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J. Morrison Smith
President
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ELECTRONICS ILLUSTRATED

March, 1961 Vol. 4, No. 3

A Fawcett Publication

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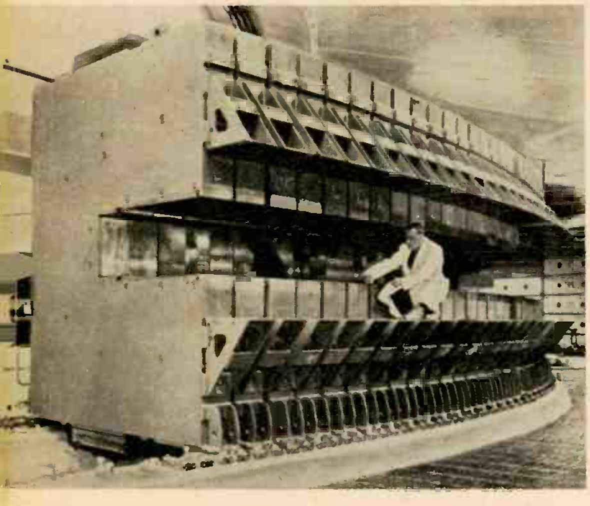
...electronics in the news



Dragon's Teeth? . . . This ominous-looking structure is only one section of a huge magnet core, part of a 7,000,000,000-volt atom smasher being built for the National Institute for Research in Nuclear Science at Harwell, England. When completed the ring will be 160 feet in diameter. Its purpose is to keep atomic particles spinning around at almost the speed of light. Known as Nimrod, the installation will enable British scientists to undertake fundamental research in nuclear physics and the behavior of the electron.

—o—

Automatic CD Alarm . . . A table radio with a built-in national-emergency alarm device developed by the Office of Civil and Defense Mobilization was demonstrated recently in the first public test of the alarm system. The radio, using two General Electric Compactron units in place of five conventional tubes, was included in OCDM's demonstration of the NEAR (National Emergency Alarm Repeater) system.

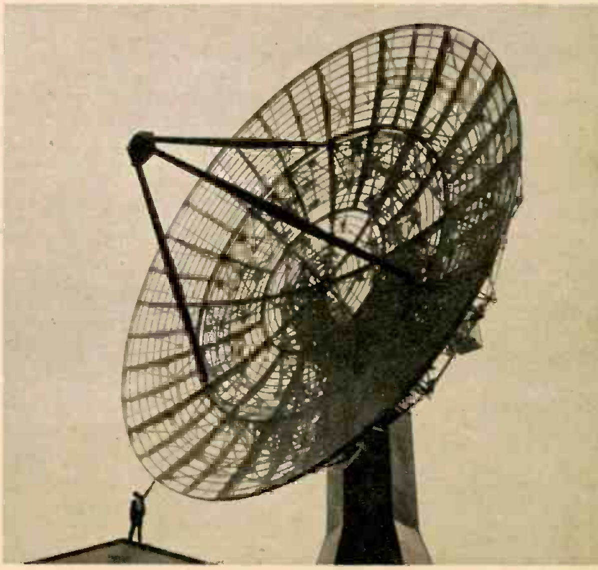
The heart of NEAR is a small black box that, plugged into any standard power outlet, provides a controlled warning system to a home or business.

The system is triggered by a signal induced on electric power lines by special generators. These generators produce a 240-cycle signal that is superimposed on the standard 60 cycles of power transmission.

The Compactron radio mockup built by GE was wired into a NEAR device. When the alarm is triggered its impulse automatically turns on the radio at full volume, and in this unit it also is capable of tuning the set to the proper frequency to receive instructions concerning the nature of the emergency.

—o—

Eye On The Sky . . . A normal-size man in the photo at right is dwarfed by the 60-foot antenna of the world's most powerful microwave radar now under construction at Cornell Aeronautical Laboratory, Inc., in Buffalo, N. Y. When an experimental 50-million watt radar installation begins operating this fall, CAL scientists will study the ability of high peak power radar to penetrate the earth's ionosphere in order to detect and track ballistic missiles and satellites with greater accuracy and at longer range.



. . . News

Teaching by Tape . . . A TV studio at Utah State University is being equipped by RCA to turn out tape recorded courses on campus for later telecast to students and home viewers. In the photo below a USU professor is watching himself on a monitor during playback of video tape just produced. Tape is on large reels in center.

A major benefit of the on-campus recording operation will be elimination of a twice-weekly trek over the mountains from the university at Logan to the nearest TV transmitters at Salt Lake City, 80 miles away. The profs, sometimes taking along truckloads of equipment, experimental devices and even lab animals, have been making the trip since 1954 and they're a little weary of playing nursemaid to psychotic dogs and hungry white rats during raging mountain storms. They are all in favor of the change.

With the new studio equipment the school will be able to produce the material on campus and then just mail it.

USU now has applications pending with the FCC to allow it to add VHF transmitting facilities to the studio setup. Equipment now being installed includes the advanced tape recorder, two vidicon studio cameras, a switcher, film camera, two film projectors, multiplexer and slide projector.

At any rate, the weary profs can now stay home and toast their feet, and tell about the time they were stranded on a 9,000-foot pass with a rabid guinea pig and . . .

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. . . News

On-Off Magnetic Material . . . Discovery of a new metallic compound with unique on-and-off magnetic characteristics has been reported by Du Pont.

The new material—a brittle, gray manganese compound—is unique because it becomes magnetic as its temperature rises above a point predetermined by its chemical composition. Let its temperature drop below that point and it becomes non-magnetic. By slight changes in composition, that point can be varied over a wide range.

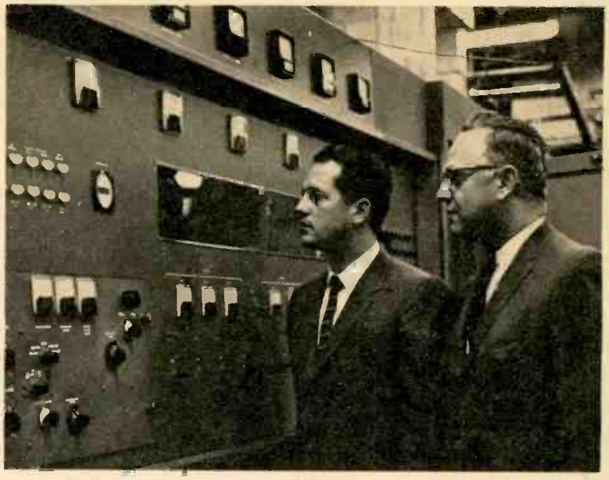
The material was discovered by scientists engaged in fundamental research on magnetism. They are deeply interested in the study of magnetism because it is a major force in nature and in science. The new compound is leading to a better basic understanding of magnetism and may, in time, lead to some new practical devices because it has strange new magnetic properties.

Most magnetic materials normally stay that way, their magnetism diminishing gradually as temperature increases until it finally disappears (in iron not until 1420° F).

Not so the new compound. It is attracted to a permanent magnet when its temperature is at or moderately above a certain level. When below, it is not.

The compound's magnetic change occurs because the distance between its atoms determines how the inner magnetic forces are lined up. When the distance is less than a specific length, the forces are aligned in a non-magnetic pattern. When it is farther, they swing into a magnetic pattern. The compound contracts and expands and its range of contraction includes the dimension at which the magnetic forces shift. Hence temperature brings about the magnetic change.

Discovery of the material resulted from work with maganese compounds, chosen for study because of their magnetic properties. It made its first appearance as a slight hump on a magnetic strength curve. Three months of study by five Du Pont scientists led to eventual development of the compound—chromium manganese antimonide.



A Loud Voice of America . . . General Electric is building six super-power transmitters for the Voice of America station near Monrovia, Liberia, on the west coast of Africa.

The 250,000-watt transmitters will be almost identical to the six at the United States Information Agency's consolidated East Coast broadcast facility near Greenville, N. C. They are the largest high-frequency, short-wave transmitters built by GE in its 40 years in the communications field. By comparison, maximum power of most broadcasting stations in the United States is 50,000 watts.

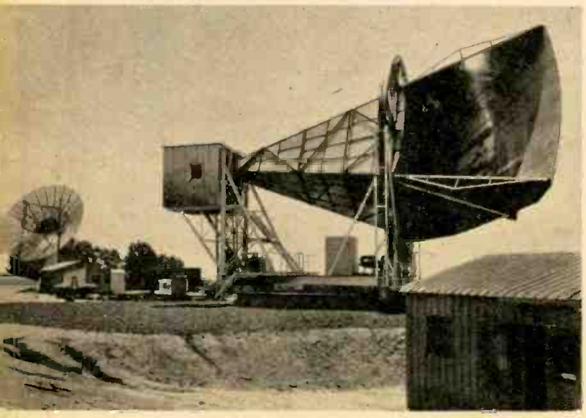
The photo at right shows VOA experts looking at the control panel of the new transmitting unit, which is rather tame when you consider the power behind it. The Monrovia installation will give VOA effective radio coverage of Africa and supplemental coverage of other areas. In addition, it will serve as an around-the-world relay station for programs originating at headquarters in Washington.

The latest electronic devices are packed into the new transmitters, which are especially suitable for rapid change in frequencies—vital to VOA as it switches broadcast coverage areas during the day. Silicon rectifiers are used in the main power supplies, and other advancements include harmonic filters to avoid interference with other communication services.

—o—

"Hello, Central, Give Me A Satellite!" . . . AT&T plans to put the first non-governmental satellite into space late this year. The sphere will be a signal relay station used for experimental transmission of telephone calls, TV and other types of communication between the U. S., Britain and the Continent.

The company is contracting for the launching of this satellite and others to make up a full-scale relay system. AT&T officials already are huddling with the National Aeronautics & Space Administration on the project. Plans are being pushed ahead for the transmitting and receiving stations on the ground and the possibilities of working satellites into regular commercial telephone communications facilities are being investigated.



"We are planning to use solar-powered satellites orbiting at an altitude of about 2,200 miles," says Henry T. Killingsworth, AT&T VP. "Electronic amplifiers would catch signals from earth and immediately boost and relay them to ground stations in the United States, the United Kingdom and Western Europe."

The photo at left shows the "telephone terminal to outer space" developed for current satellite communications work by AT&T's Bell Labs at Holmdel, N. J. In the foreground is an enormous horn antenna used for recep-

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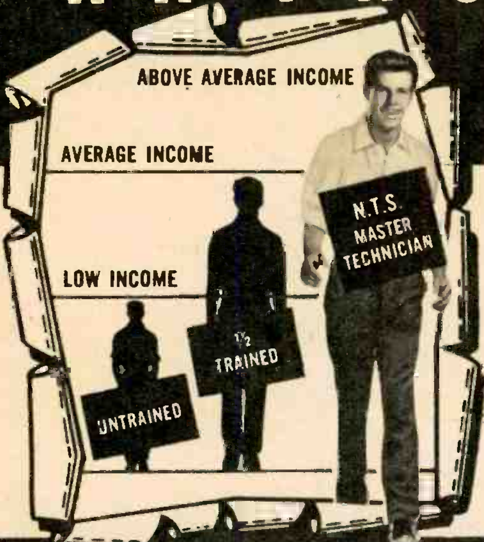

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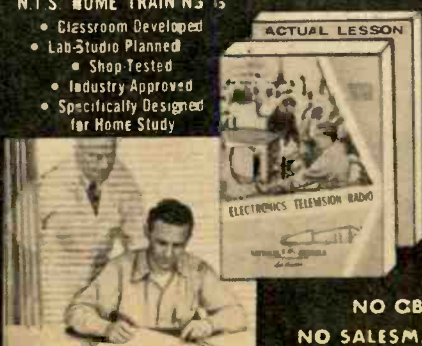

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Typical Knight-Kit hi-fi value—incomparable at the price. With AFC, tuned RF stage on FM, multiplex jack. Straight FM tuner kit also available at $38.95. For deluxe Stereo FM-AM and FM tuner kits, see the Allied catalog...

The most satisfying do-it-yourself experience awaits you when you build a Knight-Kit! You'll marvel at the sheer ease of assembly, absolutely assured by exclusive "show-how" manuals, wall-sized picture diagrams, step-by-step do-and-check instructions, pre-cut wire, "visi-packed" parts and an engineering perfection that eliminates guesswork. You'll get perfect results. You'll enjoy with pride a true custom-built electronic product, professionally engineered and styled—the best you can own. And to top off your pleasure, you'll save substantially at the unbeatable Knight-Kit price...

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Biggest bargain in quality Stereo hi-fi. Has special clutch-type dual-concentric level control; simplified control facilities; DC preamp filaments. Similarly styled 32-Watt Stereo Amplifier Kit with full frequency center channel available at a low, low $59.95...

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Super-power to drive any of today's speakers, a do-it-yourself stereo masterpiece, featuring: special "blend" control; full-range center channel; tape-source monitor; dual phasing switches; Stereo paralleling switch. For deluxe 40-watt Stereo amplifier at only $76.95, and 60-watt Stereo amplifier, see the Allied catalog...

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Every Knight-Kit is unconditionally guaranteed to meet our published specifications for performance or your purchase price is refunded in full.

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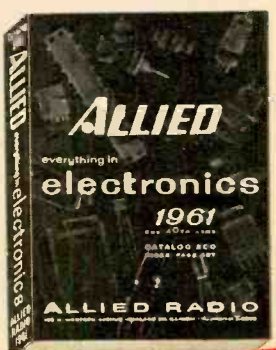

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High sensitivity general-purpose VTVM; 11 meg input resistance; balanced-bridge circuit; 4½" meter. One of many fine instrument kits including 5" scopes, AC VTVM, tube checkers, signal tracer, audio generator, sweep generator, and others, described in detail in the Allied catalog...

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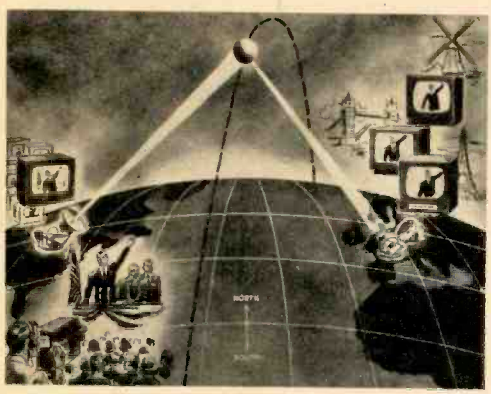
City ______________ Zone ____ State ______ tion of satellite signals. It is completely flexible, despite its size, and can hit any spot in the sky. The smaller dish antenna at left is for transmitting. The initial U. S. ground station for communication with the private satellites also would be built at Holmdel and the equipment would be somewhat similar.

AT&T's proposed satellites would be four feet in diameter and weigh 175 pounds. About 60 per cent of the surface would be glass-coated solar cells. A metal skin and two slotted antennas would comprise the rest of the surface.



The drawing above shows how the system would work. TV or voice signals from a ground station would be picked up by a satellite, immediately regenerated and flashed back to earth on the other side of the ocean.

"We expect this system to be capable of transmitting up to 35 minutes three or four times a day during satellite passes over the earth station areas," Killingsworth says. "The satellites would act as microwave towers in the sky, performing the same boosting and transmitting functions as the microwave towers of our radio relay systems on the ground."

The system would employ active satellites, containing electronic devices to receive, amplify and send signals back to earth. An earlier phase of this program was Bell's work on Project Echo, which employs a passive or reflecting satellite.

Demand for overseas communications is growing rapidly.

BECOME A RADIO

Build 20 Radio and Electronic Circuits at Home

ALL GUARANTEED TO WORK!

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HUNDREDS OF DOLLARS FOR A RADIO COURSE

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

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

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

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 20 Receiver, Transmitter, Square Wave Generator, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the complete price of $26.95. The Signal Tracer alone is worth more than the price of the entire Kit.

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

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

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build 20 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, selenium rectifiers, volume controls and switches, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

SERVICING LESSONS

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

J. 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 Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

PRINTED CIRCUITRY

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

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

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

NOW! TRAIN AT HOME IN RADIO AND ELECTRONICS

ORDER DIRECT FROM AD . . . . USE COUPON ON NEXT PAGE

RECEIVE FREE BONUS RESISTOR AND CONDENSER KITS

New Products

Wireless Microphone . . . The device hanging from the young lady's neck looks like an ordinary microphone of the lavalier type but it is actually a self-contained FM transmitting station, including mike, transistors and batteries. The neck strap is the antenna. (See *EI's* cover story this month—Ed.)

Weighing only 7½ ounces and measuring one inch in diameter by five inches long, the Vega-Mike is a product of Vega Electronics Corp., Cupertino, Calif. The power output is about 20 milliwatts but the useful range with a special receiver is a half-mile or more. The operating frequencies are in the 25-45 megacycle band, in channels assigned by the FCC for general business and broadcast relay purposes.

—o—

Cartridge Tape Recorder . . . An extremely compact automatic magnetic recorder has been introduced by the Amplifier Corporation of America, an affiliate of Keystone Camera Co., Inc., 398 Broadway, New York 13, N. Y. The new unit, the Bookshelf Magnematic, was designed to make tape easier to

. . . New Products

play than phonograph records, according to the manufacturer.

The Magnematic is available in two types: the Bookshelf for the home (shown in the photo) and the Broadcaster in rack panel form for professional use. The Bookshelf unit is 3¼ inches high, 10 inches deep, and 11½ inches wide. The Broadcaster fits a standard 3½-inch rack panel.

The specially lubricated tape for the machine is contained in plastic cartridges holding 300, 600 or 1,200-foot lengths. The cartridge is inserted into the player and the start button is pressed. Cartridges are of the continuous, self-contained, single-reel type which operate on an endless-loop principle.

This new unit provides instantaneous start-stop by utilizing a push-button operated solenoid with a mechanism designed for continuous operation. It readily lends itself to remote control for automatic start and stop.

Models are available with stereophonic or monophonic facilities, utilizing one, two, three, or four tracks operating at speeds of 1⅞, 3¾, 7½ and 15 inches per second. Depending upon tape speed, maximum record-play time ranges from 30 minutes to eight hours.

—o—

Tiny Photoelectric Cell . . . A sensitive microminiature photoconductive cell of the cadmium sulphide type, smaller than a pencil eraser, has been introduced by Amperex Electronic Corp., Hicksville, N. Y. The device has many uses for automatic light control, headlight dimmers, illumination stabilizers, alarm and safety instruments,

Here's The Offer No Other Radio-TV School DARES MAKE!

LEARN AT HOME in Spare Time!

YOU DO MANY PRACTICAL JOBS with the kits we send you. That's right, you PRACTICE what we TEACH! You build a Signal Generator, AC-DC Power Pack, and AC-DC Superheterodyne Radio Receiver and top quality 21 inch TV Set. EARN AS YOU LEARN with the famous RTS 30 Day Income Plan. Full instructions provided. NO HIGH SCHOOL DIPLOMA NECESSARY. This is a COMPLETE course which starts with basic subjects and gradually advances to Radio-TV. . . . ALL FOR A PRICE YOU CAN AFFORD!

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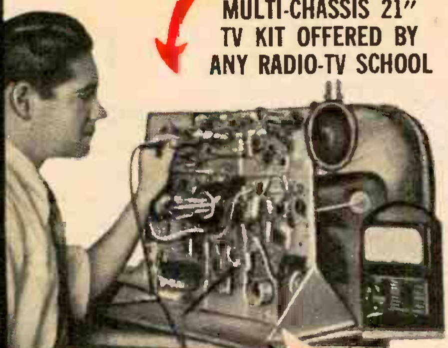

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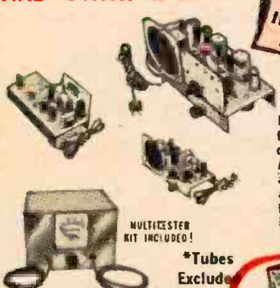

*Tubes Excluded

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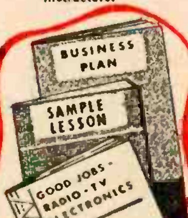

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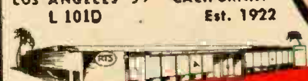

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REPAIR ANY ELECTRICAL APPLIANCE!

Save on repair bills! . . . . Earn in your Spare Time!

This 370-page, profusely illustrated ELECTRICAL APPLIANCE REPAIR MANUAL helps you service practically any electrical appliance in common use—even if you've never fixed an appliance before. Basic principles are first explained—then the book gives you specific how-to-fix-it instructions for both standard and automatic washers, ironers, toasters, ranges, cleaners, mixers, razors, clocks, motors, and many more. Handy troubleshooting charts quickly help you locate what is wrong. Easy instructions guide you in making repairs, adjustments and parts replacements. Tells how to make your own low-cost test tools. Describes wiring problems. Includes appliance refinishing methods. Throughout, it gives you the practical "know how" to fix your own appliances—or to build a profitable full or part time repair business. Price $6.25.

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SHORT CUTS TO TV REPAIRS!

Eliminate Useless Testing—Fix TV Receivers Twice as Fast!

Just turn the dials of these handy, pocket-size Ghirardi & Middleton PIX-O-FIX TV Trouble Finder Guides. When the picture in the PIX-O-FIX window matches the screen image on the television set you're repairing . . . presto! . . . you've got your clue. PIX-O-FIX shows the causes of the trouble, indicates the receiver section where it has probably happened, then gives repair instructions. PIX-O-FIX No. 1 identifies 24 common troubles and gives 192 causes and 253 remedies for them. No. 2 covers 24 more advanced troubles. Together, they are an easy guide to quick "picture analysis" servicing of any TV set . . . AND THE PRICE IS ONLY $3.00 for both.

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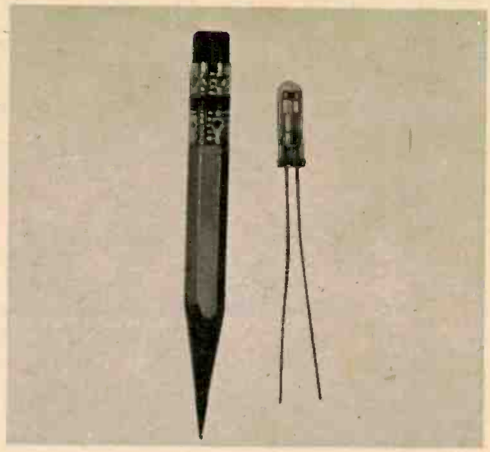
. . . New Products

and no doubt other uses will be devised by the manufacturers. That pencil



stub probably was ground down by the man who figured out the design.

—o—

Handy Combination Tool . . . A standard flashlight has been adapted by Bright Star Industries, Clifton, N. J., to double as a useful continuity tester for checking wiring, fuses, relays, switches, etc. The test leads have clips on one end for connection to the device undergoing test and a plug on the other end for quick insertion in the end of the flashlight case.

A carrying case that hangs from the user's belt has space for the flashlight, the test leads, extra batteries and a small screwdriver.

[*More New Products on page* 98]

REALISTIC PORTABLE V-O-M TEST KIT

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Our own exclusive low priced portable test instrument kit! Efficient, accurate, stable. Checks batteries, line voltage, tests continuity of circuits. Ideal for home repair of TV, radio, appliances. 4½" easy-to-read meter face dial and 400 μa movement. 14 AC/DC scales to 5000 V. 8 AC/DC current scales. 3 ohms scales! 6 db scales, 6 output scales. 6¾x5¼x3" bakelite case. Simple instructions. Ship. wt. 3 lbs.
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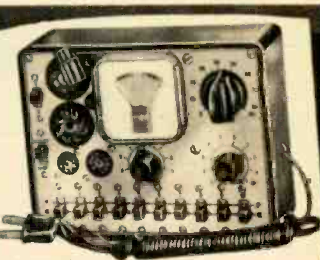
Gonset G-11 Citizen's Band 2-Way Radio **$84.50**

Exclusive special purchase to sell at $40 off net price while they last! Famous Gonset "communicator" transceiver transmits, receives within 25-mile range! For car, tractor, boat, plane—or fixed station. Press button to talk, release to listen. Ceramic mike, crystals for 1 channel. Noise eliminator, adjustable "squelch." Mounting bracket. No exam needed—fill out FCC form for license.
No. 1-45DX785—117 VAC 3303
No. 1-45DX786— 12 VDC 3304
(Express, ship. wt. 10 lbs.) . . **$84.50**



Bargain PORTABLE TUBE CHECKER KIT **$14.80**

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Weighs only 2¼ lbs., yet performs like larger, costlier units! Tests octal, loctal, 9-prong, 7-prong miniature tubes for radio, hi-fi, TV. Tests emission, shorts, leaks, opens, intermittents. Easy-to-read meter. Complete with tube chart, operating manual. Operates on 105-130 VAC, 60 cycles. Precision crafted—ideal for radio-TV servicemen, technicians, amateurs. Wt. 3 lbs. Mailable.
No. 1-94L002-Kit **$14.80**
No. 1-94L001-Wired **$18.80**

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This little M bargain turns your model boat into a speed demon! Lightweight die-cast aluminum construction, battery operated on 1.5 to 4.5 volts. Has battery clips, switch lever, swirl mount, stern clamps. 4 in. high.
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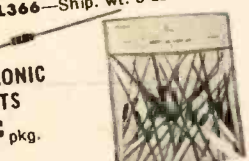

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88¢ pkg.

50 PIGTAIL RESISTORS—shown. ½ watt size with long axial leads. Std. color code.
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Kit $25.95 Wired $39.95
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Kit $79.95
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5" Push-Pull Scope #425
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Kit $34.95 Wired $49.95
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Wired $39.95
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Extra-filtered for transistor equipt. #1060
Kit $38.95 Wired $47.95
R-C Bridge & R-C-L Comparator #950B
Kit $19.95 Wired $29.95
Multi-Signal Tracer #145A
Kit $19.95
Wired $28.95

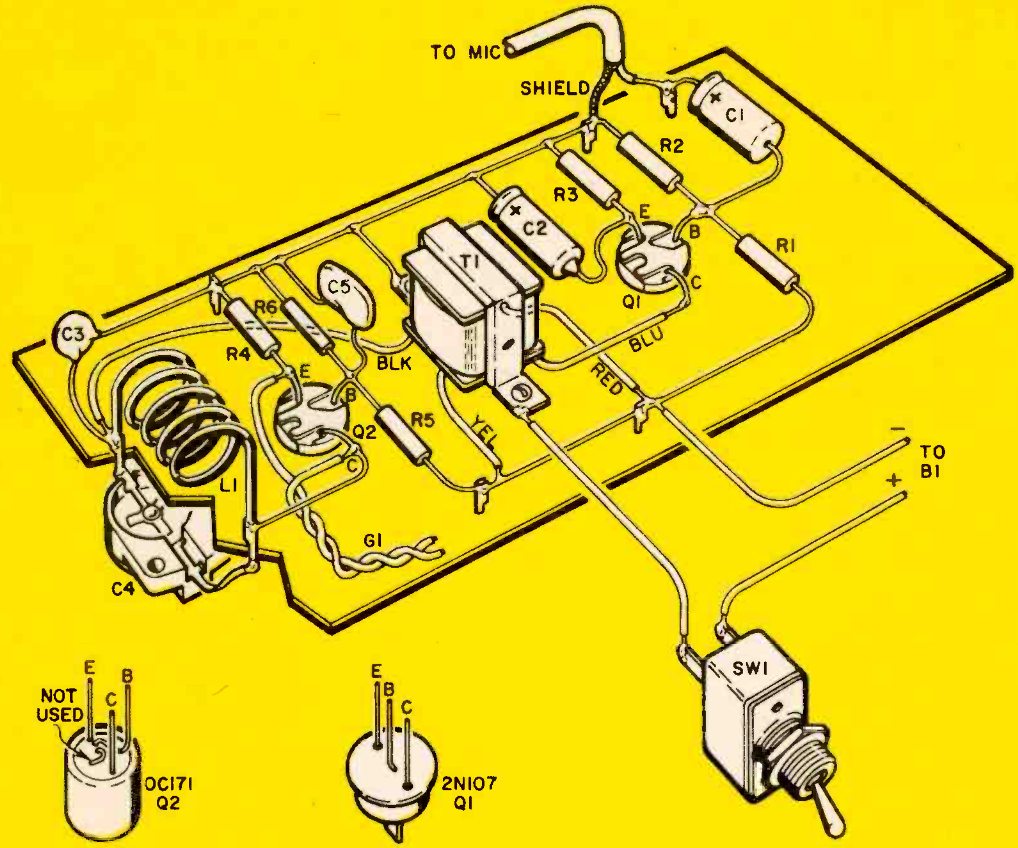
build an

FM Wireless Microphone

By Herb Cohen and Dave Gordon

IN almost any area demanding on-the-spot radio and TV coverage you'll find one or more reporters wandering about with a miniature microphone-transmitter combination relaying the news to the world as it happens. You can make your own experimental hand-held FM broadcast mike using the circuit shown below. The fidelity of the unit is limited mainly by the characteristics of the mike and the parts for the transmitter (excluding the mike) can be purchased for under $10. As a party gadget, or hooked up to a PA system via an FM tuner, this handy device has all sorts of possibilities, serious and amusing.

Why FM? Because FM inherently has excellent audio frequency characteristics and is insensitive to most electrical noise. This little self-contained unit will broadcast 50-100 feet into a standard FM tuner or radio tuned to about 106 mc. Although some fading will be experienced if you use the microphone while in motion, when set on a speaker's podium or desk and oriented correctly it will operate reliably. A tuner with good quieting and AFC action will insure stable results. While broadcasting keep your hands



Transformer has its frame connected to the ground buss and serves as tie point for switch lead.

and metal away from the unit's (antenna/tank coil L1) or it will detune.

It must be remembered that the wireless microphone described is an experimental device. Any wireless microphone built for actual PA or entertainment use would have to comply with FCC regulations with respect to transmitter frequency, frequency stability, and power.

Construction

The microphone is mounted on an inverted plastic salad bowl and the transmitter board is held in place by a couple of strands of wire threaded through the holes in the perforated board.

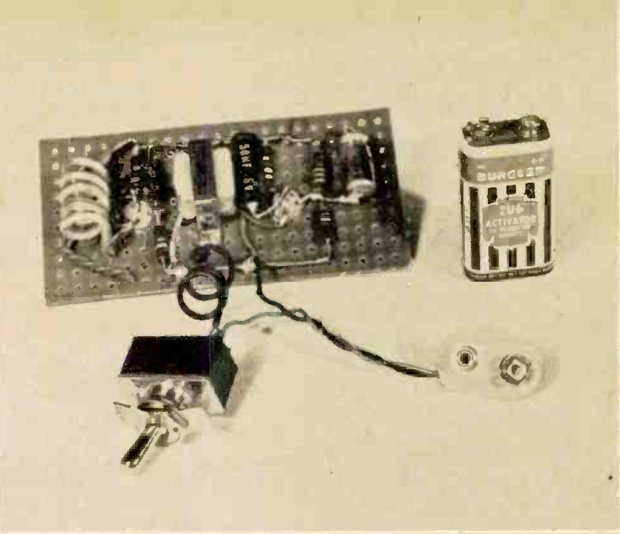
The microphone used should be a low-impedance dynamic type to insure a good match to the transistor's input impedance. Use the microphone in the Parts List with its switch in the *low* im-

[*Continued on page* 112]

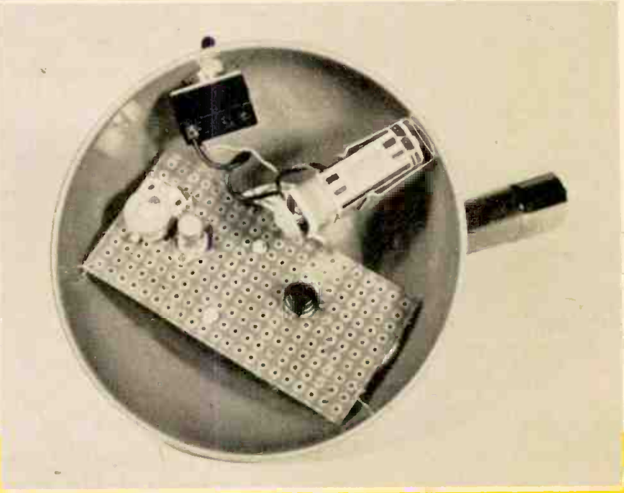
PARTS LIST

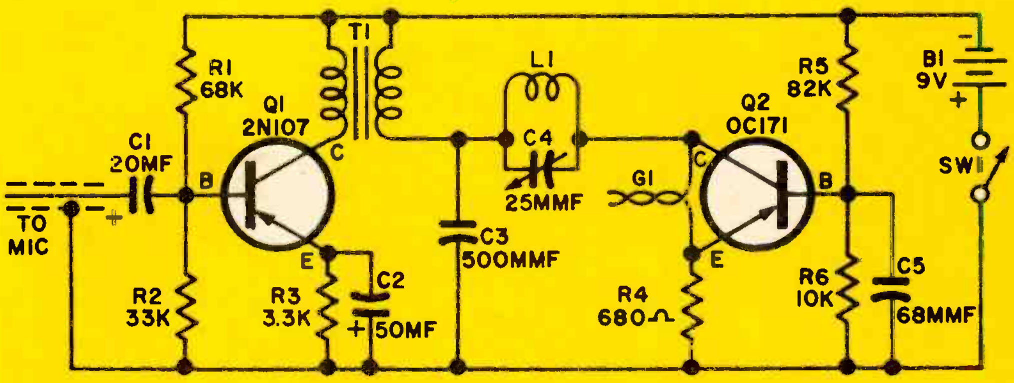
Resistors: 1/2 watt, 10%
R1—68,000 ohms
R2—33,000 ohms
R3—3,300 ohms
R4—680 ohms
R5—82,000 ohms
R6—10,000 ohms

Capacitors
C1—20 mf, 12 volt miniature electrolytic
C2—50 mf, 6 volt " "
C3—500 mmf disc capacitor
C4—4.5-25 mmf trimmer capacitor (Centralab 822-AZ or equivalent)
C5—68 mmf disc capacitor
Q1—Transistor 2N107
Q2—Transistor OC171 (If not available at parts distributor contact Amperex Electronic Corp., 230 Duffy Avenue, Hicksville, Long Island, N. Y.)
SW1—SPST Toggle or slide switch
T1—Transformer 20,000 ohms primary, 400 ohm secondary (Argonne AR-105)
B1—9-volt battery (Burgess 2U6, Eveready 216, RCA VS-323)
M1—Microphone, low-impedance dynamic (Argonne AR-58 or equivalent)
Misc.—2 transistor sockets, 12-14 gauge buss wire, 5" diameter plastic bowl, mike flange to fit M1 (Atlas AD-12), perforated phenolic board, flea clips, shielded microphone wire, hardware, battery plug, hook-up wire



Board before mounting shows parts arrangement. Spacing of L1's turns is unequal since initial adjustment may require expansion or compression for precise tuning. Clip holds battery and fine wire holds board in place in underside of bowl.





Q2's base-collector capacity changes with modulation varying tuning of L1-C4 tuning circuit.

Underground Radio Is News Again!

By Steve Lawson

UNDERGROUND radio, which was quite a topic of conversation 40 years ago when the boys came back from the trenches of France, has popped into the news again after slumbering quietly for a few decades.

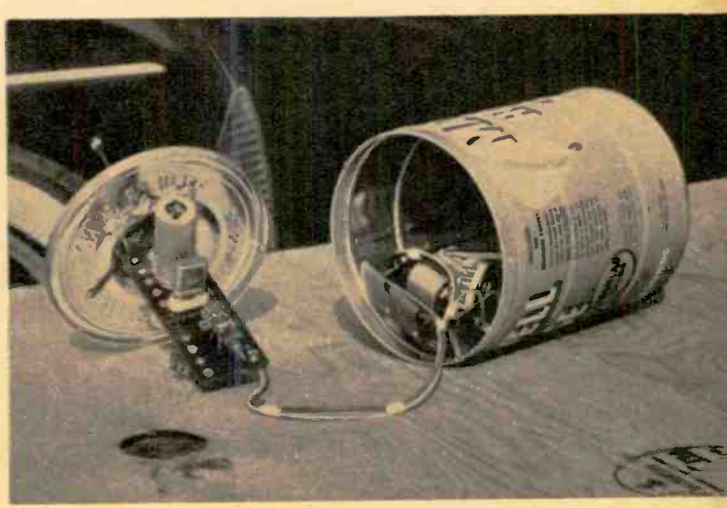
Several experiments using different theories are being carried out and some hobbyists have even rigged up their own subsurface communications systems. One of the factors spurring the new boom in an old idea is the possibility of using underground radio in defense applications, particularly in connection with the growing network of buried missile installations. In this area it seems to have many advantages.

One dramatic experiment is being conducted near Edwards Air Force Base in an abandoned borax mine hundreds of feet beneath California's desolate Mojave Desert. Deep in the hole, scientists are transmitting electromagnetic waves into the earth and attempting to pick them up at various distances.

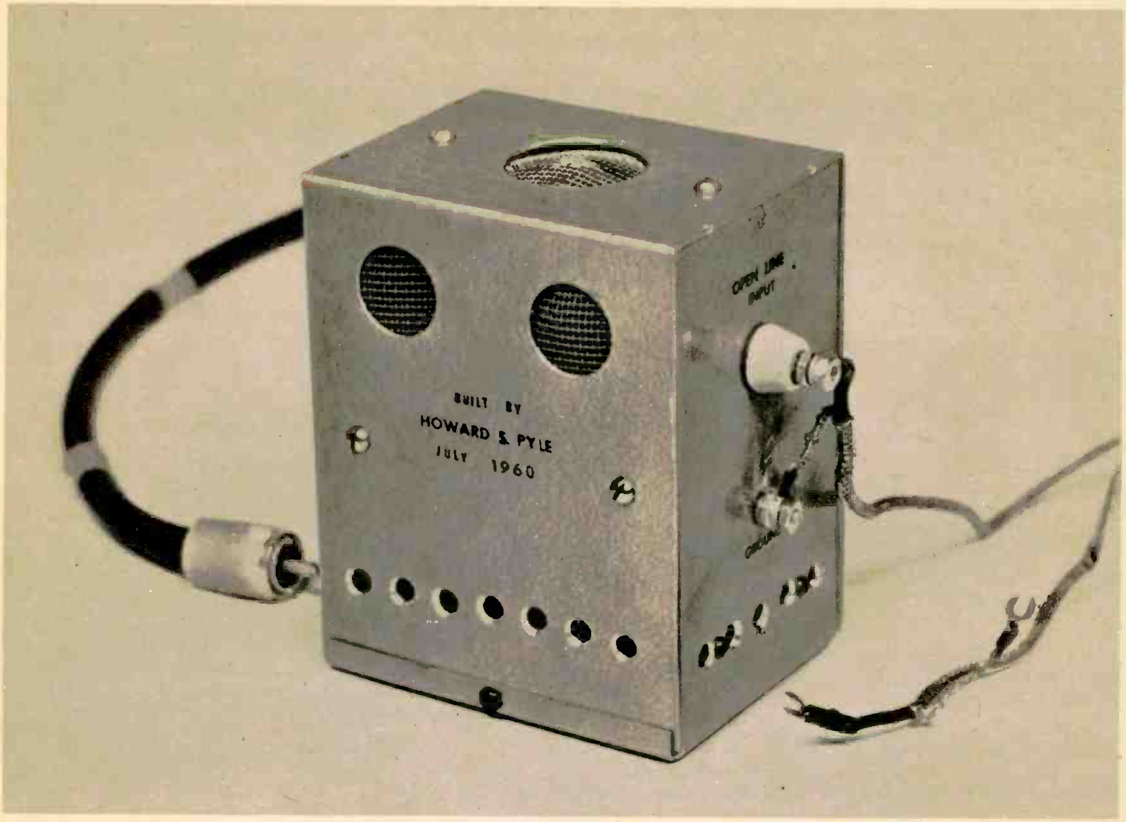
What does underground radio offer? Security is the main advantage, security against destruction and against interception. In an enemy attack our surface facilities would not be difficult to knock out but the only way to sever underground wireless connections would be to destroy the deeply buried transmitters and receivers. This would not be easy. Even [*Continued on page* 97]

Typical earth current signaling system as it would be used for communication in underground missile operations, where it offers great security.

A small rig on the tailgate of a station wagon has been used by the Space Electronics Corp. for experiments with underground radio. The receiving electrode, driven in the ground with sledge hammer, is in the foreground. Note the clamped-on lead-in wire.



This motley collection in a coffee can, resembling something built by a neophyte hobbyist, was the first piece of gear used by Space Electronics in sub-surface radio studies. The company operated it underwater in a feasibility test.



test your rig the legal way—with

A Shielded Dummy Load

By Howard S. Pyle, W7OE

PROBABLY one of the lowest cost and handiest contrivances around the ham shack is a "dummy" antenna load. Too many handbooks, periodicals, and manuals casually suggest that in tuning up a ham transmitter, you need merely "hang a lamp bulb across the transmitter output and tune for greatest brilliance." This is correct electronically; legally, *no!*

Did you know that such a procedure can, and often does, result in radiating a signal up to several miles without the benefit of a conventional outdoor antenna? If your "dummy" light bulb antenna radiates sufficiently to be heard by your next door neighbor you are radiating a signal which may interfere with others on the band.

Shielding the Dummy

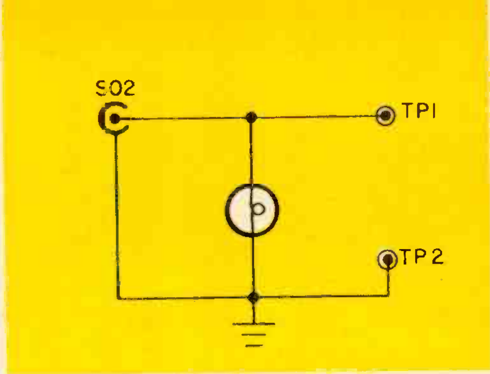
Actually, a good shielded dummy antenna is simple to build and will eliminate most if not all RF interference. Mount an ordinary porcelain incandescent lamp socket SO1 in a 3" x 4" x 5" aluminum cabinet. The combination lamp socket and cabinet size used will accommodate up to and including a 75-watt lamp bulb. If the *input* power of your transmitter exceeds 75 watts, make the necessary allowance for a larger cabinet and bulb. Wattage of the light bulb should approximately equal the input power of your transmitter at full load. The rest is easy.

While the little gadget doesn't get too hot if you use it for short periods, you might as well be generous and let all the heat escape. I used a chassis punch for the larger vent holes (1"); if you don't have one, settle for a concentric pattern of ¼" holes.

Flexible Connections

And, regardless of whether your transmitter has a coax output connector or simple open-wire lead-in terminals, provide for both with an Amphenol 83-1R chassis receptacle SO2 and a ceramic feed-thru insulator TP1 as shown. If you don't use coax, provide a ground-return connection on the outside of the box—a binding post or a screw (TP2) will do.

If you are an average ham, your present transmitter will probably change many times in the coming years and you can't guess beforehand what your



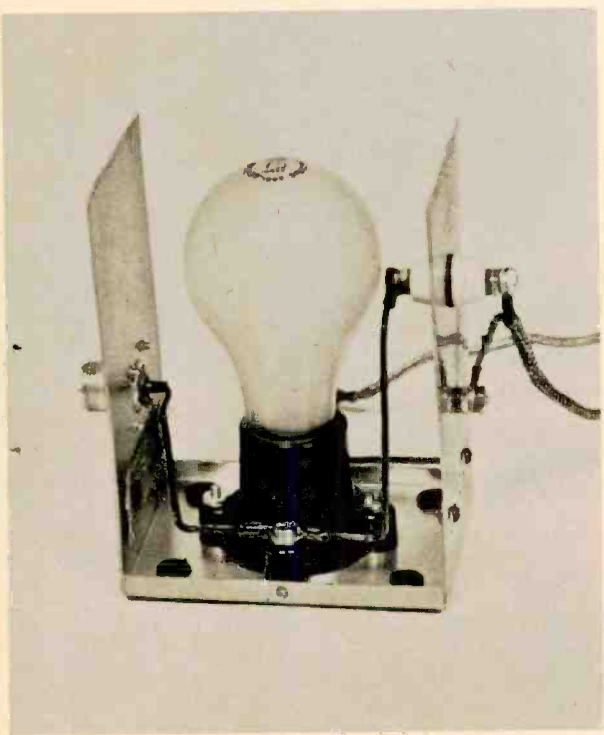
Schematic shows standard 75-watt incandescent lamp shunted across transmitter output.

future output connectors may be. My dummy load is able to take care of both types of connectors and I find it mighty convenient when checking out various rigs for novices, myself, and others.

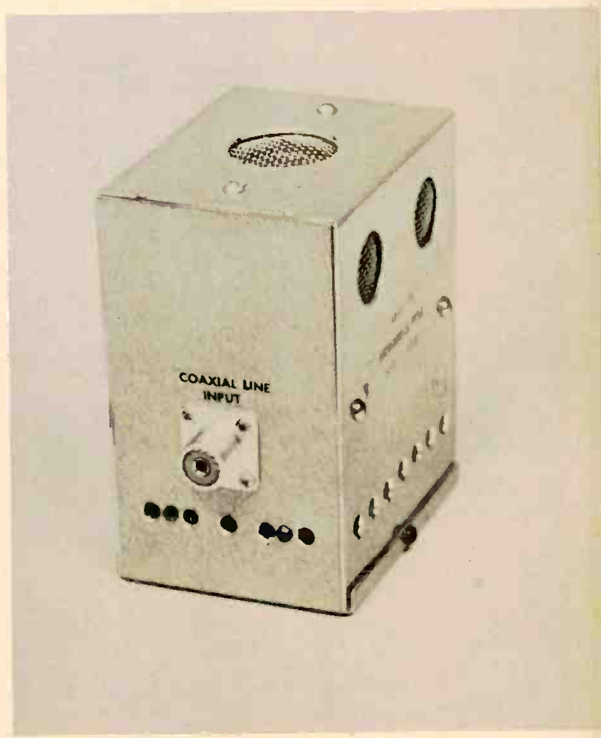
PARTS LIST

L—75-watt incandescent lamp
SO1—porcelain lamp socket
SO2—Coaxial chassis receptacle (Amphenol 83-1R or equivalent)
TP1—½" ceramic feed-through insulator
TP2—Binding post or 6-32 screw, nuts, etc.
1—aluminum cabinet 3"x4"x5" or larger
Misc hardware—#12 enamel copper wire, fine-mesh window screen

Component arrangement keeps the "hot" RF lead spaced well away from the cabinet sides.



Ventilation holes at top and bottom of cabinet provide for dissipation of RF-generated heat.



The Tube That Prints

Cathode ray printer tube can reproduce photos of high quality, although design actually is for readout of data from a computer.

COMPUTER designers constantly strive to make the most efficient use of the quick calculating abilities of electronic brains. One of the bottlenecks is the readout device, the magnetic or punched tape or card on which the computer gives its answer to the problem fed to it. Many present readout devices are just not fast enough. This is especially true in data handling systems where the readout speed must be measured in dollars and cents— the inventory report for example, must be completed fast enough to justify the high rental or purchase cost of the computer.

Most readout systems consist of two steps: (1) the data signal comes off the magnetic tape where it is stored and winds up as punched holes in a tape which (2) is used to operate a conventional printer. Most of these high-speed printers are mechanical. A new faster method for printing computer data has just come out of the Industrial Components Laboratories of the Raytheon Company and this idea is applicable not only to computers but also to facsimile and photo transmission systems.

The Raytheon device is a cathode ray printer tube that works something like a TV picture tube. It can be described as a picture tube which has been pressed down on top and up on the bottom until the face is only as high as one line. A matrix of fine wires is put into the face extending from inside to just a little past the outer surface. These wires do not touch each other. They are held by the glass.

When a cathode ray beam is deflected to sweep across this line, each of the wires gets an electron charge at the moment the beam hits it. It keeps this charge until it can be conducted off. Now, a sheet of special dielectric type paper is passed over this matrix (at high speed) so the charges leak onto it in the same pattern that appears on the matrix. These negative charges have no immediate visible effect but appear when the paper is developed in a positively charged ink. The ink adheres to the negative dots and is washed off the uncharged spaces, leaving (after fixing) a visible pattern of the electron beam.

To make the pattern of dots an intelligent one, the cathode ray beam is modulated by the information signal from the computer. Where the computer wants a spot the beam will be intense; for blank spaces the beam is cut off by the control grid in the tube and no charge hits the matrix.

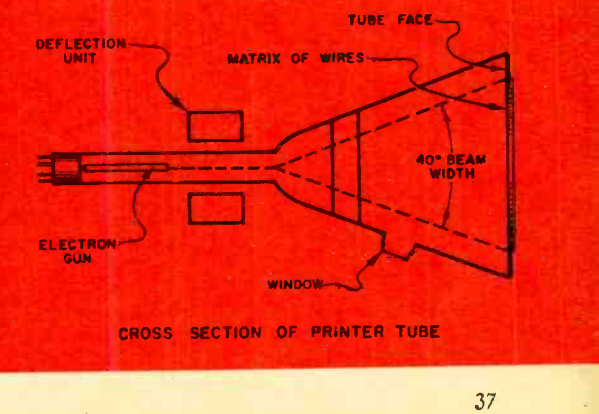
The inside of the tube face is coated with phosphor, just as in ordinary TV picture tubes, to allow the operator to adjust the beam properly for correct sweep width and alignment. A small bulge on the side of the tube contains a window through which the operator may observe where the beam strikes.

Operating voltages for this tube are similar to those of picture tubes: 6.3 volts for the filament and 20,000 volts or so for the anode or collector. Magnetic deflection moves the cathode ray beam across the matrix of wires and magnetic focusing sharpens the beam.

What can these tubes do? In tests at Raytheon, these printer tubes (there are four sizes) have printed 20,000 characters per second or more than 10,000 lines of computer output information per minute directly from a signal stored on magnetic tape or in a memory core. In printing pictures, the detail matches that of good magazine illustrations. The pickup and transmitting mechanisms for pictures and other information can be any of those in current use. Raytheon's readout tube is merely the printer. When used with photos sent over telephone or telegraph lines, or by radio, the tube can print up to three 8½ x 11-inch sheets every second. That is 1,000 times faster than current methods.—*Paul Daniels*

Printer tubes are offered in two sizes, the larger for 8½x11-in. sheets, the smaller for labels. Viewing window protrudes from side.

Diagram of large tube shows location of all its components. Electron gun is conventional TV tube type. Wires in face are .004 in. apart.



EI builds

A Communications Receiver

FOR the novice or ham with a thin pocketbook who has been yearning for a high-quality communications receiver, the Lafayette KT-200 is the answer to a prayer. The kit sells for only $64.50. We hesitate to classify the KT-200 as a kit, since all the major components are pre-mounted, including tube sockets, terminal strips, and knobs. Even the dial cord has been strung. All coils and capacitors in the tuning section are prewired and pre-aligned.

The KT-200 is a high sensitivity superheterodyne circuit which utilizes eight miniature tubes, plus a transformer operated full-wave rectifier. The receiver tunes from 550 kc to 31 mc continuously in four switched bands. In addition to the main tuning scale, there is a band-spread tuning control with a large logging scale which makes tuning on a crowded band a snap.

The many features of the KT-200 include a built-in adjustable "S" meter for measuring the relative strength of incoming signals, an AVC that may be switched off when added gain is needed for the reception of a weak signal or when tuning in a weak station adjacent to a strong one, and tunable BFO for CW reception.

An IF gain control prevents strong signals from overloading the receiver and a diode noise limiter may be switched in to minimize impulse-type noise.

Other features are: a standby switch, a phone jack, an auxiliary control socket for remote standby switching (for use with a transmitter) and an audio output stage which will deliver 1.5 watts to a 4 or 8 ohm external speaker. An RF stage and separate local oscillator and mixer tubes are used rather than a combined converter.

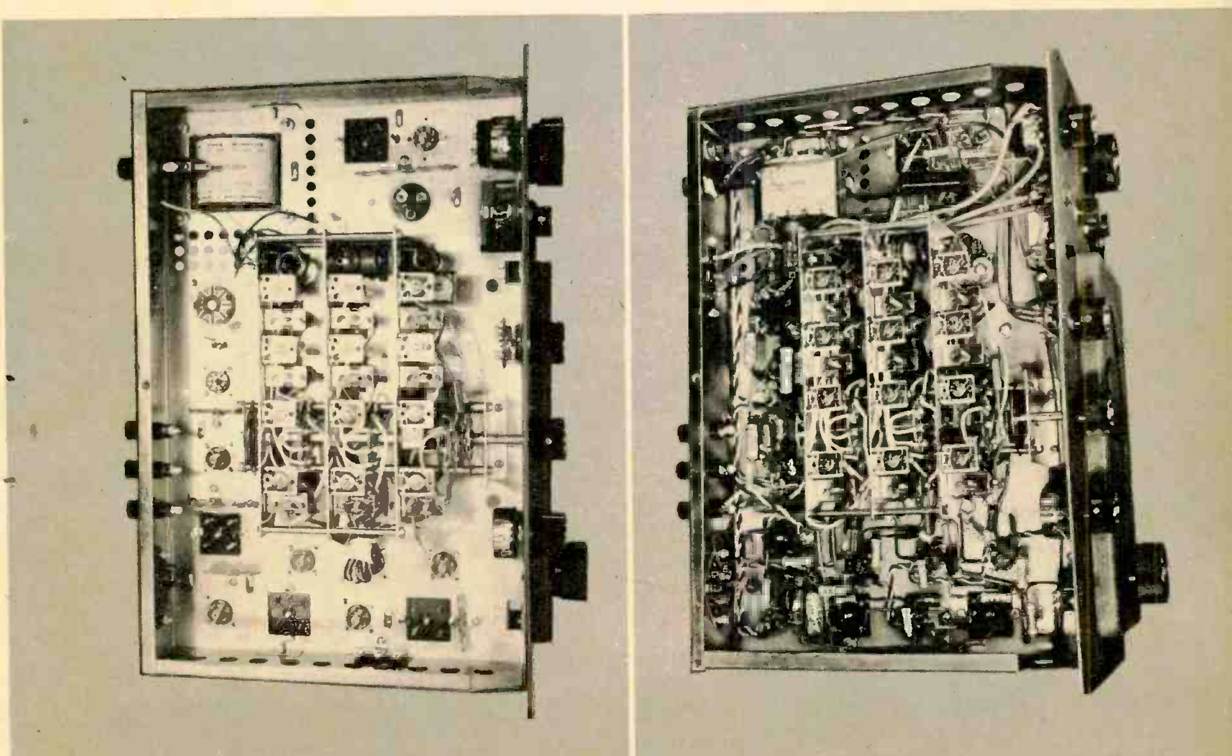
There is nothing to say about construction except—follow Lafayette's manual. It is well written and even the most inexperienced constructor should have no trouble. Since so much of the receiver is preassembled and wired, only eleven hours were required to complete construction.

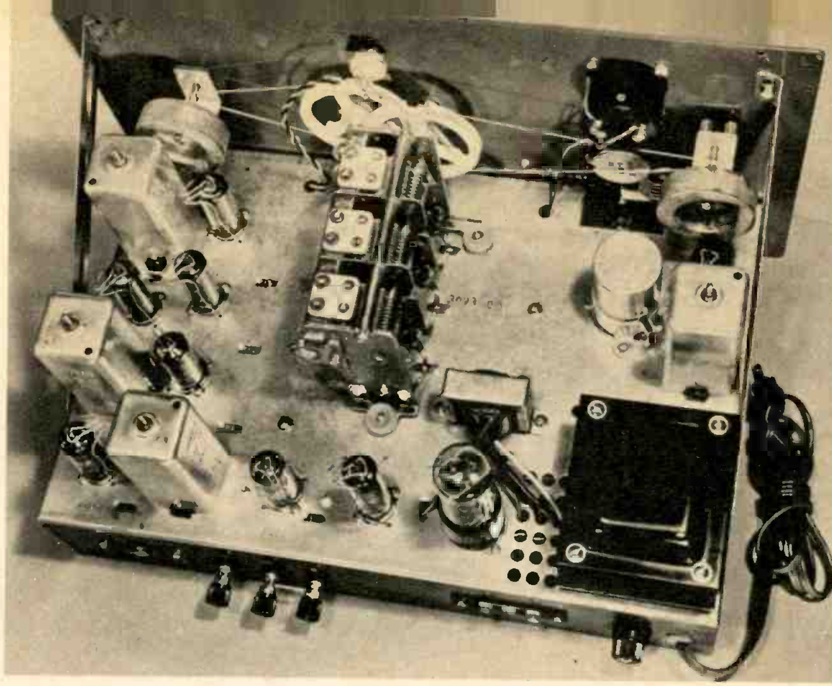
Operation

After the completion of the KT-200, a speaker (most higher price receivers use separate speakers) and short length of antenna wire were connected. The unit was turned on and signals literally poured in all over the four bands right up to 31 mc. Sensitivity was so great that on the broadcast band the IF gain had to be turned all the way down to prevent overloading. The sensitivity was measured and found to be slightly *better* than that quoted by the manufacturer (1.25 microvolts for a 10 db S/N). The selectivity was also excellent—60 db down at the 10 kc points.

The general description of the receiver which appears in the front of the Lafayette manual claims that all coils and IF transformers have been prealigned—and they aren't kiddin'. We attempted to align and calibrate the receiver, but found that it wasn't necessary—the calibration on all four bands

View at the left is of chassis as it is unpacked. Note complete mechanical preassembly of band switch, coils and IFs. Finished unit at right. All trimmers are accessible for minor adjustments.





Bandspread is electrical and flywheels speed tuning across bands. Spring clips hold tubes in place.

was right on the nose. The only adjustment that was necessary, and that only very slightly, was the BFO coil.

After building and testing the Lafayette KT-200 communications receiver, it gets our vote as a great buy.

Novel Desk Stand For Small Mikes

FOR small "salt shaker" type mikes which fit standard mike connectors, this novel stand has several advantages: it only costs about 60¢ to make; the mike can be adjusted to a desired angle; the stand can be carried in your coat pocket. And the soft rubber stand helps to reduce mechanical shocks to the mike. Lastly, the rubber base will prevent sliding on polished surfaces. To construct the stand, first cut a 3/8" diameter hole in the rubber door stop with a pocket knife, and mount the electrical ball-and-socket swivel by means of a short threaded nipple and matching hex nut. File down the threads on the neck of the swivel, remove the cord-protecting spring from a standard mike cable connector, and push the neck of the swivel into the end of the connector, as shown. A little solder run around the joint holds the two parts together securely. The mike cable connects to the mike connector in the usual way, but in this case the shield on the cable is clamped under the nut on the underside of the door stop.

—*Art Trauffer*

DXing The CAP

The Civil Air Patrol's scramble of code words is meaningful, exciting listening with EI's handy guide.

By Tom Kneitel

WHAT do you do when you stumble into a signal like the following? "Empire 6, this is Wildcat 29 with one REDCAP." "This is Empire 6. All stations stand by on Channel 7 for REDCAP. Go ahead, Wildcat 29."

Some DXers puzzle a moment, confused by the use of code words, then move on. But if you know the story you'll recognize this as some fascinating short-wave listening coming from stations operated by the Civil Air Patrol. The handy guide *EI* is printing with this article will make that jumble of code words more meaningful. In the case imagined above, Empire 6 and Wild-

CAP team sets up UHF ground-plane antenna (term means radiation plane, not airplane).

Rescue missions such as this one lead to heavy air traffic on Civil Air Patrol frequencies.

cat 29 are identification calls for stations. REDCAP is the CAP word for a top-priority emergency message. A REDCAP message means that the next few hours will have the channels buzzing with hundreds of ground stations, aircraft and mobile units which are participating in any one of a score of operations. The REDCAP might relate to a SARCAP (Search And Rescue, CAP) operation, a flood or even a report of an unidentified sub.

When traffic is hot and you know enough of the lingo to understand what is going on you can have hours of exciting listening. There are more than 12,000 individual Civil Air Patrol stations which buzz most of the day (or around the clock when there's a disaster or missing aircraft). Some stations run as much as 400 watts, although the average is 75 to 150 watts. Even the weaker stations have been heard across the country.

The fixed CAP stations vary greatly in size and equipment. This one is in a member's garage.

The CAP is an auxiliary of the Air Force and its radio stations are operated by members from their homes, cars or private aircraft. It is divided into 51 wings (one in each state and one in Puerto Rico). Each wing uses its own tactical call sign for fixed, mobile and aircraft stations. The calls consist of the code word (which denotes the wing and type of station), followed by a number (which indicates the number of the particular unit). Typical calls would be Cyclone 14 (Aircraft No. 14 of the Iowa Wing), Empire 187 (fixed station No. 187 of the New York Wing) or Jayhawk Bug 22 (mobile unit No. 22 of the Kansas Wing). Although the wings are assigned regular FCC calls, they are seldom used.

It's a real challenge to see how many wings you can bring in. The really exciting signals, of course, are those from far-off wings. DXers also sometimes try to bring in as many different stations—fixed, airborne and mobile—as possible from one wing. Each wing ordinarily holds a check-in drill about once a week. All stations participate.

The accompanying chart gives you the basic information you need for ready identification, including frequencies and coded calls. Most popular channel is 2374 kc. Happy listening!

DXer's GUIDE FOR CAP STATIONS

CAP Frequencies

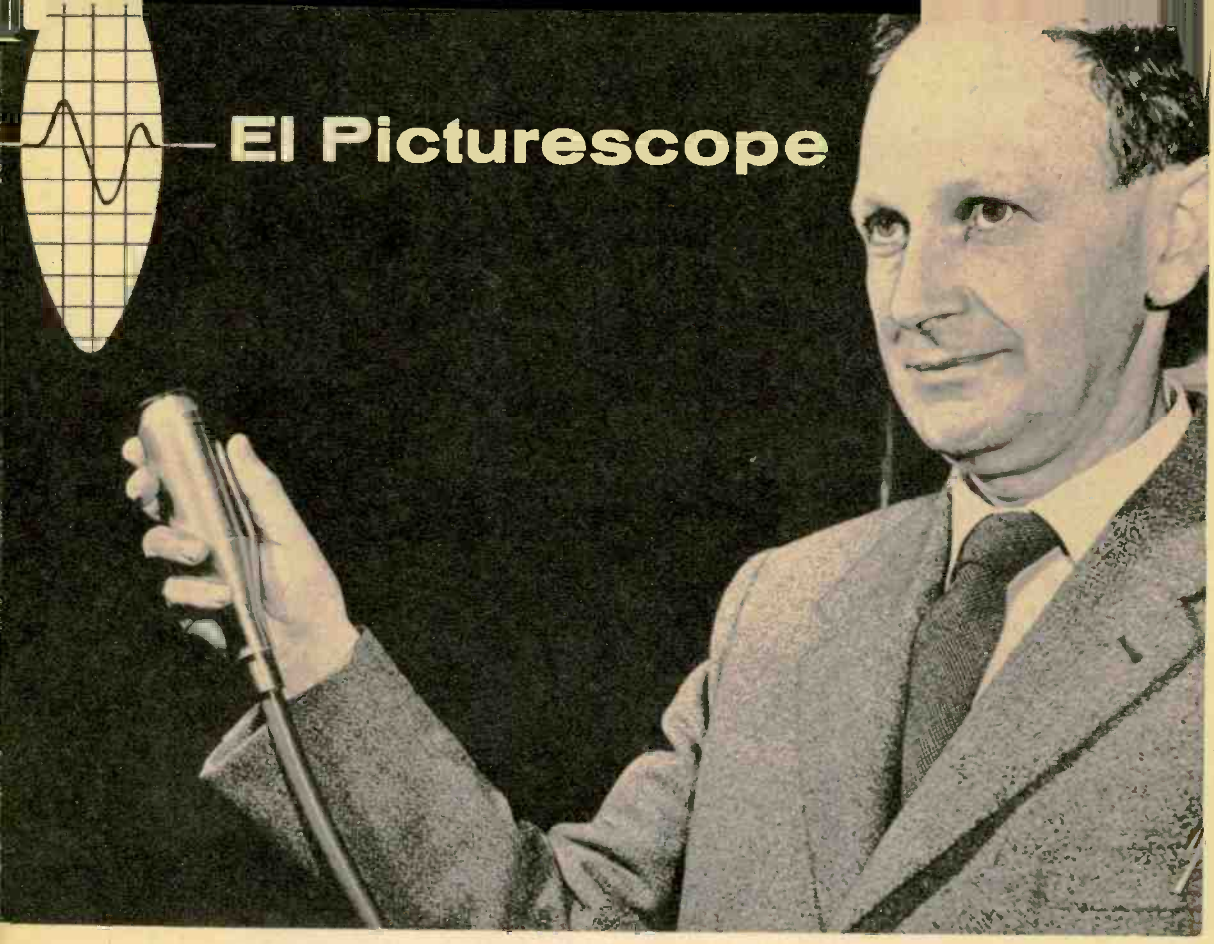
CHANNEL 1	2374	kc
CHANNEL 2	2394	kc
CHANNEL 3	4325	kc
CHANNEL 4	4507.5	kc
CHANNEL 5	4585	kc
CHANNEL 6	5500	kc
CHANNEL 7	26620	kc
CHANNEL 8	143910	kc
CHANNEL 9	148140	kc

Code Identifications Used In Tactical Calls

Code Name	FCC Call	Type*	Wing
AERO	KGC463	F	D. C.
AERODYNE	KGC463	M	D. C.
AERONAUT	KGC463	A	D. C.
AIRCAN	KEC994	A	N. J.
AIR RHODY	KCC594	A	R. I.
ANGEL	KOF426	A	Mont.
ASH	KOF430	A	Wash.
AURORA	KWA677	A	Alaska
BADGER	KSC954	F	Wis.
BARFLY	KGC462	A	Del.
BEAVER BIRD	KOF428	A	Oreg.
BEAVER FOX	KOF428	F	Oreg.
BEAVER MUSKRAT	KOF428	M	Oreg.
BLACK BEAR	KME284	M	Calif.
BLACK FOOT	KAF363	F	N. D.
BLACK HAWK	KQD406	F	Ohio
BLUE BIRD	KAF361	F	Mo.
BLUE CHIP	KIG448	F	Tenn.
BLUE DOG	KIG446	M	N. C.
BLUE EAGLE	KKI724	A	Tex.
BLUE FIRE	KSC953	M	Ind.
BLUE FLITE	KIG449	F	Va.
BLUE FOX	KSC952	A	III.
BLUE RIVER	KAF357	A	Colo.
BLUE ROBIN	KQD405	A	Mich.
BLUE STAR	KIG443	A	Ga.
BOBCAT	KCC593	M	N. H.
BOX CAR	KIG447	A	S. C.
BROWN BEAR	KME284	A	Calif.
BUFFALO	KAF362	M	Neb.
BULLDOG	KAF358	M	Iowa
BUZZARD	KSC954	A	Wis.
CAT FISH	KAF360	A	Minn.
CHEYENNE	KAF364	A	S. D.
CLIPPER	KCC592	A	Mass.
CORN STATE	KAF358	F	Iowa
CRANE	KIG444	M	Fla.
CYCLONE	KAF358	A	Iowa
DAKOTA	KAF364	F	S. D.
DIAMOND	KKI719	A	Ark.
DOG FISH	KAF360	M	Minn.
DOGWOOD	KKI719	F	Ark.
DOMINO	KEC994	M	N. J.
EAGLE	KIG444	A	Fla.
EAGLE NEST	KKI724	F	Tex.
EMPIRE	KEC995	F	N. Y.
FATHER	KOF426	F	Mont.
FIR	KOF430	F	Wash.
FIREBRAND	KUA341	F	Hawaii
FLIGHT STONE	KGC465	A	Pa.
FREEDOM	KCC592	F	Mass.
GABBY	KGC462	F	Del.
GASWELL	KKI723	A	Okla.
GERONIMO	KOF424	M	Ariz.
GOLD CHIP	KIG448	A	Tenn.
GOLD EAGLE	KKI724	M	Tex.
GOLDEN ROD	KIG442	F	Ala.
GRAY HAWK	KQD406	M	Ohio
GREEN FIRE	KSC953	A	Ind.
GREEN FLITE	KIG449	M	Va.
HIBOY	KUA341	A	Hawaii
HIGHLAND	KQD407	A	W. Va.
HORNET	KOB425	A	Idaho
HOT ROD	KIG442	M	Ala.
HURRICANE	WWA353	A	P. R.
JACK	KOF431	A	Wyo.
JAY BIRD	KKI721	M	Miss.
JAYHAWK BAT	KAF359	A	Kans.
JAYHAWK BUG	KAF359	M	Kans.
JAYHAWK POST	KAF359	F	Kans.
JET	KGC464	A	Md.
JET PILOT	KIG445	A	Ky.
KEYSTONE	KGC465	F	Pa.
KIDDY CAR	KIG447	F	S. C.
KING	KOF431	F	Wyo.
LITTLE RHODY	KCC594	M	R. I.
LOWLAND	KQD407	F	W. Va.
MAD DOG	KIG446	A	N. C.
MAGNOLIA	KKI720	F	La.
MAGPIE	KOB425	F	Idaho
MANDAN	KAF364	M	S. D.
MANSFIELD	KCC595	A	Vt.
MAPLE	KOF430	M	Wash.
MARBLE	KCC595	M	Vt.
MEADOWLARK	KAF362	A	Neb.
MIDDLEGROUND	KIG445	F	Ky.
MOBILE	KUA341	M	Hawaii
MOCKINGBIRD	KKI721	F	Miss.
MOHAWK	KAF363	A	N. D.
MOTHER	KOF426	M	Mont.
MULLUK	KWA677	M	Alaska
MUSKRAT	KKI720	M	La.
NAVAJO	KKI722	A	N. M.
NORTH WIND	KOD427	F	Nev.
NUTMEG	KCC590	F	Conn.
OILWELL	KKI723	M	Okla.
OVERLAND	KQD407	M	W. Va.
PELICAN	KKI720	A	La.
PICO	KCC595	F	Vt.
PILGRIM	KCC592	M	Mass.
PIKES PEAK	KAF357	F	Colo.
PINEAPPLE	WWA353	F	P. R.
PINEAYR	KCC591	A	Me.
PINEKARR	KCC591	M	Me.
PINETREE	KCC591	F	Me.
PLANT	KGC464	F	Md.
PROFILE	KCC593	F	N. H.
PUEBLO	KKI722	F	N. M.
QUEEN	KOF431	M	Wyo.
RABBIT	KOB425	M	Idaho
RAMBLER	KCC590	M	Conn.
RAM ROD	KIG442	A	Ala.
RAZORBACK	KKI719	M	Ark.
RED BIRD	KAF361	M	Mo.
RED CHIP	KIG448	M	Tenn.
RED DOG	KIG446	F	N. C.
RED FIRE	KSC953	F	Ind.
RED FLITE	KIG449	A	Va.
RED FOX	KSC952	F	III.
RED RIVER	KAF357	M	Colo.
RED ROBIN	KQD405	F	Mich.
RED SPIDER	KOD427	A	Nev.
RED STAR	KIG443	F	Ga.
RHODY	KCC594	F	R. I.
ROCKET	KCC590	A	Conn.
ROLLING STONE	KGC465	M	Pa.
SAUCER	KCC593	A	N. H.
SCOOTER	KSC954	M	Wis.
SIDE CAR	KIG447	M	S. C.
SIOUX	KAF363	M	N. D.
SNOW BIRD	KKI721	A	Miss.
SOONER	KKI723	F	Okla.
SOURDOUGH	KWA677	F	Alaska
SPARROW	KIG444	F	Fla.
STARFISH	KAF360	F	Minn.
SUGAR	WWA353	M	P. R.
THUNDERBIRD	KOF424	F	Ariz.
TOMAHAWK	KOF424	A	Ariz.
TOMCAT	KEC995	M	N. Y.
TUG	KGC464	M	Md.
UNCLE ABLE	KOF429	A	Utah
UNCLE MIKE	KOF429	M	Utah
UNCLE WILLIE	KOF429	F	Utah
VAGABOND	KGC462	M	Del.
WHIRLAWAY	KIG445	M	Ky.
WHITE BEAR	KME284	F	Calif.
WHITE HAWK	KQD406	A	Ohio
WHITE ROBIN	KQD405	M	Mich.
WHITE STAR	KIG443	M	Ga.
WIGWAM	KAF362	F	Neb.
WILDCAT	KEC995	A	N. Y.
YELLOW FOX	KSC952	M	III.
YELLOW JACKET	KOD427	M	Nev.
ZIGZAG	KEC994	F	N. J.
ZUNI	KKI722	M	N. M.

* Type designations: F—fixed, M—mobile, A—aircraft

EI Picturescope

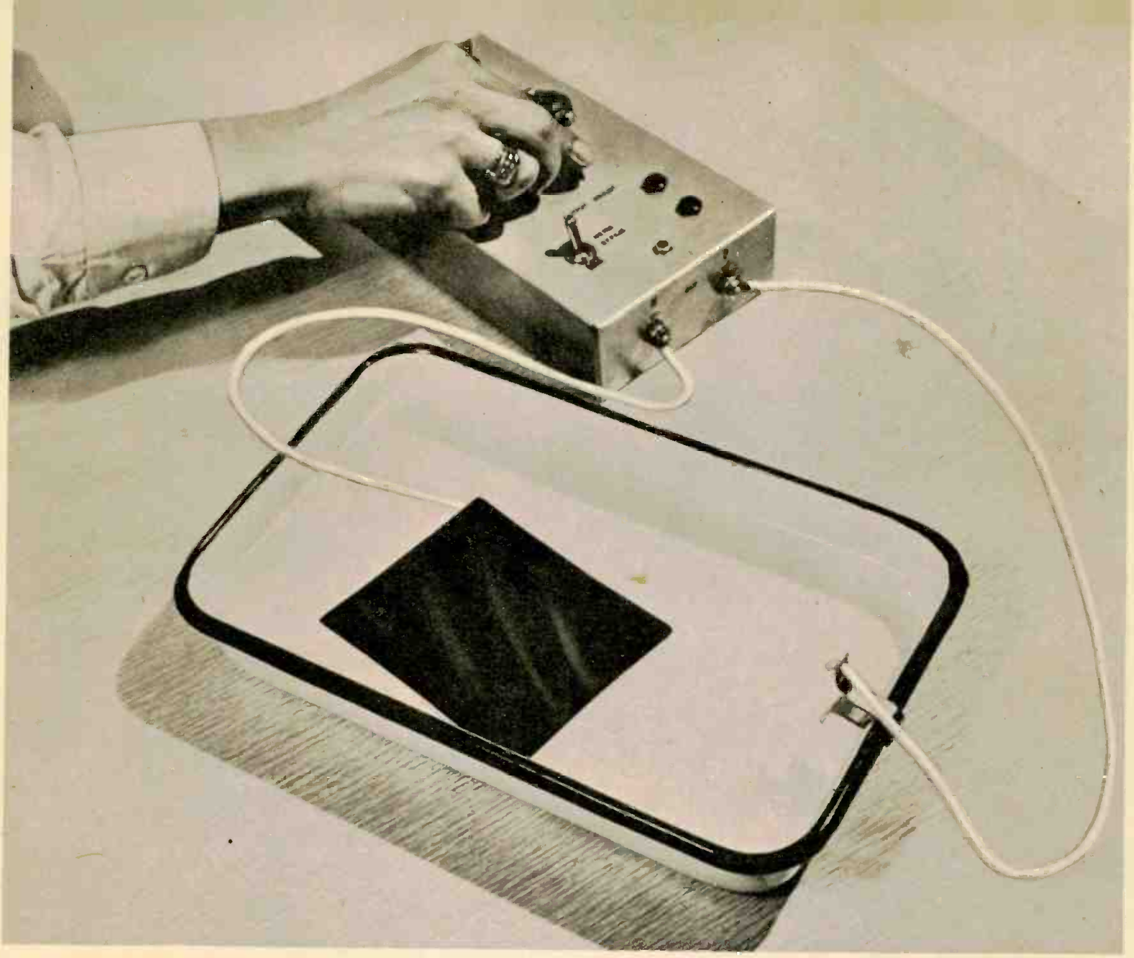


The bantam television camera shown above was developed by Australians in conjunction with new TV/X-ray unit which picks up X-ray images during an operation and holds them on a TV screen for detailed study by surgeon in charge.

This miss in a mess has a point to make: she has just discovered a split-pea size silicon rectifier lost by her employers, the IT&T Corp., in this haystack of their other electronic products. Must happen every day.

Pert English TV star Pam Beckhambelieves in taking her brand-new 7-in. portable TV set along where ever she goes. (It is made by Fergusan Radia, London, has 24 transistors and weighs an even 20 lbs.) Goodnight there, pert Pam!

Those clever Germans have now thought up a way to get rid of bartenders, and this is it. That is an electronic drink-mixer you see. Just press the buttons and you get whatever you want. You might not hear the bartender's gab but with a gal like that to press the buttons who cares?



All About Electroplating

Part I. Theory and construction of a transistor controlled electroplater for both fun and utility.

By James E. Pugh, Jr.

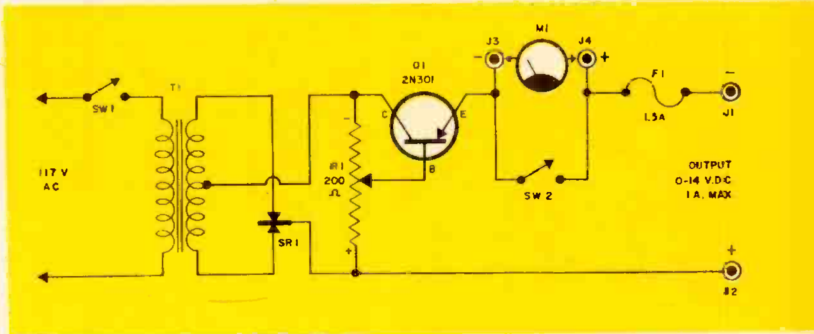
FOR the electronics experimenter who wants to expand his hobby into a related field, this inexpensive easy-to-build transistorized electroplater will provide many hours of pleasure. In addition to small decorative and protective plating jobs it can be used for metal forming, cleaning and etching metals, or as an adjustable battery charger or power supply for small DC motors and model trains.

The unit described has an output of 0-14 volts at 1 amp. maximum—sufficient for plating objects with a surface area up to 8 or 10 square inches. Total cost of parts is less than $13.

The Circuit

Referring to the schematic, a negative 12 volts is applied to the

R1 biases Q1 which acts as a variable resistor. F1 protects M1 and Q1 if the electrodes short.



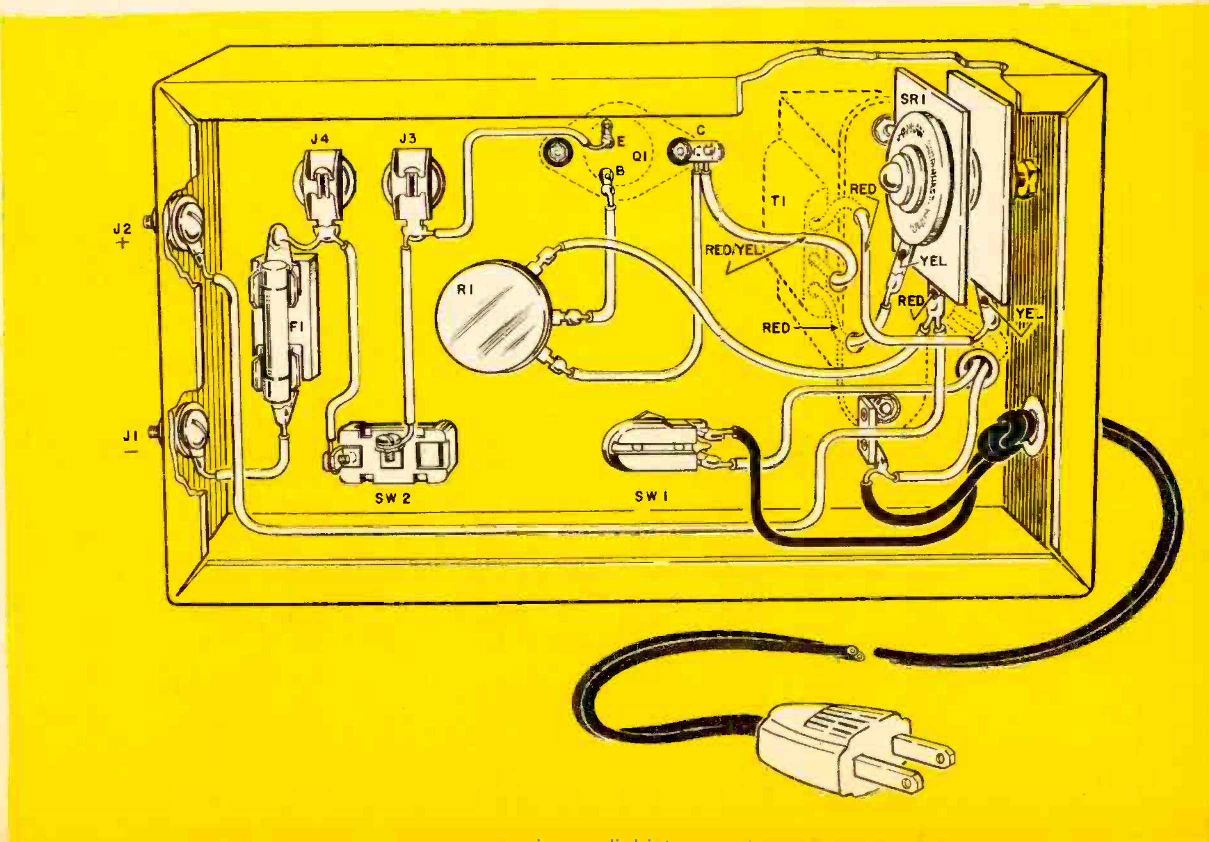
PARTS LIST

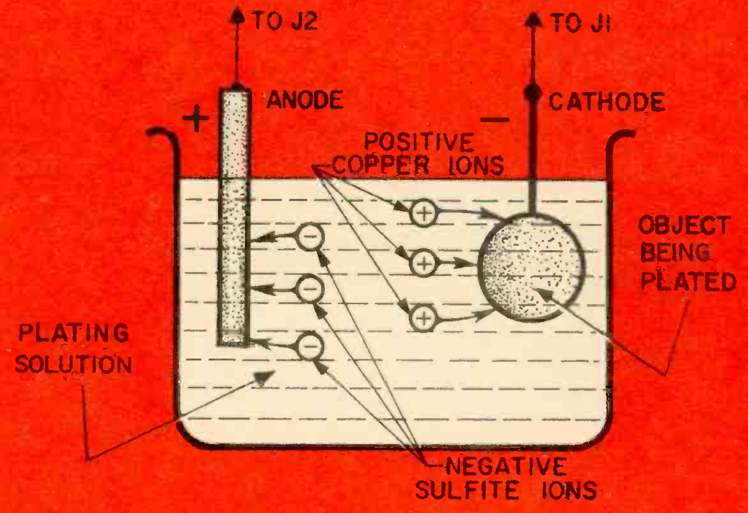
R1—200-ohm wirewound potentiometer
Q1—2N301 transistor
F1—.5a @ 250 V with fuse holder
SW1,SW2—SPST toggle switches
M1—External multirange ammeter
T1—24-28 volt, 1A filament transformer
SR1—Full-wave selenium rectifier, 1.5A (International Rect. J14C1. Available from Allied Radio Corp.)
J1-J4—Any suitable insulated jack
1—Aluminum chassis box 5"x9½"x2"
Misc.—Line cord and plug, plastic tank, plating solution, wire, hdwe.

collector of transistor Q1. Potentiometer R1 applies a voltage ranging from 0 to −12 volts (less a small amount lost across the internal resistance of Q1) to the base of Q1. Thus, when the arm is at the negative end of the control, Q1 conducts heavily and the output voltage will almost equal the input voltage. When the arm is at the positive end of R1, Q1 is cut off and the output voltage is 0.

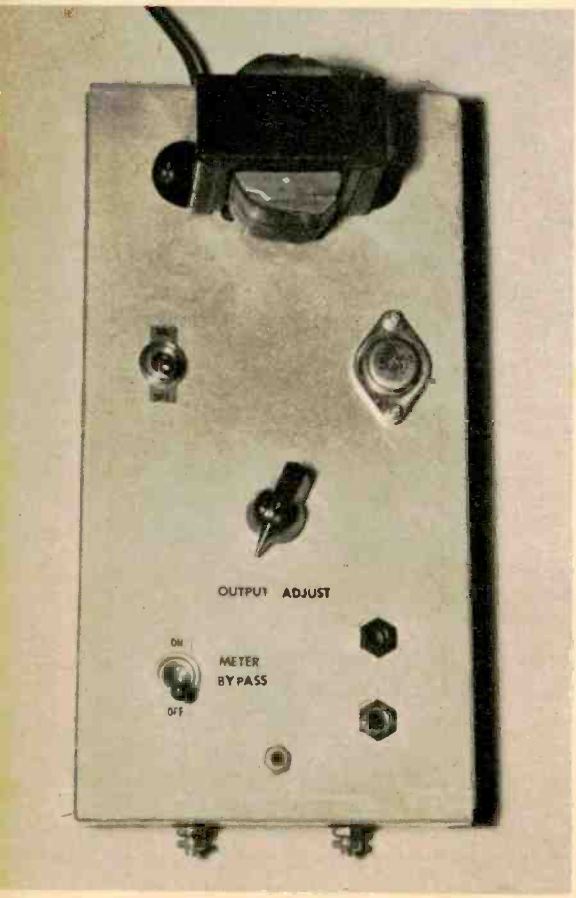
An external multi-range ammeter M1

Bottom view shows open layout. Note the insulating washers under transistor mounting nuts.





Copper atoms of anode separate. Power supply circulates the electrons back to the cathode.

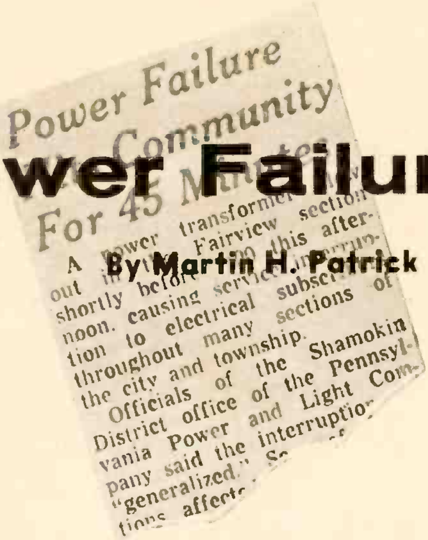


in the emitter output lead indicates the plating current, and by-pass switch SW2 enables use of the Electroplater with the meter removed. Fuse F1 protects M1 and Q1 against damage if terminals J1 and J2 are accidentally shorted.

The positive output at J2 is connected to an anode which is *always* the same metal that the object is to be plated with. The object to be plated (cathode) is connected to negative output terminal J1. The plating solution contains a chemical partly composed of the same metal to be deposited on the cathode. For example, copper sulfate solution is used for copper plating, silver cyanide for silver plating, and nickel chloride for nickel plating.

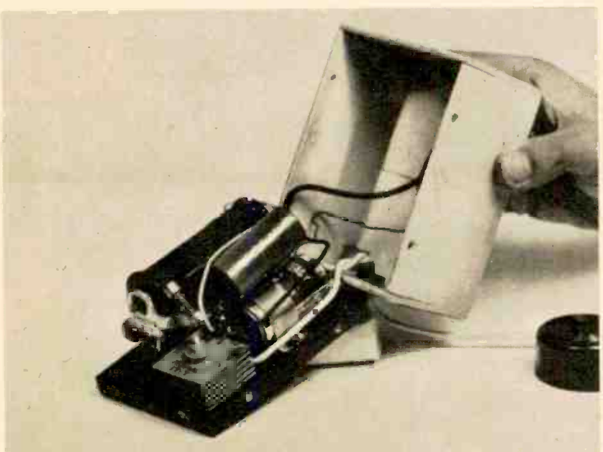
The Electrochemical Process

For copper plating, copper sulfate is dissolved in water where it separates into positive copper ions and negative sulfate ions. When the voltage is applied to the electrodes as shown, the copper ions flow to the cathode where they take on electrons, thus becoming copper atoms, and are instantly deposited on the cathode. At the same time an equal number of copper atoms of the anode separate into ions and electrons. The copper ions go [*Continued on page* 108]

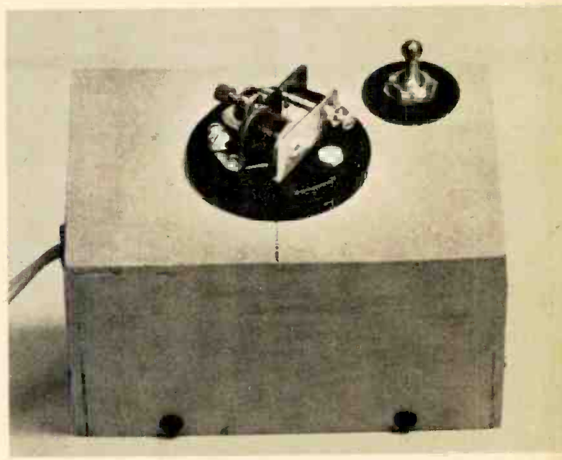

Power Failure
Community
For 45
A power transformer
out in the Fairview section
shortly before this after-
noon, causing service
tion to electrical subscr
throughout many sections of
the city and township.
Officials of the Shamokin
District office of the Pennsyl-
vania Power and Light Com-
pany said the interruption
"generalized."
tions affect

Power Failure Alarm

By Martin H. Patrick



Large size components shown could be replaced by a silicon rectifier and smaller relay.



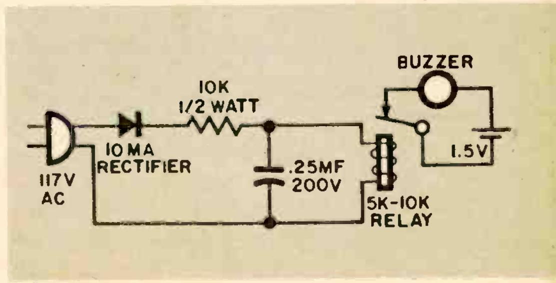
Buzzer shown with its plastic cover off. Toggle switch may be placed in series with D cell.

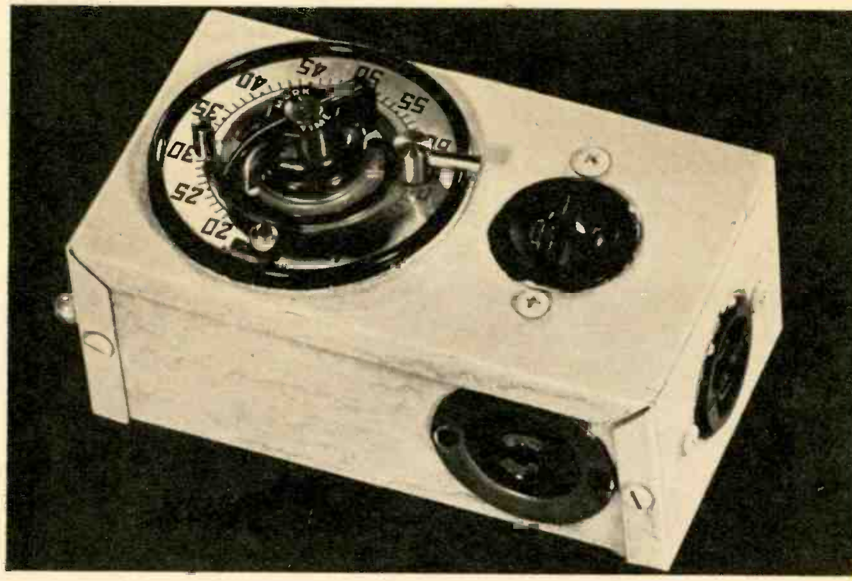
ALTHOUGH power failures are relatively few in metropolitan areas, they nevertheless may cause unforeseen inconvenience, damage, and even the loss of a day's wages. Many people rely on their electric clocks to be awakened in the morning; thermostatic controls must function to prevent loss, damage, or disappointment.

After getting up late for work once too often, I decided to make a power failure alarm. Put under the night table and out of way, this alarm sets into operation a high-frequency buzzer as soon as the power fails, giving me an opportunity to set the wind-up clock.

The circuit is quite simple, and consists of a 5000-10,000-ohm relay, power supply, buzzer, and a size "D" cell. The cell should last approximately its shelf life. Once plugged in, it is left that way, for the current drain is negligible.

Standard half-wave rectifier provides minimum amount of current for proper operation.





A Darkroom Timer

for split-second accuracy and safer printing.

By F. A. Garlick

WITH the advent of the new color printing processes, many a photo bug is spending more and more time in his darkroom. Since the color printing papers are sensitive to *all* colors, they should have an absolute minimum of safelight exposure. This means that your photo timer should turn off your safelights when you are exposing the paper and, as a convenience, also when you are focusing. I built such a unit for under $15.

A mechanical photographer's timer sold by radio suppliers serves as the heart of the unit. The timer energizes relay RY which opens the NC (normally closed) contacts and turns *off* the safelights plugged into SO1. The NO (normally open) contacts simultaneously close turning on the enlarger (SO2). A focusing switch (SW) is connected in parallel with the timer contacts so that the enlarger may be turned on for focusing. As most negatives need a little dodging and burning in, a footswitch outlet (SO3) was added in parallel to the timer switch so that the hands are left free for this work. The footswitch (a good home-built job was shown in the June 1960 *EI*) is connected with a twistlock type of plug to prevent its being accidentally plugged into either of the other receptacles and causing a short. The Mark-Time timer unit has its base and rear covers removed and an automobile radiator hose clamp holds it in place very well.

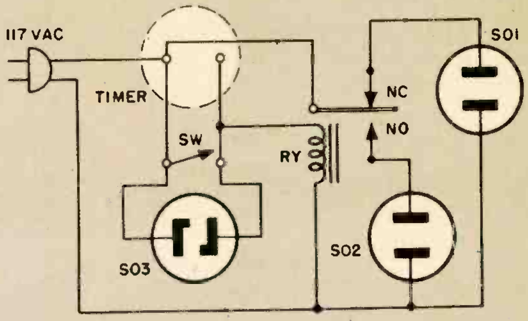
The newer models of the Mark-Time timer have an on-off switch that locks in either position so that toggle switch SW can be eliminated if the newer timer is used.

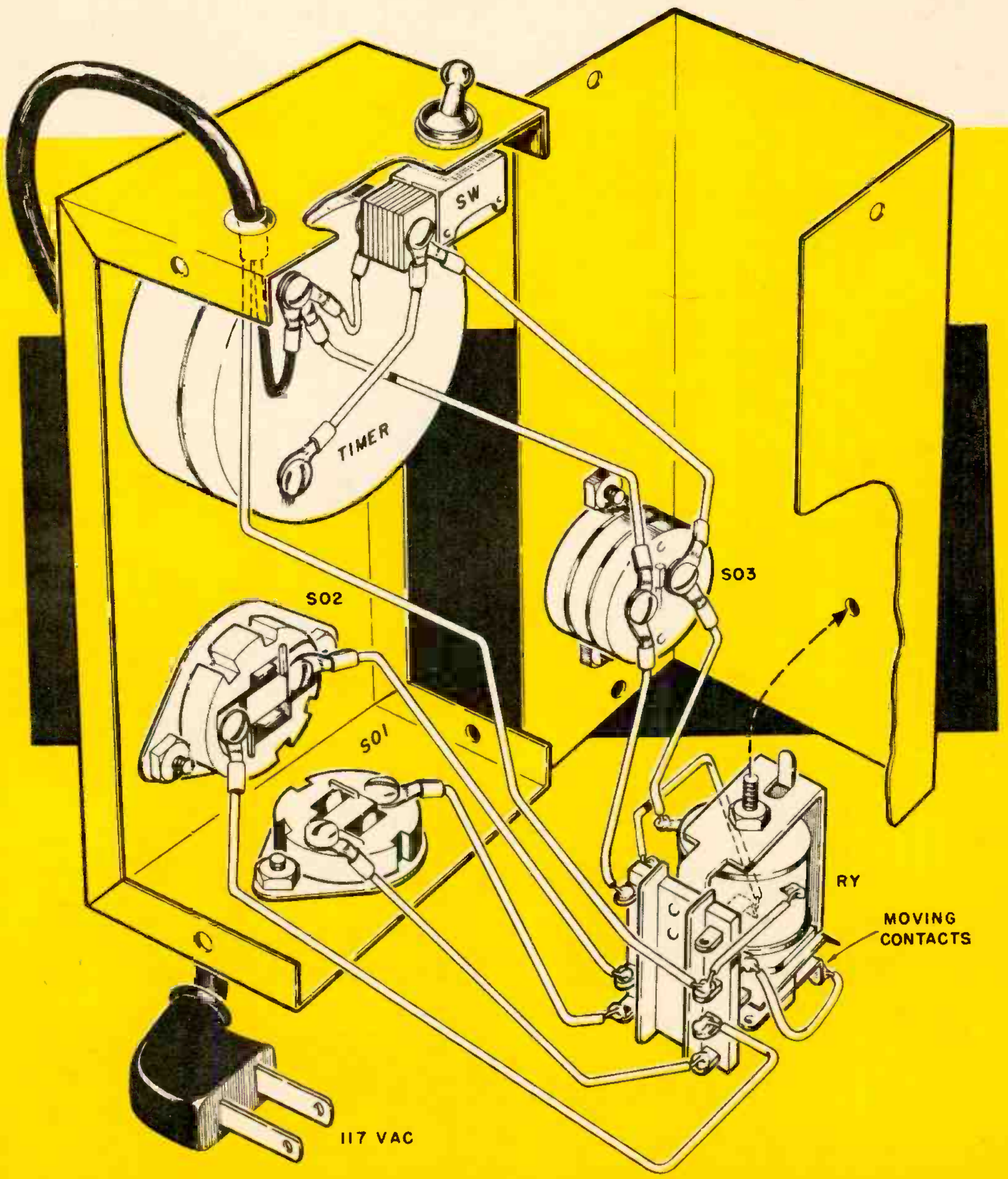
When you have to make several prints of the same negative, this unit will give them all uniform exposures.

PARTS LIST

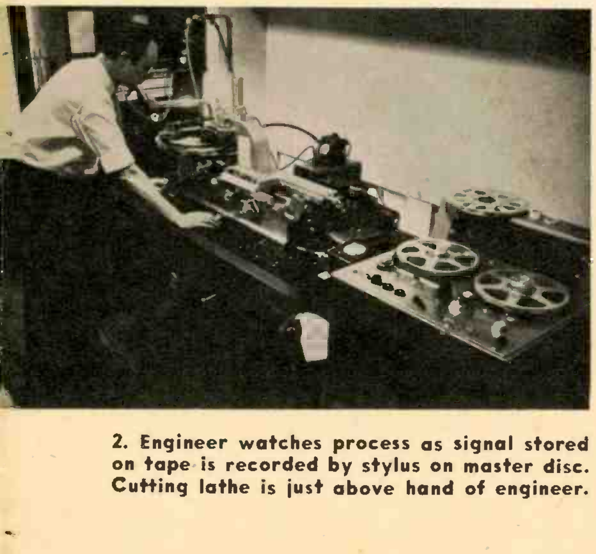
Timer Assembly (Mark-Time Model 78174)
RY—relay 115 volt DPDT (Potter & Brumfield KA 14A)
SO1,SO2—2 prong receptacles
SO3—female twistlock receptacle and male plug to match (Hubbell)
SW—SPST toggle switch
Case—Minibox 2⅛"x3"x5¼"
Misc.—4 rubber feet, #16 wire

When relay (RY) is energized it opens, turning off safelight plugged into SO1. Enlarger at SO2 will then operate.





1. Before actual transfer of sound from tape to disc, the tape is edited and an engineer makes needed splices, as shown.



2. Engineer watches process as signal stored on tape is recorded by stylus on master disc. Cutting lathe is just above hand of engineer.

3. Girl in white gloves makes careful visual inspection of the master disc after cutting. Stereo cuts are on 45-degree walls of groove.

stereo recordings:

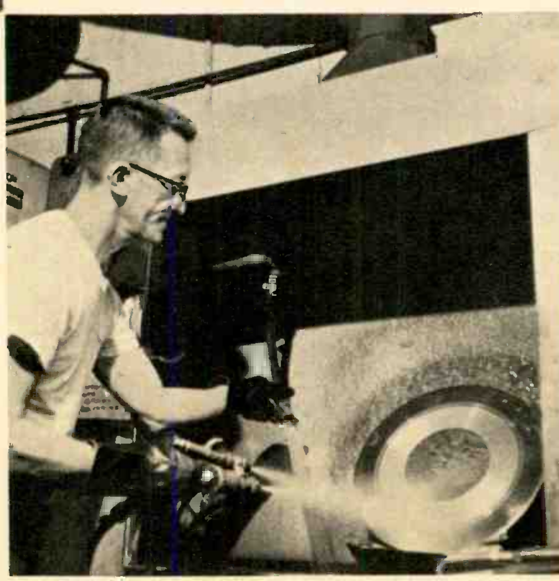
From Tape To Turntable

By Sanford Maizel

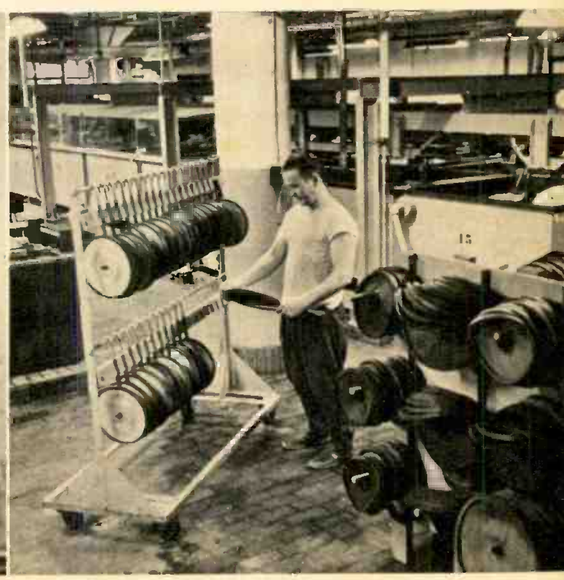
THE process of converting the impulses of a stereo master tape to grooves on a vinyl record sounds fairly simple—you just play the tape and record it on a blank disc. We thought so, too, until we watched the operation at the Columbia Record laboratories. We found out differently. The D-day landings were simple by comparison.

First, let's take a look at the equipment that is used, beginning with the cutting lathe. You might call the lathe just another turntable, and it is, except for the fact that it is a machine-turned platform about two inches thick, beautifully balanced and engineered to run soundlessly at a precise 33⅓ revolutions per minute. A worm gear, mounted across the diameter of the turntable, carries the actual cutting head. This gear determines at what rate the cutting head will be driven toward the center. By speeding it up or slowing it down the distance between the grooves can be varied.

The system that governs this variation is called the automatic variable groove spacing control. By sensing the difference in the



4. Master disc is given a thin coating of silver, making its face conductive for two later electroplating operations. Next, a plating of nickel.



5. Silvered, nickeled masters are put in rubber rings in preparation for the copper electroplating tanks, which are lined up behind man.

6. Copper negative is stripped off. Positive copper "mother" is made next from the master.

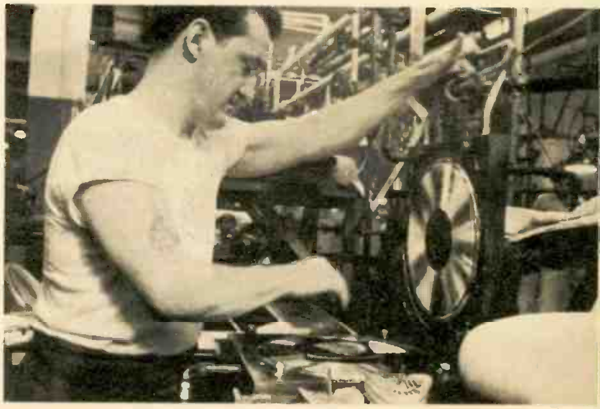
7. Mother is retouched if blemishes appear. Stampers are made from mother in next step.

volume of the sound going into each groove, the cutting stylus is constantly placed just far enough away from the last groove for a proper shoulder, but close enough so there is no wasted space. Use of the automatic variable groove control enables records to carry 10 to 15 per cent more program material.

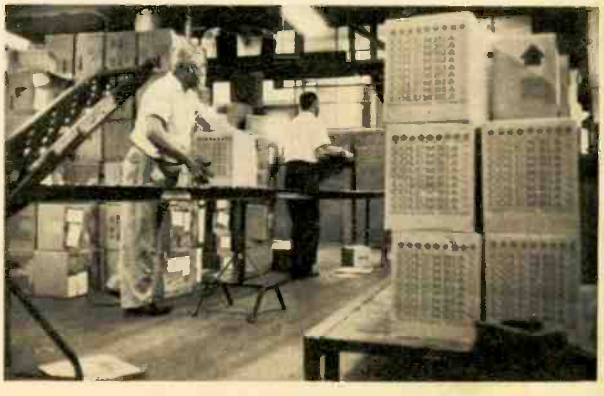
The Westrex cutting head is fed from a pair of 75-watt power amplifiers and cuts each side of the 45-45 groove according to the information it receives from each half or track of the tape. Since the amount and direction of the stylus movement at any time varies on each side of the groove, the stylus motion is a combination of these two forces.

At one time there were several ways of cutting a stereo groove. However at the present time, the 45-45 system is used universally. The lathe employed by Columbia features a sapphire cutting stylus with a carefully inspected square point. This produces a groove with 45-degree walls on each side.

The master disc used for the cutting is a metal plate coated with nitrocellulose lacquer and held in place on the turntable by a vacuum chuck. It is a blank; that is, it contains no grooves. Some years ago it was noted that the vibrations of the cutting stylus sometimes chipped the lacquer of the disc, especially in the higher frequencies. Bad as this was for regular high fidelity, it was intolerable for stereo. For this reason, Columbia de- [*Continued on page* 110]



8. Vinyl record you buy is made when stampers are pressed down on a blank piece of plastic.



9. The labeled records are trimmed, inspected, packaged and shipped out to the retail store.

How to Repair Radios

Part II—Troubleshooting a 5-tube Superhet.

By George Gordon

LAST month we discussed the history and theory of the superheterodyne radio. Now we are going to get into the heart of the matter and discuss some specific techniques you can use to repair that ailing set. To troubleshoot the superhet you will need a voltohmmeter (VOM) and a schematic. Although the tube basing arrangements may differ, the diagram on page 54 will serve for more than 90% of the sets now available. If you run into trouble, however, you can usually get the specific schematic from

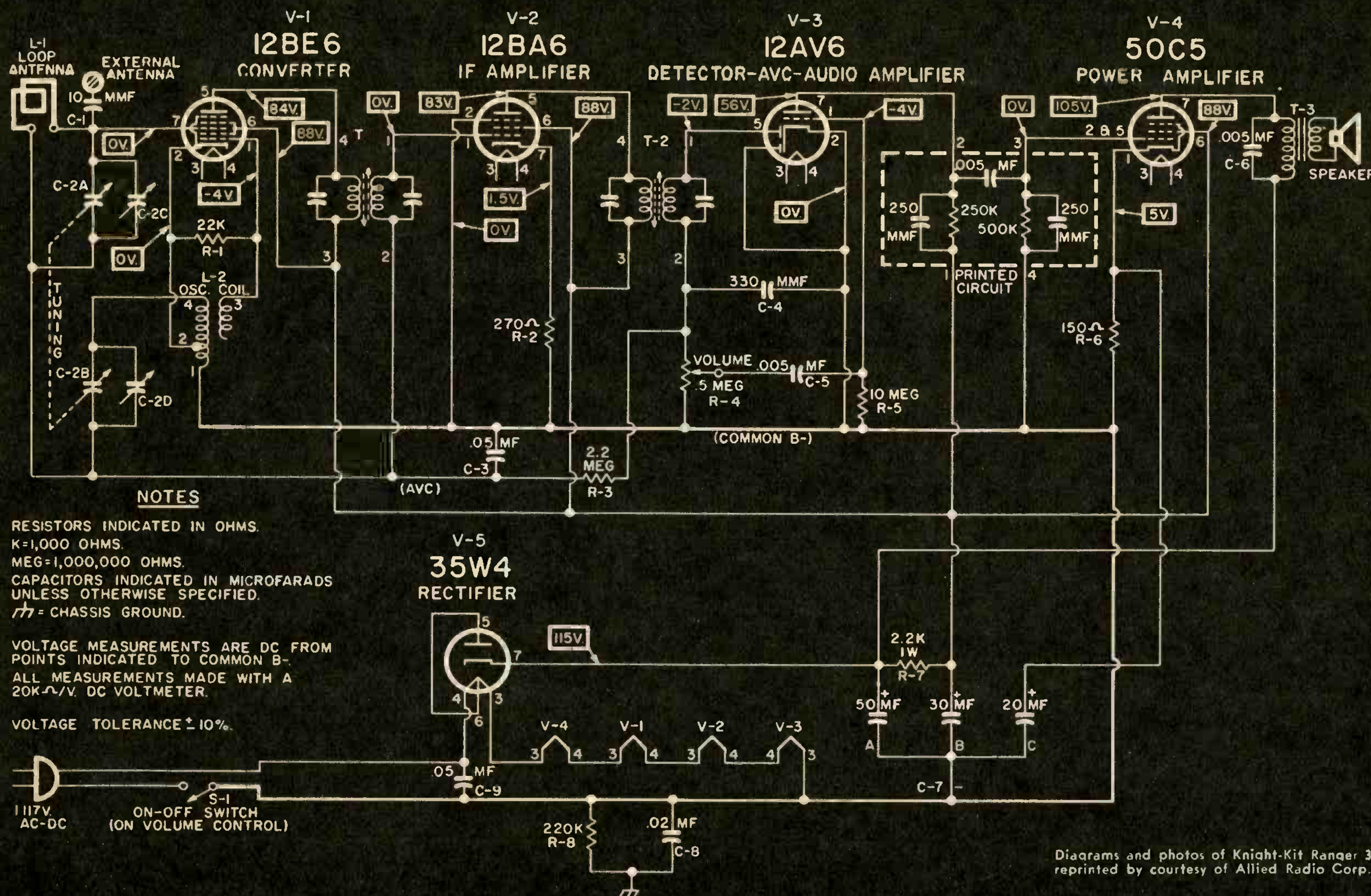
Howard W. Sams Co. (*Photofacts*), Supreme Publications Co. (*Radio Diagram Manuals* compiled by M. N. Beitman) or John F. Rider Co. These can be purchased at any radio parts dealer.

The meter need not be expensive but should have a sensitivity of at least 1000 ohms/volt. If the reference voltages on the schematics are based on a 20,000 ohms/volt sensitivity, you may get a somewhat lower reading in high impedance circuits such as the plate of the 12AV6 (V-3). Some grid and cathode voltages cannot be measured at all.

Besides the meter and schematic you can make use of three other aids: your eyes; ears and nose. With these reliable "instruments" you can spot trouble by *looking* for charred resistors, leaky electrolytic capacitors, or broken connections; by *listening* to the quality or lack of sound at the speaker; and by *smelling* a burnt or burning resistor or rectifier. These preliminaries may save you many needless measurements. Now let's start with a simple problem and work our way to the tougher ones.

Dead Set (tubes don't light)

Since the tube filaments in an AC-DC set are connected in series, one open filament will cut off current to all the others. Remove one tube at a time and check its filament with the ohmmeter or with a filament continuity checker. To determine the filament pins of each tube, refer to the schematic or to a tube manual. In this set, all the filament pins are 3 and 4. Depending on the tube, you will read anywhere from 10-200 ohms if the filament is good. If there is no meter reading (infinite resistance), the fila-



NOTES

RESISTORS INDICATED IN OHMS.
K=1,000 OHMS.
MEG=1,000,000 OHMS.
CAPACITORS INDICATED IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
⏚ = CHASSIS GROUND.

VOLTAGE MEASUREMENTS ARE DC FROM POINTS INDICATED TO COMMON B-.
ALL MEASUREMENTS MADE WITH A 20K Ω/V. DC VOLTMETER.

VOLTAGE TOLERANCE ± 10%.

Diagrams and photos of Knight-Kit Ranger 3 reprinted by courtesy of Allied Radio Corp.

ment is open. Replace the tube and check the operation of the set. If the filaments check out, but the tubes still don't light, the trouble is in either the line cord or the on-off switch. Unplug the set and place the meter probes across the switch contacts. Turn the switch on and off; the meter should indicate continuity (zero ohms) in the *on* and infinity in the *off* position.

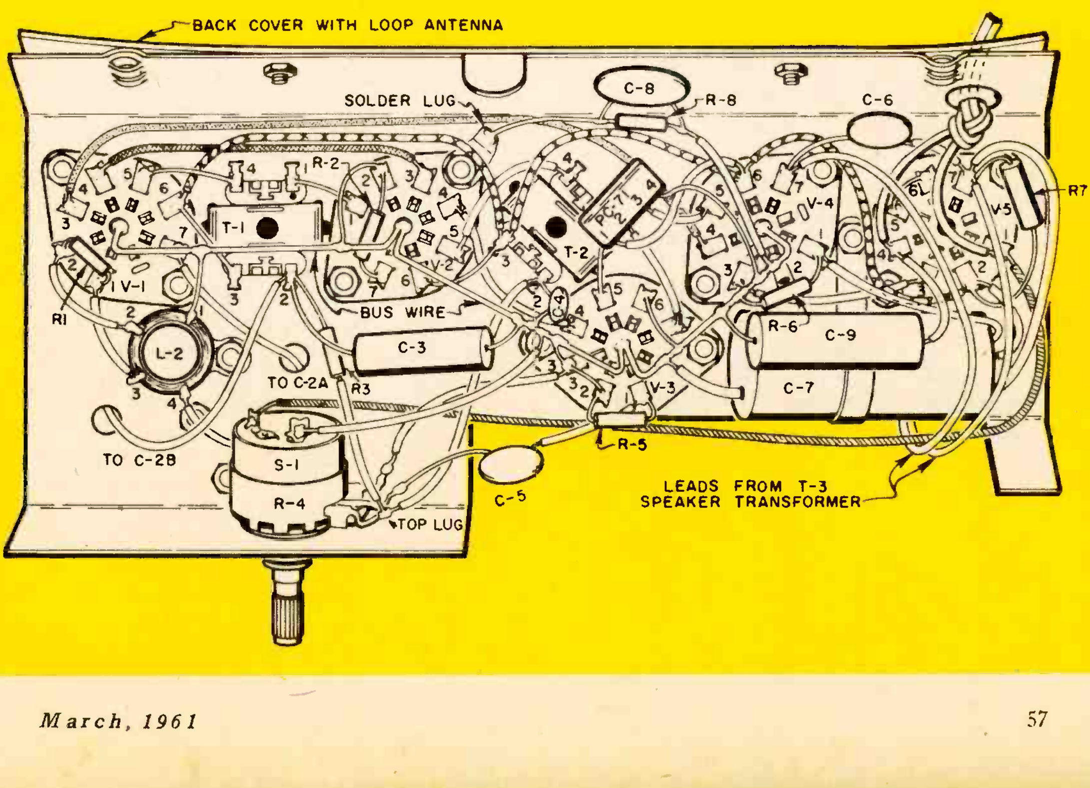
Now is a good time to warn you that most of the radios you'll be called on to repair are likely to have an AC-DC hookup and certain safety precautions should be taken. You can determine the safe way to plug in the set by connecting one lead of your VOM to a convenient ground such as a cold water pipe, electrical conduit, or BX cable. Now with the set plugged in and turned on, check the AC voltage between the receiver chassis and ground. Then reverse the AC plug and make the same check. The meter reading that is substantially lower indicates the safe polarity. Note that this must be done with the set switched *on* or the results may not be truly indicative of a safe condition.

It is also possible to check for an open filament without removing all the tubes once you've removed the chassis from the cabinet. Plug in the line plug, turn the switch on and set your VOM to the 150-250 volt AC range. Measure from one end of the line cord (at pin 4 of V-5) to each filament pin at the tube sockets underneath the chassis. Follow the filament string arrangement shown in the schematic. As soon as the meter indicates full line voltage, you've found the open in the circuit.

Dead Set (tubes light)

By a dead set we mean there is no *sound of any kind* (including buzz, hum, or noise) although all the tubes are lit. Whether you're tuned to a station or not and even if the volume control is turned down, you should hear some hum if you hold your ear close to the speaker. If there is no hum we can assume there are three possible areas of trouble: the

Underchassis view of a typical AC-DC receiver. Note use of buss wire connected to center pins of the tube sockets as a "floating ground" tie point.



power supply; the power amplifier stage; or the speaker. The first thing to do is remove all the tubes and check them with a tube tester. Any tube that reads *bad*, or has shorted elements, should be replaced. However, before replacing a rectifier (35W4 in our set) a few circuit checks should be made.

Since the tubes light, we know that AC is present in the filament circuit, so let's check for DC at rectifier tube V-5. The normal B-plus reading at the cathode (pin 7) of V-5 is 115 volts according to the schematic. Set your meter to measure at *least* this voltage (for example, use the 150-volt range), and measure from the cathode to the common ground (buss wire connecting the center pins of V-1, V-2, V-3 and V-4). *Note:* In many sets the chassis itself is used as the common ground. If the voltage is low or absent pull the line plug and measure the resistance from the cathode to ground. Reason? There may be a short which is draining off the current. If a short exists and you replace V-5 you will ruin the new tube. If capacitor C-7A or B is shorted, or has very low resistance your meter will read much lower than the normal 200,000 ohms. Allow time for the capacitors to charge. If the reading is normal, you can safely replace V-5.

However, a short elsewhere in the B-plus line will also pull down the voltage, so let's check to see if C-7 actually is at fault. Disconnect the positive leads

RESISTANCE CHART

All resistance measurements with respect to the bus wire (COMMON B—). Readings may vary ±20%, depending on the meter used. Remove the line cord plug from power outlet before taking readings. Receiver turned off.

TUBE	PIN 1	2	3	4	5	6	7
V-1 12BE6	22K	.2	37	27	*	*	2.7M
V-2 12BA6	2.7M	0	27	16	*	*	270
V-3 12AV6	10.M	0	0	16	500K	0	*
V-4 50C5	150	500K	85	37	500K	*	*
V-5 35W4	NC	*	90	130	120	120	*

*This measurement indicates leakage resistance of the filter capacitors. After capacitors have charged up, the reading should be at least 200K Ω.

Resistance chart, typical of those found in service notes, refers to Knight-Kit receiver.

of C-7A and B and using the *high* resistance scale on the ohmmeter, measure the resistance from the positive lead of each capacitor to common ground. The meter needle should swing toward zero then slowly move back toward infinity as the capacitor is charged by the current from the meter battery. A reading of 100,000 ohms or more usually indicates a good electrolytic. A reading of 5,000 ohms or less indicates a leaky or shorted condition. *Note:* Most receiver electrolytics contain one or more sections in a single can or cardboard tube. If you find that one section of the electrolytic is defective, it's a good policy to change the entire unit. Watch the voltage rating of the replacement capacitor, for if the replacement is not rated at least 25% above its normal operating voltage, frequent breakdown may occur. The leads are color-coded and their polarity identified on the body of the capacitor. If you make a mistake in polarity and apply power, it's good-by electrolytic. Assuming you do get a reading of 115 volts (±20%) at the cathode of V-5, measure the voltage at the other side of R-7. If B-plus is lower than 75 volts, or absent, R-7 may have changed value or be open. Pull the line plug and measure the resistance of R-7. If a replacement is in order, make sure to use a 2,200 ohm resistor of the same or higher wattage.

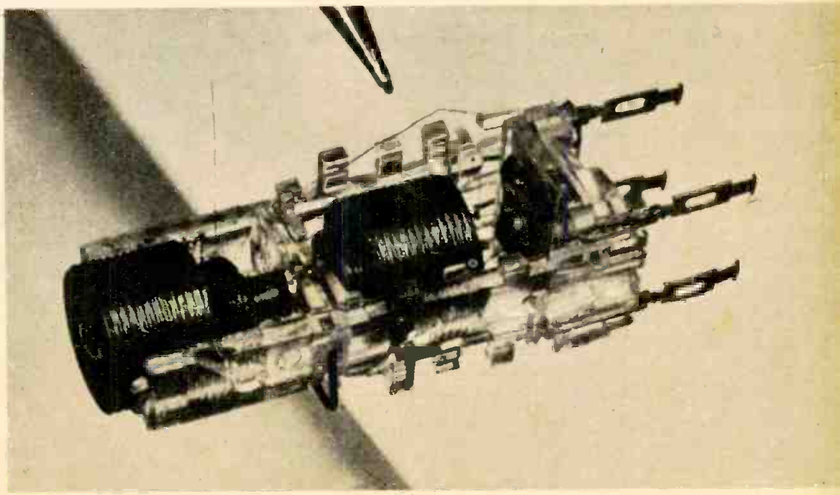
If the power supply section checks out okay, your next move is to the power amplifier stage. With the set on, measure the plate voltage on power amplifier tube V-4. A reading of 105 volts DC from the plate to common ground also means that the primary of the output transformer T-3 is in good condition since the plate voltage is supplied through this winding. Should the voltage at the plate be very low, pull the line plug and make a continuity check across T-3's primary winding with the ohmmeter. There is no need to disconnect one lead as the top winding goes directly to the plate of V-4. If the resistance is zero ohms, replace C-6 as it's probably shorted.

Since the screen grid (pin 6) receives its voltage directly from the power supply, we can assume the screen grid voltage is correct unless there is a broken connection. Plug the set in again, turn the power on and measure the cathode voltage at pin 1 of V-4. You should read about 5 volts. If there is no reading, or voltage is very low, pull the plug and measure the resistance of cathode bias resistor R-6. Again, there is no need to disconnect a lead of R-6 since its resistance should be much lower than cathode by-pass capacitor (C-7C) which shunts it.

Note that although the 50 mf and 30 mf sections of C-7 are rated at 150 volts, the 20 mf section is rated at only 10-25 volts as the normal cathode voltage of V-4 will never be higher than 5 volts. If your voltmeter reads less than 5 volts or zero, the 20 mf electrolytic may be shorted. Because R-6 carries the full current of the output tube it may sometimes overheat and open. If you measure an unusually *high* voltage across R-6 it is because R-6 is open and capacitor C-7C is acting as a leaky high resistance. In fact, if R-6 opens while the set is in operation, C-7C may be ruined. If you have to replace R-6, be sure to check this capacitor. After the power amplifier stage (V-4), (including the primary of the output transformer) the only other suspect is the loudspeaker. There is little chance for a breakdown to occur in the transformer secondary but it is possible for the speaker voice coil to open.

For a quick check of the speaker, set the ohmmeter to the low resistance scale and touch the two probes across the voice coil. You'll hear a distinct click if the speaker winding is okay. To test the secondary open one lead from the secondary winding to the voice coil and measure resistance. You should read a few ohms. A quicker way to check out the output transformer *and* speaker is to remove the 50C5 while the set is on. As you pull it from the socket, you should hear a distinct click in the speaker.

We will continue our step-by-step trouble shooting next month.



Slug-tuned IF transformer with can removed. Note the point of possible short where hair-thin wire may contact metal wall inside shield can.

Electronic Brain

Any question on electronics? Send it in with a stamped return envelope and the Brain will reply.

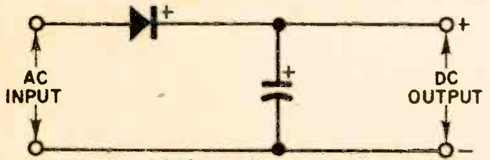
Full-Wave vs. Half-Wave Rectifier

What are the advantages of a full-wave bridge rectifier circuit over a simple half-wave rectifier beside the fact that the full-wave system is easier to filter?

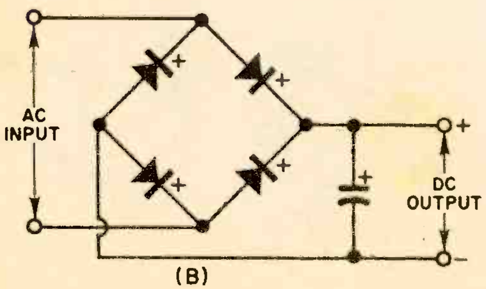
Robert Carrol, Jr.
Turkey, N. C.

The bridge circuit in B of the accompanying figure has two very significant advantages over the simple half-wave rectifier in A beside the fact that the output waveform is full-wave.

1. *Higher average load voltage compared to the r.m.s. input voltage.* For instance, if the r.m.s. input AC voltage is 120 volts, the average voltage across the load would be 120 × 0.45 = 54 volts. For the bridge, the average load voltage would be 120 × 0.90 = 108 volts. The net effect of this is that it requires a much larger capacitor to bring the half-wave system close to peak voltage.



(A)



(B)

2. *Lower average rectifier current compared to average load current.* If you built a simple half-wave power supply that would have to provide, say, 100 ma average DC for the load, the rectifier would have to carry 100 ma, too. In the bridge circuit, however, 100 ma average current in the load would only draw 50 ma average through *each* rectifier.

Crystals, Series and Parallel

Can oscillating quartz crystals be connected in series or parallel, like resistors or capacitors, to produce other frequencies beside the ones for which they are ground?

Robert M. Sechler
Bellmore, L. I.

No, they cannot.

The principal advantage of a quartz crystal in oscillating circuits is that it *insists on oscillating at one and only one* frequency when used in a circuit that is tuned to its fundamental frequency. A crystal prevents a transmitter from broadcasting on a frequency unassigned to the station, or an illegal frequency.

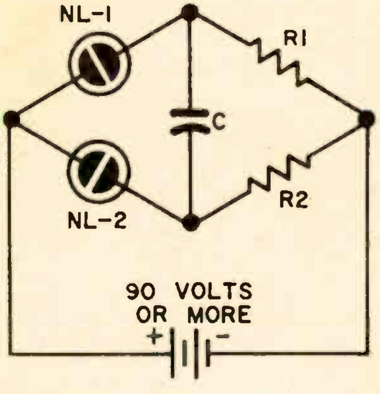
You might object that a crystal in a Pierce oscillator circuit does not make use of a tuned circuit, and so why not connect two crystals in series or parallel to produce a new frequency. There are two serious arguments against this notion. First, two simultaneous signals of different frequencies in the same circuit would tend to damp each other out like two pendulums of different length strapped together. The natural period of one supplies out-of-sync pulses that interfere with the natural vibration of the other. Second, in any circuit containing two mutually-exclusive elements (like the pendulums), the more active of the two will tend to "take over" at the expense of the other. Hence, if the circuit were to oscillate at all, the oscillation would take place at the frequency of the more active of the two crystals.

Neon Tube Circuit

Can you explain the operation of the neon tube circuit shown in the diagram? The tubes flash alternately.

Jack Smiley
Madison, Wisconsin

When the battery voltage is first applied, both neon tubes "try" to ignite because they are effectively in parallel across the battery through their respective resistors. No two neon lamps are identical, so that one has a lower ionization potential than the other; hence, one of them will ignite a fraction of a second before the other. Assume that NL-2 lights first.



At the instant that current begins to flow through NL-2, a voltage drop appears across R2 causing a potential to similarly appear across the capacitor C. C now starts to charge through both R1 and R2, causing the drop across R2 to increase so much that NL-2 is forced to extinguish.

C is now charged and must begin to discharge through both R1 and R2 in the direction *opposite* from that of charge. The discharge current bucks the voltage drop across R1 and adds to the drop across R2, giving rise to a higher applied voltage to NL-1 than NL-2. This causes NL-1 to ignite, starting the cycle again.

Interchanging Capacitors

If a parts list specifies one type of capacitor, paper for instance, can I use a mica or ceramic capacitor of the same value and voltage rating? Can a mica be used when a silver mica is specified?

Mark Kachel
Milwaukee, Wisconsin

Here are a few simple rules to guide you.

(1) A mica capacitor of the same value and voltage rating may be substituted for a corresponding paper type without degrading circuit performance. Equivalent ceramic capacitors may also be used in place of paper types without any problems arising.

(2) If a mica or air capacitor is used in a *resonant* or tuned circuit, paper and ceramic capacitors *cannot be substituted*. In bypass applications at high frequencies (radio frequencies) a paper capacitor of good quality might serve in place of a mica type, but this substitution is not recommended except in emergencies. It is safe, however, to replace a mica capacitor in an *audio* bypass circuit with either paper or ceramic of equivalent rating.

(3) An ordinary mica capacitor should *not* be substituted for a silver-mica type. When the latter type is recommended in the original circuit, the designer is indicating that a very low-loss capacitor is required for the specific circuit to function in the manner he intended.

Interstation Whistles

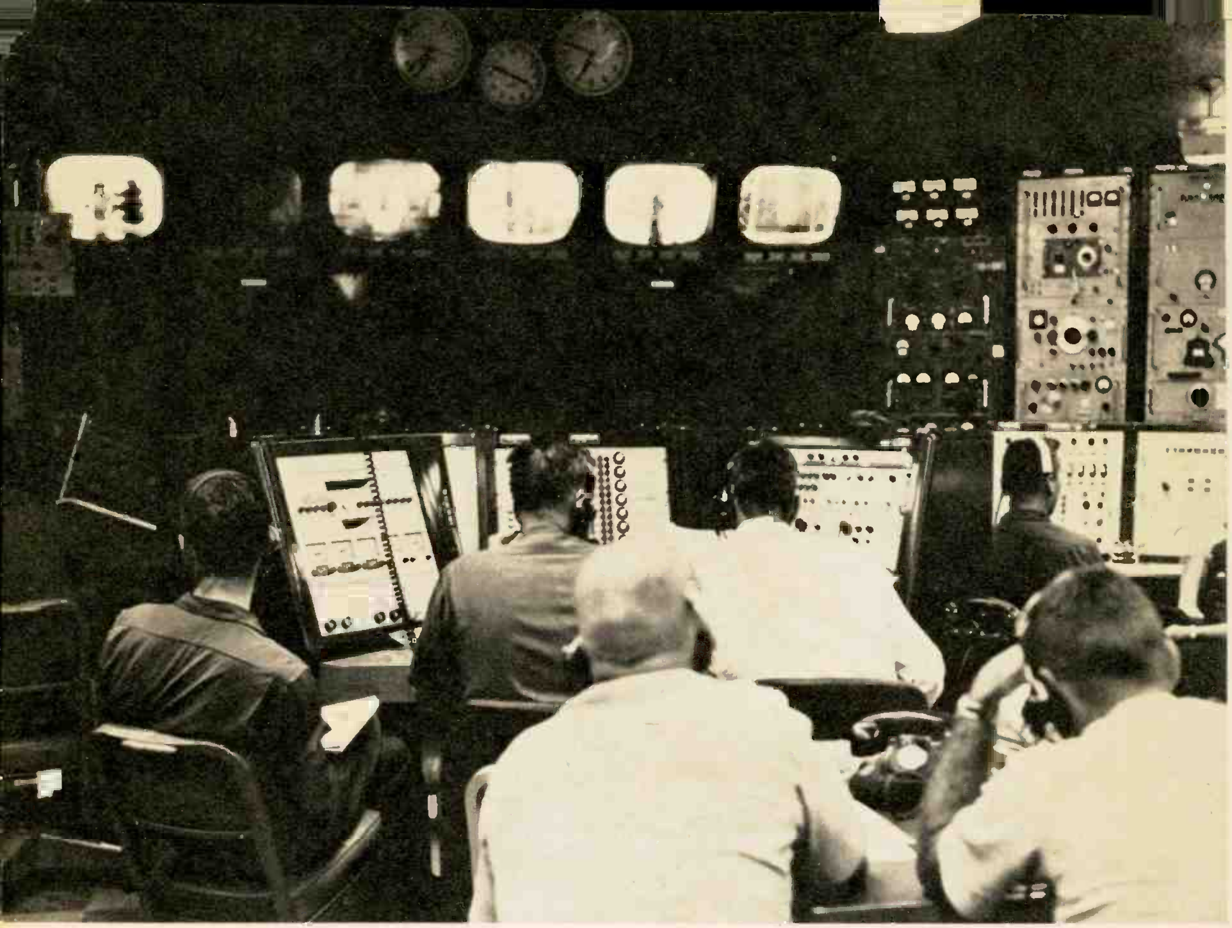
I have an AC-DC radio that has developed a hum; in addition, there is loud whistling between stations. I have changed filter capacitors but this did not help. Can you suggest a solution to my problem?

Frank J. Seeley
Santa Ana, Calif.

The real clue to your trouble probably lies in the interstation whistling. It sounds very much as though either the converter or intermediate frequency amplifier is oscillating. Such oscillation produces audio-frequency beat notes with all signals to which the radio tunes, causing a tunable whistle on virtually every portion of the dial.

First have both tubes checked on a tube tester. If the tubes are good, look for open screen bypass capacitors. Check them out by shunting with equivalent values of capacitors known to be in good condition.

When you cure this instability, you will probably find that the hum will also vanish.



Most of the wall space in the Titan blockhouse at Cape Canaveral is taken up by automatic checkout system which spots trouble during countdowns.

The Indispensable Birdbrains

Behind the big missiles is an unsung team of tiny electronic devices which makes success possible.

By Jim Kyle, K5JKX/6

ONE of the top defense experts on the current scene and in the new administration, Sen. Stuart Symington, said not long ago that in the past the United States has usually had about 18 months to prepare for war, but for World War III we would be lucky to have 18 minutes to get ready.

Although a rather frightening statement, the time it allots is ample. In 18 minutes our missiles could be checked out, given directions and fired.

The secret is some small and simple electronic devices which, when clustered together in hundreds and thousands, become automatic checkout systems.

It may take a skilled technician months to check out a missile before firing if he works alone. With the aid of electronics the same job can be accomplished in an incredibly short time.

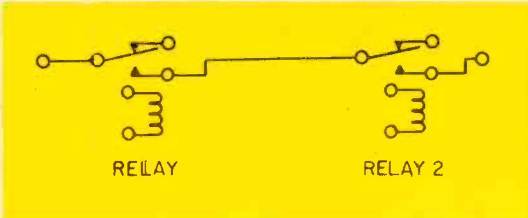


FIG. 1: AND computer circuit. Both relay 1 and relay 2 must close before through circuit operates.

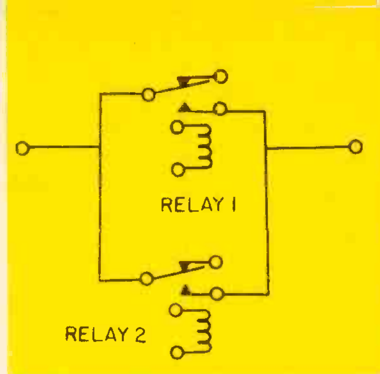


FIG. 2: OR circuit. Either 1 or 2 must close to operate through circuit.

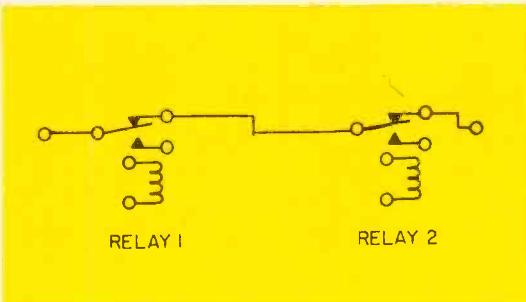


FIG. 3: NOR circuit. The through circuit operates if neither 1 nor 2 (normally closed) is actuated.

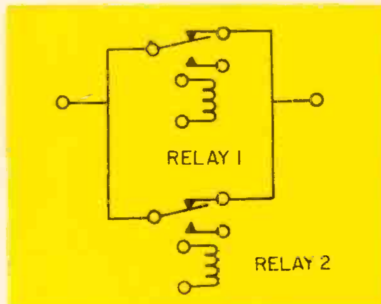
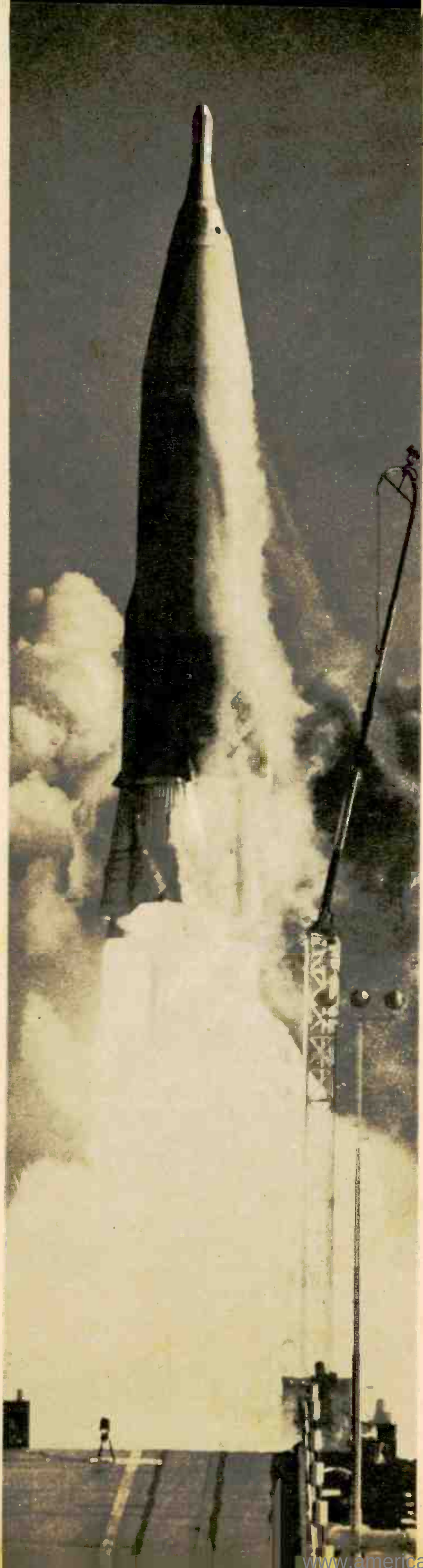


FIG. 4: NOT AND circuit. Does not operate if 1 and 2 are both actuated.

View in Martin-Denver blockhouse shows the birdbrain at left and right with dials and lights. Television screens give missilemen a look at several points of the bird.



Birdbrain's triumphal moment comes when missile it has checked out blasts off successfully to show it has done its work properly; what occurs after launching is some other machine's worry. It can wait for next bird.

Virtually every missile or rocket system built or planned includes an automatic checkout system, known by missilemen as a birdbrain because it is actually an electronic brain which performs continuous troubleshooting on a missile, or bird.

The birdbrains—described by one missile manufacturer as "highly developed voltmeters"—check each of a missile's thousands of electrical circuits in a matter of seconds. Each step is completed in less time than it would take a human technician to connect a meter to a test point.

In addition to testing electrical circuits, the computer checks performance of other components including fuel, pumps, and the rocket motor itself. Only when every portion of the missile is in perfect condition does the birdbrain allow it to be fired.

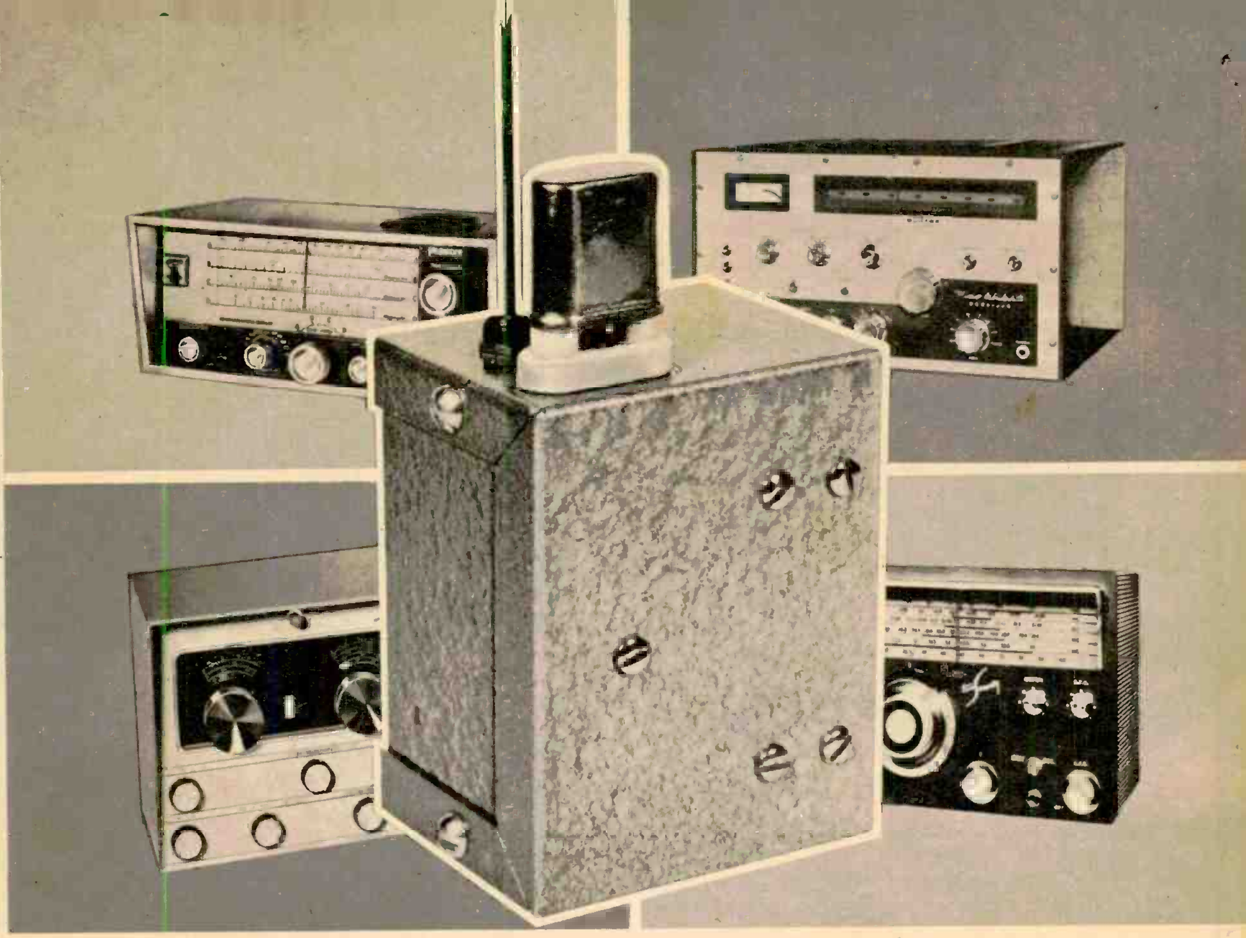
Any troubles which develop are pinpointed instantly, allowing rapid repair.

Detailed descriptions of how these systems operate cannot be published, partly because almost every installation is different from every other, partly because of a cloak of military secrecy. The broad outline, however, is neither secret nor complicated. The general idea is not even new. For several years a few radio and TV manufacturers have used robot technicians to test every unit coming off the assembly line.

Such a checkout computer can be considered a talented idiot, capable of checking voltage, current and resistance values in thousands of circuits at the same time if someone just tells it what to do.

Circuits and components used in missile computers are remarkably simple. Each portion of a checkout device usually contains only two or three electronic parts such as relays, transistors and resistors.

However, these basic components are used in vast quantities. Some installations contain [*Continued on page* 102]



Crystal-Controlled Frequency Spotter

For the Ham and Short-Wave Listener

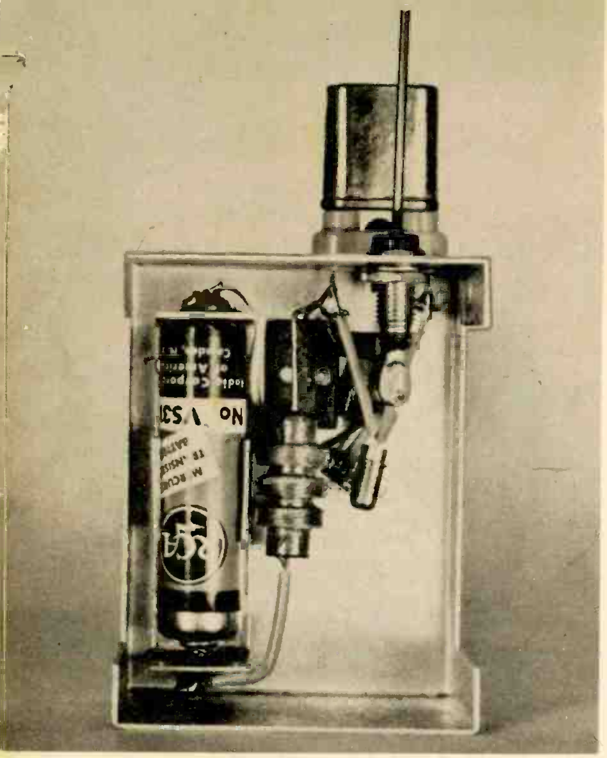
By Donald L. Stoner, W6TNS

DO you know how good your new antenna is, or if it is tuned to exactly the right frequency? How about that new communication receiver? Do you know exactly where the band edges are, and if it is aligned properly?

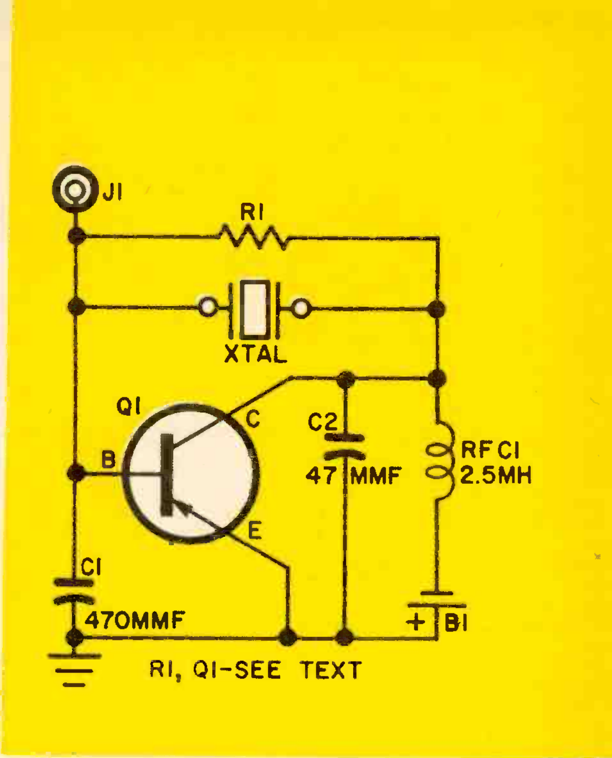
If you can't answer one or more of these questions, you need this Spotter. With this tiny package, containing less than $5 worth of parts, you can make all these tests and many more. No special construction information is needed, the pictorial should answer all your questions.

After assembling the Spotter, connect a 1 ma meter in series with battery B1 and wire it into the circuit. Temporarily connect a 100,000-ohm, ½-watt resistor R1 across the crystal socket and note the collector current on the meter. The target value is .2 ma (200 microamperes). If the reading is higher, increase the value of the resistor. If the meter reads less, reduce the resistor value.

Once you have achieved .2 ma (plus or minus 10%), permanently install the correct value resistor R1 across the crystal socket. Remove the meter from the circuit and connect the excess wire on the base end of R1 to the insulated pin jack J1. Install B1 when you are ready to use the Spotter.



Interior view. If different based crystals are used, appropriate sockets may be paralleled.



Most drift or surface-barrier transistors will oscillate at the crystal frequency chosen.

The author tried many different types of transistors in this simple circuit and found that almost any *drift* or *surface-barrier* type oscillated.

Since the Spotter is a stable fixed-frequency signal source, it is valuable for testing and adjusting antennas. While carrying the Spotter, walk away from the antenna until the signal on your communications receiver becomes quite weak. At that point set the box down on a fence or the ground. While checking the signal on the receiver (use the "S" meter or observe the signal-to-noise ratio), adjust the antenna length or matching for best reception. If you are able to bring about an improvement in reception, you can assume that other received signals will "perk-up" by the same amount. In effect you are peaking your antenna on an actual signal. And, you can obtain the last ounce of performance since the Spotter signal does not go on and off or vary in strength.

You can also use the Spotter to check the directivity of your antenna. With the Spotter in a fixed location, rotate the antenna and note the variations in signal strength. Signals from the front of the average three-element beam should be at least 20 decibels stronger than from the rear. If you don't have a rotor, ask a friend to carry the Spotter around the antenna in a large circle while you watch the signal strength. This method is not as accurate (due to buildings and other obstructions) but will give you a good idea of antenna performance.

PARTS LIST

R1—33,000 to 330,000 ohm, ½ watt resistor (see text)
C1—470 mmf, disc or mica capacitor
C2—47 mmf, disc or mica capacitor
B1—1.5 volt dry cell or mercury battery
RFC1—2.5 millihenry RF choke
J1—Insulated pin jack
Q1—Transistor (see text)
1—Crystal (see text)
Misc—Aluminum chassis box, 2¾"x2⅛"x1⅝", piano wire, six 4/40 nuts, bolts, and washers, ground lug, crystal socket

Receiver Testing

Have you ever tried to align a receiver? The instructions usually tell you to check the calibration at each end of a band. If you have a geared-down signal generator, this can amount to a lot of knob twisting on a five-band receiver.

But if you have two crystals, each near the edge of the band you are calibrating you can jump back and forth simply by changing crystals in the Spotter. If you need a band-edge marker, so that you don't get too near the upper or lower limit, simply place the appropriate crystal in the Spotter and set the unit near the antenna lead of the receiver. Since the Spotter input power and radiated signal strength are pretty much the same for all crystals, you can also get an excellent idea of your receiver performance by checking its sensitivity at various points.

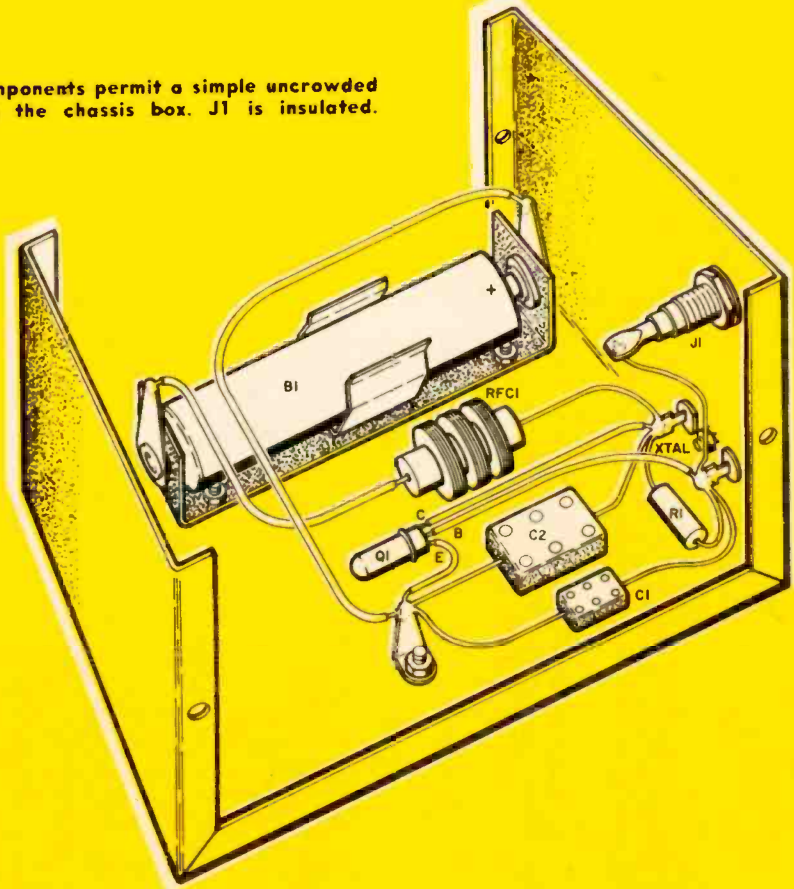
The frequency range of the Spotter has a limit of 30 megacycles, but it is also useful at VHF. The author used the device to align 2-meter equipment by using the harmonics of a lower frequency crystal. In this application, a 9 mc crystal was used and the 16th harmonic tuned by the receiver at 144 mc. By the same token you could use an 8 mc crystal and listen for the 18th harmonic on the same frequency.

It should be pointed out that the Spotter is a handy device for testing crystals. When you purchase crystals at a surplus store, you can never be sure that they are good. With the Spotter you can be sure! *Any* good crystal will oscillate in the Spotter circuit.

Although only a few applications have been described, undoubtedly many more will occur to you after constructing the Spotter. I think you will agree with me it is one of the most useful pieces of gear in your shack or lab.

The Spotter is a crystal-controlled transistor [*Continued on page* 112]

Small components permit a simple uncrowded layout in the chassis box. J1 is insulated.



4,800 WPM Via Meteor Trails

By John Dowell

NEW communications links, which once came along every quarter-century or so, are now cropping out of the landscape like ants at a picnic. In recent months we have heard much of modulated infrared beams, a signal-bouncing satellite, a relay satellite and other developments. Now an ingenious team of scientists at the Central Radio Propagation Laboratory of the National Bureau of Standards has discovered a communications use for meteor trails.

The newest idea, called the Meteor Burst Communication System, promises new channels for transmission of information at incredible speed, and accuracy to match.

The basic idea is simple—just bounce radio signals off the 15-mile-long ionization trails of any of the millions of tiny meteors that enter the earth's atmosphere every day and pick up the messages when they come to earth 400 to 800 miles away. It has long been known that ionization of any stratum of the atmosphere, such as the Heaviside layer, turns it into a reflector of radio waves. The usefulness of the Heaviside layer, however, is limited to the nighttime and its reflecting action stops above 30 megacycles.

But there are a few small problems with meteor-trail bounce. At times no useful meteor burst is present. Electrical storms, atmospheric static and such also may interfere. The NBS team, working at the laboratory in Boulder, Colo., came up with an answer.

Since transmission necessarily is intermittent, messages are sent at an extremely fast rate when good conditions exist, making up for the idle in-between periods.

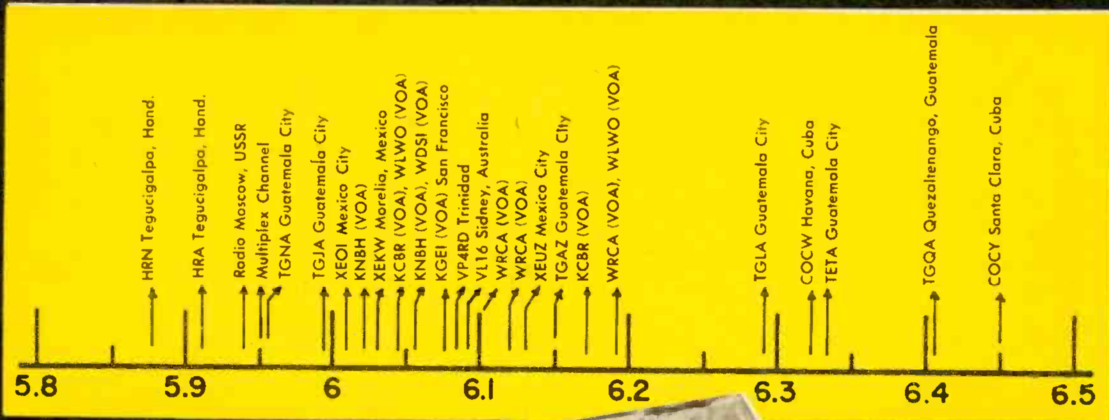
That they've succeeded is shown beyond doubt. Messages are transmitted between two stations at 4,800 words per minute from magnetic tapes and recorded on tapes at the same speed. Then on each end the messages are transcribed at normal teletype speeds of 60 words per minute.

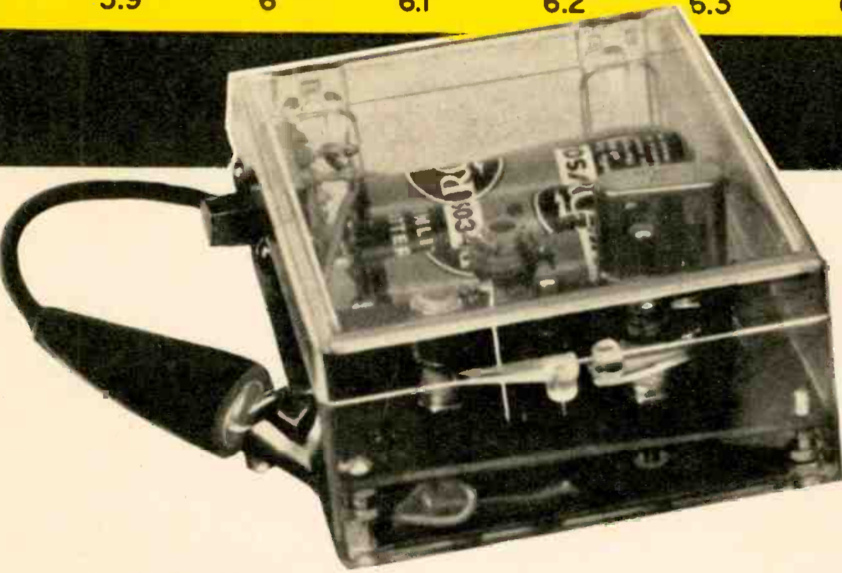
Making the system work, of course, is not quite as simple as it sounds. If messages are to be transmitted simultaneously between station A and station B, teletype data (frequency-shift-keyed teletype modulation) is stored on magnetic tape at each station. Both stations then turn on their transmitters and receivers. The units receive each other weakly, if at all, until a reflected signal is present. When the reflected signal from station A received at station B exceeds a preset threshold intensity, the transmitter at station B shifts its transmitting frequency from "space" to "mark" frequency in order to signal station A that it is receiving satisfactorily. Under the same path conditions in the opposite direction, station A will do the same thing. When both stations have continuously received "mark" frequency for approximately nine milliseconds, the paths in both directions are deemed satisfactory and high-speed duplex transmission of messages begins.

Each station in such a setup is tuned to listen for the other but not for itself. Merely finding a meteor trail in the antenna pattern of the two stations is not enough, however. The trail must be properly oriented for proper reflection of the signal from one point to the other. Slight differences in frequencies and antenna locations of the oppositely directed radio paths make it necessary also for the equipment to verify the existence of suitable signal paths in both directions before simultaneous transmission between stations can take place. [*Continued on page* 102]

Incoming meteor burst signal of high-speed data shows on oscilloscope, left, is recorded on tape at right, fed at low speed to teletype.

Meteor burst project chief Robert J. Carpenter (seated) and colleague examine some strip charts of signals received from meteor trails.





EI 49'er

Short-Wave Converter

For Short-wave Listeners—a two-transistor unit that pulls in 49-meter band on a standard radio.

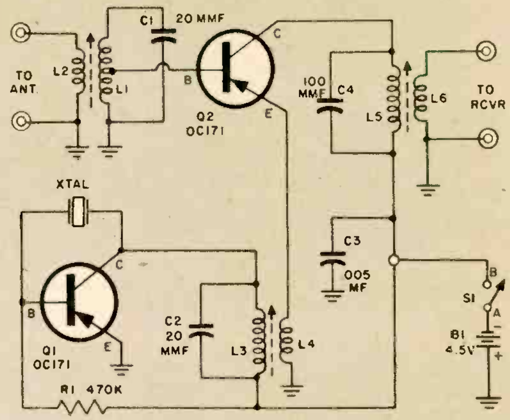
By Don Stoner, W6TNS

YOU can eavesdrop on the world with a handful of parts that would easily fit in the space occupied by a pack of cigarettes. Transistors, of course, are the answer to such high degrees of miniaturization.

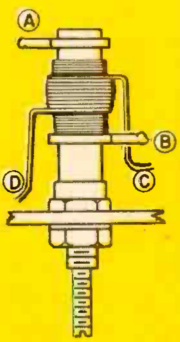
The "49'er" is a two-transistor crystal-controlled converter for the 49-meter short-wave band that occupies less than five cubic inches! The device will convert this band so that it may be received on a standard broadcast radio. The compact feature makes

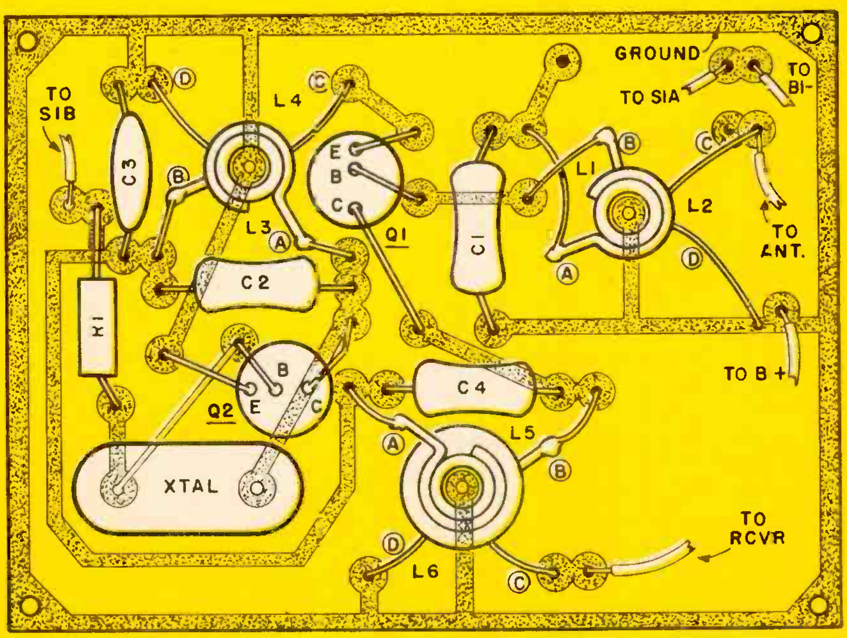
PARTS LIST

R1—470,000 ohms, 1/2 watt resistor
Capacitors (low-voltage types)
C1,C2—20 mmf tubular or disc
C3—.005 mf disc
C4—100 mmf tubular or disc
L1—70 turns, #38 enameled or cloth covered wire, tightly scramble wound on 1/4" slug tuned form, modified per text (J. W. Miller #4311)
L2—10 turns, #38 wire, wound over coil L1
L3—Same as L1
L4—Same as L2
L5—170 turns, #38 wire, tightly scramble wound on 1/4" slug tuned form, modified per text (J. W. Miller #4315)
L6—60 turns, #38 wire, wound over coil L5
Q1,Q2—SB100, 2N247 or OC171 transistors (see text)
S1—SPST slide switch
B1—Three penlite cells (RCA VS034A or equiv.)
Misc.—Crystal 6.5 to 7.5 mc., plastic box 2 3/4"x3 3/4"x 1 1/2", 2/56 hardware. Circuit board available from Semiconductors 'N' Stuff, Box 288, Alta Loma, California, $2.00 post paid

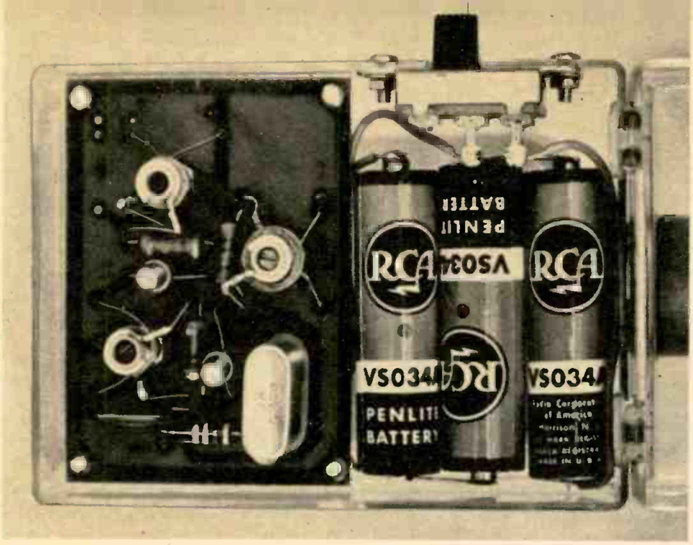


Crystal oscillator circuit using Q1 beats with incoming 49-meter signal in Q2 circuit and converts it to BC band.





Arrangement of components on printed-circuit board. Shading indicates conductive areas. Point-to-point wiring may be used instead of board, if desired.



Neatness of layout is inherent with use of etched circuit board for all components except batteries.

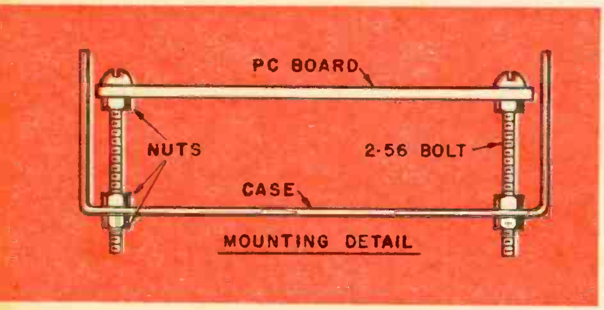


Fig. 1 Cutaway view of printed circuit board mounting. Four bolts are used as grounds.

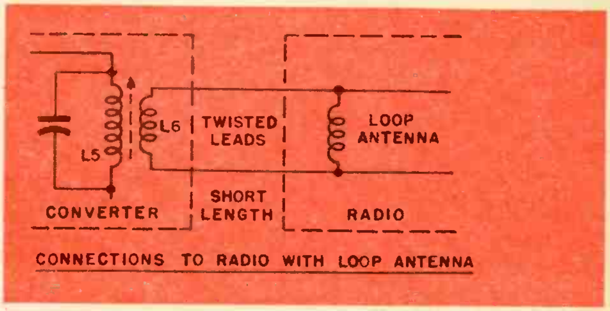


Fig. 2. Method of connecting converter to radio with loop antenna. L6 ground is removed.

it ideal as a shortwave adapter for your car radio.

Operation—The antenna is connected to coil L2. Signals arriving at the antenna are coupled to coil L1 which is tuned to the 49-meter band or about 6.5 mc. This coil also serves to match the antenna to the base of transistor Q2.

The oscillator energy, necessary for the superheterodyne process, is generated by transistor Q1. The oscillator produces a tiny crystal-controlled signal which mixes with the incoming station. The *difference* frequency between the two signals is within the receiving range of the broadcast radio to which it is connected.

To understand how this occurs, assume that a signal is received on 6 mc. This beats or heterodynes with the crystal (in the unit shown it happens to be 6.925 mc). The difference frequency, then, is .925 mc or 925 kilocycles which can be picked up near the center of the broadcast band (550-1600 kc). With a crystal frequency of 6.925 mc, the radio can tune stations between 6.375 and 5.325 mc. Other crystal frequencies will shift the receiving range accordingly. More about this later.

Construction—The majority of components are installed on an etched circuit board to aid in duplicating the converter. The board, in turn, is mounted in a small plastic box, which also contains on-off switch S1 and the three penlite cells B1.

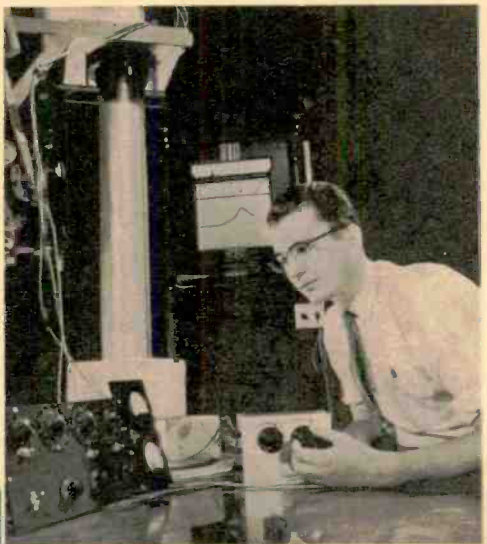
The first step in building the "49'er" is to prepare the coils. Unfortunately no suitable coils exist for shortwave transistor circuits, and commercial coils must be modified. The Miller coils are very tiny and therefore ideal for the miniature converter.

Coil L1 is modified by winding 10 turns of #38 wire immediately under existing coil. One end of the new winding connects to terminal B (see pictorial) the other is soldered to the metal coil form base. [*Continued on page* 111]

they call it

Giaever's Discovery

SCHOOLBOYS who get stuck with memorizing names like Ohm, Volta and Faraday may one day be slightly horrified at the spelling of another name they have to learn. That name would be Giaever. Ivar Giaever in full. The man who owns it is a young Norwegian who took a mechanical engineering degree at the Norwegian Institute of Technology in 1952 and now is listed as a physicist at the General Electric Research Laboratory at Schenectady, N. Y. Mr. Giaever (he is neither PhD nor DSc) joined GE in 1955 and just recently was the honored guest at a full-scale press conference held to announce a new scientific concept called Giaever's Discovery. [*Continued on page* 99]



Ivar Giaever applies voltage to his tunneling device (shown below on a penny for comparison of size) which led to Giaever's Discovery. Strips of metal on microscope slide are separated by insulator. Dip in curve on recorder behind Giaever is negative resistance area.

EI's Hi-Fi Doctor . . .

Audio Fact and Fiction III—Speaker Power

As a follow-up on last month's discussion of speaker efficiency, let's move on for a look at the subject of power handling capacity. Thanks to the vague specifications of many speaker manufacturers, many audiophiles are needlessly confused over speaker power ratings and how to interpret them.

Before we actually tackle the question of power handling, one fact has to be clear: a speaker's specified power rating *doesn't* refer to the amount of audio power it *needs* from an amplifier. Instead, it means that the speaker will theoretically handle up to 20 watts of audio power before trouble ensues. If a speaker manufacturer wants to advise you on the power *needed* to drive his unit, his spec sheet will usually include an item labelled "Power Requirements" or "Recommended Power."

If you have no trouble understanding that a speaker's power rating *doesn't* mean its power requirements, you've earned the right to wonder just what it *does* mean. Only a moment ago I said that it referred to the amount of power a speaker will handle before trouble crops up. But I didn't say what *kind* of trouble. And neither, unfortunately, does the manufacturer. There is no way of telling from specifications what will happen to a speaker when it's fed a bit more power than it's rated to handle. The speaker rated at 20 watts of power handling capacity may simply start to distort at 21 watts. But it also may be mechanically damaged or "burned out."

A speaker's design gives you your only clue as to what may happen to it when it goes beyond its nominal power rating. For instance, a massive woofer with a long-travel voice coil will start to distort as the voice coil moves out of the speaker's magnetic gap. But the long-throw characteristic insures that the voice coil can go a long way into distortion before it jumps completely out of the gap or "bottoms" against the pole-piece ledge or slug assembly of the speaker. So it may be able to survive up to twice the power for which it's rated without real damage. But a tweeter or mid-range speaker usually has a very small margin of safety between distortion and destruction.

Since a speaker's sound, rather than its power rating, prompts your decision on whether to buy it, your only real concern is how to protect it from possible damage when hooked up to your rig. The answer is to fuse it. Fusing is a good idea even if you don't usually play music at a loud enough level to do any damage; for an accident like the loosening of an amplifier's input plug can still wreck the speaker.

Using Mr. Ohm's law it should take you only a few seconds to figure that a 16 ohm speaker (with 20 watts applied) has a current flowing in it of 1.1 amps. But if you cut that figure in half (.5 amp) and use a slo-blo type fuse, you'll have a margin of safety which will allow momentary musical peaks to get through to the speaker. The same formula yields a one-amp fuse for an 8 ohm speaker with a 20 watt rating, or 1.5 amps for a 4 ohm speaker. A 10 watt rating at 16 ohms means a half-amp, and 5 watts calls for a quarter-amp fuse. When you've finished calculating, install the fuse *in series* in the speaker line, with a 47-ohm resistor in parallel with the fuse (to prevent an open circuit if the fuse blows).

and Clinic

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

4-Track Tape

Now that 4-track tape is becoming popular, I would like to buy a tape deck. I was told, however, that frequency response is not good on a 4-track machine. Are there disadvantages to 4-track and should I give up the idea?

J. Olson
Orange, N. J.

The frequency response of a tape recorder has nothing to do with how many tracks are recorded on the tape but is dependent upon the gap width of the playback head and the speed at which the tape is recorded. The higher the speed, the better the fidelity. With the recent development of microgap heads, good response is possible at speeds of 3¾ ips, and excellent response at 7½ ips. The fact that the signal is impressed on a narrower track means less output from the tape and a deterioration of signal-to-noise ratio.

Four-track tapes are also at a serious disadvantage if you wish to make live recordings because of the difficulty in editing. The main advantage of four-track tapes is the increase in playing time for a given length of tape; twice as much is now available than with 2-track stereo tape. Almost all material available on discs is available on 4-track tapes. The great savings afforded by 4-track techniques has enabled the recording companies to lower the price of pre-recorded tape to a level close to disc recordings.

Stereo Stylus for Mono

I understand that a stereo cartridge can be used to play monophonic LP records. What will the .7 mil stereo stylus do to my mono records? Should I use a dual stylus cartridge equipped with a 1 mil tip for mono records and a .7 mil tip for stereo records? Will the wrong stylus affect the fidelity of the sound?

James J. Graham
Amityville, N. Y.

If you use a .7 mil stereo stylus to play mono records there will not be any excessive record wear. However, the fidelity may be poorer. The smaller stylus will tend to bottom in the record groove rather than ride on the groove walls. This will cause noise much like you heard from the old 78's. We recommend a dual-stylus cartridge with 1 mil and .7 mil styli.

Cartridge Loading

As a first step toward converting my system to stereo, I purchased a stereo preamplifier. My problem is that I wish to use my mono cartridge which requires a terminating load impedance of 27,000 ohms, but my preamplifier has an input impedance of 100,000 ohms. What circuit changes are required?

B. Harvey
Pasadena, Calif.

Connect a 36,000 ohm, ¼ watt or 1/10 watt, 10% resistor across the cartridge lugs in the pickup head. This reduces the load on the cartridge to the required value. Remove the terminal clips from the cartridge pins before soldering the resistor across the clips. This external installation of the resistor may actually cut down hum and can be easily removed without disturbing the preamp wiring. Check the tone arm pressure after the installation of the resistor.

Headphones for Stereo

Can I operate a pair of stereo headphones directly from a stereo preamplifier? I would like to avoid using a large power amplifier.

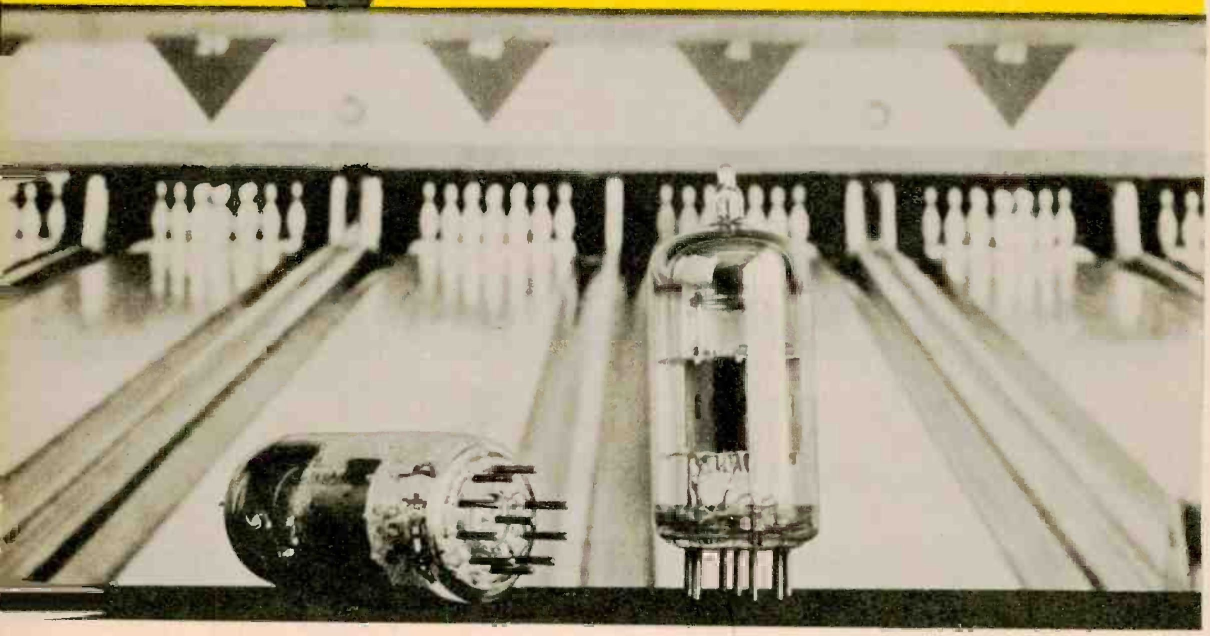
Frank W. Smith
Tulsa, Oklahoma

You can use magnetic headphones if their impedance is at least 10,000 ohms. Lower impedance phones will mean less volume or may not work at all. Crystal phones, which usually have a very high impedance, would be the best type to use.

a new tube design

The 10 Pin

Two miniatures have a new look with extra pin located in center.



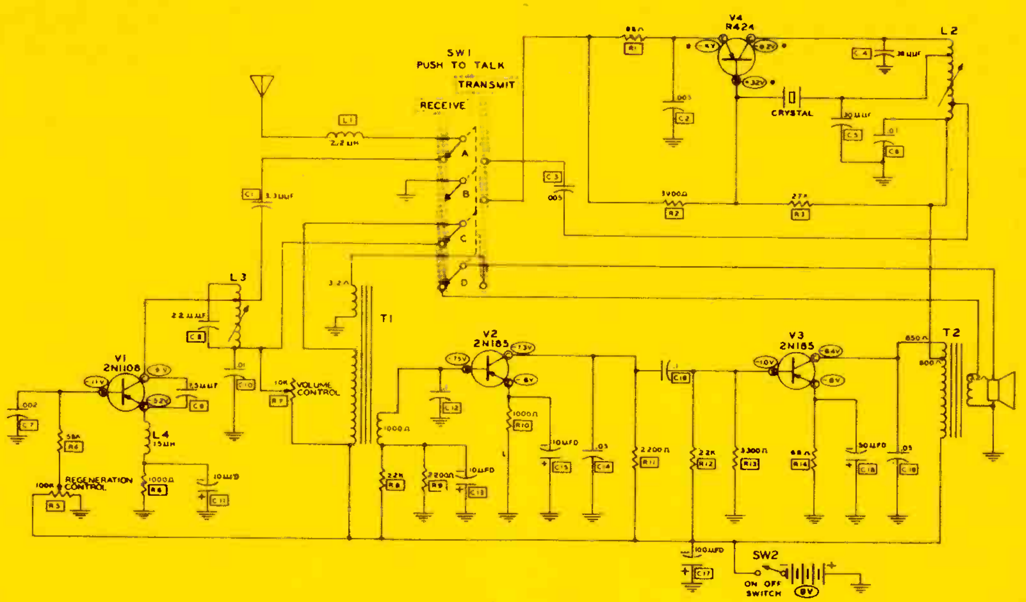
STANDARD nine-pin miniatures have now been updated with the addition of a tenth pin, located in the center. The first two of Sylvania's new Ten Pins are a double tetrode and a triple triode. The double tetrode is intended as an RF amplifier and oscillator-mixer for FM tuners and receivers. The triple triode checks in as an RF amplifier, oscillator-mixer and AF control tube. Ten Pin advantages claimed by the manufacturer include the possibility of reduced costs in chassis designing and circuit simplification. The extra pin will mean less wiring in a given circuit. It also will mean better (closer) spacing in high-frequency circuits, as would any repackaging of circuit functions which would lead to a smaller number of envelopes. Such a trend in design thinking could lead to some strange developments, with tubes incorporating even more functions and having . . . more pins. One problem might be where to put the new pins but a hep designer could figure out a fast answer. Pin diameter on the Ten Pin is .040 in.

EI builds a
"Handi-Talkie" CB Transceiver

PERHAPS remembering the handi-talkie from your army days or having seen the new commercial ones in operation, you've said to yourself "it would be fun to own a pair, but not at $100 apiece." Well, the Heath Company has broken the price barrier and brought out a Citizens Band transceiver kit (Model GW-30) for less than the cost of the parts alone. For $32.95 ($64.95 a pair) you get a license-free (when used with a similar unit) two-way radio no bigger than a camera for which you will find more uses than we can tell you about. We used two of these units on a fishing and canoe trip in the mountains and wondered afterward how we ever did without them. They have become as indispensable around the house as the telephone and as a "walking intercom" these little transceivers are rugged enough to take the usual household abuse.

Construction

Most of the components are soldered to a printed wiring board so the assem-



Speaker doubles as microphone and T2 serves as modulation transformer during transmission.

bly of this transceiver is a cinch. All parts are outlined and labeled on the board and the step-by-step instructions are tied directly to full-page diagrams in the well-planned instruction manual accompanying the kit.

The push-to-talk switch (SW1) must be wired to the board before installation on the case and this is a job requiring care. Be careful when stripping the wires since a slip may leave the wire too short for its connection.

Use a well-tinned 25-50 watt soldering iron and keep its tip bright. This will assure maximum heat transfer and prevent overheating the printed wiring.

No test equipment of any kind is needed to get on the air. All assembly and tuneup steps are detailed very clearly in the 28-page instruction book furnished with the kit. It will take at least two full evenings to assemble a unit or if you're not inclined to do-it-yourself you may buy the transceivers completely assembled for $50.95 each or $99.95 a pair.

The Circuit

In the *transmit* position, the model GW-30 uses a high-frequency transistor (V4) in a crystal-controlled oscillator modulated by a two-transistor audio amplifier (V2, V3). The speaker serves as a microphone and output power is under 100 milliwatts.

During transmission, the audio signal passes from the microphone-speaker through switch SW1 and transformer T1 to the first audio amplifier (V2), through the second amplifier (V3) and then to the primary of transformer T2. The signal is tapped off the primary of T2 and fed to the RF transistor V4 in the crystal-controlled oscillator-output stage. C4 and L2 make up the tank circuit whose output is fed back through SW1 to the antenna through loading coil L1.

When the push-to-talk switch is released, the antenna is connected to the receiver tuning circuit (L3-C8) and the superregen detector V1. The detector output is fed to transformer T1 and then to the two stage audio amplifier (now serving the receiver) and the speaker.

The single 9-volt battery specified will power the GW-30 for about 75 hours of intermittent use. Transmitter drain during operation is about 22 ma.

Don't expect these Heath units to substitute for a long distance telephone; you can't DX with it (and you shouldn't try to with *any* CB equipment). With a pair of these units you will be able to communicate intelligibly at about 1½ miles line of sight over water or in a relatively light forest. Hills and densely built up areas severely limit the range.

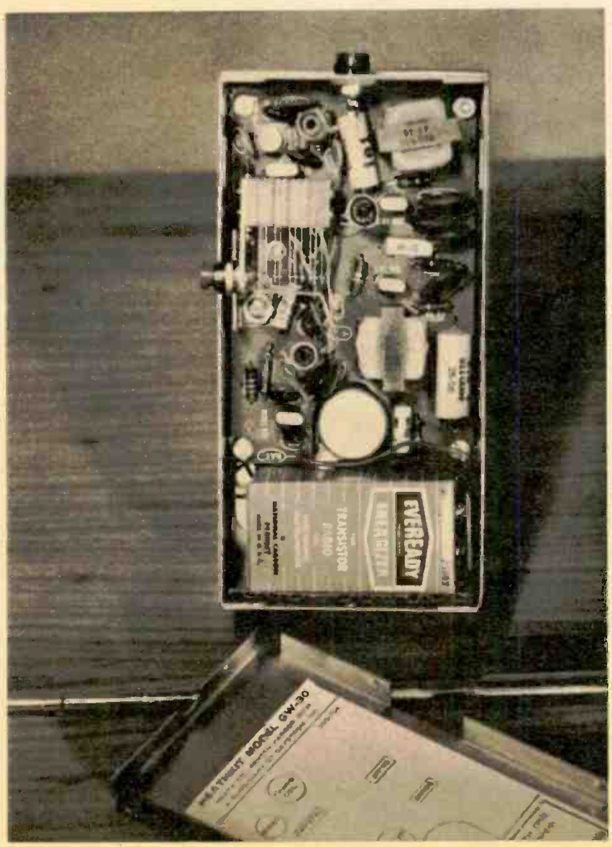
If you use one of these units in conjunction with a standard full-power Class D CB transceiver using a high-gain antenna you can expect greater range, but your receiver's noise level will always be a limiting factor.

When ordering the Heath GW-30 you may request a crystal for any specific CB channel to match the operating frequency of any other CB Class D unit you may have. If used in this way you must fill out the Citizens Radio license application packed with your unit; instructions are included. You will also get part 19 of the FCC rules and regulations for the Citizens Radio Service.

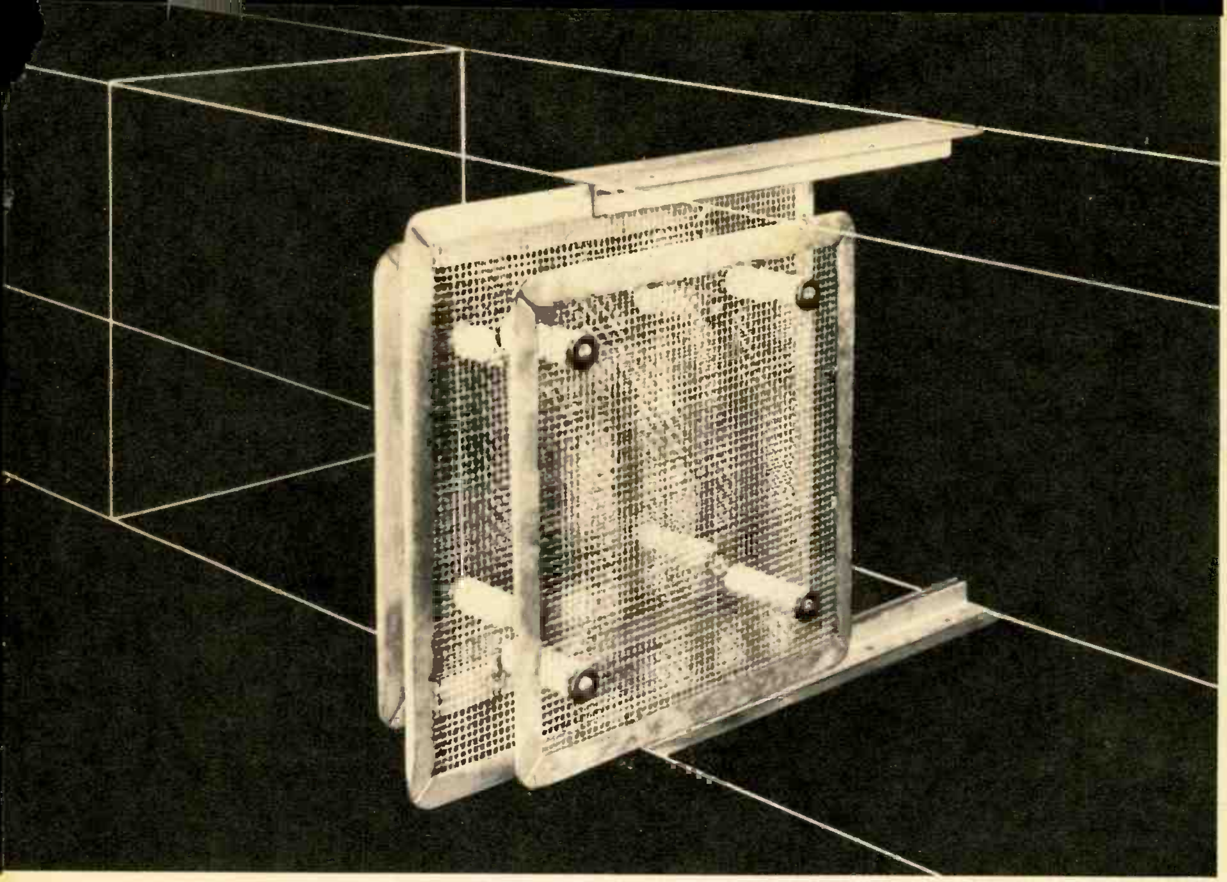
This transceiver may be used *without* a license if operated with another unit whose output power is also under 100 milliwatts. Part 15 of the FCC rules governs this use.

The unit is furnished with a carrying strap and it's no phony, the transceiver weighs only about 2 pounds total. It measures 6½"x3¼"x2⅜" and comes in a snappy black leather case with an attractive aluminum face plate.

Interior view of completed unit shows battery placement, push-to-talk switch and parts.



Transceiver carrying case. Whip antenna may be collapsed or removed from the unit.



a new electronic

Dust Control

Three screens and 28,000 volts eliminate dust and dirt in the air by shattering the tiny particles.

FAGGED-OUT office workers in factory areas and in the teeming cities get that way partly because the air they're breathing is full of dust and smoke particles, and sometimes unpleasant odors are present, also. CRS Industries of Philadelphia has now come out with a new method of cleaning up the fresh air drawn into working areas, one that promises to make conditions just a little pleasanter during that long 9-to-5 grind.

Factories and other smoke and dust producers for years have used precipitators in their stacks and ventilation-system outlets to prevent pollution of the outside air. These precipitators really are giant air-dielectric capacitors with high voltage between their plates. Dust, smoke and chemical fumes, all of which tend to carry a positive electrical charge, are attracted to the negative plates and some of these unpleasant substances stick there.

But what about working areas that are located in an environment containing air pollutants? Any office in a big city or a factory area falls into this category. Air drawn into the building from outside is polluted to some degree. Filters have been used to screen out some of the sludge but this system is not too effective.

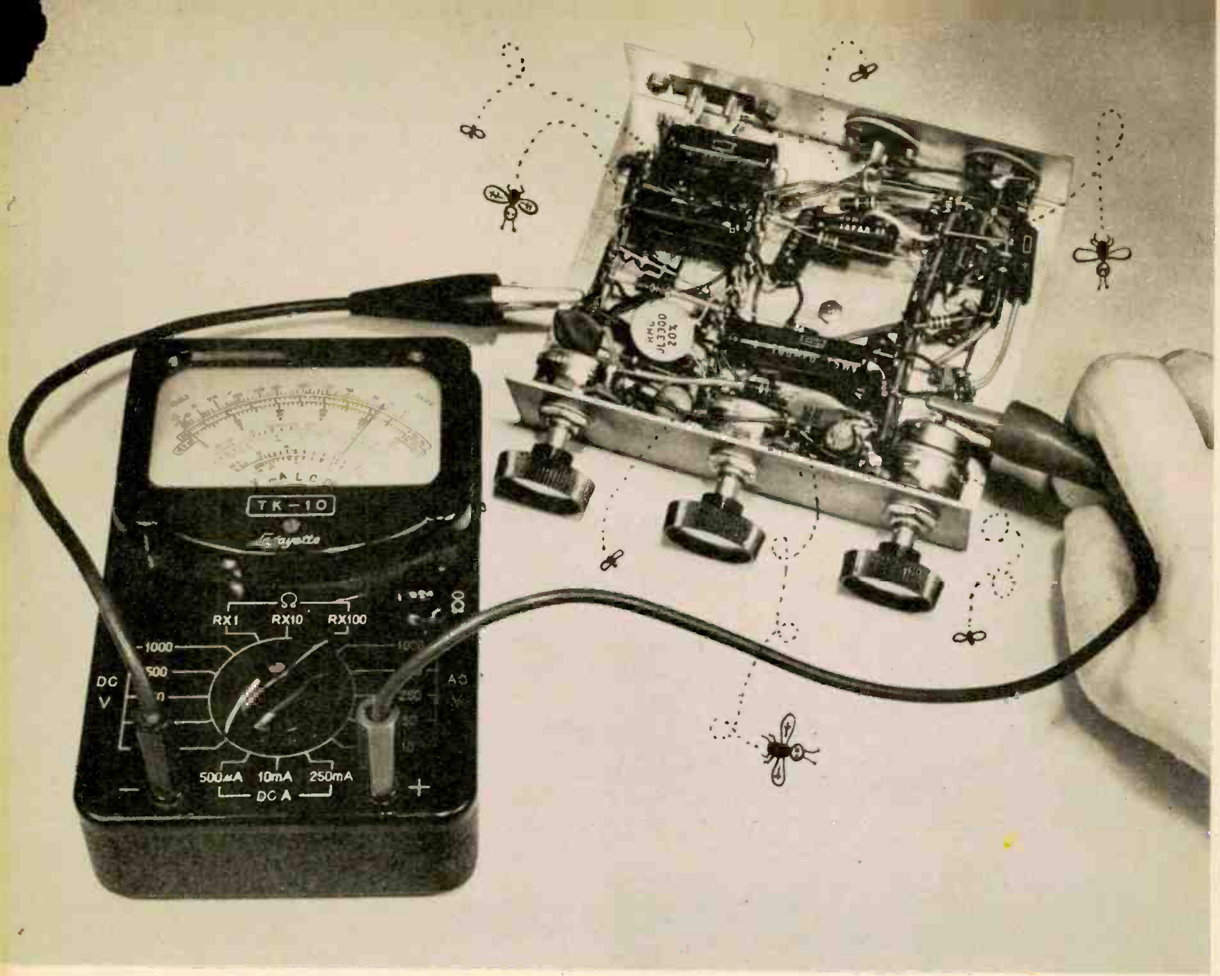
The new CRS equipment, called the Statronic System of Dust and Odor Control, might at first appear to be merely another precipitator, set up to do its work on incoming air. But it is not. Its unique method of operation is to bombard dust and other particles in the air with electrical energy, shattering them until they are too small to settle. It also furnishes them with a negative charge and because of this charge they tend to be repelled by surfaces on which they might have settled. After Statronic bombardment the particles are left in sizes smaller than .1 micron, or one ten-millionth of a meter. This dimension is comparable to the wavelengths of visible light.

Because of the tiny inherent motions of any fluid, including air, called "Brownian movement" (take a peek in your physics textbook), the charged micro-particles keep getting pushed and bumped and blown around, and tend to become permanent components of the atmosphere, never to settle anywhere.

New Statronic control on the incoming air duct (high-voltage screens shown on opposite page) means clean and fresh air for offices.

The power supply system which furnishes high voltage to screens in duct is shown in picture at left. Small box fits snugly in any corner.

How does the new dust control work? Three screens of quarter-inch mesh are placed in the incoming air duct of an air-conditioning or ventilating system. The center screen is grounded. The two other screens are given a strong negative charge by an electronic power supply which delivers 28,000 volts DC, pulsating at a high frequency. Apparently the particles pick up a negative charge by passing through the first screen, get accelerated by being drawn toward the neutral or grounded screen and then shatter upon passing the second negative screen. The second negative screen tends to repel them but their accelerated speed forces them to pass through—with [*Continued on page* 107]



how to

Troubleshoot Your Projects

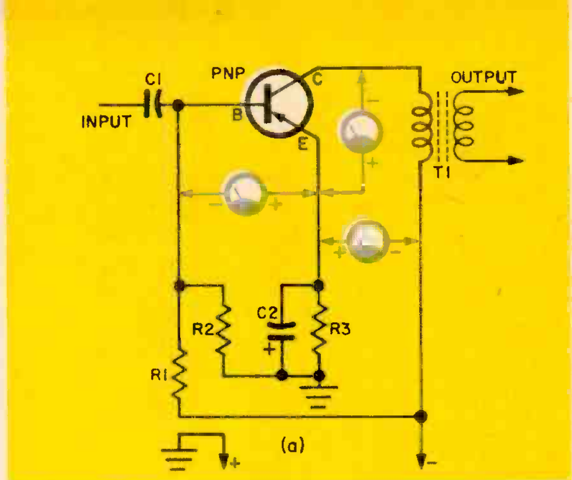
Some ideas and checks to help chase those "bugs."

By Lou Garner

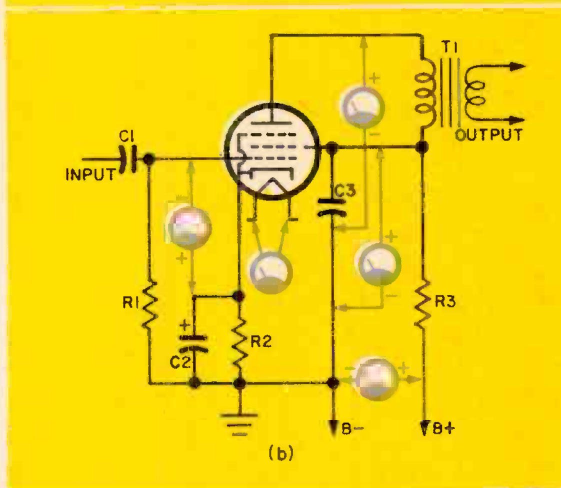
SOMETIMES no matter how carefully you build a project it won't work right. The darn thing is just crawling with a variety of electronic bugs that foul up your best attempts to get the unit operating. Unfortunately, Flit won't solve the problem; down-to-earth troubleshooting techniques must be used.

At first glance, it would seem that troubleshooting a home-built project is much like troubleshooting any piece of commercial electronic equipment. But such is not the case, as many a top-notch service technician has learned when called in on the "check out" of a friend or neighbor's project. The difference lies in the nature of the beast, for a factory-built piece of equipment "worked" at one time . . . otherwise it never could have been sold.

A home-assembled project, on the other hand, may never have

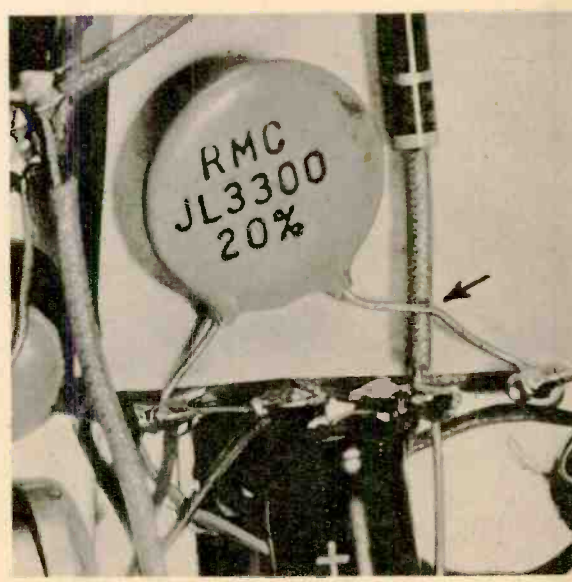


Voltage measurements to be made in a transistor circuit. The NPN transistor's polarities are reversed so be sure to switch the meter test leads.



Five voltage checks to be made in a pentode circuit. Note that the grid bias is measured with respect to the cathode rather than to the ground.

Stick to specified components on projects. Don't substitute unless you're sure it will work.



Watch out for possible shorts! Where component leads cross, insulated tubing is a must.

worked. Whether assembled from a kit or according to the plans in a magazine article or book, the project may be incapable of "working," due to an error in wiring, the use of incorrect parts, or a combination of factors. Where second-hand or used components have been employed, the situation may be further complicated by one or more defective parts.

Common Troubles

When a home-built project fails, the usual causes are:

(a) a wiring error.

(b) use of incorrect parts.

(c) an accidental "short," "open" or bad solder connection.

(d) one or more defective parts.

(e) misadjustment.

Project failures fall into two broad classes . . . (1) the completed project "doesn't work" at all, and (2) the project "works" but not quite right. In the first case, a receiver or amplifier may be completely *dead*, or the relay in a control device may fail to close. In the second case, a receiver or amplifier may lack sensitivity, may have a distorted output, or may be plagued by some interfering signal, such as hum, oscillation (squeals), or noise; a control device may lack sensitivity or the relay may tend to chatter.

As a general rule, the failure of a project to work at all is the result of causes a, b and c, and, less frequently, d. If the completed project works after a fashion, but its performance is not quite as expected, the causes are generally d and e, although improper performance may result from causes a, b and in some cases c.

Where a project has been assembled from a commercial "kit" rather than from published plans, the more common causes of trouble are a, c, and e, although b may be the culprit if wiring or value color-codes are misinterpreted. Frequently, circuit defects c are the result of sloppy soldering or the use of acid-core rather than rosin-core solder. An "open" may result from a *rosin* or *cold-soldered* joint, a "short" from excessive solder which bridges closely spaced terminals.

Proper soldering is extremely important. If a joint is not heated adequately, a bond may be made by solidified rosin flux rather than by the metallic solder. The rosin has a high resistance and causes an "open" connection. A high resistance connection may also result if a soldered joint is disturbed before the solder has a chance to solidify . . . here, the solder crystallizes and the joint has a frosty-white appearance.

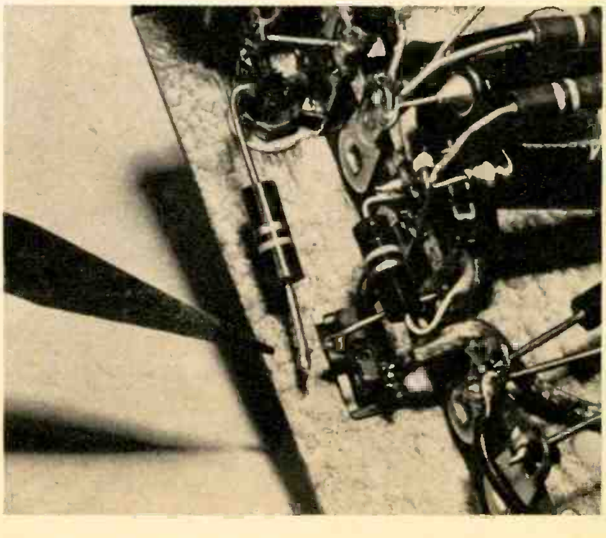
Avoiding Trouble

That old adage . . . "An ounce of prevention is worth a pound of cure . . ." is as true as always. Just as "debugging" a house is made easier if most of the insects are kept out by adequate door and window screens, so is "debugging" an electronics project made easier if care is taken during initial assembly and wiring.

More experienced hobbyists . . . those who have successfully completed dozens of projects . . . generally follow a few important rules during their work. If you're an "old hand," chances are you follow these rules without realizing it . . . if not, you'll find them extremely valuable in avoiding trouble. Several of these are illustrated in the photographs.

● *Use specified components.* If assembling a unit [*Continued on page* 106]

Watch out for opens! These turn up in broken connections, "cold-soldered," or "rosin" joints.



Electro-Magic

By Paul Harvey

YOU can amaze your friends, startle your neighbors, and even teach basic magnetic theory with this easily constructed device. Ideal as a science fair project, the entire unit can be put together in a couple of well spent evenings in your workshop.

The simple demonstrations outlined in the following pages are but a few of the possibilities; the number of things you can try is limited only by your imagination.

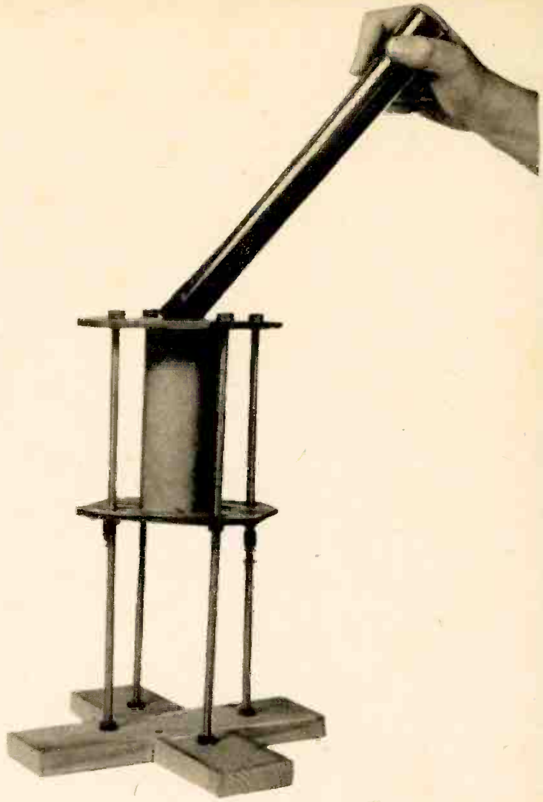
Science Fair Project

Construction

Three one-pound rolls of No. 16 Formvar-coated copper wire are required for the coil. If a slow lathe is available, mount the form on the lathe using an inside chuck at one end and a cone-center at the other. As the lathe rotates, let the wire slip through the folds of a piece of cloth held tightly between your fingers. This removes the kinks and bends in the wire, forming a professional looking coil. If you cannot get at a lathe, the coil may be wound by hand, using the same method to straighten out the kinks as you go along. After one layer of wire is on the form, continue winding in the same direction, going back along the form the other way. No additional insulation is necessary as the Formvar insulation is safe up to 350 volts.

When the first one-pound roll is in place, wind a few turns of plastic tape around the last few turns to hold them in place while you solder the end of the next roll to the first. Scrape the Formvar off *cleanly* with a sharp knife or razor blade until the copper is bright and shiny. Lay the two ends alongside each other with a ¾" overlap. Solder both sides of the overlap securely, insulate the splice, and continue the winding. The same soldering step must be repeated once more when you add the third one-pound roll of wire.

The coil is given a finished appearance by adding a pair of binding posts to terminate its ends. A single layer of plastic tape is wound over the coil windings. Over the tape wrap two or three layers of heavy wrapping paper secured with rubber cement. The paper and tape help protect the coil against damage, as well as give it a smooth, finished look. The threaded steel rods are passed through the holes in the end plates for form legs. Tighten nuts cautiously to avoid warping the plywood. Then set the legs on the cross-base and mark the arms of the cross for holes to

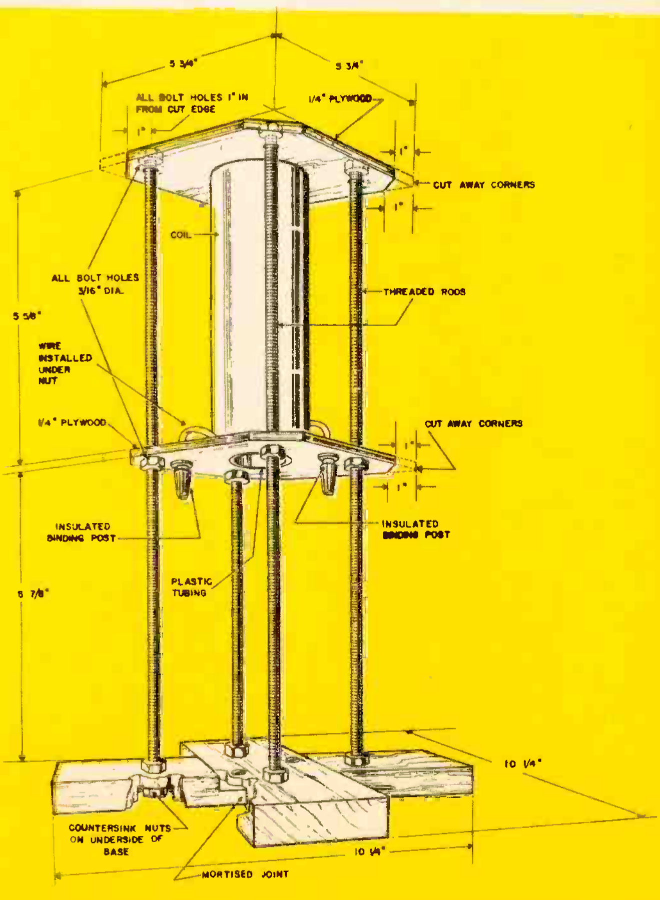


PARTS LIST

3 lbs.—Formvar-coated copper wire, B & S gauge #16, in one lb. rolls
6 inches—Bakelite tubing, 1½" o.d., 1⅜" i.d. Industrial Plastics Supply Co. 324 Canal Street, New York 13, N. Y. for: Bakelite and Plexiglas tubing cut to size. (75¢ postpaid for the Bakelite tubing $1.50 postpaid for the Plexiglas tubing)
12 inches—Plexiglas (lucite) tubing, 1¼" o.d., 1⅛" i.d.
2—plywood end plates, ¼" pine or fir, 5¾" on a side
1—tube of cement
2—insulated binding posts
4 inches—spaghetti tubing, large enough to slip over overlapped solder joint in #16 wire
1 roll—vinyl tape
1 pc.—heavy wrapping paper, about 6"x10"
2 pcs.—firring strips, 2½"x¾" pine or fir, each piece 10½" long
4—fourteen-inch lengths of 3/16" threaded steel rod
16—hex nuts to fit the threaded rod
60—wire coat hangers, any thickness
1—line cord, standard 117 volt type

Other Supply Sources

Welch Scientific Supply Co., 1515 Sedgewick Street, Chicago 10, Illinois
Central Scientific Supply Co., for: 1 Seamless aluminum ring, 1700 Irving Park, Chicago 13, Illinois



Both wood plates should be drilled simultaneously to assure perfect hole lineup for the threaded rods. Roughen the Bakelite slightly with a coarse file where it meets the inside of each end plate, then glue to hold securely.

take the rods. Complete the assembly by fastening the legs to the base with countersunk hex nuts. Of course, variations on the above construction plans are permissible providing the basic idea is followed.

Assembling the Core

The electromagnetic core consists of a 12" length of Plexiglas (lucite) tubing, packed tightly with 12" rods cut from ordinary wire coat hangers. About 80 coat hangers may be needed; this is not nearly as prohibitive as it sounds. A ten-minute canvass of the neighbors should do the trick.

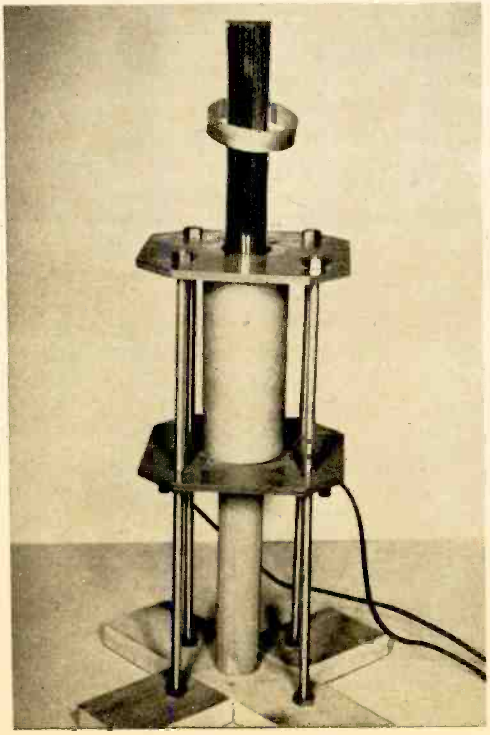
Push as many wires into the Plexiglas tubing as you can. They must be *tight* to prevent vibration once the current is turned on.

To make certain that your coil has no short-circuits, you can check its resistance (1.5 ohms) with an ohmmeter. Next, connect a 117 volt line cord to the binding posts, insert the core so that it rests on the cross base, and plug the cord into a convenient AC receptacle. (Never apply power unless core is at least partially inserted in coil.) With the core in this position, the current drain will be approximately 2 amperes. There should be a subdued hum and the core should show strong magnetic properties.

If you get these results, you are ready to perform the experiments that follow.

The Floating Ring

Additional Materials: You will need a 7" and a 11" length of 1½" round dowel (sold in lumber yards) and a seamless aluminum ring (see Parts List).
Procedure: Place the 7" dowel under the core so that it projects about 6 inches above the top of the coil. Apply power and gently lower the aluminum ring down over the core. The ring will float about 4 inches above the top plate. Press it down and feel the repulsive force. Notice how hot the ring becomes, especially when held down.



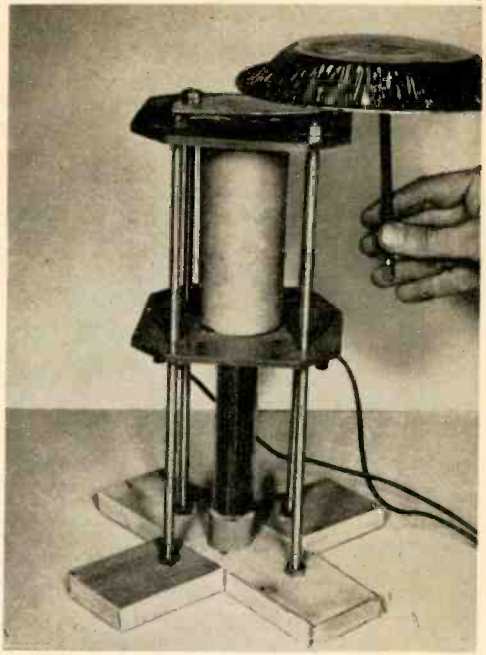
Explanation: The ring is a closed loop of extremely low resistance. The voltage induced in it by the coil is enough to develop over 100 amperes in the ring. This tremendous current generates a magnetic field of its own, opposing the fluctuating field caused by the primary current causing the ring to float.
Alternate Procedure: Prop up the core on the 11" length of dowel so that it projects about 10 inches above the top of the coil. Set the aluminum ring down over the core. Apply power momentarily by a fast plug-in and unplugging action; or connect a heavy-duty push-button switch in series with one leg of the AC line to the coil. When power is applied momentarily, the ring will leap several feet in the air as though propelled by an explosive charge.
Explanation: The induced ring current for this core position is much greater than the previous experiment which results in a larger repulsive force and more spectacular action.

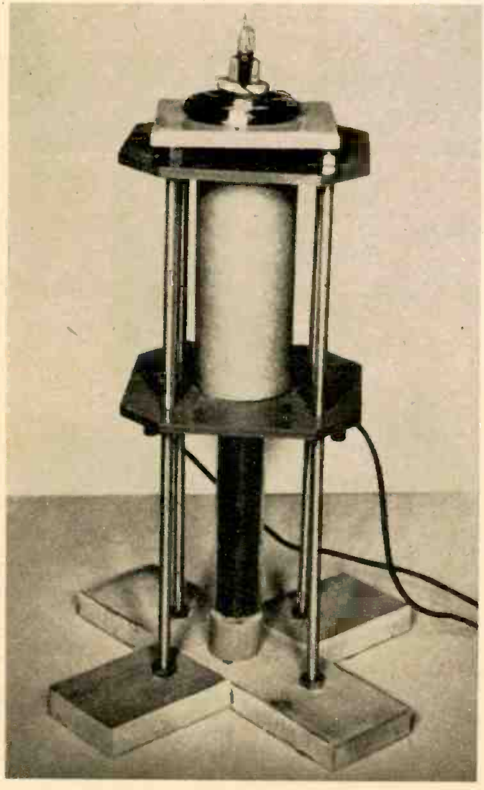
Pie-Plate Motor

Additional Materials: A flat sheet of aluminum (16 or 14 gage may be used; the thicker the better) is cut to 3″ x 4″ and then notched in two corners so that it can clear the hex nuts on the top end plate and still cover about half the core area. You will also need an 8-inch aluminum foil pie plate, a nail, and a sharply pointed pencil.

Procedure: Dent the center of the pie plate carefully to form a small depression for balancing on nail or pencil point. Insert the core so that it is flush with the top end-plate and bring the balanced pie plate down very close to it. When correctly placed, the plate will rotate.

Explanation: This uses the principle of "shading." The aluminum shading sheet distorts the magnetic field making it weaker in some places than in others. When the portion of the pan right over the core attempts to move from a strong to a weak field, rotation results.





The Wireless Light

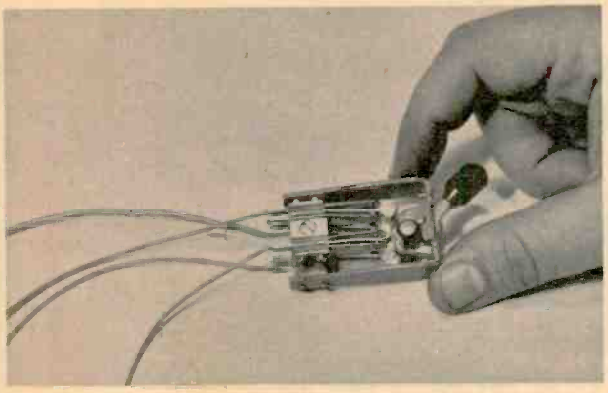
Wind a coil of 75 turns of No. 24 or No. 26 Formvar, cotton-covered, or enameled copper wire having an approximate diameter of 2.5 inches. This is best done by winding it, layer on layer, on the lower portion of a tapering glass tumbler. It will slip off easily when finished. A few narrow strips of masking tape hold the coil together. Clean the insulation from the ends and attach a miniature screw-base Mazda socket to the coil terminals. Screw a 2.5 volt flashlight bulb into the socket. Place a 1″ thick block of wood under the core so that the latter comes up flush with the top end plate.

Procedure: Lower the 75-turn coil down toward the top of the core. The little bulb should light when the coil comes within an inch or two of the core. You can stand the coil on an obvious insulator such as a ceramic tile (see photo) or a plate of glass without affecting the action.

Explanation: This is the principle of a step-down transformer. Current is induced in the [*Continued on page* 98]

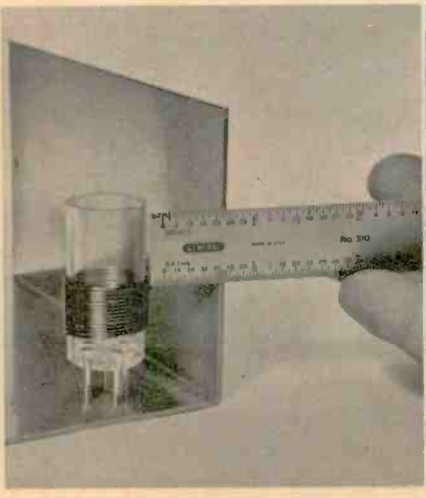
Construction Kinks

By Len Buckwalter

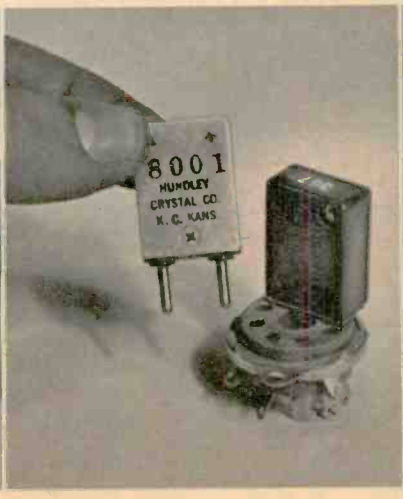


Always attach the leads to a multi-contact switch before installing it in the chassis. Otherwise, lug soldering will be impossible.

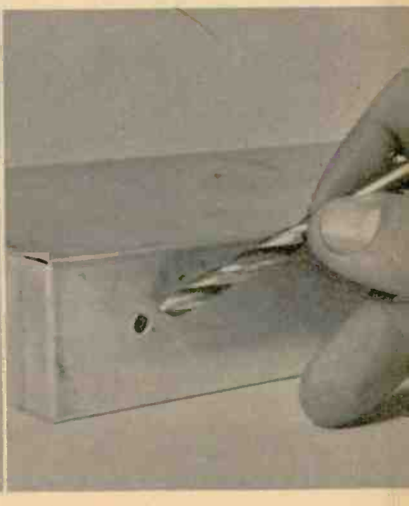
To increase chassis heat dissipation when using power transistors, dissolve all the chassis paint all around transistor mounting points.



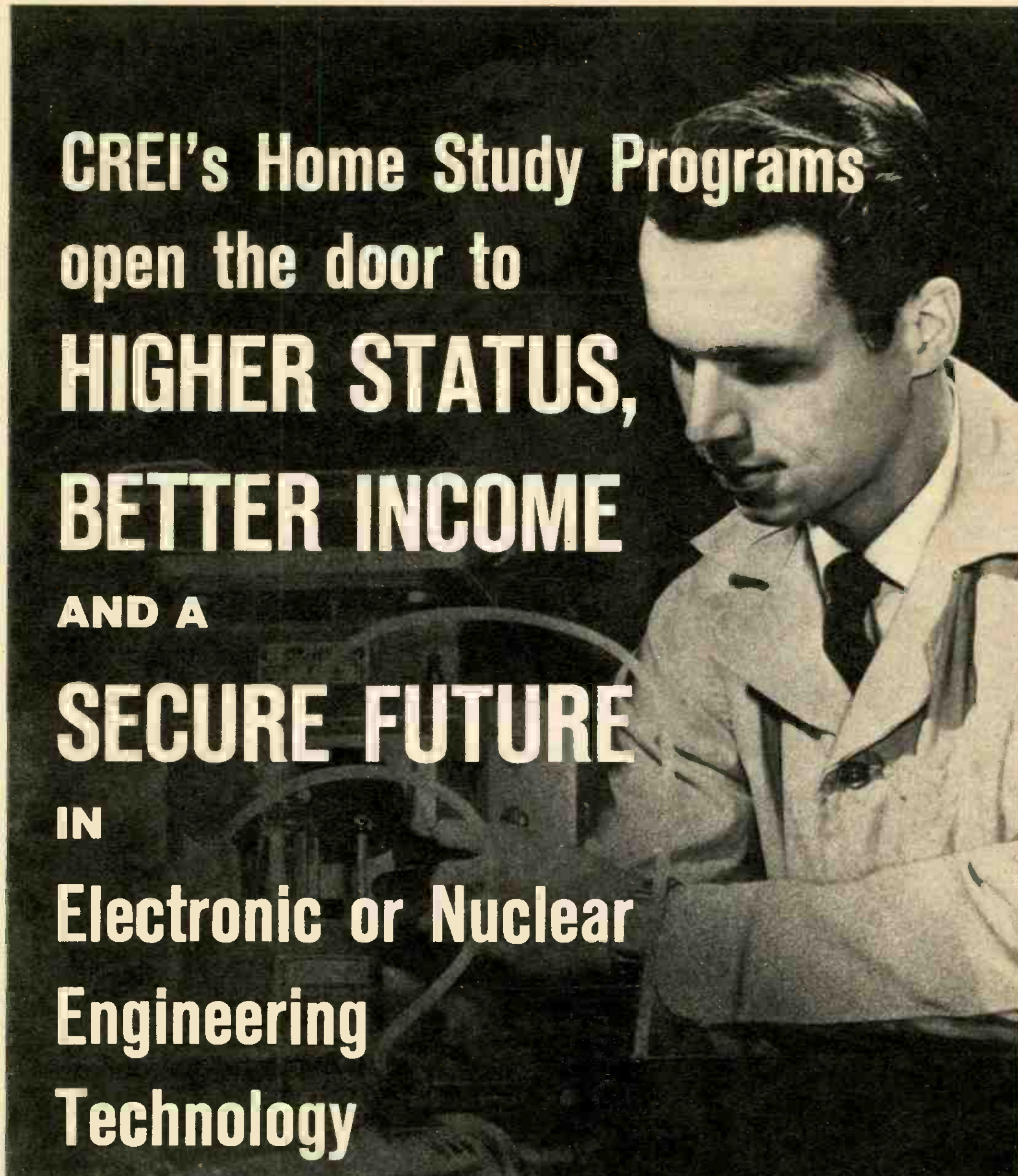
Keep RF coils away from metal chassis surfaces, otherwise the "Q" of the coil will drop considerably and losses will occur.



An octal tube socket is a perfect holder for the popular FT-243 size crystal. One socket will hold two crystals.



Jagged burrs found around drill holes can cut cables. To remove these: hand-rotate a 1/4 inch drill bit on both sides.



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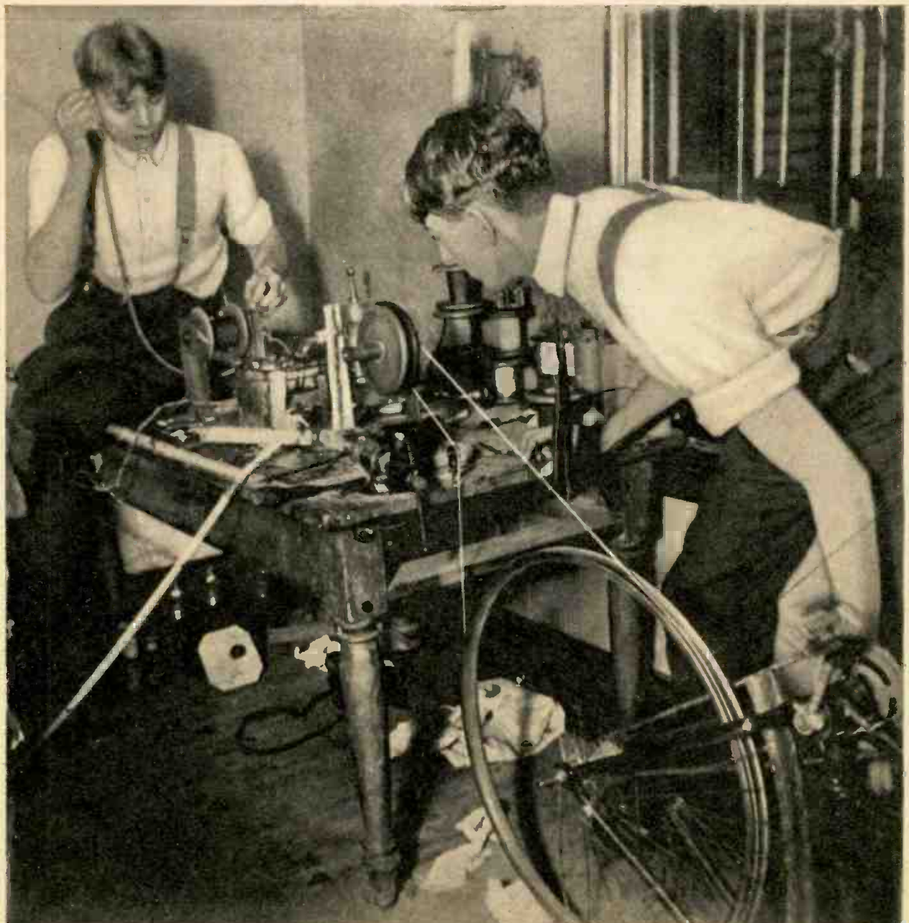
Memories of an Old Timer

Here is how they did things in those good old days when hamming was new, strange and a barrel of fun!

By Walter B. Weber, K2EE

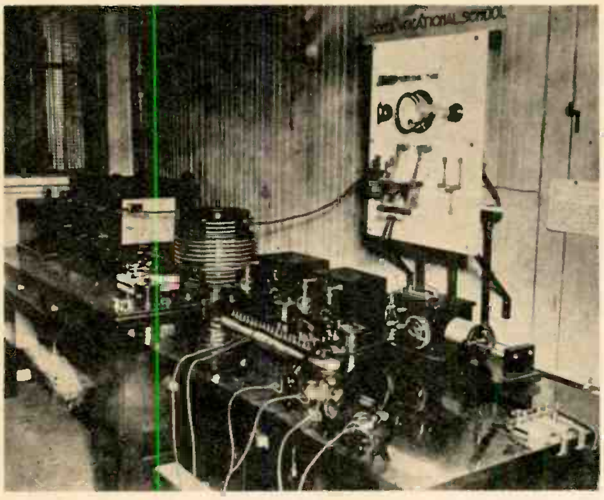
AFTER 45 years as a radio amateur, I am afraid that the public and younger hams of today are poorly informed about how amateur radio came into being. We are losing contact with a romantic past which is rich in lore, and we're neglecting the present as well. I think every amateur should do what he can to foster the hobby as it stands at present.

As a retired Professor of Electricity and Radio from New York State's University of Education, I look back to 1915. It was in that year that I started teaching a wireless course at Seneca Vocational School in Buffalo, New York. I now find that



Snapshot dating back to World War I shows half a bicycle being used to supply power to a gosh-awful gadget that is . . . you guess! Give up? Why, it's a code practice setup, that's what!

This was amateur radio station 8TM (there were no prefixes back then) at the Seneca Vocational School in Buffalo, N. Y., about 1916.



Navy code class is taught at Seneca during days of World War I. Author pounds key at center of table. Navy coordinator is at left.

this was the first such course taught in a public school in the United States.

Anyone having a 1916 call book will find the school station listed as 8TM under my name (my personal call was 8JJ). The photo just above shows the school's equipment. It consisted of a one-KW, 15,000-volt transformer, an 18-inch square plate glass capacitor, rotary spark gap, a 12-inch helix tuning coil, a large marble switchboard with (no less!) a *hot wire* ammeter for measuring the radio-frequency current.

The receiving apparatus had a one-tube detector in one case, a two-stage audio amplifier in another, a *loose coupler* for tuning and headphones. Loudspeakers were not used at this time. The tubes were of the Western Electric candelabra screw-base type.

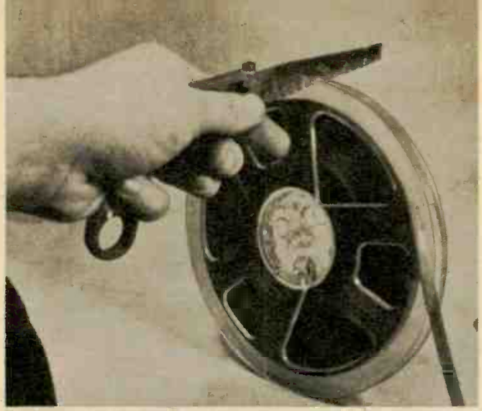
The call book at that time listed about 3,500 amateurs. Each station was alphabetically listed twice, once by call letters and again by name. Today such a call book, with 200,000 amateurs in this country alone, would be about three inches thick, or thicker still if foreign hams were included.

My first amateur radio experiments were in 1903. With an iron filing coherer operating a sensitive relay and a sounder, I was able to receive CW signals. I used a two-inch spark coil for transmitting.

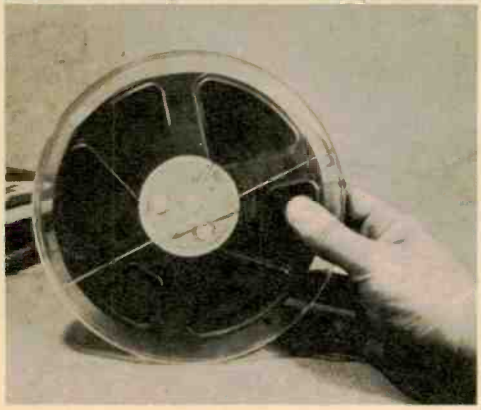
I wonder how our mothers or XYLs of today would react to a two- or three-inch spark flashing in a rotary gap, making a sound like a machine-gun? I remember the time when I was told to either put that noise-maker in the cellar or the clothes closet, or else.

When radio tubes came into use, the DC plate power supply battery was usually homemade. Some 50 glass test tubes were encased in wax and placed in a small box. The battery plates were made of thin strips of lead. Holes were bored in the strips to hold the red lead paste for the positive plates and the yellow lead paste for the negative plates. One plate of each type went in each test-tube cell. A 20 per cent solution of sulphuric acid was used for the electrolyte. (Some amateurs dismantled old Edison storage batteries. Small sections of their plates were used for the elements.) A quart fruit jar with strips of aluminum and iron and a solution of baking soda became a charging rectifier. The charger was usually left on continuously.

One of the earliest radio tubes was the Audiotron. This glass tube cost $5 or $6, [*Continued on page* 108]

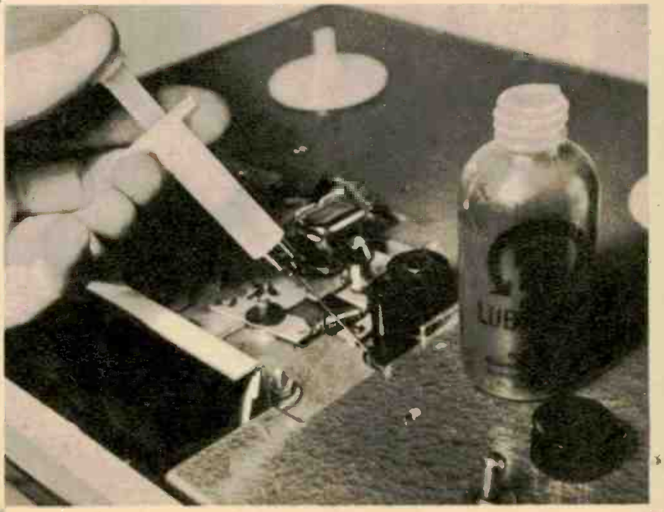


Tape Tips



Are you tired of trailing long streamers of tape behind whenever you have to move a couple of unboxed reels? Cut a slot through both rims at opposite sides of the reel. This will enable you to slip on a rubber band as shown which will grip the tape securely. It would be best to slot blank reels and wind the tape on later. Depth of cut depends on amount of tape used.

A disposable penicillin syringe which doctors throw away after use, can be a very usable addition to any tape recordist's cleaning and lubricating kit. Syringe will give you accurate control of fluid even in recessed places.



Do you have short pieces of recording tape which you want to save? Instead of tying up a regular reel, use an empty adhesive tape spool, and snap it back into its cover. Add an identifying label, or write on the metal with a grease pencil. Spool is also good magnetic shield.

Continued from page 33

buried telephone cables can be cut at any point along their length but sub-surface radio is vulnerable at only two specific points.

Our missile bases, now being outfitted with underground launching pads, or silos, apparently will soon be equipped with underground communications as well. While earth-current signaling systems are much more expensive than above-ground radio links, they still are cheaper than buried telephone cables which, as mentioned, cannot offer a greater amount of security.

The idea of using earth currents for wireless communications was first suggested by two German scientists in 1909. Some of the people most interested in the concept were Frenchmen, who a few years later were able to use it against the Germans in World War I.

As the old story goes (perhaps embellished a bit through the years), the Germans in their march toward Paris cut off and surrounded a French unit. Since the walkie-talkie was still a good many years off, the Frenchmen desperately needed a way to contact their main forces. A runner dramatically sneaked through the Hun lines and told about an earth-current signaling system his buddies had rigged up by hooking their telegraph to two bayonets driven into the ground six feet apart. The arrangement was duplicated on the spot and soon the surrounded men were directing their own rescue.

Equipment used today is not quite so rustic, being entirely conventional in circuit design. Frequencies range from 400 cycles (a new low for electromagnetic wave propagation) to 50 kc. Transmitter power goes from 100 watts to a kilowatt. Receivers employ peak clipping to eliminate large pulses of underground noise.

Two wave propagation theories enter the picture. One states that when electromagnetic waves traveling in a dense medium (earth or water) encounter a less dense medium (air) they tend to change direction and follow the interface between the two media. When a buried antenna pumps electromagnetic waves into the earth they radiate in all directions. Most of them dissipate rapidly. Something else happens to those waves which reach the surface, however. An electromagnetic field is established immediately above and below the interface. The part of the field above the interface is in air (a relatively good propagating medium) and is able to sustain a portion of the signal in the earth (a poor medium). A buried receiving antenna intercepts this underground signal.

Long-wire antennas are used for transmitting, aimed in the direction of the receiving station. The waves are nearly non-directional but have a slight tendency to favor the direction the antenna is pointed, several hundred feet beneath the surface.

A second underground radio system uses signals propagated entirely within the earth and thus is impervious to jamming and atmospheric noise. In this approach, signals are fed into a dry rock substratum, a relatively good propagation medium, compared to moistened earth. The wet, conductive layers of the earth act as a shield while the dry layer passes the signal as would a waveguide.

To attain any distance in underground communications a great deal of power is required, so much that any comparison with the power required for overground communications for the same distance is pretty one-sided. Maximum usable range now is thought to be 100 miles. Besides inherent propagation difficulties, the earth offers other communications hazards in the form of plain noise, made up of its own magnetic field currents plus all the grounds of nearby 60-cycle AC power systems. The low frequencies are best for good communications underground.

Despite these drawbacks, Space Electronics Corp., Development Engineering Corp. and others are diligently improving antennas for greater directivity, coding messages for more efficient traffic handling, trying to solve the noise problem and experimenting with relay stations.

The work is being carried on because scientists are convinced that earth-current communication has a place, not only in military applications but for civilian use as well. Storms have no effect on the system, making it useful during such severe acts of nature as hurricanes, tornadoes and cyclones.

A company engineering a long pipeline in the Middle East is considering an earth-current system to connect its flow-control stations, which are about 50 miles apart. Instruments at these stations measure the rate of oil flow and transmit the information to other stations, which adjust valves accordingly. Microwave links are now used but this equipment, being above ground and unguarded, is notoriously susceptible to vandalism.

Should nuclear war ever come, earth currents might be the only thing to hold together a crumbling world.

Electro-Magic

Continued from page 88

small coil by lines of force from the electromagnet growing and decaying in synchronism with the fluctuations of the AC line current.

The Magnetic Dimmer

Additional Materials: A 100- or 150-watt lamp in a socket.
Procedure: Connect the lamp in series with one leg of the AC line going to the coil. Remove the core and apply power. The lamp will light to practically full intensity. Now slowly move the core into the coil and watch the lamp dim.
Explanation: Without the core, the coil has very little inductive reactance, hence virtually all of the 120 volts appears across the lamp. As the core is moved in, the inductive reactance rises due to self-induction. This causes an increasing voltage drop across the coil, leaving less current to light the lamp.

The Sucking Coil

Procedure: Lay the coil assembly on its side and prop up the top end so that the coil is horizontal. Pull the core out so that 8 inches of it project beyond the surface of the top end-plate. When the line cord is plugged in, the core will zoom back inside the coil like a pile driver.
Explanation: Forces acting on a core of an electromagnet are balanced only when the core is centered in the field. With the core protruding as above, a large centering force acts on the core to suck it back into the coil.

Magnetizer

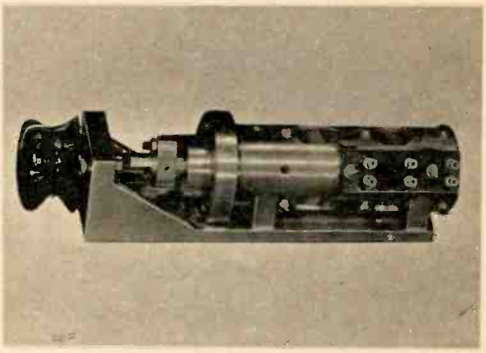
Additional Materials: A 6-volt DC source, preferably a storage battery.
Procedure: Connect the battery across the coil terminals for no more than 10 seconds at a time. Any steel object, such as a knife blade or screwdriver inserted in the coil and tapped sharply will become magnetized.
Explanation: The DC field causes the molecules (or domains) of the steel to line up facing the same direction. Each molecule is a tiny magnet and, when aligned, their tiny fields all add up.

See April *EI* for
RF Signal Generator

. . . New Products

Miniature Coaxial Tuner . . . The Technical Products Division of Emerson Radio & Phonograph Corp. has received a patent for a new type of inductive tuning device which was developed at its engineering laboratories in Jersey City, N. J.

The Emerson inductive tuner is rotary-axial in operation and provides close linear calibration and tracking of the RF and oscillator sections of a receiver with respect to the rotary-axial motion applied to the component.



The device is relatively inexpensive for the accuracy it provides and is inherently miniaturized, an important factor to be considered in the light of present trends toward reduction in size of electronic components in consumer, industrial and military equipment.

Only slightly larger than a flashlight battery, the tuner provides linear frequency tuning from 500 to 1600 kc.

—o—

Remote Dictation Machine . . . A new concept in business communications equipment which makes possible remote dictation and recording has been introduced by American Geloso Electronics, Inc., 251 Park Avenue South, New York 10, N. Y. Called Remote-Tape, the system consists of a pocket-size wireless microphone (actually a license-free transmitter operating on the Citizens Band), a receiver-control unit and an actuator installed on a standard Geloso Stenotape recorder. Effective range of the transmitter is about half a mile.

An important feature of the system is that the recorder runs only when the person carrying the transmitter talks into his mike. During periods of silence it reverts to stand-by. This makes it possible to dictate at interrupted intervals without blank spaces on the tape.

Another technical feature is a gating arrangement that permits only the Remote-Tape transmitter to actuate the receiver. Signals from conventional Citizens Band equipment will not trip the mechanism.

The first photo shows a wireless microphone unit in the foreground. The Geloso CB unit which serves as a receiver and control box appears at right, coupled to a Stenotape actuator which is mounted on top of the Stenotape machine. The second photo depicts a grocer taking inventory and dictating his findings to the recording unit which, one would suppose, is tucked away in a neat corner of the office.

Giaever's Discovery

Continued from page 73

Although now a fairly remote idea to the layman, Giaever's Discovery may in the future prove to have practical applications that will make it well known.

Giaever's Discovery is concerned with the electronic process known as tunneling, and with the ability of some metals to become superconductors. Tunneling is now a familiar term because of semiconducting tunnel diodes. The word describes this phenomenon: electrons traveling along a conductor are reflected when they hit a thick insulator, but if the insulator is thin enough a few electrons (or a portion of an electron wave) are able to tunnel through and flow into a conductor on the other side. Superconductivity describes a condition wherein certain metals become perfect conductors (offering no resistance) at extremely low temperatures.

Giaever began his experiment by crossing two tiny strips of metal on a microscope slide and separating them with an insulator only ten to 100 atoms thick. Electrons flowing into one strip tunneled through to the other. In this set-up the current on the far side of the insulator normally increases proportionally with the voltage (pressure) applied, as most any bright schoolboy could guess.

Giaever, who's just 31, made his discovery when he made the metal strips super-conductors by cooling them to liquid helium temperatures. Under these conditions, he applied voltage and found that his curve of rising current suddenly developed a wrinkle. At one point the current *decreased* as voltage increased, confounding all known theories and laws. Giaever had found an unexpected negative resistance.

What does it mean? Nobody is sure right now. One guess is that it will make possible a new family of electronic devices unequalled for their small size (see photo of Giaever's microscope slide).

For the device to be useful, its action must be controllable. Fortunately, this is no problem. Magnetism has the ability to cancel the superconductivity of a metal, forcing it to return to its usual resistive state depite its low temperature. By varying the amount of magnetism, one can vary the degree of superconductivity.

This control may make it possible for Giaever's tiny device to function as a switch, diode, negative-resistance diode, triode, resistor or capacitor—all adding up to a fair bundle of possibilities.

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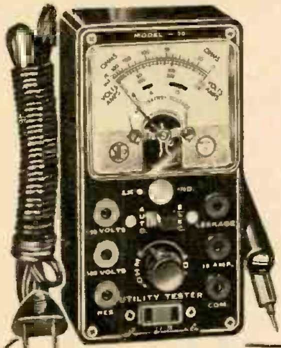

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☐ Include Model 82A Picture Tube Adapter at $5.50

Export Division: Rocke International Corp., 13 East 40th St., New York 16, N. Y.

4,800 WPM

Continued from page 69

Both transmitters and receivers are turned on continuously, waiting for conditions favorable for transmission of messages.

Degeneration of a meteor trail, signal fading because of interference and certain other possible factors cause the system to stop at once, and the apparatus at each end returns to its original frequency. Under normal conditions, the signals to start and stop are so timed that no messages are lost.

The receivers are double-conversion superheterodynes, each with an FM detector for messages and an AM detector to measure signal strength. A filter sets the receiver pass band to correspond to the modulation, while a second filter rejects signals from system's own transmitter.

The transmitters are commercial units operated at 49 megacycles with a power output of two kilowatts. Frequency control is by a direct, current-coupled, frequency-modulated exciter.

The antenna system consists of two arrays, each with two five-element Yagis. One array is used for receiving, one for sending. The two antennas of each array are fed out of phase to produce a directional signal. This makes it possible to aim toward an area most likely to produce meteor trails.

Performance was found to vary considerably with equipment settings and atmospheric conditions.

The system appears to operate most effectively at speeds of 2,400 words per minute (4,800 WPM if you add both transmissions together in a simultaneous exchange of data). This is 40 times normal teletype speed. At this speed, and with a suitable operating threshold setting, a daily average of 40 words per minute is achieved and yields an error rate of .35 per cent. Higher transmission rates will give better results as improved control systems and storage facilities are provided.

At lower transmission rates, noise interference causes much trouble since the signals have to remain good for a longer time before transmissions are completed, thus increasing the possibility of error.

The system is affected by confusion from two coexistent meteor trails, electrical storms, general atmospheric static and nearby ignition systems and power lines. Also causing interference is the existence of bits and pieces of ionospheric forward scatter and the sporadic reflecting effect of the E-layer. The aurora borealis causes trouble now and again.

In spite of its limitations, Meteor Burst Communication shows great promise of relieving some of the overcrowding that now exists on commercial short-wave bands. And it gets messages from here to there at an amazing speed.

Indispensable Bird Brains

Continued from page 64

as many as 250 six-foot relay racks, each rack housing more than 100 separate portions of the computer.

Interconnection of the component circuits is frequently complex. Some indicator circuits require the operation of more than 50 of the computer portions before giving one indication.

Rocket-testing equipment falls into two broad categories, relay logic devices and transistor trees.

In the relay logic series, ordinary multiple-contact relays are the key element. Tens of thousands of them are used. By itself, a relay can do little. But in conjunction with other relays, it can almost think. Here's an example:

With two single-pole normally-open relays connected in series (see Fig. 1) no current can flow through the contacts unless *both* relays (1 and 2) are actuated. Under any other circumstances current is blocked. Such a setup is known to computer engineers as an *and* circuit (1 must be closed *and* so must 2).

When the relays are connected in parallel (Fig. 2) current will flow through the contacts if either relay is actuated. This is known as an *or* circuit (1 *or* 2 is actuated).

By using normally-closed relays instead of normally-open ones, the *and* circuit becomes a *nor* circuit, as in Fig. 3 (neither 1 *nor* 2 is open if the through circuit is operating). With normally-closed relays the *or* circuit becomes a *not and* configuration, as in Fig. 4 (both 1 and 2 are *not* actuated *and* the circuit therefore is closed).

In transistor trees the work of the relays is done by semiconductors. These assemblies appear to be drastically different but they produce exactly the same results.

These four simple circuits can perform many complicated operations. When programmed, they can check out the most complicated rocket almost instantly.

Programming is simply the computer-man's way of describing the process by which the machine is given directions. However, since the machine can perform only four basic functions, directions must be specific.

For instance, you can't tell the computer, "Measure the thrust of the engine and report OK if it exceeds 30,000 foot-pounds."

The program for that test would be like this: "Connect to circuit No. 4. Compare voltage of this circuit with reference voltage No. 1. If it is more than .1 volt less than reference voltage report red on thrust indicator and halt countdown. If it is equal to or greater than reference voltage report green on thrust indicator and proceed to circuit No. 5."

Here's how that program is interpreted. In the first place, the machine can only compare voltages, currents and resistances. Thrust must be converted to one of these before the machine can measure it, so circuit No. 4 is the output of a transducer which does this conversion.

The reference voltage is built into the machine. It is exactly equal to the voltage the transducer produces at 30,000 foot-pounds thrust. Therefore, if the transducer voltage is less, the thrust is insufficient. If the voltage is higher than the reference, thrust exceeds 30,000 foot-pounds and the computer proceeds to the next step.

Instructions are fed to a computer as coded electrical signals. There are many ways of doing this. They include punched cards, in which each hole completes a certain part of the circuit; magnetic tape, which can carry dozens of commands at the same time and built-in memory units (previously-made settings) such as are used in general-purpose computers.

Each programming method has its place, and many rocket-checking devices use combinations of the three methods.

Present-day rocket-testing robots, though highly sophisticated, are but a sample of what must come. So, too, with rockets and missiles. The basic function even yet is to get off the ground here and return to it there, although satellite-launching is becoming a more important job as time goes by.

In the future, however, when men ride the big birds to destinations as far away as Mars and Venus and even another solar system the birdbrains will be required to take into account not only the performance of each tiny part of a missile itself but also precise measurements of time and the positions of the heavenly bodies in order for the ship to leave earth at the proper instant and on the proper course.

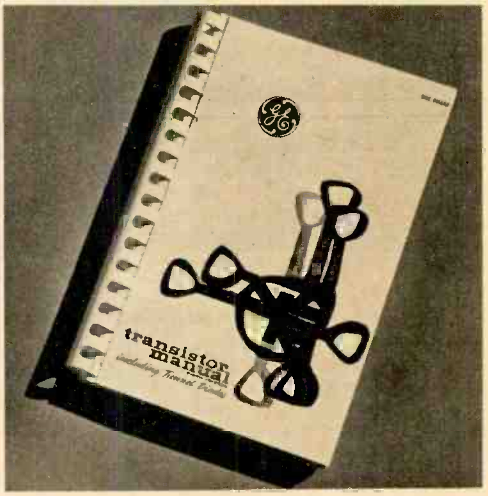
Meanwhile, our simple-complex birdbrains are helping make that future possible by doing their work well today.

New Literature

Replacements for Japanese Radio Transistors. A useful chart listing more than 100 Japanese-made transistors and their American counterparts. Free from Electronic Transistors Corp., 9226 Hudson Boulevard, N. Bergen, N.J.

—o—

Transistor Manual. Fifth edition of a spiral-bound reference work. Especially valuable to electronics experimenters and technicians who want to catch up on semiconductors. New chapters discuss tunnel diodes, switch-



ing circuits, feedback and servo amplifiers, test circuits, etc. 339 pages. $1 from GE distributors or directly from Semiconductor Products Department, General Electric Co., Kelley Building, Liverpool, N. Y.

—o—

All About Crossover Networks, by Howard M. Tremaine. A good book for audiophiles and service technicians who need to refresh their knowledge on the frequency-dividing systems used to channel sound signals to hi-fi speakers. 80 pages. $1.50. Available at electronic parts distributors and bookstores or from the publishers, Howard W. Sams & Co., Inc., 2201 East 46th Street, Indianapolis 6, Ind.

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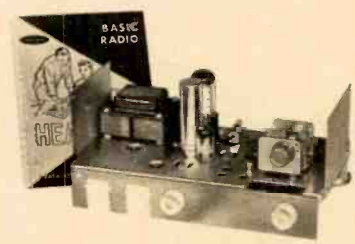

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Troubleshoot Your Project

Continued from page 84

described in a book or magazine article, obtain the components specified in the author's parts list. Don't make casual substitutions unless you're *sure* the substitute has the electrical and physical characteristics of the original part. If you employ one or more second-hand or used components, make sure these are in good condition *before* installation. When assembling a kit, be sure you've correctly identified *all* parts.

● *Double-check your wiring.* Follow *EI's* pictorial and the author's suggestions regarding lay-out and lead dress. If assembling a kit, check the step-by-step instructions against applicable pictorial diagrams. A good general rule is to check the schematic against the pictorial diagrams as you go along. If trouble occurs, have a friend check your wiring, for even the most capable of hobbyists (and professional technicians, for that matter) will repeatedly overlook simple errors. Observe color codes and circuit polarities.

● *Use proper soldering techniques.* Do a neat soldering job, using a hot, clean, well-tinned soldering iron and *rosin-core* solder. Use enough solder to insure a good joint, but not an excessive amount. Don't disturb a soldered joint or wiggle a connecting lead until the solder has "set." Avoid overheating sensitive components such as transistors, etc.

● *Watch for accidental "shorts."* These are avoided easily when wiring but may be difficult to locate when a project is finished. Use insulating spaghetti tubing on bare component leads and watch for shorts caused by scraps of stranded wire or drops of solder.

● *Make recommended adjustments.* Once a project is completed, make any necessary circuit adjustments, using the techniques *and* equipment recommended by the author. In the case of control devices, these adjustments may include a setting for "sensitivity," and adjustments of relay contacts or spring tension. In the case of superhet receivers, IF and RF *alignment* is a "must." If you don't have, or can't borrow, the necessary equipment for this job . . . or if you're not sure of the proper technique to use, turn the job over to a technically inclined friend who has more experience and access to the necessary test gear. In any case, don't try to make adjustments at random . . . be sure you know what you're doing, for improper adjustment may lead to serious trouble and hard-to-correct defects.

Troubleshooting

Suppose you've observed all the "rules," used the specified components, and have taken real pains in your wiring and soldering . . . and the project still fails! What next?

Don't despair. If you've paid attention to details, chances are the defect is a simple wiring error that will be found when a friend double-checks your wiring . . . or when you double-check it yourself after a "breather." In some instances however, trouble may be caused by defective or off-tolerance parts, even when new components are used.

After the wiring has been rechecked, test any "plug-in" components, such as vacuum tubes, transistors, or batteries. If you don't have test equipment, you can use simple substitution techniques . . . simply replace suspected parts with components known to be in good condition.

Next, check circuit operating voltages. Use a standard VOM for this job, checking power supply as well as individual stage voltages. If a lower than normal voltage is obtained from the power supply, it indicates either a defect in the power supply itself or a partial short in circuit wiring or in one or more components (causing an excessive load). Batteries, if used, should be checked *under load* with the circuit turned on. Weak batteries should be replaced.

Stage voltage measurements generally are made with respect to a common electrode in transistor circuits. For example, base (B) and collector (C) voltages are measured with respect to the emitter (E), as shown in Fig. 1(a). The polarities shown are for PNP transistors, these would be reversed in the case of NPN units. In tube circuits, voltage measurements are made with respect to ground, and include tests of grid bias, plate voltage, screen grid voltage, and B-plus. A DC voltmeter is used for all of these measurements, but the AC ranges are needed for checking filament voltage . . . except in portable (battery-operated) equipment.

When making voltage tests, watch for *major* differences from expected values. These will give a clue as to the source of trouble, indicating either improper stage operation or a defective part.

Depending on your project, try to isolate the trouble to a specific section. In a receiver, for example, you can treat the RF and audio sections separately, using an audio generator (or other signal source) to insert a test signal into the audio section. If the audio section is working normally, you know that the trouble is in the RF circuitry.

Once the trouble is isolated to a specific section and stage, the parts and wiring in that stage may be checked in detail.

In general, failure of a project to operate at all is the result of a dead stage(s) and may be caused by lack of operating voltages due to an open, short, or by the complete failure of a specific component. Improper operation (distortion, lack of sensitivity or selectivity, etc.) is the result of incorrect operating conditions, such as abnormal voltages (low or high), off-tolerance components, weak tubes or transistors, or leaky components. Hum, noise, or oscillation generally is caused by open by-pass capacitors, improper lead dress, ineffective shielding, poor layout, or, in some instances, incorrect alignment.

If your troubleshooting results in a "dead end," put the project aside for a few hours . . . or even days. Often, a fresh approach with a clear mind will help you isolate the trouble in jig time.

Electronic Dust Control

Continued from page 81

devastating effect. They're still in the air at this point but too small to cause trouble.

The power supply measures only 17x10x9 inches and looks like a good-size hi-fi or public-address amplifier. The screens require a foot of space in the duct.

The high-frequency pulsating DC produces no radio or TV interference unless the set is six inches from the power supply.

Statronic installations have been made in such places as the IBM world headquarters in New York; the Eastern Air Lines, Pan American, and United Air Lines buildings at Idlewild International Airport, and Carleton Hotel in Pittsburgh.

CRS Industries intends to introduce small, low-cost Statronic units for the home some time in the future. Home devices with somewhat similar names now on the market are advertised only as odor destroyers. They operate on a different principle, using ultraviolet light to generate ozone (an active form of oxygen with three instead of two atoms in the basic molecule) which either oxidizes or masks the odors. Ozone has a distinct pungent odor of its own. In some localities these units have been outlawed because the breathing of too much ozone is considered dangerous. The Statronic system generates no ozone and does not fall under this ban.

Memories of an Old Timer

Continued from page 95

depending on whether it had one or two filaments. Solid wires leading out of one end were the connections to the filament, and at the other end were wires for the plate and grid. The tube was held on the panel by a spring clip. Great care had to be exercised in handling these tubes because breaking a lead wire close to the glass meant a loss of several dollars. The second filament was used when the other one burned out. (In those days the question of finance was important, the theory being that to increase the range six miles another tube had to be added!)

The early detectors were of the carborundum and electrolytic cat-whisker types. My brother, who was a wireless operator on the battleship New Jersey, tells of his experience with an electrolytic detector. It consisted of a very small wire (cat-whisker), the point of which was immersed in a small cupful of liquid. When it was carefully raised (and just touching the surface) a small pointed "wave" was formed at the tip by capillary action. This made the detector more sensitive. However, every time a gun was fired the wave broke and the detector had to be readjusted.

[*Editor's note: Why don't you try this idea? Use a metal cup and a small sharpened wire in place of a crystal detector (this is a diode, you know). For an electrolyte, try things like lemon juice, diluted battery acid, etc. With plenty of strong signals on the air today, you should have no trouble and lots of fun.*]

During World War I the Seneca Vocational School was designated by the Navy to train radio operators. I taught code with a rather strange piece of equipment. Keying was at first made audible by a high-frequency buzzer. But we all know how inefficient buzzers are for code practice. A homemade contraption saved the day.

Five old DC motor armature discs were fastened to the shaft of a DC speed-controlled motor. Next, the cap and diaphragm were removed from an old telephone receiver. The pole pieces of the receiver's permanent magnets were fastened as close as possible to the teeth on the edges of the rotating discs. The moving disc teeth disturbed the magnetic field and caused a pulsating current to be induced into the magnetic coils. The frequency was adjusted by changing the speed of the motor. This current was keyed to 25 sets of headphones. Drive power was supplied by the rear half of a bicycle with the wheel turning a belt.

That was radio—crude, unscientific, interesting . . . and the only kind there was—in those far-off days that we've almost forgotten.

Hams have demonstrated how person-to-person contact crosses boundaries of race, religion, politics and distance. It strengthens good will throughout the world.

We should be proud of our amateur fraternity and use every opportunity to further its cause. We must operate in the public interest in order to continue justification of our existence. Let us not for one moment operate in such a way as to antagonize the public, but rather demonstrate that we appreciate the privileges we have.

All About Electroplating

Continued from page 48

into the solution to replace those lost at the cathode, and the electrons travel up the anode bar to the positive terminal of the power supply. The DC power supply acts as a pump that circulates these electrons through the external circuit from the anode to the cathode.

The copper anode gradually erodes as it supplies copper ions to the object to be plated. The solution remains unchanged since the anode supplies a new copper ion each time an ion is deposited on the object being plated. The cathode takes on the same number of ions (now combined with the electrons to become atoms) that the anode loses.

Construction

Transistor Q1 is mounted on top of the chassis which serves as a heat sink. The case of Q1 (collector) must be insulated from the chassis using a commercially available power transistor mounting kit.

The collector lug of Q1 should not be connected until wiring is complete. After wiring is completed, apply the input voltage and check that the polarity of the lead going to the collector is negative. If correct, bolt the lug to the collector and test to see that R1 controls the output voltage at J1 and J2 from zero to —14 volts. If all is satisfactory the unit is ready to connect to the plating tank.

Next month we'll continue with instructions for using the Electroplater and some hints that will give your plating jobs a professional look.

From Tape to Turntable

Continued from page 54

vised a method of heating the stylus so it cuts through the lacquer like a hot knife through butter.

In cutting the master disc, a log is used. All instructions for engineers are noted and each movement of the musical work is timed to the fraction of a second. With the tape on the deck, a fresh blank is placed on the turntable of the cutting lathe, and the tape-to-disc operation begins.

First, a few revolutions are made with the stylus describing a steeper-than-usual spiral to lead your needle into the record (the stylus here carries no sound). At just the right spot on the record the signal from the tape is cut in and the actual transfer of sound from one medium to another begins. The sound is monitored by many people, of course, and in the case of symphonic music when the end of a movement is reached the producer signals "Spiral," the engineer speeds up the worm gear and the stylus cuts several revolutions carrying only room noise. This makes the separation between movements on a record.

When the final grooves are cut the stylus spirals right up to the label so that an automatic tone arm, if used, will be actuated. Care must be taken not to cut program material too close to the center since this can cause inner groove distortion.

When there are passages that are in doubt, a test cutting is made of that part and played back at once. If approved, the setting are noted and incorporated later when the master is cut. The actual working master, though, is not played back at all for fear of damaging the grooves.

The master disc is sent to the factory, where it is sprayed with silver (much the way a mirror is silvered) to make its surface conductive. Then it is placed in a chemical bath and plated with nickel. With a good metallic surface, the master is coated (again by electroplating) with a much thicker layer of copper.

The copper negative is stripped away from the master disc and, though it could be used for pressing, it rarely is. Instead, the negative is used to make a positive "mother" which is in turn used to form the necessary number of dies or stampers. The mother is a positive with the grooves the way they will appear on the final disc. Therefore, the mother is carefully checked and, if needed, etched by hand to retouch the grooves. This is done by an expert working with a microscope.

The number of stampers needed is determined by the size of the run planned. There is a limit to the number of quality pressings that can be made from any one stamper.

The stampers, actually copper negatives, are mounted in presses and test pressings are made. These are carefully checked by the producer in playback after playback. If they pass, the stampers are approved for the production run.

A vinyl "biscuit" is fed into the press with the two appropriate labels, heat and pressure are applied and out comes the finished disc. The record is trimmed of any excess vinyl while it is still warm, inspected and packed by a staff of white-gloved technicians.

As a further check, random samples are taken all through the production run and subjected to additional quality checks.

We tend to take the high-fidelity, noise-free performance of modern LP's for granted but producing them takes an infinite amount of care.

Short-Wave Converter

Continued from page 72

This produces a coil with a tap (terminal B) and the other two terminals are A and the coil base which is automatically grounded when mounted on the board. Cement this winding in place and then wind an additional 10 turns of #38 over the top of the original coil. This winding is L2 and about 1" of wire at both ends should be left free. Next, wind 10 turns of #38 over winding L3. This additional winding becomes L4. Leave both ends of this coil free, also.

Modify coil L5 (A and B) by adding 40 turns over the top of the winding. This coil is shown as L5 (C and D) in the schematic.

Next, solder the transistors, capacitors, resistor, crystal, and coils directly to the circuit board, in that order. Use a pencil iron to avoid overheating the board and grip the transistor leads with a long-nose pliers to remove heat from the junctions. All the components are mounted on the board on the side opposite the printed wiring. The shield lead on the OC171 should be cut short and bent out of the way.

The circuit board is mounted in the box as shown in Fig. 1. Be sure to drill holes in the plastic box slowly or it will crack. The board's mounting bolts serve as the ground terminals. All wires to the various terminals and the battery should be connected before the board is installed. The input terminal (from the antenna) is marked S1A, and the output eyelet is S1C.

Testing—Connect a 0-10 ma meter across the terminals of S1 (with the switch off) and measure the transistor current. It should be between 6 and 9 ma. Touch the top terminal of the oscillator coil L3/L4. If the current rises noticeably it indicates the oscillator circuit is working properly. If the current is slightly higher than normal, or if you do *not* note an increase when you touch the coil, adjust the slug of the coil until a dip in current is noted. Once this position is found, the coil need not be adjusted further.

To check performance, connect the converter to the antenna terminals of your receiver, and an antenna exceeding 20 feet to the input terminals of the converter. By tuning across the band you should receive shortwave stations. Adjust the slugs of coils L1/L2 and L5/L6 for the loudest signal strength. If you also hear broadcast stations, it indicates your receiver does not have adequate shielding.

You may also use the converter with radios having a built-in loop antenna system by connecting it as shown in Fig. 2. Connected in this manner it eliminates pickup from the loop. Note that the ground end of L6 must be disconnected from the circuit board.

Notes—The crystal determines the frequency at which the shortwave stations appear on the radio dial. Any crystal between 6.5 and 7.5 mc. will allow you to receive the 49-meter short-wave band. The exact frequency is not at all critical.

If you would like to pick up other bands, the crystal and coils will have to be changed. A detailed explanation of how to accomplish this will be found in the *ARRL Amateur Radio Handbook*. Complete coil and crystal data is given. Any PNP type transistor with a 30 mc alpha cutoff will work in the circuit. The printed circuit plate specified in the parts list need not be used, a perforated board with flea clip terminals will work as well.

THE 49 METER BAND

Location of the 49 meter broadcasting band is shown in diagram on page 70. The stations shown have the strongest signals on the West Coast, although there are many other weaker ones. The European stations, in particular, should be well received on the East Coast. Voice of America stations (VOA) are quite prominent because of their high power. The best time to receive stations on the 49-meter band is around sunrise.

Frequency Spotter

Continued from page 67

oscillator. A high-frequency transistor Q1 is connected in a grounded-emitter configuration. Collector voltage from B1 is applied to Q1 through RF choke RFC1. Forward bias is fed to the base of Q1 through R1. The crystal, which determines the frequency of oscillation, is connected between collector and base. When the crystal is inserted in the circuit, current flows between collector and base through the crystal. The base signal is amplified by Q1 and appears across RFC1 which acts as a tuned circuit for all frequencies. The highly-amplified signal is again fed to the base and Q1 breaks into oscillation. In effect the crystal acts as a coil and capacitor in determining the frequency of oscillation. Inserting the crystal will cause the Spotter to produce a signal at the desired frequency.

One exception is overtone crystals such as used in Citizens Band equipment. These crystals operate at two or three times their actual frequency and will only oscillate on the fundamental in the Spotter. Since the overtone is not an exact multiple of the fundamental (due to circuit characteristics) these crystals can not be used for accurate calibration work.

FM Wireless Microphone

Continued from page 31

pedance position. A high impedance microphone can be substituted with an input matching transformer with about a 250 ohm secondary. You can even play records through your FM set if you use a magnetic cartridge. (The load impedance will be approximately correct.) Mount a phono jack in the plastic bowl and parallel the input with that from the microphone.

A perforated board with flea clip soldering lugs serves as a chassis. Standard transistor sockets are mounted in holes drilled in the board. Gimmick capacitor G1 is formed by tightly twisting together two 1" insulated leads and connecting them to the collector and emitter lugs of socket Q2.

Coil L1 has its two ends soldered directly to flea clips. Tuning capacitor C4 is also soldered directly across the same two clips, but on the opposite side of the

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perforated board. Since C1 and L1 together establish the frequency of oscillation (broadcast frequency) the exact spacing of L1 must be established for operation at the desired spot on the dial. Buss bar (12-14 gauge) is formed into a coil as shown in the pictorial. Overall coil length is about ¾″ with a ⅜″ internal diameter, but you'll probably have to compress or expand the coils slightly for correct tuning. This should be done with C4 set to about the middle of its capacity range.

The input stage of the transmitter uses a common-emitter amplifier Q1. Approximately —3 volts base bias is applied by 68,000-ohm resistor R1 in series with 33,000-ohm resistor R2. Q1's emitter is clamped to the base voltage (—3 volts) by 3,300-ohm resistor R3. This establishes and limits the emitter and collector current to 1 ma. R3 is bypassed by electrolytic capacitor C2 to prevent degeneration. T1 steps up the input voltage and modulates the signal developed by oscillator Q2. Q2 has collector to emitter feedback through G1. Resistors R5 and R6 form a voltage divider network that fixes the base bias on Q2 at about 1 volt. 680 ohm resistor R4 is the emitter load resistor for the feedback signal and limits the emitter and collector current to 1.5 ma. L1 and C1 determine the frequency of oscillation. The output of T2 is fed to the collector of Q2 changing the base to collector voltage and therefore the base to collector capacity. Since this capacity is in parallel with the tuning circuit, frequency modulation results.

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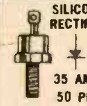

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