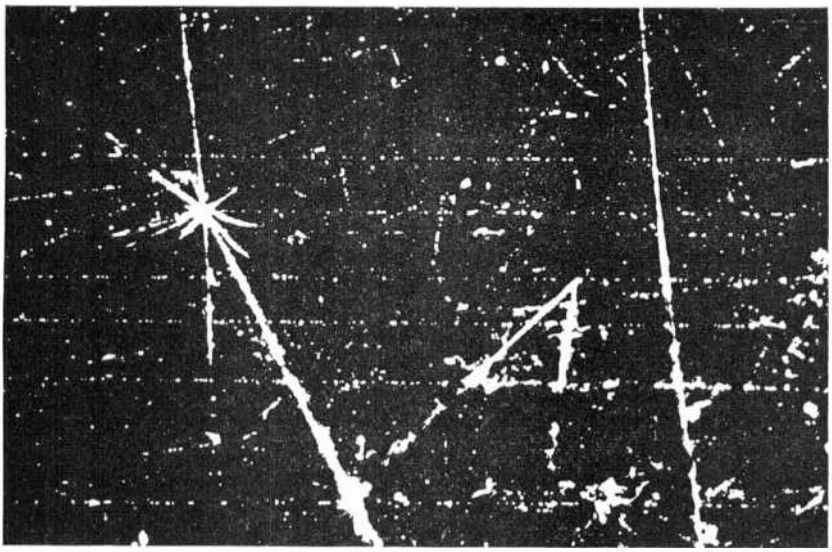


Fig. 2. Cloud chambers such as the one above at the Brookhaven National Laboratory provide clues for atomic detectives. The device bombards atomic nuclei with billion-volt nuclear particles. Atomic fragments leave a path in the moist, gas-filled air which can be photographed and interpreted. Diagram shows basic construction of cloud chamber.



Tracks left by high-speed protons on a sheet of photographic film are shown at left. The dotted horizontal lines were made by protons. The "star" was made when an atom disintegrated in the photographic emulsion. (Brookhaven Lab photo)

tron's charge was assigned a value of −1 and the proton's charge a value of +1. Besides the difference in charge, it was also discovered that the proton was much greater in *mass* than the electron. It was, in fact, 1836 times the mass of its smaller opposite.

Obviously, a proton is too small to be seen directly, and you may wonder how it was detected. Consider a trail left in the sky by a jet plane traveling at high speed. By looking at such a trail you can follow the flight of the jet without actually seeing the plane. On a smaller scale, this is how atomic particles are observed. Figure 2 shows a cloud chamber, a major tool in the detection of atomic particles.

As high-speed particles pass through the cloud chamber, they produce ions in the chamber's gas-filled atmosphere. When the piston in the bottom of the cloud chamber is suddenly lowered, this gas, which is saturated with water vapor, expands and drops in temperature. Water vapor condenses on the ions and outlines the path of atomic particles through the gas. Photographs can be made of the ion tracks, and by studying photos of the trails, physicists are able to identify the mass and charge of the various particles.

SUB-ATOMIC PARTICLES

Particle	Charge	Mass	Life in Seconds
Electron	−	1	stable
Positron	+	1	stable
Photon	0	0	stable
Nutrino	0	0	stable
Graviton	0	0	stable
Proton	+	1836	stable
Neutron	0	1838.5	750
Positive Mu Meson	+	210	2.1×10^{-6}
Negative Mu Meson	−	210	2.1×10^{-6}
Neutral Pi Meson	0	265	10^{-15}
Positive Pi Meson	+	276	2.6×10^{-8}
Negative Pi Meson	−	276	2.6×10^{-8}
Lambda	0	2182	2.7×10^{-10}
Xi	−	2585	10^{-10}
Tau Meson	±	975	10^{-8}
Kappa Meson	±	1100	?
Positive Chi Meson	+	1400	10^{-9}
Negative Chi Meson	−	1400	10^{-9}

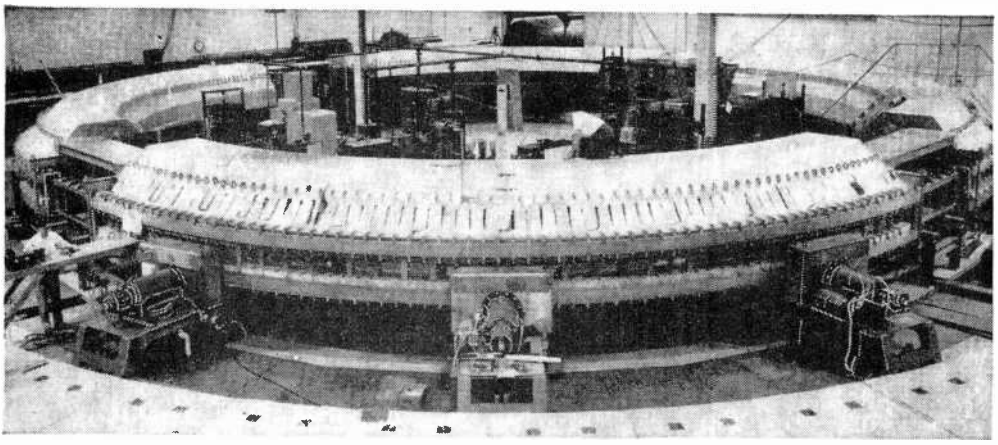
ANTI-MATTER

Particle	Mass	Charge
Anti-nutrino	0	0
Anti-electron	1	+
Anti-proton	1836	−
Anti-neutron	1837	0

Bohr's Atomic Model. In physics, when a theory is proposed, the known facts are often organized by fitting them into a model. Based on this model, observations are explained and predictions are made. Our present understanding of the atom has come about in such a manner.

The first proposed model of the atom suggested that it was spherical, like a golf ball, and that its mass consisted of protons with rings of electrons between them. This model, however, did not explain certain phenomena such as atoms giving off light when excited electrically or by heat. It remained for a Danish physicist, Niels Bohr, to offer a model which would explain these phenomena.

Bohr's conception of the simplest atom, the hydrogen atom, consisted of a positively charged nucleus with a "planetary" electron in orbit around it. To move around the nucleus, the electron had to be influenced by some force. This force, Bohr



Cosmotron at the Brookhaven National Laboratory accelerates particles to energies of two or three billion volts. Inside diameter of the Cosmotron is over 60 feet.

said, was the electrostatic attraction of the positive proton nucleus for the outer electron. Figure 3 shows a model of the Bohr atom. Bohr was able to explain with mathematics many of the experimental results which were obtained through the use of his model.

Isotopes. In 1932 a new particle was unexpectedly discovered. While experimenting with radioactive polonium, German scientists detected a strong, penetrating radiation. In France, the Curies noticed that the placing of a substance containing hydrogen in the path of this radiation caused the release of high energy protons. These results were analyzed in the laboratory of James Chadwick, an English physicist, and it was determined that the radiation was a new type of particle which had no charge. This third particle was called the *neutron*.

The fact that various atoms of the same element had been found to have different weights could now be explained by the difference in the number of neutrons in their nuclei. For example, there are three types of hydrogen. H^1 has a nucleus which contains one proton. H^2 has a proton and a neutron in the nucleus. The heaviest, H^3, so rare that only three pounds of it are thought to exist on earth, has one proton and two neutrons in the nucleus. Atoms with an "excess" of neutrons are called *isotopes*.

Isotopes can appear in all elements. The important thing to remember is that planetary electrons in the outer orbits balance the number of protons in the nucleus.

Energy and Radioactivity. With our three particles, the electron, the proton, and the neutron. we could set up a mechanical model of the atom such as Bohr's. This model would account for most of the things physicists have observed. What it would *not* do is explain how mass could be converted into energy (and energy into mass) without loss. In other words, the

(*Continued on page* 137)

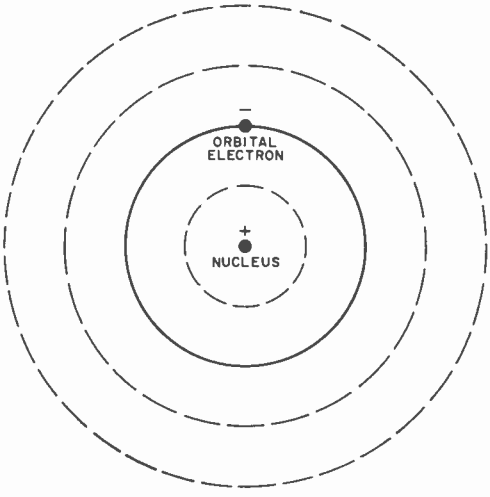
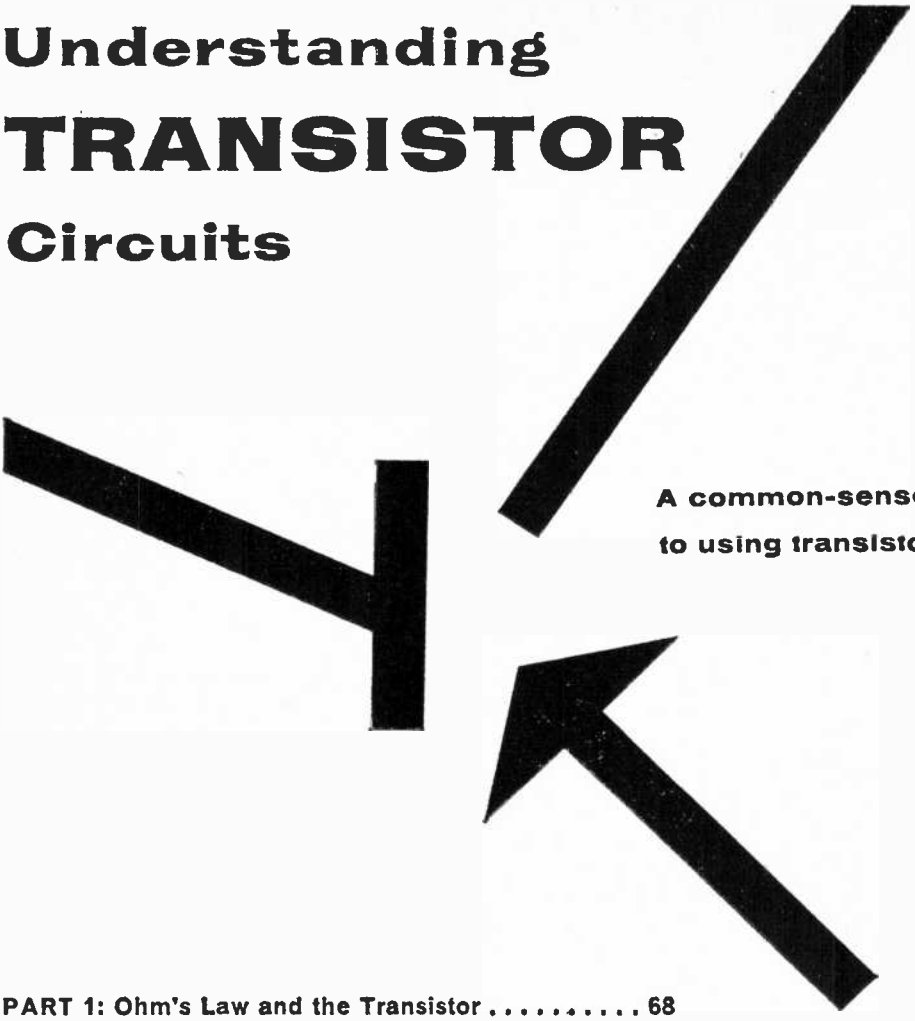


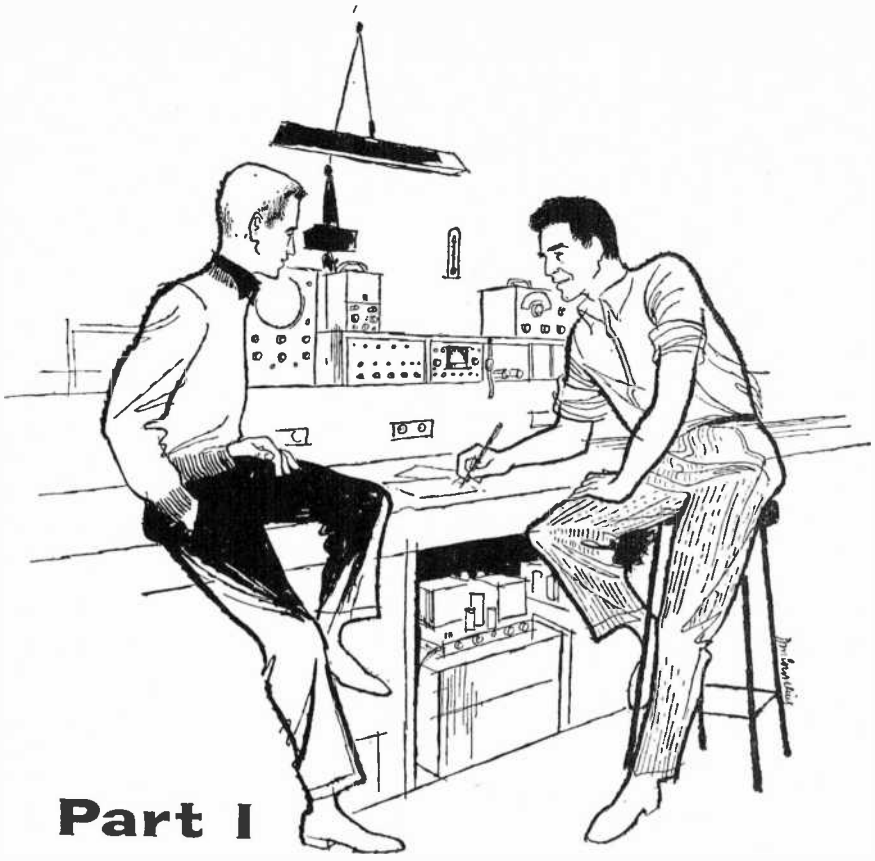
Fig. 3. Bohr's model of the hydrogen atom. Solid line indicates normal orbit of the planetary electron. When electron moves to inner orbit, energy in the form of light is given off. When energy in the form of heat is applied, the electron will move to the outer orbits.

Understanding TRANSISTOR Circuits



A common-sense guide to using transistors

By James Butterfield
Canadian National Telegraphs



Part I

Ohm's Law and the Transistor

"This should do it," grunted Pete, as he soldered a final connection. "Now, let's try out the amplifier."

"*That's* an amplifier?" snorted Johnny. "You must have dreamed up that circuit during a fit of indigestion! Anybody knows even the simplest transistor amplifiers are bristling with resistors and oversize coupling capacitors. And where's the output transformer for the speaker?"

"Don't need any." Pete clipped on the ground lead from the audio generator and inserted a .1-μf. capacitor in series with the other lead. "Trouble with most of you experimenters is that you just copy diagrams—maybe change 'em a little here and there to see what happens—but you never bother to find out what really makes things tick." He touched the other end of the capacitor to his input lead, and the speaker sang with a clear tone.

"Pete, I've got six books on transistors, and I still don't know what I'm doing," complained Johnny. "They are either so simplified that they don't say anything—or they're crammed with equations from stem to stern."

"Nothing wrong with equations." Pete was busy tidying up his workbench. "But you don't always need 'em. I threw this amplifier together without fancy calculations—just horse sense. Let's go into the kitchen for coffee, and I'll try to fill you in on the *practical* side of transistors."

Diodes Back to Back

"First off," said Pete settling in a chair, "You know that a transistor is sort of like a pair of diodes, back to back, like this." He sketched rapidly on a napkin.

"The way I've shown it here, the transistor is a *p-n-p* unit. To get an *n-p-n* job, you flip both diodes end-for-end. We'll dig deeper into this later—but for now, just remember when positive voltage is on the *p* section and negative voltage on the *n* section, the transistor conducts."

"I suppose the lead in the middle is the base," said Johnny. "But which is the collector and which is the emitter? Your diagram doesn't show any difference."

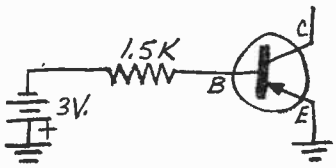
"Here's something that will probably surprise you, Johnny. The collector and the emitter could be changed around and the transistor would still work! But since the manufacturer normally builds the collector bigger and stronger than the emitter —take his advice and use the collector lead as the collector.

"The real difference between the collector and emitter is in the way we treat them. The emitter is biased to allow *maximum* current flow (forward bias) and the collector, on the other hand, is back-biased for *minimum* current."

"Hey," Johnny cut in. "Wouldn't a heavy current flow from the base through the emitter mean that there would be darn little voltage drop between the emitter and base?"

"Right, Johnny, there's seldom more than a quarter of a volt difference between emitter and base,

which makes it easy to figure emitter current. Take this circuit for example:



"The collector isn't important just for the moment, so I won't show any wiring to it. Since the emitter is at ground, you can figure that the base is almost exactly at ground, too. This means . . ."

"I get it," cried Johnny. "The battery puts exactly three volts across the 1500-ohm resistor, so Ohm's law says that the current must be . . . ah . . . two milliamps!"

"Bravo!" chuckled Pete. "And since this part of the transistor is conducting in the forward direction, the current will not be affected by the collector. By the way, what type of transistor did I show in the diagram?"

"Negative voltage on the base, and positive on the emitter . . . so the transistor must be a *p-n-p*!" exclaimed Johnny triumphantly.

A Current Problem

"Now, here's point number two. The collector must be biased in the *non*-conducting direction. How would you do that?"

"Put negative voltage on it, I suppose," said Johnny thoughtfully. "But, wouldn't that mean that no current would ever flow?"

"That would be true if the collector and base *only* were connected," replied Pete. "But when the emitter is in the circuit with positive bias, an interaction allows current to flow through the collector."

"Now you're getting complicated," complained Johnny. "You sound like a textbook."

"Okay, let's put it this way. Whatever current flows through the base will produce an amplified current through the collector. You know how to find the base current—we just did it by Ohm's law. So you take the base current (I_b), multiply it by your amplification factor (H_{fe})—and there's I_c, your collector current."

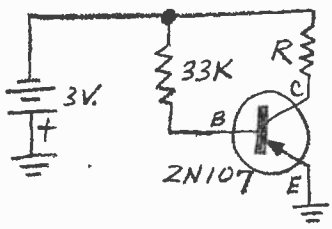
$$I_c = I_b \times H_{fe}$$

"Just a minute," argued Johnny. "Suppose I put a higher voltage on the collector. Wouldn't that make more current flow?"

"Not at all! Ignoring the fine points, I_c will always equal I_b x H_{fe}. The latest G.E. transistor

manual, by the way, lists H_{fe} for over four hundred transistors of all makes.

"The experimenters' transistors, such as the 2N107 and the CK722, have gains of about 20. Commercial grade transistors can run gains as high as 100 or more.



"Let's take a look at another circuit," Pete continued, sketching rapidly. "See what you make of this."

"Let me see," murmured Johnny. "With the emitter grounded, the base has to be at almost zero volts—which will cause the battery's three volts to drop across the 33,000-ohm resistor. That would give about 0.1 ma. flowing through the base. If the amplification of the transistor is 20, that means the collector will take almost two milliamps. But, doesn't the size of resistor *R* make any difference to the collector current at all?"

"Nope," said Pete cheerfully, "with one exception. What would happen if that resistor were, say, 2000 ohms?"

"Well . . . Ohm's law says that two milliamps times 2000 ohms makes a drop of four volts. Oh, I see what you're getting at. If your collector resistor is too big, it won't pass any voltage . . ."

"And once you lose the voltage, you lose your transistor action," finished Pete. "A resistance of about 800 ohms would be dandy for this circuit."

"That would give a collector voltage of—let's see—three volts minus a 1.6-volt drop across the resistor leaves a little under a volt and a half for the collector. Isn't that too low? You'd never be

able to put out a decent signal voltage with a supply like that."

"Depends on what you're using the amplifier for. Usually, you don't need voltage—all you want is current."

Beating the Heat

"Another thing, Pete, what about heat effects? Are transistors as heat-sensitive as some of my books say? Does the gain change, or what?"

"No, the gain of a transistor usually stays fairly steady; but when the thermometer is high, a little leakage current sneaks through. Don't worry about it, though. You'll seldom have trouble if you stay well within the maximum ratings of the transistor."

"These 'max' ratings—anything complicated about them?"

"Gosh, no! Maximum collector-to-base voltage, maximum collector current, and maximum collector dissipation—that's all you'll have to worry about. They mean just what they say. Don't put too much voltage across a transistor; don't put too much current through it; and don't heat it up too much with a combination of the two.

"Now—you've made a start on logical transistor design. The fine points will come later. Whomp yourself up a few circuits. You'll find that theory and practice go hand in hand. Then when you think you've got the basic idea under your hat, we'll dig into this thing a little deeper."

Part II

Design "Do's" and "Don'ts"

"Pete, I've been playing around with transistors like you told me, and I've got problems."

Pete carefully set down his soldering gun and turned toward his visitor. "What seems to be the trouble, Johnny?"

"Well . . . I wanted to boost the output of the radio I'm using as a tuner. I laid out a circuit the way you showed me, but it doesn't seem to work right. The volume is just as low as before—and what's worse, the tone is mushy and distorted. I tried a new transistor with no better results. Pete, tell me, where did I goof?"

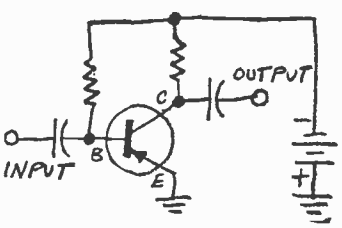
Pete grinned. "I think I know what the trouble is, Johnny. Your circuit is probably good for a vacuum tube. You'll have to learn to think in different terms for transistor amplifiers.

"First of all," said Pete, reaching for a pencil and scratch pad, "do you remember how I told you that a transistor was really a pair of diodes back to back?"

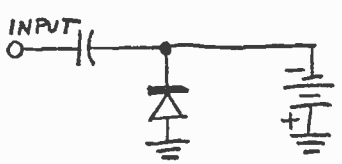
"Yes. I got that part okay."

"Fine. Now let's go back to fundamentals again and attack the problem from a different position.

"Remember that the base-emitter 'diode' must be hooked up to conduct in the forward direction. Let's look at the circuit of an ordinary transistor amplifier.



"As I told you last time, in a *p-n-p* transistor negative voltage is applied to the base and positive voltage to the emitter, and conduction takes place in the diode formed by the base and emitter. I'll sketch this part of the circuit in detail for you.



"When a diode conducts, it's just as if a switch has been closed. Now, when this base-to-emitter diode is conducting, all your a.c. signal goes directly through the diode to ground. For most purposes, the input impedance is so low that you can consider it zero."

"Just a minute," interrupted Johnny. "If the input is a short circuit, how can you get any ampli-

fication? There won't be any voltage left at the input if you short it all out."

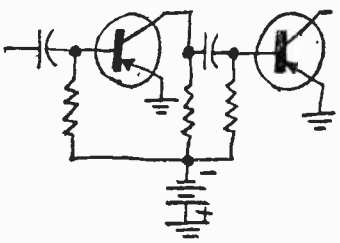
"Forget about voltages. Here's the important thing. Since the transistor has a 'short-circuit' input, it may not have much voltage at the input, but *current* flows *into* the transistor. Current is what a transistor amplifies.

"Suppose we have a transistor with a *beta*—that's current gain—of 20. Then if I put one milliampere of signal into the base, I'll get 20 ma. at the collector. Write this in your notebook in capital letters an inch high—A TRANSISTOR AMPLIFIES CURRENT."

"Pete, I notice you always put your signal into the base and take your amplified output from the other collector. It seems to me I've heard of other ways of connecting a transistor."

"Forget them, Johnny. There are very few jobs that can't be handled by the grounded emitter. We'll talk about the other circuits when an occasion arises that requires their use."

Cascaded Amplifiers



"Pete, how do I go about using an output that's rated in milliamps instead of volts? The current goes through the collector resistor, so it can't be used as it stands."

"That's not exactly true, Johnny. It depends on how you hook into the transistor output.

"Suppose we put the output directly into another transistor stage," continued Pete. "Since the input of this stage is a short circuit, all your signal will be 'shorted' directly to this stage through the coupling capacitor. In other words, all your output goes to the next stage.

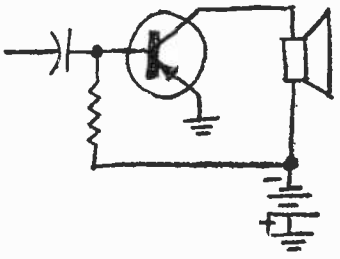
"If both these transistors have a current amplification of 40, we can do some fairly accurate figuring. An input of 0.5 ma. will produce 20-ma. output. All of this goes to the second stage to be amplified, giving you a final output of 800 ma.—almost a full ampere."

"Wow!" Johnny exclaimed. "That's a lot of current!"

"A little too much current for comfort. To pass that amount of current, even in a power transistor, you'd have to be careful of heat effects.

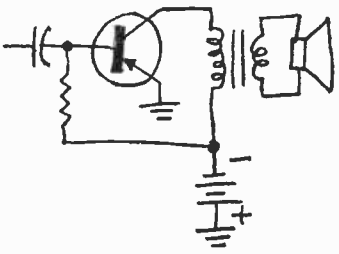
This doesn't just mean mounting your transistors to dissipate heat—it means using special circuits to compensate for heat effects.

"For the time being, with the simple circuit we're using, it would be wise to keep your output signal to a quarter of an ampere or less. At this level, you can bring your d.c. bias down to about a third of an amp collector current, which is well within safety limits for a low collector voltage. If you use more than a couple of volts on the collector, keep an eye on your power ratings. And use a heat sink, of course."



"Pete, I still don't see how we're going to use that final output current. Do you connect a coupling capacitor to the speaker or what?"

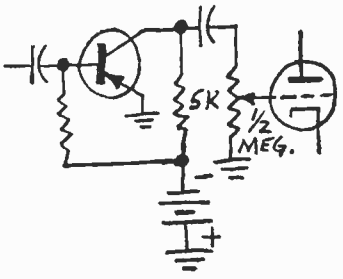
"You could do that, but you'd waste a lot of power. The easiest way to do it is to put the speaker directly in series with the collector, like this. But if the collector load is too *small*, there won't be enough voltage drop across it for appreciable power to be transferred to the speaker. Ohm's law, $W=I^2R$, (where W is the wattage delivered to the speaker, I is the collector current, and R is the speaker impedance) explains the problem.



"Get a transformer whose primary matches the collector load requirements and whose secondary fits the speaker, and you're in business."

Voltage Out

"Let's get back to your original question on figuring your output. If you're using a transistor as a preamplifier for a vacuum tube, you'll have to know your voltage out. This is really very easy when you think about it, because the input of the vacuum tube is usually high enough to ignore.



"In this diagram, the total transistor load is the 5000-ohm collector resistor shunted by a ½-megohm volume control. For all practical purposes, our output load is 5000 ohms. If our design shows we have a signal current of one milliampere on the collector, we use Ohm's law . . ."

"Don't tell me!" exclaimed Johnny. "That will be . . . ah . . . five volts!"

"You're sharp this morning. May I point out that if you want to use a transistor in this way—

and handle these levels—it would be common sense to put at least seven volts or so on the collector?"

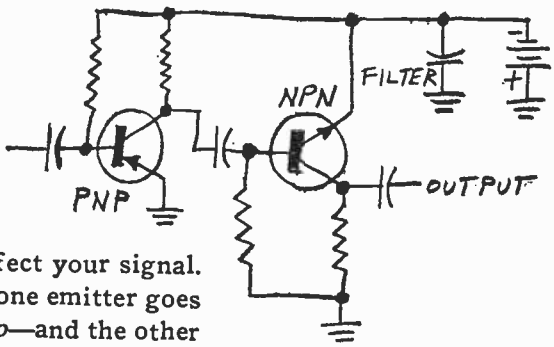
"I see what you mean, Pete. And I suppose it would also be a good idea to have at least one milliampere of d.c. current through the collector?"

"Right. Remember, of course, that a milliamp of a.c. will draw almost 1.5-ma. peak current, so you should allow a little extra. And that's just for pure sine waves—when you're figuring in terms of average music levels, leave lots of room for swing.

"Generally, it's best to choose your d.c. bias currents keeping in mind the a.c. signal voltages you want to handle," Pete went on. "And usually it's best to have at least 1 ma. of collector current, even at low levels. The reason for this is complex, having to do with impedances and distortion. We'll save this topic for another time."

N-P-N or P-N-P

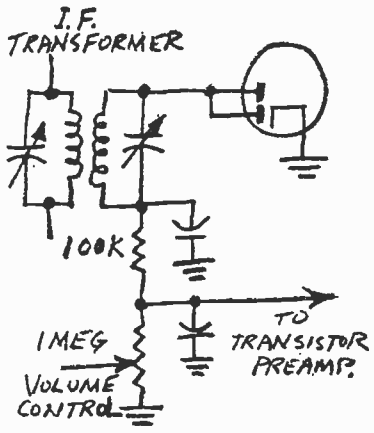
"You've probably noticed that all the transistors I've shown have been *p-n-p* types. As far as signal amplification goes, *n-p-n* transistors are exactly the same. Your signal goes into the base and comes out from the collector. Your connections for bias will be different, but that won't affect your signal.



"If you use both types together, one emitter goes to positive ground—that's the *p-n-p*—and the other emitter will go to your negative voltage supply. This is quite okay, since they are connected together signal-wise through the filter capacitor, making both emitters 'grounded.'

"Your bias currents are easy to set up on any of these stages. I've left the base and collector resistors unmarked, for two reasons. First, the size of these resistors depends on the battery voltage you are using. And, second, it will do you good to work out the values yourself using the techniques I showed you before."

Getting the Signal In



"Let's discuss the booster you tried your hand on, now. Where did you connect the transistor?"

"Across the volume control. I wanted to be able to turn the volume on the radio down and still feed my hi-fi."

"Well, let's sketch out a typical receiver circuit. Notice that the detector is designed to work into a very high resistance . . ."

"I see!" exclaimed Johnny. "The transistor booster would short out the volume control, and put a heavy load on the detector circuit. Well . . . how *can* I get the input impedance high enough so that it won't affect the circuit?"

"That's a story in itself, Johnny. The best way is usually to put a resistance in series with your input. But even though your radio isn't an a.c./d.c. job, you'll probably have hum problems if you try using a common ground. For the moment I'll say this: the best way will probably be to use an input transformer that matches from 500K down to about 100 ohms.

"In the meantime, dust off some of those old transistors and see if you can put them to work. A lot of design 'failures' result from the experimenter forgetting to take into account the very low impedance of transistors.

"Look me up when you've digested this session and I'll show you how to check out some of the transistor design parameters, and incidentally how to test the little gadgets."

Part III
Controlling, Coupling and Testing

It was a week later that Johnny once again sauntered down the stairs into Pete's basement workshop. Pete looked up from a small amplifier he was wiring. "How's tricks, Johnny?"

"I'm just a little confused, Pete. All this dope you've been giving me on transistors is hard to digest so fast. For example, you said that the input is a short circuit. Well, the *Radio Amateur's Handbook* has a table of specs for quite a few transistors, and for the 2N107 they say . . ."

"They told you the input impedance was around 600 ohms, I bet. Well, in a sense we're both correct. Here, Johnny, look at it this way—you've done a fair amount of wiring. How much resistance would you say there is in hookup wire?"

"I never thought about it. Oh . . . maybe a half an ohm a foot . . . but it doesn't make much difference to the circuit."

"Why not?" demanded Pete.

"Because even if the resistance were as high as an ohm or two, it's usually so much smaller than any other resistance in the circuit that you don't count it. Who cares about half an ohm or so when you're dealing with resistors of several thousand ohms?"

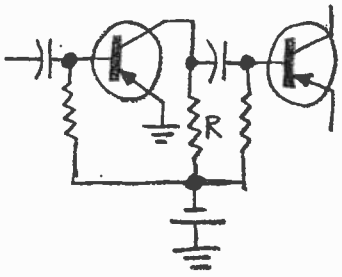
"Right you are, Johnny. And the same thing goes for your question about a transistor input impedance. Even at six hundred ohms, it's so much smaller than any other resistance in the circuit that you can count it as a short."

Short and Simple

"It's very simple to figure out a circuit this way, too. Using the short-circuit input approach, you eliminate most of the calculating."

"But wouldn't that make your calculations inaccurate? You couldn't get the exact values of gain. You'd have to be a few per cent off."

"Look at it this way, Johnny. To begin with, transistors are never rated exactly. A transistor with a rated gain of 20 might have an actual gain as low as 10 or as high as 40. So, fancy calculations usually aren't worth the trouble."

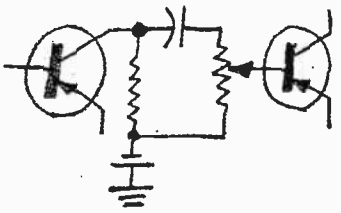


Johnny nodded. "True. But let *me* draw *you* a circuit. Now, if the voltage supply were very low —such as a single dry cell—then the collector resistor *R* would have to be small enough so that it didn't drop all the battery voltage. Wouldn't that mean . . . ?"

Pete chuckled. "Johnny, you're too sharp for me today. Yes, that would mean your small collector resistor would prevent some of the signal from getting to the next stage. Not only would amplification be poor, but the low resistance would call for some mighty hefty coupling capacitors. And to put another fly in the ointment, as soon as your signal began to get lost in the resistor, distortion would increase sharply. But don't worry—unusually low voltages are almost the only cause of such a situation."

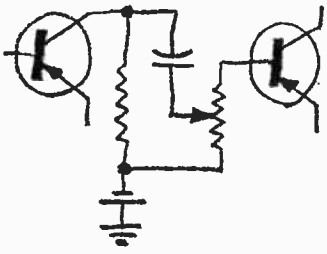
"Pete, you lost me. I guess I still don't dig this whole low impedance input idea."

"You've been brainwashed by vacuum-tube theory, Johnny—you've got to learn to rethink the problems. Let's look at some volume controls."



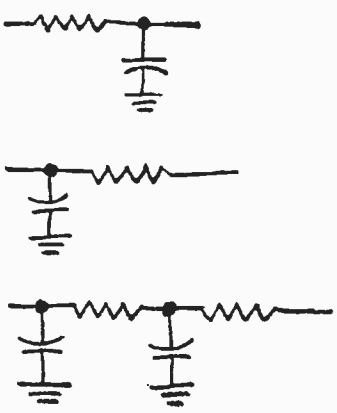
Volume Control

"A vacuum-tube circuit volume control transferred to a transistor circuit would look like this. Whereas a tube draws almost no grid current, the base input of the transistor does—and right through the control. You can see how moving the "pot" arm up and down is not only going to tap off a part of the signal current, which is what we want it to do, but unfortunately it's also going to change the value of the base bias resistor. A volume control with no problems looks like this.



"If you run into volume control problems such as distortion at low volume, abrupt changes in volume as you move the control, or just excessive noise from the control, check to make sure that you're not goofing up the bias in some way and that there isn't too much current flowing through the control."

Capacitors—Filtering and Coupling



"You'll find that transistor filter circuits, too, have to be approached differently," Pete continued. "Here's a typical tube low-pass filter. A transistor input following the filter would short out the capacitor, making it useless.

"We'll redraw the circuit for transistor use like this. It could function as a scratch filter or a simple equalizer for a magnetic phonograph cartridge. The values, of course, depend on the use."

"Could I put two filter sections together, like this?" asked Johnny.

"You sure could. That will give you a sharper frequency cutoff."

"Looks like all you have to do to adapt a vacuum-tube circuit for transistors is turn it end for end."

"That's partly right, Johnny. But it applies only to coupling circuits between transistors, and it won't always work. Remember to make the resistances smaller and the capacitances larger than with tubes. And check out your circuit *practically* after you work up the design."

"Speaking of capacitors, Pete, I've been meaning to ask you: how do you figure the size of your blocking capacitor?"

"Match it to your collector resistor, usually. You know the formula—it goes, '*C* equals 1 over . . .' "

"Ouch! Spare me those formulas!"

"Tarnation!" grumbled Pete. "If you ever want to get anywhere in electronics, you'll have to start using formulas. Things are getting too complicated for anyone to get along with a wet finger and a screwdriver.

"This time I'll give you a break. Here's a table for you. I've rounded off the values for a frequency response down to about 20 cycles."

COLLECTOR RESISTOR	BLOCKING CAPACITOR
2K	4 MFD.
4K	2
8K	1
10K	0.8
20K	0.4

Test Techniques

Johnny looked at his watch. "Pete, I'll have to run soon. But first, you told me last time that you'd give me the low-down on how to test transistors."

"Well, it's fairly easy. A nice thing about transistors is that they usually *don't* gradually deteriorate—they burn out. And you can spot almost all faults real quick by two simple tests: leakage and gain.

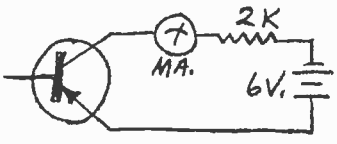
"This makes the transistor easy to check—no fancy testers needed. Just select *n-p-n* or *p-n-p*, check for leakage and current gain . . . and that's it!"

"Just how do you make these tests, Pete?"

"Easy. Let's take leakage. If I leave the base of a transistor disconnected, current can't flow through the other two leads. The transistor is just two diodes, back to back; so one of them will block the current flow.

"Practically, this isn't quite true. A small leakage current will flow—usually less than a tenth of a milliampere for most low and medium power transistors. A reading over 1 ma. means your transistor has 'had it'.

"So, to test for leakage, just place about six volts across the emitter and collector, using the normal polarity for the transistor type. A milliammeter with a range of anywhere from 1 - 10 ma. will do the trick. And for the protection of the meter, it's a good idea to add a 2000-ohm series resistor. This won't affect the accuracy of the test.

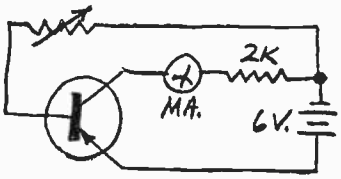


"Testing for gain is just as simple. Think back to our first talk. Whatever current is put into the base of a transistor appears multiplied by the am-

plification factor (*beta*) in the collector circuit."

"Of course," exclaimed Johnny. "All you have to do is put a milliammeter in the base circuit, another in the collector circuit—and you can see your amplification!"

"You can do it even easier than that," replied Pete. "With an exact known current in the base, you need only one meter in the collector, which you can calibrate to read directly in gain, if you wish. The ratio of the collector current to the base bias current gives you your gain figure. An open element, of course, gives you a zero-gain reading, as does a base-to-emitter short.



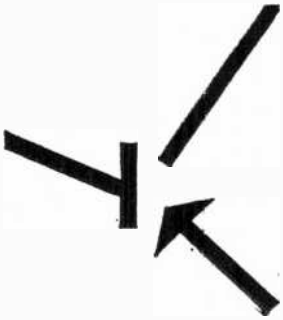
"If a transistor's *beta* reads low, don't throw it out. Remember, you're *not* working with vacuum tubes where low gain usually means that the tube is wearing out.

"Power transistors are checked in the same way—but you'll find much more leakage, sometimes as high as 10 ma. Because of this, it's easiest to check this type at much higher current levels.

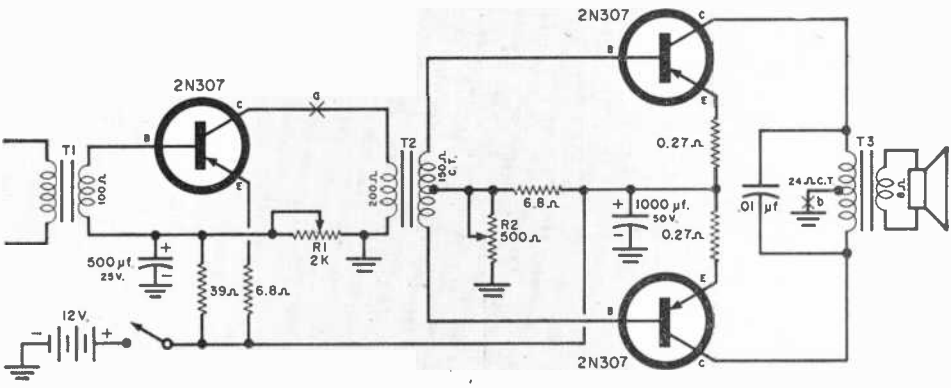
"Transistor testers are quite inexpensive. Kit models are available, and it's a lot easier to build yourself a finished tester than it is to rig up a circuit every time you want to check a transistor.

"And another thing. You'd better learn how to use a little math! Those formulas are there to help you. Dust off an old textbook, and . . ."

"Yes, sir! Just as you say, sir! I'm on my way right now!" Johnny seized the pile of circuit sketches and ran up the stairs. He waved back. "Thanks, Pete. See you later!"



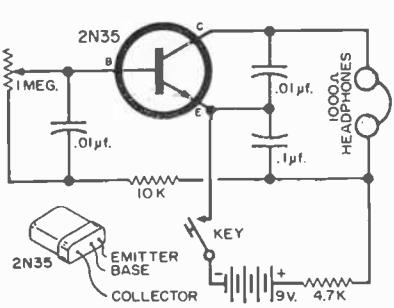
8-Watt Audio Amplifier



Driver stage of the above amplifier is mocked up on this month's cover

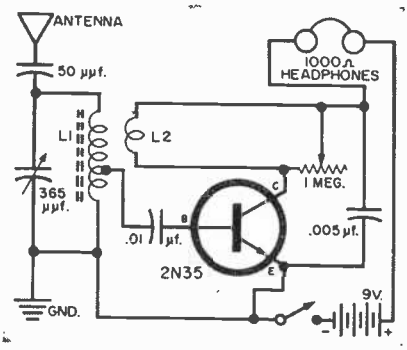
This class B audio amplifier will deliver 8 watts output with less than .5 watt of audio drive. *T1*'s impedance primary is chosen to load the previous stage properly. Collector current in the first stage is set at 70 ma. at *a* with *R1*. Pot *R2* is adjusted for 100 ma. at *b*. Both output transistors require the use of large heat sinks for proper operation.

Code Practice Oscillator



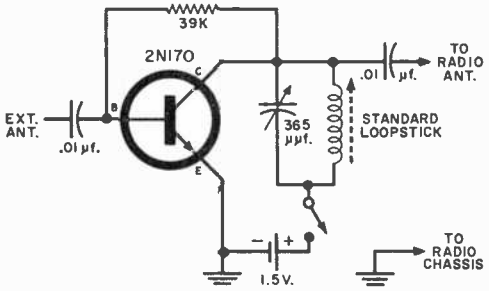
A transistor version of the Colpitts oscillator is used here as a code practice oscillator. The 1-megohm tone control may be adjusted for the most pleasing tone. Ordinary magnetic headphones are used and serve as an inductance in the oscillator circuit.

Pocket Regen Receiver

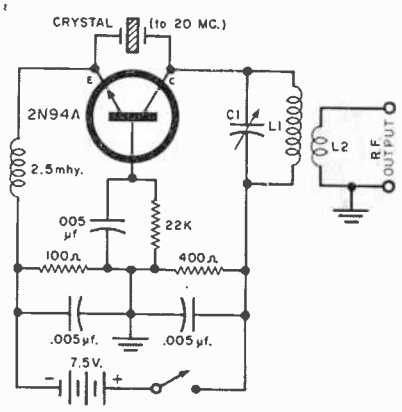


Regenerative detectors are easily adapted to transistor radio use. In this circuit, coil *L1* is a standard transistor antenna coil and the feedback winding (*L2*) consists of 10 - 15 turns of wire wound around the center of *L1*. The 1-megohm potentiometer is the regeneration control and should be set just below the point where whistles or "motorboating" are heard in the headphones. If no regeneration is heard, reverse the connections to tickler feedback coil *L2*.

R.F. Preamplifier



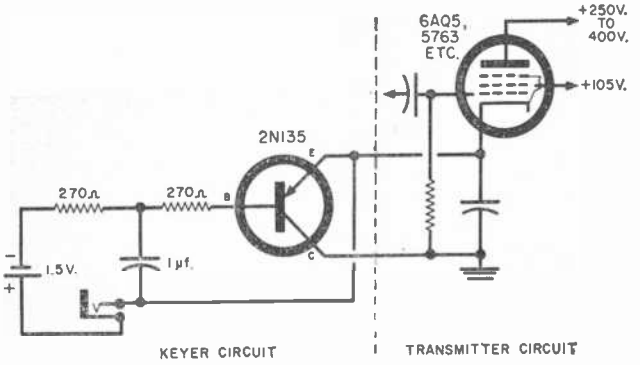
Some of the better broadcast-band receivers include an r.f. stage for increased sensitivity. Extra r.f. amplification can be added to almost any receiver without any complicated rewiring by means of a simple r.f. preamp such as the one shown here.

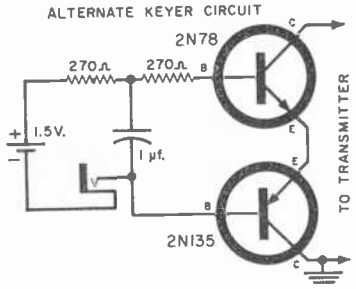


High-Frequency Xtal Oscillator

Shown above is a general-purpose crystal oscillator for use at frequencies up to 20 mc. designed around a 2N94A transistor. Approximately 10 milliwatts of r.f. output are developed at the crystal frequency. The low-impedance pickup coil (*L2*) consists of two or three turns wound close to the lower end of *L1*. Coil *L1* and *C1* are chosen to resonate at the crystal frequency.

Code Keyer

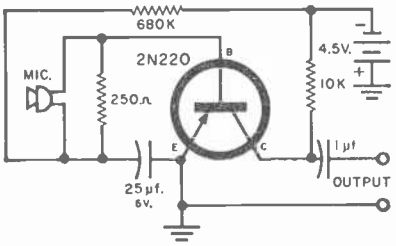




Here is a code keyer unit designed to eliminate the key clicks and thumps that may be cluttering up your transmissions. With the key up, the transistor is cut off, as is the tube being keyed. With the key down, current drop across the collector-emitter circuit is about 0.1 volt, and you're on the air.

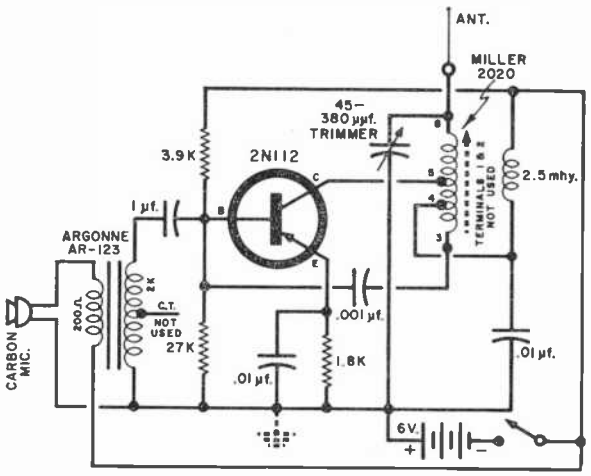
Before adding the keyer unit to your transmitter, make these checks. 1. Connect a 20,000-ohm voltmeter across your transmitter key jack. If the voltage is greater than 25 volts, it may be necessary to reduce the screen voltage on the keyed tube to 150 volts or less. Use a voltage-regulated supply or voltage-divider network rather than a simple series resistor. 2. Measure the current to be keyed by placing a milliammeter across the key. This current should not be much greater than 50 ma. 3. If it was necessary to lower the screen voltage, check the r.f. output. If the output is too low, return the screen voltage to normal and use two complementary transistors in series back-to-back, as shown in the alternate circuit diagram. Note that the keyer should never be left in the key-down condition.

Dynamic Microphone Preamp



Some high-grade dynamic microphones have too low an output to be used with tape recorders or p.a. systems. A simple self-contained preamp can be designed using one transistor which will boost the output of these low-level microphones sufficiently for almost any type of application.

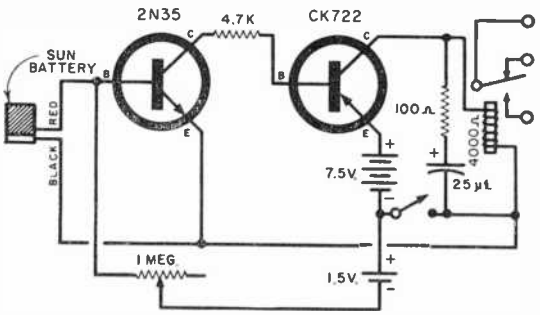
Wireless Microphone



A miniature hand-held wireless microphone can be constructed using an r.f. transistor in a Hartley-type oscillator. Good short-range results can be obtained on the broadcast band with a 2′ whip antenna.

Follow the manufacturer's coil terminal numbering shown or oscillation will not occur. Adjust the coil and trimmer for best reception on a clear spot in the broadcast band.

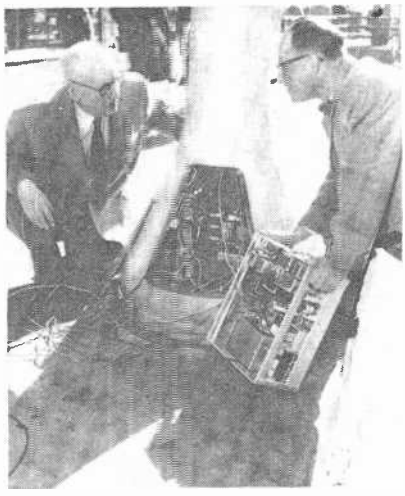
Sensitive Photo Relay



This two-stage direct-coupled circuit offers high sensitivity in photocell applications. A 1-megohm pot is included for sensitivity adjustment over a wide range. The relay is a sensitive Advance Type SO/1C/4000D or equivalent.

By
WALTER F.
VALAIKA

Radio Triggers Street Lights



EVERY DAY at dusk in Chicago, millions of lumens of light burst into action, illuminating the State Street shopping district. The State Street system utilizes radio control for the automatic switching of street lights.

Similar radio techniques are now being used to control traffic lights in several major U. S. cities, but Chicago is the first to employ them to turn street lights on and off at desired times.

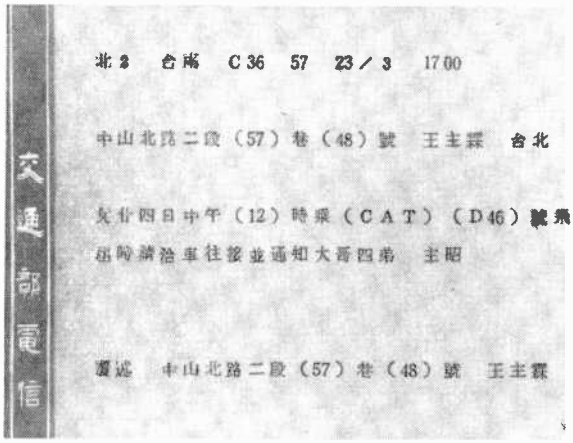
The radio control equipment handles the simultaneous switching of all the lights and eliminates the necessity for costly tearing up of pavement to install new ducts and conduits for wired control circuits.

Designed by General Electric, the system consists of a master controller base station (transmitter), centrally located in a department store building, and receiving units located in the bases of 28 light poles. The control system turns all lights on at dusk, turns some lights off at midnight, turns the balance of the lights off at dawn, and turns special decorative festoon-lighting circuits on and off at any chosen time.

In the base station, there is a 30-watt transmitter and an astronomically calibrated timer and control panel which automatically advances or retards the lights accordingly. A code sender panel selects a particular switching operation, keys the transmitter, and produces an audio-frequency pulsed-tone code which modulates the transmitter carrier.

The receivers in the bases of the light poles, and the circuit breakers and heavy-duty contactors (which perform the actual switching operations), have heaters to protect them from freezing weather and moisture. Special weatherproof adapters were made to mount whip antennas to the pole tops. —30—

Chinese Language Teleprinter



The development of a Chinese Teleprinter marks a new era in the history of Chinese telegraphic communications, allowing the Chinese language to enjoy the same technical advantages as Western languages in the telecommunications field. Containing 4300 selected Chinese characters in addition to the English alphabet, numerals, and punctuation, the teleprinter utilizes International Standard five-unit code teletype impulses.

Since the inauguration of Chinese telegraphic communications in 1882, the Chinese characters, a selection of approximately 8000 of them, have been transmitted over the line by means of four-digit figure representation. For instance, the Chinese character for "home" is transmitted by the four-digit number "1367"; the receiving end then decodes the figure into its corresponding Chinese character, according to a code book published by the Ministry of Communications. This code book has been recognized by the International Telecommunication Convention as a means of telecommunication in the Chinese language.

The new teletype transmitter has the same keyboard that an English language machine has. Only numerical keys are used for Chinese language telecommunication.

Magnetic Plastic

This flexible magnet developed by B. F. Goodrich for refrigerator door seals proves its drawing power by holding king-size paper clips. The new lightweight magnetic material has twice the permanency of many conventional rigid magnets. It should find thousands of uses in many products—from toys and novelties to home appliances.

TUNE UP Your Car's IGNITION SYSTEM

UNDER the hood of your car is a high-voltage pulse generator consisting of only a few simple parts. During high motor speeds, as many as 48,000 pulses are generated every minute with a peak amplitude as high as 30,000 volts. This is the ignition system of your car's engine. If it is properly adjusted, the engine will operate at peak efficiency, start easily, and run economically. Improperly adjusted, as much as 20% of your gas will be wasted, and generally poor performance will result. Or even worse, your car will not start at all.

It is surprising that some people will go to great lengths to keep their appliances, TV sets, hi-fi's, etc., working as efficiently as possible, yet will balk at the equally simple task of adjusting their car's ignition system. The parts required can be purchased in kits from local auto parts stores or mail order houses like Sears-Roebuck. Replaceable parts of a distributor, for example, cost three dollars or less, depending upon the make of the car. When compared with the price charged by garages for an ignition tune-up, it is easily seen that a do-it-yourself tune-up can save a handy hunk of cash.

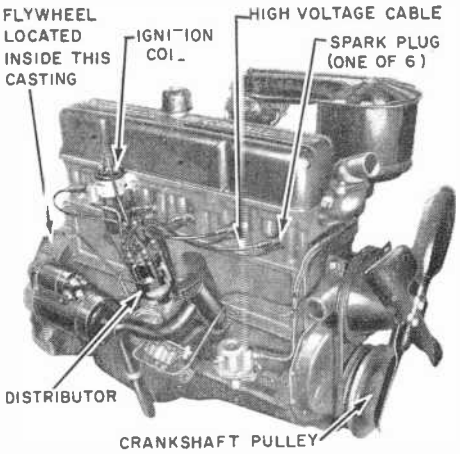


Fig. 1. 1959 Chevrolet six-cylinder engine.

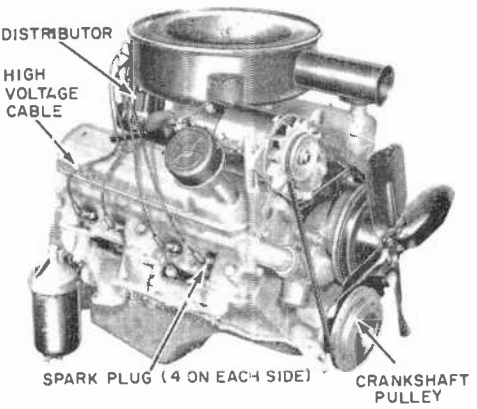


Fig. 2. 1958 Pontiac eight-cylinder engine.

The complete ignition system tune-up consists of replacement of the contacts, condenser, rotor, and cap, and the gapping and timing of the points in the distributor. This should be done, of course, only after the spark plugs have been replaced or cleaned and gapped.

Parts and Functions. Before you can begin your ignition tune-up, you must be able to recognize the various parts and their location on the engine. Figures 1 and 2 point out the ignition system parts on typical 6-cylinder and 8-cylinder engines. Figure 3 shows a top view of a distributor with the cap and rotor removed, and also a cross-section view of a complete distributor. The distributor shown is for a 6-cylinder engine since the cam (5 of Fig. 3) has six sides. The cam for an 8-cylinder engine has eight sides.

The ignition system has two functions:

You can bring your gasoline bill down by following these simple instructions

By JOSEPH TARTAS, W2YKT

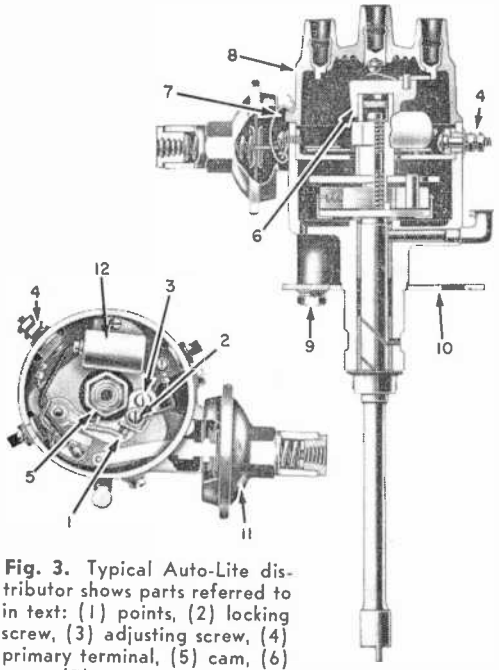


Fig. 3. Typical Auto-Lite distributor shows parts referred to in text: (1) points, (2) locking screw, (3) adjusting screw, (4) primary terminal, (5) cam, (6) rotor, (7) cap retaining spring, (8) cap, (9) plate adjusting screw, (10) adjusting plate, (11) vacuum advance mechanism, and (12) condenser.

it converts the low d.c. of the battery to high-voltage pulses and it delivers these pulses to the spark plugs at the proper instant in the engine cycle. The gas-air mixture in the cylinders is then ignited in proper sequence for best engine performance.

When the points close, as in Fig. 4(A), the battery is connected to the primary winding of the ignition coil and a magnetic field builds up. When the points open, as in Fig. 4(B), the magnetic field collapses, and the high voltage induced in the secondary winding jumps the gap in the spark plug. The minimum voltage required to jump the gap is about 4000 volts. However, the ignition system usually produces around 25,000 volts to insure a good spark.

The condenser across the points (Fig. 5) provides a path for the current while the points are opening, thus quenching the spark due to the coil inductance to prevent excessive burning and pitting of the points.

The action of the distributor (Fig. 6) is the same for each spark plug. The internal rotor supplies the high voltage to one spark plug at a time, in the proper sequence. This is done by connecting the distributor shaft on which the rotor is attached to the engine via a gear drive. The rotor advances to each contact in the distributor cap in the engine firing order. Cables connect these contacts to the spark plugs.

Removing the Distributor. Since few manufacturers place the distributor where it can be worked on easily, it's advisable to remove it from the car and take it to your workbench.

The first step in removing the distributor is to unsnap the two clips holding the distributor cap. Push the cap out of the way, being careful not to pull out any high-voltage cables. Using a small wrench, back out the nut that connects the copper tubing to the vacuum advance mechanism on the side of the distributor. (See Fig. 3.) Pull out the flared end of the tubing, being careful not to bend it excessively.

Now remove the wire connected to the primary terminal of the distributor (Fig. 3). Loosen the adjusting plate that fastens the body of the distributor to the engine block. Note the position of the rotor and make a scratch on the distributor case opposite the end of the rotor. (This step is very important for the re-installation of the distributor.) Then remove the distributor by pulling it away from the block, twisting it back and forth slightly at the same time. The replacement of the points may now be done at the workbench.

Replacing the Points. Pull off the rotor and discard it. Loosen the screw or nut connecting the condenser lead. Remove the condenser lead and wire from the primary terminal (Fig. 3). Remove all the screws holding the condenser and points in place. Then, take out the condenser and points

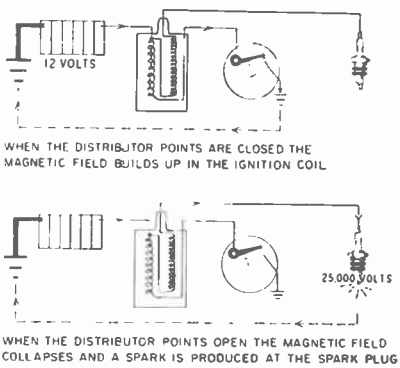


Fig. 4. The distributor points function as a switch in the ignition coil circuit to generate high-voltage pulses.

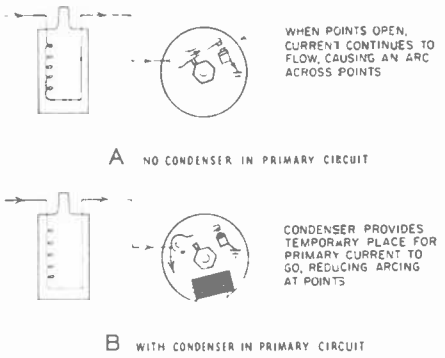


Fig. 5. Distributor condenser reduces arcing and thus increases useful service life of points.

and discard both. You are now ready for the new points and condenser.

Points are installed in reverse order to the removal procedure. Insert the locking screw to hold the points in place. Tighten the screw until it is snug, but not tight. Put a drop of oil on the shaft over which the points fit. Make sure the contacts align properly, as shown in Fig. 7, bending only the stationary contact support (if necessary) to make this adjustment.

The old condenser usually held down by a single screw should now be replaced. Be sure the new condenser is correctly positioned by seating guides. Attach the condenser lead and wire from the primary terminal to the same screw as the spring of the moving point and tighten. Smear a small amount of *high-melting-point* grease on the cam where the insulating block rides. (See Fig. 8.) This reduces block wear and increases contact life. The reassembly of the points and condenser is now complete.

Adjusting the Gap. Turn the shaft until the insulating block is on one of the high points of the cam, and the gap between the points is at its widest mark. By turning the eccentric adjusting screw (Fig. 8), you can now vary the gap. With a wire gauge between the points, turn the adjusting screw until the gauge drags slightly as it is moved back and forth in the gap. The size of the gauge will be determined by the make and year of your car (see chart on page 92). Now, gradually tighten the locking screw. If the gauge binds, readjust until it drags when the locking screw is tight.

If the stationary contact on the points is a screw, the same procedure may be used to set the gap, except that the adjustment is made by turning the screw, then tightening the lock nut. For dual points, set and lock each point individually. Run a strip of clean cloth between the contacts to remove any grease or oil that might cause burning of the new contacts.

Put *one drop* of oil on the felt in the end of the shaft. Install the new rotor by placing it over the distributor shaft in the proper position and pressing it into place. Note that the rotor is keyed to fit in only one way.

Replacing the Distributor. Align the rotor with the scratch mark on the distributor which was made when the old rotor was removed. Using a back-and-forth motion, push the distributor back into place. If there is a gasket between the distributor and the engine block, check it for alignment and condition. Make sure the wire connecting to the primary terminal is not touching metal.

Now use your starter to turn the motor

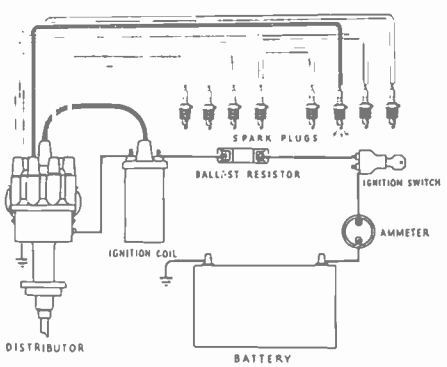


Fig. 6. This ignition system is for a standard eight-cylinder car.

over. Timing marks will be seen on the crank shaft pulley as it turns, or in some cars a small ball will appear in a window near the flywheel at the rear of the engine. Often, this window or hole is near the starter motor. The crank shaft pulley is located directly below the cooling fan.

A fixed pointer is mounted over the crank shaft pulley to indicate the timing mark position—when the markings are on the crank shaft pulley. These marks indicate the number of degrees before or after top dead center. When the proper mark is near the pointer, a quick flick of the starter will cause a slight advance. If necessary,

PLUG GAP AND POINT GAP CHART

Make	Plug Gap	Point Gap
BUICK		
1946-52 All	.025	.015
1953 40 Ser.	.025	.015
1953-55 V-8	.032	.015
1956 All	.032	.015
1957-59 All	.032	*
CADILLAC		
1946-48 All	.030	.015
1949-52 All	.035	.015
1953-55 All	.035	.016
1956-59 All	.035	*
CHEVROLET		
1941-48 All	.040	.018
1949-52 All	.035	.018
1953-55 All (exc. Corvette)	.035	.016
1953-54 Corvette	.035	.015
1955 Corvette	.035	.018
1956 All	.035	.016
1957-59 6 Cyl.	.035	.016
V-8	.035	*
CHRYSLER		
1946-53 6 Cyl. (Reg.)	.030	.020
8 Cyl. (Reg.)	.030	.018
All (Resistor)	.035	.017
1954 All 6 Cyl. (Reg.)	.030	.020
(Resistor)	.035	.020
All V-8 (Reg.)	.030	.017
(Resistor)	.035	.017
1955 All (Reg.)	.030	.017
(Resistor)	.035	.017
1956-59 All	.035	.017
DE SOTO		
1946-55 All 6 Cyl. (Reg.)	.030	.020
(Resistor)	.035	.020
1952-54 All V-8 (Reg.)	.030	.017
(Resistor)	.035	.017
1955 Firedome V-8, FireFlite	.035	.017
1956-57 All	.035	.017
1958 All	.035	.016
1959 All	.035	.017
DODGE		
1946-55 All 6 Cyl. (Reg.)	.030	.020
(Resistor)	.035	.020
1953-55 V-8 (Reg.)	.030	.017
(Resistor)	.035	.017
1956 All 6 Cyl. (Reg.)	.030	.017
(Resistor)	.035	.017
All V-8	.035	.020
1957 All	.035	.017
1958 6 Cyl.	.035	.020
Coronet and Royal	.035	.017
Sta. Wag.—Cust. Royal	.035	.017
1959 6 Cyl.	.035	.020
V-8	.035	.017
EDSEL		
1958-59 All	.035	.015
FORD		
1938-48 All	.025	.015
1949-51 All 6 Cyl.	.030	.025
1949-53 All V-8	.030	.015
1952-54 All 6 Cyl.	.035	.015
1954-56 All V-8	.035	.015
1955-57 All 6 Cyl.	.035	.025
1957-59 All	.034	.015
HUDSON		
1938-56 All 6 Cyl.	.032	.020
1938-52 All 8 Cyl.	.032	.017
1955-57 All	.035	.016
LINCOLN		
1940-48 All	.025	.015
1949-52 All	.030	.015
1953-57 All	.035	.015
1958-59 All	.032	.015
MERCURY		
1939-48 All	.025	.015
1949-54 All	.030	.015
1955-56 All	.035	.015
1957 All	.034	.015
1958-59 All	.032	.015
NASH		
1941-49 All	.025	.020
1950-54 All (exc. Metropolitan)	.030	.020
1954-56 Metropolitan	.025	.020
1955 Statesman	.030	.022
1955 Ambassador: 6 Cyl.	.030	.022
V-8	.035	.022
1956 Ambassador: Packard V-8	.035	.017
Nash V-8	.035	.016
6 Cyl.	.030	.020
1956 Statesman	.030	.016
1957 All	.030	.016
OLDSMOBILE		
1937-50 6 Cyl.	.040	.020
1937-54 8 Cyl.	.030	.015
1955 All	.030	.016
1956-59 All	.030	*
PACKARD		
1937-49 All 6 Cyl.	.028	.020
1937-50 (Early) All 8 Cyl. (10 mm.)	.028	.015
1950 (Late) All (14 mm.)	.025	.015
1951-54 All	.025	.015
1955-56 All	.035	.016
1957-58 All	.035	.015
PLYMOUTH		
1946-56 All 6 Cyl. (Reg.)	.030	.020
(Resistor)	.035	.020
1955 V-8 (Reg.)	.030	.017
(Resistor)	.035	.017
1956 All V-8	.035	.017
1957 All (exc. V-8 Fury)	.035	.020
1958 All	.035	.017
1959 6 Cyl.	.035	.020
V-8	.035	.017
PONTIAC		
1934-49 6 Cyl.	.025	.020
1934-37 8 Cyl.	.025	.018
1938-49 8 Cyl.	.025	.015
1950-53 6 Cyl.	.025	.022
8 Cyl.	.025	.016
1954 All	.025	.016
1955-56 All	.035	.016
1957-59 All	.035	*
RAMBLER		
1953-55 All	.030	.020
1956 6 Cyl.	.030	.020
V-8	.030	.016
1957-59 All	.030	.016
STUDEBAKER		
1942-50 All	.025	.020
1951-54 6 Cyl.	.025	.020
1951-55 V-8	.035	.015
1955-59 6 Cyl.	.030	.020
1956 Golden Hawk	.035	.016
1956 All Other V-8	.035	.015
1957 All V-8	.035	.015
1958-59 V-8	.035	.016
WILLYS		
1941-45 Military Jeeps	.030	.020
1942-59 All	.030	.020

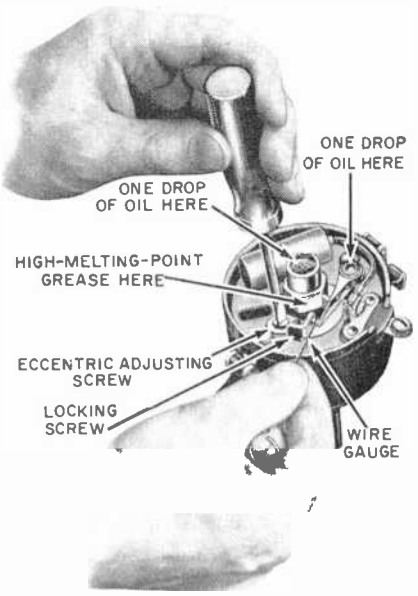
**For "External Adjustment," insert hex wrench through window, turn screw clockwise until engine misfires, then turn counterclockwise 180°.*

EDITOR'S NOTE: Space prevents listing of all years and all models. Check with your dealer for point gap and plug gap settings if your car is not listed.

turn the motor over several times until it is within two degrees of the recommended setting.

Connect a timing indicator to the primary terminal of the distributor and the primary lead which normally connects to the terminal. Turn the ignition switch on. The timing indicator will now light up. Next turn the distributor case until the indicator light goes out, showing that points have just opened.

The distributor should now be tightened to the engine by its mounting clamp or plate. Make certain the setting does not change as this is done. Then turn the ignition switch off. This completes the timing itself—now all you have to do are the "finishing operations."



First, reconnect the tubing to the advance mechanism and tighten the nut. Then disconnect the timing light and reconnect the wire to the primary terminal. After installing the new distributor in the car, make sure that all cables are firmly inserted into the corresponding holes of the cap being replaced. This is very important. If done incorrectly, the motor will run very roughly if it starts at all.

New Type of Distributor. Beginning in 1957, GM adopted a new type of distributor for its V-8's which uses a preassembled point assembly with the spring tension, point alignment, and gap factory-adjusted. A trap door (Fig. 9) in the side of the cap allows a "hex" wrench to be inserted to adjust the timing with the motor running, and eliminates the need for timing marks and indicators.

To remove the cap, insert a screwdriver in the slot head of the latch, press down, and turn one-quarter turn either way. The

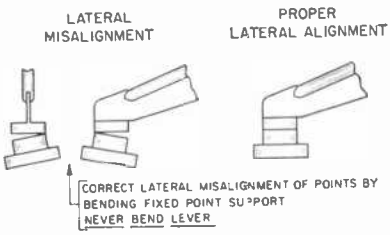
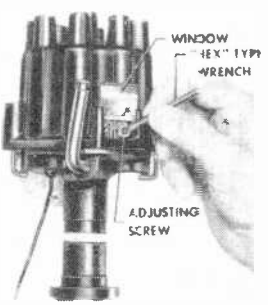


Fig. 7. Improper point alignment will result in excessive burning, pitting, and uneven point wear.

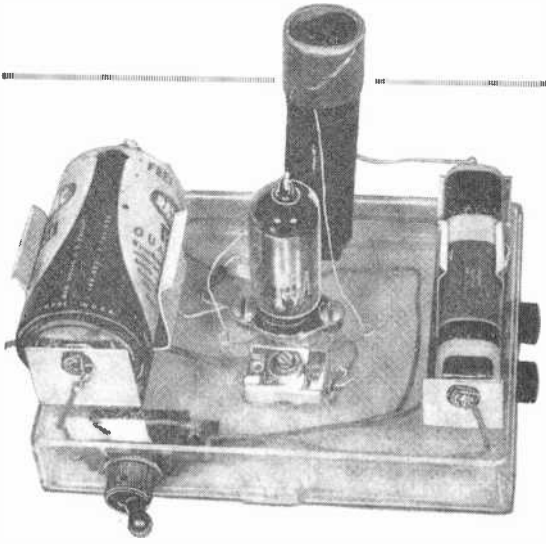
Fig. 8. Points are adjusted for proper gap width with a screwdriver and a wire gauge. See text for details.

Fig. 9. Adjustment of late-model GM distributor (below) is easy. It is partially factory-adjusted.

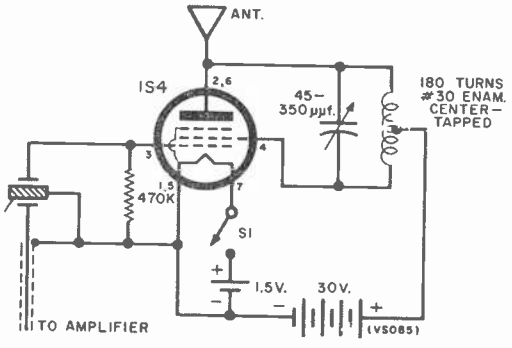


point adjustment may be made with the indicator lamp at the workbench or in the car. Turn the screw in until the lamp goes out, or until the motor begins to miss (if it is done with the motor running), and then back it out one-half turn. This completes the gap and timing adjustment simultaneously. Replacement of the point assembly and condenser is the same as in

(*Continued on page* 135)



Stereo Phono Oscillator



YOU haven't had an opportunity to get your feet wet in the stereo swim? Here's an easy way to do it at a total cost of only $12.00 or so, which includes an inexpensive ceramic or crystal stereo cartridge.

The trick is to use a phono oscillator for broadcasting the second stereo channel to a nearby AM radio. All you have to do is replace your present cartridge with a stereo model and run the extra stereo signal leads to the oscillator unit.

Find a dead spot on your radio dial and tune the oscillator to it. Place the radio for the best stereo effect. Quality of reproduction is of course limited by the radio used.

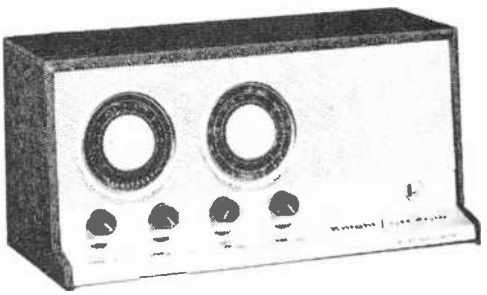
The oscillator unit is built on a small plastic case, with the battery holders, tube socket, capacitor and coil form all mounted on the hinged lid. Wiring is straightforward, with all leads as short as possible. The coil is hand-wound on a ⅝" plastic or fiber form, using #30 enameled wire.

Output of the oscillator is through a short length of wire. When it is brought into the vicinity of an AM radio, signal pickup will take place over a frequency spread of about 1100 to 1500 kc. —30—

By JOSEPH ELKHORNE

POPULAR
ELECTRONICS
Builds a
4-Band Regen Receiver

Easy to assemble, the Knight-Kit Span Master tunes in a new world of listening adventure

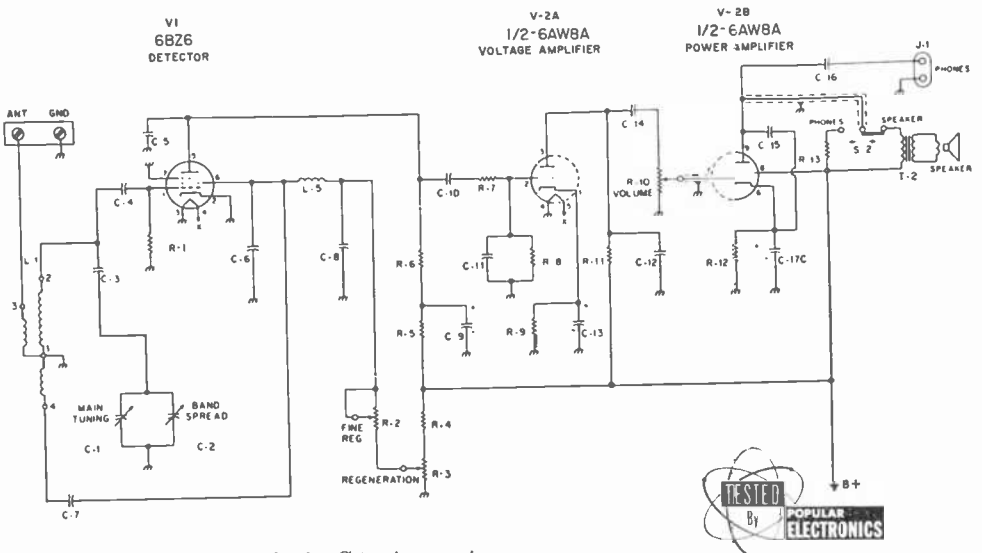


THE Knight-Kit "Span Master" four-band kit (Allied Radio, 100 N. Western Ave., Chicago 80, Ill.) is an ideal receiver for the SWL'er who gets a kick out of DX'ing stations with a two-tuber.

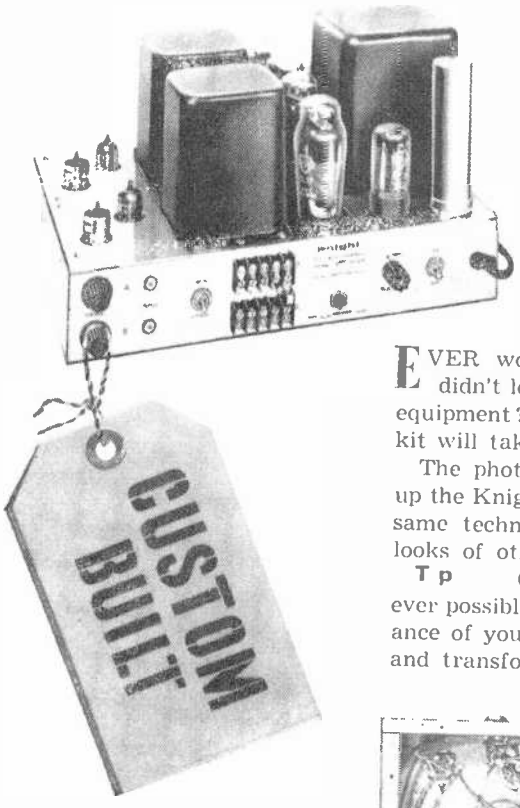
The received signal is detected and amplified in the 6BZ6 tube. A portion of the signal is taken off the screen of the 6BZ6 and fed back to the grid via *C7*. Amount of feedback or regeneration is controlled by REGEN and FINE REGEN potentiometers which raise or lower the screen voltage. A 6AW8A combines the functions of audio amplifier and power output tube.

Assembly procedure is a marvel of simplicity. Step-by-step instructions and extra large pictorial diagrams direct your every move. All parts, including precut wire and solder, are included in the kit.

Operation of the receiver is slightly different from that of a superhet. After the bandswitch is set to the frequency range desired, slowly turn the regeneration control clockwise until a whistle is heard, then stop. Turn the main tuning dial until a very low pitch sound is heard. Then turn the regeneration control counterclockwise until the hissing stops and the station comes in loud and clear. The fine regen control is for critical settings. —30—



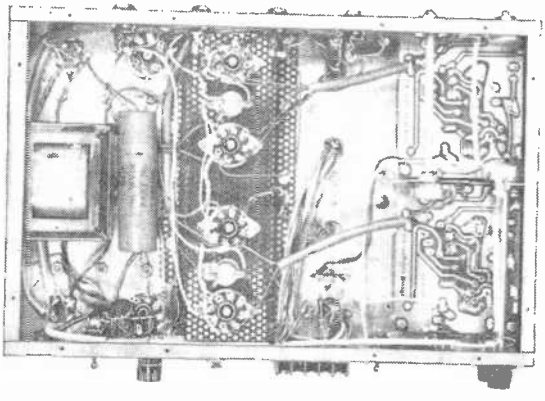
Cus 'ze ur 'ts

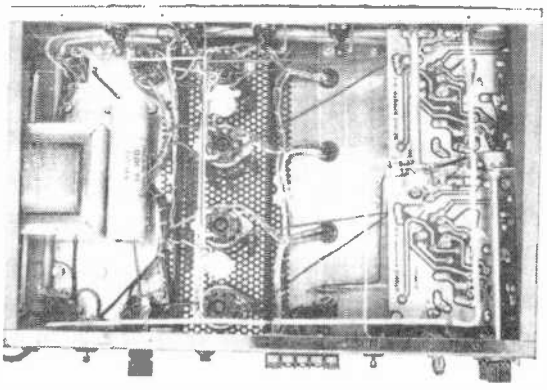


EVER wonder why your latest kit project didn't look as neat as a piece of commercial equipment? Follow these tips and your next kit will take on that factory-built appearance.

The photos show what can be done to jazz up the Knight-Kit 60-watt stereo amplifier. The same techniques can be used to improve the looks of other units.

T p Cable groups of wires together wherever possible. Nothing will improve the appearance of your kit more than neatly laced wires and transformer leads.





Cabling helps to minimize the tangle of wires under the chassis. Compare chassis which has been wired conventionally (at right, above) with chassis wired using cabling techniques (below). "Square-corner" wiring also improves the under-chassis appearance.

Here are some tips that will help give your next kit that finished professional look

By **DONALD L. STONER,** W6TNS

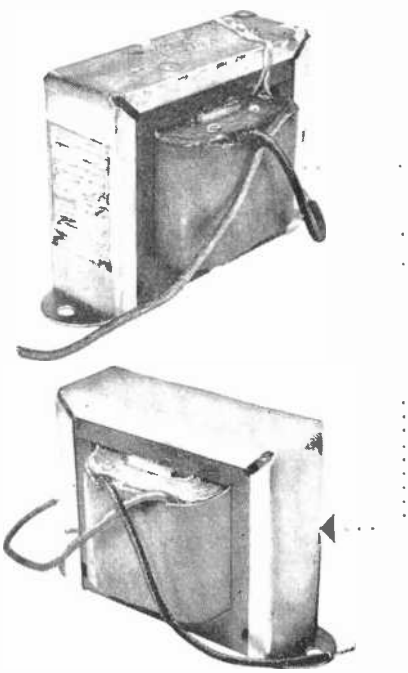
Tip #2 When you are working with printed circuits, mount all components before soldering. Then, after bending the leads sharply to keep them in place, cut them just above the eyelets. The solder will cover the joint and give the board the appearance of having been dip-soldered.

Tip #3. After a printed-circuit board has been completed, use a stiff toothbrush and solvent to remove the soldering flux. This will cause the conductive sections of the printed circuit to stand out.

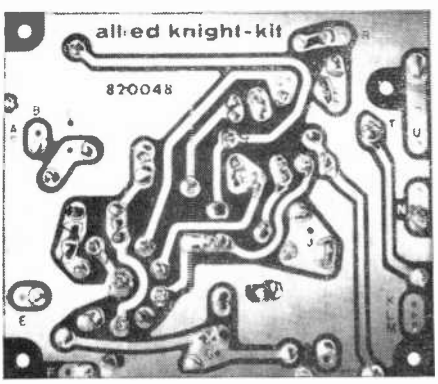
Tip #4. Remove varnish and wax from small parts such as chokes, etc. Then shine 'em up with steel wool and apply a protective coat of clear plastic lacquer to prevent rusting.

Tip #5 Position resistors so tolerance bands all point in the same direction. Mount capacitors so that their values may be easily read.

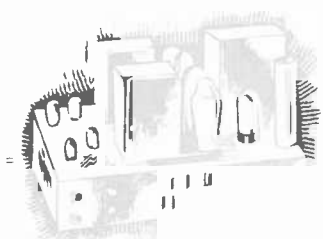
Tip #6. If the chassis of your kit isn't chrome-plated, don't forget that a chrome job does wonders for a chassis. -30-



It's the little things that count! Top photo above shows choke as it was received from the manufacturer; below it is the same choke after varnish has been removed and case has been polished with steel wool.



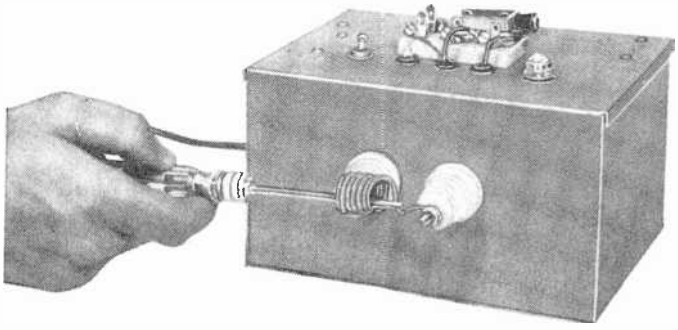
Printed-circuit boards look better if solder completely covers the joints and excess flux is removed with a toothbrush and solvent.



Magnetize Your Tools

...with this easy-to-build unit

By JOHN SHIELDS



THERE are many times when the experimenter has need of a simple, effective magnetizer for screwdrivers, nut drivers, PM speaker magnets, various small parts, etc. The unit described here works on the same principle as the large commercial magnetizers, and will completely saturate a small block or slug of Alnico 5. It is quite simple in construction and, even if all new parts are used, the cost is under $15.00.

The principle of operation involves the gradual charge of one or more large capacitors from a d.c. source through a comparatively large resistor, then the discharge of the capacitors through a low resistance coil in which the work to be magnetized is placed. When the capacitors are discharged, a tremendous surge current (several hundred or more amperes) will pulse through the coil, generating a brief but intense magnetic field.

Construction Tips. The magnetizer is simple enough to be "breadboarded" but the author's model was built into a small aluminum cabinet. While the unit will perform just as well if powered directly from 117-volt lines, the use of an isolation transformer is preferred to eliminate shock hazard. A silicon rectifier was used because it happened to be on hand, although a 100-ma. selenium rectifier would be just as satisfactory.

There is one item in the magnetizer that cannot be skimped on. This is the d.p.d.t. knife switch which *must not* be replaced by a toggle switch as the contacts of a smaller switch would probably weld together the first time it was used, due to the extremely heavy surge currents involved. As many capacitors as desired can be paralleled: the greater the capacitance, the greater the charging current. The capacitors need not be of the same capacitance value as long as they are rated at a minimum of 150 working volts d.c. or higher.

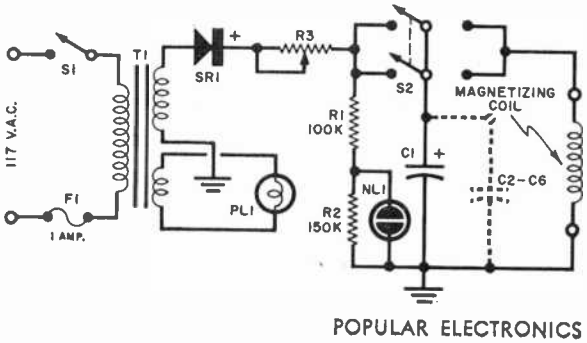
The magnetizing coil should be wound with at least #10 and preferably heavier wire. Four to seven turns of wire should be shaped roughly to the form of the work to be magnetized.

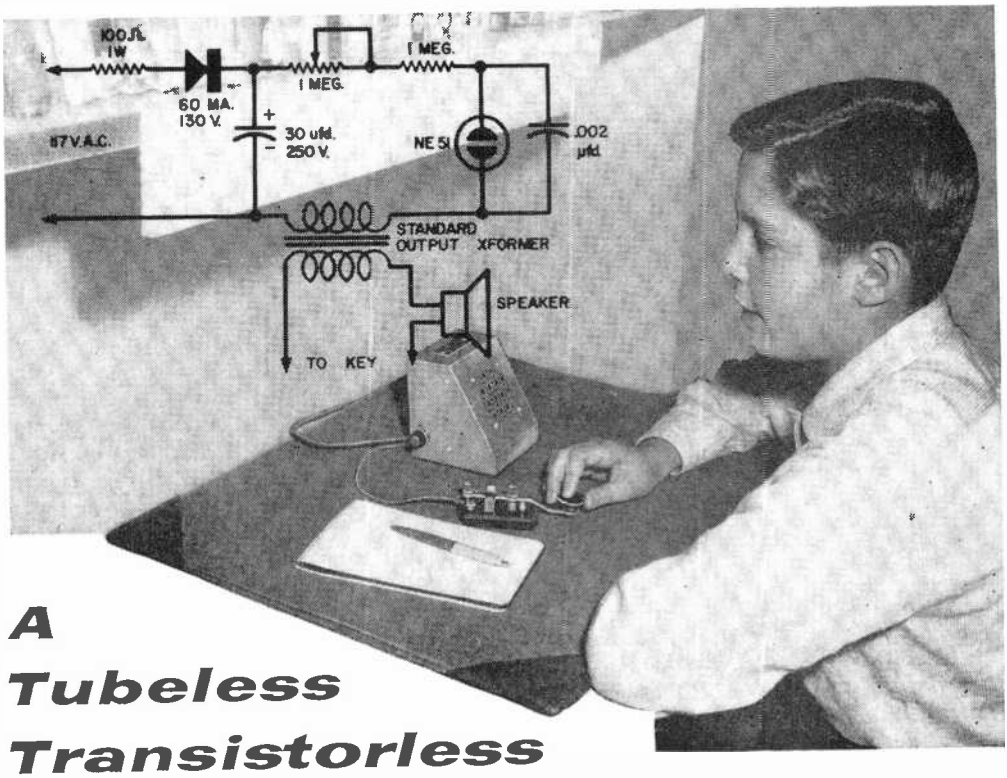
Heavy Current. The king-size feed-through insulators are not really necessary;

(*Continued on page* 136)

PARTS LIST

C1-C6—150-μf., 150-volt electrolytic capacitor (connected in parallel)
F1—1-amp. fuse and holder
NL1— NE-2 neon bulb
PL1—#47 pilot light assembly
R1—100,000-ohm, ½-watt resistor
R2—150,000-ohm, ½-watt resistor
R3—100,000-ohm, 10-watt wire-wound resistor (adjustable)
S1—S.p.s.t. toggle switch
S2—D.p.d.t. knife switch
SR1—100-ma. selenium rectifier
T1—Power transformer; secondary 117 volts, 50 ma., 6.3 volts, 2 amperes (Merit P 3045 or equivalent)





A Tubeless Transistorless Code Practice Oscillator

HERE'S a simple CPO that uses a neon tube relaxation oscillator. It operates without tubes or transistors and has enough output to drive a built-in loudspeaker. And if extra power is needed to serve a code class of a dozen or more people, output to an amplifier can be tapped off across the speaker voice coil leads.

A case intended for use with a 3" meter movement serves as a housing for the unit. Such cases are obtainable with the meter holes already cut out, thus saving you considerable time and labor. A small square of perforated metal or metal window-screening can be placed behind the cutout to serve as a loudspeaker grille.

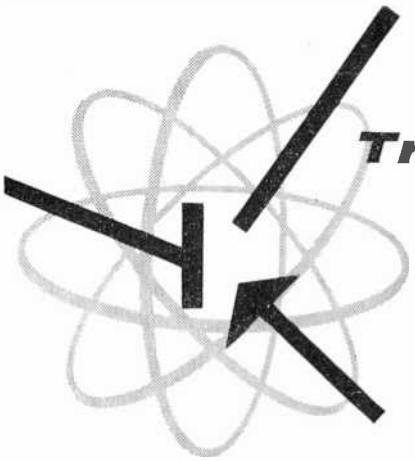
It is convenient to use one of the so-called "Postlite" neon indicators (manufactured by the Drake Company) for the neon lamp oscillator; this is a plastic unit, threaded for panel mounting, with the neon lamp molded in. Or, you may prefer to use a standard NE-51 along with a socket assembly.

Keying is accomplished by putting a key in series with the secondary winding of the output transformer. The circuit shown works nicely on 105 to 125 volts a.c. If it is used with d.c. power lines, or with a 90-volt battery, the selenium rectifier and the 30-μf. capacitor should be eliminated. For power line operation, make sure that no part of the circuit is connected to the cabinet.

No warm-up time is necessary—just plug in the line cord and press the key.

The potentiometer varies the pitch of the generated tone. Parts values given provide a variable-pitch control from about 500 to 900 cps. If you want to experiment with a wider tone range, try other values for the .002-μf. capacitor and the pot. —30—

By LEON A. WORTMAN



Transistor Topics

By LOU GARNER

RESEARCH SCIENTISTS have long sought some electronic or electromechanical method for duplicating the basic functions of animal nervous systems. This goal has been brought a step closer to reality by engineers of the Bell Telephone Laboratories, who have developed a transistorized circuit which simulates the functions of the biological *neuron*. As you may recall, the transistor itself was invented a little over a decade ago at these same laboratories.

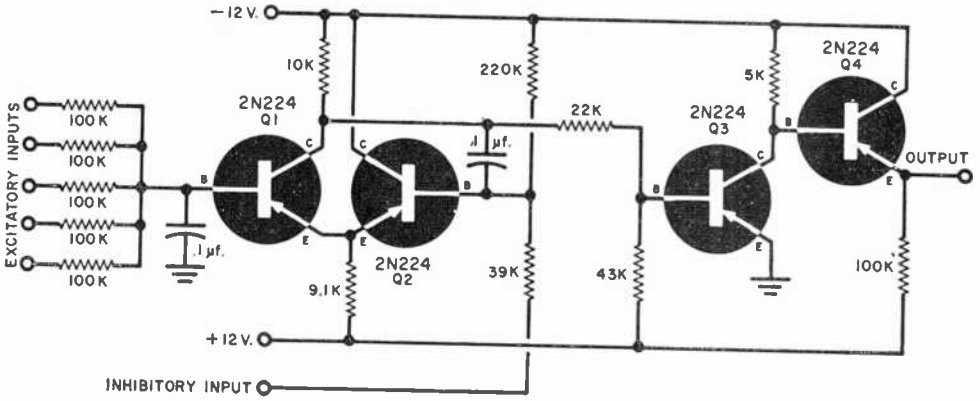
In case biology isn't one of your strong points, the neuron is the basic "building block" cell of a human or animal nerve system, including the brain. This cell receives electrical signals developed by receptor cells sensitive to light, heat, or other stimuli and, in turn, delivers an electrical control pulse of fixed amplitude and duration to other cells in the body.

The schematic wiring diagram of a single artificial neuron, designed by Bell scientist R. M. Wolfe, is given in Fig. 1. Using four *p-n-p* transistors, this circuit delivers output pulses of standard amplitude and duration; if driven by a constant excitation signal or "stimulus," it develops a train of pulses, with the pulse frequency or repetition rate directly proportional to the intensity of the input signal.

As in a biological neuron, the input excitation must exceed a minimum threshold value; however, the circuit will integrate two or more input pulses, each of which is below the threshold value, and will "fire" on the combined signal. Provision is also made for applying an "inhibitory" signal which prevents the circuit from responding to other inputs. This permits a group of cells to be connected together in such a way that a very strong signal applied to one cell prevents the other cells from responding.

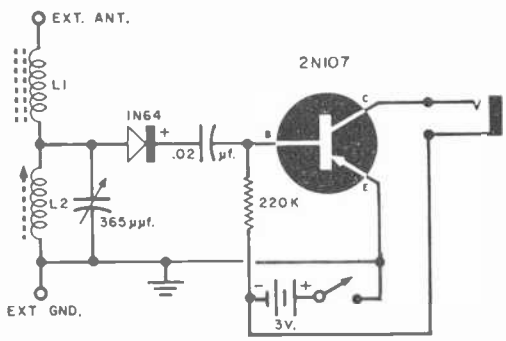
The circuit simulates a biological neuron in still another way; immediately after responding to a signal pulse, its threshold level rises almost to infinity, so that it will not fire on additional input pulses for a few milliseconds.

Fig. 1. Transistorized "nerve" cell circuit developed at Bell Telephone Laboratories.



Physically, the electronic neuron circuit is assembled on a 3" x 4" printed-circuit card designed for plug-in mounting. This simplifies the assembly of groups of cells into networks roughly analogous to nerve systems in animal and human organs.

For example, several cells may be combined with photosensitive semiconductors to simulate simple functions in the eye's retina. Here, the photocells take the place of the light-sensitive rods and cones found in the eye and serve as receptors for the



neuron circuits. As in the eye, some receptors, known as "on" receptors, trigger the neuron only when the light intensity they receive is increasing; "off" receptors fire only when the light is decreasing; and, finally, "during" receptors fire only when they are receiving a steady light.

Some cell combinations have permitted flicker-fusion phenomena to be duplicated. Known as "persistence of vision" in the human eye, this causes a sequence or train of flashes to be seen as continuous illumination. It is this characteristic of vision, of course, that makes motion pictures and television possible.

Eye nerve system operation is not the only bodily function that has been duplicated electronically using transistorized "nerve" cells. Other experiments are being conducted with nerve system models simulating the operation of the ear.

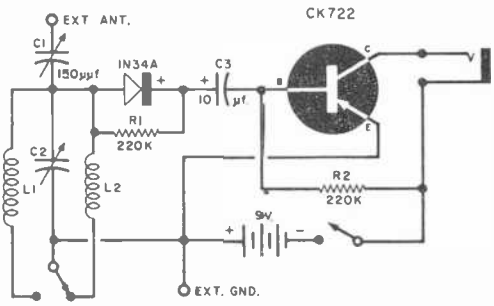
The immediate goal of these experiments is to learn more about the functioning of visual and auditory nerve systems and, more specifically, how the signals developed by these systems are interpreted by the brain. The knowledge derived from this research may lead to better and more economical communication systems. On a long-term basis, it is conceivable that other circuits may be designed which can duplicate the functions of every basic cell found in an animal's body.

If these "cells" are manufactured using the microminiaturization techniques discussed in an earlier column, it may become possible to assemble an electronic computer which duplicates the sensing and thinking processes of a human being.

Readers' Circuits. This month we are featuring another pair of those ever-popular single-transistor receiver circuits. Designed for reception of the AM broadcast band (550-1600 kc.), the circuit shown in Fig. 2 was submitted by readers Jay Evilsizer (2257 Fairway) and George Aspbury (2344 Fairway), Birmingham, Mich. Easily

Fig. 2. Single-transistor receiver circuit for the 550-1600 kc. broadcast band submitted by Jay Evilsizer and George Aspbury.

Fig. 3. Reader Peter James, WV6CVT, contributed this short-wave receiver circuit.



assembled in a single evening from standard components, this receiver, according to Jay and George, has better selectivity and sensitivity than is usually found in single-transistor sets. They report picking up broadcast stations up to 15 miles away with "ear-splitting" volume, and without using an external antenna or ground connection.

Referring to the schematic diagram, *L1* is a ferrite antenna coil (Lafayette No. MS-330) and *L2* is a variable loopstick (Lafayette No. MS-299). The on-off switch can be omitted entirely if you prefer, since current drain is very low when the earphones are unplugged. The receiver can be used with any moderate or high impedance magnetic earphones. Neither layout nor

Transistorized code practice oscillator for the beginning amateur introduced by Heath in kit form.

lead dress should be critical, and you can assemble a duplicate receiver on a metal chassis, on an etched-circuit board, or in a small plastic case.

In response to your many requests for simple short-wave receiver circuits, another such circuit is given in Fig. 3. Submitted by reader Peter James, WV6CVT, (4801 Thor Way, Carmichael, Calif.), this set is designed for use with a moderately long outside antenna and a good ground. According to WV6CVT, he's had good luck in picking up other amateur stations in Arizona and Nevada with standard 1000-ohm magnetic earphones.

Capacitor *C1* may be either a fixed mica or ceramic instead of the variable unit shown; a variable capacitor is preferred, however, as this permits "trimming" the antenna circuit for maximum sensitivity and selectivity. *C2* is a standard 100-$\mu\mu$f. tuning capacitor, but a 365-$\mu\mu$f. unit could be used. *C3* is a 12- or 15-volt electrolytic, and *B1* is a 9-volt transistor battery.

Coils *L1* and *L2* are hand-wound to cover the frequency range desired. WV6CVT indicates that he used standard 1¼"-diameter coil forms for each, with *L1* consisting of 20 turns of No. 28 enamel-covered wire close-wound in a single layer, and *L2* made up of 14 turns of the same wire. Using a 100-$\mu\mu$f. tuning capacitor (*C2*), he found that *L1* provided coverage from 2.8 to 4.1 mc. and *L2* from 4.1 to 7.8 mc. If you wish to cover other bands, use more turns for lower frequency coverage, fewer turns for the higher frequency bands.

In operation, *either L1* or *L2* is connected across *C2*, depending on the coverage desired. Signals picked up by the antenna-ground system are selected by the tuned circuit and detected by the 1N34A. The resulting audio signal is coupled through *C3* to a common-emitter audio amplifier which, in turn, drives a pair of standard magnetic earphones. Depending on the exact characteristics of the transistor used, you may find that some experimentation with *R2*'s value will prove profitable; try values from 100,000 ohms to 1 megohm here, installing the one which gives maximum gain.

Pin-Point Your Troubles. Coyne Electrical School (1501 West Congress Parkway, Chicago 7, Ill.) is now publishing the latest in their series of "Pin-Point" books. Entitled *Pin-Point Transistor Troubles in 12 Minutes,* this volume covers practical servicing techniques, and includes dozens of easy-to-use trouble-shooting charts. Although the book's major emphasis is on techniques of value to the serviceman and technician, experimenters and gadgeteers will find the methods described valuable in "debugging" their experimental projects.

Items of particular interest are a tran-

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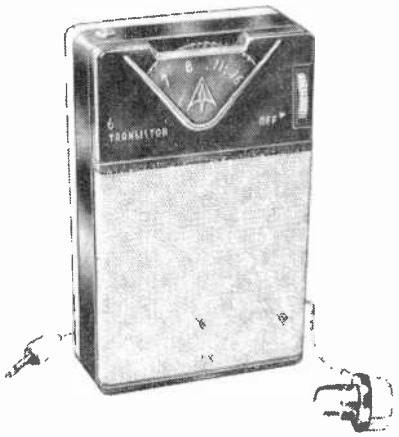
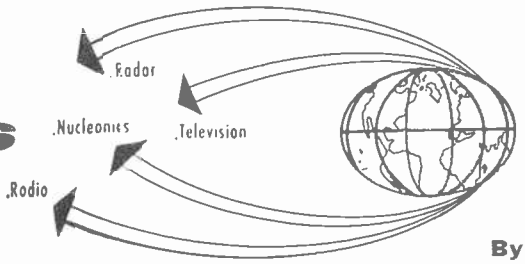


Personal-sized six-transistor receiver now available from Argonne features push-pull output to its built-in PM loudspeaker.

After Class



By
SAUNDER HARRIS
WINXL

GROUND, GROUNDS, AND GROUNDED

WHY is a good ground so important? Why are some circuits grounded and others not grounded? What is the physical and electrical meaning of the ground symbol when it appears in a diagram?

Grounding actually means making an electrical connection between a piece of equipment or circuit and the earth, thus bringing the connected point to the earth's neutral potential. There are many ways of accomplishing this. The most common way is by connecting the equipment to a cold water pipe by means of a wire and a metal grounding clamp.

Why specifically a *cold* water pipe? Well, a cold water pipe goes directly to the outside water line which is buried in the earth. A hot water pipe is connected to a furnace or hot water heater and is not a direct ground connection.

Another way of making a ground connection is by connecting the equipment to a metal rod which has been driven deep into the earth. The metal rod is called a ground rod and, to be effective, should go at least eight feet into the ground. A properly installed ground rod is shown in Fig. 1.

If you check your TV antenna, you may find that a ground rod is part of the installation, as is a lightning arrestor. Should lightning strike the antenna, it would find an easier path through the lightning arrestor to the ground rod, and thus into the earth, than through your house.

A Good Ground. Whether or not a ground is "good" is determined by the amount of ohmic resistance between the ground rod, or other means of grounding used, and the earth. The less this "earth resistance," the better the ground. The actual resistance measurement is made with an instrument called a megohmmeter which applies a high voltage to a resistance and then measures the current flow.

There are many factors that determine the earth resistance. Some of the more important are:

1. Moisture content of the soil surrounding the grounding element.
2. Composition of the soil. For example: clay is a good contact, rock a poor one.
3. Temperature of the soil.
4. Size, shape, and number of the grounding elements buried in the earth. The more element area in contact with the soil, the better the ground.

Circuit Grounds. The ground in an electrical circuit is the circuit's electrical reference point. Normally when something is "above" ground, it is positive, since the negative side of the circuit is usually grounded. There are times, however, when

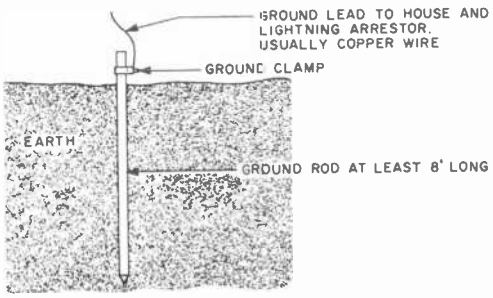


Fig. 1. Ground rod system of grounding is good if the rod is driven well into some moist earth.

the positive side is grounded, as in some of the new 12-volt automobile electrical systems. In such cases, the potentials would be considered negative or below ground. Before installing mobile equipment in a car, it is important to determine whether the positive or the negative terminals of the battery are grounded.

When a circuit is grounded and the cir-

cuit diagram shows various parts to be at ground potential by the ground symbol, it means, in effect, that these parts are electrically connected. This is generally done by using the chassis as a common grounding point and then connecting the chassis to an external ground.

Equipment is grounded as a safety measure as well as for proper operation of the circuit. If a ground connection is made to the chassis, possibility of shock through contact with the chassis is eliminated since

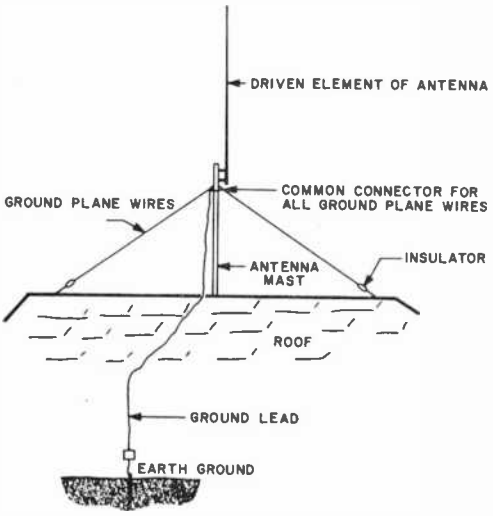


Fig. 2. Ground plane system is useful when an antenna must be installed at a distance from an external ground.

both you and the chassis are at "ground potential."

There are some circuits, in which the chassis is "hot," that should never be grounded. A common example of equipment which should not be grounded is the typical a.c.-d.c. table radio. The instructions which come with these sets generally state, "Caution: Do not connect a ground wire to this set." Since you may have either ground potential or 117 volts a.c. on the chassis (depending on which way you insert the a.c. plug into the power line), these inoffensive-appearing little sets should be handled with due respect, and never be operated outside of their insulated cabinets without taking proper precautions.

Grounds and Antennas. An antenna is nothing more than a conductor whose specific job is to radiate or receive electromagnetic energy. Very often in ham radio the same antenna serves for both transmitting and receiving through the use of a switching arrangement. In this discussion we shall limit ourselves to the role that the earth, or ground, plays in the functioning of the antenna system.

Although antennas are sometimes discussed without taking the earth into consideration, we cannot ignore the earth. When the antenna radiates electromagnetic energy, the earth acts as a reflector for energy which is directed in a downward direction. These waves are reflected back by the earth and combine with the waves which have been radiated directly from the antenna.

If the reflected wave and the direct wave are in phase, that is, if their maximums and minimums coincide, they tend to strengthen each other. If they are out of phase, or do not coincide, the reflected wave weakens the direct wave to the point where, if the two waves are 180° out of phase, cancellation occurs. The way the two waves combine depends to a large extent on the relationship of the antenna to the ground beneath it. Is the ground a good conductor or a poor conductor? Is it rocky? Is it wet or dry? Is the antenna high above the earth? All of these factors are important.

Currents are induced in the earth by that portion of the radiated wave which travels along the ground and is known as the ground wave. Valuable energy is dissipated into the earth by the ground wave and every attempt is made to keep ground-wave losses to a minimum. Fewest losses occur when the wave travels over ground which is a good conductor. This is the reason many commercial stations place their antenna systems near water or marsh lands, the water or wet earth being a much better conductor than dry earth.

Where this physical placement is not possible, in order to make the ground around the antenna as conductive as possible, metal rods or mesh screens are buried near the surface of the earth. They extend about one-half wavelength to either side or radially around the antenna. The actual height of the antenna then becomes its height above this ground screen.

Many times it is practical to mount a vertical antenna on the roof of a building at an inconvenient distance from a good grounding point. A ground system is still

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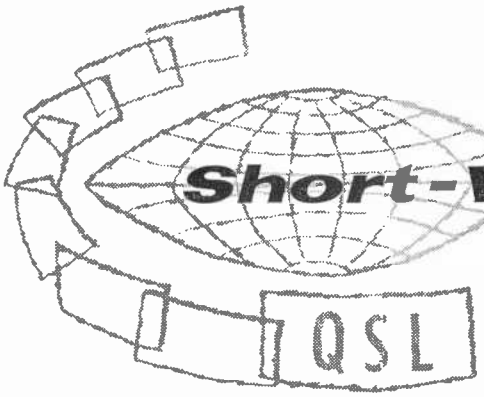

Short-Wave Report

By HANK BENNETT
W2PNA/WPE2FT

FOR the DX'er who can resist the temptation of a shady hammock and a mint julep, a dial-spinning session on the higher frequency bands may provide good hunting during August. The summer months are usually the slack season on the lower frequencies, from the broadcast band upwards to around the 49-meter band (540 to 6300 kc.). Thunderstorm activity causes frequent static, which cuts long-distance logging in those ranges. The static is much less on the higher frequencies.

There are those brave souls, however, who will ignore the heat and static, and continue to tune the various bands and faithfully send in monthly reports. But regardless of whether you are a hammock-swinger or a dial-spinner, the late summer is about the best time for you to overhaul your installation. With a new DX season in the immediate offing, you should have every piece of equipment and all accessories in top operating condition.

Check Your Equipment. The receiver and other vacuum-tube equipment should have a complete tube check. This includes preselectors, crystal calibrators, Conelrad monitors and any test or maintenance equipment, as well as your transmitter, if you are a licensed operator. All tubes found to be low in operating efficiency should be discarded. If your receiver is operating much below normal operating efficiency, it might be a good idea to have it thoroughly overhauled and aligned. You might consider returning the receiver to the manufacturer for this work; be sure to write for shipping instructions first, however.

The next step is to check all the wiring. Have all electric plugs in good condition; replace those that are faulty. Extension cords and other wiring should be kept off the floor where possible. Don't permit any wiring to be placed under rugs where it could become a fire hazard.

Check your antenna and ground connections to the receiver. Make sure that the wire is bright and clean where the insulation has been removed. If it is dirty, it can be cleaned by gently scraping it with a pocket knife or a piece of emery cloth.

Check the lead-in connection to the antenna itself. Be sure each splice is soldered. And make certain that the ground wire connection to the grounding pipe is clean and tight.

By all means protect your equipment with a lightning arrestor. Another safety

Royston Lawson, WPE4EB, of Murfreesboro, Tenn. DX's on a Hallicrafters SX-99 and has 89 countries logged. His antenna is a 50' long wire running north-south.

feature would be to install—or have installed—a master switch which, when switched to "Off," would immediately cut the power from all equipment.

Short-Wave Stationery. Check your supply of report cards and sheets (available from your Short-Wave Editor at no charge) and other necessary items such as logbooks, station listings and reference books, and note paper of course, so that you'll be ready to begin a new season of DX'ing. Your Editor also has available high-voltage decals, an amateur radio reference sheet, a DX log, and a leaflet explaining preferred methods of sending reports to stations. There is no charge for any of these items.

If you are running low on correspondence stationery, such as report forms, letterheads, envelopes, or QSL's, make sure you have your Short-Wave Monitor call letters printed on them when you reorder. If you have not yet received your own call letters and Short-Wave Monitor Certificate, you'll find the registration form and instructions on page 139. Your own call letters on your correspondence will help identify you and your station.

Incidentally, the Short-Wave Monitor Registration Program being run by POPULAR ELECTRONICS is fast becoming a project of major importance to SWL's. With over ten thousand SWL's already registered, the project is giving the short-wave fraternity the distinction it has long deserved, and promises many worthwhile advantages.

An Achievement Award program is being planned to give outstanding DX'ers formal recognition of their skill and experience in digging out the rare ones. The details are now being worked out. Every SWL who registered for a Short-Wave Monitor Certificate will be eligible. If you have not yet sent for yours, don't delay.

Broadcast Station Books. The Foreign Broadcast Information Service has a set of four books available for the DX'er that is an excellent source of station listings. These four books may be purchased in whole or in part. They are known as "Broadcasting Stations Of The World" and the Catalog number is Pr 34.659:957/pt 1 (to pt 4).

The listening post of Don Beebe, Seattle, Wash., features a Hallicrafters SX-99 and an RME DB-23. WPE7AT's antenna is 60' long and 50' high; he also uses a 15' vertical.

All known radio stations in broadcasting service are listed as follows: in Part 1 according to country and city (316 pages), $1.50; in Part 2 according to frequency (245 pages), $1.50; and in Part 3 according to station name or slogan (110 pages), $1.25. Part 4 lists FM and TV stations (124 pages), $0.75. All stations outside of the Continental United States are included.

Orders for these books should be addressed *only* to the U. S. Government Printing Office, Division of Public Documents, Washington 25, D. C.

Current Reports. The following is a resume of the current station reports. At time of compilation all reports are accurate. Stations often change frequencies and/or schedules with little or no advance notice. Please send all reports to Hank Bennett, W2PNA, Short-Wave Editor, P.O. Box 254, Haddonfield, N. J., in time for them to arrive by the tenth of each month. All times shown here are Eastern Standard and the 24-hour system is used.

(*Continued on page* 142)

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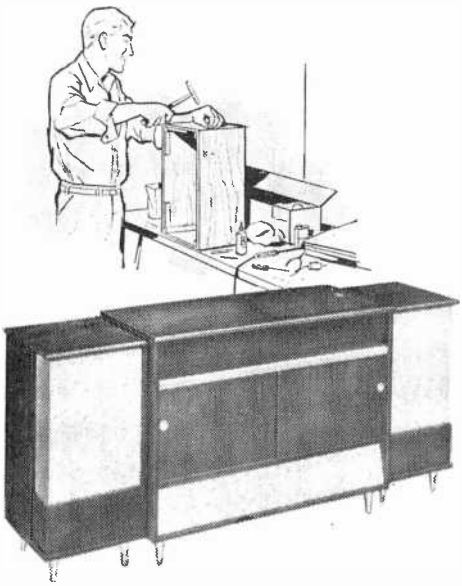
With absolutely no previous experience or knowledge of electronics you can assemble your own HEATHKIT hi-fi system, Ham station, test equipment or marine gear. Easy to understand step-by-step instructions, along with large pictorial diagrams, guarantee your success—and you save ½ or more on the highest quality equipment available today at any price!



STEREO EQUIPMENT CABINET KIT

A thing of beauty as well as utility, this stereo equipment cabinet ensemble houses your complete stereo hi-fi system. It consists of a stereo equipment center flanked by two stereo speaker enclosures. The kit is supplied with mounting panels pre-cut to accommodate Heathkits and interchangeable blank panels are also furnished. The pre-cut panels accommodate the Heathkit AM-FM Tuner (PT-1), Stereo Preamplifier (SP-2), and Stereo Record Changer (RP-3-S). The changer slides out smoothly for easy record loading. Convenient record and tape storage space is provided. Ample room is provided in the rear of the center cabinet for a pair of matching Heathkit amplifiers from 12 to 70 watts. The stereo wing speaker enclosures are open-backed, cloth-grilled cabinets designed to hold the Heathkit SS-3 or similar speaker enclosures. The cabinets are available in beautifully grained ¾" solid core Phillipine mahogany or select birch plywood suitable for the finish of your choice. Entire top features a shaped edge. Hardware and trim are of brushed brass and gold finish.

$149.95 each (shpg. Wt. 162 lbs.)

STEREO EQUIPMENT CABINET KIT
Model SE-1B (birch)
Model SE-1M (mahogany)

$39.95 each (shpg. wt. 42 lbs.)

STEREO WING SPEAKER ENCLOSURE KIT
Model SC-1BR (birch—right end)
Model SC-1BL (birch—left end)
Model SC-1MR (mahogany—right end)
Model SC-1ML (mahogany—left end)

MODEL MF-1
$26.95

DIAMOND STYLUS HI-FI PICKUP CARTRIDGE

Get the most from your LP microgroove records. Designed to Heath specifications by Fairchild Recording Equipment Corporation, the MF-1 is one of the finest pickup cartridges on the market today. Shpg. Wt. 1 lb.

ENJOY A HOME HI-FI SYSTEM NOW! PAY LATER . . .

Heath's convenient Time Payment Plan allows you to buy all of your hi-fi components right away . . . and pay for them in easy installments. Only 10% down on purchases of $55 or more. Send coupon today for FREE Heathkit catalog with full time-pay details.

TRADITIONAL
Model CE-2T (mahogany)

CONTEMPORARY (not shown)
Model CE-2B (birch)
Model CE-2M (mahogany)

$43.95 each

CHAIRSIDE ENCLOSURE KIT

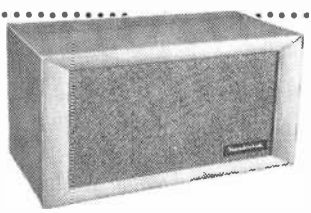
Put your entire hi-fi system right at your fingertips with this handsome enclosure. Available in either traditional or contemporary models and constructed of beautiful veneer-surfaced plywood suitable for the finish of your choice. It is designed to house the Heathkit AM and FM Tuners (BC-1A and FM-3A), the WA-P2 Preamplifier, the RP-3 Record Changer, and adequate space is provided for any Heathkit amplifier designed to operate with the WA-P2. All parts precut and predrilled for easy assembly. Shpg. Wt. 46 lbs.

NEW

HEATHKIT EA-3
$29.95

NEW! 14-WATT HI-FI ECONOMY AMPLIFIER (EA-3)

From HEATHKIT audio labs comes an exciting new kit . . . New Styling. New Features. Brilliant Performance! Designed to function as the "heart" of your hi-fi system, the EA-3 combines the preamplifier and amplifier into one compact package. Providing a full 14 watts of high fidelity power, more than adequate for operating the average system, the EA-3 provides all the controls necessary for precise blending of musical reproduction to your individual taste.



Build it in one Evening

HEATHKIT SS-2
$39.95

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

With performance comparable to speakers costing many times more, the SS-2 employs a Jensen 8" woofer and compression-type tweeter to provide total frequency response of 50 to 12,000 CPS. Shpg. Wt. 26 lbs.

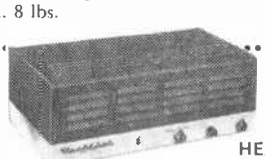
ATTRACTIVE BRASS TIP ACCESSORY LEGS: convert the SS-2 into handsome consolette. Shpg. Wt. 3 lbs. No. 91-26. $4.95.

BASIC FIR MODEL: same as SS-2 except constructed of non-premium plywood without trim or grille cloth. Shpg. Wt. 26 lbs. Model SS-3. $34.95.

HEATHKIT FM-3A $26.95

HIGH FIDELITY FM TUNER KIT

The thrills of FM entertainment are yours at budget cost with this handsomely styled tuner. Featuring broad-banded circuits for full fidelity and better than 10 microvolt sensitivity for 20 db of quieting, the FM-3A pulls in stations with clarity and full volume. Shpg. Wt. 8 lbs.



HEATHKIT W-7M $54.95

"EXTRA PERFORMANCE" HI-FI 55 WATT AMPLIFIER KIT

Offering full fidelity at less than a dollar per watt, the power output of this remarkable amplifier is conservatively rated at 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout this entire range. Shpg. Wt. 28 lbs.

HEATHKIT PT-1
$89.95

MONAURAL-STEREO AM-FM TUNER KIT

This professional quality 16-tube tuner offers you outstanding AM, FM or stereo AM/FM performance at minimum expense. Features include individual flywheel tuning and automatic frequency control. A multiplex jack is also provided. Shpg. Wt. 24 lbs.

HEATHKIT SP-2
$56.95

MONAURAL-STEREO (two channel mixer) PREAMPLIFIER KIT

Control your entire stereo system with this 2-channel preamplifier. A remote balance control with 20' of cable allows balancing the stereo system from listening position. Shpg. Wt. 15 lbs.

HEATHKIT TR-1A $99.95

Includes tape deck, tape recorder electronics, microphone and roll of blank tape.

HIGH FIDELITY TAPE RECORDER KIT

Whether making your own recordings or playing pre-recorded tapes you'll enjoy the many fine features of this tape recorder kit. Included are fast forward and rewind functions and choice of 7½ or 3¾ IPS tape speeds. Printed circuit boards simplify assembly. Shpg. Wt. 24 lbs.

HEATHKIT RP-3
$64.95

(stereo model RP-3S $74.95)

AUTOMATIC HI-FI RECORD CHANGER KIT

Combining the convenience of an automatic record changer with true turntable quality the RP-3 obtains full fidelity from your hi-fi and stereo records while treating them with the care they demand. A "turntable pause" feature prevents records from dropping on moving turntable or disk. Plays at 33⅓, 45, 78 and 16 RPM. Shpg Wt. 19 lbs.

HEATH COMPANY
Benton Harbor, Mich.

A Subsidiary of Daystrom, Inc.

HEATHKIT®

HEATHKIT TX-1
$234.95

"APACHE" HAM TRANSMITTER KIT

Features 150 watt phone input and 180 watt CW input. Provision for single-sideband transmission using the SB-10 External Adapter. Shpg. Wt. 110 lbs.

HEATHKIT RX-1
$274.95

"MOHAWK" HAM RECEIVER KIT

Covers from 160 through 10 meters on 7 bands with an extra band calibrated to cover 6 and 2 meters using a converter. Outstanding SSB reception. Shpg. Wt. 66 lbs.

HEATHKIT SB-10
$89.95

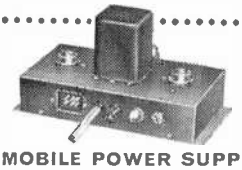
SINGLE SIDEBAND ADAPTER KIT

A compatible plug-in adapter unit for the "Apache" Transmitter, the SB-10 covers 80, 40, 20, 15 and 10 meter bands. Produces USB, LSB or DSB signals, with or without carrier insertion. Shpg. Wt. 12 lbs.

HEATHKIT DX-40
$64.95

PHONE AND CW TRANSMITTER KIT

Providing phone and CW operation on 80, 40, 20, 15, and 10 meters, the DX-40 features built-in modulator and power supplies. Shpg. Wt. 25 lbs.



HEATHKIT MP-1
$44.95

MOBILE POWER SUPPLY KIT

Furnishes all power required to operate both MT-1 Transmitter and MR-1 Receiver from 12-14 volt battery. Delivers full 120 watts continuously or 150 watts intermittently. Kit includes 12′ battery cable, tap-in studs for battery posts, power plug and 15′ connecting cable. Shpg. Wt. 8 lbs.

Mobile Fun! With all New Heathkit Mobile Ham Gear

HEATHKIT MR-1
$119.95

"COMANCHE" MOBILE HAM RECEIVER KIT

Handsome styling, rugged construction, top quality components and economy are all wrapped up in the "Comanche". It is an 8-tube superheterodyne receiver operating AM, CW and SSB on the 80, 40, 20, 15 and 10 meter amateur bands. Operates from 12 volt car battery through the MP-1 Mobile Power Supply. Can be converted in minutes to a fixed station unit by using an AC power supply. Shpg. Wt. 19 lbs.

MOBILE ACCESSORIES

Quality 5″ PM speaker in rugged steel case with mounting brackets. Heathkit AK-7. $5.95. Shpg. Wt. 4 lbs.

Mobile base mount holds both transmitter and receiver. Universal floor mounting bracket. Heathkit AK-6. $4.95. Shpg. Wt. 5 lbs.

HEATHKIT MT-1
$99.95

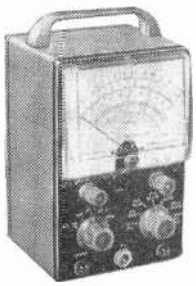
"CHEYENNE" MOBILE HAM TRANSMITTER KIT

The fun and convenience of mobile operation are yours with the compact and efficient "Cheyenne" Transmitter. Featuring high power with minimum battery drain, the unit provides up to 90 watts phone input and covers 80, 40, 20, 15 and 10 meters. Featured are a built-in VFO, modulator, 4 RF stages with a 6146 final amplifier pi network (coaxial) output coupling. The "Cheyenne" is designed as a companion to the "Comanche" receiver and is powered by the MP-1 Power Supply. Shpg. Wt. 19 lbs.

HEATHKIT VHF-1
$159.95

"SENECA" VHF HAM TRANSMITTER KIT

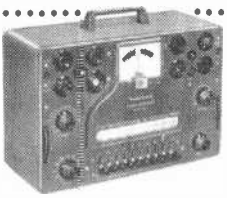
General, technician or novice class hams wishing to extend transmission into the VHF region will find the "Seneca" ideal. A completely self-contained 6 and 2 meter transmitter, the VHF-1 features up to 120 watts input on phone and 140 watts input on CW in the 6 meter band. Included are controlled carrier phone operation, built-in VFO for both 6 and 2 meters, and four switch-selected crystal positions. Shpg. Wt. 56 lbs.



HEATHKIT V7-A
$25.95

ETCHED CIRCUIT VTVM KIT

World's largest selling VTVM, the V7-A measures AC voltage (RMS), AC voltage (Peak-to-peak), DC voltage and resistance. Features 7 AC (RMS) and DC voltage ranges of 0-1.5, 5, 15, 50, 150, 500 and 1500. In addition there are 7 peak-to-peak AC ranges of 0-4, 14, 40, 140, 400, 1400 and 4000. Seven ohmmeter ranges are provided. Battery and test leads are included with kit. Shpg. Wt. 7 lbs.



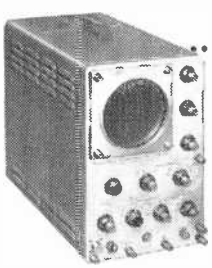
HEATHKIT TC-3
$39.95

TUBE CHECKER KIT

An invaluable aid to servicemen, the TC-3 tests for open, short, leakage, heater continuity and quality of all tube types commonly encountered in radio and TV servicing. Checks 4, 5, 6 and 7-pin large, 7 and 9-pin miniature, 7-pin sub-miniature, octal and loctal tubes and pilot lamps. A blank socket provides for future tube types. Shpg. Wt. 12 lbs.

Model 355.

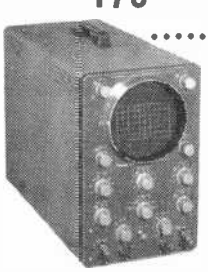
TV PICTURE TUBE TEST ADAPTER
For use with TC-3 or earlier model TC-2. Includes 12-pin TV tube socket, 4' cable. Octal connector and data. No. 355. Shpg. Wt. 1 lb. $4.50.



HEATHKIT OP-1
$179.95

"PROFESSIONAL" 5" DC OSCILLOSCOPE KIT

Offering complete versatility, the OP-1 features DC coupled amplifiers and also DC coupled CR tube unblanking. Triggered sweep circuit operates on internal or external signals and may be either AC or DC coupled. Transformer operated power supply has silicon diode rectifiers. Shpg. Wt. 34 lbs.



HEATHKIT OM-3
$39.95

"GENERAL PURPOSE" 5" OSCILLOSCOPE

Ideal in servicing as well as routine laboratory work, the OM-3 features wide vertical amplifier frequency response, extended sweep generator operation and improved stability. Vertical response is within ±3 db from 4 CPS to 1.2 mc. Sweep range covers 20 CPS to over 150 kc. Shpg. Wt. 22 lbs.

HEATHKIT T-4
$19.95

VISUAL-AURAL SIGNAL TRACER KIT

Doubling as a utility amplifier, test speaker, or substitution transformer, the T-4 represents an outstanding buy. Traces RF, IF and audio signals in AM, FM and transistor-type radios. Shpg. Wt. 5 lbs.

HEATHKIT SG-8
$19.50

RF SIGNAL GENERATOR KIT

Aligns RF, IF and tuned circuits of all kinds. Provides extended frequency coverage in five bands from 160 kc to 110 mc on fundamentals and up to 220 mc on calibrated harmonics of the fundamental frequencies. Shpg. Wt. 8 lbs.

HEATHKIT CT-1
$7.95

IN-CIRCUIT CAPACI-TESTER KIT

Check capacitors for "open" or "short" right in the circuit. Detects open capacitors from 50 mmf up and checks shorted capacitors up to 20 mfd. Checks all bypass, blocking and coupling capacitors of the paper, mica and ceramic types. Shpg. Wt. 5 lbs.

HEATHKIT TO-1
$16.95

TEST OSCILLATOR KIT

Provides fast and accurate selection of test frequencies most used by servicemen in repairing and aligning modern broadcast receivers. Five fixed-tuned frequencies are quickly selected for trouble-shooting. Shpg. Wt. 4 lbs.

add that "extra" speaker

HEATHKIT US-1
$7.50

12" UTILITY SPEAKER

This high quality auxiliary speaker offers many possibilities in audio, radio and TV work and will handle up to 12 watts with a frequency response from 50 to 9,000 CPS ±5 db. Speaker impedance is 8 ohms and employs a 6.8 ounce magnet. Shpg. Wt. 7 lbs.

HEATHKIT BR-2
$18.95
(less cabinet)

BROADCAST BAND RADIO KIT

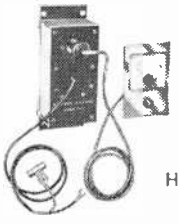
Fun to build, and a fine receiver for your home. Covers complete broadcast band from 550 to 1600 kc. Built-in 5½" PM speaker and rod-type antenna. Transformer operated power supply. Excellent sensitivity and selectivity. Shpg Wt. 10 lbs.

Cabinet optional extra: No. 91-9A. Shpg. Wt. 5 lbs. $4.95.

HEATHKIT AK-1
$9.95

MICROPHONE ACCESSORY KIT

Useful in countless applications, this kit consists of a rugged high fidelity crystal mike and three holders; a mike stand adapter, a lavalier neckband and desk stand. An 8' cable with phone plug is included. Shpg. Wt. 1 lb.



check engine RPM

HEATHKIT TI-1 $25.95

ELECTRONIC TACHOMETER KIT

Easy-to-build and simple to install. Operates directly from the spark impulse of any 2 or 4 cycle engine with any number of cylinders. Operates on 6, 8, 12, 24 or 32 volt DC systems and is completely transistorized. The easy-to-read indicator shows RPM from 500 to 6,000. A calibration control is also provided. Shpg. Wt. 4 lbs.

Fun for the whole family

HEATHKIT XR-1P
$29.95

6 TRANSISTOR PORTABLE RADIO KIT

This easy-to-build portable radio offers fun and enjoyment for the whole family. Features 6 transistors, large 4" x 6" PM speaker for "big-set" tone quality, and built-in rod-type antenna. Uses standard size "D" flashlight cells for extremely long battery life (between 500 and 1,000 hours). The modern molded plastic case with pull-out carrying handle is two-tone blue with gold inlay and measures 9" L. x 7" H. x 3¼" D. Shpg. Wt. 6 lbs.

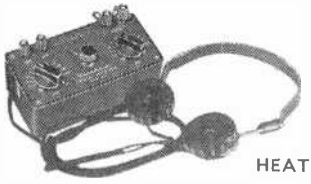
Complete Engine "Tune-Up" Facilities!

ELECTRONIC IGNITION ANALYZER KIT (IA-1A)

Just clip the two test leads to operating engine (400 to 5,000 RPM) and check condition of coil, condenser, points, plugs and wiring. Shows either primary or secondary circuit patterns, parade or superimposed secondary patterns. Shpg. Wt. 20 lbs.

MODIFICATION KIT for IA-1 Models: Provides switch selection of primary and secondary circuit patterns, or, choice of parade and superimposed secondary patterns. Shpg. Wt. 2 lbs.
Heathkit MK-6. . . . . **$4.95**

HEATHKIT IA-1A $59.95



Let your boy learn radio

HEATHKIT CR-1 $7.95

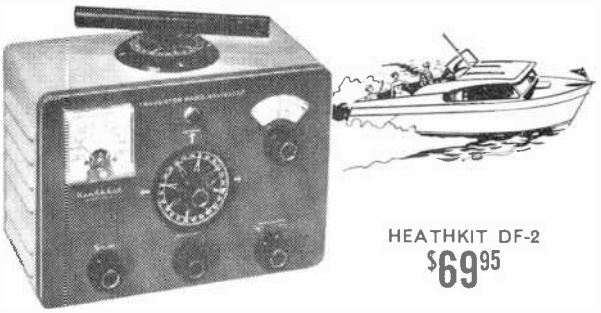
CRYSTAL RADIO KIT

Any youngster interested in radio or electronics will enjoy building and using this fine little crystal receiver. Frequency coverage is from 540 to 1600 kc. A sealed germanium diode is used for detection —no critical "cats whisker" adjustment. Headphones included. Measures 6" L. x 3" W. x 2⅛" D. Shpg. Wt. 3 lbs.

HEATHKIT TK-1
$9.95

COMPLETE TOOL SET

This handy tool kit provides all the basic tools required for building any Heathkit. Includes pliers, diagonal sidecutters, screwdrivers, and soldering iron with holder. Pliers and sidecutters are equipped with insulated rubber handles that provide protection from electrical shock. All of the tools are of top quality case hardened steel for rugged duty and long life. Shpg. Wt. 3 lbs.

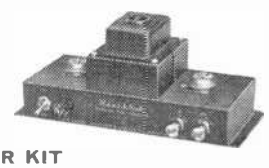


HEATHKIT DF-2
$69.95

2-BAND TRANSISTOR RADIO DIRECTION FINDER KIT

Economically powered by 6 standard flashlight cells, the DF-2 provides you with a completely portable 6-transistor standard and beacon band receiver of unusual quality and performance. Covers the beacon band from 200 to 400 kc and broadcast band from 540 to 1620 kc. A tuning dial light is provided for night operation. Large 4" x 6" speaker provides superb tone reproduction. Shpg. Wt. 9 lbs.

HEATHKIT PC-1
$24.95



12 VOLT POWER CONVERTER KIT

Household electricity right on your boat or in your automobile is yours with this 12-volt power converter kit. Operate your radio, electric razor, lights, etc., directly from your 12-volt boat or car battery. Power rating is 125 watts continuously and 175 to 200 watts intermittently. Note: not recommended for record players, tape decks, power tools or radio transmitters. Shpg. Wt. 8 lbs.

HEATHKIT MC-1
$39.95

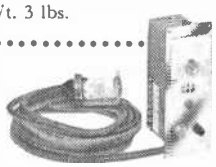
MARINE CONVERTER KIT

Charge your 6 or 12 volt batteries at dockside even while your boat's electrical system is in use. Provides up to 20 amperes continuously for charging 6-volt batteries or 10 amperes continuously for charging 12-volt batteries, regardless of type. Charging current is continuously monitored by a 25 ampere meter. Shpg. Wt. 16 lbs.

MARINE BATTERY CHARGE INDICATOR KIT

See at a glance the exact percentage of charge in your boat batteries. Checks from 1 to 8 storage batteries instantly. Operates on 6, 8, 12 or 32 volt systems. Note: for mounting on non-ferrous metals or wood only. Shpg. Wt. 3 lbs.

HEATHKIT CI-1
$16.95



HEATHKIT FD-1-6 (6 volt)
FD-1-12 (12 volt)
$35.95 each

FUEL VAPOR DETECTOR KIT

Protecting against fire and explosion on your boat, the FD-1 indicates the presence of explosive fumes and shows immediately if it is safe to start the engine. The kit is complete including spare detector unit. Shpg. Wt. 4 lbs.

Free Send now for latest Heathkit Catalog describing in detail over 100 easy-to-assemble kits for the Hi-Fi fan, radio ham, boat owner and technician.

HEATH

pioneer in do-it-yourself electronics

COMPANY BENTON HARBOR 10, MICH.

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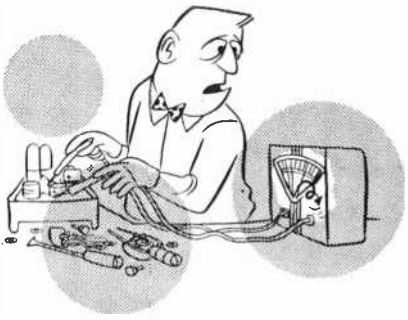
All prices and specifications subject to change without notice. Please include postage on orders to be shipped parcel post. 20% deposit is required on all C.O.D. orders. All prices are NET F.O.B. Benton Harbor, Mich., and apply to Continental U.S. and Possessions only.

NAME

ADDRESS

CITY ZONE STATE

QUANTITY	KIT NAME	MODEL NO.	PRICE



UNPOPULAR ELECTRONICS

Poems by **Saunder Harris**

Cartoons by **Carl Kohler**

Cornelius Cathode, electronics misfit,
Saved up his dough and bought him a kit,
Did away with instructions; "For beginners," said he,
"I know what I'm doing, just watch me and see."
He finished in jig time, plugged the thing in.
Smoke, fire and sparks burned off his smug grin.

Percival Prod paid no heed,
To where he placed the meter lead,
To where he set the meter switch,
Red or black, no matter which.
Now pity poor Perc who repents his sin,
With the meter needle wrapped 'round the pin.

Timothy Twerp was most astounded,
When what he thought was—WASN'T grounded.
In fact, one could say, he was really transfixed
With his thumb on pin 3 of a live 6L6.

A wizard at wireless named Wallace McGee,
Never thought he'd be caught by the old FCC;
But to his surprise, they received him quite well.
Unlicensed, his choice was a fine or a cell.

Learn Radio-TV Electronics

by Practicing at Home in Spare Time

Without Extra Charge You Get special NRI kits developed to give actual experience with Radio-TV equipment. You build, test, experiment with receiver or broadcasting circuits. Keep all equipment.

Have High Pay, Prestige, Good Future as a Skilled Radio-TV Electronic Technician

People *look up to* and depend on the Technician, more than ever before. His opportunities are great and are increasing. Become a Radio-TV Electronic Technician. At home, and in your spare time, *you* can learn to do this interesting, satisfying work—qualify for important pay.

A steady stream of new Electronic products is increasing the job and promotion opportunities for Radio-Television Electronic Technicians. Right now, a solid, proven field of opportunity for good pay is servicing the tens of millions of Television and Radio sets now in use. The hundreds of Radio and TV Stations on the air offer interesting jobs for Operators and Technicians.

More Money Soon—Make $10 to $15 a Week Extra Fixing Sets in Spare Time

NRI students find it easy and profitable to start fixing sets for friends a few months after enrolling, pick up $10, $15 and more a week extra spending money. Many who start in spare time soon build full time Radio-Television businesses.

Act Now—See What NRI Can Do for You

NRI has devoted 40 years to developing simplified practical training methods. You train at home, learn by doing.

NATIONAL RADIO INSTITUTE Wash. 16, D.C.

NRI Has Trained Thousands for Successful Careers in Radio-TV

Studio Engr., Station KATV
"I am now Studio Engineer at Television Station KATV. Before enrolling, I was held back by limitation of a sixth grade education." BILLY SANCHEZ, Pine Bluff, Ark.

Has All the Work He Can Do
"I have repaired more than 2,000 TV and Radio sets a year. NRI training certainly proved to be a good foundation." H. R. GORDON, Milledgeville, Georgia.

Has Good Part Time Business
"Early in my training I started servicing sets. Now have completely equipped shop. NRI is the backbone of my progress." E. A. BREDA, Tacoma, Washington.

SEE OTHER SIDE

Cut Out and Mail This Card—No Stamp Needed

Sample Lesson and Catalog Both Sent FREE

OLDEST & LARGEST HOME STUDY RADIO-TV SCHOOL

National Radio Institute

Dept. 6 , Washington 16, D.C.

Please send me sample lesson of your Radio-Television Training and Catalog FREE. (No salesman will call.)

Name..... Age.....

Address.....

City..... Zone..... State.....

ACCREDITED MEMBER NATIONAL HOME STUDY COUNCIL

NRI SUPPLIES LEARN-BY-DOING KITS WITHOUT EXTRA CHARGE
Technical Know-How Pays Off in Interesting, Important Work

YOU BUILD AC-DC Superhet Receiver

NRI Servicing Course includes all needed parts. By introducing defects you get actual servicing experience practicing with this modern receiver. Learn-by-doing.

YOU BUILD Broadcasting Transmitter

As part of NRI Communications Course you build this low power Transmitter; learn commercial broadcasting operators' methods, procedures. Train for your FCC Commercial Operator's License.

YOU BUILD This 17 Inch Television Receiver

As part of your NRI course you can get all components, tubes, including 17" picture tube, to build this latest style Television receiver; get actual practice on TV circuits.

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J. E. Smith, Founder

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40 TUBE SOCKETS 4 to 9-pin; ceramic, mica, shielded-based incl. 2 lbs. Reg. $10. 88¢

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70 TBLR COND'NS'RS Paper, molded, oil, porc.; to .5mf to 1000V. 2 lbs. Reg. $14. 88¢

WIRE STRIPPER Strips, cuts #10 thru #22 hookup wire. Wt. 1 lb. 88¢

10 ELECTROLYTICS Radio, TV. 10-50 mf to 450VDC. 3 lbs. Reg. $12. 88¢

60 RADIO-TV KNOBS Assid. colors, insulation. Some worth $1 ea. 2 lbs. Reg. $17. 88¢

16-END WRENCH SET For home & auto. Box & open: 15 64ths thru 7/16". 16 sizes. Reg. $2.50. 88¢

70 ONE-WATTERS Assid. value carbon resistors. 5%, too! 88¢

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35 POWER RESISTORS W.W. 5 to 50W, to 10,000 ohms. Vitreous, too! 3 lbs. Reg. $15. 88¢

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5 ROLLS MICRO-WIRE #24 thru 32; for transistor, sub-mini circuits. 1 lb. 88¢

2 VARI-LOOPSTICKS Adj. 540-1500 Kcs. Transistor radios, etc. 1 lb. 88¢

MINI-RADIO KIT World's smallest! 2 x 1 x 1". Loopstick, jacks, diode, etc. w/instructions. 1 lb. Reg. $3. 88¢

100 RADIO PARTS Wide variety resistors, condensers, pots, forms. 3 lbs. 88¢

4 POWER WOOD BITS Hi-Q steel. ⅜s, ½, ¾, 1". 5" long. Reg. $3. 88¢

FREE! SURPRISE GIFT FREE WITH EVERY ORDER!

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100 HALF-WATTERS Assid. value carbon resistors, incl. 5%. Reg. $12. 88¢

30 MOLDED COND'S'RS Assid. Finest made! Wt. 2 lbs. 88¢

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40 PRECISION RESISTORS Carbon, W.W. wide variety. 1%, ½, 1-2 w. 1 lb. Reg. $15. 88¢

5-IN-1 DRILL BIT Reams, saws, cores, shapes, drills; hand or power drills. 88¢

40 SUBMINI RESIST'RS 1½" long. Asst. Values: 1 5W to 10 megs. Reg. $6. 88¢

5" HOBBY SPEAKER For radios, code oscs., intercoms. 2 lbs. Reg. $5 88¢

TEN 3-SECOND TIMER Mechanisms; precision geared. 2 lbs. Reg. $30. 88¢

6 SILICON DIODES Sylvania 1N22, 1N23. Reg. $36 88¢

$25 SURPRISE PACK! Large, varied assortment radio, TV parts. 3 lbs 88¢

7-SCREWDRIVER SET 7 assid. drivers w wall rack. Plastic handles. 1 lb. List $3.70. 88¢

40 SUBMINI COND'SRS For transistor, printed circuit work. 1 lb. Reg. $7. 88¢

70 HI-Q RESISTORS Insulated, carbon: 1%, too! ½ & 1w, 10 ohms to 10 megs. 2 lbs. Reg. $13. 88¢

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1500 PCS. HARDWARE Nuts, screws, washers, etc. 11 lbs. Reg. $6. 88¢

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75 RESISTOR SPECIAL! WW precision, carbon, variable, mixed types. 3 lbs. Worth $15. 88¢

15-PC. DRILL SET 1/16" thru 1/4" x 64ths w calibrated case. Reg. $4. 88¢

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State price with each item. Send check or M.O. including sufficient postage; excess returned. C.O.D. orders, 25% down; rated net 30 days. INCLUDE POSTAL ZONE in address. (Canada postage, 48c 1st lb.; 28c ea. add'l lb.)

LEKTRON 131-133 EVERETT AVE. CHELSEA 50, MASS.

By
JOHN T. FRYE
W9EGV

Carl and Jerry

Away From It All

JULY was melting into August; and Carl and Jerry, sitting on the latter's front steps watching the advent of another hot summer day, were becalmed in the Dog Day Doldrums.

"You know, Jer," Carl remarked, as he brushed the palm of his hand pleasurably back and forth across the close-cropped, dew-wet grass beside the steps, "lately I get the feeling we're hitting the electronic kick a little too hard. It's reached the point where we aren't interested in anything unless it's somehow mixed up with wires, tubes, transistors, batteries, and so on. Electronics is the most fascinating thing in the world, but I don't want to become a nut about it—or about anything else, for that matter."

"Me, neither," Jerry promptly agreed; "and I think, too, that we're getting a little far out on the subject of electronics. The other day I caught myself walking along the street reading the signs and mentally tapping them out in Morse code."

"Brother, you're sicker than I thought! You're just about ready to be fitted for a white jacket with the wrap-around sleeves. We better act fast. Let's pack up our gear, grab our bicycles, and go for an overnight camping trip up along the river; and let's not take a single thing electronic, or even electrical, with us."

"Not even a flashlight?" Jerry queried.

"Not even a flashlight," Carl said firmly. "We'll use candles. And the first one who mentions electronics has to pitch the shelter and do all the cooking. Let's make like electricity hasn't even been discovered yet."

"It's a deal," Jerry said as he grasped Carl's wet hand. "Get your part of the camping stuff and let's get going."

THE BOYS had done this sort of thing often enough in the past so that a minimum of preparation was necessary. An hour later they were pedaling past the city limits sign with all the needed gear contained in two neat bundles fastened to the luggage carriers of the bikes.

They soon turned off on the quiet tree-lined river road and cycled leisurely along the shaded tunnel formed by the arching limbs. Now and then they stopped to watch huge leather-back turtles sunning themselves on the rocks or to drink from a cool spring that bubbled up through the limestone. Even so, when the sun was directly overhead they were several miles from home and were beginning to look for a camping site.

After they had pedaled briskly up a steep incline, Carl braked sharply.

"How's this?" he asked as he looked down at the river twisting and turning below. "We'll get any breeze that's blowing up here, and the mosquitoes won't be as bad as they are down close to the water. We can pitch our shelter over there in the grove of trees where we can't be seen from

the road and where we can look right down on the river. This bluff must be the highest place for miles. What a spot for a six-meter rig!"

As soon as the words left his lips, Carl realized what he had done; and he glanced quickly at Jerry in the hope that his chum had not noticed the slip. No such luck! Jerry's round face was wreathed in a bland smile as he leisurely got off his bicycle, sat down on the ground, and leaned lazily back against the trunk of a big tree.

"Well, you brought up the forbidden subject," he drawled; "so get with it. I think I'll take a nap while you pitch the shelter. When that's done, you can get some dinner. I'd like three or four eggs, well basted, and several slices of crisp bacon. Open a can of pork and beans, too. When it's all ready, wake me; but do it gently. I startle easily."

"Do you suppose a dash of cold water right in your smirking face would startle you?" Carl growled as he began unrolling the light, waterproof shelter. Jerry relented, though, and cut and sharpened tent stakes while Carl was laying out the tent. Then he gathered firewood and had a good fire going by the time the shelter was up.

After dinner the boys made everything shipshape in their camp and then rested an hour before going for a swim. The river below the bluff on which their tent was pitched was quiet, crystal-clear, and just about shoulder-deep, with a sandy bottom free of holes and step-offs; it was a good safe place to swim. Carl and Jerry spent the whole afternoon playing in the river and exploring the shallow caves worn into the base of the cliff by the water.

When the trees on the bank began throwing long shadows far out across the mirror surface of the river, the boys changed out of their swimming trunks and made their way back to camp. The exercise had given them wolfish appetites, but they took time to prepare a good nourishing supper that was no less appetizing for being smoked, slightly scorched, and seasoned with wood ashes.

By the time the tin pans had been thoroughly scoured and put away, the sun had gone down—after setting fire to a few small clouds drifting in the western sky. Darkness closed in rapidly. The boys kept their little fire going by alternately feeding it with pieces of broken branches. It was strange how the camp site that looked so friendly and inviting in daylight sud-

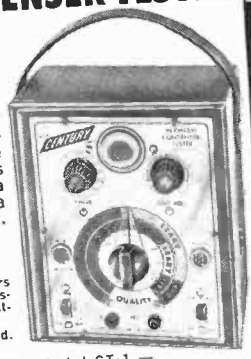
SHIPPED ON APPROVAL

IN-CIRCUIT CONDENSER TESTER

Model CT-1

AN ABSOLUTE 'MUST' FOR EVERY SERVICEMAN!

Here is an in-circuit condenser tester that does the whole job. The CT-1 actually steps in and takes over where all other in-circuit condenser testers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation. . . .



in-circuit checks:

- Quality of over 80% of all condensers even with circuit shunt resistance present . . . (leakage, shorts, opens, intermittents)
- Value of all condensers from 200 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- Transformer, socket and wiring leakage capacity

out-of-circuit checks:

- Quality of 100% of all condensers . . . (leakage, shorts, opens and intermittents)
- Value of all condensers from 50 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- High resistance leakage up to 300 megohms
- New or unknown condensers . . . transformer, socket, component and wiring leakage capacity

Model CT-1 — housed in sturdy hammertone finish steel case complete with test leads **$34.50** Net

SIZE: W–6" H–7" D–3¼"

SPECIFICATIONS

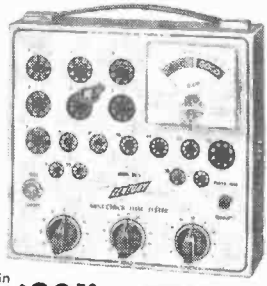
• Ultra-sensitive 2 tube drift-free circuitry • Multi-color direct scale precision readings for both quality and value . . . (in-circuit or out of circuit) • Simultaneous readings of circuit capacity and circuit resistance • Built-in hi-leakage indicator sensitive to over 300 megohms • Cannot damage circuit components • Electronic eye balance indicator for even greater accuracy • Isolated power line

MINI-CHECK TUBE TESTER

Model MC-1

A Real ECONOMY MULTIPLE SOCKET TUBE TESTER without sacrifice in ACCURACY, SPEED or VERSATILITY

Here is a multiple socket tube tester designed to meet limited budgets. Although low in price it boasts a unique circuitry that enables you to check over 600 tube types — and has a range of operation that far exceeds others in its price class.



Model MC-1 — housed in sturdy wrinkle finish steel case **$39.50** Net

SIZE: W–9" H–8½" D–2¾"

SPECIFICATIONS

• Checks emission, inter-element shorts and leakage of over 600 tube types. This covers OZ4s, series-string TV tubes, gas regulators, auto 12 plate volt, hi-fi and foreign tubes • 3 seltings enable a test of any tube in less than 10 seconds • Employs dynamic cathode emission test principles • 3½" D'Arsonval type meter — most accurate type available . . . its greater sensitivity means more accuracy . . . its jewel bearing means longer life • 17 long lasting phosphor bronze tube sockets • Combination gas and short jewel indicator • 9 filament positions • Handy tube chart contained in special back compartment • New tube listings furnished periodically at no cost • Detachable line cord

plus these BONUS FEATURES . . . found in no other low price tube tester

✓ Checks for cathode to heater shorts ✓ Checks for gas content ✓ Checks all sections of multiple purpose tubes . . . will pickup tubes with one "Bad" section ✓ Line isolated — no shock hazard ✓ Variable load control enables you to get accurate results on all tubes ✓ Positively cannot become obsolete as new tubes are introduced.

IN-CIRCUIT RECTIFIER TESTER

Model SRT-1

Checks all power rectifiers in-circuit whether SELENIUM, GERMANIUM, SILICON, etc.

With the growing trend towards compactness, portability and low price, TV manufacturers are resorting more and more to producing series-string TV sets employing selenium, germanium or silicon power rectifiers. Now the need for an in-circuit rectifier tester is greater than ever.

THE SRT-1 CHECKS ALL POWER RECTIFIERS IN-CIRCUIT AND OUT-OF CIRCUIT WITH 100% EFFECTIVENESS FOR:

✓ Quality ✓ Fading ✓ Shorts ✓ Opens ✓ Arcing ✓ Life Expectancy

Model SRT-1—housed in sturdy hammertone finish steel case complete with test leads **$29.50** Net

SIZE: W–6" H–7" D–3¼"

SPECIFICATIONS

- Checks all types of power rectifiers rated from 10 ma. to 500 ma. (selenium, germanium, silicon, etc.) both in-circuit or out-of-circuit.
- Will not blow fuses even when connected to a dead short.
- Large 3" highly accurate multi-color meter . . . sensitive yet rugged.
- Separate meter scales for in-circuit and out-of-circuit tests.
- Cannot damage or over heat rectifier being tested.

SIMPLE TO OPERATE Just clip SRT-1 test leads across rectifier under test right in the circuit without disconnecting rectifier from circuit. Press test switch and get an instant indication on the easy-to-read three-color meter scales. . . .

TRANSISTOR TESTER

Model TT-2

AN INEXPENSIVE QUALITY INSTRUMENT DESIGNED FOR ACCURATE AND DEPENDABLE TESTS OF ALL TRANSISTORS AND DIODES QUICKLY AND ACCURATELY

Every day more and more manufacturers are using transistors in home portable and car radios . . . in hearing aids, Intercoms, amplifiers, industrial devices, etc. Since transistors can develop excessive leakage, poor gain, shorts or opens, the need for TRANSISTOR TESTER is great.

SPECIFICATIONS

• Checks all transistors, including car radio, power output, triode, tetrode and unijunction types for current gain, leakage, opens, shorts, cut-off current • Checks all diodes for forward to reverse current gain • All tests can be made even if manufacturers' rated gain is not available • Less than half a minute required for tests of either transistors or diodes • Large 3" meter is extremely sensitive yet rugged . . . with multi-color scales designed for quick easy readings • Power is supplied by an easy to replace 6-volt battery — current drain so small, service life almost equal to shelf life. Battery cannot be drained due to accidental shorting of test leads • Cannot burn-out its own meter or damage transistor or diode under test • Long test leads and insulated test clips enable tests without entirely removing transistor from circuit • Test leads are identified by E.I.A. color code so that connection to the correct terminal is assured • Comes complete with replaceable transistor set-up chart that fits into a special rear compartment.

Model TT-2 — housed in sturdy hammertone finish steel case complete with test leads **$24.50** Net

SIZE: W–6" H–7" D–3¼"

IMPORTANT FEATURE: The TT-2 cannot become obsolete as the circuitry is engineered to enable you to check all new type transistors as they are introduced. New listings will be furnished periodically at no cost.

EASY TO BUY IF SATISFIED
see order form on facing page

FOR 10 DAY *FREE* TRIAL

Convince yourself at no risk that CENTURY instruments are indispensable in your every day work. Send for instruments of your choice without obligation . . . try them for 10 days before your buy . . . only then, when satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

NEW Battery Operated Peak-to-Peak VACUUM TUBE VOLT METER Model VT-1

WITH LARGE EASY-TO-READ 6" METER —

featuring the sensational new MULTI-PROBE · *Patent Pending*

No extra probes to buy! The versatile MULTI-PROBE does the work of 4 probes

❶ DC Probe ❷ AC-Ohms Probe ❸ Lo-Cap Probe ❹ RF Probe

The VT-1 is a tremendous achievement in test equipment. With its unique MULTI-PROBE it will do all the jobs a V.T.V.M. should do without the expense of buying additional probes. No longer do you have to cart around a maze of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to do any one of many time-saving jobs. A special holder on side of case keeps MULTI-PROBE firmly in place ready for use.

SIZE: W–7¾" H–9" D–4¼"

FUNCTIONS

DC VOLTMETER . . . Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts . . . Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges . . . Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

AC VOLTMETER . . . True Peak-to-Peak measurements of any wave form including TV sync, deflection voltages, video pulses, audio in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1.20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, t.f. stage-by-stage gain and detector inputs.

OUTSTANDING FEATURES

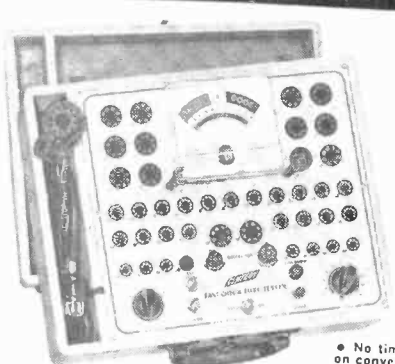
- Completely portable — self powered with long life batteries — permits use everywhere
- New advanced pentode amplifier circuit assures amazingly low battery drain
- Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s
- Laboratory accuracy performance — 2% of full scale on DC, 5% of full scale on AC
- Simplified multi-color easy-to-read 4-scale meter
- No heat operation assures rigid stability and accuracy
- Immune to power line fluctuations
- Amplifier rectifier circuit with frequency compensated attenator — a feature found only in costly laboratory instruments
- Meter completely isolated — practically burn-out proof
- Hand-crafted circuitry eliminates the service headaches of printed circuitry
- 1% resistors used for permanent accuracy
- Separate RF ground return for low-loss RF measurement
- Micro-phone type co-axial connector
- Matching cover protects instrument face — snaps on and off instantly.

SPECIFICATIONS

- DC Volts — 0 to 1.5/6/30/150/300/600/1500 volts
- AC Volts (RMS and Peak-to-Peak) — 0 to 3/12/60/300/1200 volts
- Ohms — 0 to a billion ohms, 10 ohms center scale — Rx1/10/100/1K/10K/100K/1M
- RF — Peak reading demodulator supplied for use on all DC ranges
- Zero Center — available on all DC volt ranges with zero at mid-scale
- Decibels — from —10 Db to +10/22/36/50/62 based on the 0bm unit: 0Db-1MW in 600 ohms
- Impedance — 11 megohms DC, 1 megohm AC, 10 megohms Lo-Cap
- Input Capacity — 130 mmfd. RMS, 250 mmfd. Peak-to-Peak, 25 mmfd. Lo-Cap

Model VT-1 — fully wired and calibrated, housed in handsome hammertone finish steel case, complete with MULTI-PROBE and thorough instruction manual covering all the applications in detail.

$58.50 Net



SIZE: W–14⅝" H–11¼" D–4⅜"

Model FC-2 — housed in hand-rubbed oak carrying case complete with CRT adapter

$69.50 Net

FAST-CHECK TUBE TESTER Model FC-2

Simply set two controls . . . insert tube . . . and press quality button to test any of over 700 tube types completely, accurately . . . IN JUST SECONDS!

Over 20,000 servicemen are now using the FAST-CHECK in their every day work and are cutting servicing time way down, eliminating unprofitable call-backs and increasing their dollar earnings by selling more tubes with very little effort. See for yourself at no risk why so many servicemen chose the FAST-CHECK above all other tube testers.

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

- Checks quality of over 700 tubes types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes, 0Z4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- Checks for inter-element shorts and leakage.
- Checks for gas content.
- Checks for life-expectancy.

SPECIFICATIONS

- No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers
- No annoying roll chart checking . . . tube chart listing over 700 tube types is located inside cover. New listings are added without costly roll chart replacement
- Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale
- 41 phosphor bronze beryllium tube sockets never need replacement
- 7-pin and 9-pin straighteners mounted on panel
- Large 4½" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out
- Special scale on meter for low current tubes
- Compensation for line voltage variation
- 12 filament positions
- Separate gas and short jewel indicators
- Line isolated — no shock hazards
- Long lasting etched aluminum panel.

NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

CONVENIENT TIME PAYMENT PLAN — NO FINANCING CHARGES

ALL CENTURY INSTRUMENTS ARE GUARANTEED FOR ONE FULL YEAR

The extremely low prices are made possible because you are buying direct from the manufacturer.

CENTURY ELECTRONICS CO., INC.

CHECK INSTRUMENTS DESIRED

- ☐ Model CT-1 In-Circuit Condenser Tester $34.50 — $9.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model MC-1 Mini-Check Tube Tester $39.50 — $9.50 within 10 days. Balance $6 monthly for 5 months.
- ☐ Model SRT-1 In-Circuit Rectifier Tester $29.50 — $4.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model TT-2 Transistor Tester $24.50 — $4.50 within 10 days. Balance $5 monthly for 4 months.
- ☐ Model VT-1 Battery Vacuum Tube Volt Meter $58.50 — $14.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ Model FC-2 Fast-Check Tube Tester $69.50 — $14.50 within 10 days. Balance $11 monthly for 5 months.

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denly changed into a place filled with mystery and menace in the dark.

As the little campfire flickered bravely, grotesque shadows leaped and fell amid the surrounding bushes. The tall trees seemed to lean in and tower threateningly over the two boys. The deathly stillness was broken only by strange chirps and cries and the rustling of the fallen leaves.

"Kinda spooky, ain't it?" Carl said, as he hugged his knees and threw back his head to peer through the openings in the leaves at the stars twinkling overhead.

"Yeah," Jerry agreed. "I suppose those are squirrels and field mice we hear out there—"

He was interrupted by the thud of a heavy body striking the earth somewhere out beyond the ring of light cast by their fire, and this was followed by what sounded like a muffled human curse.

"Field mice are pretty b-b-b-big around here, aren't they?" Carl stammered in a hoarse whisper.

Jerry didn't answer. Attracted by some sound from the river below, he walked over to the edge of the cliff and looked down. Carl was right behind him, and as he looked over his chum's shoulder a sound of surprise escaped him. A circle of bright white light was moving slowly along the surface of the water.

"What do you know!" Carl exclaimed in a whisper; "underwater flying saucers!"

Before Jerry could answer he was frozen

announcing

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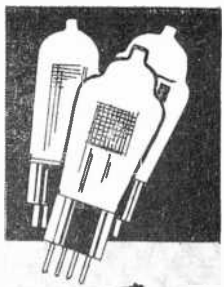

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1C7	3Q4	6AH4GT	6BE6	6CQ8	6SF7	7C4	12AV7	12V6GT	43
1F4	3S4	6AH6	6BF5	6CR6	6SG7	7C5	12AX4GT	12W6GT	45
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1R5	5AN8	6AQ7	6BN6	6DQ6	6T4	7F8	12BE6	19BG6G	58
1S5	5AT8	6AR5	6BQ6GT	6F5	6U8	7G7	12BF6	19J6	71A
1T4	5AV8	6AS5	6BQ7	6F6	6V6GT	7H7	12BH7	19T8	75
1U4	5AZ4	6AT6	6BR8	6H6	6W6GT	7N7	12BQ6	24A	76
1U5	5BR8	6AU4GT	6BS8	6J4	6X4	7Q7	12BR7	25Z6GT	77
1V2	5J6	6AU5GT	6BY5G	6J5	6X5GT	7S7	12BY7	26	78
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3A4	5V6GT	6AW8	6CD6G	6N7	7A6	12A8	12K7	35C5	
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by the clutch of a huge hand on his shoulder.

"Be quiet!" a man's voice whispered gruffly. "I'm the game warden, and the light you see is on the boat of a couple of guys who are illegally spearing fish. I saw your fire and thought you boys might be connected with them until I sneaked up and heard you talking. I tripped over a root out there in the darkness and darned near broke my neck. Did you hear me?"

"Did we!" Jerry quavered. "Mister, don't *ever* sneak up and grab me like that again. If you hadn't got a good hold on me, I'd have jumped right off that cliff."

"I'm sorry," the warden said, "but I was afraid you'd call out or something and scare the giggers away. Now I'm going back to my car and radio for help. We'll catch those two red-handed."

"We're going along," Jerry announced. "You've spooked us until we're afraid to stay here alone."

THE CAR parked along the road at the foot of the hill was easy to spot because its courtesy light was shining out the open door.

"Oh, oh!" the warden exclaimed; "someone's been here. I never left that door open."

Someone *had* been there; and that someone had ripped out the speaker from beneath the dash, had broken off the little whip antenna protruding from the roof, and had stolen the distributor rotor from the engine.

"The spearers did this," the warden said bitterly. "Those two are always armed and know I can't take them by myself. They wrecked my radio and crippled my car to make sure I don't get help. The transmitter and receiver are locked up in the trunk out of reach, but their making off with the speaker and breaking the antenna puts both units out of commission anyway. Now they're out there slaughtering all kinds of fish just for the fun of it—they only keep about one fish in ten they kill with the gig—and they're laughing at me, knowing I can't do a thing about it."

"I'm not so sure," Jerry said as he used the warden's flashlight to peer beneath the raised hood. "You got any tools?"

The warden unlocked the trunk and brought out a small tool box.

"Here, Carl, use these pliers to cut a strand of wire from that old fence," Jerry

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ordered as he traced some figures in the sand with his finger. "Let's see: this rig works somewhere around 154 megacycles. A quarter-wave antenna in inches equals 2770 divided by the frequency in megacycles, or about eighteen inches. Cut a piece of wire that long according to the steel tape and tape it to the stub of the antenna on the roof."

"You going to transmit blind? You won't be able to hear without a speaker," Carl pointed out.

"I'm going to try to use one of the car horns for a speaker," Jerry's muffled voice came from where he was upended across the car fender as he unbolted a horn mounted behind the grille.

IN A FEW MINUTES the makeshift antenna was in place and the auto horn was lying on the front seat and was connected to the broken speaker leads. Jerry handed the mike to the warden. "Let's try it," he said.

The warden pushed the button on the mike, and the dynamotor could be heard whirring in the trunk. He gave a short call for the sheriff's office and released the transmit button. Instantly an answering voice, far away and tinny but perfectly intelligible, came from the horn.

"It's not exactly hi-fi, but it works!" Jerry gloated.

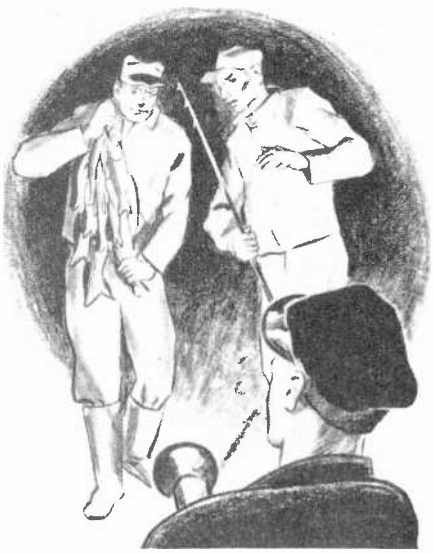
Quickly the warden explained the situation. Arrangements were made for the sheriff to come out and help capture the poachers. A game warden and sheriff from an adjoining county were to approach on the other side of the river to cut off possible escape that way. "And bring me another rotor for my distributor," the warden said as he signed off.

While waiting for the sheriff to arrive, the warden and the two boys scouted up and down the river bank until they located the boat trailer well hidden in some bushes. That told them where the fish-giggers would land, so when the sheriff arrived an ambush was quickly organized. They were none too soon, for almost immediately the bright circle of light that the boys had seen once before now appeared around the edge of the bluff and came directly toward them.

As the light approached, the boys could see that two gasoline lanterns were mounted on a platform fastened to the front of the flat-bottomed boat right at

the water level. A curved hood of sheet aluminum kept the light from the eyes of the spearwielder standing on the front of the boat. The man at the rear of the boat poled it silently toward the shore.

The sheriff and warden waited until both men were on the bank, one carrying the spear and the other a big string of fish, when they turned a spotlight on them and



ordered them to surrender. The man with the gig tried to hurl it back into the river, but the warden was too quick for him and grabbed it. In a matter of minutes the men were handcuffed and ordered into the sheriff's car.

"If you boys are afraid to stay out here, you can ride back to town with me," the warden offered. "We certainly owe you a lot more than that for the help you gave us tonight."

"Aw, we're not scared now," Carl said. "I'm just shaking because this night air is turning chilly. But could we borrow your flashlight to find our way back to our tent?"

SOON the two boys were snuggled beneath their blankets watching the dying embers of the camp fire through the open flap of their tent.

"Well, Carl," Jerry said as he smothered a huge yawn, "we got away from electronics for a little while, anyway."

"That we did," Carl answered drowsily; "but electronics found us, even away out here." —30—

Inside the Power Amplifier

(*Continued from page 60*)

to 1 — to match for example, a 4-ohm speaker to 10,000-ohm power tubes.

Feedback Loops. Despite every effort to keep distortion out of the amplifier, it always creeps in. The feedback loop is added to bring the distortion down to an acceptable level. The loop usually starts at the secondary of the output transformer and goes to the cathode of the input tube as indicated in Fig. 3. The amount of feedback is a function of the ratio of *R1* to *R3* and also of the gain inside the loop. In the highest quality amplifiers, designers aim for about 20 db of feedback; but even the most modest hi-fi amplifiers have 14 db.

Feedback is usually taken from a single tap on the secondary of the output transformer. At least one manufacturer, however, goes a little further. In Marantz amplifiers there is a separate loop for each tap to guarantee equal stability with speakers of various impedances.

Phase Correction. Feedback is worse than useless unless the amplifier is stable under operating conditions. It is almost always necessary to "trim" the feedback loop to obtain adequate stability.

The problem is to keep the feedback in the negative feedback loop from turning positive at extreme frequencies and causing a peak in the response curve, usually at some supersonic frequency between 20 kc. and 200 kc. If a peak is present, the amplifier will "ring" or may even go into outright oscillation at the peak frequency.

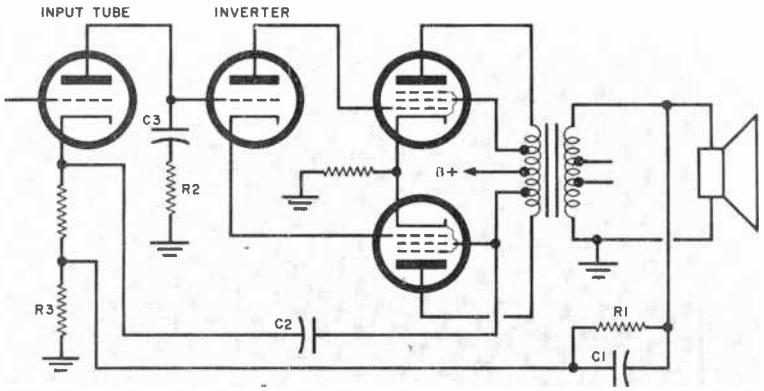


Fig. 3. Simplified diagram of feedback amplifier. Parallel circuit of R1 and C1 is primary feedback path. Additional "trimming" is provided by C2 and bypass network of R2 and C3. Note that components not essential to feedback operation are omitted for the sake of clarity.

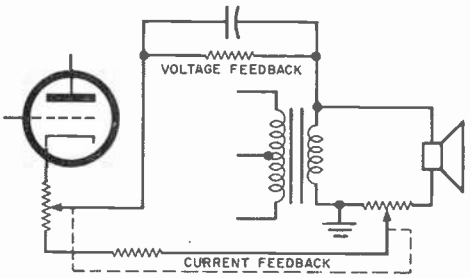


Fig. 4. Ganged potentiometers allow varying the damping factor of the amplifier without affecting the amount of feedback.

A 10- or 20-kc. square wave, as observed on a scope, gives a good indication of stability. In a perfectly stable amplifier the top of the trace should be flat. An unstable amplifier produces traces with jagged tops which indicate ringing.

An easy way to trim a feedback loop is shown in Fig. 3. By inserting a small capacitor (*C1*) in parallel with the feedback resistor (*R1*), the feedback remains truly negative over a wide frequency range. The value of *C1* is usually selected by observing a 10-kc. square wave on an oscilloscope and then trying various values until the best possible square wave is produced by the amplifier.

Sometimes additional trimming is needed. The Dyna amplifier obtains extra

trimming by putting an "inner" feedback loop inside the over-all loop, from the screen of one of the output tubes to the input cathode. This loop consists of capacitor *C2*, which rolls off the gain at the frequencies that are causing trouble.

Another way to obtain this roll-off is by inserting a bypass or "step" network inside the feedback loop to bypass the troublesome frequencies to ground. This is the function of *R2* and *C3* in Fig. 3.

Damping Factor. The greater the feedback factor, the more the amplifier damps a loudspeaker. A certain amount of damping is highly desirable to remove peaks in the speaker response and to improve the transient response. But too much damping may reduce the bass efficiency of some speakers and result in a "dead" tone.

Actually, while every speaker has a critical or optimum damping factor, there is a great deal of controversy as to the objective necessity for adjusting an amplifier to it. In any case, an amplifier's damping factor can be adjusted by using a second feedback loop to provide *current* feedback which, while it also decreases distortion, has the effect of decreasing damping instead of increasing it. By varying both the voltage and current feedback loops with a ganged pot, as in Fig. 4, simultaneously but in opposite directions, it is possible to keep the over-all feedback factor constant but provide a wide variation in damping factor. Many amplifiers provide such a damping control.

Five or ten years ago, the true hi-fi fan looked with scorn on any power amplifier that wasn't built on two chassis, had fewer than eight tubes, and weighed less than 30 pounds per chassis. Nowadays amplifiers have been greatly reduced in size and complexity, and due to the availability of new tubes and output transformers, they outperform their predecessors handily.

Price has also been brought down considerably, and one well-known amplifier kit offers hi-fi output at a cost of less than a dollar a watt. We don't know what the future holds in store for us, but if improvements in amplifier design continue at the pace of the last ten years, the amplifiers of the future should approach perfection.

Be sure and join us next month for a discussion of hi-fi tuners. If you own a tuner, or are planning to buy one, you should find "Inside the Hi-Fi Tuner" of considerable interest. —30—

On the Citizens Band

By TOM KNEITEL, 2AØ3Ø5

IN RECENT months there has been a heap of interest in the new 27-mc. (11-meter) Citizens Band. Along with the interest, there has been a big cloud of dust kicked up by manufacturers eager to get their CB equipment on the market, with new rigs appearing faster than you can say "transceiver."

The prospective CB'er therefore has many sets to choose from before deciding which rig is the one for him. If you are going to contact only your Uncle Elmer's set, you need not worry about having a tunable receiver. If you intend to work various stations which may or may not be operating on your own frequency, you will want a tunable job.

Transceivers made by International Crystal are available in either version. Others, like Gonset and RCA models, send and receive on one channel. Globe, Polytronics, and Multi-Elmac sets send and receive on 3-, 4-, and 5-crystal controlled channels (respectively). The soldering gun crowd will be pleased to see a number of kits on the market, with many of the major circuits pre-wired.

Of the kits available, we just recently tried out the one made up by Essco. This kit is based generally on the Stoner unit shown in the March RADIO & TV NEWS, plus several improvements.

Using a ground plane antenna on top of a 15-story building, we grabbed off an S-5 report from a station over 20 miles distant. We worked a solid S-8 contact with a station 15 miles away in a valley, and also snagged numerous local boys who reported that we were making them jealous with our ferocious signal. We then tried just a mobile whip on the window sill on the first story and had reliable contacts over five miles away. This set is a peewee in size, but it's packed with power.

One of the big things in CB is going to be antennas. With everyone running five watts, the deciding factor in signal

strength will be what happens to the signal when it leaves the transmitter's antenna posts.

From our preliminary experiments with antennas, we found that height is a big factor in tossing the signal into the ether. Not that without the height you should throw in the towel, but a little altitude will give you that extra zing. Of course this relates mainly to "ground wave" contacts. When "skip" conditions are right, you'll be able to knock off stations hundreds of miles away even if you operate from the bottom of a well.

Station activities in New York are progressing nicely. Most of the stations are active on the lower CB channels (Channel 1 through 7), with just about everyone raising a squawk about the periodic diathermy noise which wipes out a handful of channels at a clip. There is also a c.w. station somewhere which sort of murders the CB Channel 4 (27.005 mc.) with some regularity when the band is "open."

The most convenient way to calibrate your receiver if you live in New York is to line it up with what is lovingly known as "Boop-Beep." This is an R/C signal with a real loud carrier on 27.255 mc.

In the area of New York City, the biggest CB signal is 2W1352, operated by Fred Turner in Brooklyn. Fred keeps his transmitter tuned to the teeth, with nary an ounce of signal lost en route to his antenna, which happens to be a ground plane on the roof of Fred's house.

The local "ground-wave" distance record for a two-way contact is held by, of course, 2W1352, who worked Bob, 2W1409, in Franklin Lakes, N. J., about 25 miles as the carrier flies.

The best signal from out of town has been 19W1552, ably run by Joe Baznik in Cleveland, Ohio. Joe has been heard in New York several times during the past few weeks with an S-7 signal.

A word to the wise should remind CB'ers that they are *not* allowed to work Canadian hams, who are still quite active on 11 meters. CB stations are allowed to QSO only other CB stations, and this doesn't include VE's, no matter how tempting they are.

If you are now on the air, or if you just listen on 11 meters, we would like to hear from you. Tell us about your station, your antenna, your contacts (or stations heard), and the general 11-meter activity in your area. —30—

products

(*Continued from page* 38)

ard 2-conductor phone plug, $1.90. Two phono jack connectors in parallel with a

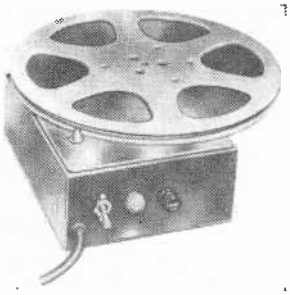
standard phono plug, $1.75. All adapters are completely shielded.

9-VOLT TRANSISTOR BATTERIES

Two new 9-volt transistor batteries are being made available by *Olson Radio Warehouse,* 260 South Forge St., Akron, Ohio. Model BA-48 is 1" in diameter and 2" long including terminals. Model BA-50 is 1 5/16"x 1"x⅝". Both have snap-type polarized connectors. These batteries are designed for use in all types of miniaturized transistor equipment.

BULK ERASER FOR MAGNETIC TAPE

Lafayette is offering a professional-type bulk eraser for all magnetic recording tapes. This heavy-duty degausser will handle any reel up to 10½" in diameter. The field generated is strong enough to erase any tape without rewinding or turning the reel over.



In operation, the reel is placed on the degausser, rotated until each segment of the reel passes over the field area several times, then lifted off slowly to a distance of six or more feet. The demagnetizer is then switched off and the tape is ready for re-recording. List price, $21.50. (*Lafayette Radio,* 165-08 Liberty Ave., Jamaica 33, N. Y.)

PLUG-IN INVERTERS

A line of d.c.-to-a.c. inverters ideally suited for use in automobiles is being offered by *American Television and Radio Co.,* 300 East 4th St., St. Paul, Minn. These inverters are for operation with 6- or 12-volt d.c.

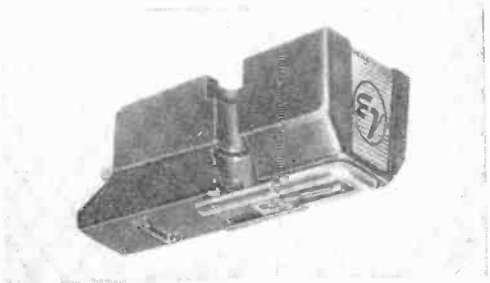
inputs and provide enough power output to operate tape recorders, record players, and other small electrical devices from the cigarette lighter receptacle found in most automobiles. There is a plug-in attachment for easy connection to the lighter receptacle. List prices are from $19.95 up, depending on the power-handling capacity required.

FIVE-PIECE PLIER SET

Kraeuter & Co., Inc., 583 18th Ave., Newark 3, N. J., is marketing a 5-piece set of pliers consisting of an electrician's side cutter, heavy-duty diagonal, all-around diagonal, chain nose with cutter, and chain nose hobby plier. A metal bracket which fits home workshop peg-boards is supplied with the kit. Price, $16.40.

"MAGNERAMIC" STEREO CARTRIDGE

A newly designed ceramic stereo cartridge has recently been announced by *Electro-Voice, Inc.*, Buchanan, Mich. The "Magneramic 31" features a built-in printed circuit which converts the output to a velocity curve. This enables direct plug-in to magnetic phono inputs. Frequency response is from 20 to 20,000 ±2 db, channel separation is 28 db at 1000 cps, and vertical



and lateral compliance is 3.5 x 10^{-6} cm/dyne. Recommended tracking weight is 2—4 grams. Available with 0.5-mil or 0.7-mil diamond styli. Net, $24.00. —30—

Transistor Topics

(*Continued from page* 102)

sistor interchangeability chart, and many complete schematics of commercially built transistorized gear—ranging from single-transistor preamps to multi-band short-wave receivers. Included, too, are numerous schematics of special-purpose transistorized equipment, such as a short-wave converter, phono oscillator, transistorized photoflash, lamp flasher, and test instruments. For price and delivery information, contact your local parts distributor or write directly to Coyne.

F.A.T. Transistors. In the past, transistor manufacture has been largely a hand operation, in contrast to the fully automatic methods used in the production of vacuum tubes. This, in part, accounts for the relatively higher price of transistors versus tubes. However, the Lansdale Tube Company (division of Philco Corporation) has recently installed semi-automatic production equipment which greatly speeds up the manufacture of high-frequency transistors.

Using this equipment, nine operators can turn out 450 transistors per hour—or, with two shifts working, up to 1,000,000 transistors per year. The components are moved from one processing station to another using rapid automatic transfer techniques, with the result that the system has been dubbed a "F.A.T." line (for Fast Automatic Transfer).

Product News. The Heath Company (Benton Harbor, Mich.) has introduced a transistorized code practice oscillator kit. Designed specifically for Boy Scout groups and beginning radio amateurs, it uses a single transistor and is powered by two size "C" cells. A panel switch allows selection of either the built-in loudspeaker for tone operation or a blinker light indicator for silent practice.

The "in-circuit" transistor tester recently developed by Philco Corporation is now being produced by a Philco subsidiary, Sierra Electronic Corporation (Menlo Park, Calif.). This instrument permits a check of transistor *beta* to an accuracy of 5%, accomplished in almost all cases without removing the transistors from their circuits.

Argonne Electronics Manufacturing Corporation (165-11 South Road, Jamaica 33, N. Y.) has a new six-transistor personal-

sized receiver. Available through the nearly 700 Argonne distributors across the nation, the AR-800 is supplied complete with battery, a personal magnetic earphone, and a leather carrying case. Covering the standard broadcast band, it features push-pull output to its built-in PM loudspeaker.

From CBS-Hytron comes news of a series of *n-p-n* power transistors to complement their well-known *p-n-p* line. This will permit the design of power amplifiers using complementary-symmetry configurations and the construction of high-gain direct-coupled complementary control and instrument amplifiers. For technical data and price information, write directly to CBS-Hytron at Lowell, Mass.

Burgess Battery Company (Freeport, Ill.) and the Sonotone Corp. (Elmsford, N. Y.) have both announced a complete line of hermetically sealed nickel-cadmium batteries. These are *rechargeable* units especially suited to the design of transistorized receivers, amplifiers, and other equipment. Included are units which are the same size as popular mercury cells and penlight and flashlight batteries as well as higher voltage assemblies.

That does it for now, fellows. See you next month. . . .

Lou

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Ignition System Tune-Up

(*Continued from page 93*)

standard types of distributors used in other cars.

The cam faces are lubricated by a wick. Never add any lubricant to it, but replace the wick whenever the contacts are replaced. Adjust it until the wick's end just touches the cam lobes.

Timing Indicator. A simple timing indicator will allow the timing to be set properly in accordance with the car manufacturer's recommendations. It shows that the points open at the proper time.

If the primary lead is disconnected from the distributor, a panel lamp of the same voltage as the car battery, with clip-leads attached, may be connected with one clip on the primary terminal and the other on the primary lead from the coil. This places the contacts in series with the bulb and acts as a switch to turn the light on or off as the contacts open or close.

The bulb may be mounted in a pilot-

light socket or the leads may be soldered directly to the bulb terminals. Test the bulb assembly by clipping it across the battery terminals. If it lights, it is ready to use.

Periodical Tune-Up. All cars, old or new, require a periodical tune-up if they are to function properly. A complete replacement of points need only be made about once a year, or about every 10,000 miles. Points should be cleaned, dressed smooth, squared off with a point file, properly gapped, and new gaskets installed at this time. To get best performance when most needed, replace plugs and points before a long vacation trip.

Trying to stretch the life of plugs and points is false economy, and you will find that proper maintenance of your ignition system will pay dividends by improving performance, economy, and your own driving disposition. —30—

Magnetize Your Tools

(*Continued from page* 98)

they were handy, too. Possibly, it might be better to use a heavy-duty barrier strip such as the Jones Type 2-150. Whatever you use, don't forget that you are dealing with very heavy currents in the discharge circuit. It would be a good idea to use wire in the discharge circuit as heavy as that in the magnetizing coil.

A neon lamp indicates when the capacitors are fully charged. Since the NE-2 will fire at around 75 volts d.c., it is tapped down a voltage divider composed of *R1* and *R2* so that it will not light until the voltage at the top of the divider reaches approximately 140 volts.

Adjustment. With the slider of the variable charging resistor, *R3*, set at maximum resistance, plug the magnetizer into a source of 117 volts a.c. Turn the unit on and place the knife switch in the *charge* position.

When the neon lamp indicates that the capacitors are charged, throw the knife switch to the *discharge* position. With a loud snap, the capacitors will discharge through the low-resistance coil, magnetizing the work.

The slider of *R3* should now be adjusted for an approximately ten-second charging time. The setting of *R3* will depend upon the number of capacitors used. —30—

The World Within the Atom

(*Continued from page 66*)

fly in the atomic ointment would be Einstein's famous equation $E = MC^2$ (energy = mass times speed of light squared).

According to Einstein, it is possible to change these two, mass and energy, into each other without a loss. The three-particle model of the atom could not mathematically explain how this is possible. Physicists were thus forced to the realization that there was more to the atom than the electron, the proton, and the neutron.

The first inkling that there was energy in the atom came about through the studies of Curie and Becquerel in the field of radioactivity. Three different types of radiation were found to be given off by naturally radioactive radium and uranium: *alpha*, *beta* and *gamma* rays. The *alpha* and *beta* rays were high-speed particles while the *gamma* rays were found to be powerful streams of energy with 100 times the penetrating power of *beta* particles.

Investigating these radiations in the light of Einstein's equation, physicists found that the energy given off did not balance with the loss of mass. In order for everything to balance, the Italian physicist, Enrico Fermi, suggested still another particle. This he called the *neutrino* or "little neutral one." Fermi theorized that the neutrino would have to be almost pure energy to make the scales balance. It would also be very difficult to detect because of its high speed and lack of charge and mass. It was finally found in 1956 through delicate atomic detective work, a major scientific triumph.

Atom Smashers. When the big "atom smashers" were built, scientists were given the necessary tools for probing the inner atom. There are many types of atom smashers, or particle accelerators, their scientific name. Among them are the cyclotron, the betatron, and the cosmotron.

Without going into detail on their operation, it is enough to understand that the atom smashers whirl ions of gas around in circular paths by electrical and magnetic means. These ions increase in velocity until they approach the speed of light. They are then deflected magnetically into an opening where they bombard the nuclei of substances under study. If you have ever whirled a stone on a string and had the

string break, you will understand the principle of an atom smasher.

With the aid of these giant scientific instruments, some of them filling huge buildings, more new particles were discovered. Many of these had been mathematically predicted—and now they were revealed. A particle was found which was the same as the electron, but opposite in charge: it was called a *positron* or positive electron. Then in the 1950's an important announcement . . . the discovery of *anti-matter*.

Anti-Matter. The French physicist, Dirac, mathematically concluded that each of the basic particles should have an opposite, or *anti*-particle. Four such anti-particles were found.

Anti-matter proved very difficult to detect because of its short life; the anti-matter particles combine with their opposites and annihilate each other almost instantly. *Gamma* rays equal to their former mass are given off. It is thought that anti-matter differs from its opposite only in that its magnetic poles are reversed, with each particle being considered a small magnet.

Mesons and Hyperons. Next, two other particles were found: the *meson,* whose existence was predicted by the Japanese physicist, Yukawa, and the *hyperon,* the most massive of all atomic particles. These are each actually families of particles, rather than single units. Mesons and hyperons are believed to act as a "glue" which binds the particles of the nucleus together.

Where do we go from here? Our 2500-year search for an understanding of matter is far from being finished. There is still no final model of the atom. Man has yet to find the complete answer to nature's atomic puzzle. —30—

"Mother! Mother! Gwen is on her way to the moon!"

Short-Wave Monitor Registration

Thousands upon thousands of POPULAR ELECTRONICS' Short-Wave Monitor certificates have been mailed to date and the end is not in sight. An SWL fraternity of over 10,000 has come into being in less than six months. Why not get on the bandwagon and register *your* listening station. Just fill out the form below and mail to: Monitor Registration, POPULAR ELECTRONICS, One Park Ave., New York 16, N. Y. Please include ten cents to help cover cost of mailing and processing your certificate.

(Please Print)

Name .....

Address ..... City ..... State .....

Receiver — Make ..... Model .....

Make ..... Model .....

Principal SW Bands Monitored ..... Number of QSL Cards Received .....

Type of Antenna Used .....

Signature ..... Date .....

Citizens Band Applicants

(*Continued from page* 54)

Communications Commission, Citizens Radio License Section, Washington 25, D. C. Do not mail it to your local FCC office. Processing time will be 60 - 90 days.

If, for any reason, you "goof up" your application, it will be returned to you. If you correct it and return it to the FCC in 30 days, it will be put in its original place in the processing line; otherwise it will be treated as a new application. When you make any changes on the returned form, it *must* be re-notarized. If the application is so badly "fouled up" that you have to make out a new one, be sure to include the original with the new application.

Follow These Rules. Here are a few important rules to which you should pay particular attention:

1. Profane, indecent, or obscene language is prohibited by law, and severe penalties are provided for violators.

2. You may *not* engage in either broadcasting (music, radio programs, etc.) or in communications for hire.

3. When you change your address, you *must* obtain a new license showing the new address.

4. The tip (or top) of your antenna may *not* exceed 20 feet above the ground, natural formation, or existing structure (building, water tower, etc.).

5. *You* are responsible for the manner in which your station is operated, regardless of who is actually operating it.

6. Your license can be revoked for failure to comply with the law and the FCC rules. Keep informed of changes in regulations.

7. Your radio equipment can *not* be used for any purpose contrary to federal, state, or local law.

8. Transmitter adjustments which might affect the proper operation of the station must be made by or under the supervision and responsibility of a licensed commercial operator holding a first- or second-class license.

9. Finally, remember that the Citizens Radio Service was set up to fill a need for a short-range personal or business communications service for the average citizen. It will work only if each user shows due regard for the rights of the other fellow. It is *not* a "no examination" ham service and it is *not* meant to be used by "rag-chewer" clubs or would-be DX artists. —30—

After Class

(*Continued from page* 104)

necessary for the antenna to operate properly and may be accomplished by simulating a ground condition at the base of the antenna through the use of a ground plane system (see Fig. 2).

In the ground plane system, copper wires cut to quarter wavelengths of the frequencies to which the antenna is tuned are attached radially, with wires of the same length opposite each other, to the base of the antenna mounting. They are insulated from the antenna's driven element and the roof but connected to a good earth ground and the transmission line shield.

In effect, the ground plane system provides a ground cut to specified wavelengths and then suspended in mid-air at the point where it is needed. In practice, ground plane radials generally act as supports for the vertical antenna mast as well as being part of the electrical installation.

Safety and Efficiency. A sound knowledge of basic ground theory and procedures is necessary for each person who works or experiments with electronic devices. Good grounding techniques assure the operation of electronic equipment at maximum efficiency and with minimum electrical shock hazard. —30—

FCC AMATEUR RULE CHANGE

Novice, Technician and Conditional Class amateurs can now be required to take an FCC-supervised examination whenever quiet hours are imposed on their stations. In the past only Conditional Class "mail order" licensees were subject to re-examination. The exact text of the new rule change is given below.

12.45 *Additional Examination for holders of Novice, Technician, or Conditional Class operator licenses.*

(a) The Commission may require a licensee holding a Novice, Technician, or Conditional Class of operator license to appear for a Commission-supervised license examination at a location designated by the Commission. If the licensee fails to appear for this examination when directed to do so, or fails to pass such an examination, the Novice, Technician, or Conditional Class operator license previously issued shall be subject to cancellation, and upon cancellation, a new license will not be issued for the same class operator license as that cancelled.

(b) Whenever the holder of a Novice, Technician, or Conditional Class amateur operator license is required by the Commission to restrict the operation of his amateur station, in accordance with the provisions of 12.152, 12.153, or 12.154, the necessity for such restriction shall be considered sufficient grounds to require the holder of the Novice, Technician, or Conditional Class license to appear for a Commission-supervised examination.

Short-Wave Report

(*Continued from page* 106)

Argentina—*R. Nacional,* LRA, Buenos Aires, operates as follows: to Central Europe on 15,345 kc. at 1400 in Spanish, 1500 in German, 1600 in Italian, 1700 in French, 1800 in English, and 1900 in Portuguese; to Eastern N.A. on 9690 kc. at 2100 in Spanish, 2200 in English; to Western N.A. on 9690 kc. at 2302 in Spanish, 0002 in English. Reports go to: *Radio Nacional,* Sarmiento 151, Buenos Aires, Argentina. They usually answer reports by registered mail. (*WPE3EK, BT*)

Ascension Island—This rare country can be heard at times between 0900 and 1100 when Cable & Wireless, Ltd. beams a single-sideband transmission to New York over ZBI235, 23,583 kc. This 5-kw. telephone station reportedly will QSL. (*TF*)

Belgium—Brussels may be noted daily except Wednesdays on 11,850 and 9655 kc. at 1930-2000. The 9655-kc. channel is the Leopoldville (Belgian Congo) relay station. Reports go to: The International Goodwill Station, P. O. Box 26, Brussels, Belgium. (*WPE9LF, WPE2RV, WPE3EK*)

Burma—Rangoon has been noted on 6035 kc. with ID at 0915, Eng. news from 1000 to 1015 s/off with fading. The 9640-kc. channel has not been heard lately. (*URDXC*)

The Rangoon outlet on 15,365 kc. also has news at 1000; it faded rapidly. The dual 11,765-kc. channel was not heard. (*MO*)

China—The latest schedule from Peking reads: to N.A. East Coast at 2030-2130 on 15,095 and 17,720 kc.; to N.A. West Coast at 2230-2330 on 15,115 and 17,745 kc.; to Asia at 0400-0430 and 0730-0800 on 11,820 and 15,095 kc., and at 1030-1100 on 15,060 and 17,675 kc.; to Oceania at 0400-0457 on 15,060 and 17,835 kc.; and to Europe at 1400-1500 and 1600-1700 on 9457 and 11,650 kc. They have a "Letterbox" on Sundays and also on Mondays. (*WPEØFA, WPE3EK, MR*)

Czechoslovakia—A late schedule from Prague reads: 1930-2000 on 9550, 11,745, 15,230, 15,285, and 17,895 kc.; 2200-2300 on 9550, 11,725, 11,745, 15,230, and 15,285 kc.; and 0333-0430 on 11,725, 17,795, and 21,450 kc. Answers to listeners are given on Saturdays at 2200, Sundays at 0330 and 1930, and Mondays at 0000. Notes for hams and SWL's are given on the first and third Friday of the month at 1930 and 0000 and on the first and third Thursday of the month at the same times. (*WPE5HO* and *WPE1JM*)

Denmark—Copenhagen currently radiates the following xmsns: on 9520 kc. at 2030-2130 and 2200-2300 to N.A. and at 1800-1900 (Mondays, Wednesdays, Fridays only) to So. America; on 15,165 kc. at 0400-0500 (Tuesdays, Thursdays, Saturdays only) to the Far East, Australia, and New Zealand; at 0900-1000 (Tuesdays, Thursdays, Saturdays only) to South Asia; at 1140-1240 (Tuesdays, Fridays only) and at 1240-1615 (daily) to Africa and the Mid-East. The latter xmsn is a Home Service program. A DX program is broadcast on Tuesdays from 2113 to 2138. (*WPE3EJ, WF, JM, RQ*)

Ecuador—New stations are as follows: HCMVI, *R. San Miguel de Ibarra,* Ibarra, 6215 kc., 250 watts; HCFK5, *R. Cuenca,* Cuenca, 6135 kc., 250 watts; HCXO1, *R. Otavalo,* Otavalo, 6115 kc., 250 watts; HCRQ2, *La Voz del Tropico,* Quevedo, 6030 kc., 200 watts; HCNF5, *R. Difusora del Ecuador,* Cuenca, 6020 kc., 250 watts; HCMH6, *Organizacion Radiofonica de Cotapaxi,* Latacunga, 5970 kc., 300 watts; HCRI1, *R. Centro Radiofonica Imbabura,* Ibarra, 5170 kc.; HCMV5, *R. Popular Independiente,* Cuenca, 5060 kc., 250 watts; HCPS5, *Ondas Canaris,* Azogues, 5030 kc., 250 watts; HCOB5, *Ondas Azules,* Cuenca, 5028 kc., 250 watts; HCGH1, *R. Tarqui,* Quito, 4970 kc., 300 watts; HCSJ1, *R. Javier,* Quito, 4950 kc.; HCUN2, *R. Unidad Nacional,* Guayaquil, 4025 kc., 200 watts; HCSM6, *R. Sira,* Ambato, 3975 kc., 200 watts; HCPZ1, *R. Rumichaca,* Tulcan, 3950 kc., 200 watts. (*WRH*)

El Salvador—A station with the ID *La Voz de Comercia* was found on 9544 kc. at 1930-1945 with music. This may possibly be the listed YSS on 9552 kc. (*VM*)

England—The current schedule from the British Broadcasting Corp. reads: to Canada, U.S. and Mexico at 1600-1845 on 17,715 kc., 1600-2115 on 15,310 kc., at 1800-2200 on 11,780 kc., and at 2100-2200 on 9825 kc.; to the West Indies, Central and South America (North of the Amazon) at 1500-1815 and 1845-1945 on 21,550 kc., at 1600-1815 and 1845-2200 on 17,810 kc., at 1800-1815 and 1845-2200 on 15,070 kc.,

SHORT-WAVE CONTRIBUTORS

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R. W. Robillard (*WPE1JM*), Holyoke, Mass.
William O'Brien (*WPE2RV*), Syracuse, N. Y.
Paul Buer (*WPE2UP*), Harrison, N. Y.
Richard Woodyatt (*WPE3EJ*), Scranton, Pa.
Richard Freeman (*WPE3EK*), Philadelphia, Pa.
George Cox (*WPE3NF*), New Castle, Del.
Royston Lawson (*WPE4EB*), Murfreesboro, Tenn.
Jerry Chouinard (*WPE5HO*), Dallas, Texas
William Flynn (*WPE6AF*), Pittsburg, Calif.
Rex Lundquist (*WPE6BO*), Los Angeles, Calif.
August Balbi (*WPE6CW*), Los Angeles, Calif.
J. Art Russell (*WPE6EZ*), San Diego, Calif.
George Crabb (*WPE8CQ*), St. Clair Shores, Mich.
Ray Bohnenstuhl (*WPE9LF*), Collinsville, Ill.
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Eugene Simpson (*ES*), Arlington, Mass.
Robert Schwartz (*RS*), Brooklyn, N. Y.
Butch Thornthwaite (*BT*), Huntsville, Ala.
World Radio Handbook (*WRH*)
Universal Radio DX Club (*URDXC*)

and at 1945-2200 on 11,750 kc.; to South America (south of the Amazon) at 1500-1945 on 17,870 kc., at 1600-2200 on 15,360 kc., and at 1800-2200 on 12,040 kc.; to South Georgia at 1700-1945 on 12,095 kc. Call signs are: GST (21,550 kc.); GRP (17,870 kc.); GSV (17,810 kc.); GRA (17,715 kc.); GSP (15,360 and 15,310 kc.); GWC (15,070 kc.); GRF (12,095 kc.); GRV (12,040 kc.); GVU (11,780 kc.); GSD (11,750 kc.); and GRH (9825 kc.). (*WPEØAE*)

SHORT-WAVE ABBREVIATIONS

BBC—British Broadcasting Corp.
Eng.—English
ID—Identification
kc.—Kilocycles
kw.—Kilowatts
N.A.—North America(n)
QSL—Verification
R.—Radio
s/off—Sign-off
s/on—Sign-on
xmsn—Transmission from station
xmtr—Transmitter used by station

Luxembourg—*R. Luxembourg*, 6090 kc., is scheduled in Eng. at 1300-1900 (to 1930 on Saturdays) with request records at 1300-1500 Monday to Saturday. (*WPE2UP, G2PE3Y, MO, LP, DR*)

Netherlands—The latest schedule from Hilversum reads: to Australia, N.Z. and Pacific Areas at 0400-0440 on 25,610, 21,480, and 17,810 kc.; to South Asia and Africa at 1045-1125 on 21,480, 17,810, and 15,455 kc. (and also on 6025 kc. to Europe); to Europe and N.A. at 1615-1655 on 17,810, 15,455, and 11,950 kc. (and also on 6025 kc. to Europe; and to N.A. at 2130-2210 on 11,950, 9745, and 6025 kc. A hobby session is aired on the third Friday of each month. (*WPE8CQ, WPEØBO, WPEØEM, WPE2RV, AC, CH, ES, RS*)

Norway—The 100-watt LLA, 25,900 kc., is noted with a good signal at 0600 s/on dual to LLN, 17,825 kc., LLP, 21,670 kc., and 15,175 and 11,735 kc. (*URDXC*)

Panama—HOLA, *R. Atlantico*, Colon, is noted on 9505 kc. with Eng. at 2100-2200 with news, pop music, and commercials. This program is not on the air Sundays. (*CM*)

Portuguese Guinea—A station believed to be CQM, Bissau, has been heard broadcasting on 3975 kc. from 1743 to 1756 with music and Portuguese announcements. Further checks are being made. (*WPEØAE*)

Rhodesia and Nyasaland—The Federal B/C Corp. is noted on 4911 kc. at a new time of 2300 with varied musical numbers, Eng. announcements, and frequent time checks. So far it has been noted on Sundays only. (*WPE3NF*)

Sierra Leone—The outlet on 3316 kc. has been operating on reduced power of 1250 watts, rather than the listed 5000 watts, with a single-wire dipole antenna. This information came from I. C. Griggs, Chief Engineer of the station. (*WPE6AF*)

South Korea—HLK29, Seoul, 17,745 kc., and HLK28, 15,410 kc., operate to Western N.A. at

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0030-0130, replacing 11,925 kc. Eng. is carried to 0100. (*WPE6CW, WPE6EZ, URDXC*)

Spain—Madrid can be well heard to N. A. on 9363 kc. at 2215-2300, 2315-0000, and 0015-0100. The dual channel is 6130 kc. (*WPE6BO, WPE2RV, CH*)

United Arab Republic—Cairo, 11,990 kc., carries Eng. to Europe at 1630-1730 with music, news, and concerts. (*WPE3EJ, WPE1AP, WPE2RV, PG, AN*)

Cairo's 17,920-kc. channel is heard well in Japan in Eng. at 0830-0928 with news from 0845. (*HK*)

Damascus is heard in Eng. on 15,165 kc. with news at 1615, and in German on 9555 kc. from 0045 to 0125 s/off. (*WPE2RV. WPE3EK*)

United States—The National Bureau of Standards, WWV, Boulder, Colo., has been conducting an extensive survey to determine the advisability of locating one xmtr in the central part of the U.S.A. This would be a unit of increased power that would enable the station to be heard throughout the service area at all times. (*WPE6EZ*)

USSR—Two stations noted recently are Khabarovsk, 9565 kc., weak at 1430 s/on, dual to 9376, but blocked by jamming from 1500 (also noted at 0600), and Magadan, 7270 and 9500 kc. at 0625 in Russian. (*WPE3NF*)

Vatican City—*Radio Vaticana* has Eng. daily at 1000 and 1315 and on Mondays and Wednesdays at 0530 and 1100 on 9660 and 11,740 kc. (*WPE3EK*)

Clandestine—The *Greek Voice of Truth,* is noted on 8067 and 9932 kc. at 0015-0030 in Greek; do not confuse this with *R. Espana Independiente.* A Caucasian Anti-Communist Alliance Station is heard on 8726 kc. with s/on at 2115 and the ID *Govorit Kavhaz;* beware of spurious 31-meter signals in this area. Another station is *Viva La Republica Dominica Liberacion,* noted on 14,352 kc. from 1930 in Spanish. (*WPE3NF, WPE4EB*)

Utility Stations—For three difficult countries to log, try the following: **Bermuda**—through the Coast Guard Station NOC on 2182 kc. at 2230-0000 (the ID is *Coast Guard Radio,* and if you want a verification, send a stamped reply card); **Libya**—try for Wheelus Air Force Base on 11,228 kc. around 1800-2000 (mail reports to 1950th AACS Squadron, APO 231, New York, and enclose a stamp); **Hawaiian Islands**—try for Hickam Field on 13,215 kc. at 0000-0300 (ID is merely *Hickam,* and reports go to Officer in Charge, USAF Aero Station, APO 953, San Francisco, Calif. with stamp enclosed). (*MC*)

—30—

CLUB NEWS

The Teen Shortwave Club (TSWC) is a year-old club with dues of $1.50 per year. Bulletins are currently being issued at one-month intervals. Report forms and various short-wave certificates are also available for members. Further details may be obtained from: David Schade, 2801 Pyramid Ave., Pittsburgh 27, Pa.

POPULAR ELECTRONICS BARGAIN BASEMENT

SAVE ON THESE SPECIAL BUYS OF THE MONTH

ONE CENT SALE

Buy One At Our Regular Low Price And Get The Second For Only 1c More

CITIZENS BAND TRANSMITTER (27 MC) chassis complete with crystal. $9.99 ea. two for $10.00.
TRANSMITTER similar to above but with 5 watt RF stage instead of ½ watt. $12.49 ea. two for $12.50.
CITIZENS BAND RECEIVER chassis tunable through all 22 channels. Complete with audio amplifier. $9.99 ea. two for $10.00.
AMATEUR BAND TRANSCEIVER (144-148 MC) chassis with dual VHF triodes for walkie-talkie radiophone. $9.99 ea. two for $10.00.
COILED CORD 4 conductor 11' telephone cord. Extends to over 4 ft. .99 ea. two for $1.00.
KIT OF PARTS for AM-FM VHF radio receiver. Tunable from 80-200 mc which includes U.S. satellite frequencies. $6.99 ea. two for $7.00.
SUPER SPECIAL: 25 watt 30 to 40 mc crystal controlled FM radiophone mobile transmitter with 8 tubes and dynamotor power supply. Orig. cost over $400.00. Can be converted to Citizens Band. Used good condition $24.99 ea. two for $25.00 F.O.B. Hollis N.Y.

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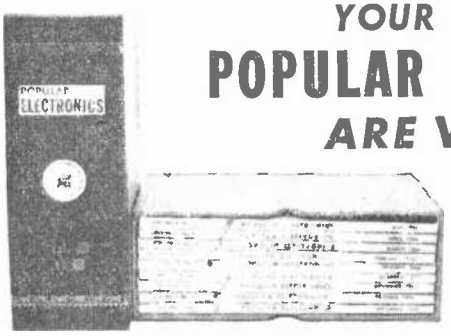

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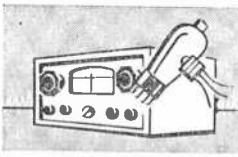

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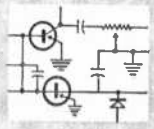

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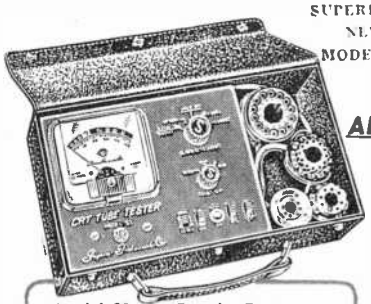

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From 50 degree to 110 degree types —from 8" to 30" types.

● Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes. ● Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types. ● Model 83 employs a 4" air-damped meter with quality and calibrated scales. ● Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode. ● Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition. ● Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

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Test ALL picture tubes—in the carton—out of the carton—in the set!

Model 83—C.R.T. Tube Tester
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Housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only **$38.50**

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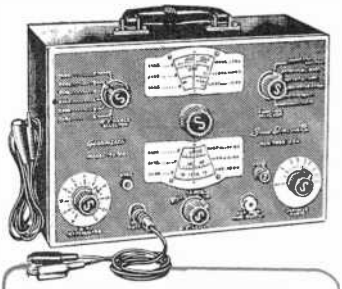
7 Signal Generators in One!



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This versatile All-Inclusive GENERATOR Provides ALL the Outputs for Servicing:

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Superior's New Model 82A

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TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
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3. Press down the quality button—

THAT'S ALL! *Read emission quality direct on bad-good meter scale.*

FEATURES:

• Tests over 600 tube types. • Tests OZ4 and other gas-filled tubes. • Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings. • Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence. • Dual Scale meter permits testing of low current tubes. • 7 and 9 pin straighteners mounted on panel. • All sections of multi-element tubes tested simultaneously. • Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

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Superior's New Model TW-11

STANDARD PROFESSIONAL TUBE TESTER

• Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity Fuse Types, etc.

• Uses the new self-cleaning Lever Action Switches for individual element testing. All elements are numbered according to pin-number in the RMA base numbering system. Model TW-11 does not use combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

• Free-moving built-in roll chart provides complete data for all tubes. Printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier detects microphonic tubes or noise due to faulty elements and loose internal connections.

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

Housed in hand-rubbed oak cabinet **$47.50 Net**

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Superior's New Model 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price

• Extra large meter scale enables us to print all calibrations in large easy-to-read type.

• Employs a 12AU7 as D. C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability. • Meter is virtually burn-out proof. The sensitive 400 micro-ampere meter is isolated from the measuring circuit by a balanced push-pull amplifier. • Uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

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AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading. Intermittents are easily found, isolated and repaired.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

SPECIFICATIONS

• **DC VOLTS**—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak)—0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER**—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS:** −10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

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SPECIFICATIONS:

● D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500. ● A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 ● D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes ● RESISTANCE: 0 to 1,000/100,000 Ohms, 0 to 10 Megohms. ● CAPACITY: .001 to 1 Mfd., 1 to 50 Mfd. ● REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms. ● INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries. ● DECIBELS: −6 to +18, +14 to +38, +34 to +58. The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings. All Electrolytic Condensers from 1 MFD to 1000 MFD. All Germanium Diodes. All Selenium Rectifiers. All Silicon Diodes. All Silicon Rectifiers.

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