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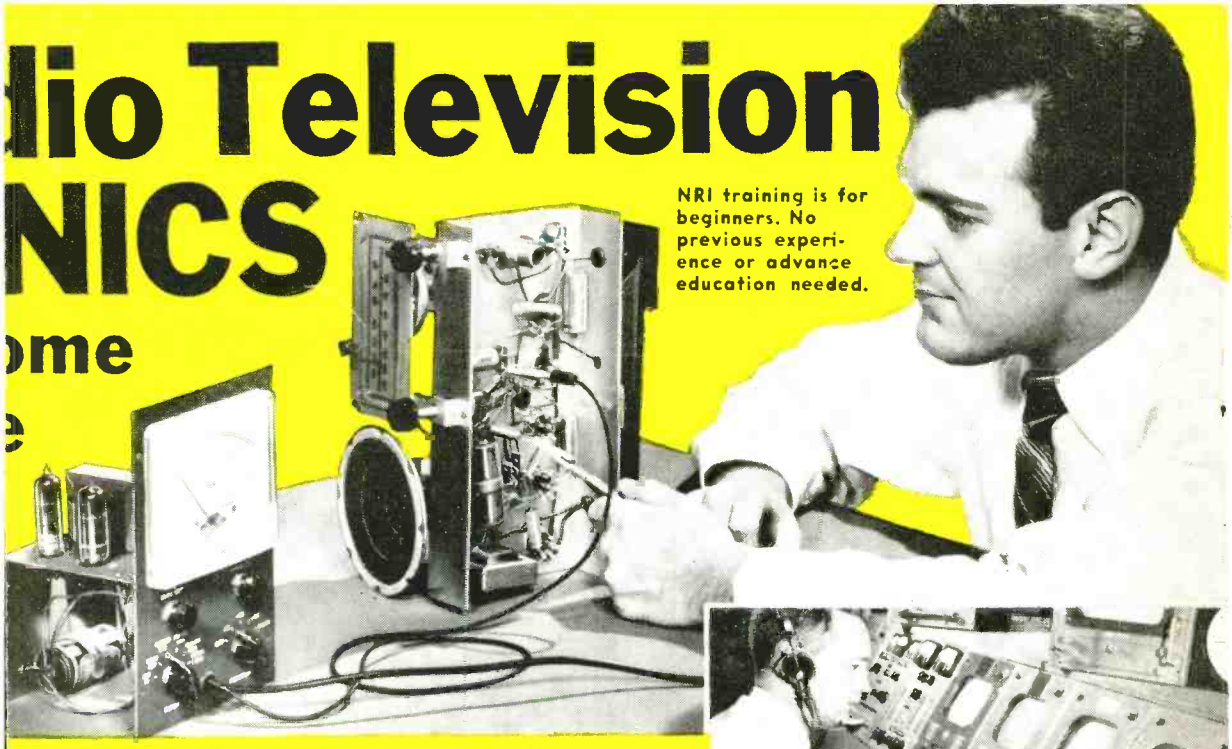

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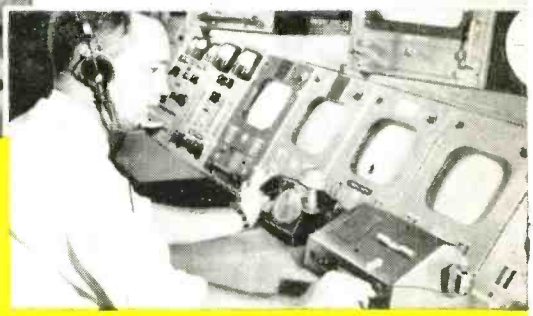
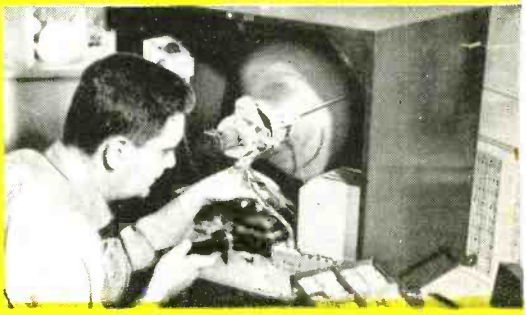


Need for Men Who Know Electronics Increasing



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ELECTRONICS ILLUSTRATED

June, 1960 Vol. 3, No. 6

A Fawcett Publication

CONTENTS

EI SPECIAL

FEATURES

BUILD-IT PROJECTS

Cover Photo by Daniel R. Rubin

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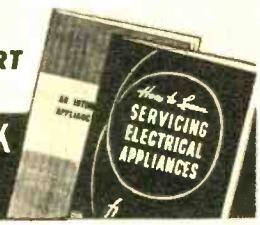

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A Message From the Editor

Some of the projects that will appear in the next issue of EI.

By now you've already seen our exclusive hi-fi test record on page 65 and perhaps even played it on your record player. We want your comments or questions relative to the use of this record or to the results you got on your hi-fi when using it. Write to us, that is what EI's Hi-Fi Clinic is for.

Incidentally, those of you who are interested in *electronic* music should read the article about the Theremin, starting on page 25 in this issue. Frankly, we are publishing this to arouse your interest and curiosity because we are now preparing a full-scale construction article on a Theremin for a future issue. We have been playing (?) it here in our office—sounds like a spook's convention!

It has been brought to my attention that many of our readers may not be aware of the intensive work that goes into our monthly kit reports. We are not a consumer-testing agency, but we use the same rigorous test methods they do. Every kit assembler is an authority on the type of equipment he assembles or works with a consultant who is. When the instructions furnished with the kit are easy to follow and instructive, when all the parts fit together well and the layout is so designed that the assembly is not tricky, when the finished product operates according to the manufacturer's published claims, and when the price for the kit represents a genuine saving over commercially assembled items with similar specifications, then we rate the kit as a "Good Buy." You realize, of course, that there are many new kits marketed every month; no magazine could hope to keep up with all of them. Therefore, we must select for our reports those kits which we think would be of greatest interest to you and which we feel warrant your attention. There are many kits of products which I am sure you would be interested in, however, we haven't reported on them because after careful investigation we don't think these will be worth your while to assemble. Either the instruction manual is inadequate, or the parts are inferior, or the assembled product tests out poorly. From time to time, however, we will report on such a kit, if in so doing

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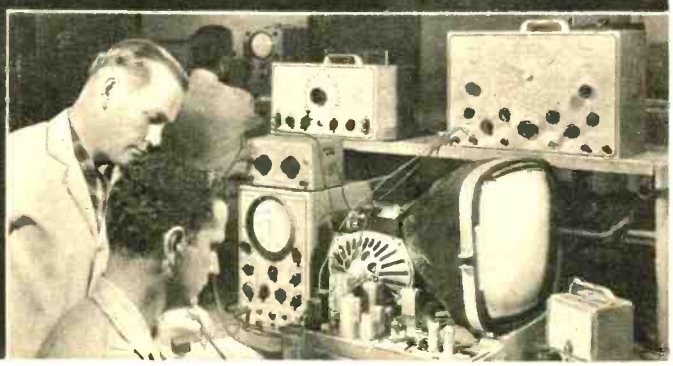
(Shown at left—Instructor explaining operation and testing of a large Motor Generator in our A.C. Department.)

TELEVISION RADIO ELECTRONICS

On Real:

- Television Receivers Black & White and Color
- AM-FM and Auto Radios Transistors—Printed
- Circuits—Test Equipment

(Right — Instructor helping students check the wiring and trace circuits of television receivers.)



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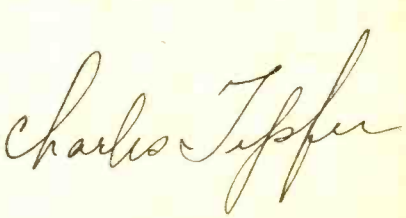
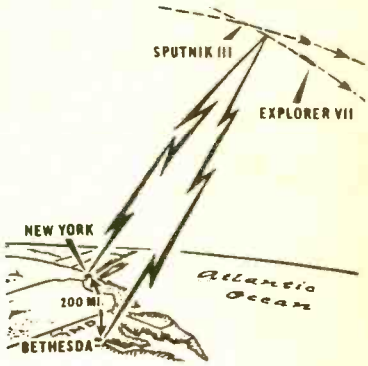
we can save many of our readers from a definitely unprofitable purchase. Ordinarily, however, most of the kits that we report on are good buys. We don't think there is much sense in telling you about the others. If you're interested in a specific kit let us know; we are making up our schedule for future reports now.

In past surveys of our readership we have come up with the stimulating fact that there is no typical *EI* reader: some are engineers, some are doctors, lawyers, students, some technicians, etc., etc. Oftimes some of our readers know more about a particular item or subject we describe than the author himself. Since this is so, and since we are constantly looking for new talent and new build-it-yourself projects, what makes more sense than to ask you, our readers, to become contributors. If you have any build-it-yourself project ideas and can develop them into articles for us, write to our technical editor. He'll tell you all about our style, requirements and payment (it is excellent).

Summertime is picture-taking time and there has been a quiet revolution occurring in photography. The new automatic cameras make picture taking easier than ever, and, of course, electronics is the magic genie behind it all. If you want to know how the new automatic still and movie cameras work, and if you are interested in building three original projects to make for better picture taking and picture making, be sure to read the special 16-page bonus section on photography in our July issue. Remember our 1-transistor FM receiver and 1-transistor AM receiver projects? If you do, you know what to expect from our 2-tube AM-FM stereo receiver coming in our July issue. Interested in building an electronics library at cut-rate prices? Read all about how you can do it in our next issue. Looking forward to seeing you then.



Electronics in the news



Two young amateur radio enthusiasts have accomplished a feat that to date scientists have been unable to match. They made a CW contact between New York and Bethesda, Maryland, a distance of 200 miles by bouncing their signals off the Earth satellites. Their moment of success came on their 35th try early February 6th when both Sputnik III and Explorer VII were in low orbit and passing at almost the same instant over the Atlantic Coast (See diagram above). Perry Klein 17 is shown with his ham gear; Raphael Soifer, a freshman at MIT, is the other half of this combination.

The eighth annual Edison Radio Amateur Award was presented to Walter Ermer, Sr., 51, for his outstanding public service in organizing and directing a 300-man emergency radio communications corps in Cleveland, Ohio. Their work during the Cuyahoga River flood in '59 is being reminisced by Ermer and a member of his corps. The two boys were among those rescued. Mr. Ermer is shown below accepting his trophy from L. Berkley Davis, a vice-president at GE, the sponsors of the award.

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"I had been in the radio-repair business for 30 years, when I enrolled in the I.C.S. Television Servicing Course.

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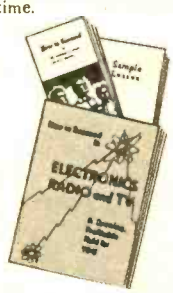

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. . . News

Leon M. Bablouzian, a technician at Arthur D. Little, Inc., has invented a device to enable blind people to bowl. The apparatus, consisting of a small box is mounted near the ball rack. The top of the box has small holes representing the position of the pins with pegs projecting through each of the holes when the pins are standing. As pins are knocked down, the corresponding peg is withdrawn. To enable the bowler to position himself, a flat rubber strip with position indicators is placed at the foul line.

—o—

In addition to processing information and deciding payment for services rendered, computers now talk to each other via regular toll telephone calls. IBM recently introduced the two 7701 Teleprocessing data machines. To get computed information from one place to another quickly, the operator places the data-filled tape reel on the 7701 and then dials the telephone number of the receiving location. Learning that data is to be sent, the receiving location operator verifies that the receiving terminal is prepared to record the transmitted data. As the operation begins, data passes at the speed of 150 characters a second from the 7701, through a modulating subset provided by the telephone company, through the communication circuits, to a demodulating subset at the other end and into the receiving 7701. The information may also be sent via telegraph.

. . . News

Yardney Electric Corp. has manufactured a silver-cadmium portable TV battery capable of more than 2,000 hours of operation. The 8-cell power pack, is rated at 5 ampere hours. Complete information available from Yardney, 40-50 Leonard Street, New York, New York.

—o—

For TV watchers who do not like to leave their comfortable seats, Admiral Corporation has developed a new transistorized remote control amplifier. It incorporates seven transistors and one power diode, no tubes, or batteries. The advantage of this unit is that it doesn't have to be activated nor shut off at the TV set itself as did previous models. The Super Son-R transmits an ultrasonic signal from the small two-button hand remote control unit which activates the TV set, changes channels, adjusts the volume and shuts the set off. Perfect for bedside TV's.

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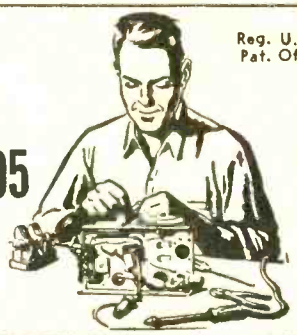

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You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 16 Receiver, Transmitter, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will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

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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.

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J. Stataitis, 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."

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. . .News

A device which will allow America's first orbiting astronaut to determine his position over the Earth at any time is being designed by Minneapolis-Honeywell. It consists of a small globe-like replica of the Earth which revolves slowly to duplicate the position of the Earth under the orbiting capsule. Mechanically powered, the Earth Path Indicator will be the prime source of position information for the astronaut should he lose contact with the ground stations.

—o—

Eric Engineering Company has unveiled a new dual channel amplifier priced at $103.70 (East), $99.95 (West). The "Dual Twenty" is an ultra-linear amp-preamp with 20 watts per channel incorporating the usual stereo controls and inputs. The nearly identical "Dual Ten" lists for $79.95.

Another of Eric's new products is the Auto FM tuner. Model FM 100 operates on any car with a 12-volt battery through the regular car radio and speaker. It is installed under the dash. Priced at $79.95 from Eric, 1823 Colorado Avenue, Santa Monica, California.

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	License	Weeks
Richard M. Wilhoit, 2104 Santa Paula, Las Vegas, Nev.	1st	12
Larry R. Perrine, 7 Normandy Place, Champaign, Ill.	1st	15
Marion Woolsey, 3246 Warwick, Kansas City, Mo.	1st	12
Harold W. Johnson, 5070 Hermosa Ave., Los Angeles, Calif.	1st	15
Ralph Frederick Beisner, 2126 Grand, Joplin, Mo.	1st	12
N. B. Mills, II, 110 So. Race St., Statesville, N.C.	1st	12
Dean A. Darling, 403 S. Chase Ave., Columbus 4, Ohio	1st	12
Gerald L. Chopp, 518 Audubon Road, Kohler, Wisc.	1st	12

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. . . News

The RE-400, a new dual speed tape recorder has been announced by Lafayette. A single knob controls all operations (stop, play, etc.) and an indicator light shows optimum volume control setting. Outputs for another speaker, recording from microphone or phonograph are provided. Playing speeds are 7½ and 3¾ ips. Priced at $54.50 complete with crystal microphone from Lafayette, 165-08 Liberty Avenue, Jamaica 33, New York.

—o—

The Pony, a rechargeable battery and plug-in charger for transistor radios has been made available by B & K Manufacturing Co. It can replace the 9-volt battery used in most transistor radios. Price for both battery and charger is $4.95 from B & K, 1801 W. Belle Plaine Avenue, Chicago 13, Illinois.

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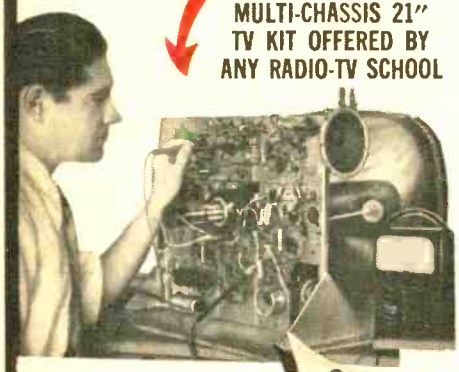

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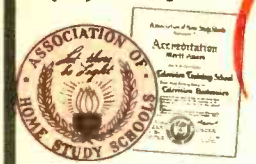

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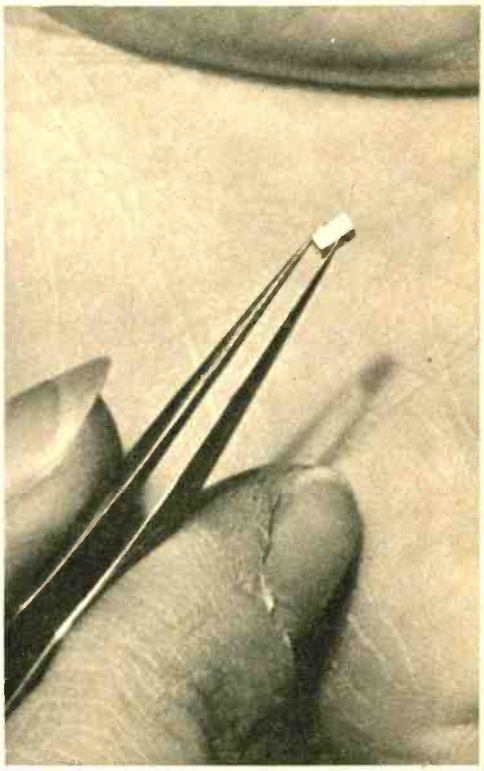
. . . News



General Electric research scientists have successfully made tunnel diodes which work at frequencies above 4000 megacycles. Key to the improved performance is the use of gallium arsenide, a little known and rarely used semiconductor material, as the basic element in the device's construction. Frequencies well above 10,000 megacycles are possible with tunnel diodes made of gallium arsenide.

—o—

Now computers not only do a job, but figure out how much they should be paid for their services. Heretofore, the computers were paid on an hourly basis, but at the RCA Electronic Systems Center on Wall Street in New York City, the stipend will be determined by the amount of work involved which is decided by the computer itself. RCA said the computer method would permit a saving of up to 50 per cent of present accounting costs.

. . .News

This new compact battery-operated tube tester is quite versatile. Only 3¾″ x 6″, the unit will test most tube types and circuits for continuity. In addition it will check out high voltage circuits, fuses and pilot lamps. Priced at $6.95 from Empire Merchandising Co., 170 Marbledale Road, Tuckahoe, New York. The tester is manufactured by Darod Electronics, Inc., Mt. Vernon, N. Y.

—o—

The whispers in the wind can now be heard with the help of microphones no larger than a letter of type on this page. Prof. Erik L. Moloo-Christensen of M.I.T. and his associates are assembling apparatus that will enable them to add known sounds at known temperatures and pressures to the air. The researchers hope to find out what becomes of the added sounds. They want to learn how jets and rockets carry and scatter their noise. In addition to the new tiny microphones, wires so fine they are difficult to see with the naked eye will be incorporated into the apparatus.

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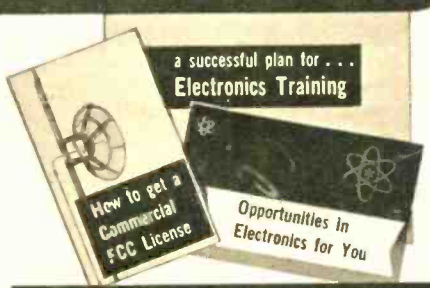

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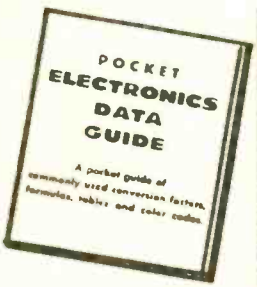

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In what branch of Electronics are you interested?

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City Zone State

EI-21

The wind can power this auto if the sun doesn't. The sail-like panel mounted atop this 1912 Baker electric is composed of 10,000 silicon solar cells which catch the sunlight and through the conversion system, power the auto. Although charging the 72-volt battery may take over 10 hours, the car's 3 hp motor is capable of running at a speed of 20 mph for almost 50 miles. Needless to say, improvements will be made. The conversion system was designed by Dr. Charles A. Escoffery of M.I.T. and the actual car was created by International Rectifier Corporation, a manufacturer of silicon cells. Mass production for a consumer market is expected.

—o—

Computer automated checkout systems for supermarkets are now in design stages. First, the Keedoozle, involves the customer inserting a special key into a case slot below the desired item and the tape in the key is punched. At the checkout stand the tape is inserted into the reader which activates a chute in the warehouse bringing the merchandise to the front. The Auto-Serve system works by having the customer take a punched card at the merchandise display and present the cards at the checkout stand where they are run through a reader and the merchandise is handled as above. In addition to speed, an automated system must allow the customer to see the cost of the items being rung up and issue an itemized receipt

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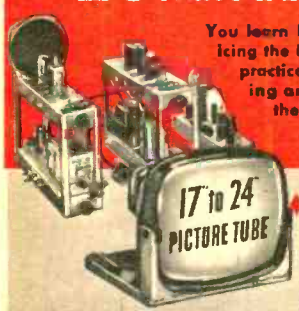

The new Sprayberry Training Television Receiver, built and tested in 5 sections.

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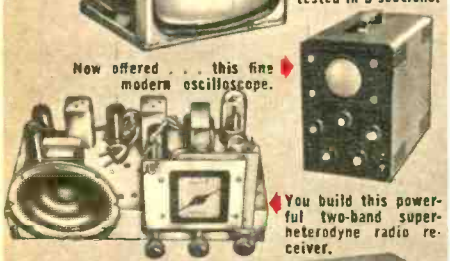

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◀ See Page 22 for the BEST BUYS in CITIZENS TRANSCEIVERS, "HAM" GEAR and TRANSISTOR RADIOS.

electronic's strangest music maker

Music From Nowhere

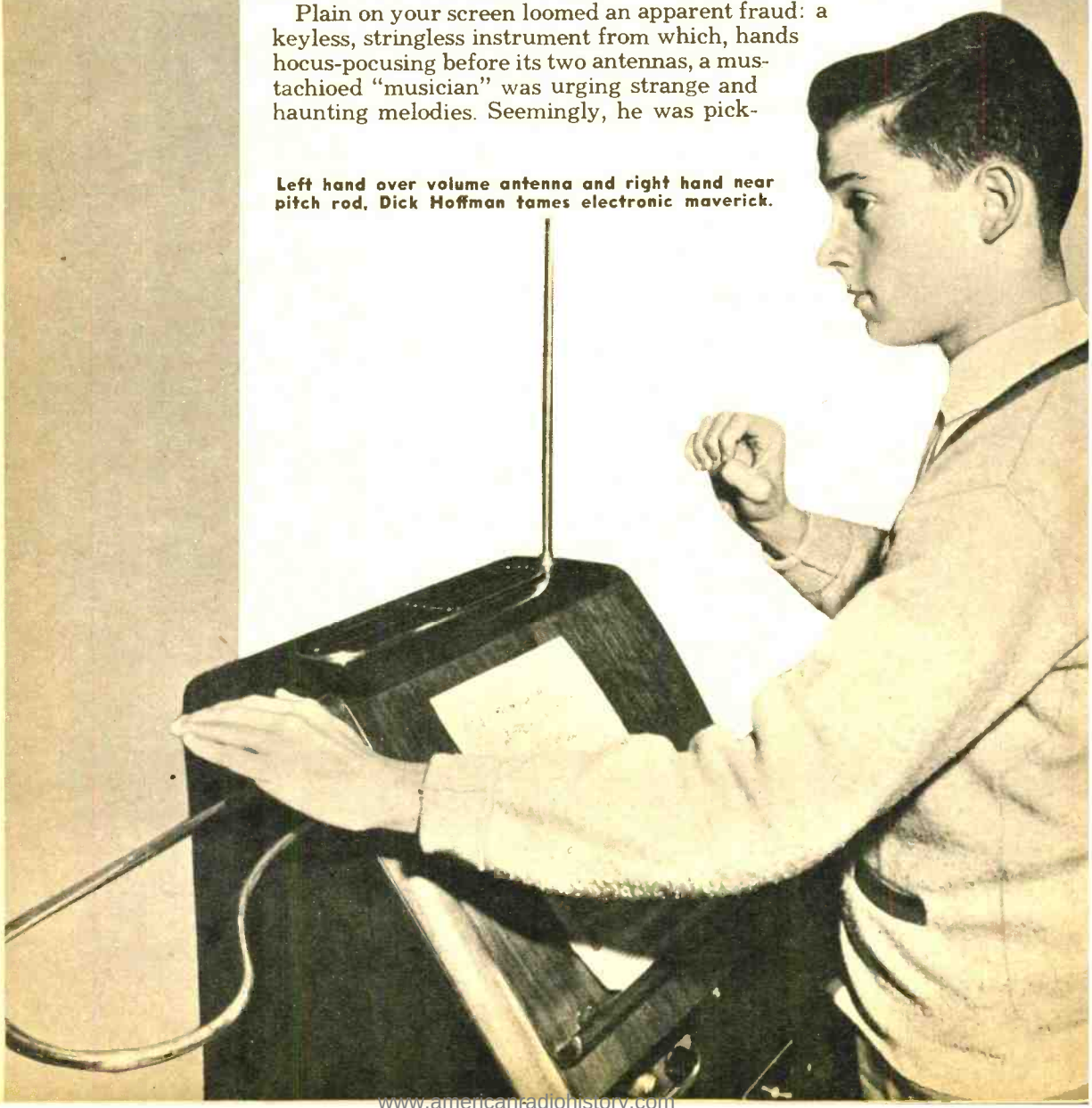
By James Joseph

The theremin—is it "electronics gone haywire?"

Picking music from air isn't as easy as it looks.

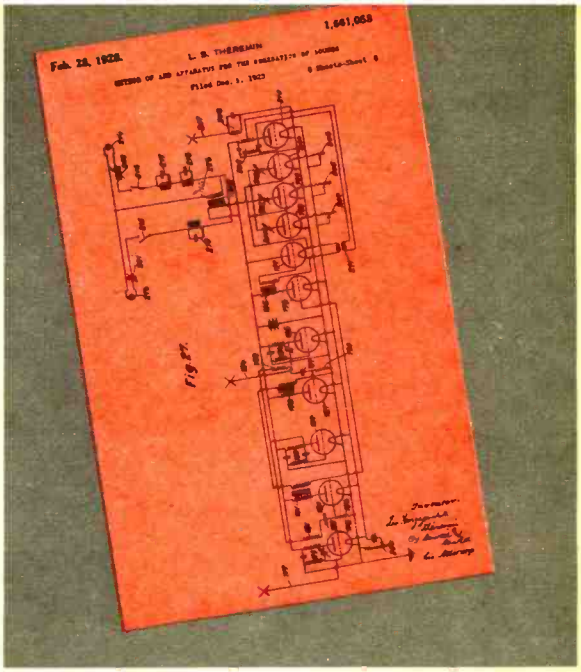
MAYBE you were among the hundreds of TV skeptics who, doubting their own eyes, recently flooded a network's switchboard with angry complaints about what appeared to be a man coaxing music out of thin air.

Plain on your screen loomed an apparent fraud: a keyless, stringless instrument from which, hands hocus-pocusing before its two antennas, a mustachioed "musician" was urging strange and haunting melodies. Seemingly, he was pick-



Left hand over volume antenna and right hand near pitch rod, Dick Hoffman tames electronic maverick.

Coaxing eerie music from electrostatic fields is Dr. Sam Hoffman. He has put theremin on many movie soundtracks. Each hand move, 1/16" nearer antenna, encounters new note.



This gadget was *really* invented by a Russian, Leo Theremin. Despite simplicity of theory, design and construction, U.S. patent (1928) carries a full six pages of schematic diagrams.

ing notes—and whole sonatas—from nowhere.

His right hand teased—but never touched—the instrument's vertical antenna. Simultaneously, his left wavered above a looped, horizontal antenna.

No hoax was either the musician, Dr. Sam Hoffman, nor his eerie-voiced music maker—a theremin.

The theremin (pronounced "thur'-a-min") is one of the world's strangest electronic instruments. And Dr. Hoffman, a mild-mannered Beverly Hills, Calif., foot doctor, is not only its musical master, but undoubtedly the world's foremost theremin virtuoso.

Together they've teamed to goose-pimple the soundtracks of more than thirty movies, including "Spellbound" and "Lost Weekend," both Oscar winners. Hypnotizing nothing more than a couple of chrome-plated antennas, Dr. Hoffman has put the theremin's electronic voice between the covers of half a dozen record albums—one aptly titled, "Music Out of the Moon." Recently, after years behind the cameras, he stepped before them to prove to skeptical viewers that the theremin is fact, not fantasy.

Strange as is its music, stranger yet is the theremin itself. Some have called it "a radio gone haywire." Others contend that it is really not a musical instrument at all, simply an oscillatory circuit bib-and-tuckered in a mahogany console.

Though hailed as "the newest of instruments," it was concocted 35 years ago by Russian-born electronic engineer Leo Theremin. Manufacturing rights were sold to RCA.

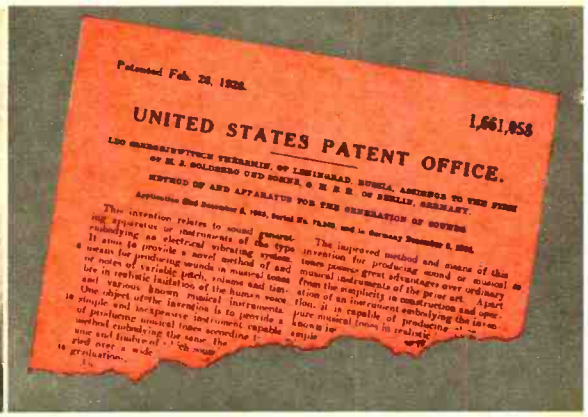
Just as paradoxical is the fact that while a beginner in electronics can easily build a theremin (so simple and low cost is its circuitry), few have ever learned to tame its electronic temperament. Perhaps not a hundred people have succeeded in turning the theremin's squeals into anything approaching music.

Shrugs one electronic engineer: "Queer duck, the theremin. Most guys who build one can't play it. And most who can play it don't know beans about electronics . . . or, in fact, how the darn thing works."

"It works, but don't ask me how," concedes the theremin's master, Dr. Hoffman.

[*Continued on page* 98]

Range of the theremin, both in pitch and volume, may be preset by musician with these controls. Theremin has a maximum range of four octaves which may be narrowed to two.



Patented Feb. 28, 1928.

1,661,058

UNITED STATES PATENT OFFICE.

LEO SERGEIEVITCH THEREMIN, OF LENINGRAD, RUSSIA, ASSIGNOR TO THE FIRM OF M. J. GOLDBERG UND SOEHNE, O. H. G., OF BERLIN, GERMANY.

METHOD OF AND APPARATUS FOR THE GENERATION OF SOUNDS

Application filed December 8, 1923. Serial No. 679,605, and in Germany December 6, 1923.

This invention relates to sound ... apparatus or instruments of the type ... embodying an electrical vibrating system. ... It aims to provide a novel method of and ... means for producing sounds in musical tones ... or notes of variable pitch, volume and tone ... ties in realistic imitation of the human voice ... and various known musical instruments. ... One object of the invention is to provide a ... simple and inexpensive instrument capable ... of performing musical tones according to ... novel methods and ... sing and timbre of ... ich sounds ... ried over a wide ... gradation.

The improved method and means of this invention for producing musical tones possess great advantages over ordinary musical instruments of the prior art. Apart from the simplicity in construction and operation of an instrument embodying the invention, it is capable of producing the purest musical tones in realistic ...

Quoting patent: "... method and means of this invention for producing musical tones possesses great advantages over ordinary instruments." Yet Theremin couldn't play theremin!

Six tubes, plus power supply (not shown), comprise the original RCA model. Note the variable pitch oscillator coil and pitch antenna (vertical), at left side of cabinet.

s w l's and hams, stop that feudin'

The Great QSL Quarrel

By Carole F. Hoover, K9AMD

WHY would any ham in his right mind purposely throw a QSL card into the wastebasket? Well, thousands of shortwave listeners wonder the same thing. Others, who know why, grit their teeth in anger when they think of what's happening to the cards they send. Hams and SWLs have been feudin' for years, and it's high time a truce was declared.

"Why should I furnish postage and one of my expensive cards to some guy who uses a postcard and a worn-out ball-point pen?" grumbles a typical ham as he shreds an SWL card into his circular file.

A good part of the fun of hamming is confirming radio contact by mail, and many amateurs spend hours designing their own cards, dressing them up with a photograph of the rig and operator, an original drawing, or some other clever idea which takes time and dollars. Swapping an artistic, custom-made QSL card for a dull, limp postcard is hardly a fair trade, although some folks seem to think so. In plain language, an SWL card should be a worthwhile addition to any "hamshack."

Next, let's tackle that ball-point pen business. No matter how attractive a card may be on one side, it's a big let-down to discover that the writing on the back is harder to [*Continued on page* 94]

If SWL's follow the checklist in this article, chances are their QSL cards won't suffer the same fate as those below. Coming home from work, Gus, K9EBA, (left) disposes of one incomplete SWL report at the mailbox. At right, another K9 and his canine sort the mail and QSL cards with the aid of a circular file.

Shortwave listening is a popular hobby all over the world and many hams enjoy collecting SWL cards—providing they are attractive, accurate and complete.

Walter Greenwood, Coffeen, Ill., has been an avid SWL for years. Through his interest, son Brent is K9RHL. Here they check DX guide, reply coupons in hand.

Ham Station Control Center

By Howard S. Pyle

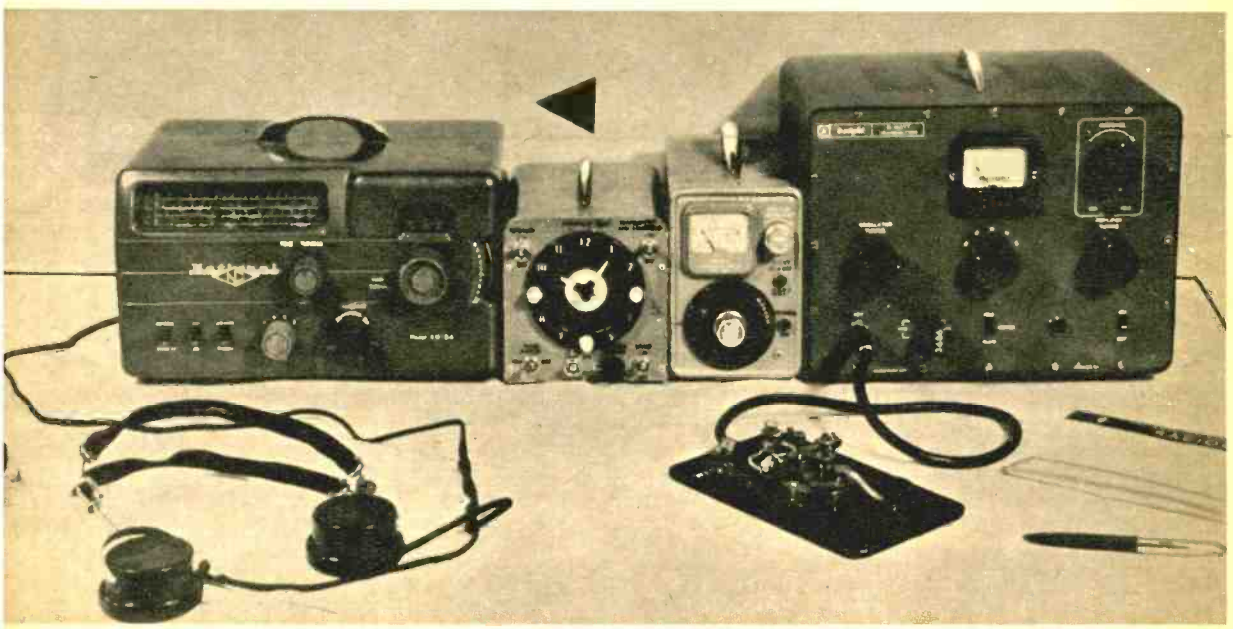
Convenient home-built device puts all ham shack switching in one compact table-top instrument.

CHANCES are that if you have a ham rig—modest or magnificent—you've also got plenty of odds-and-ends of station equipment in addition to your basic receiver and transmitter. There's the clock, the Conelrad monitor, audio noise limiter, keying monitor, external VFO, and what-have-you. Now wouldn't it be nice if all this gear could be plugged into one "little magic box" to provide fingertip control for *all* your gear?

That's what we have here—a versatile ham station control unit that can serve as the heart of any ham shack. Moreover it may be unplugged for quick, trouble-free station set-up wherever you may go on your vacation—or Field Day. Very light and completely portable (5″ x 5″ x 7″), all station equipment plugs into it. Switches and fuses for each item are built right in, along with an electric clock and timer, an audio noise clipper, transistorized keying monitor, speaker, plus a few other "gimmicks." Antenna provision is very flexible. You can use a whip or random length antenna while traveling, as well as any conventional home skywire or beam.

Power Circuits

There are no 'trick' circuits and both mechanical and electrical



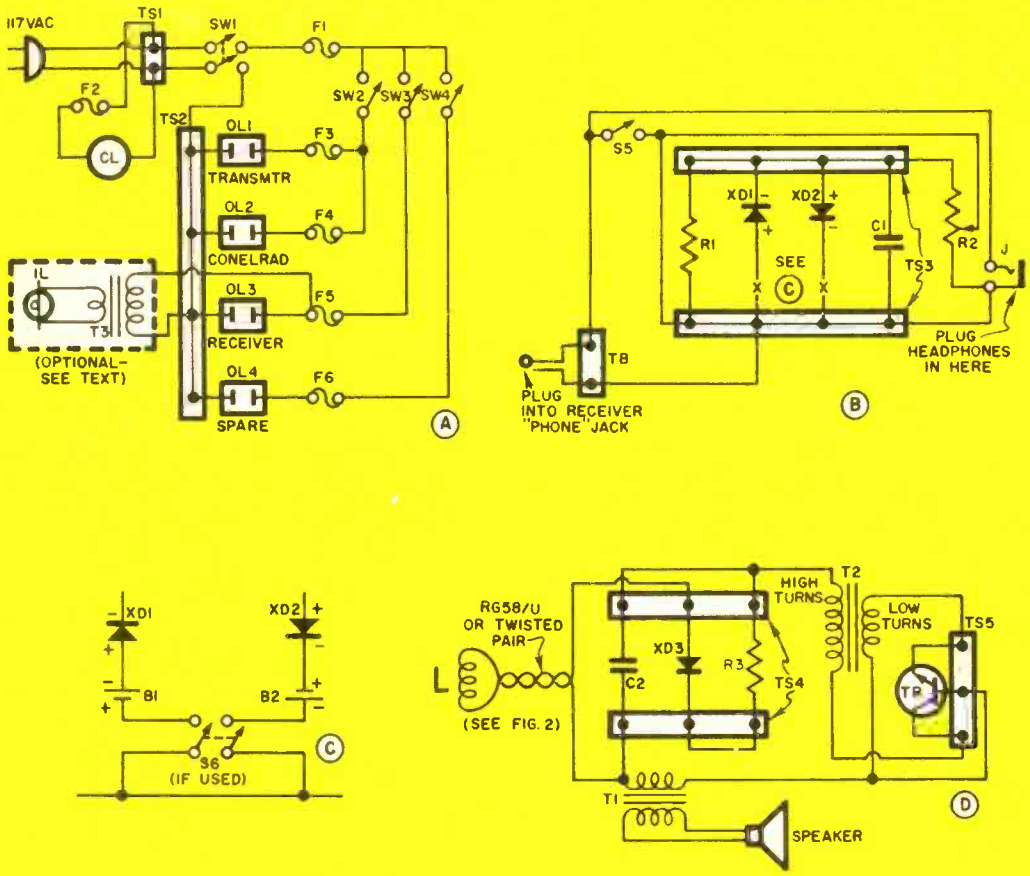
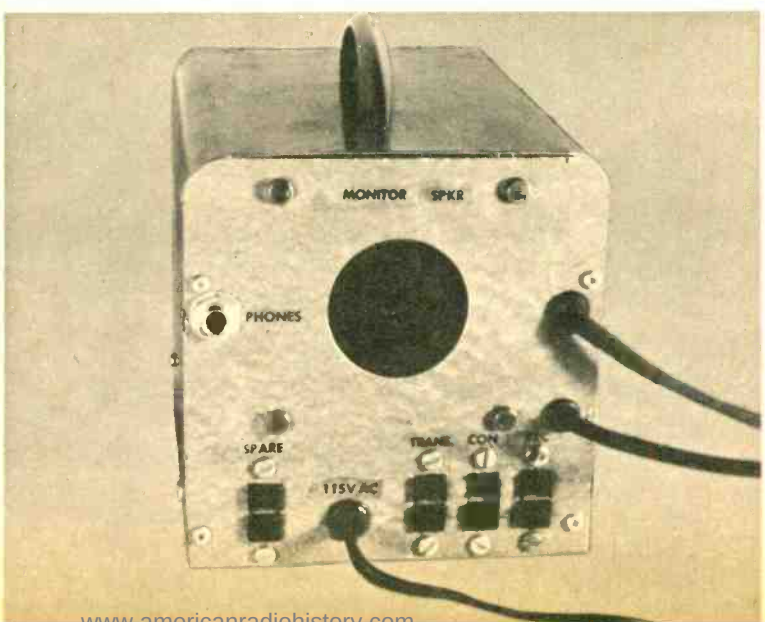
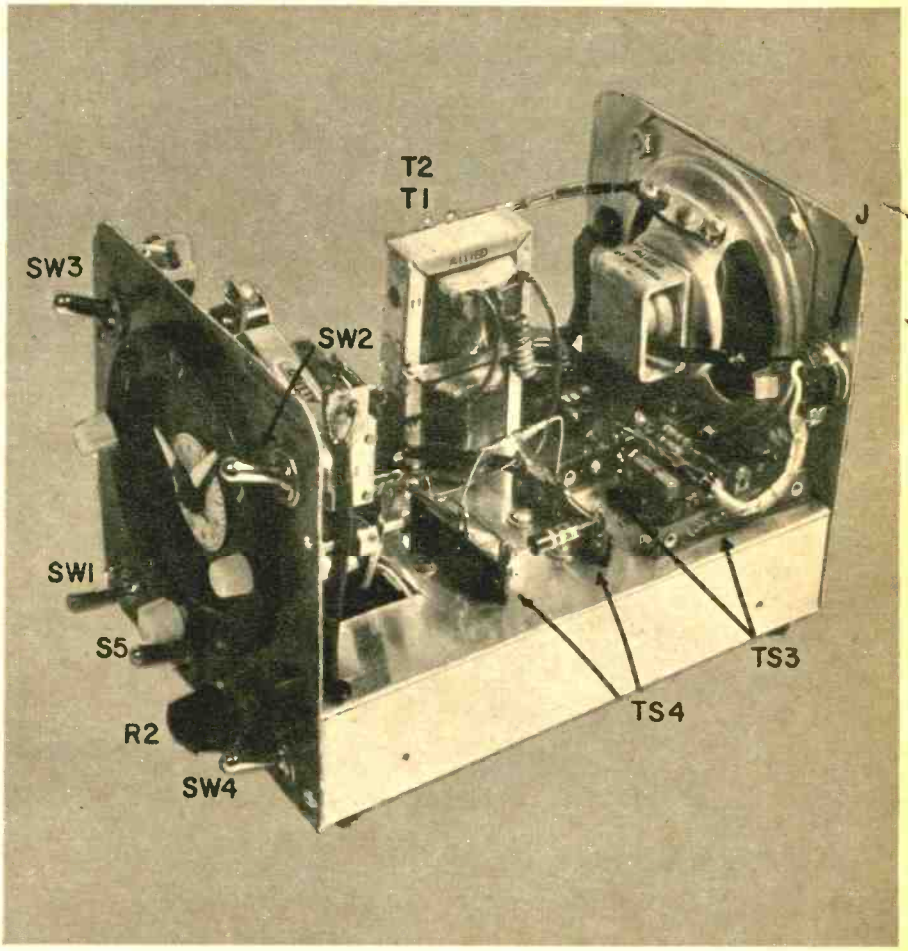


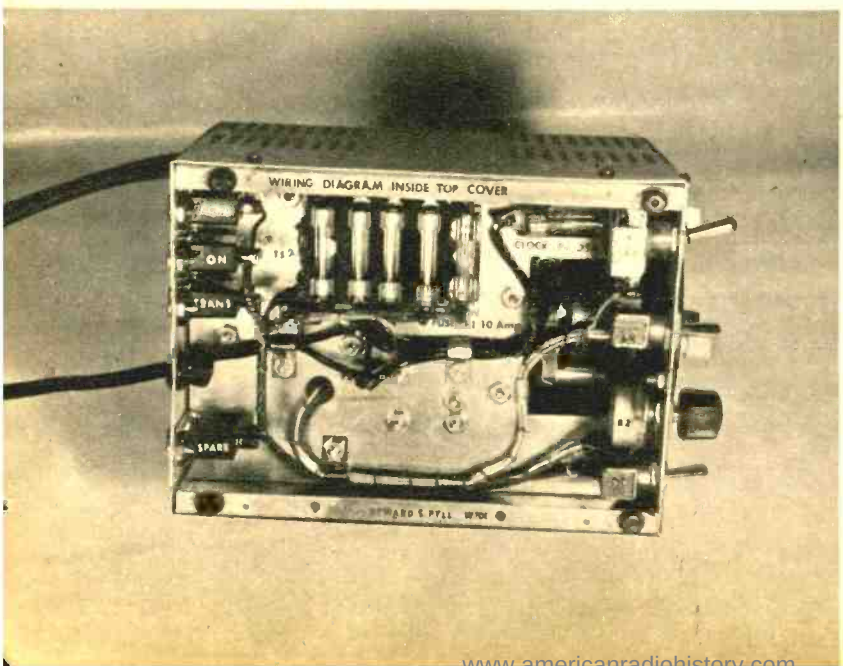
Fig. 1. Schematics A, B, C and D break down the unit into its component circuits for simplicity. Details on the above are described in the text.



Rear view of control unit. All cords, plugs, cables, etc., are connected to the rear panel concealed from a frontal view of the equipment. This also keeps the cables out of the operator's way.



Control unit with cover removed. Note that T1 and T2 are stacked to save space. Refer to the parts list on the opposite page for identification of all components.



Underside view of chassis. Wires have been laced for permanence and neatness. Each circuit has an individual fuse held in its place by a clip-holder. Cutout for clock mechanism on chassis is seen in photo.

design are flexible. You can add more AC outlets to accommodate a self-powered VFO such as the Knight-Kit V-44, an external modulator or a spare outlet as is shown for a desk lamp.

The AC cord enters the cabinet through a grommeted hole and terminates on a two point tie-strip, TS1. (Schematic A.) From here the electric clock (CL) on the face of the unit takes off through a .25 ampere fuse, F2. Also from TS1, a pair of wires goes to SW1, a DPST toggle switch. See the trick? SW1 becomes the "main switch" and turns on or off all equipment connected to the control unit *except* the clock. When you're through with the rig after an evening of contacts, throw SW1 'off' and hit the sack; you haven't forgotten a thing!

Individual switches are provided nevertheless, for the transmitter and receiver. Sometimes you may merely want to listen; turn on the receiver outlet (OL3) with SW3 and the transmitter off with SW2. Note that the transmitter and Conelrad monitor are switched on and off simultaneously with SW2. As long as your transmitter is on, your Conelrad must be also, to comply with FCC requirements. For receiving only, you don't need Conelrad.

The indicator light circuit represented by IL and filament transformer T3 is optional since most transmitters, receivers and Conelrad units are so equipped. Note that each piece of equipment is separately fused in the control unit. The cabinet includes a matching chassis and has a bottom cover plate which may be left off for convenient access to the [*Continued on page* 113]

PARTS LIST

F1 thru F6—clip-type fuse holders and fuses (see text)
SW1,S6—DPST toggle switches
SW2,SW3,SW4,S5—SPST toggle switches
IL—6.3-volt pilot light assembly (optional)
OL1 thru OL4—chassis mounting AC sockets (Olson X-803)
T3—filament transformer 6.3 volt @ 1 amp or less (optional)
TS1—2-point tie strip
TS2—4-point tie strip
TS3—two 4-point tie strips
TS4—two 3-point tie strips
TS5—3-point tie strip
R1—15000 ohm, ½ watt resistor
R2—10000 ohm potentiometer
R3—470 ohm, ½ watt resistor
PL—phone plug
XD1 and XD2—1N34A crystal diodes
XD3—1N56A crystal diode
C1—.0025 mfd, 600-volt mica capacitor
C2—.001 mfd, 600-volt mica capacitor
L—monitor pick-up loop (see text)
T2—Audio transformer (Allied Radio 62G062)
T1—Universal output transformer (Allied Radio 62G023)
TR—2N35 transistor
TB—terminal board
J—phone jack
CL—clock
Loudspeaker—3" or 4" PM type

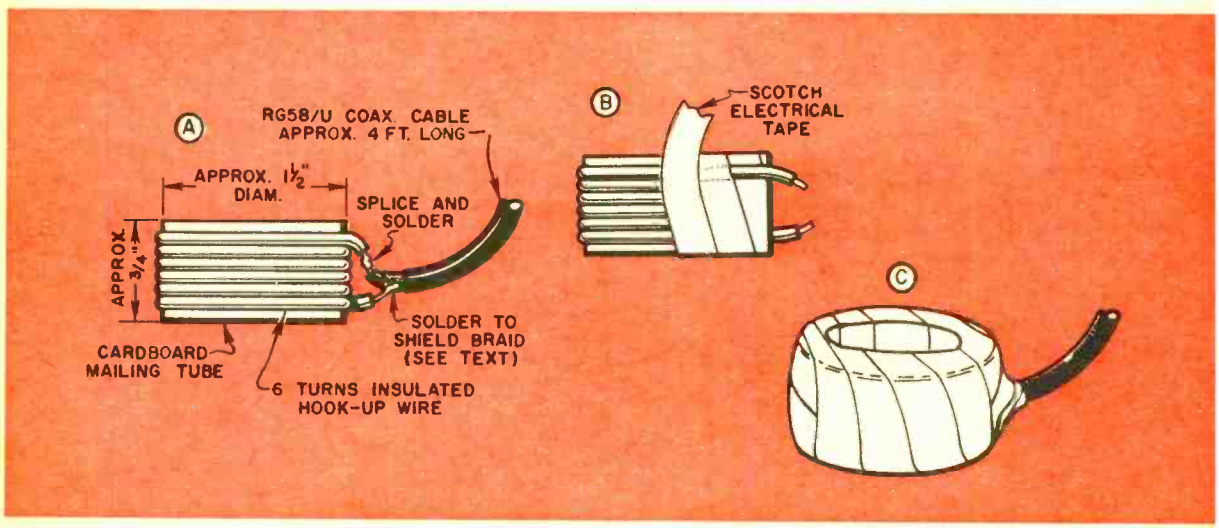


Figure 2. A step-by-step procedure for constructing the RF pick-up coil is shown in the drawing above. Black electrical tape holds wire to coil form.

electronics "talks" to the universe through

Cosmic Clearing House

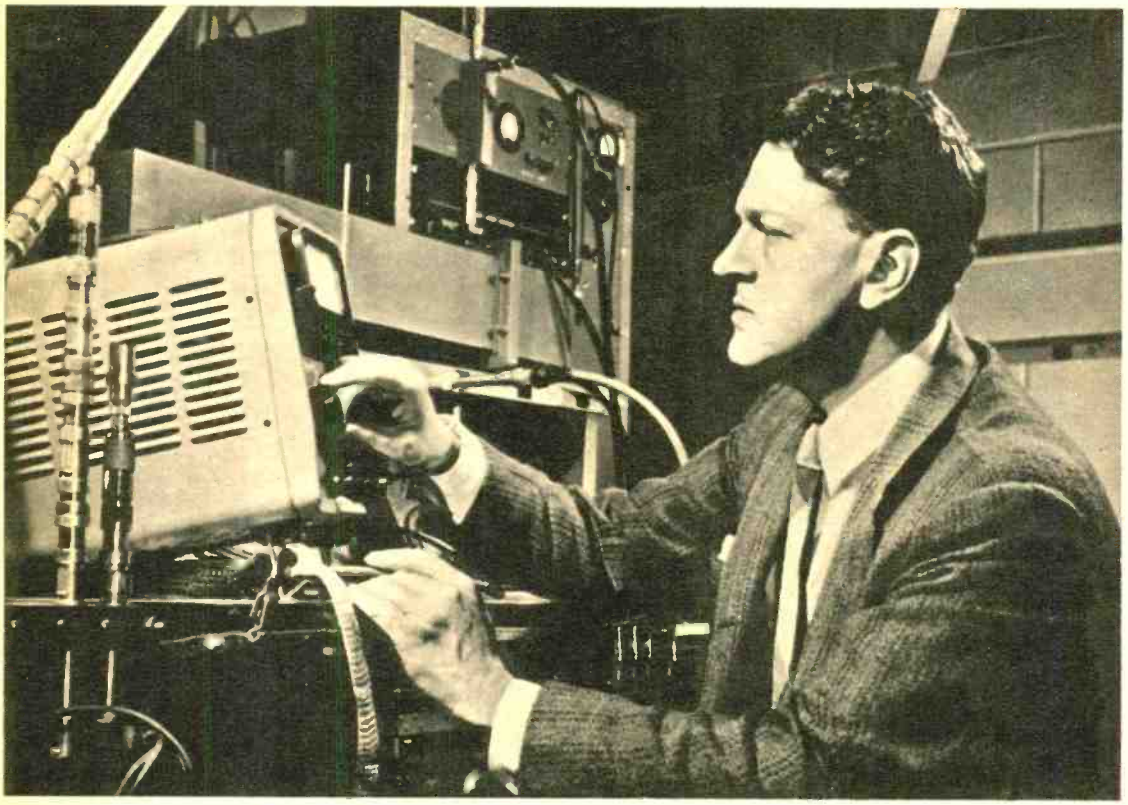
By Lloyd Mallan

Life on other planets? How can we communicate? These are questions for Cornell's new space center.

THERE are about ten-billion suns in our "local" universe, the Milky Way. Will man be able to communicate with countless planets that are probably revolving about them? Is our knowledge of radio adequate? The planet Venus—apart from the moon, our closest celestial neighbor—may very well be teeming with life. Can powerful radar pulses penetrate through its cloudy atmosphere to verify or deny this?

Below is working model of fabulous 1000-foot wide radar, designed by Cornell U. for construction in Puerto Rico (see artist's conception, left). It will explore cloud-covered Jupiter, more than 400-million miles away. Model was built by G. M. Zeitlin, shown holding driven element which is suspended above dish.

Photos by Dan Schreher

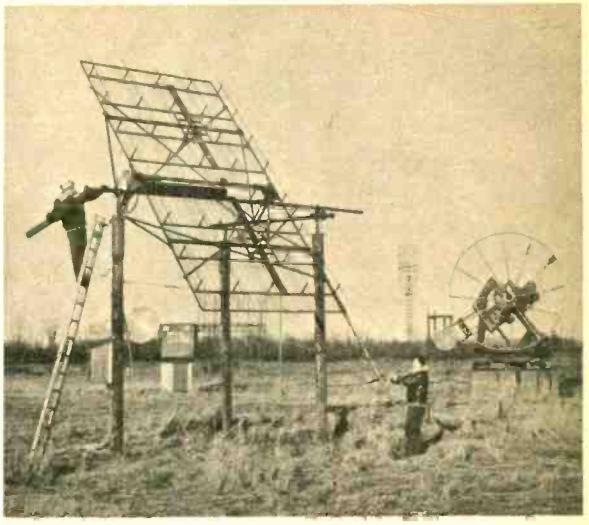


Prof. Thomas Gold, director of the space center, is a world famous theoretician, yet keeps his hand in electronics. Here he works with microwave counter.

Radio astronomy is not new at Cornell. The University has long operated field station at airport near campus. New equipment for center will greatly advance knowledge of space.

Researchers below operate 18-foot radio-telescope at field station. In background is a fixed unit 28-feet in diameter. This field station will be obsolete by end of next year.

New tools are always being sought to help man learn more about universe. Antenna design is vital project of new center. Here Profs. W. Gordon and W. McGuire study new dish.



Many variations of antennas have been tried for radio astronomy work. Wavelength sensitivity varies from one to another, depending upon what area of the sky they are to cover.

Man's questions are many. Are new universes continuously being created somewhere in the depths of intergalactic space, or did one gigantic explosion spread the stuff that made the atoms, the stars and the dust? How did the earth itself originate? How did intelligent life evolve on its surface? Those recently discovered high-energy radiation belts that surround the earth—are they a cause of human illness?

The answers to such important questions may very well be answered by a new coordinated effort of scientists at Cornell University. Outstanding experts in electronics, nuclear physics and astrophysics will coordinate with top authorities in radio, electrical and aeronautical engineering. They will also work closely with the scientists of the National Aeronautics and Space Administration (NASA) as well as with those of the Defense Department's Advanced Research Projects Agency.

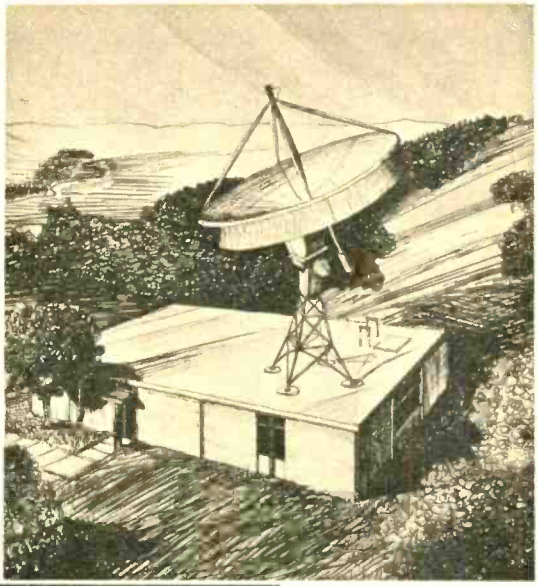
The new effort is dedicated to pure scientific research, finding the keys to unlock the mysteries of the *total* universe. The Cornell Center for Radiophysics and Space Research is being headed by Professor Thomas Gold, an Austrian-born astrophysicist who has startled the scientific world with his bold theories. He is one of those rare birds of science—a combination engineer and theoretician—a practical dreamer.

Soft-spoken but intense, Professor Gold's theories are derived from an incredible store of knowledge. In 1953 he said that sunspot "explosions" start solar magnetic fields suddenly expanding into space, pushing electrically charged gases ahead of them. In effect, they are magnetic shock-waves and when they finally strike the earth's magnetic field, violent fluctuations occur, causing auroras and disrupting communication. This theory was proposed five years before the IGY. Six years later, in May 1959, scientists at AVCO proved the correctness of his theory by simulating the same effects in their laboratory.

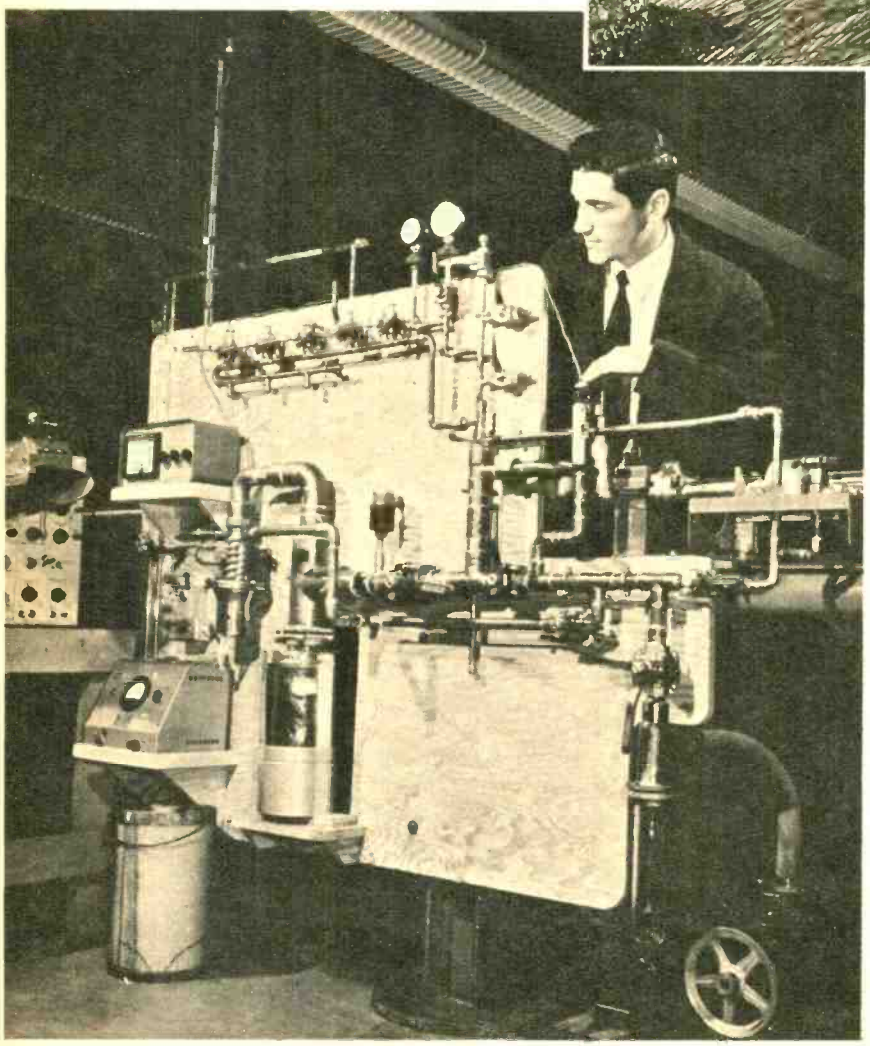
Professor Gold is even more famous among astrophysicists for another theory that he developed in collaboration with Herman Bondi and Fred Hoyle at Cambridge U. in England. This is the assumption of a "steady-state" universe. Gold says that the universe is eternally adding new material to itself from some secret source. As the universe's matter accelerates away from its

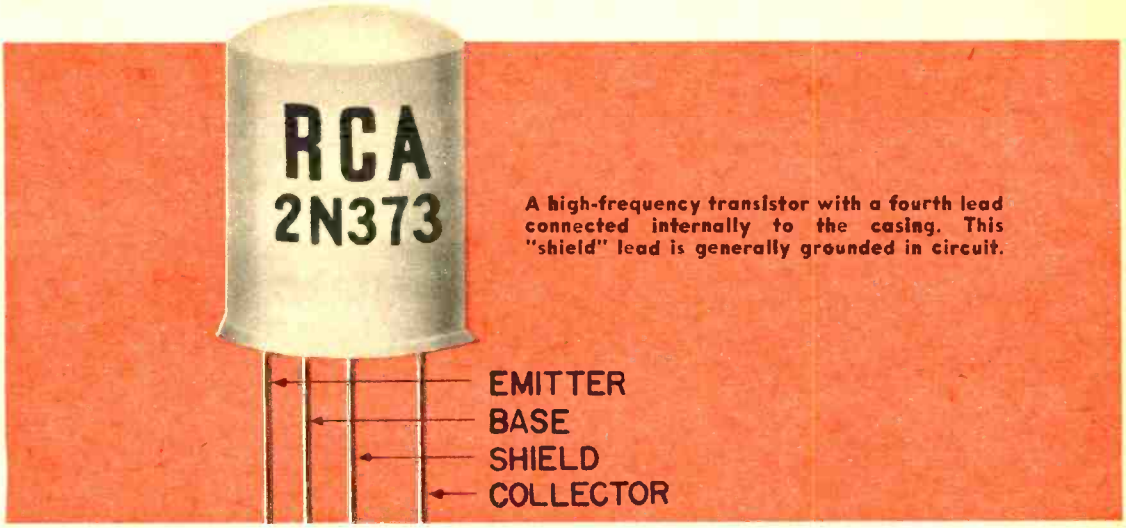
[*Continued on page* 104]

One of several major new units for probing the universe at the Cornell Center will be this 28-foot antenna for transmitting signals to any area of sky.



Prof. Stanley Byron, researcher in the aeronautical labs at Cornell, is studying equilibrium ionization behind strong shock waves, adding to ionization data.





A high-frequency transistor with a fourth lead connected internally to the casing. This "shield" lead is generally grounded in circuit.

Milt Kiver on

Transistor Testing -1

This first article in the new series discusses transistor types—theory—and important parameters.

THE rising importance of transistors and their increasing appearance in home receivers makes it imperative that the technician have some sort of quick and reliable testing method. Such testing devices are particularly important now while transistors are still quite new, and not only still subject to failure but have wide variations in characteristics within the same type number.

While tubes and transistors serve a similar purpose, that of amplifying signals, their mode of operation is completely different. Tubes are basically voltage amplifying devices; that is, they amplify or increase the *voltage* of a signal rather than its *current.* It is true that power tubes deliver considerable amounts of current, but they do this from an input voltage, not an input current.

Transistors, on the other hand, are current or power amplifying devices; that is, they utilize the power or current of an input signal as the factor that controls the current that passes through the transistor. This current, in turn, when passed through an output load resistor, will make available a greater amount of power than was present at the input. Hence, when a transistor is checked, the most important characteristic to be measured is the current gain. This may either be "alpha" or "beta" current gain. Both quantities represent different ways of looking at what is essentially the same thing—the current flow through the transistor and how well it can be controlled. Alpha represents the ratio of collector current to emitter current and has a value less than 1. Beta is the ratio of the change in collector current to a change in base current and beta is considerably higher than 1. Both quantities are related however, and knowing one will enable the tech-

nician to calculate the other quantity.

There is still another significant difference between tubes and transistors. In tubes, electrons flow from cathode to plate. This means that the plate is always positive with respect to the cathode while the grid is almost always negative with respect to the cathode. If the plate is made negative with respect to the cathode, current flow ceases.

Not so with transistors. Here the collector may be negative *or* positive with respect to the emitter, depending on the transistor type; i.e., PNP or NPN. (These letters stand for the *doping* accorded the various transistor sections during manufacture.) In a PNP transistor, the operating voltages of the base and collector are *negative* with respect to the emitter. For an NPN transistor, just the opposite voltage conditions must be established—in that the base and collector are both positive with respect to the emitter.

In checking transistors, it is very important that the type, either NPN or PNP, be known. Transistor testers will contain either separate sockets for each transistor type or one socket and a polarity reversing switch of the voltages fed to the elements of the transistor. If an NPN transistor is mistakenly tested as a PNP transistor (or vise versa), the meter will indicate that the unit is internally shorted—and the transistor may be damaged. This situation, which is peculiar to transistors, has absolutely no counterpart in vacuum tube testing.

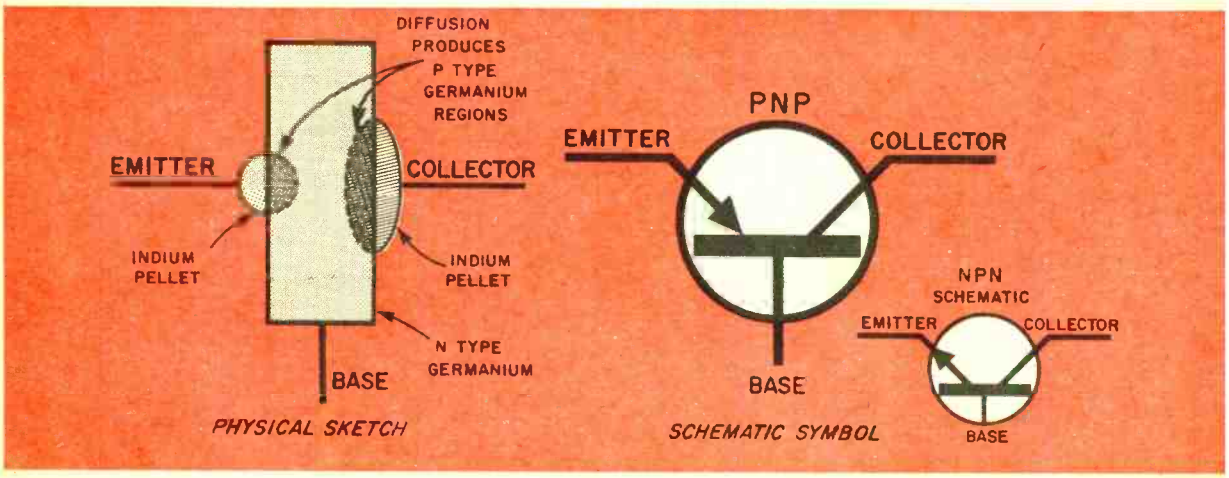
When the statement is made that transistors are "rugged," the reference is to a physical, *not* electrical, property. For although physically rugged, transistors are extremely fragile devices electrically and if not carefully and properly checked, can be easily destroyed.

There is one characteristic for which both tubes and transistors are tested—that is leakage. As our tube-testing discussions have indicated, leakage testing in a vacuum tube will frequently uncover defects which have a marked effect on circuit operation. In a transistor, leakage is even *more* important, for a transistor which has more than the normal amount of leakage will frequently have much lower gain. Hence, nearly *every* transistor checker currently available has some leakage checking provision, which is not true with tube testers.

Transistor Varieties

Before we examine transistor testing procedure, it's necessary to become familiar with the many different transistor shapes and electrode arrangements. Fortunately, a degree of standardiza-

Fig. 1. At left is a physical representation of a transistor showing its basic semiconductor material composition. Standard symbols are at right.



tion of transistor housings is being established. Not too long ago, however, when the transistor housing was at the discretion of the manufacturer, a wide variety of shapes were developed; a good many of which are still in use. It is desirable to be familiar with their terminal arrangements should they be encountered.

Recently, in high-frequency transistors, another lead has been added to the usual collector, base, emitter arrangement. (See photo of RCA 2N373 at the head of this article). The new lead, the one closest to the collector, is connected internally to the metallic transistor housing. If this lead is present and employed in the circuit, it is generally grounded. Sometimes these transistors will be found in a circuit with the lead clipped off; which means there is no need for the ground.

In addition, there are a wide variety of other lead arrangements and the more important of these are shown in Figs. 2 and 3. Some transistors use a colored marker near collector or a locating tab positioned generally nearest the emitter lead. If one of these transistors has four leads, the locating tab is positioned between the emitter on the right and a ground lead on the left. (The same arrangement of four leads and a locating tab has also been employed with transistors possessing two bases. These are called tetrodes and at the present time, few are being manufactured.)

All the transistors in Fig. 2 are small, low power units. When we come to power transistors (Fig. 3) we find an equally wide variety of lead types and positions. For example, on some of the power units there is a stud that comes out at the center of the housing base and is connected internally to the collector. A green sleeving might be placed over the base lead while a white, yellow, or brown sleeving identifies the emitter. A power transistor with flexible leads

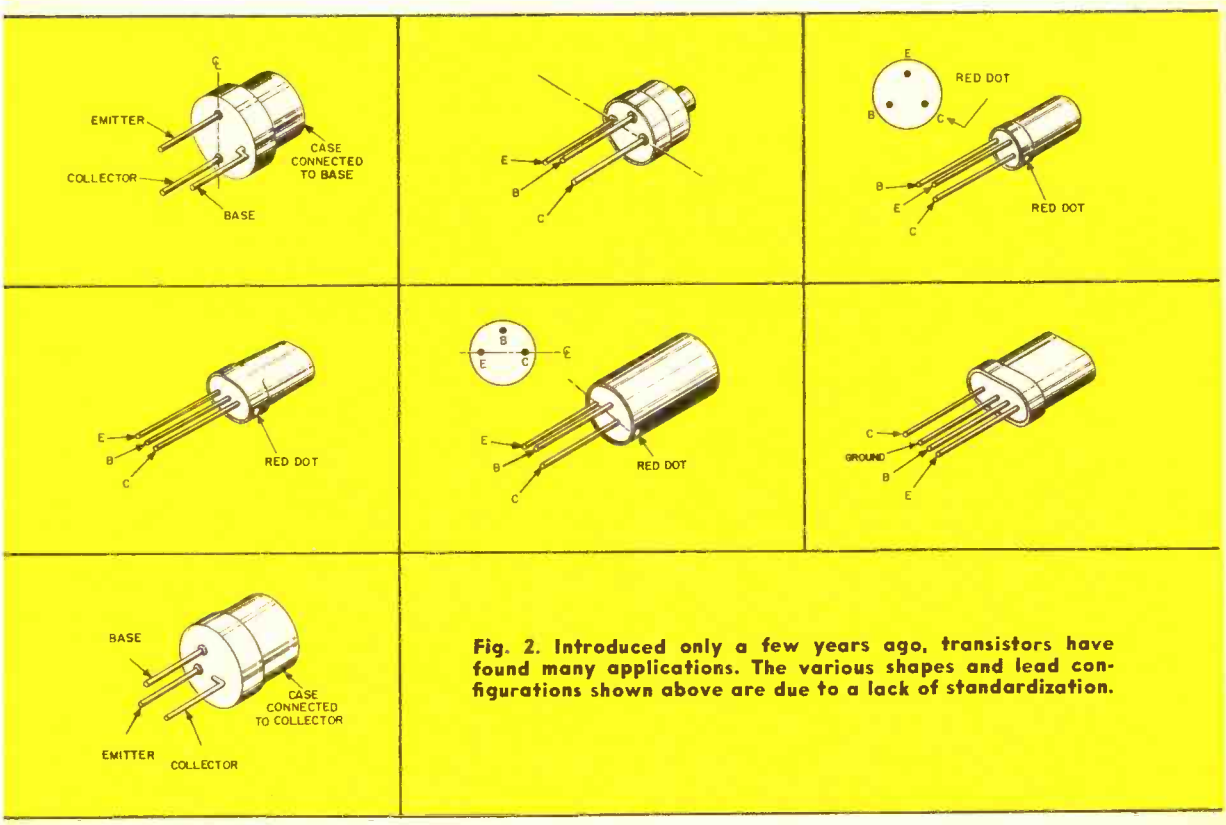


Fig. 2. Introduced only a few years ago, transistors have found many applications. The various shapes and lead configurations shown above are due to a lack of standardization.

(rather than solid connectors) frequently has a yellow emitter, black base, and red collector wire. Sometimes the collector may have a red dot with the base and emitter positioned away from it.

The foregoing illustrations represent most of the transistor housings likely to be encountered. Undoubtedly a few units will be met which do not fall into the categories indicated. In that case, it may be necessary to refer to the manufacturer's literature. If not available, check the unit using the transistor. Because of the large number of imported transistor radios now flooding the country, it may be necessary to check with the importer for a source of replacement transistors for the foreign types in these sets. With a schematic and the equipment, there should be little difficulty in identifying each of the various elements.

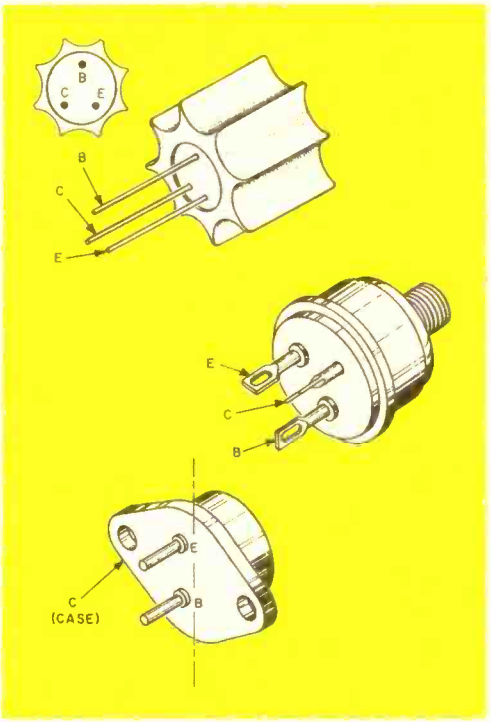
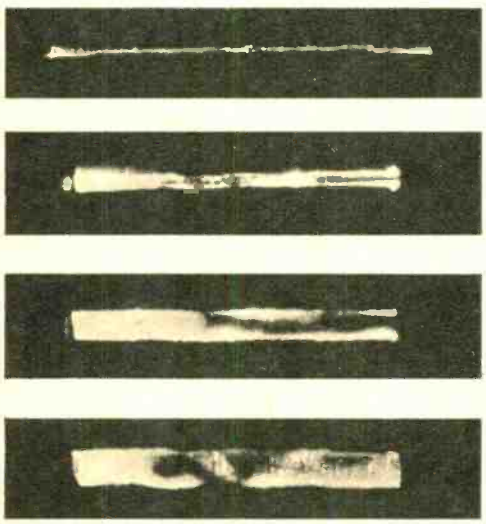


Fig. 3. Additional power transistor housings and types which are likely to be encountered in home or industrial equipment. These are the generally larger power types for heavy use.

Courtesy Precision Apparatus Co.

Exploding Wire

WHAT happens when you switch several thousand amperes into a 1 mil wire about ¼-inch long in a time period no longer than a few millimicroseconds? Simple: it explodes—with vaporization energy many times normal, temperatures above 100,000 degrees centigrade and pressures in the megabar range. This is powerful stuff. An Army sponsored study by Electro-Optical Systems, Inc., Pasadena, Calif., claims that exploding wire impulses could provide a space vehicle with 2 to 10 times the thrust now obtainable by chemical means. The technique, developed as a result of detonator research, may also be used for space communications via light, as well as terrestial searchlight operations. A .002 to .02 mfd capacitor is charged to 10,000 to 20,000 volts and suddenly discharged into the wire. Current is switched by a hydrogen thyratron and triggered air spark gap.



Here, in series of ultra-highspeed photos, aluminum wire explodes after switching of current.

EI's Hi-Fi Doctor. . . .

The Evolution of Audio—Part I

Those old timers who can remember back to the days when hi-fi was a pursuit reserved for broadcast station engineers and Bell Telephone lab workers may recognize what I like to call "The Mythology of Hi-Fi."

Most of these issues are long since dead, and by most forgotten, but it is interesting to peek into the not-too-distant audio past to see what insights it can provide into today's sound squabbles.

One of the biggest past hassles was the *Triode vs. Pentode* controversy. Triodes, claimed some, "sound sweeter" and conversely of course, pentodes grated on their delicate golden ears. The build-it-yourself magazines of the day ran a number of all-triode amplifier projects and the 2A3 output tube which was on the verge of being consigned to the junk heap received a new lease on life. The Collins and Brook Companies produced all-triode amplifiers—massive jobs, almost too heavy for the average audiophile to lift—with a total output of a big 10 watts. No feedback, no tricks, just a straight-forward all-triode power amplifier.

Which brings us directly to the question of what, if any, advantage did push-pull triode output configurations have over the beam-power pentode equivalents? Aside from what the amplifier's distortion vs. power output curves show—the major advantage of the triode seems to be in the fact that it has a much better damping relationship with the speaker (which does *not* show up in an amplifier test). Proper damping holds the speaker in tight control and subdues resonant peaks. The unfed-back pentode, on the other hand, tends to let the speaker go its merry way uninhibited by a low shunting load or to say it a different way—a high damping factor.

Things change somewhat after the product of Mr. Williamson burst upon the scene. Although seldom billed as such, the Williamson power amplifier is an all-triode job. In fact, in the original circuit separate triodes were used instead of the dual triode 6SN7 so popular in the Yankee version. What made the Williamson so good was the particular attention paid to the construction of the output transformer. In the original articles by Williamson, which appeared in *Wireless World*, there were complete specifications for rolling your own transformer. Another factor which separated the Williamson from the rest of the herd was the 20 db feedback loop (which the improved transformer made possible) from the transformer secondary to the input triode cathode. Numerous versions of the Williamson appeared with push-pull 6L6s, 807s, 5881s, all triode connected.

Right about this time, a most significant advance in the audio art appeared—which forevermore ended the triode vs. pentode argument. That was the Ultra-Linear output transformer configuration. Output tubes so connected to this transformer have almost the linearity and damping factor of a triode and almost the power output of a pentode.

A good demonstration of this could be made with the old UTC Williamson amplifier. In its original version this job used one of the fine UTC LS-series output transformers and 6L6s or KT66s as triodes. Its output was a clean 10-12 watts. After the invention of the Ultra-Linear, the UTC engineers discovered that there were taps on the primary of their output transformer which, when connected to the output tube screen grids, would convert their fine 10-watt Williamson to an even better 20-watt Williamson.

We will continue our informal history next month.

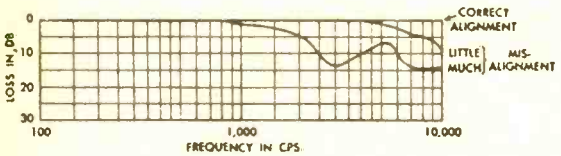
and Clinic

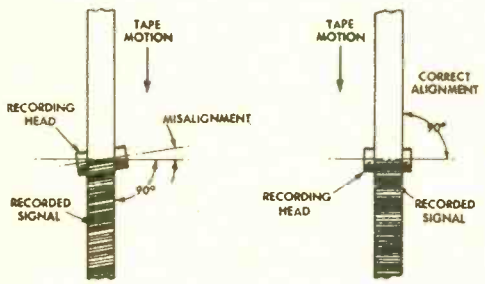
Hi-Fi questions are all answered by mail. If of general interest they will appear in this column.

Tape Azimuth

When I play back tapes made on my next-door neighbor's machine they sound very dull. They sound fine on his machine. I have a few pre-recorded tapes and they sound okay to me on my machine. What is this?

E. Schreiber
Phila., Penn.





This sounds like a matter of azimuth adjustment. If the angle of the head (or heads) in each machine is not the same, high-frequency loss will be the result when tapes are swapped. I'd say your machine was alright in this respect since the pre-recorded tapes sound good. Play one of these on the other machine. If it sounds dull, the azimuth (head angle) must be adjusted on your neighbor's machine. *Don't* make this adjustment yourself; special equipment is needed.

Record Hiss

When I play records I hear a hissing and shrillness that is not present on the tuner. What could this be?

Charles Reme
Chicago, Ill.

The first thing I would do is check your cartridge by replacing it with a borrowed one. Your cartridge may have a resonant peak at its high-frequency end. If this doesn't help, have your serviceman check the treble equalization in your preamplifier with an audio signal generator. At high frequencies there should be a definite drop in output when compared to the output at mid-frequencies. This drop in volume is known as "roll-off" and is part of the technique used to reduce hiss and scratch on records. Absence of this equalization would definitely make records sound shrill.

A less likely source of your problem may be the setting of your tweeter or level control. If your tweeter is set for too *high* an output to compensate for an inadequate treble response from your tuner, the net result will be a treble boost in your system which makes your tuner sound normal, but your phono sound shrill.

FM Coupling

I was told to couple my FM antenna to my TV antenna. Not only is there no improvement, I'd say my FM reception is even worse. The TV signal is very good. Why is this?

E. Rogers
New Haven, Conn.

This isn't very surprising at all. Barring a defective coupler your trouble is simple. Some TV antennas are very broad, covering the lower TV bands from 2-6, thru the FM band which is in the middle, and 7-13. Other antennas simply use two elements, one for the low band, and the other for the high. In between, just where the FM band is, they have a very great dip in the response, and in some cases—yours apparently—have no signal pickup at all. The cure is simple, either get a separate FM outside antenna, or go back to your previous indoor FM antenna.

EI Build-it Course–10

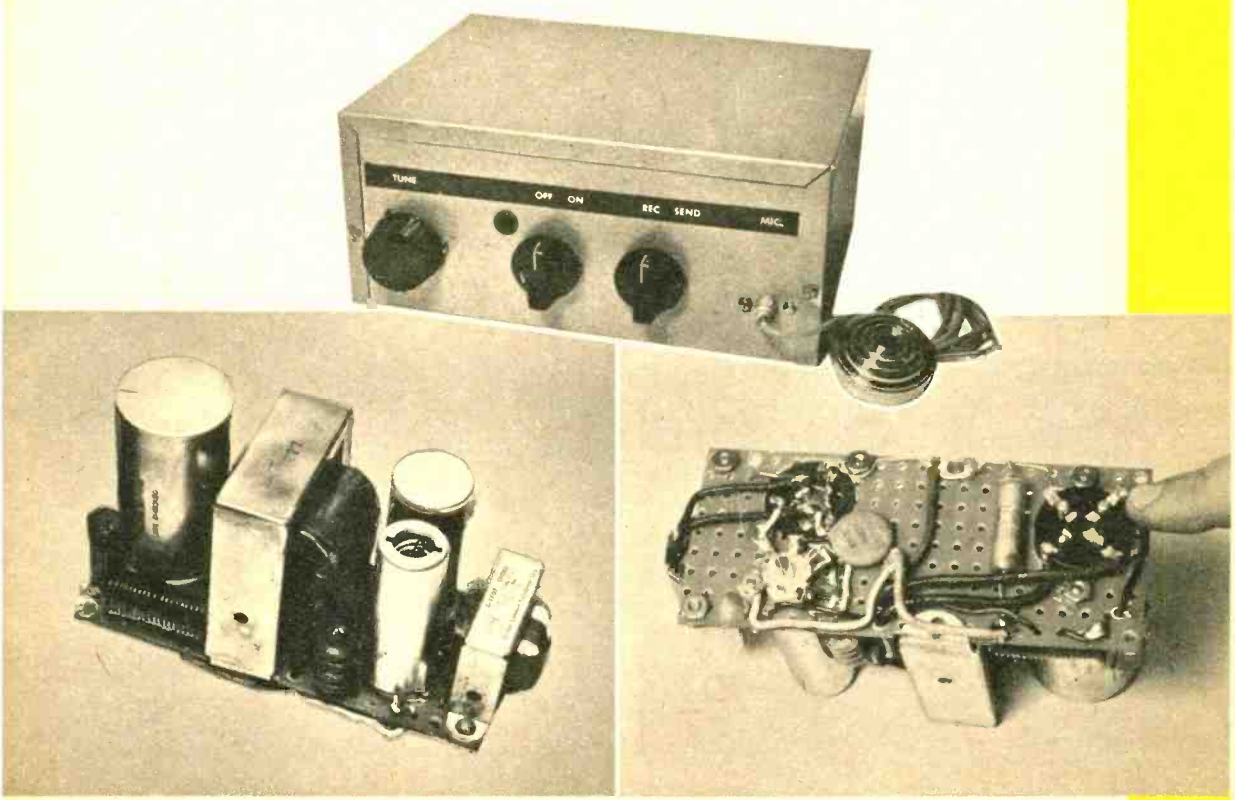
Completing the CB series, here are 6 and 12-volt DC and 117-volt AC power supplies for the rig.

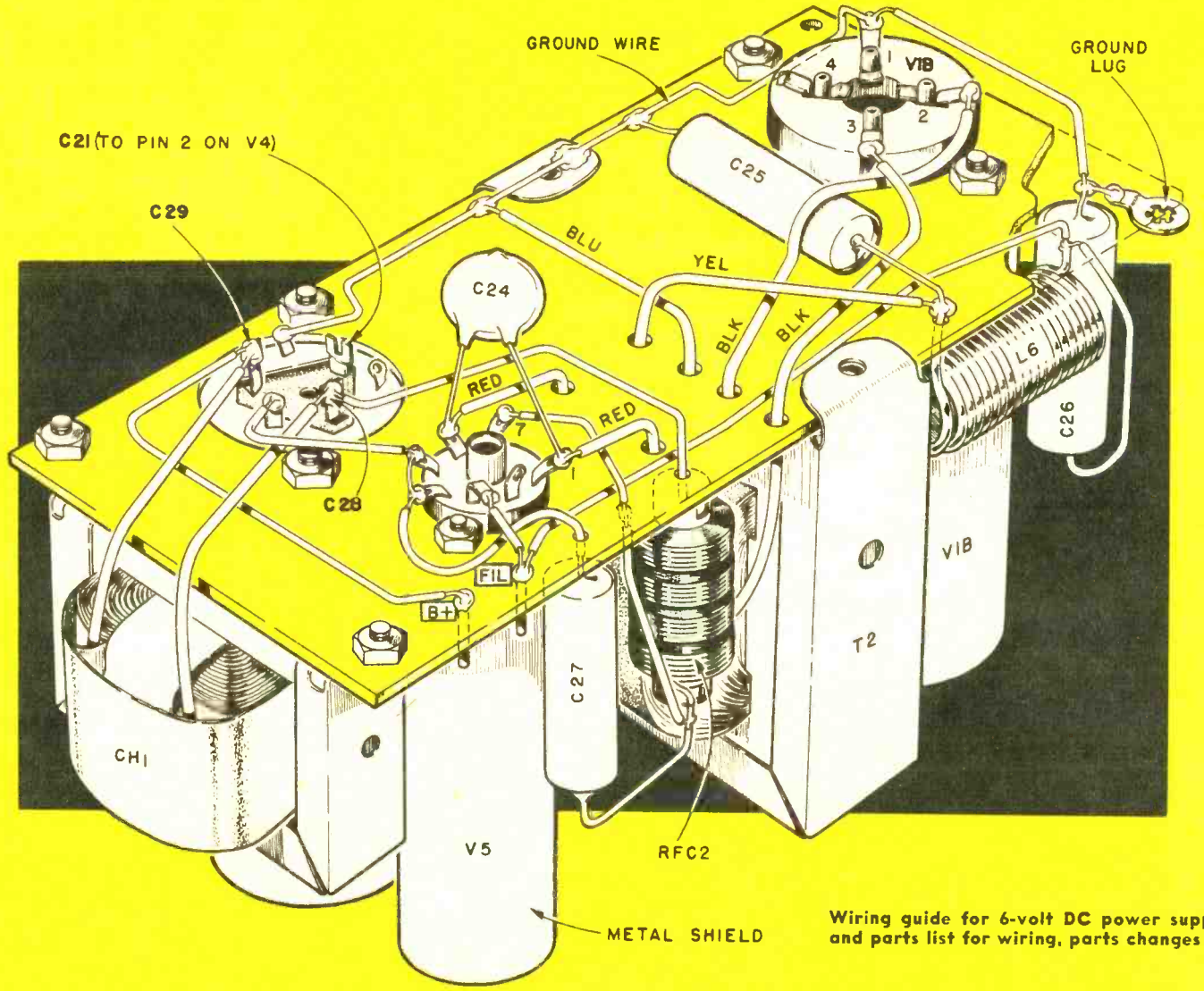
THE Citizens Band rig described in this series will be ready for operation once a power supply is built and various interconnections are made. These items, plus some "loose ends" are detailed in this wind-up article. At this point, the buider should decide on the type of operation desired and build the appropriate power supply: 6- or 12-volt DC for mobile operation, or the 117-volt AC supply for home use.

No matter which supply is chosen, the physical dimensions remain the same. It's possible to interchange the supplies for use of the rig at home, in a car or boat.

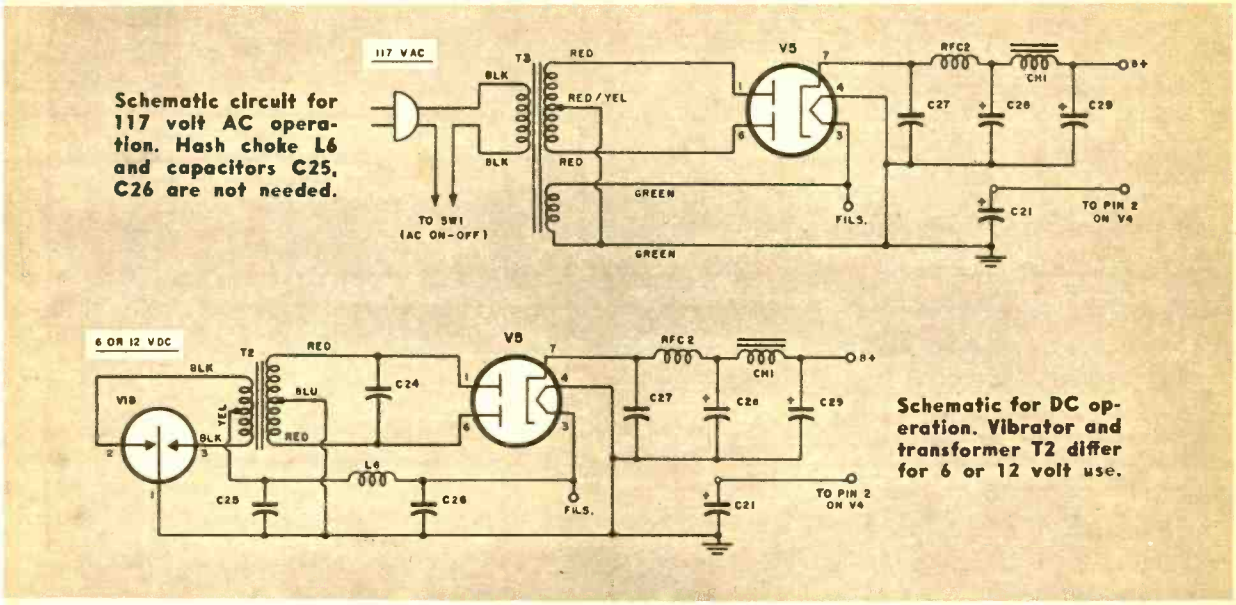
One of the problems encountered in vibrator power supplies is a form of interference known as "hash." The waveform output of a vibrator is rich in harmonics; energy which reaches up into the 27 mc band and is heard as an annoying buzz in the speaker. Various measures were incorporated into the design of the sup-

Top view of power supply module, below left as it is wired for 6 or 12 volt DC operation. Vibrator socket is pointed out in the underside view at right.





Wiring guide for 6-volt DC power supply. See text and parts list for wiring, parts changes for 12V unit.



Schematic circuit for 117 volt AC operation. Hash choke L6 and capacitors C25, C26 are not needed.

Schematic for DC operation. Vibrator and transformer T2 differ for 6 or 12 volt use.

plies described here to minimize this—but results are somewhat unpredictable. To reduce hash, keep the power lead (6 or 12 volts DC, as the case may be) as short as possible. A good ground is important, too. The best way to find a suitable grounding point is to connect a wire to the case of the rig and touch various metallic points under or near the dashboard. Find the one producing the quietest response in the speaker and connect the wire to it. More on installation later.

The pictorial wiring guide basically shows the wiring of the 6-volt vibrator supply; for 12 volts, there are several minor changes. Note that there is a different parts list number for both the 12-volt vibrator and its transformer. The other change is that the filament of the 6X4 rectifier tube is wired *in series* with another tube. Since this filament rewiring affects other tubes, too, be sure to consult the drawing devoted to 12-volt filament wiring—see p. 109.

Building the rig for 117 volts AC operation requires some alterations. Filament wiring remains the same as for the 6-volt DC unit. The major modification is the replacement of the vibrator and its transformer with a 117-volt power transformer. Wire one of the primary leads (black) of the power transformer to the unused pair of contacts on SW1.

Once the power supply has been wired and mounted, the other modules (converter, RF oscillator-amp., modulator) are interconnected according to the wiring guide. The lead wiring is the same for the 6- or 12-volt supplies. For the 117-volt AC unit, omit the lead

PARTS LIST

For 6 volts DC

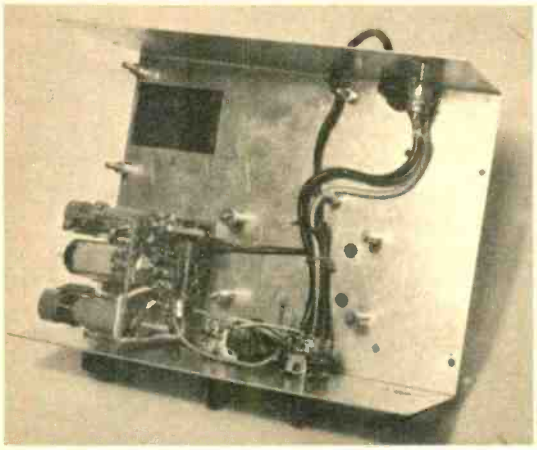
V1B—6-volt vibrator, 4-prong
T2—6-volt vibrator transformer
V5—6X4 tube
C24—.006 mfd, 2000 volt disc buffer capacitor
C25—.22 mfd, 200 volt or higher capacitor
C26—.05 mfd, 400 volt capacitor
C27—.01 mfd, 600 volt capacitor
C21,C28,C29—Triple-section electrolytic capacitor 20-20 mfd @ 450 volts (C29,C28) 20 mfd @ 25 volts (C21) (Mallory FP 345.8)
RFC2—RF choke 2.5 millihenry, @ 100 ma
CH1—Filter choke, 7 henries @ 50 ma (Stancor C-1707)
L6—Hash choke, constructed of 20 turns #16 solid enamelled wire, air-wound with 5/8" diameter
SW1,SW2—4P3T rotary switch (Lafayette SW-30) (Some sections not used)

For 12 volt DC, substitute following

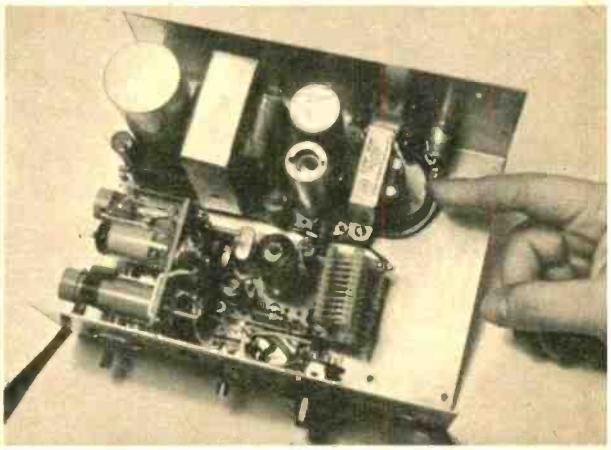
V1B—12-volt vibrator, 4-prong
T2—12-volt vibrator transformer
Note: Replace V4 (6AQ5) in Modulator with 12AQ5 and wire filaments as shown in diagram

For 117-Volt AC

T3—Power transformer, 117-volt pri. 230-0-230 volts sec. @ 50 ma, 6.3-volt sec. @ 2.5 amp. (Stancor PC-8418 or equiv.)
Misc.—7-pin miniature tube socket with shield, 4-pin tube socket, perforated Vectorbord 2 7/16"x5½", shielded phono cable, four 3/8" metal spacers, four 1" 6-32 machine screws and nuts, auto-radio type antenna jack (chassis-mount) and plug, hookup wire

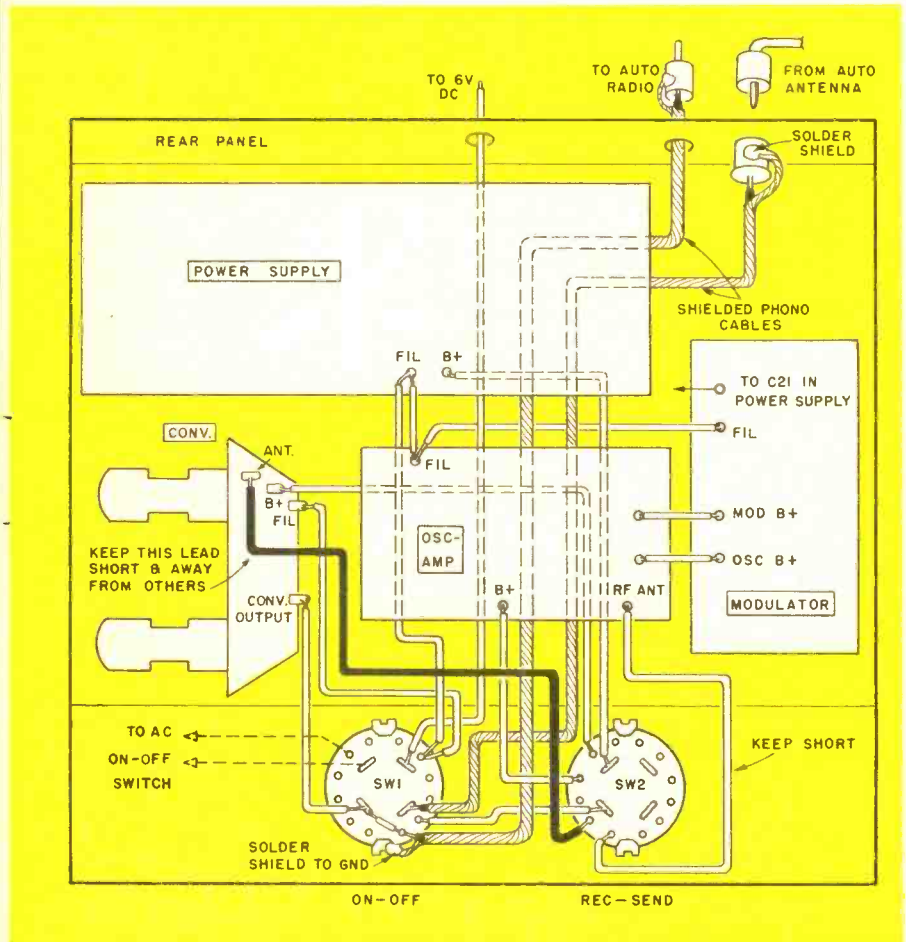


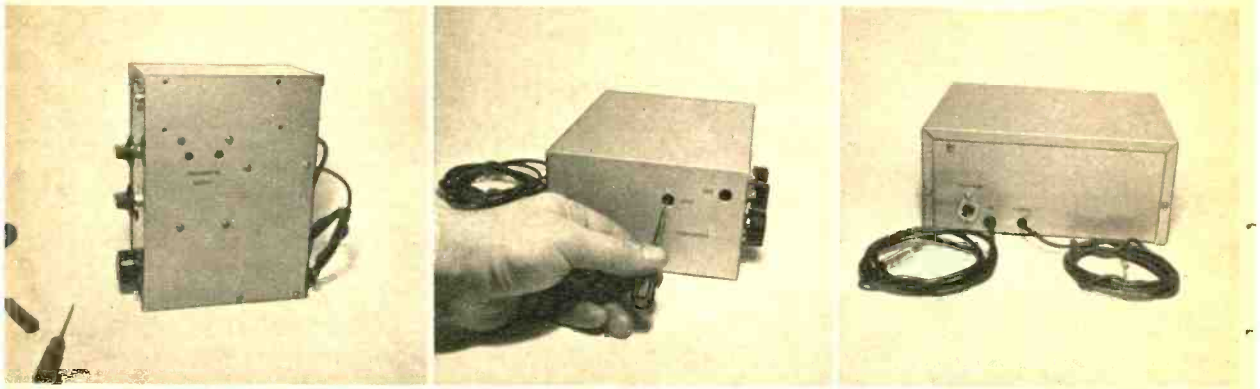
On upper left corner of chassis, strips of tape prevent vibrator socket from shorting to case.



Power supply is shown mounted in chassis. All modules except modulator are also visible.

Wiring guide below shows all modules properly interconnected in chassis.





Bottom, side and rear views of completed unit shows position of holes to be drilled. Rear of unit contains auto antenna plug, and input and output cables.

marked "to 6 V DC" at the top of the pictorial. Instead, substitute an AC line cord and run it through the same hole for connection to the primary of the power transformer.

Putting the rig into operation requires an alignment procedure that should be done with the aid of a voltmeter of at least 20,000 ohms-per-volt sensitivity and an RF output indicator such as the "A Citizens Band Power Indicator" in the June 1959 issue of *EI*.

With the mobile job, pull the antenna plug from the auto radio and insert it into the jack marked *antenna* on the rear of the CB rig. The plug on the CB unit marked *"to auto radio"* should be inserted in the auto radio's antenna jack. Connect the power lead to the source of 6 or 12 volts located on one of the "hot" leads behind the dashboard. Fasten the ground lead and turn the rig on and switch to the receive position.

For 117 volts AC operation, a length of wire approximately 8 feet long is plugged into the CB antenna jack. The cable to the broadcast receiver (marked "to auto radio") should be terminated in a three-turn loop of wire about the same size as the loop on the back of the broadcast receiver and taped flat against it.

Converter Tune-Up

Turn on the radio and tune it to an empty spot on the dial in the vicinity of 1400 to 1500 kc. Insert a thin screwdriver into the access hole for coil L3 and tune its slug until a hiss is heard in the radio's speaker. (L3 is the oscillator coil and serves to adjust the converter's output to the BC receiver). Antenna coil L2 is now tuned until signals in the Citizens Band are heard. Converter alignment is best done with a signal generator, but a nearby CB transmitter will also supply calibrating signals. If a known frequency is received, L2 and L3 may be adjusted alternately so the tuning dial will be at maximum counterclockwise while the lowest Citizens Band frequency is received.

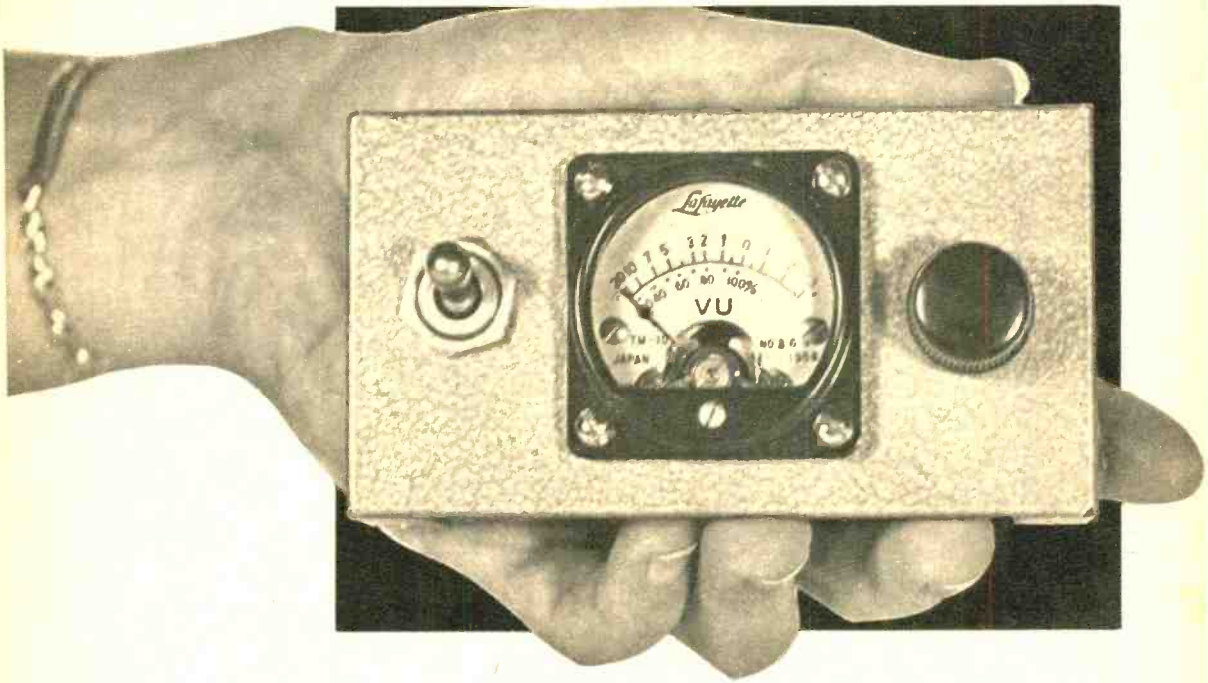
Transmitter Alignment

The first step in aligning the transmitter section is to trim the crystal oscillator for reliable output. Place the negative lead of a voltmeter on pin 2 of V2A, the positive to case ground. Switch to *Send* and tune L4 slug until the meter reading suddenly jumps to several times its initial value; from a volt or two, to about 5-7 volts negative. Switch back and forth between *Send* and *Receive* to make sure that the crystal oscillates each time. If not, touch up L4 until it does. C15 and C16 are in the output section and are tuned for maximum indication on the RF output indicator. You'll find some interaction between C15 and C16, so tune them alternately several times.

The modulator needs no adjustments —simply plug the microphone in.

Once the rig has been installed it will

[*Continued on page* 109]



professionalize your recordings with a

Transistorized VU Meter

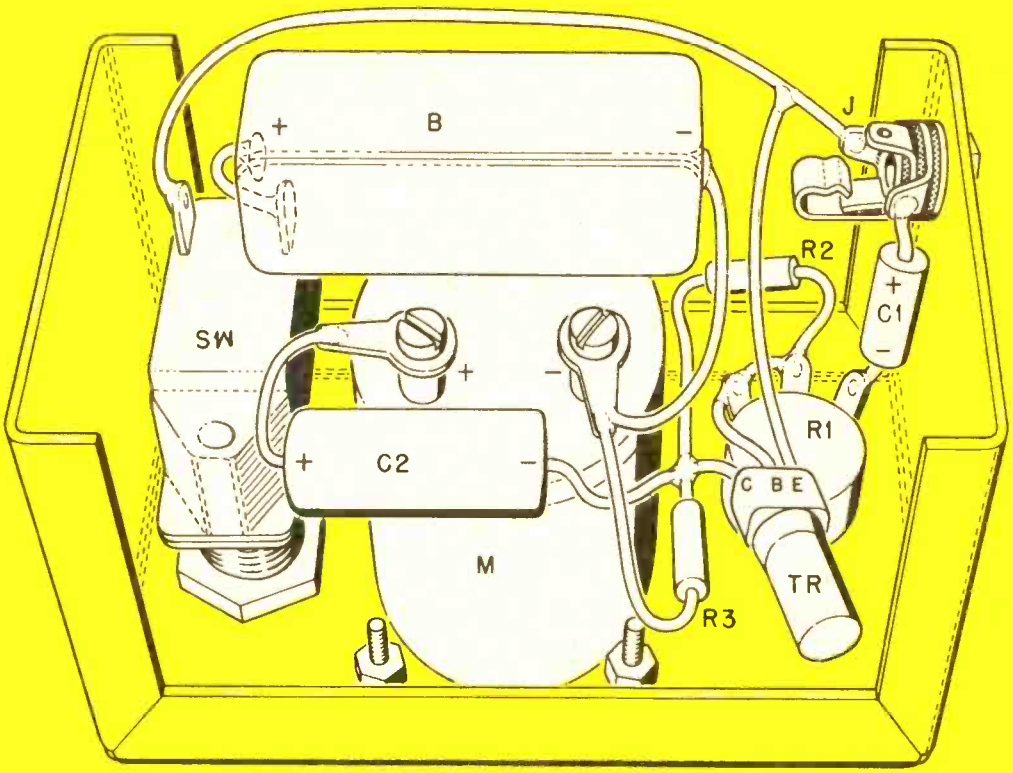
By Harry Kolbe

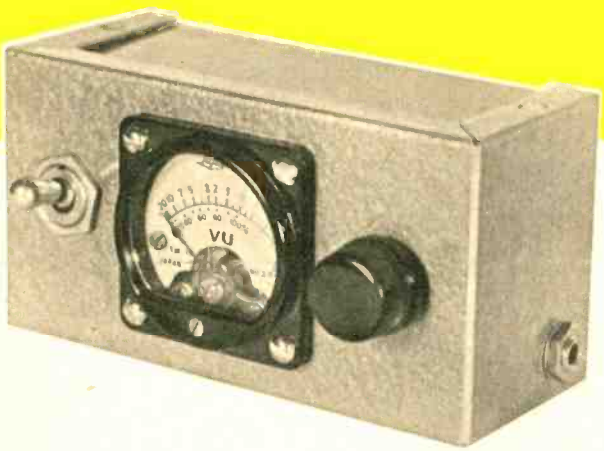
UNHAPPY with the sound quality of the tapes you've been turning out on your home tape recorder? Your distortion and noise problems may be due to an incorrect recording level. If the level is too high, overload distortion results or, if the level is set too low (in an effort to avoid distortion) hum and noise

THE VU METER

Designed especially for reading the intensity (level, volume, loudness) of program material, the VU meter is actually a special type of AC voltmeter. Speech and music, composed of complex audio signals have asymmetrical waveforms and a constantly varying frequency, intensity and duration. VU meters, unlike conventional AC meters, are designed so that their dynamic characteristics (meter needle damping, speed of response, amount of overswing, etc.) enable them to follow accurately the complex audio signal.

The characteristics of the VU meter have been standardized so that under the same conditions it will always read the same on any given program material. For this reason, VU meter readings can be correlated closely with distortion due to overload of the recording head and/or amplifier. In short, the point of first audible distortion will always occur at the same VU reading regardless of the type of program material. The magic eye, neon lamps and conventional meters will indicate overload but *not* by how much, and the reading corresponding to distortion will *not* be the same for different material.





Many of the components shown in the wiring guide above are miniaturized to fit easily into the compact case. A separate subchassis is not needed.

creeps in and you get a poor signal-to-noise ratio. The margin of safety between these two extremes is relatively small, which means that an accurate recording level indicator is a *must* for top quality recordings.

The level indicator employed by the professional is the VU meter. Chances are that your home-tape recorder does *not* have a VU meter but rather a magic-eye, neon lamps or a conventional meter. These less desirable indicators are capable of a fair degree of accuracy when the recordist has acquired sufficient experience to compensate for their limitations, but in the last analysis, the VU

meter is the best recording level indicator—simply because it is designed specifically for this purpose. Unfortunately, the combination of high cost and relatively low sensitivity of the VU meter makes its use with the home tape recorder rare indeed.

The transistor VU meter described here eliminates the problem of both cost and sensitivity. Construction cost is less than ten dollars and provision is made for adjusting the sensitivity of the meter to meet the requirements of your particular recorder. Battery drain is low enough so that, for all practical purposes, battery life is equal to shelf life. Since the VU meter is a low impedance device of low sensitivity (it has an internal resistance of 7500 ohms and a full-scale sensitivity of 1.23 volts), an amplifier of some sort must be inserted between the recorder and the meter.

The amplifier used is straightforward, using a 2N109 transistor in a common-emitter connection. The collector load resistor, R3, is 3900 ohms, which provides the correct source impedance for proper operation of the VU meter. A 22½-volt battery is needed to provide sufficient collector voltage to respond to the voltage peaks which occur in speech and music. Sensitivity is controlled by the 500,000 ohm series input pot. (R1).

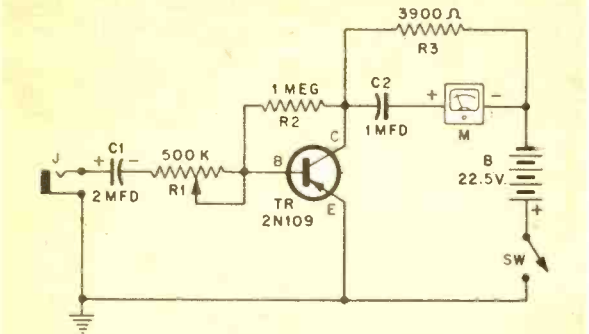
The meter and amplifier are completely contained in a 4″x2⅛″x1⅝″ Minibox. Construction and layout are clearly indicated and no further explanation should be necessary.

The transistor VU meter can be connected almost anywhere in the audio system. However, it is best to connect it to a high signal level point within the amplifier. If possible, connect it to the grid of the last stage. In this case R1 must be set to its high resistance end. This makes for a very high meter input impedance with negligible loading effects. Avoid connecting the meter to points where a high DC voltage exists, such as the plate of an amplifier stage. If you can get adequate signal only at a point where a high DC voltage appears, remember that the input capaci-

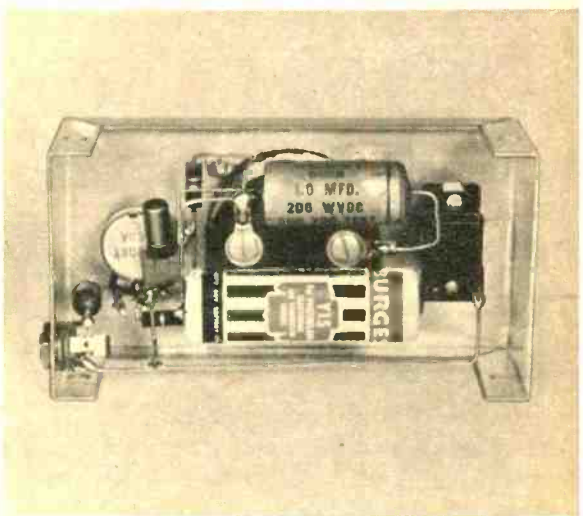
[*Continued on page* 108]

PARTS LIST

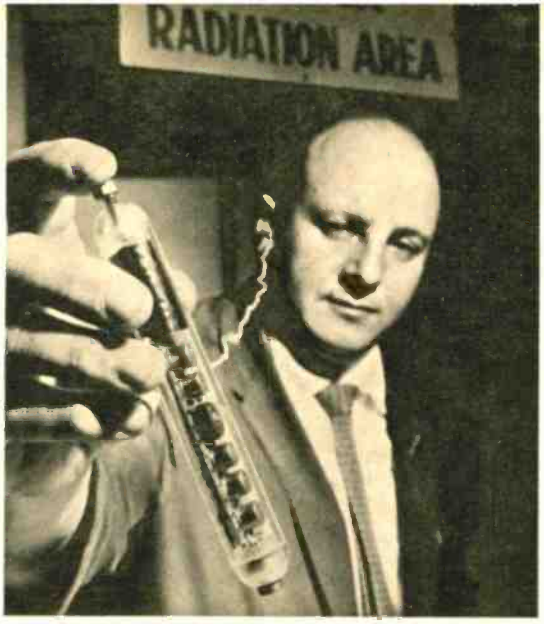
R1—500,000 ohms miniature potentiometer
R2—1 megohm resistor, ½ watt
R3—3,900 ohm resistor, ½ watt
C1—2 mfd 25 volt miniature electrolytic capacitor
C2—1 mfd 200 volt metalized paper capacitor
TR—2N109 transistor
M—miniature VU meter (Lafayette TM-10)
SW—SPST toggle switch
B—22½ volt battery (Burgess Y-15 or equiv.)
J—miniature phone jack
Case—(Minibox CU-2102-A)



R3 provides the recommended source impedance for proper damping of the VU meter.



Neatness of wiring is evident from this view. Transistor socket is suspended by wiring.



The radiation detector, battery and amplifier all are enclosed in this single small package that has been tabbed an "Alpha cigar" by Hughes.

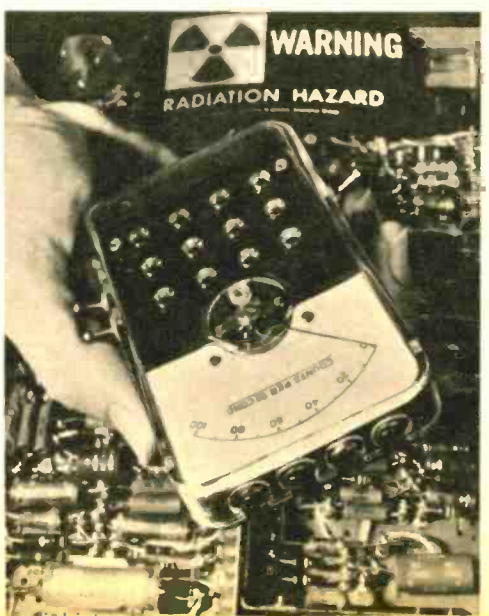
for space, industry and medicine

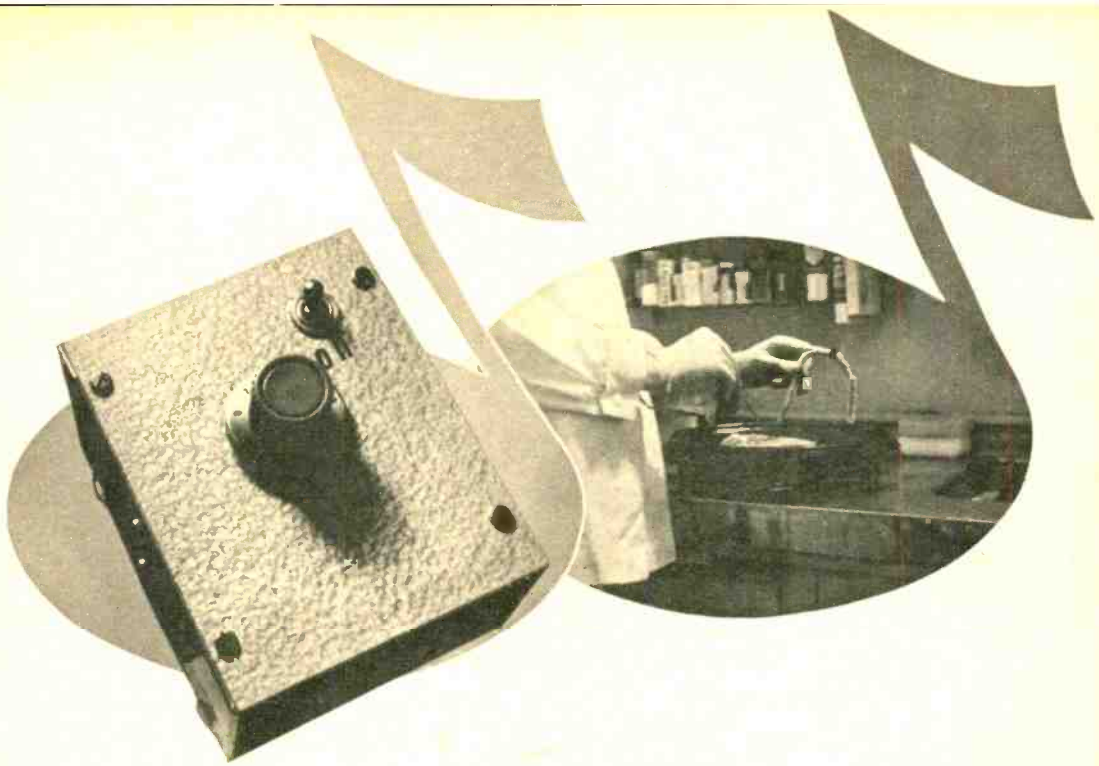
Tiniest Radiation Monitor

IT fits into the tip of a hypodermic needle, operates on low voltage (no big power pack), and is 1000 times faster than previous radiation detectors—that's Hughes Aircraft's new solid state ionization chamber. It's actually a slice of "doped" silicon which emits a measurable pulse when struck by a charged nuclear particle. It may be used for space exploration (precise measurements of cosmic rays), for instant information on ground-level radioactivity, for reactor power control, radiation cancer treatment control, and for various industrial processes.

Here is tiny heart of sensitive but rugged instrument—a very thin slice of doped silicon.

Palm-sized radiation detector will be low-cost, handy for use in industrial radiation surveys.





Electronic Oven Thermometer

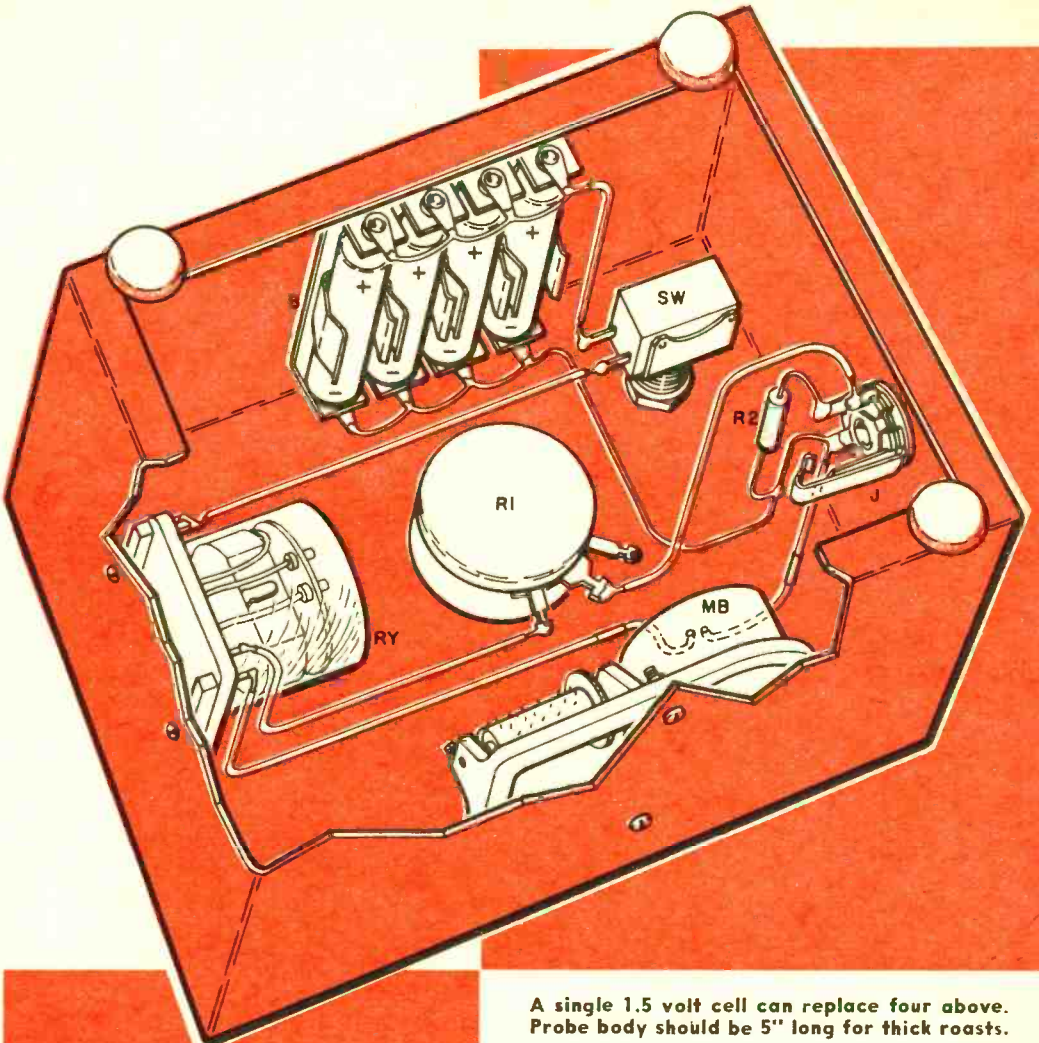
By Steve Hahn

Meat "meter" will play "Smoke Gets In Your Eyes" when the roast is cooked to your own specifications.

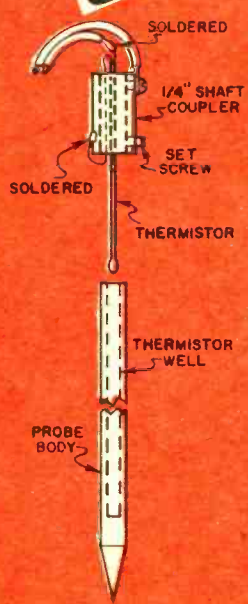
MEN! You can insure yourself against coming home to a burnt-to-a-crisp dinner by building for your wife, mother or girl-friend this simple but super-accurate electronic meat thermometer. Let her wander from the kitchen, take a nap, read or watch TV. When the preset temperature has been reached for succulent ham or rare roast beef, she will be subtly reminded to high-tail it back to the kitchen by a tinkling music-box rendition of "Smoke Gets In Your Eyes." (An alternate appropriate tune also available is "How Dry I Am.") The cable that connects the probe to the rest of the circuit may stretch 50 feet, and the entire device can be constructed for under $10—a bargain.

The entire unit is built into a 3″ x 4″ x 5″ utility cabinet with removable top and bottom. It is desirable to utilize a metal chassis since it will act as a sounding board for the music-box mechanism. Leave off the bottom plate of the utility cabinet and mount rubber feet in the bottom-plate mounting holes, thus raising the entire cabinet ½″ or so off the table top. This allows the sound to escape from the inside of the box.

The circuit is simplicity itself and no difficulties should be



A single 1.5 volt cell can replace four above. Probe body should be 5" long for thick roasts.



encountered in wiring. The temperature sensing probe input jack (J) is of the closed-circuit variety. This jack is wired in such a manner that when the temperature probe is removed, a resistor of approximately the same resistance as the probe thermistor at about 150°F is inserted into the circuit. This allows the user to check the thermometer prior to use merely by turning the temperature control to a minimum setting at which point the music box mechanism should begin to play. Any 1.5-volt battery powers the circuit and it is not necessary to use four batteries in parallel (as we did) unless extremely frequent usage is indicated.

The relay is a sensitive meter type

relay. In some instances, the relay failed to release once it had closed, even though the current was removed. This later turned out to be a blessing in disguise since it simply meant that the music box kept on playing until the box was tapped lightly.

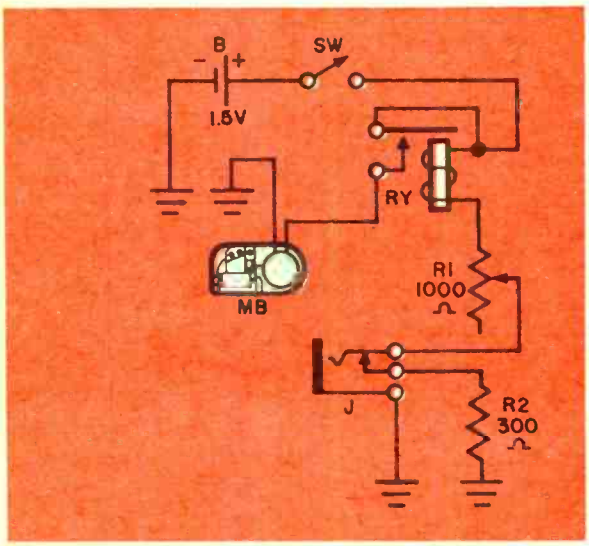
The Probe

The most critical component of the meat thermometer is the probe itself. The heart of the probe is a glass-encapsulated bead-thermistor useable up to 300° C. This thermistor has an internal resistance of about 1500 ohms at 50° C. which drops down to about 100 ohms at 100° C. The probe housing is made from a ¼" round piece of brass, aluminum or stainless steel tubing, up to 5" in length (depending upon the thickness of roasts normally cooked). One end of this probe is flattened and sharpened to a point with a grinder. The thermistor, which comes with glass insulating sleeving, is inserted into the probe and should rest about ½" away from the sharpened end of the probe. Assemble and wire the probe as per the diagram.

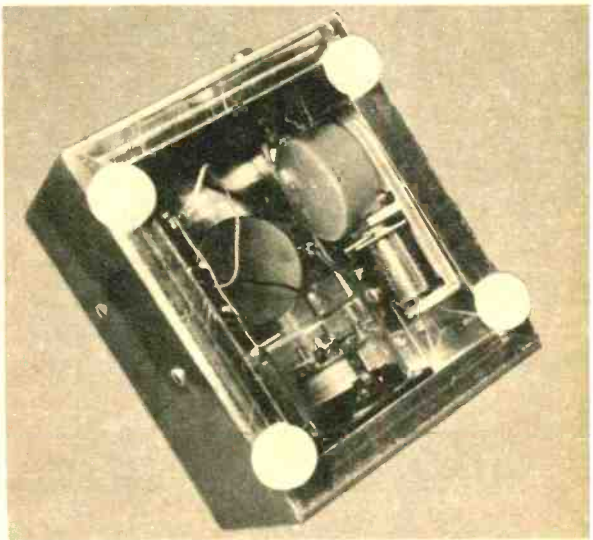
Probably the most difficult step in the whole procedure is the problem of getting a wire which is able to withstand typical oven temperatures—which may go as high as 500° F. For those who want the very best, the Birnback Company makes thin wall Teflon tubing (cat. No. T500) which remains stable over this temperature range. About three or four feet of No. 20 or No. 22 stranded bare wire is soldered to one lead of the thermistor, protruding through the shaft extension bushing. Ordinary radio solder wire which melts at around 600° F. should hold up. The Teflon tubing is then slipped over the entire length. The grounded leg uses #20 or 22 stranded wire soldered or clamped under the set screw of the shaft extension bushing and then wound around the Teflon protected cable. Operation of the thermometer is not [*Continued on page* 99]

PARTS LIST

R1—1000-ohm wirewound linear taper potentiometer
R2—300-ohm resistor, ½ watt
SW—SPST toggle switch
RY—relay (Lafayette F 482)
J—phone jack, normally closed
B—1.5 volt battery
MB—1.5 volt music box movement. Lafayette MS-761, "Smoke Gets in Your Eyes," or Olson X-768, "How Dry I Am"
Thermistor—Glennite Type 32P82
Case—3"x4"x5" (Bud CU-728B or equiv.)



Normally-closed jack J, places R2 in circuit, permitting user to check unit prior to use.



Four rubber or plastic feet (in white) serve to raise cabinet, for greater music volume.

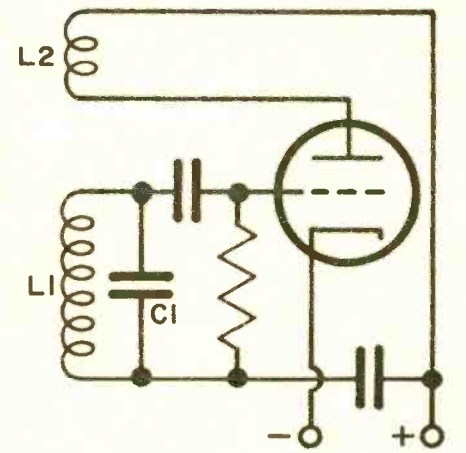
Electronic Brain

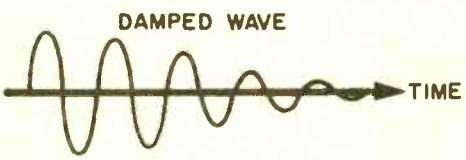
Have you any questions on electronics? Send it in and the Electronic Brain will provide the answer.

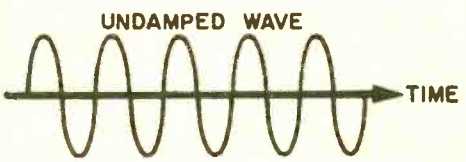
Armstrong Oscillator

Can you explain why the circuit shown oscillates?

Richard Pomp, Newark, N. J.







The basis of any oscillator of this type is the resonant circuit formed by L1 and C1. The oscillator you have drawn is the Armstrong series-feed type.

If C1 can receive a charge from some source in the circuit, it will discharge through L1 in an oscillatory manner, producing a sine wave that quickly damps out due to the resistance present in the coil and connecting wires. This is true of any capacitor-coil combination whether it is connected in a tube circuit or not.

The tube and the rest of the associated components should be viewed merely as "helpers." The oscillatory energy passing back and forth from L1 to C1 causes the voltage on the grid of the tube to vary at the same frequency. This then produces a variation in plate current flowing through L2; due to the inductive coupling between L2 and L1, a part of the plate circuit energy is fed back into L1 so that the *resistance losses* are compensated for and the original damped wave is changed to an undamped oscillatory voltage. This is comparable to the mechanical analogy of the pendulum in a grandfather clock: the pendulum tends to swing back and forth whether it is connected to the clock mechanism or not; all that the spring and escapement does is feed small amounts of energy to the pendulum to make up for the friction and air resistance losses it suffers as it swings.

In both the vacuum tube oscillator and the pendulum, the bits of feedback energy must be properly timed so that the natural frequency of oscillation undergoes no interference. Timing in the oscillator is effected by phasing L2 properly with respect to L1; in the pendulum, the escapement mechanism dictates the right instant at which the spring adds some of its energy to the pendulum.

Tachometer

Is it possible to build an electronic tachometer to check the RPM of small electric motors?

Leo Michaels, Wheeling, West Va.

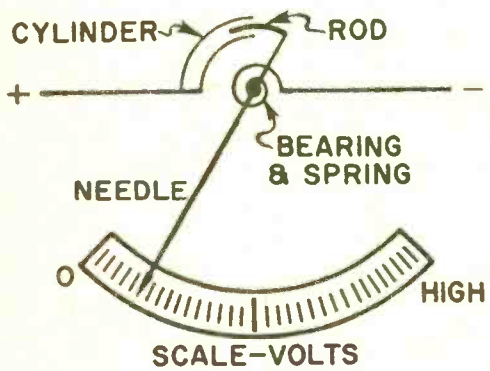
An electronic tachometer was described in the July issue of *Electronics Illustrated* on page 81. This tachometer can be used to measure the RPM of any rotating device. This meter is available in kit form from Heath.

Electrostatic Voltmeter

I have been told that the right way to measure the voltage across a Geiger counter tube is by means of an electrostatic voltmeter. What is this instrument and how does it work? Can an ordinary test voltmeter be used to measure from 900 to 1,000 volts on a Geiger tube?

Fred E. Follis, Nashville, Tennessee

A good vacuum tube voltmeter *can* be used to measure voltages across Geiger tubes provided that the input resistance is 25 megohms or higher. The need for this high input resistance arises from the fact that the power supply ordinarily used to energize a counter tube is not designed to supply more than a few microamperes of current. If the meter needs current to deflect its needle, this would reduce the voltage—often seriously—so that the reading



would be unreliable. This would be true, for example, if you attempted to measure this voltage with an ordinary volt-ohmmeter or multitester.

An electrostatic voltmeter is a simple device in which the attraction of unlike charges is made to produce a deflection of a needle. As the deflection is proportional to the *square* of the voltage, its scale must obviously be non-linear; it is crowded at the low voltage end and spread out at the high voltage end. The instrument must have a very well-balanced, frictionless bearing since the attractive forces are quite small, even for the higher voltages. Unless one has machinist's facilities, it would hardly pay to attempt to build an electrostatic voltmeter for the use you mention. Essentially, the instrument is intended for precise laboratory work rather than test purposes.

The diagram shows the essential parts of a popular type of electrostatic voltmeter. The return spring holds the needle on zero when there is no applied voltage. When connected to a source of potential, the curved cylinder attracts the rod so that it moves further to the left, causing the needle to move across the scale. The instrument must be calibrated with accurately known sources of voltage.

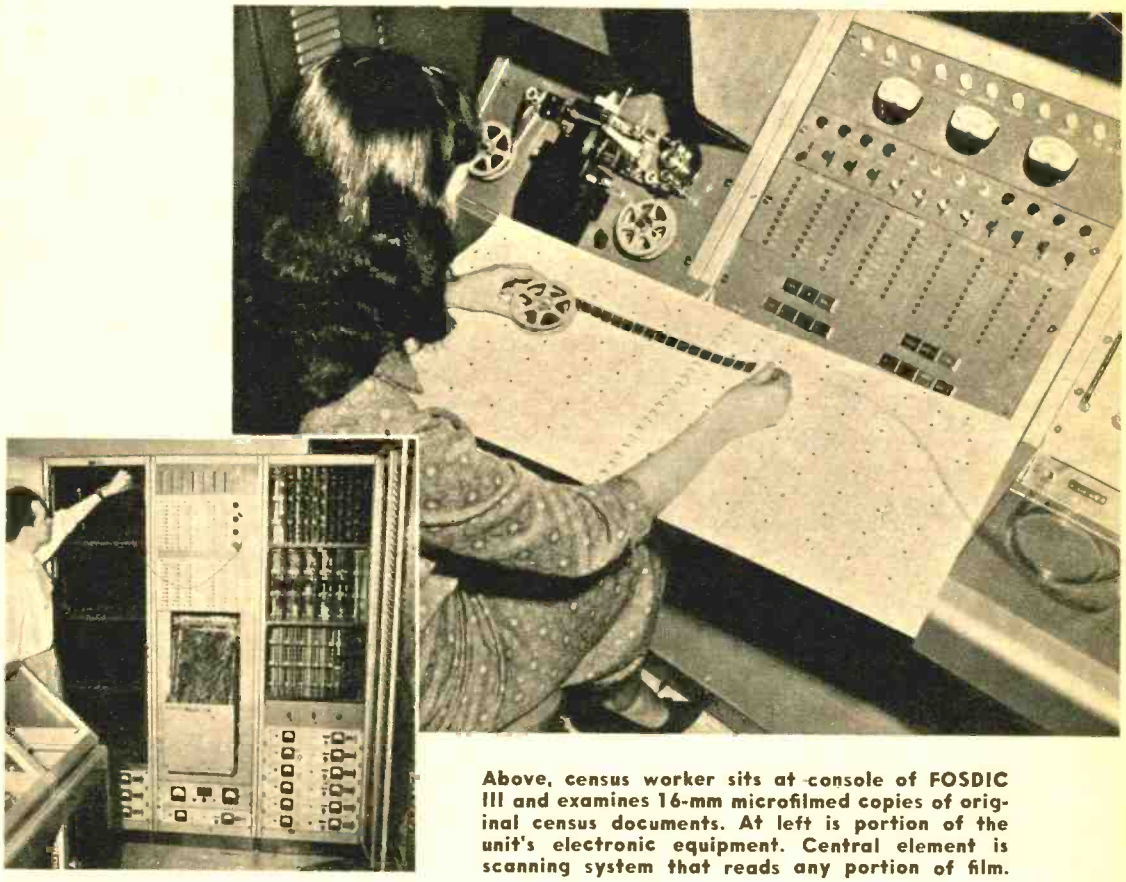
AC/DC Receiver

One side of the loop antenna on my AC/DC radio accidentally came in contact with an external ground. When this happened, something in the radio was damaged. Can you tell me what it might be?

James Moody, Dayton, Ohio

In most cases, experiences like yours can be explained when we remember that many AC/DC radios are still poorly designed. One end of a loop antenna should be at signal ground potential; when the manufacturer is careless, he allows this common ground point to be the same as the B— of the receiver. In an AC/DC set, the B— point is often connected to one lead of the AC line cord and hence the AC line.

If the radio's AC plug happens to be placed in the receptacle so that this particular lead joins the ground system of the house, nothing can happen. But there is a 50-50 chance that the plug is reversed from this position, placing the B— point (hence the whole loop) at the potential of the "hot" side of the AC line. Now should the loop touch a radiator or pipe, the current that flows through it will be determined only by the resistance of the loop wires connected right across the 117-volt outlet. This resistance is small, hence the current flowing may be several amperes—more than enough to melt one of the loop wires or one of its solder joints. It would appear that you have an open or high resistance circuit somewhere in the loop and its associated wires.



Above, census worker sits at console of FOSDIC III and examines 16-mm microfilmed copies of original census documents. At left is portion of the unit's electronic equipment. Central element is scanning system that reads any portion of film.

fosdic III and the

'60 Census

Electronics lends a much needed helping hand to the census takers for this big once-in-10-years event.

IF you haven't already, you'll soon be filling in the decennial census form, 1960 version, designed to include every U. S. family. Nearly 160,000 persons will be employed by the Bureau of the Census to collect and process this data. The National Bureau of Standards has made their job easier by developing FOSDIC III (Film Optical Sensing Device for Input to Computers), an electronic workhorse that rapidly reads (detects) pen or pencilled marks in multiple choice answer areas that have been microfilmed. The information conveyed by these marks, scanned by an electron beam and photocell, is automatically coded into computer characters and then recorded onto magnetic tape. Thus FOSDIC III takes human information, identifies it, and converts it into computer language with electronic speed.

How to Test Your HI-FI

THE EAR AS A TEST INSTRUMENT

THE most versatile and sensitive of all hi-fi test instruments is the human ear. This is convenient because when meter, generator and scope remain at home, our ears are along, ready for instant appraisal of a friend's hi-fi components or for sizing up some new item at the store.

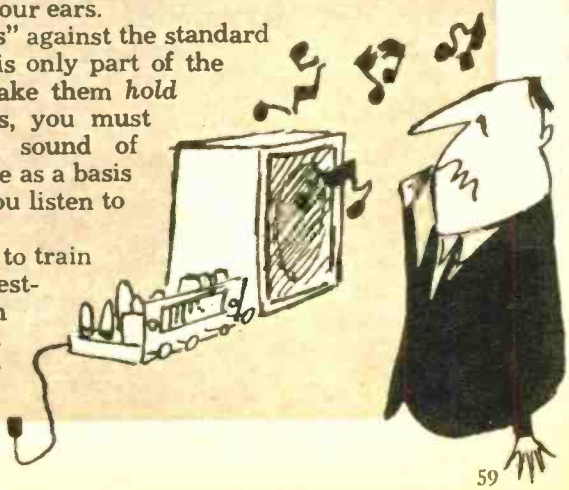
If properly used, ears are the best yardstick to measure the merits of any sound system. That's why experienced hi-fi designers, after all measurements are made, put away their instruments and let the ear be the ultimate judge.

Such critical "evaluative" listening is neither simple nor can it be casual. If the ear is to serve as a gauge, it must—like all test instruments—be calibrated to a standard. This standard, of course, is the actual sound of "live" music.

Compared to other primary lab standards—which sometimes cost thousands of dollars—this one is cheap to come by. A two-dollar seat for a good symphony concert and careful listening are all you need to "calibrate" your ears.

But "calibrating your ears" against the standard of actual orchestral sound is only part of the job. The real trick is to make them *hold* calibration. In other words, you must accurately *remember* the sound of "live" music to make it serve as a basis of comparison later when you listen to your hi-fi system.

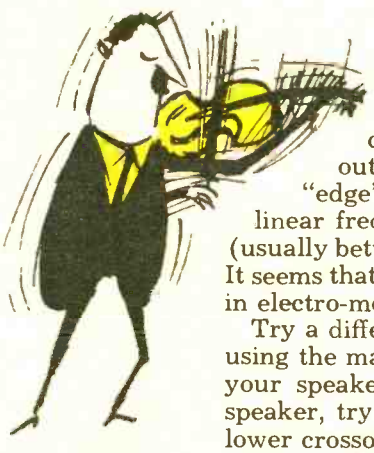
Fortunately, it *is* possible to train our tonal memory for hi-fi testing. The main thing in such training is to know just what to listen for. Here we



shall try to isolate and define these tell-tale factors in tone. When you get them firmly in mind, they are as clear in their indication of hi-fi quality as the meter of a tube tester: your trained ear can immediately flash you the signals—"good," "no good," or "so-so."

Good aural test material includes strings, percussion, brass, organ, male speech, etc. Each reveals specific performance factors in a hi-fi system. We have incorporated a number of these musical "telltales" in the *EI* Test Record; but they must be supplemented by frequent and careful listening to *live* music to achieve a permanent "built-in" standard of quality comparison.

Strings and Full Orchestra



Listen for silky sheen in the violins; solid weight in cellos and contrabass and clear separation of individual instruments throughout the entire frequency and dynamic range.

The massed strings of a first-rate symphony orchestra should have a clear, smooth brilliance without a trace of fuzz or stridency. Is there a rough, grating "edge" in the violin sound? That's a tell-tale sign of nonlinear frequency response. It may mean that there is a peak (usually between 5,000 and 10,000 cps) in your pickup or tweeter. It seems that engineers find it far more difficult to obtain linearity in electro-mechanical devices than in the purely electronic ones.

Try a different cartridge and tweeter, and make sure you are using the manufacturer's recommended crossover frequency for your speaker system. If you have only a single "full-range" speaker, try adding a good tweeter which uses a 1000-cycle or lower crossover network.

Full orchestra is the payoff. All the factors we need to consider combine into the making of orchestral sound. For instance, the benefit of good transient response is not confined to percussion alone. The tonguing of the woodwinds, the cellist's bow digging hard into the string—all these come into sharper focus in a sound system with good transients. The whole texture of even the heaviest orchestral passage stays amazingly "transparent" when you have a good amplifier and loudspeaker.

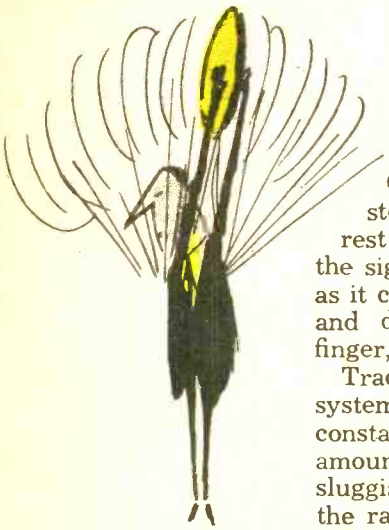
Brass

Listen for metallic blare and brassy "edge." There should be no harshness, buzz or breakup.

The bold tone of a loud trumpet is one of the best checks for upper midrange frequency response. It should come through with a tingling metallic edge. You recall the brassy blare of a bugle call and the almost bell-like ring of a marching band; listen for it. If instead you hear a dull, spongy sound, chances are that one of the components in your system restricts the range. Check your pickup and your tweeter.

But don't mistake harshness for brilliance. For all its sparkle, the trumpet should stay sweet. A tinny, grating sound betrays the presence of distortion perhaps in the amplifier or in a peaky tweeter. But your first suspects should be a worn stylus or an unyielding, low-compliance pickup. Your tone arm may be stiff in the joints. If you hear a rattle or buzz, it's a good idea to check the stylus pressure of your arm—it may be too *light*.

Percussion

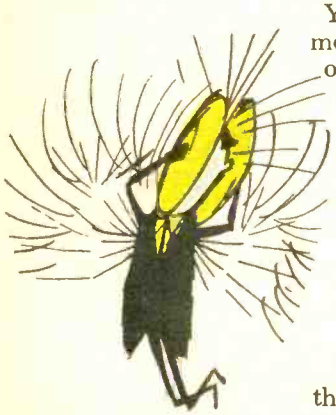


When the drummer's stick crashes against the tight skin of the drum, there is an almost explosive moment of hard collision, a sharp, articulated impact. It lasts only a split second and is gone; but for your hi-fi system this kind of "hit-and-run" sound is the "moment of truth." Crash-and-bang sounds viewed on an oscilloscope have steep wavefronts, rising like peaks above the ripples of the rest of the music. This abrupt change in the amplitude of the signal is called a "transient" because it is gone as quickly as it came. It is the moment of brief encounter between drum and drumstick, xylophone and mallet, harp and plucking finger, etc.

Tracking such transients is a task that really puts your hi-fi system on its mettle. What with capacitive and inductive time constants in nearly all its circuits, your amplifier has a certain amount of electronic inertia. When the transient comes along, a sluggish amplifier just can't jump fast enough to keep pace with the rapid signal change. Result: the transient waveform gets bent out of shape and loses its sharp contours. What does this mean to the ear? Simply this: instead of a sharp, exciting "click" you're more likely to hear a "clunk."

So far in our discussion of transients we have concerned ourselves only with the "arrival" of such sounds—their steep initial wavefront. Yet the departure of these percussive sounds, the moment of their stopping, is equally important to their faithful reproduction through the loudspeaker. Here again the attentive ear renders "data" in many ways more informative than instrument readings obtained in anechoic chambers.

One of the common troubles of inferior amplifiers is that they literally don't know when to stop. The transient sound (let us again visualize the impact of stick against drum skin) provides so much power that, like a bell that has been struck, the amplifier may continue ringing long after the initial pulse is gone. An amplifier needs lots of "self-control" to check such spurious oscillation. Technically such self-control is usually achieved by good design and careful attention to circuit details. The knowing ear, remembering the sound of "live" music, can readily spot such "runaway" amplifiers by the blur trailing the drumbeats.



Yet the chief culprit that robs percussion of its keen edge is more likely lurking in the loudspeaker. After the sudden swing of the speaker cone that mirrors the motion of the struck drum skin, some speakers keep jiggling after the original sound is silenced. In doing so, they not only tend to falsify the percussive stroke itself, but blur whatever follows it. This so-called "hangover" (no relation to the familiar "morning after") may last for only a fraction of a second. But this is long enough to wipe out the sharp contrast between the percussive portion of a sound and the sustained note following it.

Good damping, therefore, is one of the prime requirements of a quality loudspeaker. It is attained in two ways: 1) By a magnet powerful enough to "inhibit" the speaker cone so that its motion remains strictly proportional to the signal wave-

form—in other words, the cone gets no chonce to do any uncontrolled jiggling of its own. 2) By an enclosure or baffle so matched to the speaker as to provide adequate "loading" of the cone. This means that at the critical bass frequencies, the acoustical conditions are such that air masses keep the speaker from running away with itself.

One final caution: In judging the transient response of a hi-fi system on the basis of percussion music, you must make allowance for the acoustics of the recording hall. Don't mistake natural reverberation in the hall for "hangover" in the playback system. Natural reverberation lends body to the percussive sound by adding a normal echo. "Hangover" adds only unrelated random vibration that strikes the ear as a fuzzy smear of sound.

Organ

A large pipe organ with its gigantic 16-foot and in some cases even 32-foot pipes provides unique tonal test material for loudspeaker bass response.

The lowest pedal notes of a large pipe organ reach to the very bottom of the audible range, producing those majestic tones in the 30 cps region that are the massive foundation of the entire tonal structure of organ music. This is the ultimate touchstone for your woofer and its housing.

To sound such deep tones with all their original beauty and power, the woofer must vibrate at the low fundamental frequency. Inferior speakers often "break up" on such low notes, producing merely the harmonics of the bass without the real fundamental frequency. Usually the octave above the true bass becomes prominent. This type of distortion is therefore called "doubling." Some manufacturers of inferior loudspeakers deliberately exploit this effect because the false octave plays tricks on the ear and makes the bass seem louder and more impressive to the listener who doesn't know the real thing. What really counts, musically speaking, is whether your woofer responds cleanly to those soft, low notes that lend a feeling of richness and solidity to the entire musical texture. Listen to the "feel" of such low pedal notes on the pipe organ. If they come through clean you get a sort of velvet impression—soft, but with a sense of great power. Even though a really low note may seem barely audible, the whole room seems filled with it.

If the organ passage played on the *EI* Test Record lacks solid-bottomed bass, it's a fairly safe bet that either your amplifier or your speaker are skimpy on lows. If you know that your speaker is capable of reaching down to 50 cps or lower without loss of volume and you still don't get that heavy, massive bass feeling—better check the power response of your amplifier. If the manufacturer's specs say your amplifier is in the 12-watt class—it may deliver those 12 watts all right in the midrange region, but get short of breath lower down where the heavier bass amplitudes demand plenty of electronic "muscle." That's why higher wattage amplifiers (20 watts and up) with their ample reserve power are good insurance that you're really getting all that rich, solid bass that forms the foundation of orchestral sound—providing, of course, that your speaker delivers what your amplifier puts out.

Male Speech

Listen for normal voice quality—lack of beer-barrel bass. Smooth, not overly sibilant "esses."

The male speaking voice readily shows up cases of "boom boxiness," a widely prevalent evil among loudspeakers *mis*matched to their enclosures. Bass reflex baffles are particularly prone to this difficulty. The acoustic mismatch results in a resonant hump in the 70 to 100 cps range which may sound "mellow" to undiscriminating listeners —but actually blurs everything to a dull boom.

Tune in any good radio station (preferably FM) and listen to the announcer. Does he sound as if he were talking inside a beer barrel? Well, either the announcer is barrel-chested or you have a boomy speaker enclosure—and we'll give you odds on the latter. As a remedy for your phonograph's "chest cold" try lining (or adding more) the inside of the speaker baffle with Fiberglas or some similar sound-absorbent padding. Try tacking a layer of burlap over the port opening.

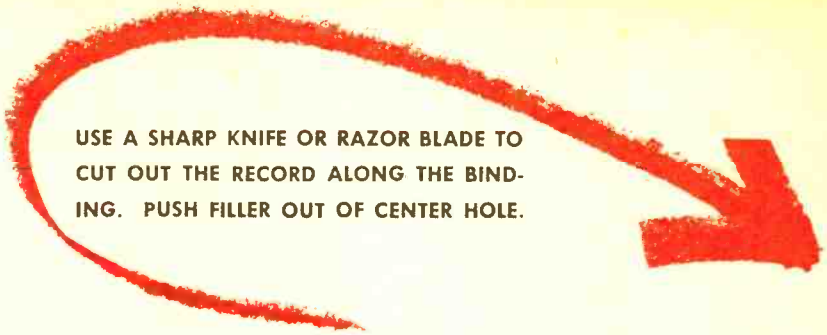
In some obstinate cases it may be necessary to change the area of the bass port opening so that the reflex enclosure is properly "tuned" to the loudspeaker's cone resonance. It's a simple enough cure and very worth while, because the "chest cold" boom of your loudspeaker will give a splitting headache from "listener fatigue" if you play music for any length of time. The effect is somewhat like monoxide exhaust gas; you don't notice it at first, but the strain builds up fast.

Summing Up

So far, we have made no reference to stereo. Not that we want to slight this vital innovation; but all we really need to explain about it is that everything we said "goes double" for stereo.

You have put your sound system to the test. You have charted its merits and its shortcomings in terms of musical performance. Now—listen to the *music*, rather than the *sound*. For the purpose of high fidelity is to *clear away* obstacles between you and the music, not create new ones.

THE EI HI FI TEST RECORD



The EI Test Record contains musical selections and frequency tones which you can use to check out the fidelity of your music reproducing system. For details on how this works refer to the preceding article, "How To Test Your Hi-Fi."

HOW TO USE THIS RECORD:

If you have a record changer set it for manual operation and place the tone arm on the first groove. If your turntable has a ridged rubber or plastic mat, first place a standard record on the turntable and then place the EI Test Record on it and tape down the corners. Adjust the volume of your system so that the 1000-cycle reference tone is at normal listening level in your home; set the tone controls to the "flat" position; the equalization control (if present) should be set to RIAA.

What to Listen For, Band-by-band:

1. **1000 cycles**—Listen for wow (a slow rise and fall in pitch) indicating variation in turntable speed.
2. **12,000 cycles**—Can you hear it? This tests the upper frequency limit of your ears, tweeter (or full range speaker), and phono cartridge.
3. **100 to 40 cycle sweep**—Does your speaker system suddenly boom out at one point in this sweep? If so, you have found its resonant peak. Also listen for rattles in the speaker cabinet.

The musical tests. Unlike the preceding three bands, the musical tests are comparative. Each of the selections is played twice. The first time each selection has been recorded with the highest fidelity. It is then immediately repeated, but now the sound has been degraded so that it resembles what you hear from a poor phonograph. If you cannot tell the difference between the "good" and "poor" then your system makes all recordings sound poor. If you can hear the difference on certain bands and not on others refer to the article "How To Test Your Hi-Fi" for further information.

4. **Clarity Test**—(selection from Mozart's *Symphony No. 40* on Westminster record XWN 18527). Listen for clear and full string (violin, viola) section, smooth treble.
5. **Transient Test**—Listen for clearly defined triangle, bells, woodblocks, snare, bass and kettle drums. Each sound should begin and end sharply without blur or fuzzy fadeout.
6. **Brilliance Test**—(selection from Kodaly's *Hary Janos Suite* on Westminster record WLAB 7034). Listen for shiny brass, brilliant blare of trumpet.
7. **Bass Test**—(selection from J. S. Bach's *Passacaglia in C Minor* on Westminster record XWN 18260). Listen for the low pedal note at the end. The first time you should hear that final low C in its soft but full sonority; the second time around it is missing due to bass cutoff.

TV Tape Takes to Road

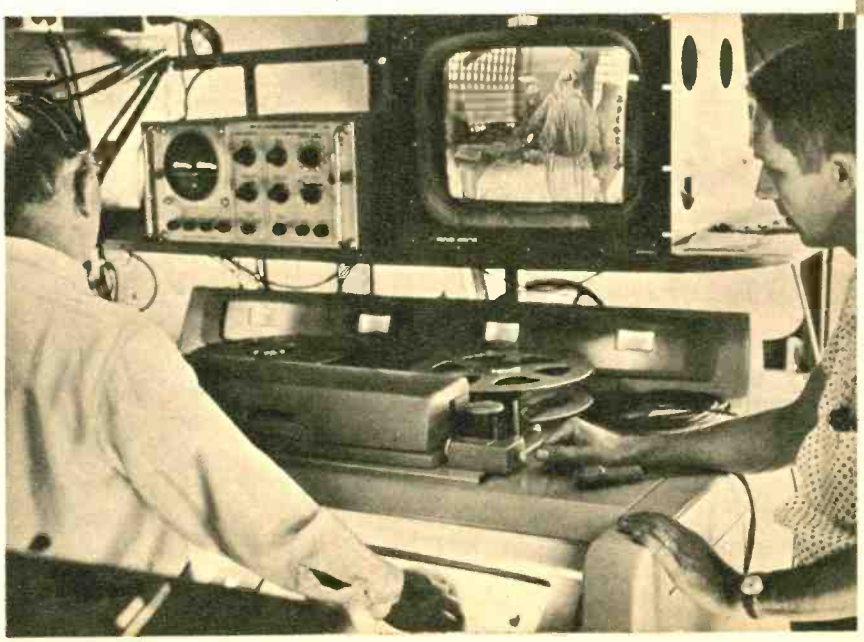
Have you noticed "live" location pictures on your TV screen lately? It's probably mobile videotape.

WHEN Soviet Premier Nikita S. Khrushchev visited a farm and meat packing plant at Coon Rapids, Iowa, CBS-TV newsmen knew they had a scoop. No, they weren't the only ones there. The other two networks also had plans to use videotape coverage of the event on their newscasts, since tape requires no processing time and yields "live" fidelity pictures. But only the CBS-contracted Giantview mobile videotape unit was able to follow Mr. K. as he ambled around farm and packing plant.

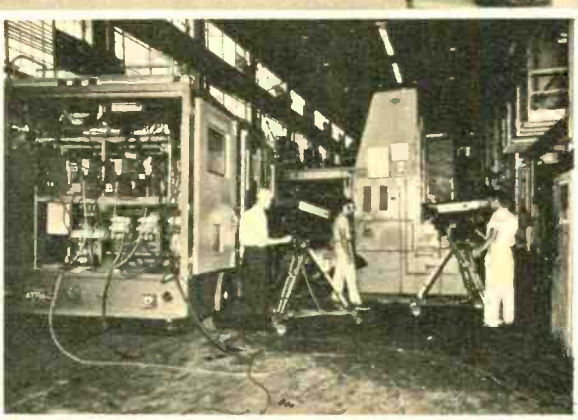
The Giantview unit can capture broadcast quality pictures on videotape at almost any location. What does this mean to the TV producer and director? Cut costs, for one thing. What does it mean to you, the viewer? Good, authentic backgrounds that studio-anchored cameras cannot get. A director can shoot westerns, commercials, sports events, etc., at remote locations, check the results on the spot, and reshoot those scenes which do not satisfy him without having to wait for a film run.

On board the truck are an Ampex videotape recorder with cue and erase channels, editing facilities, four TV cameras which are electronically switched and mixed, audio recording facilities with six microphone channels, lighting equipment, monitors, cables, a complete servicing shop and radio-telephone.

A hospital documentary is recorded and played back on the spot inside six-ton truck that houses complete gear for recording, editing and repairing.



Cameramen on non-skid roof of truck and on ground level aim lenses at performers on location for TV commercial.



Cameras, plugged into truck, move right in on demonstration of machine tools that are to be auctioned via television.

Man, upper right, has a "long lens" on camera while others in recording crew get ready for Mr. K's Iowa farm visit.

June, 1960

spotlight on:

6-Meters

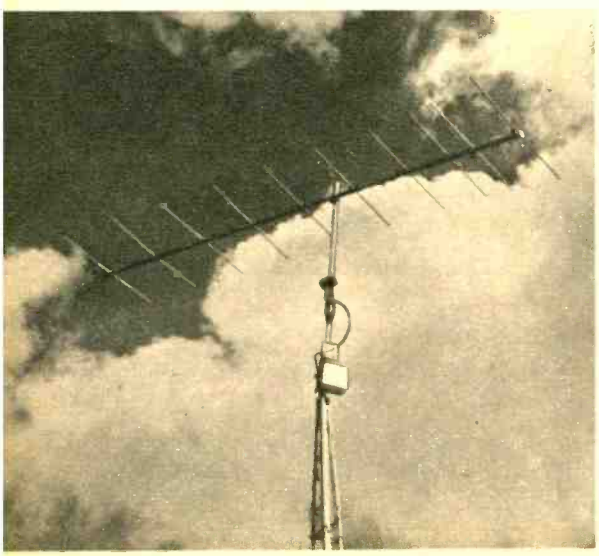
By C. M. Stanbury II

Reliable short-range communications, mobile operations and even some exciting DX—that's VHF on 50-54 mc band.

PRIOR to World War II, all of VHF (30-300 mc) was experimental territory. Efficient equipment for this frequency range was in the developmental stage and no reliable long range communication was available. Wide band television and FM broadcasting were not yet commercial. After the war, when they were ready for the public, VHF mushroomed into a first rate and popular means of communication.

The first VHF amateur band (after VHF was divided into bands), was five meters—roughly where TV Channel 2 now meets Channel 3. Later it was dropped down to 54 mc, just below Channel 2. While pioneering VHF, hams made two important discoveries. First they found that dependable short range QRM-free communications were easy to establish. This offered many

At left is highly directional multi-element beam for six meters (TACO model 10A6M). At right, 1960 Edison Award Winner, Walter Ermer, Sr., picks up mike of ham-equipped sports car to discuss traffic patrol problem with other public spirited hams assisting Cleveland police during parade. Note horizontally polarized mobile six meter antenna. CD, RACES use six meters.



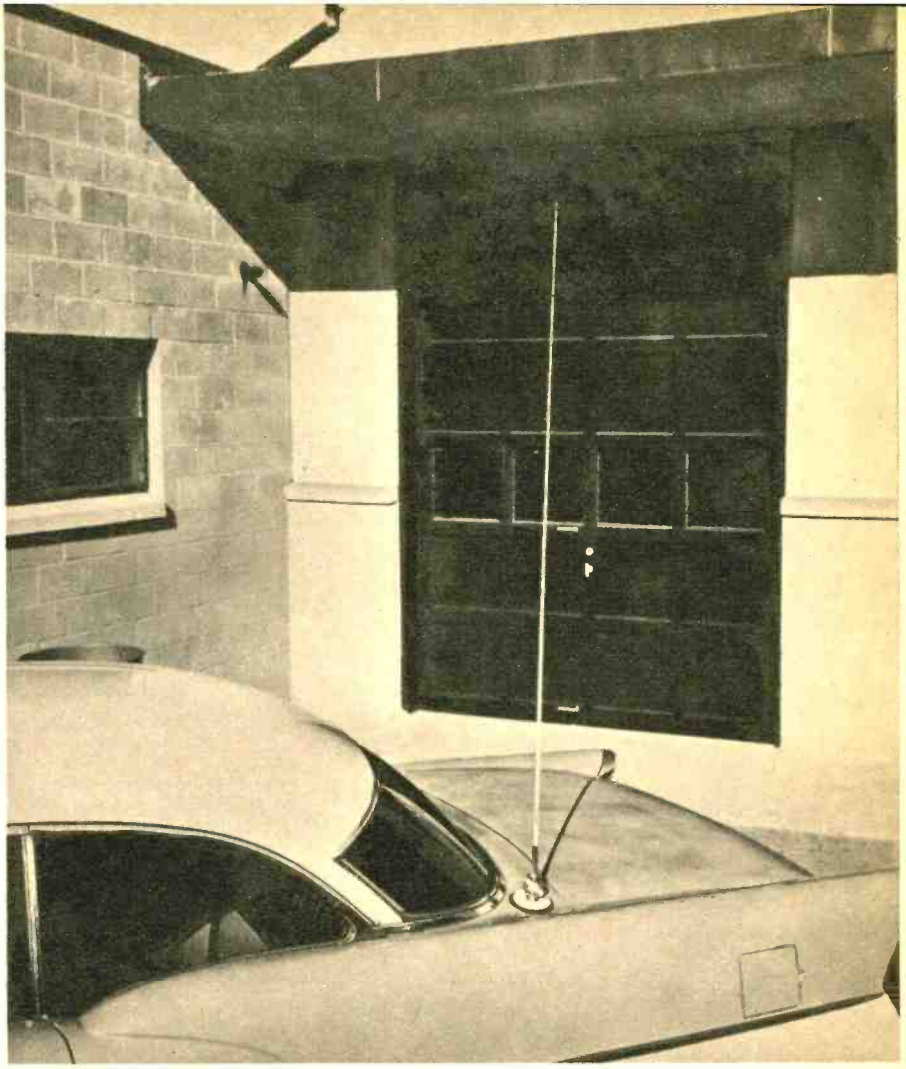
Primarily for General and Technician Class licensees, Heathkit "Seneca" transmitter tunes up on all the VHF ham frequencies, covering both six and two meter bands. It has built-in VFO, four crystal positions and delivers 120 watts input for phone work.

advantages for amateur radio communications. Secondly, VHF DX was not only possible, but in some respects even more exciting than its shortwave counterpart.

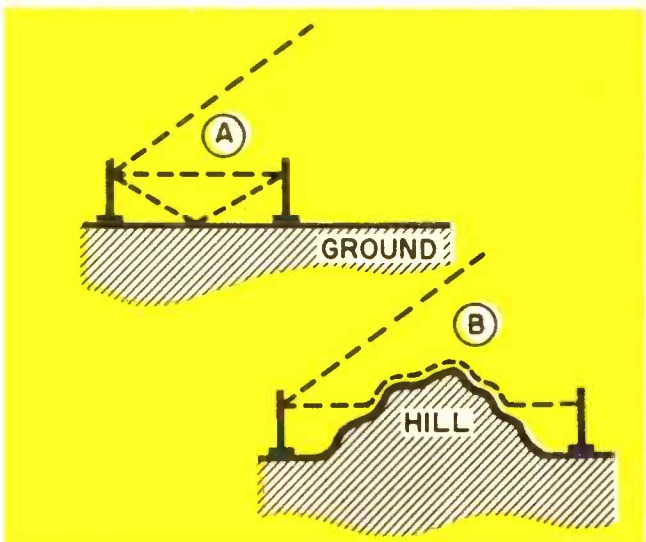
Under normal conditions (and we use the term loosely), six meter transmission (50-54 mc) is limited to space wave reception and, to a certain extent, by the line of sight principle. Of course, the higher your antenna, the broader your horizon. Signals can be received beyond line of sight range with the help of a slight bending effect always present in the lower atmosphere. Diffraction also may add distance. Such "normal" beyond-the-horizon propagation improves as the frequency drops. A well-known example of this is TV Channel 2, often received at far greater distances than channels at higher frequencies.

There are two major sources of DX in VHF. Tropospheric inversion (ducting) can produce distances up to 500 miles or better. Upward extension of ionospheric effects can do the same. From a DX standpoint, the latter is a key factor on six meters, so we'll look at it in detail this month, and do the same with the troposphere next month.

With a high sunspot count, the F2 layer will become ionized to the point where it will reflect frequencies above 30 mc. This usually occurs during fall or early winter, and only at certain



The non-directional, vertically polarized whip antenna is popular for mobile ham operations on six meters. Length of a six meter whip is about 54 inches. This Shakespeare Wonderod (model 10-1) is attached to car by a simple ball mount.



A) Six meter communication occurs via direct space wave and reflected ground wave. Latter is out of phase and reduces signal strength, thus antenna with maximum radiation parallel to ground is best. High angle radiation probably will not be returned to earth. B) Diffraction can bend VHF frequencies around curvature of earth only for short distances.

hours of the day. Transmissions are generally limited to one, or at best two hops. Far more common is Sporadic-E layer reflection. This has the same maximum hop distance as the normal E layer (approximately 1200 miles), and because its formation is quite erratic, the Sporadic-E does not usually support more than two hops. However, the past couple of summers it has made six meter world-wide communications possible on a scale never before thought feasible. The exact nature and cause of the Sporadic-E are unknown, but VHF-wise it appears most often during the summer months (as does tropospheric DX) and when the sunspot count is high. Six meter DX is like roulette, long dry spells—then suddenly a lucky streak.

Operating on the Band

When we began this series back in January, we referred to 80 meters as a short-range band. The term was used comparatively: 200 miles contrasted with the continent-spanning common to other shortwave frequencies. Now six meters is a short-range band (normally) and by short here we mean 75 to 100 miles, depending upon terrain, antenna height and power. Obviously this figure should be scaled down for mobile operations. However, six meters has the greatest working range (reliable working range) of any VHF or UHF band. It is the lowest in frequency and therefore most subject to diffraction and *normal* tropospheric bending (as distinguished from a duct).

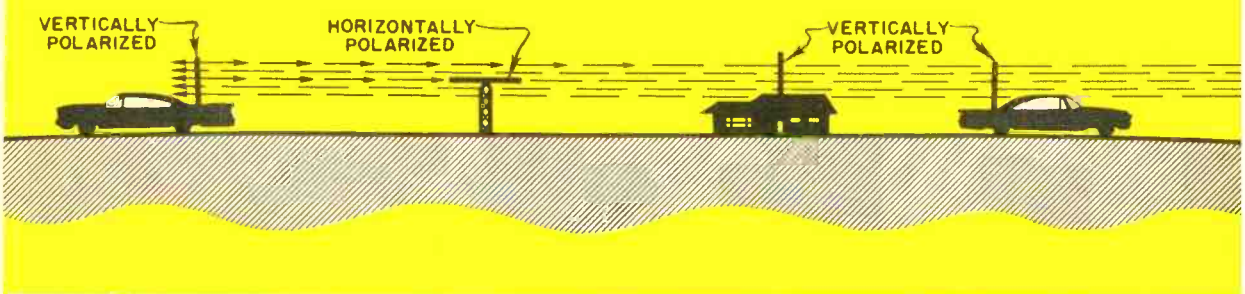
For mobile work this band is a compromise between ten meters and two meters. There is a possibility of real DX, and the shorter wavelength increases the number of practical antennas. Anything from a highly directional beam to a simple vertical half-wave could conceivably be mounted atop your car (the latter is the most common). A beam is best for DX, but the vertical radiates in all directions and is best for utility mobile use.

Portable and mobile stations, in addition to providing companionship for traveling hams, are of vital importance to civil defense. And by civil defense we don't necessarily mean a national emergency, but rather the local disasters—floods, twisters, etc.

The ham civil defense organization is RACES (Radio Amateur Civil Emergency Service). It is a joint undertaking of government CD agencies and the am-

[*Continued on page* 107]

For VHF communications such as those on six meters, polarization of the antenna is as important as type of antenna used. Vertical or horizontal? Neither has been proven "better" than the other, but there are certain practical factors which determine the amateur's choice. First, what are the other local hams using? If you want to communicate with them you had better have the same polarization. In figure below, note that signal from mobile vertically polarized antenna on car at left is readily received by other vertical antennas, while horizontally polarized antenna only gets a small portion of the signal. For DX, use a beam vertically because signals can be beamed in a single direction for a power gain.



A Signal Pencil

By R. L. Winklepleck

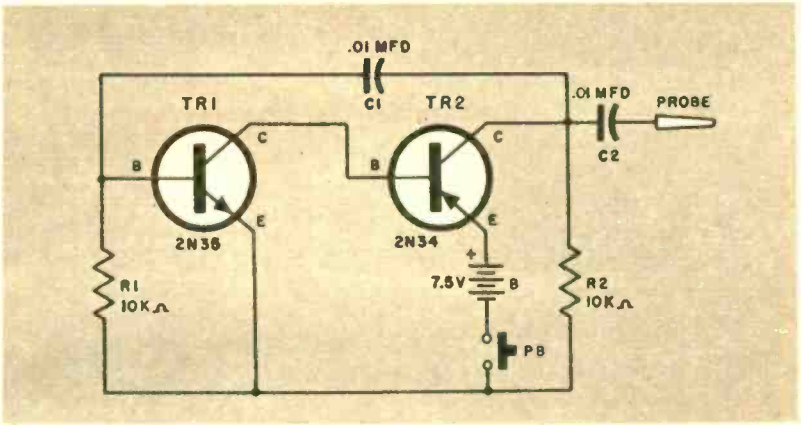
Pocket signal injector—handy for radio & TV audio.

THERE have been many plans published of small oscillators specifically designed for use in signal-injection trouble-shooting. Some have been very good and they've been well accepted and widely used. Many have been quite compact and this is important—especially if this handy signal generator is to see maximum use.

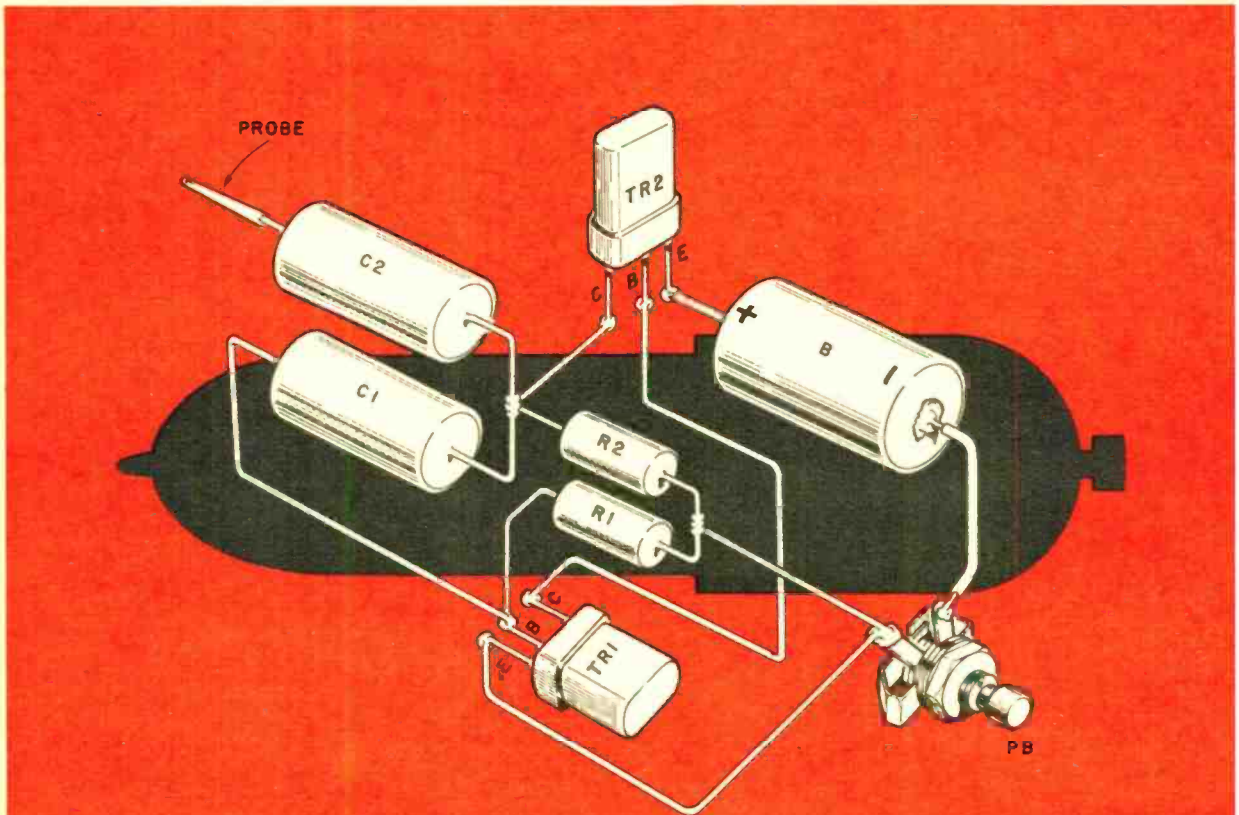
The "signal pencil" was designed to take advantage of the many small components now readily available. It has the shape and approximate size of a cigar for shirt pocket portability and to make it easy to use in the crowded "innards" of today's electronic equipment. It produces a powerful audio signal loaded with harmonics which covers the audio, IF frequencies and the RF broadcast band.

The Circuit

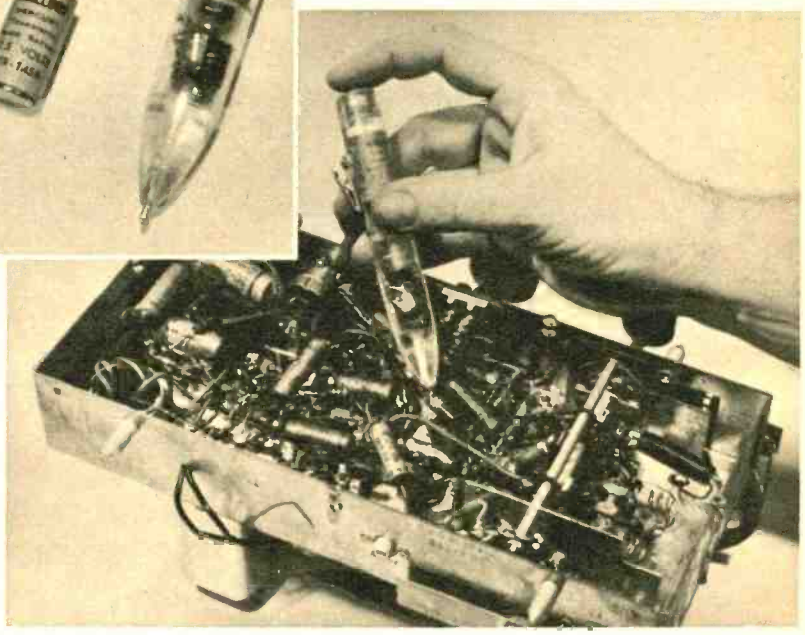
A simple two-stage, direct-coupled, complementary-symmetry transistor amplifier, with a feedback capacitor coupling the output back to input functions as an audio frequency multivibrator. The output signal, a modified square wave, appears across load



Two transistor amplifier using capacitive feedback to make multivibrator.



All the miniature components must be wired as shown above with all leads short. This requires the use of a low wattage soldering iron and heat sinks.



The two major sections of the author's signal pencil are at left. The mercury battery is the largest single component. In photo below the pencil is shown in use with a table radio.

resistor R2 and is coupled through C2 to the pencil's output tip.

Since current consumption of the unit is only three milliamperes, the small mercury battery should last for many months under hard usage. The battery, small though it is, actually is the largest component.

Construction Details

Your version of the pencil can be as complicated as you desire. The author's model was constructed of ¾" polystyrene tubing with ⅝" inside diameter. A ½" plug of ⅝ inch polystyrene rod is drilled out to accept the pushbutton switch which is fastened in place with poly cement. However, since the layout is not at all critical, you can assemble the components in any sort of metal or plastic container you wish. If desired, a ground lead can be wired to the portion of the circuit connected to the emitter of TR1. Or if a metal Mini-Box is used, TR1's emitter circuit can be connected directly to the cabinet (as a chassis ground) and the ground lead connected under a chassis screw.

Servicing With The Signal Pencil

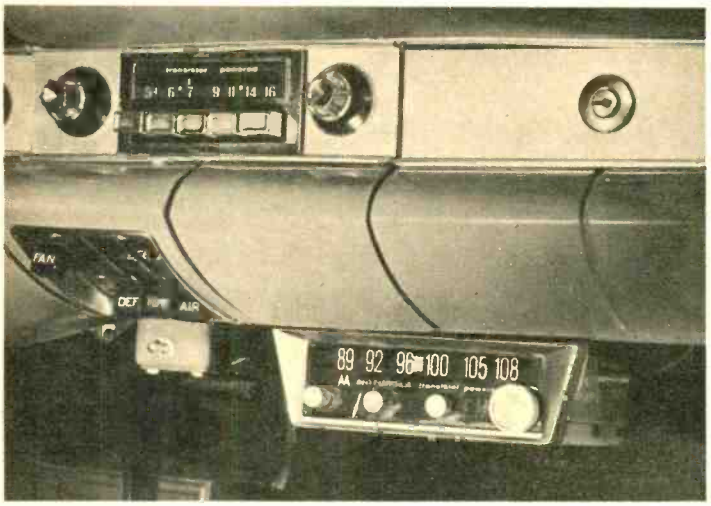
The pencil is used to supply a test signal, usually to a dead or weak receiver or amplifier, to pin-point the faulty section. The standard approach, is to insert an audio signal across the speaker leads and then work, "backwards" from stage to stage, through the audio amplifiers, the detector, the IF amplifiers and possibly clear out to the antenna until the weak or dead stage is encountered. If all is well the signal as heard in the speaker should increase in volume as more stages of [*Continued on page* 99]

PARTS LIST

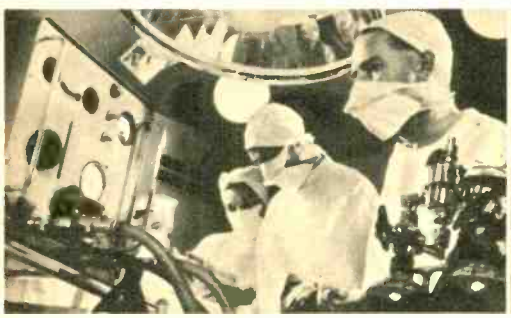
R1,R2—10,000 ohm resistor, ½ watt
C1,C2—.01 mfd capacitor 200 volts (Aerovox miniature Type P83Z)
TR1—transistor 2N35
TR2—transistor 2N34
PB—pushbutton switch (Switchcraft No. 903 or equiv.)
B—mercury battery, 7½ volts (Mallory TR-145R or equiv.)
Misc.—Case or ¾" polystyrene tubing, ⅝" polystyrene rod, alligator clip

New FM Auto Radio

OUR recent survey "FM Radios for Your Car" (December 1959) contained several reports from leading auto radio makers which stated flatly they had no plans for marketing an FM auto radio. Motorola was one of them. In spite of their former stand—or perhaps because of our article—Motorola is now mass producing the FM-900, a mobile radio that tunes 88-108 mc. This under-the-dash-installation unit can operate independently of the car's AM set. Three transistors power the hybrid circuit, which contains seven additional tubes. FM-900 shares the AM set's antenna and can be used with any 12-volt, negatively grounded ignition system. No need to sell the FM set when you sell your car. It may be moved from auto to auto, or auto to boat. Other features are AGC, AFC and $125 price.



Transistorized Lung



In the operating room the ventilator controls anaesthesia and patient's breathing rate. At bedside of patients with respiratory illnesses, it sets pace for air entering and leaving lungs. Distributed by Pye Ltd., unit has only two lightweight tubes that touch patient, permitting freedom of movement.

CUMBERSOME, uncomfortable iron lungs may be a thing of the past. The British invention of the transistorized, battery-powered Barnet "ventilator," weighing only 56 pounds, can do just about everything an iron lung can do, and then some. Automatic respiration, administration of anaesthesia and resuscitation are but a few of its uses, while portability adds to its versatility. Batteries last 20 hours, are recharged from house current.

unusual compounds find uses because

Electronics Tells The Chemist

By Shirley Motter Linde

THERE are about 750,000 known organic chemical compounds. Less than one percent of these have any known medical or industrial use!

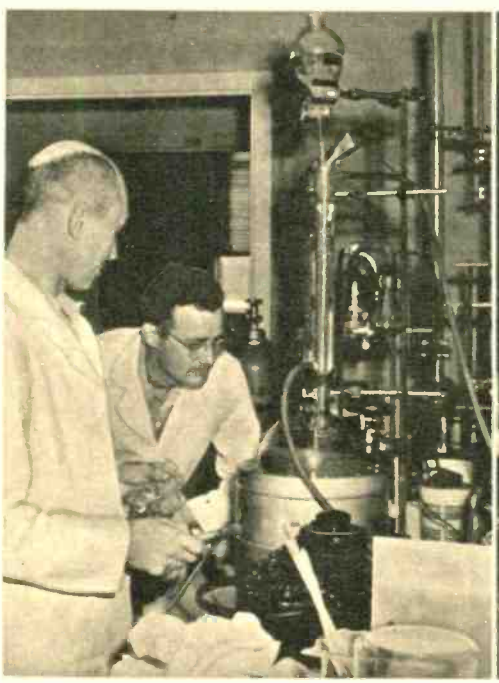
The other 99 percent are a huge potential of untapped applications. They represent hundreds of thousands of chemicals sitting idle on laboratory shelves when they might possibly be useful in curing cancer, fighting viruses, killing insects, giving more gas mileage, making rocket fuels for space vehicles, producing new synthetics, etc.

With present methods, it's a long, time-consuming, laborious process ferreting out practical uses for new compounds. Let's say a company comes up with a new chemical as a by-product. They may spend millions of dollars in research trying the compound in one application, [*Continued on page* 100]

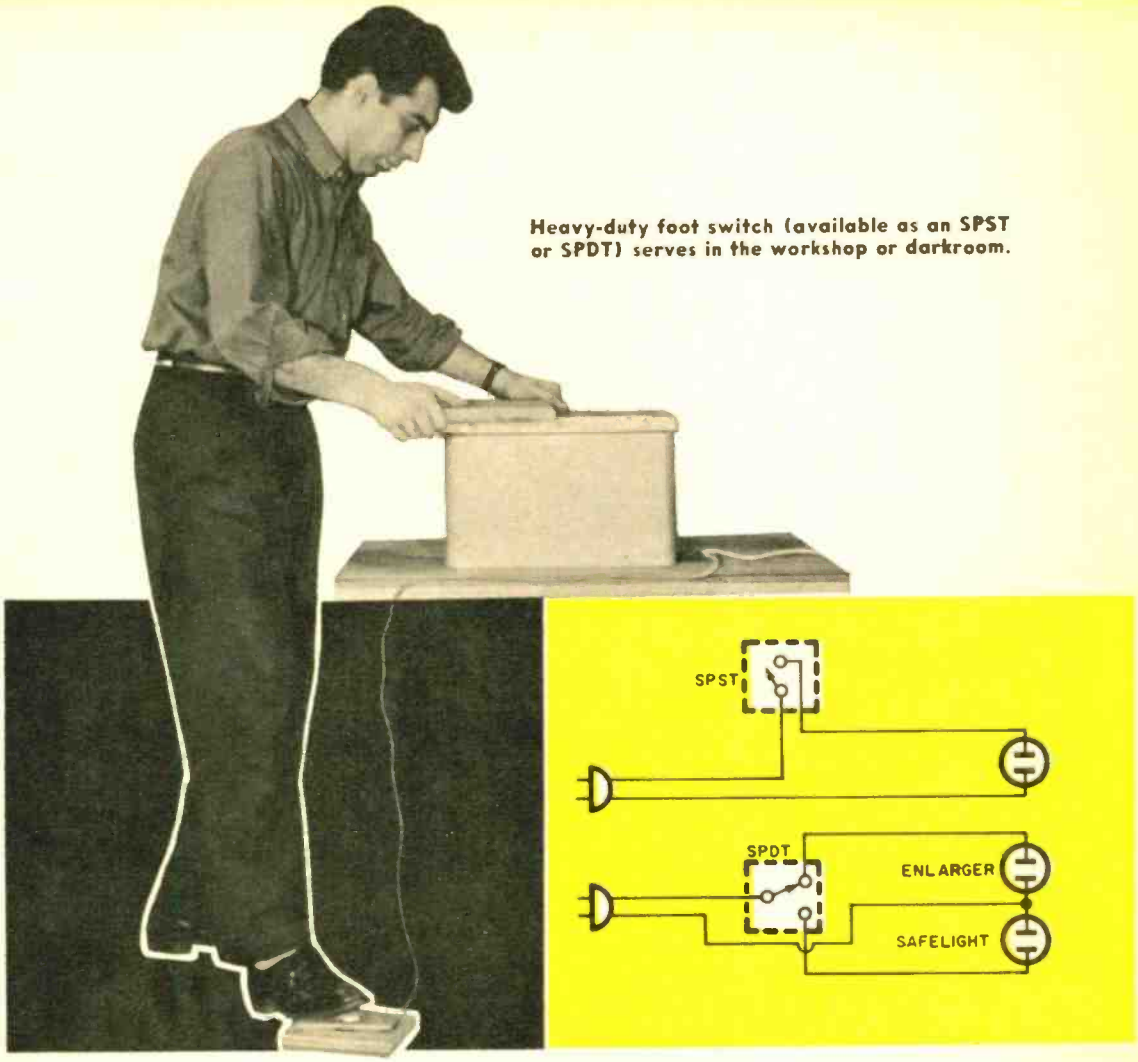
With computer in background and stack of facts on chemicals with known uses waiting to be coded, scientists check model of hydrocarbon molecule.

Chemists, engineers and computer experts join forces at Midwest Research Institute to expand computer memory in field of chemistry.

Data on punch cards held by R. A. Carpenter, right, has to be translated and prepared on magnetic tape for big Vanguard computer.



Having classified a new compound, the chemist is often at a loss to find a use for it. Comparisons of the compound's structure with those of other known-use chemicals, such as is being done in photos above, is often a tedious, hit-and-miss project. The computer is expected to find industrial and medical uses for now idle compounds.



Heavy-duty foot switch (available as an SPST or SPDT) serves in the workshop or darkroom.

A Handy Foot Switch

By David Gordon

ARE you handicapped by the lack of a third hand? Then use your head—and build a foot switch! Probably one of the handiest accessories for the darkroom and workshop, the foot switch hasn't achieved the popularity it deserves both because of high cost and lack of flexibility. But a relatively new push-button wall switch manufactured by Honeywell under the name Tap-Lite is both inexpensive and available in single and double-throw types suitable for all manner of souped-up switching.

Since the Honeywell switch was designed as a wall switch for the home only, a little experimentation was necessary to adopt it for use as a foot switch.

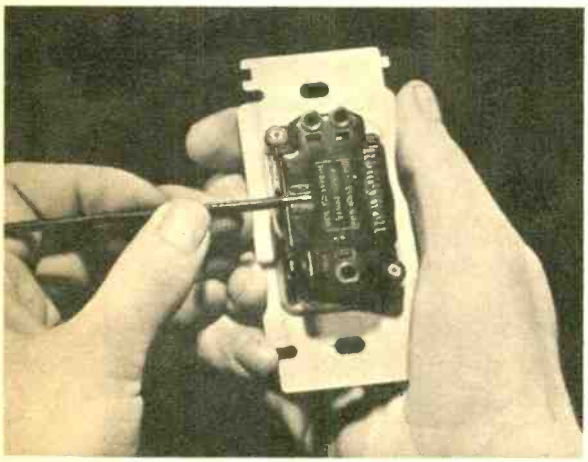
The base plate is cut from a 5″x7″ piece of scrap ¾″ plywood or pine. A hole must be cut through its center large enough to allow the mounting flanges of the switch to be screwed down flush with the surface of the plate. The plastic "flush plate" provides a neat cover for the switch's "works" and is simply pressed on over

the switch button as per the instructions accompanying the unit.

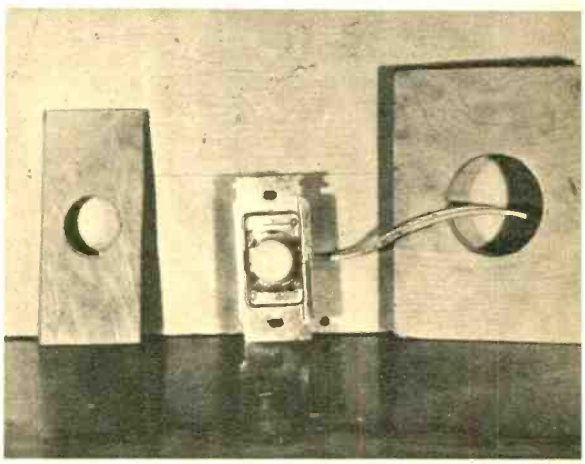
If you intend to give the switch hard usage—such as on the floor of a woodworking shop—it might be worthwhile to construct a more durable switch cover. A small piece of ¼" plywood cut out properly will serve nicely. It may be necessary to shim up the plywood top plate with washers to insure proper switch action.

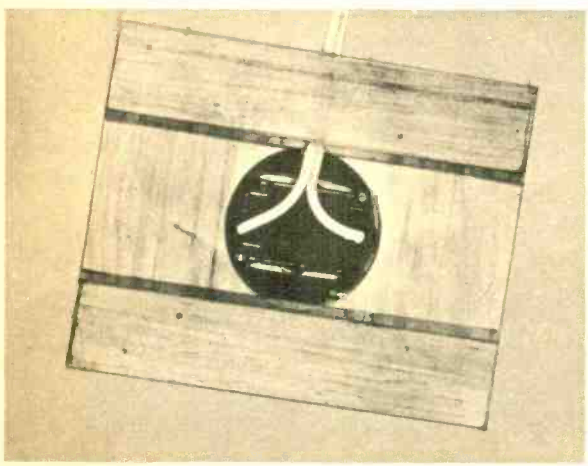
Two more scraps of plywood serve as the feet of the switch and allow sufficient space for the wiring. The SPST switch (Honeywell #25WS1) serves for normal on-off use in machine shops, etc., but for the photographer and his darkroom, a Honeywell SPDT switch (#25WS2) will provide enlarger on - lights off action. Both the Honeywell switches listed have a rating of up to 15 amps—adequate for all of your switching needs.

Built-in gauge on rear of switch determines length of connecting wire to be stripped.

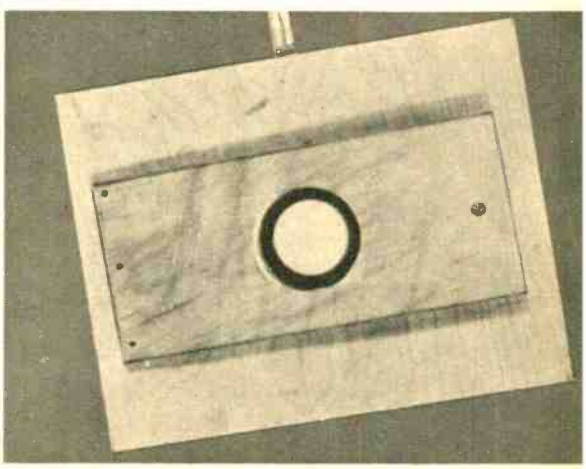


A pre-assembly view showing front plate, switch with wire attached and base plate.

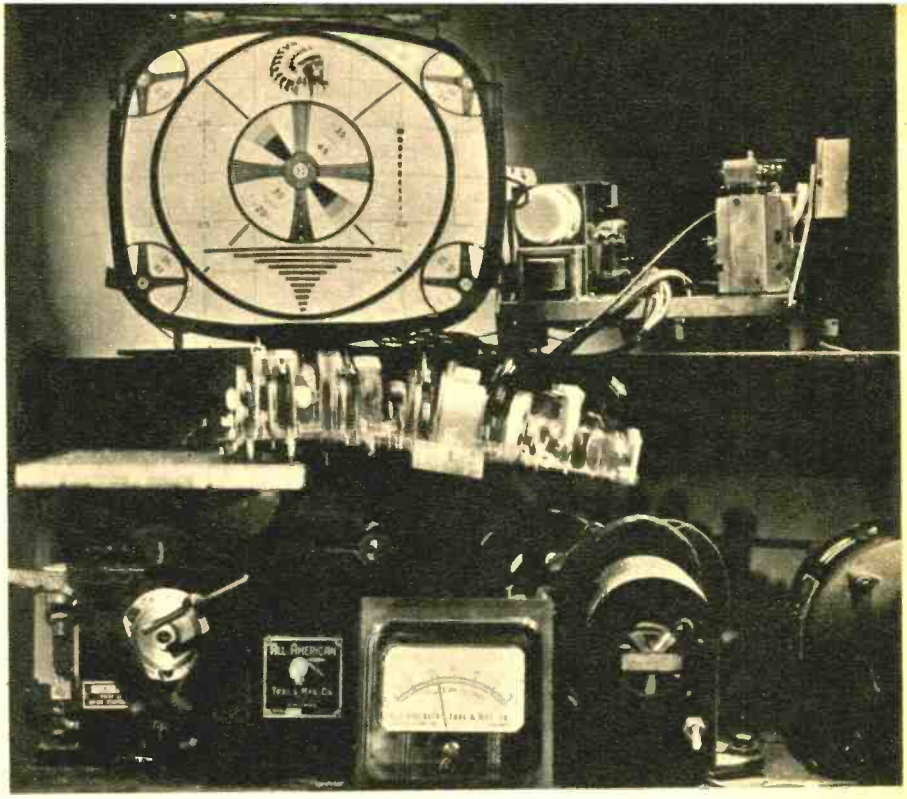




Rear view of the assembled switch showing the bottom strips which holds the wire in place.



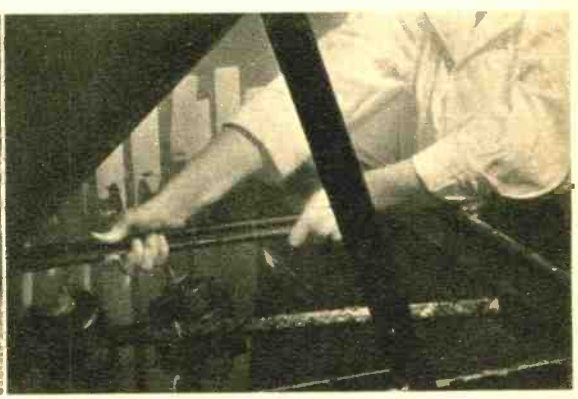
The completed foot switch. Shim up top piece for proper push-button action if necessary.



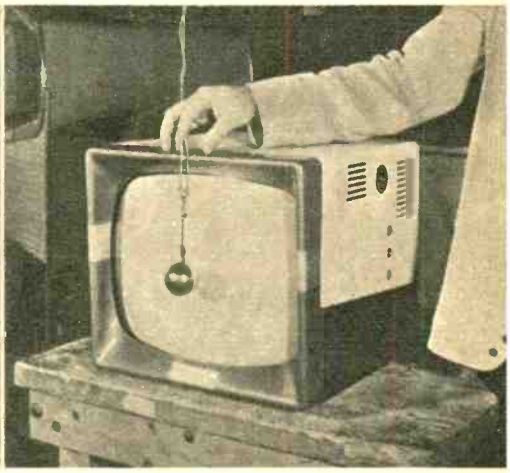
Groaning printed circuit of Sylvania TV set, with tubes and components in place, is made to vibrate up to four inches out of position 22 times per sec.

Torture Test!

It's murder! Sardonic schemes check consumer products to see if they can take rugged treatment.



At left, simulated rainstorm pounds down on boxes of electronic components. This environmental test center at Frankford Arsenal, Philadelphia, also can subject components to searing sunshine. At U.S. Testing Corp. labs, right, electric motors are placed in tank where they will be soaked with salt spray.



Shure mobile radio microphone suffers indignity of being dragged along concrete road behind speeding auto. It survived 35,000 separate impacts.

Above right, Underwriters' Laboratory technician checks to be sure steel ball will hit center of TV set's screen when ball is swung from high point.

Quality control engineer shovels wet snow over Electro-Voice's "Musicaster" outdoor speaker to see if new silicone-treated cone can take it. The Buchanan, Michigan, snowfall rose over two feet.

Don't Fry That Ham!

By Carole F. Hoover, K9AMD

Never trust outdoor power lines. Get to know 'em from a distance and be dead sure, not sure dead!

THE familiar nets of electric light and power wires that criss-cross city and country miles alike may look as harmless as Granny's clothesline, but they certainly have lots more personality. The shocking truth is that practically every red-blooded ham who shinnies up a tree, pole, or ladder to string his own antenna probably rubs elbows with enough electricity in those same little wires to lay him low. Of course, as long as he minds his amps and volts, there's no harm done. The time taken to study a few power poles with its electrical distribution system will not be wasted.

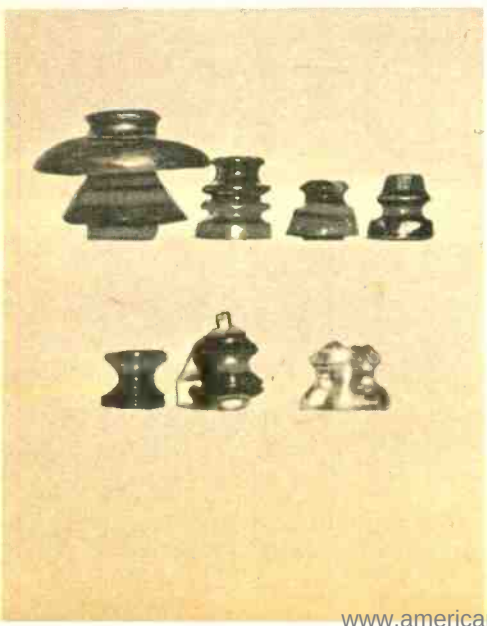
The first lesson in learning to identify voltages tells us that electricity is carried from pole to pole in many ways. Anywhere from two to eight wires may run between supporting pins on wooden crossarms; a single wire sometimes rides a steel pin and insulator at the center-top of a pole with no crossarms at all; or maybe two to four wires run on distribution racks on the sides of other poles without crossarms. The high-power lines carrying lethal, "primary" voltages of 2300, 7200, [*Continued on page* 110]

So anxious to rig new beam, ham doesn't notice element swing onto pole circuit carrying 13,000-V, enough to add him to "Silent Key" list.

When you don't let power company trim tree branches entire tree may become booby trap for amateur. Insulation wears, tree conducts.

Obviously this OM is trying to string a long wire antenna, but he probably won't feel much like working his rig after he gets a jolt from the house power lead-in wires. There are about 240 volts between his left jaw and his right hip.

Top (l to r): 34,000-v two skirts; 16,000-v top groove; 7200-v top groove; 2300-v side groove. Bottom: 117-v spool used with secondary; same with support; glass telephone insulator.



Size of insulators identify voltages: Three on top carry 34,500-v conductors. Below them are 7200-v lines. Bare wires extending to right are 110/220-v secondary wires running into home.

A Wide-Range Watt Meter

For appliance testing and troubleshooting

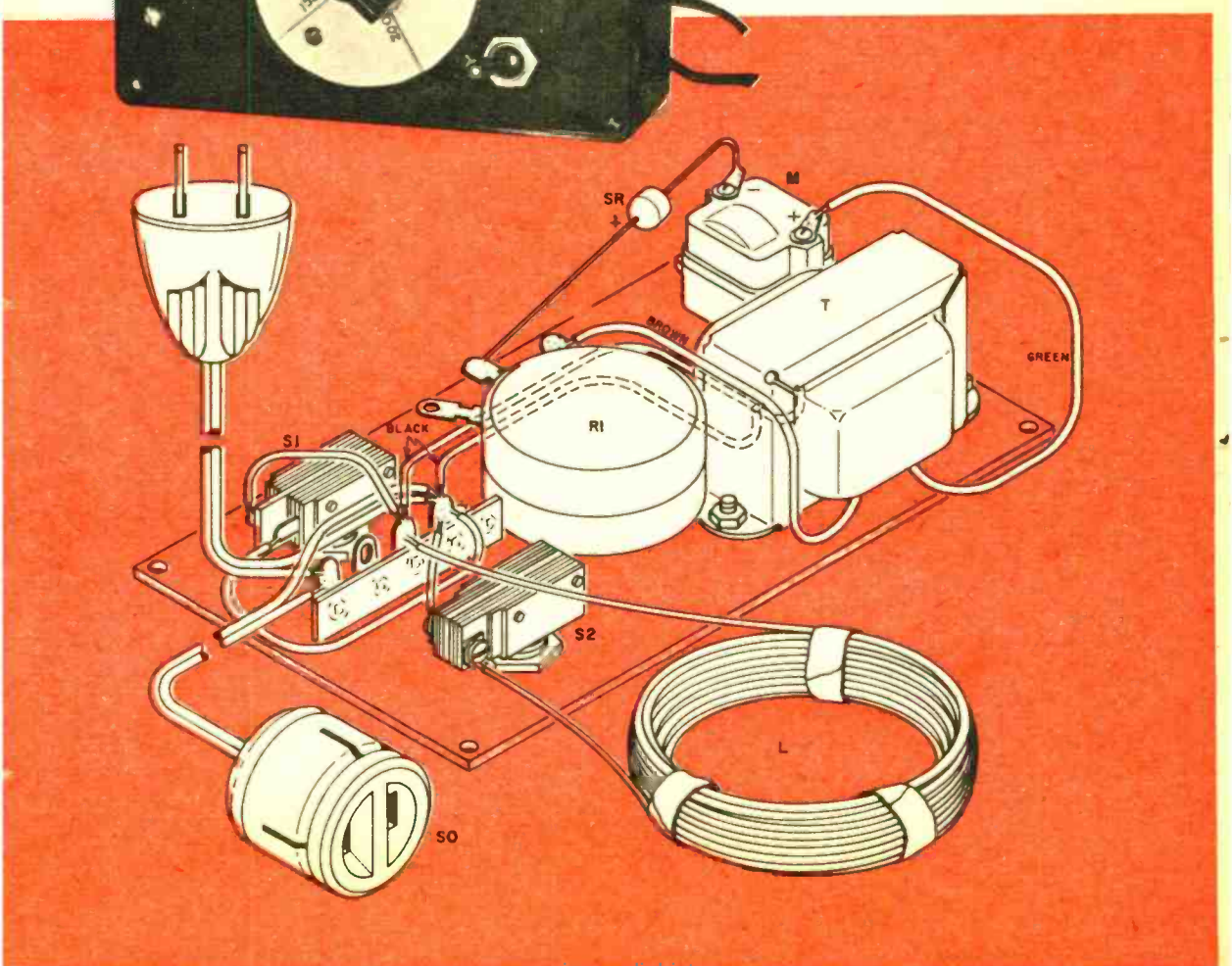
By Branch Jurgen

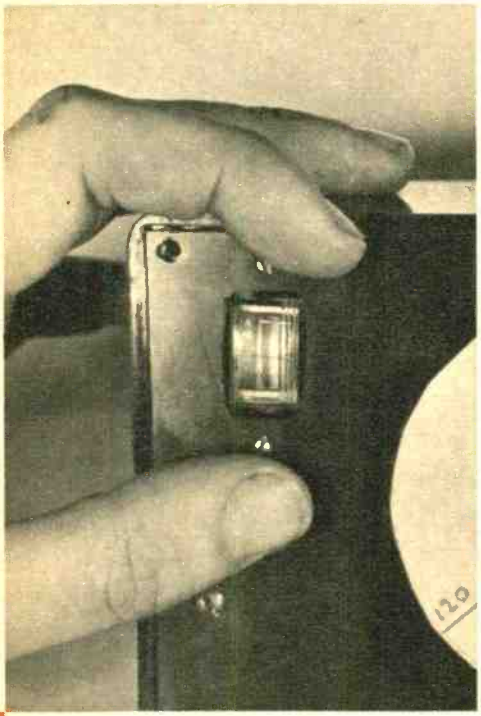
HAVE you ever plugged an appliance into an already heavily taxed outlet, hoping that the power lines were just carrying electricity and not beginning to heat up the walls? If the lights didn't dim, you probably felt pretty safe.

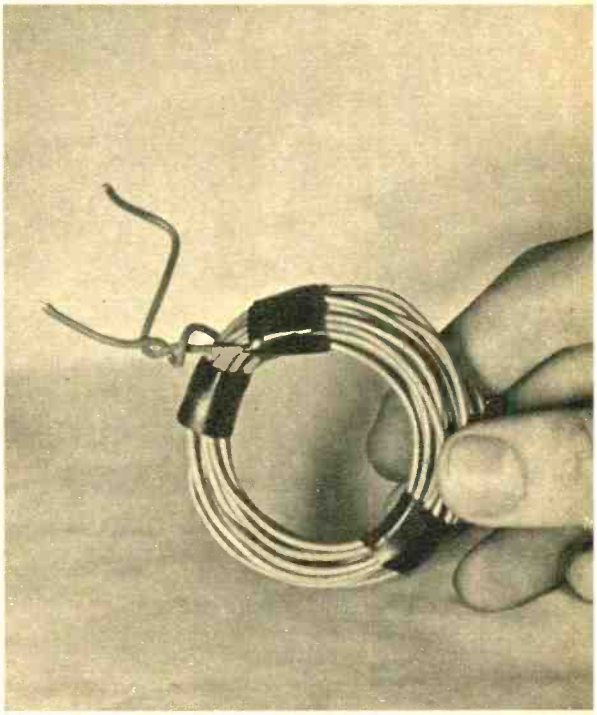
Here's a little device that can be built for about five dollars and will answer all your power questions. In addition, it is a useful test bench service tool in detecting shorted circuits and other equipment faults which are reflected in excessive power demands from the AC line.

The device utilizes an under $2.00 intercom transformer with

All components are mounted directly on the Bakelite front panel of the cabinet as shown in pictorial diagram below.







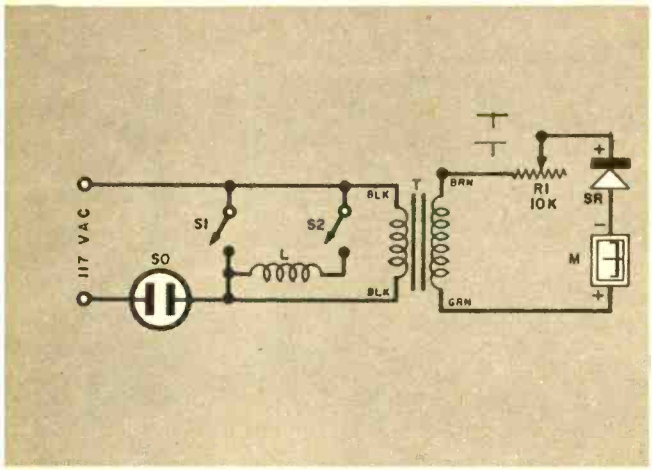
A miniature AM tuning meter provides accurate reading of wattage when properly calibrated. An inked-in scratch marks its "null" point. Simple coil serves as high-current, low-resistance input shunt resistor.

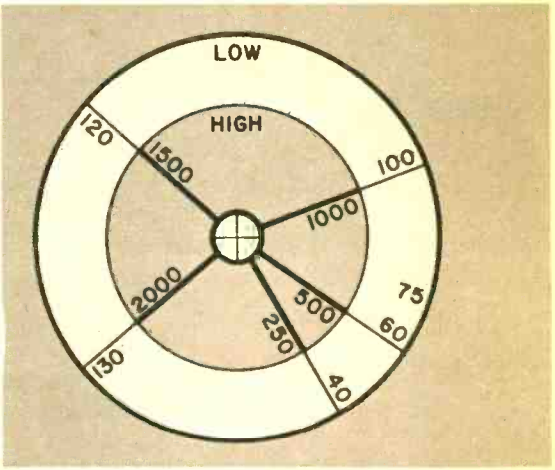
a 4-ohm primary and a 25,000 ohm secondary, providing very high turns ratio. When the 4-ohm side of this transformer is connected *in series* with the appliance whose power rating is being measured, a very small voltage drop determined by the current drawn appears across the transformer's winding. This voltage drop is so low that the appliance receives, for all intents and purposes, the full line voltage. Since the transformer primary is in series with the load, the current through it is the same as the current through the load. Although the primary voltage drop remains quite small with loads up to 1500 watts, it is much larger at the transformer secondary. It is now possible to rectify and read it on a DC meter. The amplitude of the secondary voltage is directly proportional to the primary voltage drop and this drop is, in turn, directly proportional to the current flowing through the primary. Thus, by calibrating the meter in the secondary, we can accurately determine the amount of power consumed by the load without introducing excessive losses in the primary circuit.

Construction

The entire unit can be built into a commercial Bakelite cabinet. The meter is an inexpensive miniature AM tuning meter. The 110 volt "in" and "out" leads are brought out at the short side of the cabinet through two ⅜" holes. Rubber grommets are not necessary since the Bakelite will not abrade the cable.

The primary circuit of T1 contains two switches; both of which





Rectification of voltage developed in the transformer secondary enables the potentiometer R1 to calibrate the meter according to the varying loads. Circular scale above is rough guide for use in the calibration procedure.

should be screw-lug rather than solder lug types. The first is a simple bypass switch (S1) which shorts out the transformer primary thus removing the wattmeter from the circuit when in the "shorted" position. The second switch (S2) is a High-Low range switch. When the switch is in the High-range position, a shunt (L) is inserted in parallel with the transformer primary. This is necessary since the transformer cannot carry more than about 2 amperes. The shunt consists of about 20 turns, 2" diameter, solid No. 20 insulated hookup wire. The exact number of turns and wire size is not too critical and is best determined through experimentation when the scale is calibrated.

Calibration

Since the meter used in this device has an arbitrary numerical scale, a calibration technique must be employed. To do this, a center line is scratched across the meter's plastic case using a sharp pointed tool. Some red ink is then carefully rubbed into the scratch to make the center line easily visible. To calibrate this unit, various size lamp bulbs (40 watts, 75 watts, 100 watts and 150 watts) are inserted as the load with range switch (S2) in the "low" position. Potentiometer (R1) is then adjusted until the meter needle falls directly under the center line. This point is noted and marked on the potentiometer scale. At least five or six calibration points are found in this manner and then the intermediate points can be interpolated. The low wattage scale will run from about 30 to 150 watts.

In calibrating the high wattage scale, S2 is thrown to the high position so that the shunt is in parallel with T's primary. Incandescent lamp bulbs can again be used. For example, to obtain a 300 watt load, two 150 watt bulbs are inserted in parallel. In calibrating at very high wattage levels, 500 watts to about 1,500 watts (the limit of the meter), the parallel bulb system may become cumbersome. To calibrate the unit in these high ranges, a 1,000 watt heating element, which is available in any hardware store, becomes very handy.

In using this wattmeter, the load is plugged into SO while the meter itself is plugged into [*Continued on page* 106]

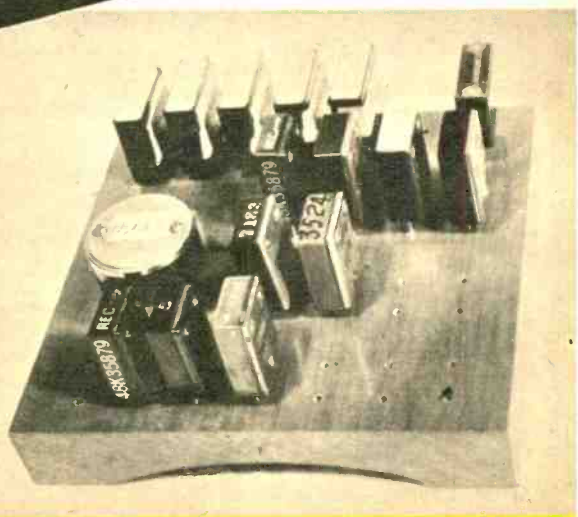
PARTS LIST

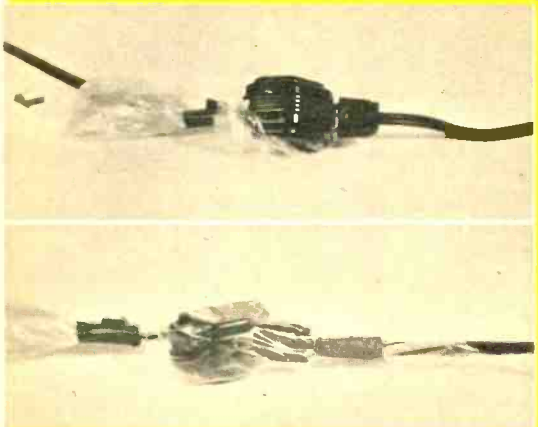
R1—10,000 ohm, 4-watt wirewound potentiometer
SR—low-voltage selenium rectifier or general-purpose diode (10 ma)
M—AM tuning meter (Lafayette type TM-12)
T—transformer, primary: 4 ohm, secondary: 25,000 ohm (Stancor A-4744 or equiv.)
S1,S2—SPST toggle switch, (12A-125v)
L—2" diameter coil, 20 turns of No. 20 solid hookup wire (see text)
Misc.—Bakelite case and panel 2¼"x3¼"x2" (Lafayette MS 216, MS 217), male plug, AC receptacle, 2" pointer knob

Try These

Crystal Storage Holder

If you keep your crystals indifferently jumbled in a cigar box or scattered among components in a drawer, you know the exasperation that arises when a needed crystal cannot be readily found. A few minutes of your time is all that is necessary to build the unit shown. The holder may be Formica, Plexiglas, or hardwood. Its dimensions are dictated by the number of crystals to be stored. Space the rows so that the crystals may be easily removed. For FT-243 type crystals, use a No. 39 drill and 1/2" spacing between holes for pins. Smaller, overtone type crystals, require a No. 55 drill. The completed unit may be hung on the wall with the addition of two screw eyes.





Insulating Outdoor Connections

If you are faced with the problem of having to run AC extension cords across the damp floor of a cellar or a wet lawn, here is a handy hint that may save you from a shock or a blown fuse. Simply wrap the receptacle and plug in a piece of lightweight transparent plastic sheeting, such as serves as wrapping for vegetables, shirts, etc. Twist the plastic tightly around the connectors and wrap securely with tape at both ends. You now have a shock-free, waterproof connection that is not likely to pull loose at a critical moment.

Color-Code Your Reamer

To indicate accurately when you have enlarged a hole enough with a reamer, color-code your reamer with bands of different colored paint. Use red paint for 1/4", black for 3/8", etc. Although in time, the paint on the outside edges of the reamer will wear off, the paint in the flutes will remain.

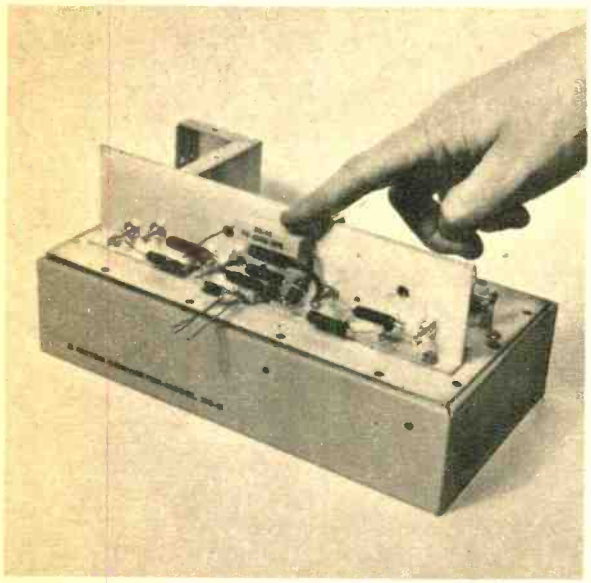
El assembles a

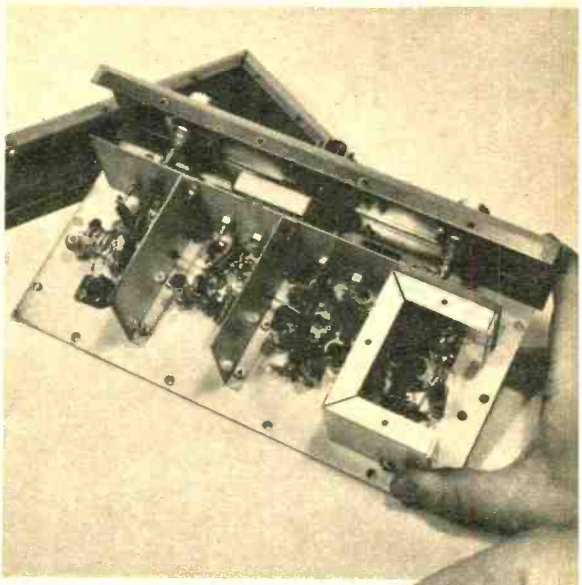
Ham Converter Kit

Two-Meter phone band is opened up by easy to build kit. Useful to Novice and General Class hams.

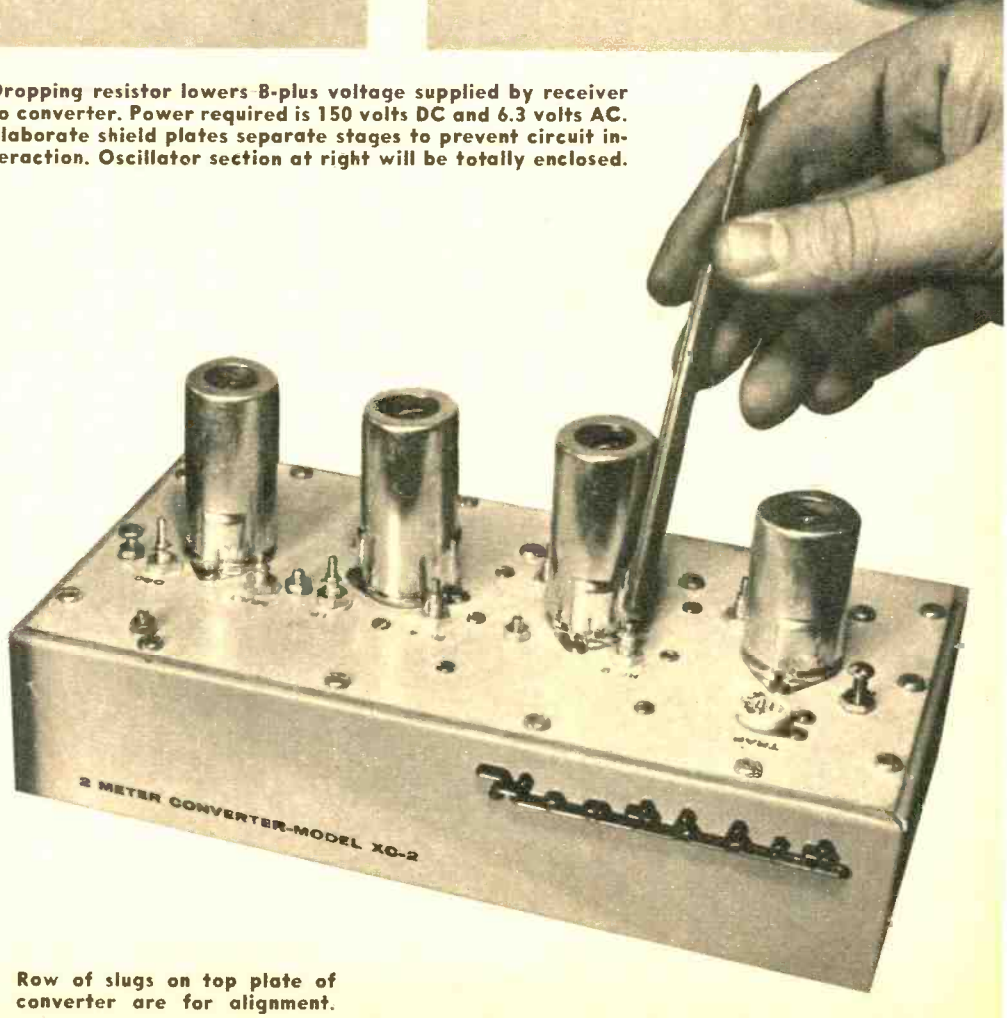
WITH the appearance of the Heath XC-2, the Novice can venture into a region where even General Class hams often fear to tread—the VHF band where coils can resemble hairpins, and capacitors are formed by parallel wires. The small army of ham designers at the Heath Co. have proved their salt once again by packaging a kit of advanced design that can be built by a beginner. Thus, the Novice is not tied to pounding a code key—he can rag chew with the rest on the peaceful 2-meter phone band.

The converter unit receives frequencies in the 144-148 mc range and converts them down into frequencies that can be handled by the conventional ham receiver. The 2-meter band appears in a slot between 22 and 26 mc on the dial and is tuned with the receiver's normal tuning controls. This 4-megacycle slot may be shifted easily into any location between 22 and 35 mc by

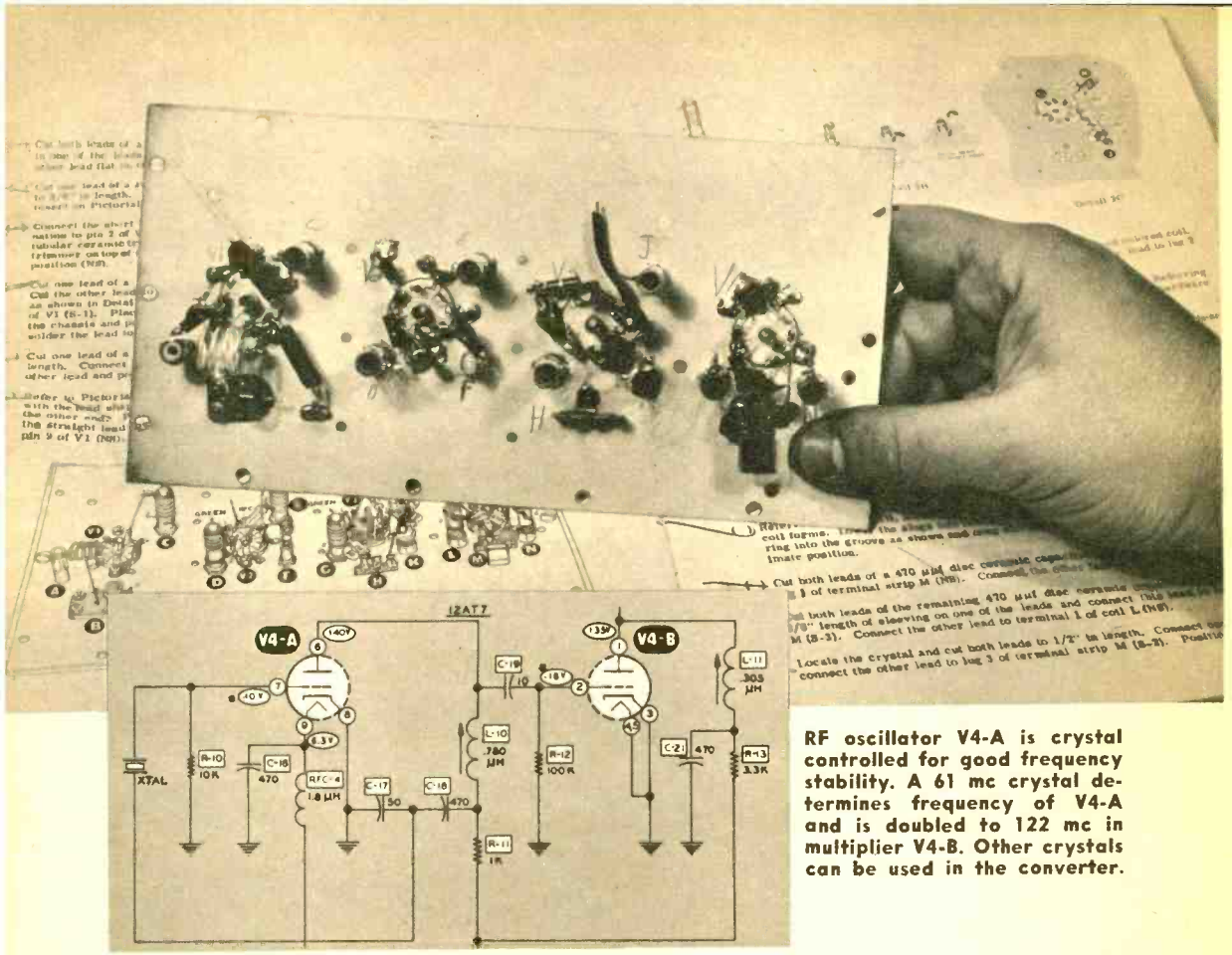




Dropping resistor lowers B-plus voltage supplied by receiver to converter. Power required is 150 volts DC and 6.3 volts AC. Elaborate shield plates separate stages to prevent circuit interaction. Oscillator section at right will be totally enclosed.



Row of slugs on top plate of converter are for alignment.



RF oscillator V4-A is crystal controlled for good frequency stability. A 61 mc crystal determines frequency of V4-A and is doubled to 122 mc in multiplier V4-B. Other crystals can be used in the converter.

proper choice of converter crystal. The only other consideration is power, which is "stolen" from the ham receiver. If your receiver is an AC-DC type, an external power supply must be used.

Construction of the converter involves almost as much "plumbing" as electronics. Since VHF circuits are notorious for interaction and instability, Heath has used a remarkable number of silver-plated shield panels, special feedthrough capacitors and sheet metal screws. This builder realized, after completing the kit, that no hookup wire was used—which points up the key to successful VHF gear—*short leads!* It is in this area that the builder must follow the manual absolutely or end up with whistles, birdies and a converter that generates several stations of its own.

The constructor who makes an error in assembling this kit has a problem for a cross-sectional view of it looks like a 7-layer cake. It has to—to measure up to the stringent demands of these nimble frequencies. Make sure you double check each step. Construction time runs about 12 hours depending upon the care exercised by the builder.

The XC-2 requires careful alignment for peak performance. Realizing that the Novice might not own a 'scope and sweep generator, the construction manual details three alternate alignment methods. The simplest uses a transmitter as the signal source. This is a safe assumption since the converter is of little interest without a companion transmitter.

The first air checks with the completed converter pulled in several 2-meter stations from two call areas. At a price of $36.95, the Heath XC-2 represents a Good Buy for the Novice, or General Class ham.

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The Great QSL Quarrel

Continued from page 29

read than a doctor's prescription. If you can't type, print; if you can't print, write neatly; and whether you write or print, don't use a pencil or half-shot ball-point.

There's got to be beef in a bun to make a tasty hamburger, and similarly, perfect penmanship on a glorious card isn't worth a hoot if the message is missing. Since a shortwave listener can't pick up a microphone and join in the rag-chew, the signal report and comments he puts on his card must be accurate and detailed. Who wouldn't toss away a card that says merely, "I heard you calling CQ on 20 meters on February 22?" That just isn't enough information.

A complete shortwave report should start with the ham's call letters and the date, time, and his exact transmitting frequency. An accurate readability and signal strength report should follow, as well as description of the receiver and antenna set-up used in listening. The calls of other stations involved in the contact should be included. Some amateurs will feel that the card is still in sad shape if a sentence or two from the rag-chew itself isn't quoted. This is the real fun of QSL'ing. If the ham describes his hometown, introduced his mother-in-law, or predicted the outcome of the World Series, mention it on your card. There's no law saying an SWL card has to be as stiff and statistical as an income tax report, so add some humor and watch the results.

"If somebody wants my QSL, let him study and save to get his own radio license and rig just like I did," say a small number of hams.

Although few hams understand why, many people prefer listening to talking, and they wouldn't take a microphone, key, or call letters even on a silver platter. On the other hand, the SWL population is full of folks already in the process of getting their own licenses and still others whose interest in amateur radio grows with each contact heard and QSL card received.

The world's best authorities on swapping cards are the DX or foreign hams who receive QSLs from every amateur contacted as well as bushels of SWL cards from all the continents. One such station collects about 100 cards each week from shortwave listeners alone.

"The incomplete cards go in the fire," he admits, and nobody can blame him.

Enclosing postage for return cards is a practice much appreciated by all amateurs and almost sure to draw an answer. Foreign stations are particularly grateful but, unfortunately, International Reply Coupons aren't always the answer. The value of an IRC in another country may be much less than what an SWL pays for it. For example, a coupon costing 15 cents in a U. S. post office is exchanged in Haiti for only two cents. This means that a 10 cent air mail stamp there would require five IRC's purchased here at 15 cents each. Although IRC's are always welcome, many foreign stations simply can't afford air mail answers.

Of course, a certain number of everybody's cards fall prey to playful children, chewing lap-dogs, spring housecleaners, and pack-rats. But, generally speaking, the shortwave listener who mails an attractive card that is both neat and complete will have it welcomed by the ham. And adding a clever comment and return postage may put a ham's card in the mailbox instead of an SWL card in the wastebasket.

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No better Amplifier at twice the cost!

MODEL 214 STEREO-AMPLIFIER . . .

Model 214 combines the features of three instruments in one. It is able to select, control and amplify any source of stereo such as discs, tape, or tuners and send it through two self contained 14W amplifiers to a pair of speakers. It consists of a complete stereo preamplifier and two separate 14 watt power amplifiers (28 watts peak for each amplifier). It can be used as a 28 watt monaural amplifier (56 watts peak). In addition it can be used as a 28 watt monaural amplifier with complete stereo preamplifier so arranged that one preamplifier is used to drive the internal 28 watt monaural amplifier while the other preamplifier is used to drive any existing monaural amplifier. Model 214 uses ganged treble and bass controls. It has a balance control, contour control switch, rumble filter switch and speaker selector switch for local and remote speaker systems. It uses a 2 color, deep etched, gold anodized aluminum panel.

SPECIFICATIONS . . .

OUTPUT: 14 watts less than 1% harmonic distortion. 2% IM 60/6000 c.p.s.) **PEAK POWER OUTPUT:** 28 watts per channel, 56 watts combined. **OUPUT IMPEDANCE:** 8, 6, and 32 ohms per channel, 4, 8, and 16 ohms when strapped. **FREQUENCY RESPONSE:** ± 0.5 DB 15-30,000 c.p.s. at 1 watt; output ± 1 DB 45-20,000 c.p.s. at full output. **DAMPING FACTOR:** 5. **HUM:** MINIMUM VOLUME: 80 DB below 14W. **TUNER, AUX. & PHONO** (hi-level): 70 DB below 14W (0.5V input reference) **PHONO (RIAA POSITION):** 60 DB below 14W (6 mv input reference); (1 mv input reference). **TAPE INPUT:** 55 DB below 14W (1 mv input reference). **CROSS TALK:** Better than 50 DB. **BASS CONTROL RANGE:** ± 12 DB at 50 c.p.s. **TREBLE CONTROL RANGE:** ± 12 DB at 10,000 c.p.s. **RUMBLE FILTER:** 12 DB per octave below 50 c.p.s. **INPUT LEVELS:** Aux., Tuner and Phono (hi-level) 300 millivolts, 2 megohms, flat response. Phono (Mag): 3 mv at 1 KC. Tape: 1 mv at 250 c.p.s. **TAPE OUTPUT LEVEL:** 1 volt from each channel. **PREAMPLIFIER OUTPUT LEVEL:** 0.5 volt, modified by all controls (one channel only). **RECORD EQUALIZATION:** RIAA. **TAPE EQUALIZATION:** NARTB. **TUBE COMPLEMENT** 1-GZ34, 4-EL84, 2-ECC82/12AU7, 3-ECC83/12AX7. (10 in all.) **DIMENSIONS:** 4½" x 15½" x 9½" deep (excluding knobs). **POWER CONSUMPTION:** 125 watts. **SHIPPING WEIGHT:** 18 lbs.

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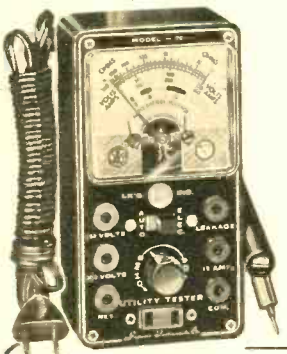

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As an electrical trouble shooter the Model 70:

- Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc.
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Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more—and as proof, we offer to ship it on our examine before you buy policy.

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

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2 Ranges: 100 ohms to 50,000 ohms; 10,000 ohms to 5 megohms.

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Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? Locates a break in any TV antenna and measures the location of the break in feet from the set terminals.

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WITH NEW 6" FULL-VIEW METER

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Model 77—VACUUM TUBE VOLTMETER . . . Total Price . . . $42.50
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• 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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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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Music From Nowhere

Continued from page 27

Not even its inventor, Leo Theremin, ever learned to make his brainchild behave. Neither have some of the ablest of musicians—which explains why RCA put together only a few hundred of the instruments (back in 1929-30), and never produced another.

The scores of theremins lying forgotten in attics are currently worth their weight in gold—anywhere from $500 to $1000.

"Why they should be worth anything at all," said one engineer, "beats me. A half dozen tubes and as many coils and you can build your own theremin for maybe $50.

(**NOTE:** Electronics Illustrated *will feature complete plans for a theremin in an early issue. Cost: Under $20! Watch for it.)*

A theremin involves nothing more complex than three radio-frequency oscillators. Two of them beat at an audible frequency. Add hand capacity—as does Dr. Hoffman with his *right hand* as he gestures before the vertical *pitch* antenna—and you lower or raise the frequency of one of the RF oscillators, thus the *pitch* of the beat frequency, which is amplified.

Amplification, or volume, is controlled by a third oscillator. Like the others, its frequency is changed by hand capacity. The player's *left hand* wavers above the looped, horizontal *volume* antenna. The volume oscillator's rectified output biases an output amplifier tube.

Actually, many oscillating circuits have been devised which give similar musical, or dissident, results. Essential to them all, however, are oscillating circuits controlled by hand capacity. The closer a musician's right hand to the *pitch* antenna, the *higher* the pitch. Some theremins range through four full octaves and can strike notes above a soprano's high-C.

The farther the left hand from the *volume* antenna, the louder the theremin's eerie output.

Most theremins, for example, lapse silent unless a hand interrupts their electrostatic fields. Reason: the two pitch oscillators, one set at fixed frequency, the other motivated by hand capacity, are adjusted to produce a zero beat (no audible sound) unless disturbed. Also assuring "silence" is the fact that, undisturbed, the volume control oscillator biases the "gain control" tube to cut-off.

A musician can limit the theremin's tonal range simply by turning a knob on the console panel. This in turn sets the fixed pitch oscillator for the lowest note the performer wishes to play.

"In effect," explains Dr. Hoffman, "turning that knob either spaces the notes farther apart or brings them closer together."

When, for example, the theremin is set for its full four octave range, the movement of the musician's right hand toward the pitch antenna "finds" a new note every $\frac{1}{16}$ of an inch in the electrostatic field. With its tonal output limited, say to two octaves, the theremin's notes are spaced about ⅛ inch apart.

In the process of "picking" notes from a theremin's field, the musician's hands must constantly vibrate to extract from raw notes a subtle vibrato quality which produces what some call "music bewitched." In its higher registers, the theremin speaks as shrilly as a violin. In its lowest it cries like a cello.

You'd think that your entire hand would cause musical havoc with a new note every $\frac{1}{16}$ of an inch. It doesn't. "Capacity" exists only between the antenna and the tip of your fingers. If, however, you make the musically fatal mistake of contacting the antenna—either the volume antenna with your left hand or the pitch control with your right—silence reigns. Why? Electronically speaking, you've grounded the oscillators.

"Critical though hand capacity is," concedes Dr. Hoffman, "there's nothing critical in the antennas themselves." Antennas, about 24 inches in length, are sized for the stature and convenience of the musician. Nor is it significant that one is vertical, the other horizontal and looped. Their structure merely adds dramatic effect. Set at right angles to one another, the chance of conflict between their electrostatic fields is reduced.

Aside from the oscillatory circuits, of course, theremins also must have a power supply, power amplifiers and a loudspeaker. Most theremin speakers are usually 12-inch jobs. Hi-fi, of course, wasn't in the commercial lexicon when RCA built what few theremins it did back in 1929.

"Hi-fidelity speakers might improve tonal quality," concedes Dr. Hoffman, "though I'm no authority on such things. My own instrument's 12-inch speaker chills movie and TV audiences without a boost from higher fidelity. And as a musician, I'm satisfied with its quality."

So, apparently, are Hollywood moguls who have hired Dr. Hoffman to harry the soundtracks of their greatest spine-tinglers with the invisible "keyboard" of electronics' strangest music maker.

Electronic Oven Thermometer

Continued from page 55

affected if the bare grounded wire touches the oven. In use, the two wires are brought out through a crack in the oven door and the remaining control cable can of course consist of any low-resistance conductor such as ordinary lamp cord.

Ordinary asbestos wrapped appliance cable, like the kind used for heavy household irons, may be substituted for the Teflon. Of course, the cable's cloth cover must be removed with a razor.

Calibration

Before putting this device in use, it must be calibrated against a fairly accurate standard. It may come as a surprise to know that although oven temperatures often go as high as 450°-550°F, the temperature inside the meat rarely exceeds 200°F. Consequently, the actual probe itself must be calibrated in this lower temperature range. The best way to do this is to borrow a good standard meat thermometer, or any other accurate thermometer marked in degrees to 212°F. A kettle of cold water is placed on the fire and both the thermistor probe and the standard are inserted into the cold water. The electronic meat thermometer is turned on and the dial is set to the lowest point (in other words, the least resistance in the circuit).

At a certain temperature, the thermometer's relay will energize and you will hear the strains of the music box movement. The temperature at which this occurs should be read off on the standard and marked accordingly on the electronic thermometer dial. (Allowing for some variation in circuit values, this usually occurs at around 140°F. or, as the cooks would have it—very rare beef temperature.) The dial on the thermometer is then turned until the meter relay drops out. Remember, you may have to tap the box if the relay sticks. This process is repeated until the water boils. Actually, you will find that this thermometer will measure higher than 212°F. However, we would not recommend roasting anything to that temperature!

A Signal Pencil

Continued from page 76

plification are added before the speaker.

An audio frequency is required in the audio stages, a modulated IF frequency next and a modulated RF signal at the broadcast frequencies at the front end. The "signal pencil," with its basic audio and its powerful harmonics, supplies all these needed signals. It's only necessary to touch the pencil point to the output and input of each stage and press the button. In the front sections of a receiver or the input of an amplifier the signal will be heard loudly.

For testing the final output stage and speaker when the signal is too weak to be useable, a short test lead may be added from the pencil's ground clip to chassis ground of the unit under test.

Actually, you can achieve three levels of output; the greatest with a ground lead from the clip, the least with only the pencil tip touching the circuit and an intermediate level if the hand holding the pencil touches the clip and the other hand touches the radio or amplifier chassis.

TIMETABLE FOR ROASTING

Kind of Roast	*Oven Temperature*	*Internal Temperature*	*Approx. Min. per lb.*
Beef Ribs (Standing)	300°F.		
Rare		140°F.	18-20
Medium		160°F.	22-25
Well-done		170°F.	27-30
Beef Ribs (Rolled)	300°F.		Add 10 min. per lb. to above
Pork (Fresh)	350°F.		
Loin, 3-4 pounds		185°F.	35
Shoulder		185°F.	30-35
Ham		185°F.	30-35
Butt		185°F.	50-55
Pork (Cured)			
Ham (14 to 18 lbs.)	300°F.	160°F.	15-20
Ham (10 to 14 lbs.)		160°F.	18-20
Half Ham		160°F.	22-25
Tender Ham		160°F.	22-25
Lamb	300°F.	180°F.	30-35
Veal	300°F.	170°F.	25-30
Turkey or Heavy Poultry	325°F.	180°F. Center of Stuffing 190°F. Center of Thigh Muscle	

Electronics Tells the Chemist

Continued from page 79

then another trying to find a use. After years of hit or miss research, they *might* be successful.

Or the company may catalog the fundamental characteristics of the compound and pass the information on to other industries in hopes of receiving suggestions on how the substance might be developed.

Or, if the compound looks like it might work as, say, an insecticide, the company might ask an insecticide expert to compare its properties with known bug killers and decide whether it's feasible.

All this set scientists at the Midwest Research Institute, Kansas City, Mo., to wondering whether a program might be developed to determine, with the aid of electronic computer techniques, the structural and physical properties which correlate the uses of chemical compounds.

Institute chemist Richard A. Carpenter said, "The mental processes of the expert led us to think of employing rapid electronic equipment to simulate his decisions. Since the expert bases his decisions on the comparison of the new compound with the properties and structures of materials previously found promising, this information could be coded and processed into a memory device. The results would be a sort of 'super chemist' armed with millions of facts, correlations and significant patterns from past experience and research. This 'super chemist' would be equipped with a never-failing memory able to make many comparisons simultaneously without bias and at a high rate of speed."

Like the expert, the computer could calculate, compare, correlate, and come up—in minutes—with possible uses for the new compound.

For example, says Carpenter, the computer can be used to pick out likely chemicals to treat cancer. So far, he points out, cancer research has been a matter of blindly trying everything that comes along in hopes of a cure. Over 20,000 compounds have been tried already. The computer, on the other hand, can analyze the common characteristics of the more promising substances and pin-point similar but different substances offering the most promise for further experimentation.

Much preliminary work was necessary even before the computer could be called into play. The research team wrote to 1,000 companies for catalogs and data sheets on their compounds. The material poured in. Hundreds of thousands of facts on boiling points, densities, formulas, and uses had to be coded and punched onto computer input cards. A system had to be devised for transcribing that data onto a magnetic tape. This process is still under way.

Monthly trips are made to Washington, D. C., to make use of the huge Vanguard computation center. Only about five minutes a month are allowed the researchers, however, because the computer priority is alloted to satellite problems. But those five minutes are the equivalent of 25 years of desk computing time. It takes researchers three weeks to get enough information together to take up the five minutes on the computer.

After two years of painstaking work, the research team has assembled and coded facts about almost all the 3,000 compounds with known uses. These facts will serve as the computer's memory. Within a few months the entire memory system will be complete. Then the electronic computer, with its high-speed classifying system, will start on practical problems.

What will be the impact of this electronic brain on chemistry? Says Carpenter: "It will certainly stimulate research, reveal better chemicals for many old and new uses, cut development costs by making research more efficient and productive, generate new knowledge by revealing normally obscured correlations, and most significantly, it will substitute a methodology for the current confusion."

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Qty.	Type	Price	Qty.	Type	Price	Qty.	Type	Price	Qty.	Type	Price	Qty.	Type	Price	Qty.	Type	Price
___	0Z4M	.79	___	4BC5	.56	___	6AQ5	.50	___	6CG8	.77	___	8AW8	.93	___	12BH7	.73	___	12X4	.38
___	1AX2	.62	___	4BC8	.96	___	6AR5	.55	___	6CM7	.66	___	8BQ5	.60	___	12BK5	.70	___	17AX4	.67
___	1B3GT	.79	___	4BE6	.54	___	6AS5	.60	___	6CN7	.65	___	8CG7	.62	___	12BL6	.56	___	17BQ6	1.09
___	1DN5	.55	___	4BN6	.75	___	6AT6	.43	___	6CR6	.51	___	8CM7	.68	___	12BQ6	1.06	___	17C5	.58
___	1G3	.73	___	4BQ7	.96	___	6AT8	.79	___	6CS6	.57	___	8CN7	.97	___	12BY7	.74	___	17CA5	.62
___	1J3	.73	___	4BS8	.98	___	6AU4	.82	___	6CU5	.58	___	8CX8	.93	___	12BZ7	.75	___	17D4	.69
___	1K3	.73	___	4BU8	.71	___	6AU6	.50	___	6CU6	1.08	___	8EB8	.94	___	12C5	.56	___	17DQ6	1.06
___	1L6	1.05	___	4BZ6	.58	___	6AU7	.61	___	6CY5	.70	___	100A7	.71	___	12CA5	.59	___	17L6	.58
___	1LA6	.69	___	4BZ7	.96	___	6AU8	.87	___	6CY7	.71	___	11CY7	.75	___	12CN5	.56	___	17W6	.70
___	1LC6	.79	___	4CB6	.59	___	6AV6	.40	___	6DA4	.68	___	12A4	.60	___	12CR6	.54	___	19AU4	.83
___	1LN5	.59	___	4CS6	.61	___	6AW8	.89	___	6DB5	.69	___	12AB5	.55	___	12CU5	.58	___	19BG6	1.39
___	1R5	.62	___	4DE6	.62	___	6AX4	.65	___	6DE6	.58	___	12AC6	.49	___	12CU6	1.06	___	19T8	.80
___	1S5	.51	___	4DK6	.60	___	6AX7	.64	___	6DG6	.59	___	12AD6	.57	___	12CX6	.54	___	21EX6	1.49
___	1T4	.58	___	4DT6	.55	___	6BA6	.49	___	6DQ6	1.10	___	12AE6	.43	___	12DB5	.69	___	25AU4	.87
___	1U4	.57	___	5AM8	.79	___	6BC5	.54	___	6DT5	.76	___	12AF3	.73	___	12DE8	.75	___	25BQ6	1.11
___	1U5	.50	___	5AN8	.86	___	6BC7	.94	___	6DT6	.53	___	12AF6	.49		12DL8	.85	___	25C5	.53
___	1X2B	.82	___	5AQ5	.52	___	6BC8	.97	___	6EU8	.79	___	12AJ6	.46	___	12DM7	.67	___	25CA5	.59
___	2AF4	.96	___	5AT8	.80	___	6BD6	.51	___	6EA8	.79	___	12AL5	.45	___	12DQ6	1.04	___	25CD6	1.44
___	2BN4	.60	___	5BK7A	.82	___	6BE6	.55	___	6EB8	.94	___	12AL8	.95	___	12DS7	.79	___	25CU6	1.11
___	2CY5	.71	___	5BQ7	.97	___	6BF6	.44	___	6H6GT	.58	___	12AQ5	.52	___	12DZ6	.56	___	25DN6	1.42
___	3AL5	.42	___	5BR8	.79	___	6BG6	1.66	___	6J5GT	.51	___	12AT6	.43	___	12EL6	.50	___	25EH5	.55
___	3AU6	.51	___	5CG8	.76	___	6BH6	.65	___	6J6	.67	___	12AT7	.76	___	12EG6	.54	___	25L6	.57
___	3AV6	.41	___	5CL8	.76	___	6BH8	.87	___	6K6	.79	___	12AU6	.50	___	12EK6	.56	___	25W4	.68
___	3BA6	.51	___	5EA8	.80	___	6BJ6	.62	___	6S4	.48	___	12AU7	.60	___	12EZ6	.53	___	25Z6	.66
___	3BC5	.54	___	5EU8	.80	___	6BK5	.80	___	6SA7GT	.76	___	12AV5	.97	___	12F5	.66	___	35C5	.51
___	3BE6	.52	___	5J6	.68	___	6BK7	.85	___	6SK7GT	.74	___	12AV6	.41	___	12F8	.66	___	35L6	.57
___	3BN4	.63	___	5T8	.81	___	6BL7	1.00	___	6SL7	.80	___	12AV7	.75	___	12FM6	.45	___	35W4	.52
___	3BN6	.76	___	5U4	.60	___	6BN4	.57	___	6SN7	.65	___	12AX4	.67	___	12K5	.65	___	35Z5GT	.60
___	3BU8	.78	___	5U8	.81	___	6BN6	.74	___	6SQ7	.73	___	12AX7	.63	___	12SA7M	.86	___	50B5	.60
___	3BY6	.55	___	5V6	.56	___	6BQ5	.65	___	6T4	.99	___	12AZ7	.86	___	12SK7GT	.74	___	50C5	.53
___	3BZ6	.55	___	5X8	.78	___	6BQ6GT	1.05	___	6T8	.80	___	12B4	.63	___	12SN7	.67	___	50DC4	.37
___	3CB6	.54	___	5Y3	.46	___	6BQ7	.95	___	6U8	.78	___	12BA6	.50	___	12SQ7M	.73	___	50EH5	.55
___	3CF6	.60	___	6AB4	.46	___	6BR8	.78	___	6V6GT	.54	___	12BD6	.50	___	12U7	.62	___	50L6	.61
___	3CS6	.52	___	6AC7	.96	___	6BS8	.90	___	6W4	.57	___	12BE6	.53	___	12V6GT	.53	___	117Z3	.61
___	3CY5	.71	___	6AF3	.73	___	6BU8	.70	___	6W6	.69	___	12BF6	.44	___	12W6	.69			
___	3DE6	.62	___	6AF4	.97	___	6BY6	.54	___	6X4	.39									
___	3DK6	.60	___	6AG5	.65	___	6BZ6	.54	___	6X5GT	.53									
___	3DT6	.50	___	6AH6	.99	___	6BZ7	.97	___	6X8	.77									
___	3Q5	.80	___	6AK5	.95	___	6C4	.43	___	7AU7	.61									
___	3S4	.61	___	6AL5	.47	___	6CB6	.54	___	7A8	.68									
___	3V4	.58	___	6AM8	.78	___	6CD6	1.42	___	7B6	.69									
___	4AU6	.54	___	6AN4	.95	___	6CF6	.64	___	7Y4	.69									
___	4BA6	.51	___	6AN8	.85	___	6CG7	.60	___	8AU8	.83									

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A complete 25/25 watt stereo power and control center (50 watts mono) . . . 5 switch-selected inputs for each channel . . . new mixed center speaker output . . . stereo reverse and balance controls . . . special channel separation control . . . separate tone controls for each channel with ganged volume controls . . . all of these deluxe features in a single, compact and handsomely styled unit! Five inputs for each 25 watt channel are provided: stereo channel for magnetic phono cartridge (RIAA equalized); tape head input; three high level auxiliary inputs for tuners, TV, etc. There is also an input for monophonic magnetic phono cartridge, so switched that monophonic records can be played through either or both amplifiers. The automatically mixed center speaker output lets you fill in the "hole-in-the-middle" found in some stereo recordings, or add extra monophonic speakers in other locations. Nearly all of the components are mounted on two circuit boards, simplifying assembly and minimizing possibility of wiring errors. Handsome cabinet features new "visor" effect, with vinyl-clad steel cover in black leather-like texture with gold design. 30 lbs.

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STEREO RECORD PLAYER KIT (AD-10)

Made by famous Garrard of England to superb specifications. "Plug-in" cartridge feature. Rubber matted heavy turntable is shock-mounted, and idler wheels retract when turned off to prevent flat spots. Powered by a line-filtered, four-pole induction motor at 16, 33⅓, 45 and 78 rpm. Supplied with Sonotone STA4-SD ceramic stereo turnover cartridge with .7 mil diamond and 3 mil sapphire styli. Assembles in minutes; mechanism and vinyl covered mounting base preassembled, arm pre-wired. With 12" record on table, requires approximately 15" W. x 13" D. x 6" H. Color styled in cocoa brown and beige. 10 lbs.

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AA-20 **$34.95**

AA-30 **$45.95**

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Although these two new Heathkit models are designed as companion pieces, either one can be used with your present stereo system. The preamplifier (AA-20) features 4 inputs in each stereo channel (RIAA "mag" phono, "xtal" phono, and two auxiliary inputs). A six-position function selector switch gives you instant selection of "Amplifier A" or "Amplifier B" for single channel monophonic; "Monophonic A" or "Monophonic B" for dual channel monophonic using both amplifiers and either preamplifier; "Stereo" and "Stereo Reverse". Self-powered. (AA-20) 8 lbs.

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Two 14-watt high fidelity amplifiers, one for each stereo channel, are packaged in the single, compact, handsomely styled amplifier (AA-30). Suitable for use with any stereo preamplifier or with a pair of monophonic preamplifiers, it features individual channel gain controls, speaker phase reversal switch and convenient pilot light. Output accommodates 4, 8 and 16 ohm speakers. Handsome satin black expanded-metal cover, gold colored chassis. (AA-30) 21 lbs.

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EK-1
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EDUCATIONAL KIT (EK-1)

Youngsters and oldsters alike will find this kit a priceless introduction into the wonderful world of electronics. Now, at less than the cost of several standard textbooks on the subject, Heath offers a complete basic electricity course, resulting in a finished test instrument of a thousand and one uses. The EK-1 is a combination kit and text-workbook designed to teach the principles of voltage, current, and resistance —the basic "yardsticks" of electronics to students of junior high level. Adults also will find the project beneficial as a beginning or refresher course in electronics. When finished with the project the student will have learned the theory and construction of direct current series and parallel circuits, voltmeter, ammeter and ohmmeter circuits and the application of ohms law to these circuits. The completed meter will then be used to verify ohms law and the maximum power transfer theorem, one of the most important theorems in electronics. The finished kit, a practical volt-ohm-milliammeter, may be used to make measurements of voltage, current and resistance in a wide variety of applications.

Procedures for checking home appliances and automobile circuits are included with the kit. The EK-1 will serve as a prerequisite to following Heathkit Educational Kits. Get started NOW in this new and exciting series. 4 lbs.

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6-TRANSISTOR PORTABLE RADIO KIT (XR-2 series)

Dependable portable entertainment wherever you are —wherever you go! Choose the gleaming, two-tone molded plastic model or the handsome simulated leather-and-plastic combination—both feature a gracefully curved grille in smart beige plastic. The XR-2P complements the handsome grille with a mocha colored case of high-impact plastic, while the XR-2L encases the grille in sun tan color Sur-o-Lon simulated leather. Vernier tuning control gives you smooth, precise station selection. Six Texas Instrument transistors are used for quality performance and long life; a large 4" x 6" PM speaker provides "big set" richness of tone. Ready to play after simple assembly—transformers prealigned. Six flashlight batteries used for power (500-1000 hrs.) (batteries not included).

HW-19 (10 meter)
HW-29 (6 meter)
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10 & 6 METER TRANSCEIVER KITS

Complete ham facilities at low cost! Ideal for beginning and veteran hams for "local" net operations. Transmitter and receiver are combined in one easy-to-use instrument. Features neat, modern styling, press-to-talk transmit/receive switch, built-in AC power supply, variable gain control and built-in amplifier metering jack. Operates mobile using vibrator power supply. Microphone and two power cables included. Styled in mocha and beige. Less crystal. 10 lbs.

Vibrator Power Supplies: VP-1-6 (6v.), VP-1-12 (12v.). 4 lbs. kit; $8.95 ea., Wired; $12.95 ea.

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Cosmic Clearing House

Continued from page 37

center, it approaches the speed of light—at which point it becomes electromagnetic energy, thus returning to the "universal" fountain of energy from which new universes are born. One of the big aims of the Cornell space center is to check the correctness of this concept.

Intergalactic space appears to be a vast mass of electrostatic charges, magnetic fields and electromagnetic radiations. The recent discovery of anti-matter indicates that an "anti-universe" must also exist somewhere—a universe in which all the atomic particles are electrically charged exactly opposite to those of our own universe. Such a situation would set up a field-force between the two universes, just as the two plates of a capacitor are charged oppositely, setting up an electrostatic tension between them. Such a universal tension could act as a conductor of energy through apparently "empty" space—again, as a capacitor transports radio-frequency, cycling it into more direct impulses.

The propagation of electromagnetic waves through space might occur in a similar way. Radio waves, like light, are electromagnetic energy. So the special way by which we see things, as well as our ability to communicate by radio, may be possible in space because space itself is an electrical conductor. This is an intriguing idea, for if it's true, man may be able to communicate through the "void" instantaneously—without being hampered by the "slowness" of the speed of light.

For example, to send a radio signal one way to the nearest star would take about four years. Another four years would lapse before the answering signal could be received on earth. Other complications are interference from natural radio sources (radio-emitting stars and galaxies) and the position of the star toward which we are beaming our signals. If the star is located in front of a strong natural radio source, cosmic radio interference will over-ride the answering signals, if any. There would be no way of knowing whether our signals were reaching intelligent beings alive on a planet orbiting about that star.

Two physicists, Drs. G. Cocconi and P. Morrison, have collaborated recently on a method to make use of radio to determine whether intelligent life exists elsewhere in the universe. A main point of their proposal is the calculation of the most favorable positions in the Milky Way toward which to beam radio signals. This would be a region where cosmic "static" is at a minimum.

Dr. Morrison is an advisor to the new Cornell Center. He and his colleague have stated that near some star like our sun there probably are civilizations with scientific interests and technical possibilities much greater than those available to us. To these intelligent beings our own sun must appear as a likely site for the evolution of a new society. It is probable that for a long time they will have been expecting the development of science near our sun. We shall assume that long ago they established a channel of communication that would one day become known to us, and that they look forward patiently to the answering signals from us that would make known to them the fact that a new society has entered the community of intelligence. In other words, they are waiting for word from us.

The word "radiophysics" in the Cornell Center's name is significant. It refers to the field of science where research into all the aspects of physics—from the formation of the earth to the evolution of the total universe—is carried out primarily by using radio as the tool of investigation. This covers everything from antenna design to microwave amplification, and from solid-state physics to magneto-hydrodynamics. This last mentioned imposing subject is one of the newest of the physical sciences and concerns itself with the investigation of the fluid relationships between magnetic fields and electrically charged gases.

Professor Gold will soon have available (by 1961), a thousand-foot-diameter radar antenna driven by a transmitter of 2.5 megawatts peak power. This instrument will permit penetration of the dense gases, thousands of miles thick, in the atmosphere of Jupiter. It will reach the very core of that planet—the giant of our solar system. Jupiter's average distance from Earth is about 500-million miles.

The radar system of the Cornell Center, to be located in Puerto Rico, will be capable of transmitting such strong signals that reflected echo will have 10,000 times the power of those received from Venus during the Air Force's recent radar probe of that planet from their Cambridge Research Center.

According to Professor Gold, "At the present time, we have just barely been able to detect Venus. This power (of the Cornell radar) would make possible the actual penetration of the Venusian surface. It will

be possible to 'see' the variations of that surface—and to plot them."

But even more than this, Professor Gold continues: "It is not unreasonable to claim that we will be able to discover the general order of magnitude of vegetation on Venus by using a number of different radar wavelengths. The clusters or concentrations of vegetation could be determined by the way the radar 'paints' different slopes and levels on the scope."

The extreme value of such pure scientific research to the practical future of landing an expeditionary space crew on Venus is self-evident. Yet of equal importance will be the radio-communications know-how that will certainly be acquired through the Venusian experiments with radar. The characteristics of microwave radio propagation between the earth and Venus should suggest new designs for efficient two-way communications over millions of miles of interplanetary space.

Determining exact distances between the earth, the planets and the sun will be another project of the Cornell Center. By combining radar with optics, precise distances can be determined. At 400 mc, the giant radar system of the center will be able to resolve the sun's surface to 1/6 of a degree, far greater accuracy than has ever before been achieved. Much new information about the sun will pay off in a closer understanding of the earth's upper atmosphere, a deeper understanding of how radio waves are affected by the ionosphere, how storms are created, and how weather systems are formed.

One technique proposed by Professor Gold to analyze the sun is the use of microwave back-scatter from the ionized layers of the solar atmosphere. Simply, a radio wave, depending on its energy and angle, strikes the electrons and charged atomic nuclei of the electrified hot gases of the sun, causing them to release particles of electromagnetic energy in various directions. The original radio energy is absorbed, but the energy released will be of the same frequency. If the angle of the absorbed radio wave is just right, then some of the released radio energy will be scattered backwards toward the source of the transmitted energy—hence the phrase, "back-scatter."

The foregoing are only a few of many important projects planned by the Cornell Center. The key men at the Center read

like a Who's Who in Radiophysics. Their job will be to correlate practical observations with the best inferences of theory—a two-way correlation between actual information and ideas. In this sense, the new Cornell space center is a unique cosmic clearing house.

NAVIGATION IN SPACE—What happens when an astronaut reaches the point where he can no longer rely on navigational aid from Earth, yet is still too far from his destination to use radar? The Franklin Institute has come up with a solution: Our spaceman will have to use star radiations as his compass and speedometer. This method of navigation will be based on the Doppler effect—the change in frequency of electromagnetic phenomena due to relative motion between two objects. Radiations from the sun, or a star, received at the space vehicle will vary in frequency with the velocity of the vehicle. If the astronaut can detect and measure this change, he will be able to chart his speed and course. The task now is to develop gear compact enough to be carried aboard a space ship, yet sensitive enough to detect the very low signal level of the stars. Packing a giant radiotelescope aboard a Flash Gordon-type rocket ship is, of course, out of the question.

A Wide Range Watt Meter

Continued from page 88

the power line. With S2 set for the high range, R1 is rotated until a center reading on the meter is achieved. Wattage can be read directly off the scale. This little unit will tell you more things than the manufacturer's specifications may indicate.

For example, a television set may be rated at 300 watts but will draw considerably more in the first second or two due to the fact that the tube filaments must be brought to the proper operating temperature from a dead cold start. In addition, the wattmeter can be a useful service tool. For example, if the filter capacitor or a tube on a high fidelity amplifier is shorted, the wattmeter will continue to show a wattage reading considerably higher than the rating specified by the manufacturer. In addition, the meter reading will drop considerably when the defective tube is removed and will obviously not return to the high wattage level when a new tube is inserted.

Though this meter can handle loads up to about 1500 watts (about 14 amps in a 110 volt line), it is not advisable to leave it constantly connected in the circuit. Thus, the transformer primary should be shorted out with the "in-out" switch whenever the unit is not being used to take a reading. On very high wattage loads (in excess of 1,000 watts), the meter will give a slight reading even when S1 is shorting out the transformer primary. This is due to the fact that the switch acts as a very low resistance shunt which nevertheless allows some current to flow through the transformer primary and thereby developing a small voltage in the transformer secondary, proving that even the best switches have some internal resistance.

6 Meters

Continued from page 73

ateur radio fraternity. Officially recognized by the FCC, specific portions of each band have been assigned to RACES. During an actual emergency, hams engaged in civil defense operation under the control of RACES would be given exclusive use of these channels. While space has been provided in all bands below 300 mc, the VHF allocation is most commonly used in an actual emergency. Drills are conducted on the lower frequencies as well since these would become important during a wide spread emergency such as a nuclear attack.

The Technician Class

For the first time in this series we encounter a new kind of amateur. He is halfway between the Novice and General Class ham. He must be able to send and receive code at a rate of five w.p.m. which is the Novice standard, but unlike the Novice, his know-how must equal that of the General Class amateur. The Technician's license is renewable year after year.

The technician may not operate on any frequency below 30 mc. But where he is allowed to operate (including the entire six meter band), he has full amateur privileges—in other words, the full kilowatt if desired and any type of modulation permitted on the particular frequency.

Not intended as a stepping stone from the non-renewable Novice license to the General Class ticket, it is nevertheless one way the ham having the "13 w.p.m. blues" can stay on the air. With this intermediate stage, all shortwave privileges are lost, at least until the ham passes that code test. Until such time his only chance for international DX would be right here on six meters.

The Technician Class originally was created for those persons interested primarily in the technical side of radio rather than in rag chewing, traffic handling and DX just for the sake of DX. It was created specifically for those persons wishing to study VHF and UHF propagation. On six meters the foremost target is, needless to say, the Sporadic-E layer. Last month we told you that summer heat and meteor showers were two possible causes of this baffling propagation phenomenon. Other factors might include sunspots and the ionospheric disturbances (magnetic storms) which accompany them. In any case, the Sporadic-E layer is just one challenge of VHF.

Transistorized VU Meter

Continued from page 51

tor (C1) of the meter is rated at only 25V. and an extra capacitor (.5 mfd or higher) with a rating of at least 400 volts will have to be put in series with the 25-volt input capacitor.

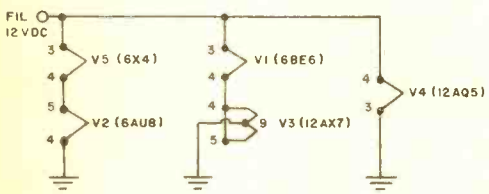
Calibration

Extremely accurate calibration of the VU meter for a specific recorder and tape requires specialized equipment. However a good calibration, adequate for most recording applications, can be made as follows: Using a phonograph as a program source, make a series of recordings of the same passage of music—each at an increasingly higher recording level. Continue until you reach the point which just begins to produce audible playback distortion. At this level, while still recording, adjust the sensitivity of the VU meter to read 0 VU. This will be easy if you record a music passage which is relatively slow and contains a few sudden changes in intensity. With the meter thus set, record the passage again and decrease the recording level until the meter reading averages —6. Leaving the level setting as is, re-record the passage and increase the VU meter sensitivity until it reads 0 VU. If you are careful always to record and make level and sensitivity adjustments on the same passage of music, you should wind up with a meter calibration which indicates a 0 VU reading when the recording level is 6 db (—6 VU) below the point of audible distortion. Now, when recording, keep the average recording level at 0 VU. The 6 db margin will prevent overloading on peaks or sudden changes of intensity in the program material.

Try out this little transistor meter. If you use it correctly, you will be amazed at the better sound of your recordings.

Citizens Band Power Supply

Continued from page 48



Filament wiring for 12 volt supply, see text.

be noted that reception on the broadcast set (auto or home) is unaffected. When the CB unit is switched to its *off* position, the antenna is automatically feeding the radio once again. However, it's a good idea to touch up the auto BC set's antenna trimmer for best response. Find the antenna trimmer hole (usually adjacent to the antenna jack). A small paper label with tuning instructions is usually fastened next to the trimmer hole. If missing, simply set the radio to a weak BC station up at around 1300 kc and tune for maximum volume (use a small screwdriver).

This completes this series on the CB rig. The unit described in these pages performs in a manner comparable to commercial sets. Final tests were conducted under adverse conditions; (in the city while driving between tall buildings) and reliable communication with the home station was achieved over a radius of 1½ miles. Far greater range is possible in open country—where intelligible communication has been achieved over six to eight miles.

BONUS PHOTOGRAPHY SECTION

IN JULY *EI*

Don't Fry That Ham

Continued from page 85

or 34,500 volts are usually strung at the very top of a pole, while farther down, wires on racks or spools at lower potentials of 115 to 440 volts are more neighborly, but still not to be trusted.

A more reliable clue to finding the voltage of a wire or conductor than checking its location on the pole is noting the size of the insulator that supports the "live wire." A brown or white-glazed porcelain insulator about the size of a bowling ball with large grooves on the sides and top is a sure sign of high voltage. This model usually has one or two covering "skirts" to protect it from water seepage during rainy weather. A fist-size insulator handles 2300 to 7200 volts while a larger one designed for 16,500 volts compares in size to a big beer mug. Many high-voltage circuits still use green glass insulators which are considered harmless in telephone lines but are quite capable of handling much higher voltages elsewhere.

Even a city-slicker knows that a rattlesnake won't hurt anybody unless he's fooled with, and the same is true of a power line high on a pole. All would be well if hams didn't have the risky habit of getting long wires, ladders, and metal beam elements tangled in everything from the chimney on the roof to the bird house in the backyard.

"But all wires are insulated, aren't they?" you may argue.

Sure, wires are wrapped up, but that covering protects the conductor against corrosion from bad weather, and not a ham who gets his pinkies on it or an antenna against it.

"The vital function of any tree includes holding up a long wire first and a birdnest second," contends the typical amateur, and the same fellow will gasp in horror when he hears that his friendly old oak can turn into a booby trap overnight. Should a power line droop through its branches and rub against a limb, the cambium layer and green sap will do what comes naturally and conduct electricity better than a trimmed Christmas tree. Any doubting Thomases in the crowd will recall that lightning often dives for the nearest tree in a spring storm.

"Don't try to tell me that 115 volts on an ordinary streetlight circuit is dangerous," scoffs the amateur who hasn't seen the right light.

If only a few volts can be deadly, certainly 115 is to be respected; besides that grim fact, there's a joker in this deck, too. While many lighting systems carry 115 volts similar to wiring in h m s, larger systems must have a "constant current" transformer to boost the voltage as each additional light is added. A town of a few thousand people might be supplied by a single series circuit with one wire meandering miles and miles carrying more than 5000 vicious volts. This series system sabotages the game of guessing voltages by the size of the insulators. The streetlight circuit where voltage to ground is lower than line voltage usually employs common 2300 volt side-groove insulators.

Although many power companies have adopted definite standards in their distribution systems, there are flies in every ointment. After a windstorm or severe icing, high and low voltage conductors are sometimes wound up with telephone lines like licorice sticks and every wire becomes dangerous. Joint construction placing power lines and communication circuits on the same poles is a common practice almost everywhere, and even in fair weather a falling limb may pull a primary line onto a normally harmless neighbor.

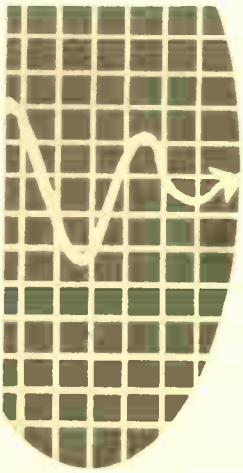
In short, the safest and best rule for all hams is to observe in handling electric power lines is "Not To." Call the company lineman who has had years of experience in identifying voltages and pointing out dangers. And what about the wire that crosses your lot or swings over the roof? Well, consider it dangerous until proven innocent. Even after checking its position on the power pole and noting the size of the insulator, too, don't march under it with a tall steel mast, nudge it with a beam element, or trust the tree it touches. You can never be quite sure what voltages are sizzling along up there. The variety of ham we're talking about isn't for frying.

BONUS

PHOTOGRAPHY SECTION

IN

JULY *EI*



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Ham Station Control Center

Continued from page 33

fuses. There is no possibility of RF radiation from below the chassis. Remember to replace the original fuse in each piece of gear with a *larger* size (by 2 or 3 amps) and put the *proper* size fuse for the specific piece of equipment in the control unit.

Audio Noise Limiter

Sure, an audio noise limiter will knock your audio level down, but if you have a half-way modern receiver you've got more audio than you need anyway. Try the simple limiter shown in schematic B. At those rare times when you want every bit of audio your receiver will produce, simply flip S5 on the control unit and the noise limiter is out of the circuit. Some authorities recommend a 1.5-volt cell in series with each of the crystal diodes. Both ways have been explored and we fail to see enough difference to warrant remembering to throw an extra switch. However, suit yourself. Schematics B and C show proper polarities of batteries and diodes.

The RF pick-up coil of this transistorized keying monitor (see schematic D) may be dropped inside your transmitter cabinet adjacent to your tank or antenna coil—wherever you get the best pickup. When using a whip antenna, you can drop the "doughnut" over the whip. Single wire antenna lead-ins can be fed through the 'hole in the doughnut' before connection to the transmitter. This little monitor will give you fair volume. If you want more, simply add *another transistor* and a small battery in a conventional transistor amplifying circuit. If the monitor doesn't oscillate readily on the first try, reverse either the primary or secondary connections to T2; not *both*. See Figure 2 for detailed drawing of pickup coil.

The clock used here has a timer that can be set to sound off an alarm as well as turn on your transmitter and receiver 10 or 15 minutes before that schedule which you would probably otherwise forget.

There you have it. There is lots of room for initiative. Using a larger cabinet would enable you to incorporate the Conelrad unit. Other changes will no doubt suggest themselves to you, but for all around convenience and operating pleasure, we suggest sticking to the *basic* design. —

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1R5	.51	6BC8	.59	12AB5	.44
1S5	.43	6BE6	.48	12AF6	.44
1T4	.51	6BF5	1.18	12AT6	.37
1U4	.51	6BG6G	.51	12AT7	.71
1U5	.43	6BH6	.51	12AU6	.43
1X2	.62	6BJ6	.51	12AU7	.58
2AF4	1.02	6BK5	.75	12AV6	.42
2BN4	.55	6BK7	.78	12AV7	.73
3AU6	.43	6BL7GT	.44	12AX4GT	.60
3BC5	.58	6BN4	.90	12AX7	.61
3BN6	.90	6BN6	.83	12AZ7	.65
3BZ6	.45	6BQ6GT	.85	12B4	.52
3CB6	.51	6BQ7A	.75	12BA6	.46
3DT6	.51	6BY5G	.45	12BE6	.46
3V4	.48	6BZ6	.95	12BH7	.61
4BC8	.69	6BZ7	.41	12BQ6	.63
4BQ7	.75	6C4	1.63	12BY7	.65
4CB6	.51	6CB6	.45	12CR6	.43
5AM8	.59	6CG6G	.51	12CU6	.63
5AN8	.64	6CF6	.45	12DB5	.59
5AT8	.54	6CG7	.44	12DQ6	.63
5AV8	.54	6CH8	.54	12K5	.44
5BK7	.68	6CM7	.44	12SA7	.45
5J6	.61	6CS6	.45	12SK7	.45
5T8	.59	6CU6	.95	12SN7GT	.56
5U4G	.43	6DE6	.43	12SQ7	.38
5U4GA	.45	6DQ6	.50	12V6GT	.43
5U4GB	.45	6HG	.89	12L6GT	.43
5U8	.59	6J5	.47	12W6GT	.43
5V4G	.49	6J6	.49	17DQ6	.68
5X8	.55	6K6GT	.61	19AU4	.60
5Y3GT	.30	6S4	.39	198G6G	1.48
6AB4	.43	6SA7	.41	25BQ6GT	.82
6AC7	.65	6SC7	.45	25CD6G	1.19
6AF4	1.02	6SK7	.54	25CU6	.82
6AG5	.52	6SL7GT	.45	25L6GT	.41
6AH6	.47	6SN7GT	.60	25W4GT	.43
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6A8	.40	12Q7GT	.48
6AB7/		12SR7	.57
1853	.60	14A7	.43
6AQ7GT	.60	14B6	.36
6AS7G	1.50	14Q7	.52
6D6	.59	27	.45
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6F6	.42	35Y4	.35
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