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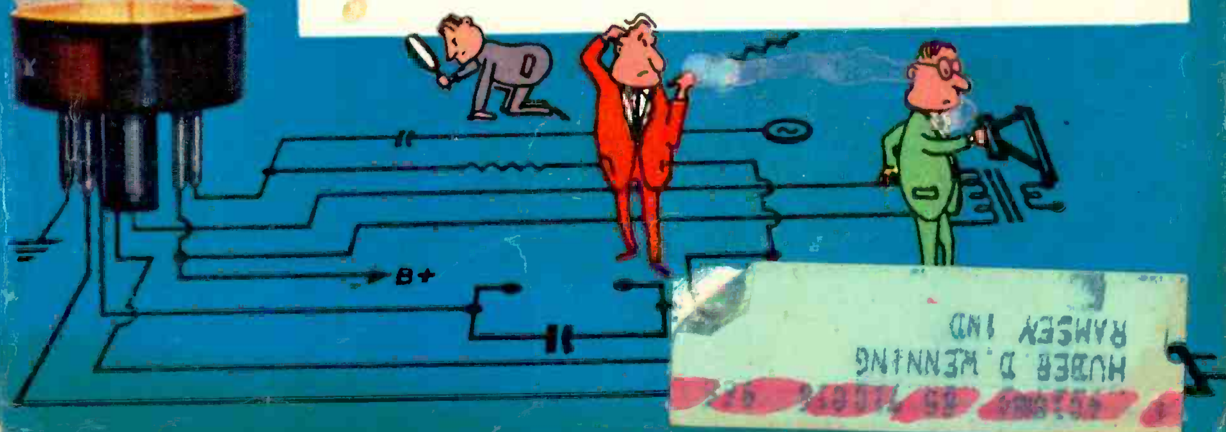

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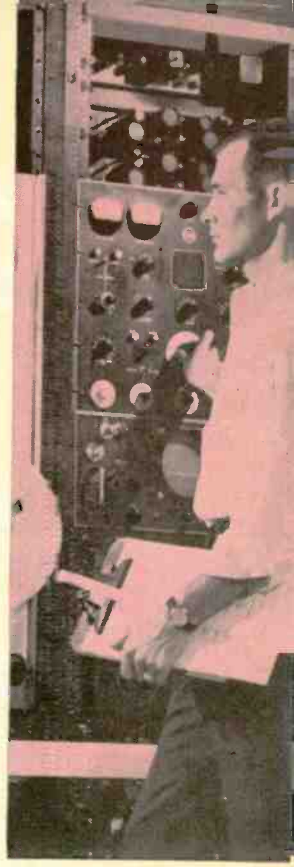

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ELECTRONICS ILLUSTRATED

JULY 1964 A Fawcett Publication Vol. 7, No. 4

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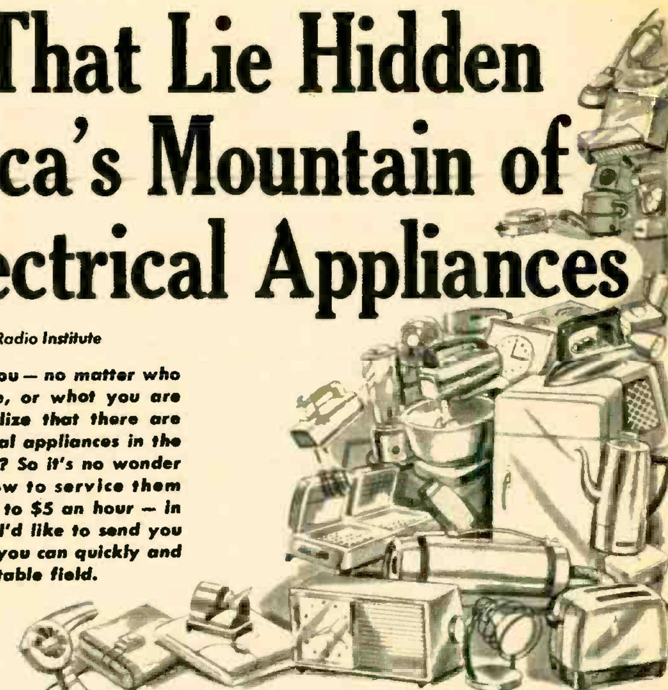
Profits That Lie Hidden in America's Mountain of Broken Electrical Appliances



By J. M. Smith *President, National Radio Institute*

And I mean profits for you — no matter who you are, where you live, or what you are doing now. Do you realize that there are over 400 million electrical appliances in the homes of America today? So it's no wonder that men who know how to service them properly are making $3 to $5 an hour — in spare time or full time! I'd like to send you a Free Book telling how you can quickly and easily get into this profitable field.

THE COMING OF THE AUTO created a multi-million dollar service industry, the auto repair business. Now the same thing is happening in the electrical appliance field. But with this important difference: anybody with a few simple tools can get started in appliance repair work. No big investment or expensive equipment is needed.

The appliance repair business is booming — because the *sale* of appliances is booming. One thing naturally follows the other. In addition to the 400,000,000 appliances *already* sold, this year alone will see sales of 76 million *new* appliances. For example, 4,750,000 new coffee makers, almost 2,000,000 new room air conditioners, 1,425,000 new clothes dryers. A nice steady income awaits the man who can service appliances like these. And I want to tell you why that man can be *you* — even if you don't know a volt from an ampere now.

A Few Examples of What I Mean

Now here's a report from Earl Reid, of Thompson, Ohio: "In one month I took in approximately $648 of which $510 was clear. I work only part time." And, to take a big jump out to California, here's one from J. G. Stinson, of Long Beach: "I have opened up a small repair shop. At present I am operating the shop on a spare time basis — but the way business is growing it will be a very short time before I will devote my full time to it."

Don't worry about how little you may now know about repair work. What John D. Pettis, of Bradley, Illinois wrote to me is this: "I had practically no knowledge of any kind of repair work. Now I am busy almost all my spare time and my day off — and have more and more repair work coming in all along. I have my shop in my basement."

We Tell You Everything You Need to Know

If you'd like to get started in this fascinating, profitable, rapidly growing field — let us give you the home training you need. Here's an excellent opportunity to build up "a business of your own" without big investment — open up an appliance repair shop, become independent. Or you may prefer to keep your present job, turn your spare time into extra money.

You can handle this work anywhere — in a corner of your basement or garage, even on your kitchen table. No technical experience, or higher education is necessary. We'll train you at home, in your spare time, using methods proven successful for over 45 years. We start from scratch — *tell* you in plain English, and *show* you in clear pictures — everything you need to know. And, you will be glad to know, your training will cost you less than 20¢ a day.

FREE BOOK *and Sample Lesson*

I think that our 24-page Free Book will open your eyes to a whole world of new opportunities and how you can "cash in" on America's "Electrical Appliance Boom."

I'll also send you a Free Sample Lesson. It shows how simple and clearly illustrated our instruction is — how it can quickly prepare you for a profitable future in this big field. Just mail coupon, letter, or postcard to me: *Mr. J. M. Smith. President, National Radio Institute, Dept. KG4, Washington 16, D.C.* (No obligation, of course — and no salesman will call on you.)

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Mr. J. M. Smith, President
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Tell me how I can "cash in" on the "Electrical Appliance Boom." Send me your illustrated FREE BOOK that outlines the whole NRI Course, tells what opportunities are open to me, answers my questions, describes success of other students, and much more. Also send me the FREE SAMPLE LESSON so I can see how clear and easy your instructions are. I am particularly interested in:

☐ Spare Time Earnings ☐ Business of My Own ☐ Better Job

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ADDRESSES
Editorial and Advertising Offices: 67 West 44th St., New York, N.Y. 10036. Subscriptions: Change of address Form 3579 to Subscription Dept., Fawcett Bldg., Greenwich, Conn. 06830.

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MEN 17-55

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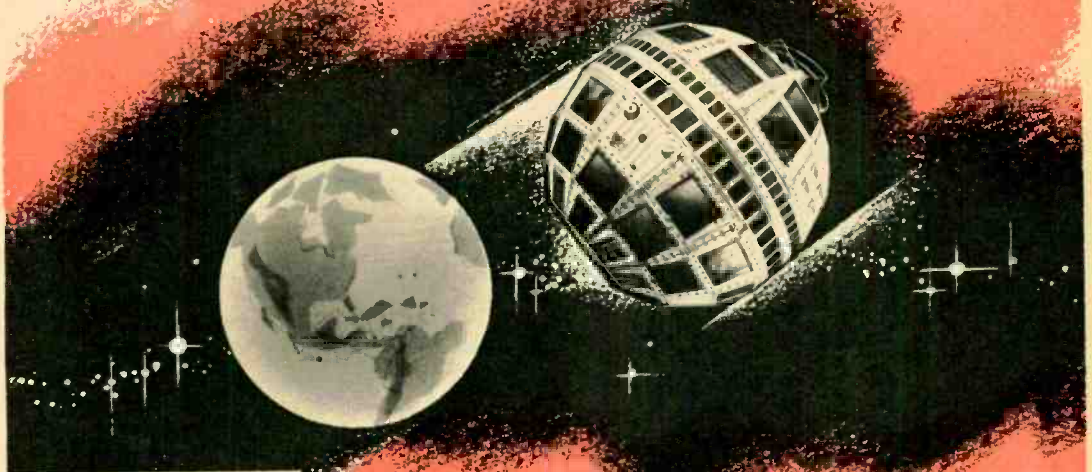

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FEEDBACK
from our readers

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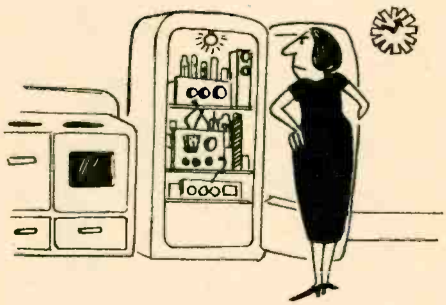
● KOOL KOOKIE



I thought you might be amused to learn about the interest your magazine creates in the breast of the average housewife, mother or girl friend. I happen to be addicted to your publication but the other night I was lying in bed reading about SUPER-COLD SUPER-MAGNETS in the May issue when my wife looked over and saw the drawings and said, "George, I'm warning you. You try to put that radio junk of yours in the refrigerator and I'll scalp you."

PS—The U. in my name below just means that I think it Unwise to put down my real name. This is a small town.

George U.
Bolivar, Mo.

● MATING CALL

I am attempting to build a ham radio transceiver which will operate on 2 meters or 80 meters. Could you give me any advice?

Rodney Welton
Brewerton, N. Y.

Unless we missed an important point in your letter, Rod, we'd suggest you first think about a ham license. With that in hand, why would anyone want to mate 2 and 80 meter equipment? That's an extremely strange hybrid because the bands have next to nothing in common. For plans for an 80-40 transmitter-receiver, see the September '63 EI. At this stage we'd suggest buying a low-cost 2-meter transceiver because high-frequency gear is hard for a beginner to build—successfully.

● JUNIOR HAM

I read your article, WANT TO BE A JUNIOR HAM? (March EI), and found it interesting. I know that it will help me get my ham license. I hope you will put more articles in your magazine for us junior hams.

Jeffrey Lenorovitz
Van Nuys, Calif.

Thanks, Jeff. We just might.

● IDEA DROPPER

Your ELECTRONIC NAME DROPPER in the May issue might be quite a commercial idea. You could make up great big sheets of the Panelescent material and then build huge flashing billboards for the highways at night. How do you like my idea?

Archie Cox
Philadelphia, Pa.

In a word, ugh.

● THE WHOLE TRUTH?

Looking through your May issue of EI, I found of particular interest the feature IN-

[*Continued on page* 8]

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Do you WISH you were EMPLOYED in ELECTRONICS?

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

	License	Weeks
Robert J. Maickel, 520 Market St., Havre De Grace, Md.	1st	20
James D. Neidermyer, R.D. 1, Leola, Pa.	1st	10
Denis Christopherson, 4402 Waite Lane, Madison, Wisc.	1st	12
Guy C. Dempsey, 1326 19th St., Washington, D.C.	1st	12
Charles Bartchy, 1222 S. Park Ave., Canton 8, Ohio	1st	10
William I. Brink, 12 Meade Ave., Babylon, L.I., N.Y.	1st	12
Earl J. Mahoney, Box 296, Newport, Vt.	1st	12
Hall Blankenship, Route 2, Rockwood, Tenn.	1st	12
David Kaus, 5218 Canterbury Way S.E., Washington, D.C.	1st	30
John A. Cork, 3535 N. Utah, Arlington 7, Va.	1st	12
Charles Deitzel, 342 Walnut St., Columbia, Pa.	1st	8½
Norman Tilley, Jr., 8613 Piney Branch, Silver Sprg, Md.	1st	30

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I AM INTERESTED IN: ☐ HOME STUDY ☐ RESIDENT CLASSES 48-K

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FEEDBACK

Continued from page 6

SIDE RADIO MOSCOW. Although I agreed with everything the article said, Radio Moscow is not the only clever user of half-truths. How about an expose of the semi-facts used in TV commercials today—in this country?

Clarence Martin
Salt Lake City, Utah

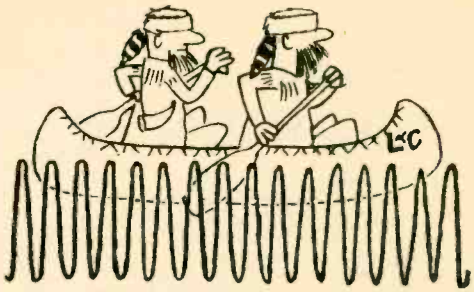
That's a little out of our line. Maybe the Federal Trade Commission could help.

● SOFT SOAP

I was pleased to see the Edison bulb in your May GOOD READING. We who reap the benefits of that invention too often forget to say thanks. Our debt is partially paid by tributes such as yours.

Bob Brady
Indian River, Fla.

● THE CARTOONIST



I was quite struck with your article on RADIO AT 100 BILLION CYCLES (May '64 EI). I'd never realized that radio really went up that high and, as a matter of fact, I wasn't quite sure previously how radio and microwaves and infrared and visible light all fit together in the spectrum. Now I have a better idea, at least. If you publish this letter why don't you draw a picture to go with it and show some radio waves to represent the unknown frontier and some explorers, sailing out in a ship like Columbus. . .

Richard Allen
Denver, Colo.

Or Lewis & Clark in a canoe?

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6AB4, 6AC7, 6AF4, 6AG5, 6AG7, 6AH4GT, 6AH6, 6AK5, 6AL5, 6AL7, 6AM8, 6AN8, 6AQ5, 6AQ6, 6AQ7GT, 6AR5, 6AS5, 6AT6, 6AT8, 6AU4GT, 6AU5GT, 6AU6, 6AU8, 6AV5GT, 6AV6, 6AW8, 6AX4GT, 6AX5GT, 6B8, 6BA6, 6BC5, 6BC8, 6BD6, 6BE6, 6BF5, 6BF6, 6BG6G, 6BH6, 6BJ6, 6BK5, 6BK7, 6BL7GT, 6BN6, 6BQ6GT, 6BQ7, 5BY5G, 6BZ6

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12BY7, 12CA5, 12J5, 12K7, 12L6, 12Q7, 12SA7, 12SG7, 12SJ7, 12SK7, 12SN7GT, 12SQ7, 12V6GT, 12W6GT, 12X4, 12Z3, 14A7/12B7, 14B6, 14Q7, 19, 19AU4GT, 19BG6G, 19J6, 19T8, 24A, 25AV5, 25BQ6, 25DN6, 25L6GT, 25W4GT, 25Z5, 25Z6, 26, 35A5, 35B5, 35C5, 35L6GT, 35W4, 35Y4, 35Z5GT, 37, 39/44, 42, 43, 45, 50A5, 50B5, 50C5, 50L6GT, 50X6

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7A7, 7A8, 7B4, 7B5, 7B6, 7B7, 7B8, 7C4, 7C5, 7C6, 7C7, 7E6, 7E7, 7F7

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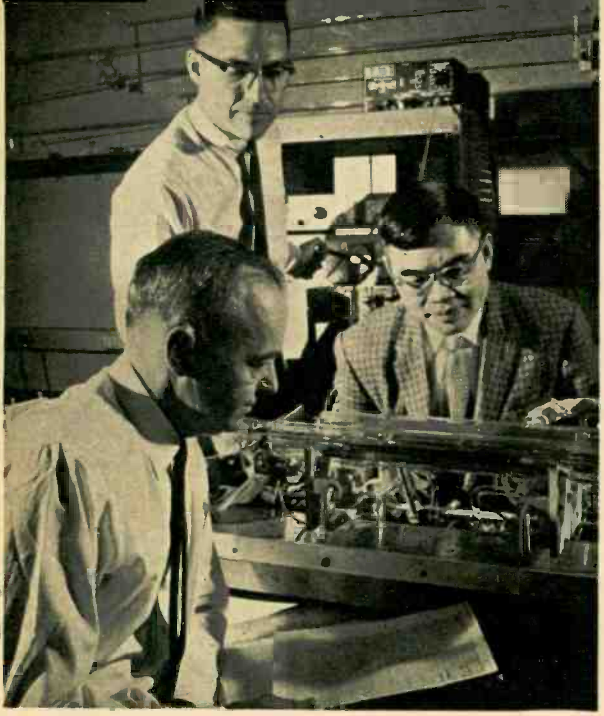

TRIODE LASER . . . Just like the familiar triode, a new gas laser can be modulated simply by varying the voltage on its grid. Though the Bell Labs laser produces light rather than RF, its vital organs are exactly what you'd expect any triode to have. Thing is, the laser's cathode, grid and anode are in the form of parallel ribbons extending eight inches along the tube's horizontal axis. Electrons from the hot-oxide cathode trigger the device into operation, while the grid controls electron flow. Understanding laser operation promises to be less nerve-wracking now that engineers can calculate excitation simply by measuring grid current and light output. A tetrode laser just might be next.

...electronics in the news

Portable Radar . . . Ni-cad powered and as carriable as they come, this hand-held radar can pick up and track most any moving object, whether it's a tank in the woods, a ship in a fog or a Labrador retriever in a coal bin. And, since this is only a prototype, engineers at General Dynamics/Electronics think they'll be able to bring the weight down below the present 8 lbs., once they manage to get some integrated circuitry inside.

Pico Welder . . . You could weld wings on a model mosquito with this iron, though that isn't quite what its designers had in mind. Instead, they made the Microwelder Mark II for welding pico-miniature circuits, which is exactly what is happening in our photo. Though the hair-thin wires in the picture are almost too tiny to see, that's an honest-to-goodness dime underneath. Mark II comes from Aerojet-General out California way.

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...electronics in the news

Pipe Down . . . Travelling-wave tubes aren't the quietest devices around, but scientists have an idea that static doesn't have to be one of the TWT's trademarks. To enforce the maxim that TWTs should be seen and not

heard, researchers at the U.S. Army's R&D Labs placed very high magnetic fields close to the source of the TWT's electron beam. The result is a TWT reportedly less noisy than a parametric amplifier and almost as sensitive as a maser.

Big Bavarian Ear . . . Part of the futuristic face-lifting being given West Germany is this satellite communications ground station at Raisting, Upper Bavaria. Instead of warily watching each other with radar, NATO partners West Germany and the United States hope to strengthen cultural and economic ties through improved communications via Relay and Telstar satellites. Supplied by affiliates of the International Telephone and Telegraph Corp. to the German Post, Telephone and Telegraph Administration, this transportable station will rely on satellites to provide 12 two-way voice channels between Raisting, Germany and Nutley, N.J., U.S.A. For the thriving business communities of both countries, facsimile, teleprinter and high-speed data communications also will be possible. Extra-long distance dialing soon may allow you to talk to Grandma even if she chooses to vacation in the Black Forest.

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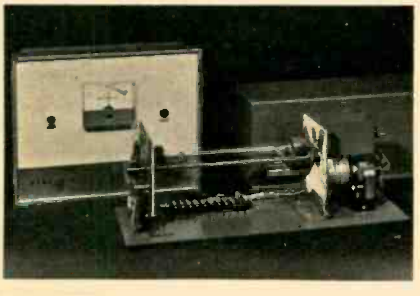
...electronics in the news

Telephone Lines of Light . . . A helium/neon-gas laser beam replaces 3.3 miles of poles and lines in ITT's experimental voice communications system. The receiver in the

photo listens with an 8-inch cassegranian telescope and a special multiplier phototube. Over on the other side of the tracks, a transmitter uses Brewster windows and confocal optics to transmit a voice-modulated beam of coherent light on a 10-kc channel.

Trouble-Sniffer . . . An electronic bloodhound developed by Honeywell can nose-out a concentration of toxic gas as slight as one part in a million. What's more, the most dedicated police pooch couldn't be expected to stand unlimited watches with the unflagging dependability of this self-checking unit. An ultraviolet lamp focused on a detector



tube contributes to the olfactory process by emitting rays that dangerous gases tend to absorb. But let the ultraviolet to the detector tube diminish, and the tube reacts by touching off an alarm. The perchlorethylene of dry-cleaning fame, gasoline and tear-gas are a few of the potential public enemies Lassie's latest competition will keep at bay.

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IF the heads on your tape recorder are considerably the worse for wear, you can select a suitable replacement from Nortronics' **Tape Head Replacement Guide.** Kits for replacing more than 500 brands and models are offered. A free copy of the guide may be obtained from the Nortronics Co., Inc., 8105 W. 10th Ave., North Minneapolis, Minn. 55427.

Or, if your recorder in toto happens to be shot, you probably will be able to find a substitute in the **Audiotape Tape Recorder Directory.** This 32-page reference guide includes every sort of machine from a 2x4½x 6¼-inch portable to a full-size professional job. Send 25 cents to Audio Devices, Inc., 444 Madison Ave., New York, N.Y. 10022.

The marvels of **epoxy,** as they apply to silver solders and conductive coatings, are celebrated in Epoxy Products' bulletin No. 7. Bond strength, joint design and field repairs are a few of the subjects covered. For free copies, write Epoxy Products, Inc., 133 Coits St., Irvington, N.J. 07100.

Scott's **stereo console catalog** displays cabinets of walnut and fruitwood in French and Italian provincial or contemporary styles. The illustrated brochure is free from H. H. Scott, Inc., 111 Powdermill Rd., Maynard, Mass. 01754.

Although intended primarily for the engineer, the **Sylvania I&M CRT Handbook** offers valuable information to anyone wishing to know more about cathode-ray tubes. Both quick-reference data and detailed information are included on multi-gun, high-resolution and double-deflection CRT's. Copies of the booklet are free from Sylvania Electric Products, Inc., 1100 Main St., Buffalo, N.Y. 14209.

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Rev. Enoch P. Sanford

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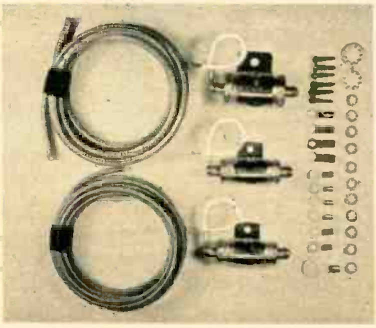

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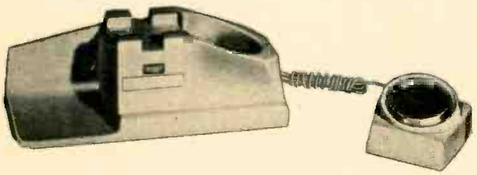

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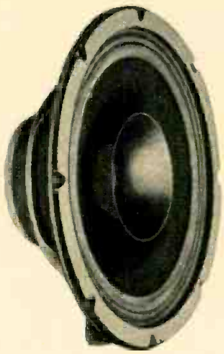

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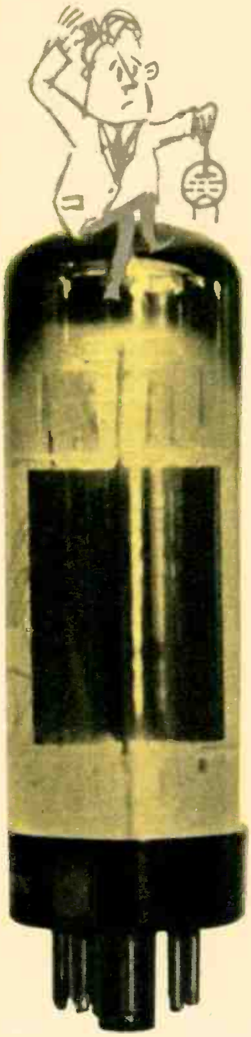

BASIC COURSE IN VACUUM TUBES

By JOHN T. FRYE, W9EGV

GETTING TO KNOW vacuum tubes is, for some people, a little like getting to know next-door neighbors. They live right along with tubes and neighbors for years without ever taking the trouble to lean over the fence and introduce themselves.

Obviously, the vacuum tube can't introduce itself to you, so we've arranged this introduction to accomplish the job. To prepare you, we'd best tell you first of all that the tube comes in many shapes and sizes. And, though tubes have been around for years, they aren't necessarily wrinkled and grey. Matter of fact, spanking new ones in a dozen different configurations are being developed at this instant.

Bear in mind, too, that the vacuum tube appears in more guises than a chameleon has colors. A tube can be, among other things: a rectifier that changes alternating current into direct current, a generator changing direct current into alternating current of any desired frequency, a flawless magnifier of varying voltages, a cross-breeder mating two frequencies and producing an entirely new offspring frequency, or a lightning-fast artist painting pictures rich in detail in a thirtieth of a second.

Ready to meet the vacuum tube? Come on, then—let's go!

OUR SPECIAL FEATURES ON THE VACUUM TUBE

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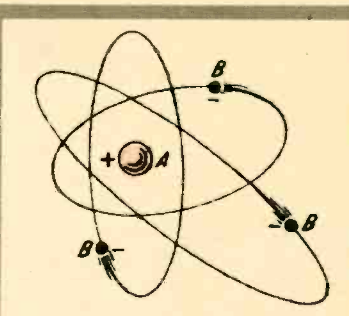
The Ingenious Electron. "I owe everything I have to spaghetti," a curvaceous, well-endowed Italian movie star said recently. In a similar vein the vacuum tube might confess, "I owe all my magic power to electrons." This being the case, let's begin by brushing up on our electron theory.



A=NUCLEUS B=ELECTRONS
Fig. 1

All matter is made up of atoms. And an atom consists essentially of a positive nucleus surrounded by whirling planets of negatively-charged *electrons*. The total charge of the negative electrons in Fig. 1 just balances the positive charge of the nucleus so that the atom normally has a neutral charge.

"Like charges repel; unlike charges attract." Remember this, even if you have to tattoo it on your chest. It explains why electrons keep circling their nucleus, why they are strongly attracted to any positively-charged object, why they are repelled by a negatively-charged object, and why, having similar charges, they even repel each other.

Consider what happens when a wire is connected from the electron-starved positive terminal of a battery to its negative terminal, just oozing with a surplus of electrons. The positive terminal steals electrons from the near-by atoms of the wire, leaving them with positive charges. They, in turn, grab electrons from neighboring atoms; and this bucket-brigade thievery goes on until it reaches the other end of the wire. There the atoms replenish their raided electron complement from the negative battery terminal.

The directed movement of electrons through the conductor constitutes an electric current. But what would you say if we proposed to create an electric current *without a conductor?* Sounds like asking a tight-rope walker to do his act without a rope, doesn't it? Let's try it, anyway.

The first step is somehow to persuade the electrons to leave their conductor. We do this by giving them a hot-foot. A certain amount of random electron-swapping always is going on among the atoms of a conductor even when no current is flowing through it. But at ordinary temperatures the atom-hopping electrons do not have sufficient kinetic energy to breach the surface. Heat, though, affects them the way it does Mexican jumping beans; they become livelier and friskier until some manage to go through the surface like leaping carp. As the temperature goes higher, more of them accomplish this feat until the heated conductor is surrounded by a cloud of escaped or *emitted* electrons.

We can do two things to aid their emission: (1) select a conductor for good emitting qualities or coat it with oxides, such as barium or strontium, that have these qualities; and (2) place the conductor inside a glass bulb and pump out the air. This last step is necessary so the truant electron will

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not have to shoulder aside atoms of air or gas 1,800 times its mass in leaving the conductor. Surrounding the hot *filament*—that's the alias our heated conductor assumes when it becomes a tube element—with lots of nothing has another advantage. It keeps the filament from burning up or "oxidizing" the way the tip on a soldering gun does in the air.

Passing an electric current through the emitter is a good way to make it hot enough to emit electrons, but there are times we do not want heating current going through the emitting material. In that case, we simply form the material into a sleeve and slip it over the filament as has been done with the tube shown in Fig. 2. The temperature of this sleeve, or *cathode*, is raised by heat radiated from the filament. With this arrangement, the filament is called a heater since it has the job of heating up the cathode to make it emit electrons.

Current Without Wires. You probably have heard of diode, triode, and pentode tubes (that's a pentode in Fig. 2); but did you ever hear of the *monode* one-element vacuum tube? That's odd; it's the most common type. Every incandescent lamp bulb is a monode vacuum tube! It has a heated, electron-emitting filament inside a vacuum, doesn't it? Admittedly, though, it's not much good for working vacuum-tube magic. The emission of negative electrons leaves the filament with a positive charge that tends to draw them back to it; furthermore, the electrons already emitted are pretty repulsive to would-be AWOL electrons. (Like charges repel, you know.) The end result is a kind of fountain-in-a-fishbowl action in which electrons are constantly leaving the filament or cathode and returning with no really significant change in the electronic *status quo*.

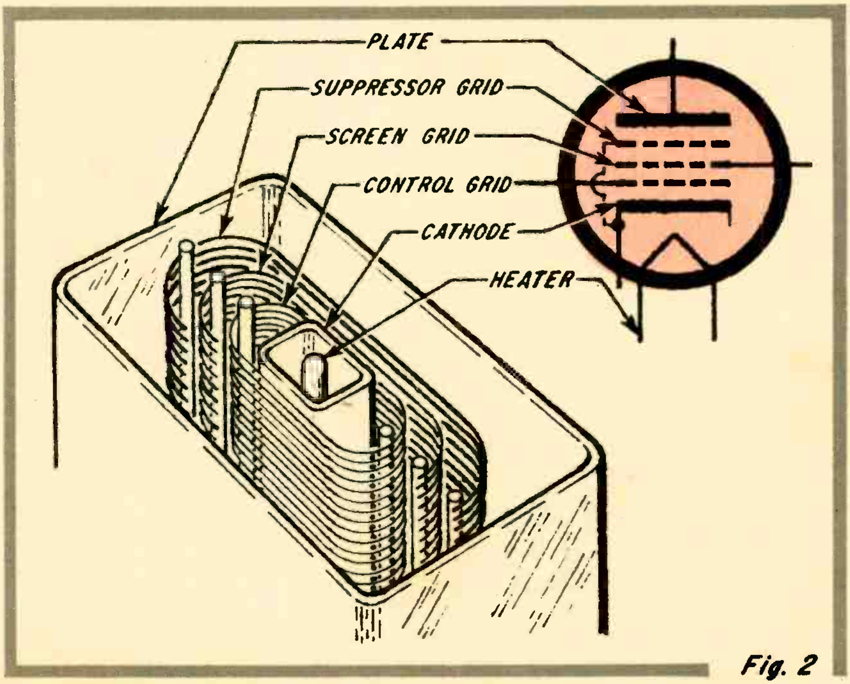

Fig. 2

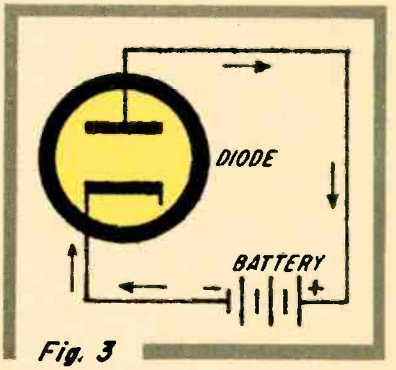

Fig. 3

What we need is some way to collect the emitted electrons and keep them from returning to the filament. This is as easy as pie for us hindsighted scientists! We simply put a metal *plate* inside the tube and use a battery to place a strong positive charge on it with respect to our cathode (see Fig. 3). Now many emitted electrons, instead of going back home, will be lured to the plate by its stronger attraction. Their places on the cathode will be filled from the negative terminal of the battery. Note the arrows in Fig. 3 and you will see that this movement of electrons from cathode-to-plate, plate-to-battery, and battery-to-cathode constitutes an electronic current flowing through the cathode-to-plate span without the aid of a conductor. We did it!

The tube is called a *diode* because it has two elements. The filament, or heater-and-cathode combination, counts as one "emitting" element. The positively-charged plate, or *anode,* is the other "collecting" element.

AC to DC. "So what good is a diode?" you ask. For one thing, a diode is a *rectifier* that can change zig-zagging alternating current (AC) into pulsating, one-way, direct current (DC). Look at Fig. 4. Transformer winding L1 furnishes current to heat the filament of the diode. Winding L2 connects between the plate and filament through the load resistor. The AC induced in this winding makes the plate first positive and then negative sixty times a second with regard to the filament. When the plate is positive, it attracts electrons from the filament and current flows in the direction indicated by the arrow. But what happens when the plate is negative? Not a thing! A negatively-charged plate is great big nothing to electrons, and they stay home. In other words, our diode is an electronic check-valve that permits current to flow freely through it in one direction but stubbornly bars movement in the opposite direction. No wonder the British call a vacuum tube a "valve"!

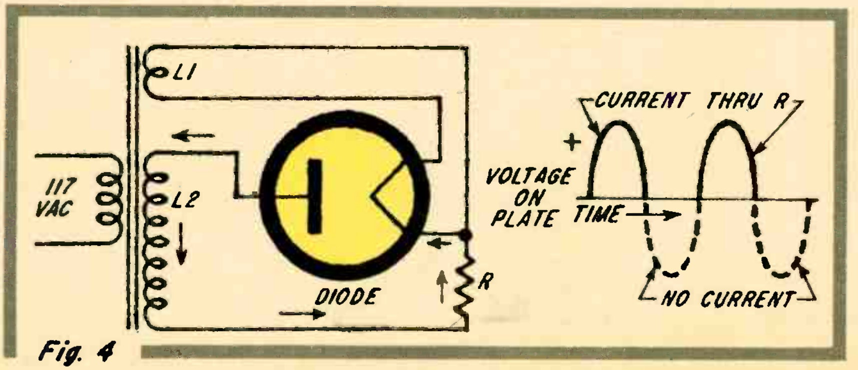

Fig. 4

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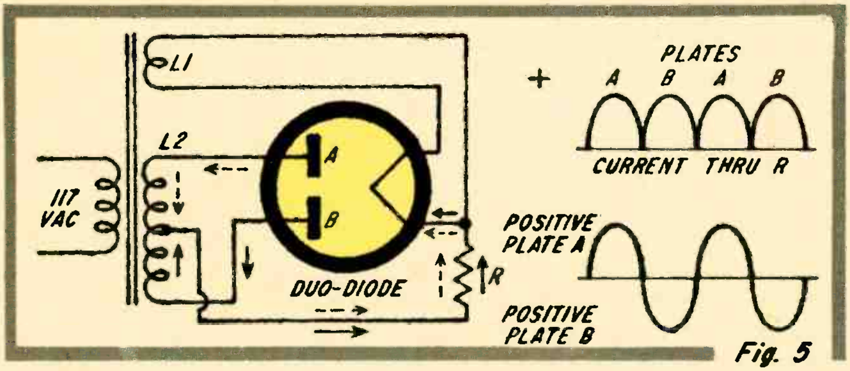

Fig. 5

Fig. 4 shows how pulses of current through the load resistor correspond to excursions of the AC voltage applied to the plate. Now we see why this arrangement is called a *half-wave rectifier.* The tube loafs while its plate is negative, and we get no current output during that half of the AC cycle. We can fix that! We just put another plate in our diode, making it a *duo-diode,* and connect the plates to the ends of a center-tapped transformer winding as shown in Fig. 5. The resulting *full-wave rectifier* puts out current during practically the whole AC cycle. When one plate is negative, the other is necessarily positive, and current is kept flowing through one half or the other of the transformer winding as indicated by the arrows.

Though both the half-wave and the full-wave rectifier perform the same task—that of changing AC to DC, the full-wave version obviously does a much better job. Assuming that our rectifier is operating from a standard 60-cycle AC line, the half-wave setup will deliver DC pulses 60 times every second. But a full-wave circuit will furnish 120 DC pulses every second, and, more importantly, there will be almost no gaps between them. This means that the output of a full-wave rectifier can be smoothed into pure DC much more easily than can that of a half-wave hookup. As a result, the simpler, half-wave version appears primarily in inexpensive electronic equipment—AC/DC radios, for example.

The graphs of Fig. 4 and 5 show that the amount of current flowing at any instant depends on the plate voltage at that time. Why don't all the electrons the filament is capable of emitting flock to the plate the instant it becomes slightly positive? The answer is *space charge.* While some of the emitted electrons are attracted to the slightly-positive plate, others just stand around, doing nothing, in the space between the filament and the plate. And electric charge exerts force according to its distance. Therefore, electrons trying to escape from the filament hear the negative "Stay put!" of the space charge much louder than the positive "Come on!" of the more distant plate. Increasing the plate voltage gradually cuts down this distance advantage of the space charge, and more electrons are drawn to the plate. A forthright way to reduce the current-limiting effect of the space charge is simply to move the plate closer to the filament so that there is less room for the space charge to exist!

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The Piggy-back Rider. Before we discuss the diode *detector* that recovers modulation from a radio-frequency carrier, we'd better examine a modulated carrier as shown in Fig. 6. Here the modulating signal "A" operates on unmodulated carrier "B" to produce modulated carrier "C." Notice modulation affects the amplitude of the carrier with regard to time. The carrier develops bulges and dips that correspond, both in frequency and amplitude, to the respective positive and negative peaks of the modulating signal. And, since the modulating signal would not go far without the carrier, you might say it's really stealing a ride, piggy-back fashion.

Unfortunately, this modulated carrier will not operate an earphone directly, either. We need an AC current surging back and forth through the earphone coil to vibrate its diaphragm. The voltage of our modulated carrier is increasing and decreasing, all right, but it goes two ways at once. Every increase or decrease on the positive side is countered perfectly by a similar change on the negative side. This is like two men trying to operate a crosscut saw by both pulling or pushing at the same time. If one yells, "Please . . . I'd rather do it myself!" and the other lets go, the saw starts working. There's an idea! Let's use our half-wave rectifier to get rid of half the modulated carrier.

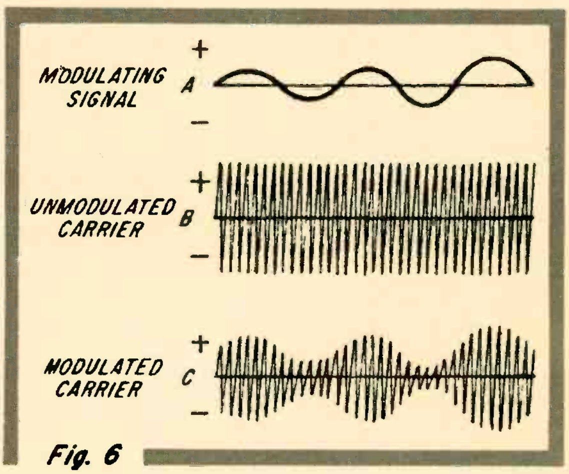

Fig. 6

Replace the AC transformer of Fig. 2 with an RF or IF transformer, substitute a pair of earphones for the load resistor, add capacitors C1 and C2 and you have Fig. 7. The diode doesn't care if the frequency has gone up from 60 cycles to 455,000 cycles per second or better and that the voltage of this high frequency is varying all over the place. It just goes right ahead chopping the negative half off each carrier cycle and passing the positive half as a pulse of current. We're not interested in the individual pulses of carrier current; so capacitor C2 is added to blend these pulses together. Its size is such it cannot charge and discharge during the time of a single carrier cycle; therefore the voltage across it follows the *average* height of the positive pulses, as shown in Fig. 8. Now the voltage across our earphones, and consequently the current through them, rises and falls exactly in step with the carrier modulation. Our rectifier has become a diode detector right before our eyes!

Controlling the Flow. Something about a flowing current of any kind invites interference; so before long an engineer stuck a loose grid of wire

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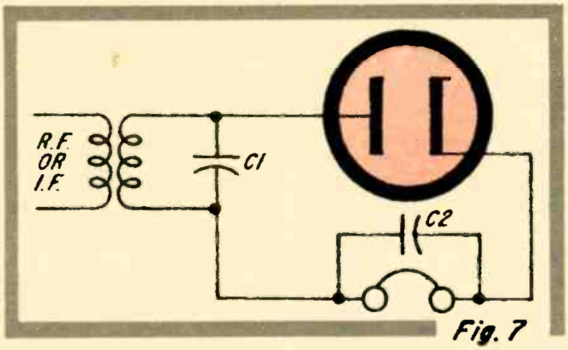


Fig. 7

in the stream of electrons flowing from cathode to plate. He quickly discovered small variations in a negative *bias* voltage applied to this grid had tremendous effect on plate current. A few negative grid volts completely nullified the attraction of many positive volts on the more distant plate and entirely cut off the flow of electrons. As the grid voltage was reduced, an increasing number of electrons slipped between the grid wires and reached the plate, causing plate current to rise. In other words, the grid voltage exerted a smooth, control-valve action on plate current. This is shown in Fig. 9 in which plate current is plotted against grid voltage for a typical *triode* tube.

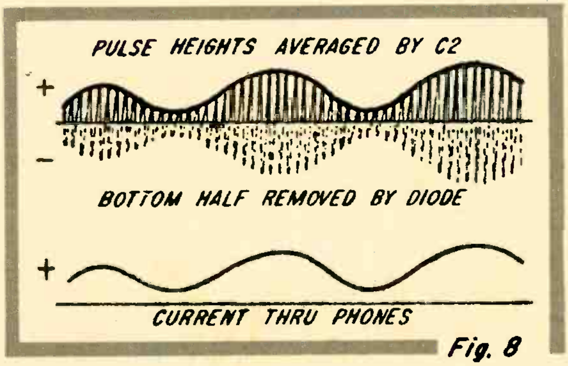


Fig. 8

If you imagine the electrons in the tube as a group of cars or people, the control grid becomes a sort of traffic policeman. It not only tells electrons to stop or go, but it also decides how many can pass by at any given instant. Thing is, the control grid is so fast even the best of policemen could not even begin to keep pace. For the grid can stop or start its electron traffic with the speed of light—186,000 miles per second! Furthermore, it does not matter one bit to the tube whether the voltage on its grid is steady DC or AC that's varying from soup to nuts. The tube will go right on controlling electron flow in precise accordance with whatever voltage happens to be on its grid at a particular time.

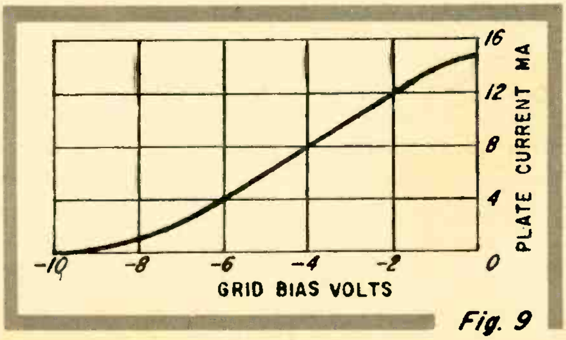
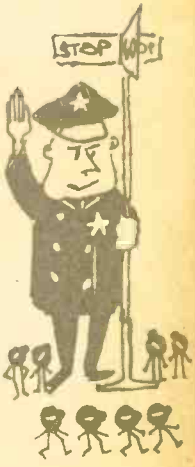


Fig. 9



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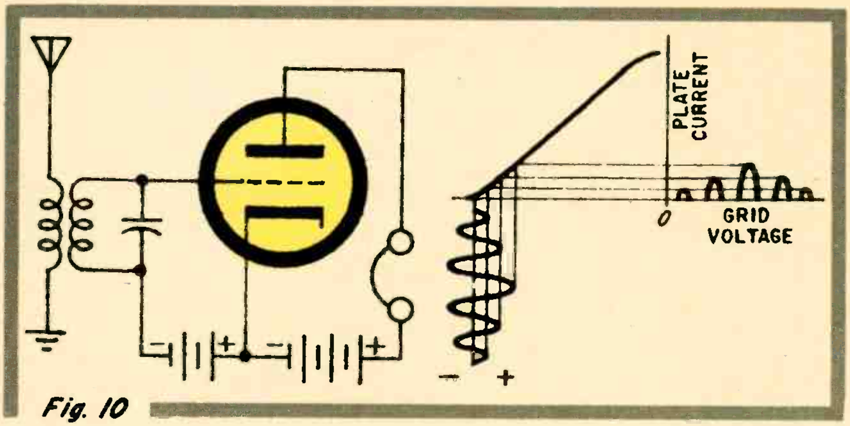

Fig. 10

We can put our new triode to work immediately as a *plate detector*. Fig. 10 is the circuit. Enough bias voltage is placed on the grid to reduce the plate current to nearly zero. A modulated carrier from a broadcast station is introduced in series with this bias voltage so positive and negative swings of the signal voltage add to or subtract from the bias voltage, as shown in Fig. 10. Negative excursions of the signal voltage, making the grid more negative, have no effect on the already-zero plate current; but positive swings reduce the bias voltage and cause plate current to flow. Thus, plate current responds only to variations in the positive half of the carrier and will work earphones in the plate lead. What's more, the plate current variations are stronger than the feeble carrier-current variations producing them.

This last fact is very important because it hints at the real advantage of a triode over a diode: the triode can *amplify* a signal. We need such amplification because the signal delivered by a detector is ordinarily quite weak and must be beefed up a great deal before it can fill a room with sound from a loudspeaker.

The Artful Amplifier. Fig. 11 shows the basic circuit and operation of a *voltage amplifier*. Grid bias from the battery sets the no-signal plate current near the center of the straight portion of the *characteristic curve*. Current through R produces a voltage drop across it directly proportional to the plate current. Making the grid less negative increases the plate current and the voltage drop across R, but it also decreases the plate voltage. Making the grid more negative decreases plate current and voltage drop across R, but increases plate voltage.

Now let's start our grid-circuit signal generator, which serves as a stand-in for a signal fed from the detector, and see what happens. The output of the generator is a low-voltage, AC, audio-frequency signal. The varying, reversing voltage of the generator output combines with the bias voltage to produce a resultant voltage on the grid that bobs up and down equally on either side of the fixed bias voltage. The plate current "twists" right along with the dancing grid voltage; and so, consequently, does voltage drop across R. But since the instantaneous voltage on the

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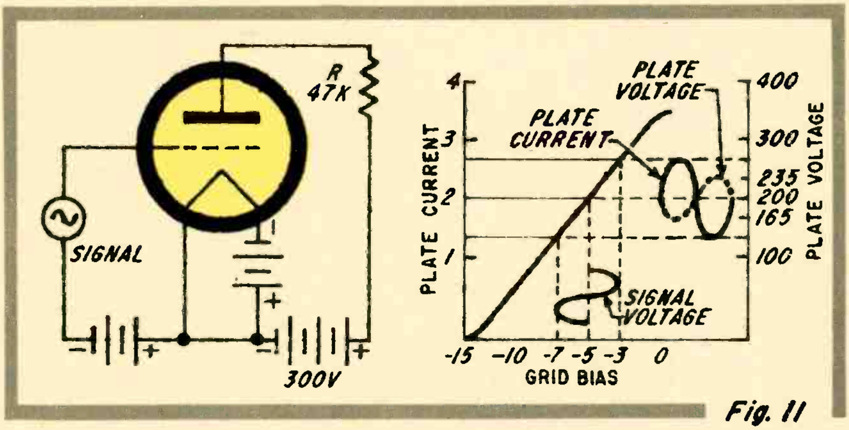

Fig. 11

plate equals 300 minus the voltage drop across R, the plate voltage goes more positive as the grid goes more negative, and *vice versa*.

Most interesting is the *amount* the plate voltage changes compared to the grid voltage change. Using Ohm's Law (Oh, come on now! You know about Ohm's Law!) to compute the voltage lost across R will convince you a change in plate current of only 1 milliampere will cause a plate voltage change of 47 volts. In Fig. 11 a peak-to-peak grid voltage swing of 4 volts causes a peak-to-peak plate-current change of about 1.6 ma and a peak-to-peak plate-voltage change of 70 volts. The output signal is a curve-by-curve mirror-image of the input signal, but it is 17½ times greater!

Our voltage amplifier is no more frequency-conscious than was our diode. If we replace the input and output circuits with tuned circuits, as shown in Fig. 12, it will amplify RF or IF voltages just as readily as it does audio voltages. The tuned circuit in the plate lead takes the place of resistor R, and a varying voltage drop occurs across its high impedance just as happened across the high resistance of R. By transformer action, this voltage is induced in the secondary of the transformer for use by the following stage. Tuned circuits not only deliver high-frequency signals to our amplifier and take them away after they are amplified, but they also serve to select particular frequencies to be amplified and to reject others. Our tube, meanwhile, merrily amplifies anything that is fed into it, silently but efficiently performing a well-nigh invaluable task.

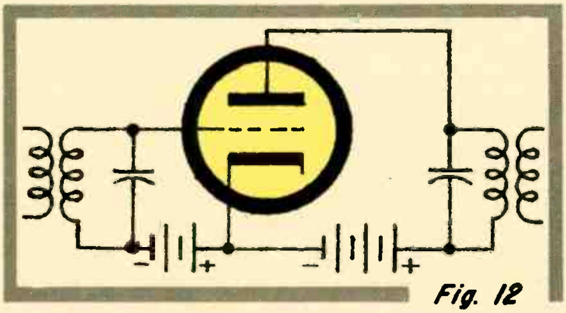

Fig. 12

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The Weight Lifter. Voltage amplifiers before and after the detector can take a weak signal and build it up to a peak value of several volts, but such a signal still lacks the power to drive a speaker. Electrical power equals voltage-times-current, and the plate circuits of our voltage amplifiers have only two or three thousandths of an ampere flowing in them. We must use another tube, as shown in Fig. 13, to transform our amplified signal voltage into power.

A power amplifier resembles a voltage amplifier the way Gina Lollobrigida resembles a skinny weight-watcher; there's just lots more of everything. In fact, the power tube is the weight lifter of the tube family. Its plate is larger and heavier; its huskier filament or cathode puts out more electrons; its bias is many volts more negative; its resting plate current is much greater; and the signal applied to its grid has much more swing. The impedance of the transformer primary in the plate circuit usually is a fraction of the resistance of the load resistor of a voltage amplifier, but much heavier current surges through it develop equal or greater voltage drops across it. The combination of high voltage and heavy current in the primary produce several watts of power to drive the speaker connected to the secondary.

More and More Grids. Great as it is, the triode is not a perfect tube for all applications. For one thing, its grid and plate form a small capacitor that sometimes permits power from the output circuit to leak back into the input circuit and cause trouble. A second fault with the triode is that an increase in signal to the grid produces an increase in plate current that causes a droop in plate voltage that tends to decrease plate current. You better read that again—slowly. Now do you understand that any change in plate voltage usurps and opposes some of the grid's rightful control over plate current? When the grid has only partial control, the tube's ability as an amplifier is impaired.

Both of these defects were solved at one stroke by placing another grid in the tube between the control grid and the plate, thus making the tube a *tetrode*. But this new *screen grid* created other problems all its own, which, in turn, were solved by adding still another grid—the *suppressor*,

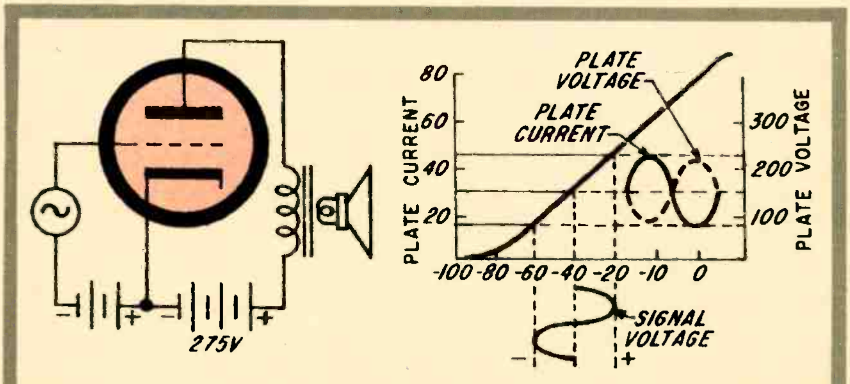

Fig. 13

thus producing a *pentode*. Each of these various types of tubes has its individual characteristics, of course, but all are variants on the simple triode. They just make greater use of some wire-mesh grids, that's all.

DC to AC. Now that we've learned something about how they amplify, let's see what else tubes can do. A very important bit of electronic magic is turning DC to AC with a vacuum-tube *oscillator*.

Think hard about what happens when a charged capacitor is connected across a coil of wire. Electrons from the negatively-charged plate race through the coil toward the positive plate, creating an expanding magnetic field around the coil. As charges on the capacitor plates begin to equalize, the current tries to slow down; but then the collapsing magnetic field drives the electrons on into piling up on the plate that was originally positive. Eventually the crowded electrons start back through the coil, and the whole process is repeated. Electrons keep sloshing back and forth through the coil the way water in a tipped dishpan sloshes back and forth. But each "slosh" of this damped oscillation (no pun intended!) is a little weaker than the previous one—unless carefully timed bits of energy are fed into the circuit to replace the energy losses.

In the case of the water, this energy can take the form of one-per-slosh nudges of the dishpan; but no one can work a switch fast enough to inject a bit of electrical help into each half-cycle of an oscillation rocking back and forth millions of times a second. A tube is fast enough, though, when it is connected to our oscillating circuit as shown in Fig. 14. Any tiny disturbance that makes the grid a bit positive causes plate current to increase and the magnetic field about L2 to expand. Voltage induced into L1 by this field drives the grid more positive, producing more plate current. The self-inflating process stops only when the voltage drop across the impedance of L2 is so great that the reduced plate voltage no longer will support an increase in plate current. At this point, the magnetic field about L2 starts to collapse, reversing the voltage induced in L1, and starting the grid voltage in the negative direction. It keeps going, pushed by the induced voltage from the collapsing field, until plate current is cut off. Then the grid moves in the positive direction, and we are back where we started.

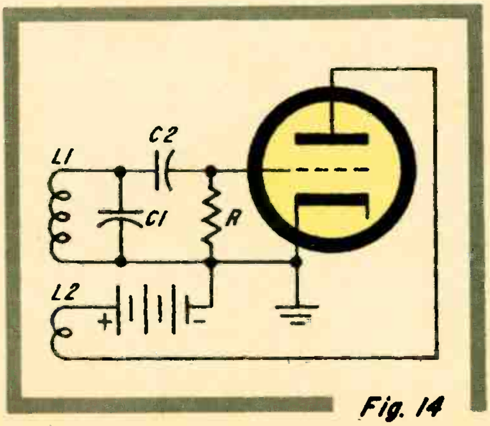

Fig. 14

Do you see how cleverly the vacuum tube succeeds in feeding just the right amount of energy into the oscillating circuit at just the right time to keep it going? And do you also see that a vacuum-tube oscillator actually is a special, dog-chasing-his-tail application of a vacuum-tube amplifier? Good! You're thinking while you read.

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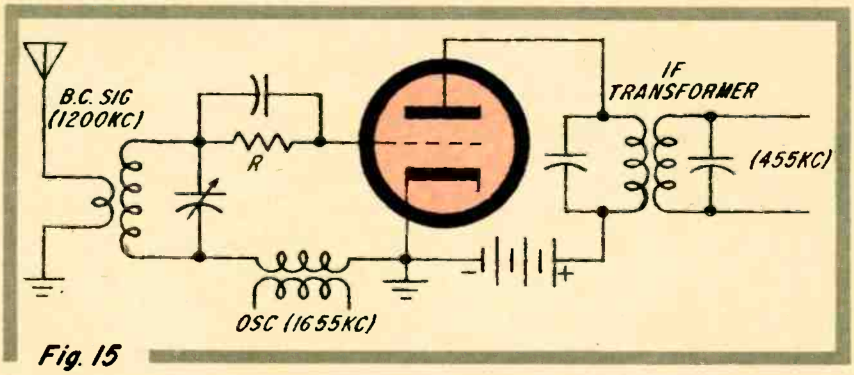

Fig. 15

Now let's talk about the tube that rubs two frequencies together and produces a new one. We call it a mixer, and Fig. 15 is the diagram of a simple circuit. Here, the carrier from a broadcast station (1200 kc) is connected in series with a signal from a local oscillator (1655 kc) between the grid and cathode of the triode. What happens? The 1200-kc carrier modulates the 1655-kc signal to produce a frequency equal to the difference between the two original ones—in this case, 455 kc.

Think first of the grid as the plate of a diode, and you can see that the demodulated signal of 455 kc will appear across the load resistor R, and consequently on the grid of the triode. Since it *is* the grid of a triode, the triode will amplify this 455-kc signal, and it will appear across the primary of the IF transformer tuned to that frequency. The carrier of any broadcast station can be converted to 455 kc simply by parking our local oscillator 455 kc above or below the broadcast frequency and allowing our mixer to extract the difference frequency. That is how the front end of a superheterodyne receiver works.

Pictures Yet! The most spectacular of all vacuum tubes probably is the kinescope or picture tube. You certainly already know about this creation, since every TV set uses one. It's a wing-ding of a tube and, by controlling electron flow with a grid, just like most any other tube, it succeeds in painting a picture made up of shaded horizontal lines. What's more, by making minute changes in that picture 30 times a second, it's fully capable of producing the illusion of movement!

A detailed explanation of a picture-drawing tube would be as hard to follow as a talking dog; so reluctantly we bring down the curtain on the vacuum-tube's one-man show. Many more characters are in his repertoire: the phase inverter, the thyratron—but just listing all the roles takes up too much space. You're not chicken, though, or you would not have held on this long; so the following list of books is appended to help you keep right on grappling with the protean vacuum tube and wringing answers out of him. Don't forget: he *has* the answers to all your electronic problems!

Basic Radio Course, by John T. Frye. Gernsback, $5.75
Electronic Technology Series. Rider
Radio & TV Circuitry and Operation, by A. A. Ghirardi. Holt, Rinehart & Winston, $9
Radio Amateur's Handbook. American Radio Relay League, $3.50
RCA Receiving Tube Manual. Radio Corporation of America, $1

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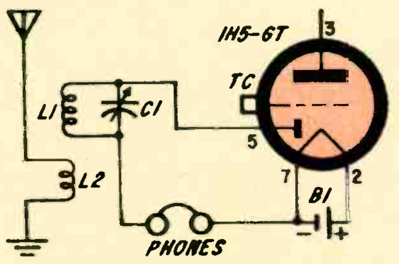
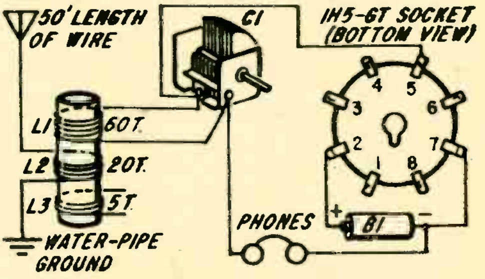
3 EXPERIMENTS with vacuum tubes

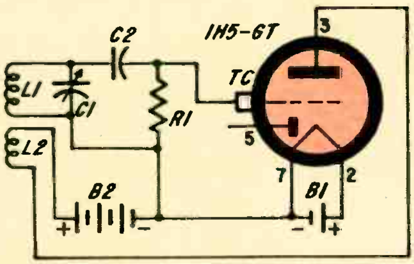
Diode Detector

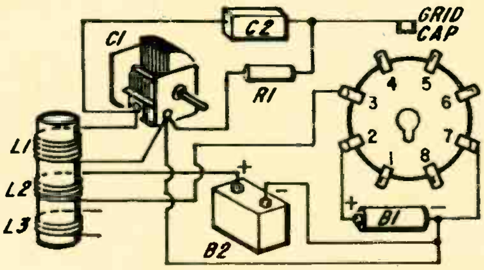




Circuit is wired in breadboard fashion and will receive local stations. Knob can be added to C1.

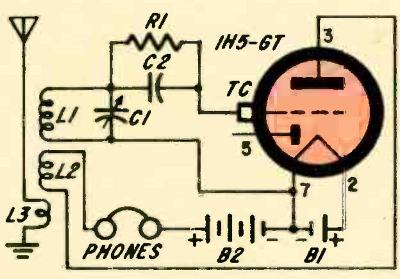
Oscillator

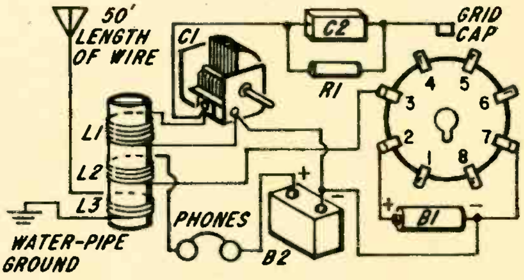




Armstrong oscillator produces unmodulated RF signal which can be picked up on nearby AM set.

Mixer





Broadcast signal induced into oscillator circuit forms mixer. Beat frequency is heard in phones.

PARTS LIST

B1—1.5-volt battery (Type D flashlight cell)
B2—67.5-volt battery (Burgess XX45 or equivalent)
C1—Variable capacitor with maximum capacity of 250-mmf or greater
C2—0.005-mf mica capacitor
L1, L2, L3—60, 20 and 5 turns respectively of #22 enameled wire closewound on 3-inch dia x 5-inch long cardboard tube (1/4-inch between windings)
Phones—Magnetic earphones with impedance of 500 ohms or greater
R1—220,000-ohm, 1/2-watt resistor
V1—1H5-GT tube
Misc.—Octal socket, grid cap, wire, solder, etc.

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The ALL-AMERICAN 5 Goes Modern

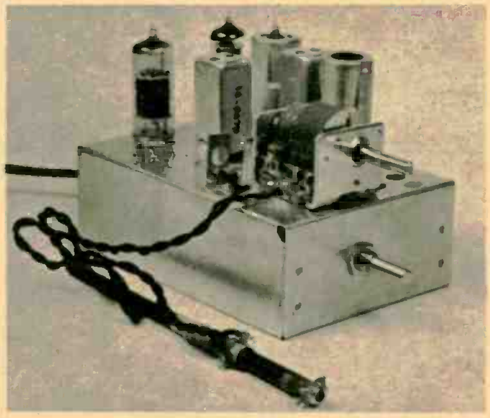
By DICK FLANAGAN and HERB FRIEDMAN

Four tubes, new circuit and as hot as its 5-tube forefathers!

YOU MIGHT SAY the All-American 5 did for radio what Betsy Ross did for the flag. Why? Well, American flags came in all shapes and sizes until a little seamstress named Betsy stitched up a design that became standard. And, in the days following development of the first AC-operated tube, radios came in every configuration under the sun. Triodes were used for everything from RF amplifiers to power tubes, and there were enough transformers on those early chassis to heat a five-room doghouse.

But the move toward line-operated receivers eventually dumped those transformers.

In time, a five-tube hookup evolved that proved all but unbeatable. Matter of fact, the All-American 5 was top dog in the radio re-



Built on 5x7x2-inch chassis to fit in cabinet above and at right, radio is styled for living room or den. The loopstick antenna is in front.

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ceiver scheme of things for years and years and years. Sure, six- and seven-pin and then octal tubes eventually gave way to modern miniatures. But the circuit didn't change one hair, and for good reason. All things considered, it was as good as could be.

Today, transistors have replaced vacuum tubes in a good many AM sets, but the All-American 5 is far from done for—yet. New tubes promise even better performance and, thanks to nine-pin miniature tubes, it takes even fewer to do the same job. Our updated All-American 5, for example, could have been the All-American 3 had we chosen to use a silicon diode in place of the rectifier. And its performance is every bit as good (if not better) as the All-American 5 that was king for so long.

Though it has one less tube, our circuit offers everything the old All-American 5 did and then some. There's a separate oscillator and mixer, something the old hookup couldn't provide, and a feedback network around the audio stages that cuts distortion and adds just the right amount of bass boost for good sound quality.

Want to learn something about the one circuit that's still a champion? Then build our updated All-American 5.

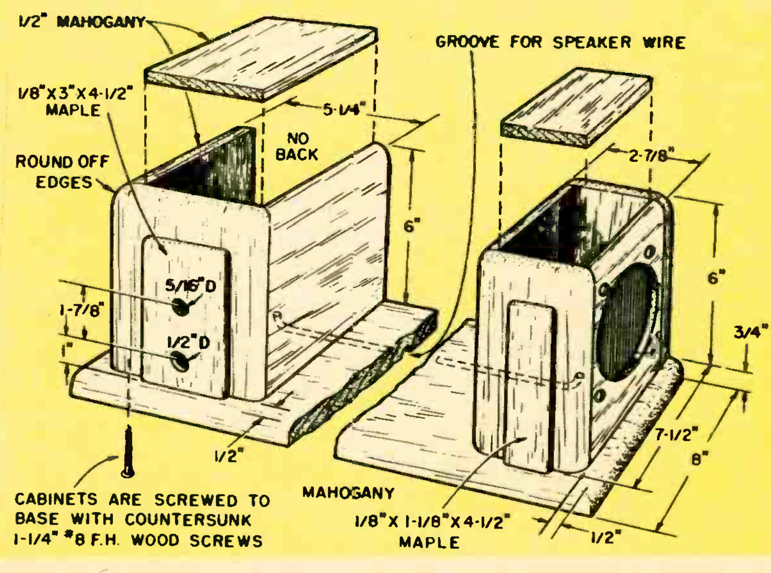
Construction. We built the radio on a 5x7x2-inch chassis so it would fit in the cabinet shown. Layout is fairly critical since you are working with RF. Give special attention to mounting tuning capacitor C1. Its mounting holes are right under the stator plates and if the screws are too long they'll ground the plates. Quarter-inch-long 6-32 screws with three star washers under their heads will prevent trouble. Drill ¼-inch holes in the chassis for the leads that go to C1 and use insulated wire for the connections.

And leave plenty of space for filter capacitors C12 and C13. We didn't use a dual filter capacitor because it would have taken up too much space in one place and might make future service difficult.

Oscillator coil T1 is supplied without a chassis mount and it isn't possible to attach one. Therefore, mount T1 on a terminal strip with #16 or #18 wire *before* mounting the terminal strip in the chassis. Make certain the mounting is rigid since considerable pressure will be applied to T1's slug during alignment. Disregard the instructions that come with T1 and connect it as we've shown. Make certain connections to the color-coded terminals are right or the oscillator will not work. T1's green lug is not used. The color-coded IF transformer leads also must be connected exactly as shown.

Do not connect T4's secondary leads until the radio is completely wired, and then do not solder them. Temporarily connect resistor R9 and C8 and turn on power. If there is oscillation or motorboating, reverse T4's secondary leads. If there is no oscillation, solder the leads.

Loopstick L1 should be mounted diagon-



Why not take the time to dress it up? Cabinet is a simple construction job and the wooden speaker enclosure makes a world of difference in the sound. Sides, top and front are half-inch mahogany. Base is three-quarter-inch mahogany and can be any length you want. Loopstick antenna should be mounted diagonally in the top of the cabinet at left. Leave back off radio for ventilation and to adjust loopstick antenna.

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PARTS LIST

Capacitors: Ceramic discs or tubulars, 500 V or higher unless otherwise indicated
C1—Two-gang superhet variable capacitor (Lafayette MS-141)
C2—470 mmf C3—.047 mf
C4—220 mmf C5—.02 mf
C6—500 mmf
C7, C8, C11, C14—.1 mf
C9—100 mmf C10—.005 mf
C12—80-mf, 150-V electrolytic
C13—40-mf, 150-V electrolytic
J1—Phono jack
L1—Seven-inch loopstick antenna (Lafayette MS-44)
Resistors: ½-watt, 10% unless otherwise indicated
R1—1,000 ohms R2, R6—1,500 ohms
R3—2.2 megohms R4, R7—470,000-ohms
R5—500,000-ohm audio-taper potentiometer with switch R8—180 ohms, 1 watt
R9—8,200 ohms R10—47,000 ohms
R11—3,300 ohms R12—1,500 ohms, 1 watt
R13, R14—220,000 ohms
S1—SPST switch on R5
T1—Oscillator coil (Meissner 14-1073)
T2, T3—455-kc IF transformer (Meissner 16-6678)
T4—Output transformer; primary: 2,500 ohms, secondary: 3-4 ohms (Lafayette TR-10 or equiv.)
V1—19EA8 tube V2—12EQ7 tube
V3—35DZ8 tube V4—50DC4 tube
Misc.—5x7x2-inch aluminum chassis, 4x6-inch oval speaker, tube shields and sockets, terminal strips.

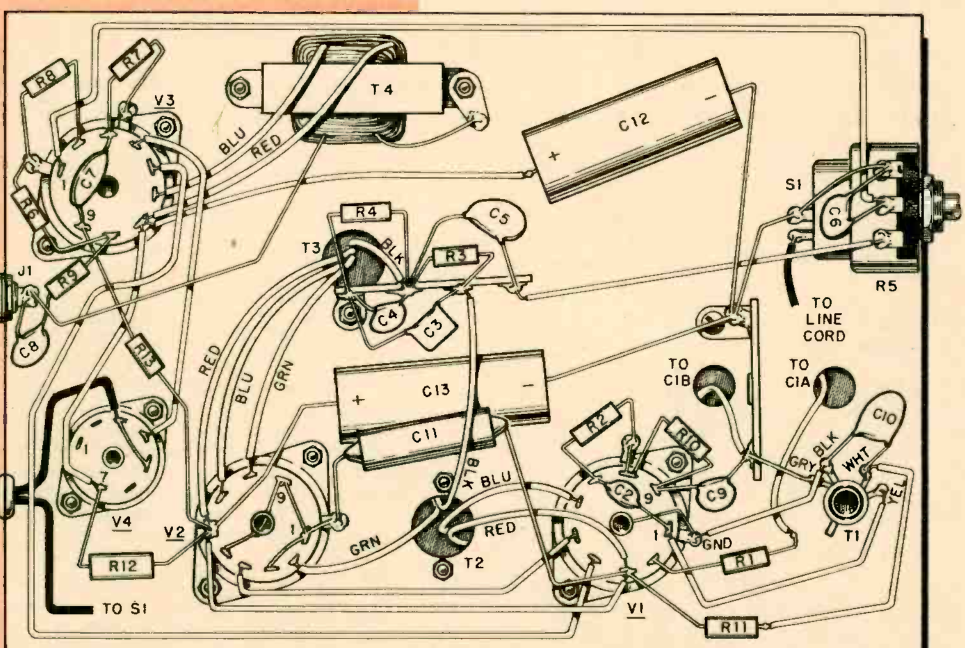
ally in the top of the cabinet away from the chassis. If it is too close to the chassis there may be oscillation at one or more spots on the dial.

Though not shown in our radio, we recommend you install a buss wire for all ground connections to reduce shock hazard. The buss is grounded to the chassis through C14 and R14.

Alignment. For top performance you must have a signal generator and know how to use it. It is not possible to do a good alignment job by ear. Alignment by ear or with a poor-quality signal generator will result in low sensitivity and tracking problems.

Connect the signal generator, set to 455 kc, to pin 2 of V1A. Set the function switch of a VTVM to measure negative DC voltage, and set its range switch to the lowest position. Connect the VTVM's ground lead to the ground buss and connect the hot lead to the junction of R3 and C4. Set C1's plates to about full mesh where there is no station to override the signal from the generator.

Turn on the radio, signal generator and VTVM and let them warm up about 15 min-



Underside of chassis is tight, but there is room for every part. Wire the heaters, IF transformers first, other parts and then install the electrolytics.

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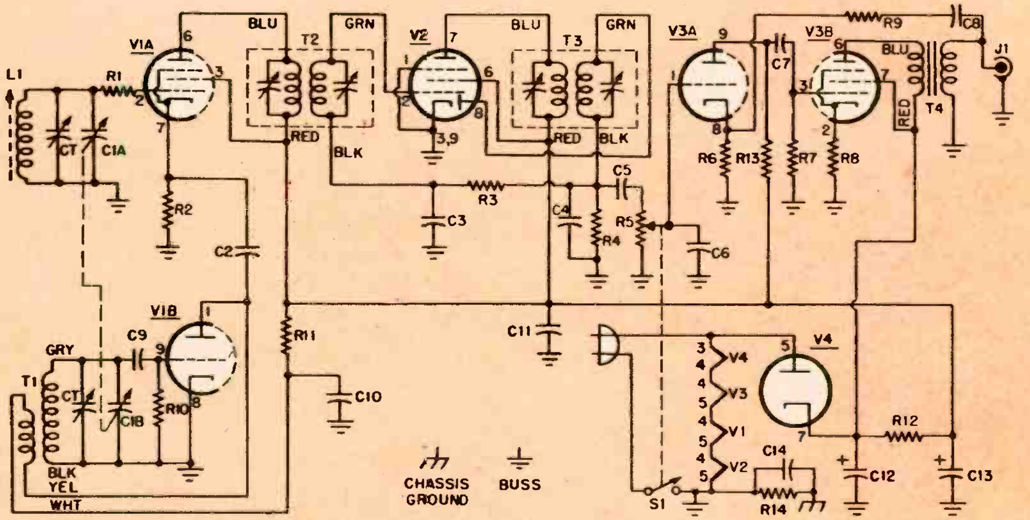
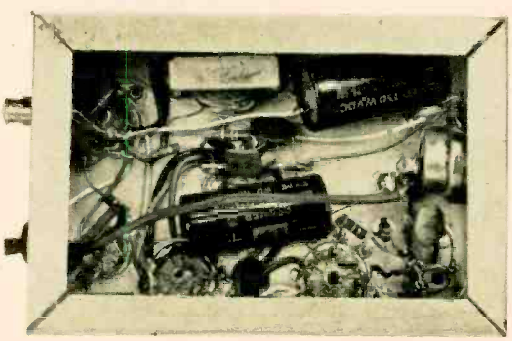
ALL-AMERICAN 5



Unlike its predecessors, our circuit has a separate oscillator and mixer (V1A, V1B) instead of a pentagrid-converter tube. Diode detector is included in first IF tube (V2). Two audio stages are combined in one envelope (V3A, V3B), and feedback network (C8, R9) improves bass response. To prevent shock hazard, make ground connections to buss wire. CT's, near C1A and C2A are tuning-capacitor trimmers.

utes. Then adjust the generator's output (unmodulated) for the lowest readable indication on the VTVM. Using a non-metallic alignment tool, adjust T2's and T3's trimmers for highest meter indication. If the voltage soars, reduce the generator's output. Repeat the adjustments two or three times.

Next, set the generator to 550 kc, fully mesh C1's plates and adjust T1's slug for highest meter indication. This adjustment is critical so do it slowly. Open C1's plates all the way, set the generator to 1600 kc and adjust C1's oscillator-section trimmer (smaller set of plates) for highest indication. Remember to keep the generator's output as low as possible. Repeat this procedure several times to get good tracking.



Mount T1 on terminal strip before installing terminal strip on chassis. We recommend using No. 18 wire for the ground buss (not shown here).

Disconnect the generator from V1 and put its output cable near L1. Set the generator to 550 kc and close C1. Adjust L1 by sliding the core within the coil for highest indication. The adjustment is critical so take care. Next, set the generator to 1600 kc, open C1's plates all the way and adjust C1A's trimmer for highest indication. Repeat this procedure several times.

Do not try to peak L1 on one station, for example, 770 kc. While you'd get really hot performance on this station, other stations might not come in as well.

If built and aligned as specified, our All-American 5 will give you more than satisfactory performance in terms of sensitivity and tone. We do not recommend any changes or modifications to the circuit.

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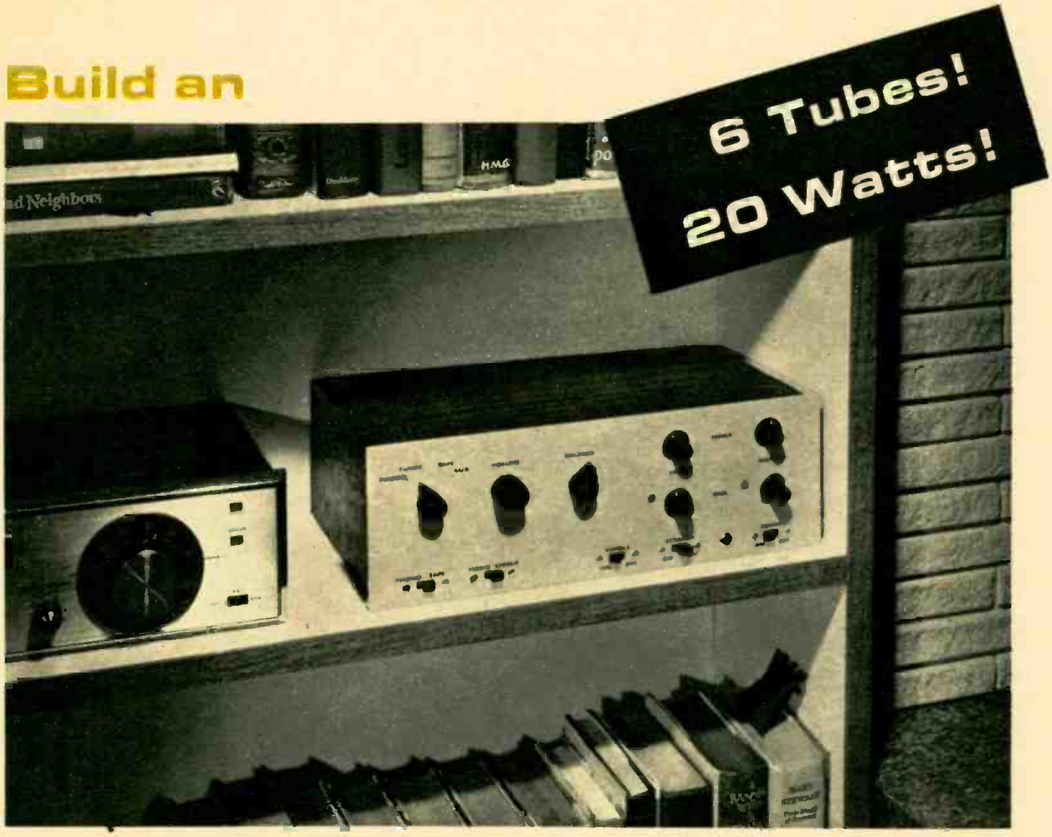
Build an



INTEGRATED STEREO AMPLIFIER

By WALTER MORROW

TIME WAS when a mono *power* amplifier required at least four tubes—two push-pull outputs, a phase inverter and a rectifier. Convert the amplifier to stereo and you're up to seven tubes. Add a preamp and you begin to lose count. But thanks to new tube designs, that's all history. EI's 20-watt integrated stereo amplifier uses only five tube envelopes—plus a rectifier—for *both* channels. Looking at it another way, that's 2½ tube envelopes for 10 watts of push-pull output per channel!

How'd we do it? By using (in each channel) a triple-triode Compactron for the preamp, half a 12AX7A, and a new-design output tube. It's an ECLL800 and in its nine-pin miniature bottle there are two power pentodes and a triode phase inverter. To see what we mean, look at V3A,B,C on the schematic. That's a lot of tube in one envelope!

The ECLL800 isn't widely distributed in this country yet, but you can obtain it from Allied Radio or State Labs, Inc. Our Parts List has the ordering information.

And not to be overlooked as contributors to the amplifier's performance and low cost are the output transformers. They're made by Allied and, because of their excellent characteristics and price, we recommend you use them.

Before we get to the building of the amplifier, let's look at its specs. At the 1-watt power level, the frequency response of each channel is flat from about 20 cps to 30 kc.

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Response is down 2db at 6 cps and 3db at 102 kc. The IHF power bandwidth (3db down) at 1 per cent total harmonic distortion is 20 cps to 15 kc. This means that at the frequency response extremes where the total harmonic distortion is 1 per cent (20 cps and 15 kc), the output power is not less than half its maximum value.

Bass boost or cut is 11db at 50 cps. Treble boost or cut at 10 kc is 12db and 16db respectively. Sensitivity (at 1 kc) of the high-level inputs (*aux, tape, tuner*) is 0.62 V for full output. Sensitivity of the *phono/tape head* input is 2.5 millivolts at 1 kc for full output. Sound good for 2½ tubes per channel? Then let's build it.

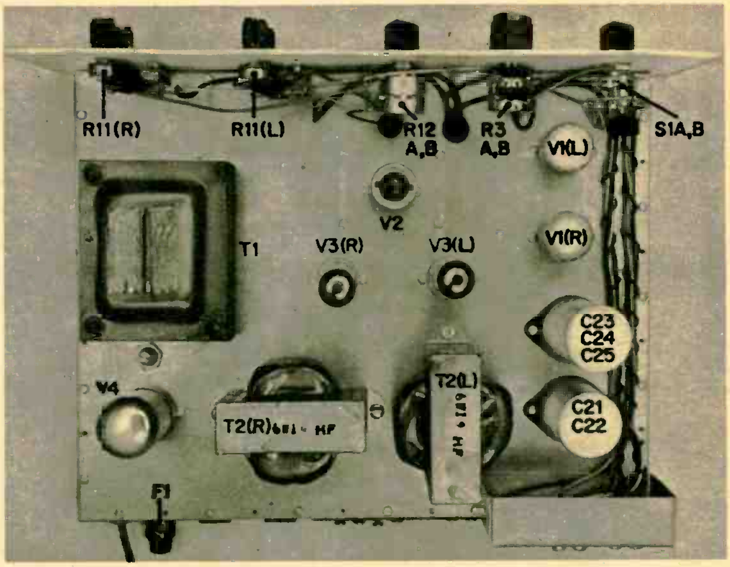

Fig. 1—Mount all parts exactly as shown on 10x13-inch chassis. Note at right how ground wires are twisted around each channel's input leads.

Construction. Before starting to build the amplifier, there are two important points to keep in mind: 1) layout, 2) grounding. To insure stability, low hum and noise and to prevent crosstalk between channels you must duplicate our layout as closely as possible. In addition, all grounds must be made to the ground points and ground buss shown in Fig. 5 or hum will be a serious problem. More about grounding later.

Our amplifier was built on a 10x13x1-inch chassis, made with Seezak chassis components (listed under *misc*, in the Parts List). A 1-inch-high chassis keeps the overall height down to 4¾ inches. If a low-silhouette appearance isn't important, build the amplifier on a standard 10x14x3-inch aluminum chassis.

The front panel is a 14⅛x4¾x⅛-inch thick piece of aluminum that was sandblasted after it was drilled. Make the rectangular cutouts for the two speaker terminal strips and the slide switches by drilling holes slightly smaller than the required size, then enlarge them with a small file.

Drill the other holes in the front panel, using the photo on the first page of this story and in Fig. 8 as a guide. Mount the bass, treble and volume controls, the selector switch and the terminal strips as shown in Fig. 2.

The 3⅜x2½x1-inch bracket for the ten phono jacks on the rear of the main chassis (Fig. 9) is made from a 5⅜x4½x1/16-inch piece of aluminum.

Do not install balance control R12 as it

Fig. 2—Rear of front panel. Mount controls, terminal strips, components and hookup buss and shielded wires before attaching panel to chassis. Wires to S1A and S1B come from the jack panel at the rear and should be installed after panel is in place.

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PARTS LIST

Capacitors: 500 V or higher unless otherwise indicated
C1, C2, C10, C12, C15, C16, C17—.05 mf tubular or ceramic disc
C3—.0047 mf ceramic disc
C4, C14—.001 mf ceramic disc
C5—.01 mf tubular
C6—220 mmf silver mica
C7, C9—.002 mf ceramic disc
C8—330 mmf silver mica
C11—50 mf, 3 V electrolytic
C13—500 mf, 15 V electrolytic
C18—1,500 mmf silver mica
C19—430 mmf silver mica
C20—.02 mf ceramic disc
C21, C22—80/30 mf, 450 V electrolytic
C23, C24, C25—80/40/40 mf, 300 V electrolytic
C26—500 mmf silver mica
F1—2 A, 3AG fuse and holder
J1-J5—Phono jack
NL1—Neon lamp assembly (Lafayette MS-478)
Resistors: ½-watt, 10% unless otherwise indicated
R1, R10—47,000 ohms
R2—10,000 ohms
R3—Dual 1-megohm audio-taper potentiometer
R4, R14, R23—1 megohm
R5, R9—180,000 ohms
R6—1,800 ohms
R7, R11—1 megohm miniature audio-taper potentiometer (Lafayette VC-38)
R8—220,000 ohms
R12—Dual 1-megohm linear-taper potentiometer (modified, see text)
R13—3.3 megohms
R15—4,700 ohms
R16—120 ohms
R17, R18, R22—470,000 ohms
R19—100 ohms, 10 watts
R20, R29—1,000 ohms
R21—150,000 ohms
R24—1,000 ohms, 1%
R25—150,000 ohms, 1 watt, 1%
R26, R32—100,000 ohms
R27—1.2 megohms
R28, R39—22,000 ohms
R30—4.7 megohms
R31—220,000 ohms, 5%
R33—500-ohm, linear-taper potentiometer
R34—4,000 ohms, 10 watts
R35—3,000 ohms, 2 watts
R36—2,400 ohms, 1 watt
R37—18,000 ohms
R38—620,000 ohms, 5%
R40—8,200 ohms
S1—2-pole, 5-position rotary switch (Centralab PA-1003)
S2, S6—SPST slide switch
S3, S4—DPST slide switch
S5—DPDT slide switch
SO1, SO2—AC chassis receptacle
*T1—Power transformer: primary, 117 V; secondaries, 540 V c.t. @ 120 ma, 6.3 V @ 3.5 A and 5 V @ 3 A.
*T2—Output transformer: primary impedance, 8,000 ohms plate-to-plate; secondary impedances, 4, 8, 16 ohms; 18 watts (Allied 62 G 058)
*V1—6C10 tube
*V2—12AX7A tube
*V3—ECLL800 tube
*V4—GZ34 tube
Misc.—Terminal strips; buss wire; tube sockets; RG174/U coaxial cable; 10x14x3-inch aluminum chassis, or the following chassis parts from Seezak Division, Rimak Electronics Inc., 10929 Van Owen St., North Hollywood, Calif.: 2—10x13-inch panels No. P-1013; $1.44 ea. 1-pr. 1x10-inch rails No. R-110; 66¢/pr. 1-pr. 1x13-inch rails No. R-113; 78¢/pr. General Cement 20-2 Copperprint solution (Allied Radio stock No. 51 N 488. $1.40. Not listed in catalog.)
*Available from Allied Radio Corp., 100 N. Western Ave., Chicago, Ill., 60680, at prices indicated below, plus postage. Specify these special stock numbers:
T1—39 A 277: $4.82
T2—39 A 276: $5.35
V1—39 A 280: $1.98
V2—12AX7A: $1.28
V3—39 A 278: $4.95
V4—39 A 279: $2.10
The above parts (6 tubes, 3 transformers: 1—T1, 2—T2's) are available as a package, with special stock number 39 A 281, for $29.48 plus postage.
The group of tubes consisting of 2—6C10, 2—ECLL800, 1—GZ34 and 1—12AX7A is available as a package for $14.24 plus postage from State Labs, Inc., 215 Park Avenue South, New York, N.Y. 10003

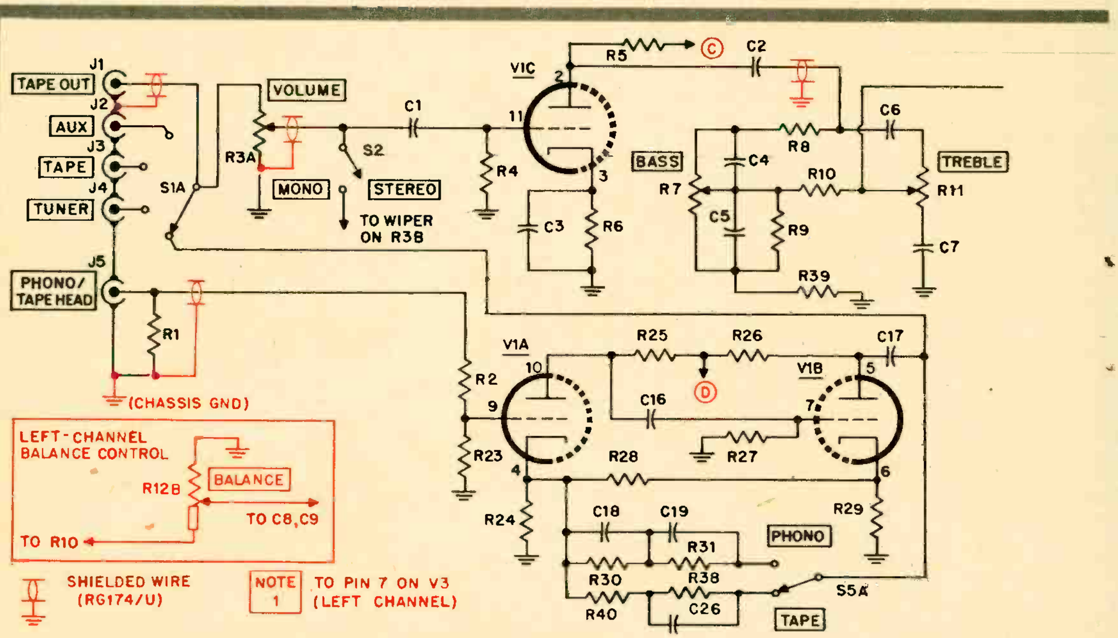

Fig. 3—Schematic of right-channel preamp only (left channel is identical) is shown above. Power supply and right-channel output stage are at the right. Other section (B) of switches, potentiometers whose part numbers are followed by letter A (S1A, for example) are in the left channel.

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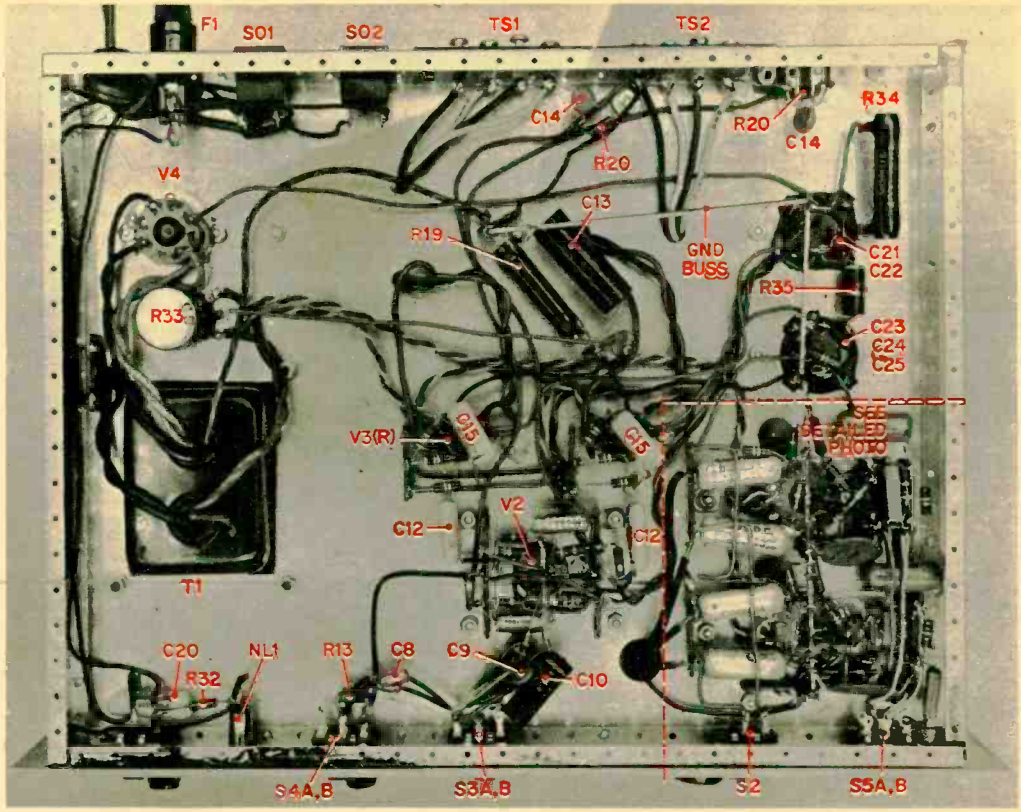
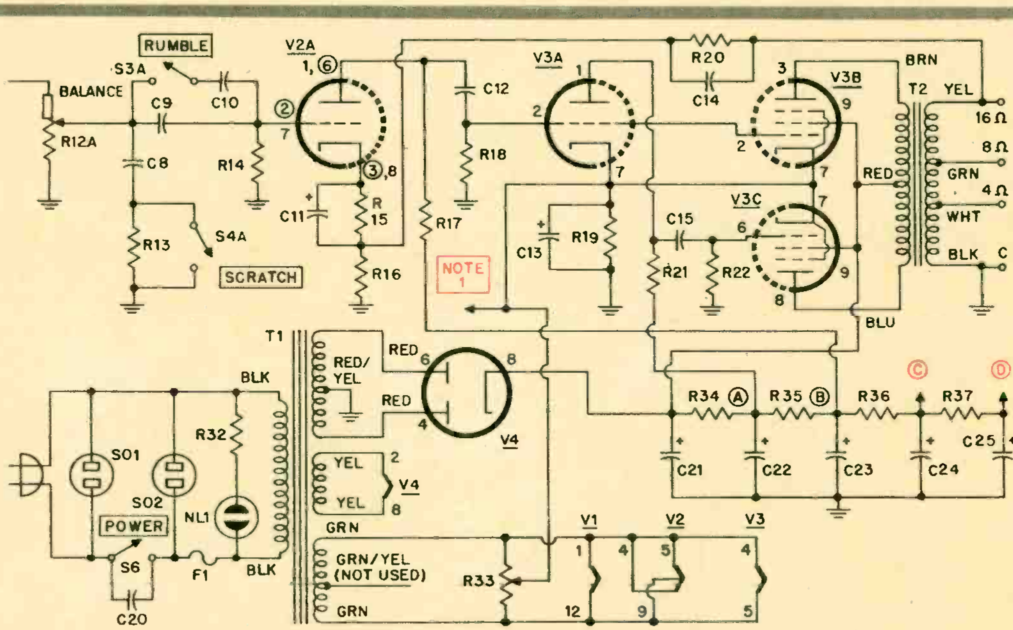


Fig. 4—Photo of underside shows location of sufficient number of components to guide you in installing other parts. Preamp in lower right corner is crowded; therefore, it is shown separately in Fig. 6.



Other half of V2 (V2B) is in the left channel. V2's circled pin numbers are for left-channel connections. Resistor R19 and capacitor C13 are used for the output stages in both channels. The points identified by circled letters C and D in the preamp (V1A, B, C) and at the extreme right are connected.

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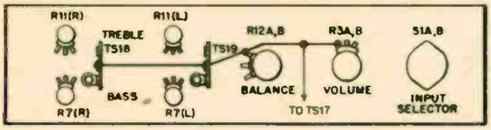
STEREO AMPLIFIER



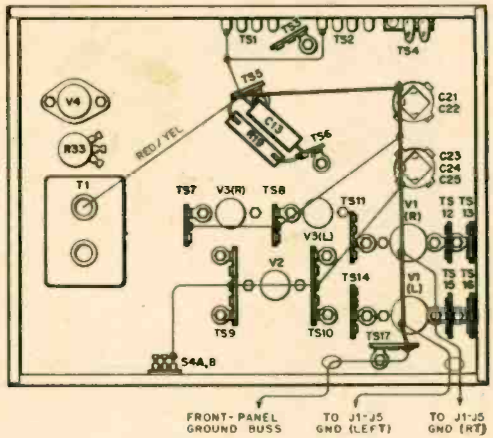


Fig. 5—Ground wiring on rear of front panel (top) and under chassis (right) is shown in gray. Use insulated wire to make connections from all terminal strips to buss wire (heavy line). Do not connect buss or any other points to chassis here.

must first be modified as shown in Fig. 7. Here's why. When R12 is mid-position, exactly half (500,000 ohms) of its resistance is inserted in the circuit. This would lower the amplifier's gain by 6db. However, by painting slightly more than half of R12A's and R12B's carbon element with Copperprint, a conductive material, this 500,000-ohm resistance is taken out of the circuit in both channels when the control is in mid-position. (The small vertical, rectangular bar on the top of R12A and bottom of R12B in the schematic can help you visualize this. The control is shown in mid-position.)

Turn the control either side of mid-position, and resistance will be inserted in one channel, but not in the other. If your tuner has a high output, or your phono cartridge's output is 6 millivolts or more, the modification need not be made.

Remove the covers of the front and rear sections of the control. Then paint a small coating of General Cement No. 20-2 Copperprint solution over slightly more than half the carbon elements, making sure it touches the lug shown and that it does not get on any parts of the control's case. Let the Copperprint dry under a warm light for a few hours, then reassemble the control. Make sure that when the wiper contact touches the Copperprint at about mid-position, the resistance between the wiper arm and the lug touched by the Copperprint is very low. If the resist-

[*Continued on page* 108]

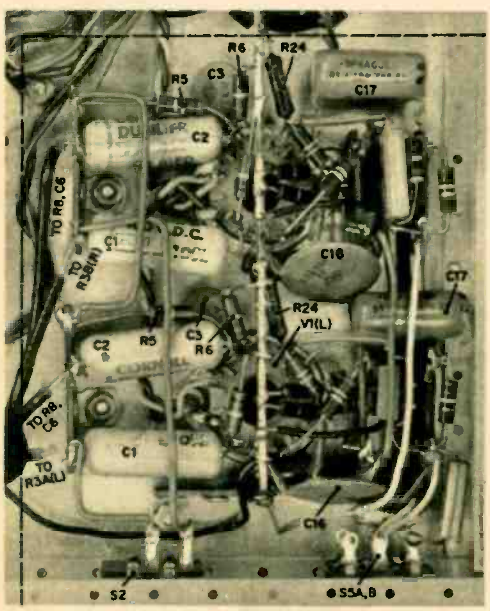


Fig. 6—Photo of preamp section. The wiring is tight and you must squeeze in each part carefully. Note ground buss (running vertically in center).

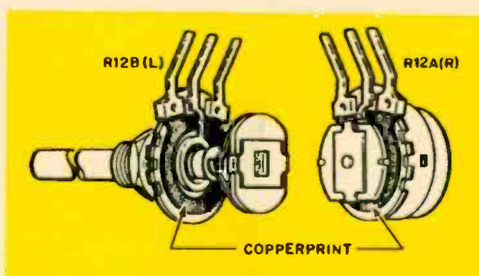


Fig. 7—To modify dual balance-control pot R12, carefully paint slightly more than half the carbon element (left side of front section, right side of rear section) with General Cement 20-2 Copperprint solution. Copperprint must touch lug.

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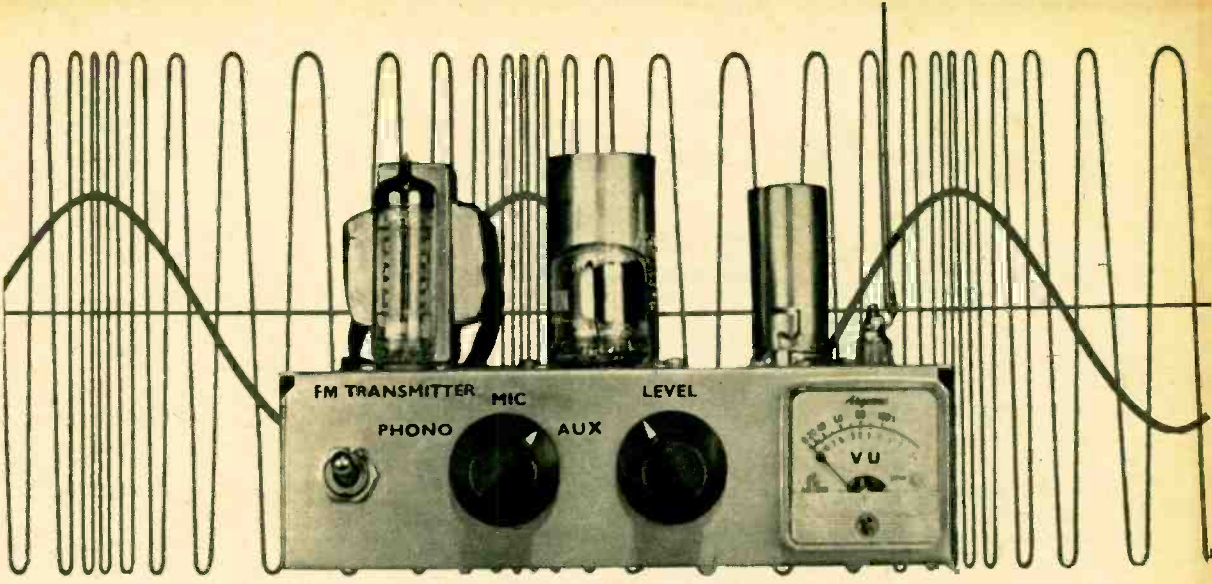

LICENSE-FREE FM TRANSMITTER

By HARRY KOLBE

ONCE UPON A TIME when AM radio was king and TV and hi-fi were only dreams, a gadget called a wireless microphone was popular. You could use it to surprise the kids by telling them over the radio where their birthday presents were hidden, or to shake up a party with a bogus police alarm for one of the guests.

But the most common application was for playing records through a radio without making connections to it. Times have changed. FM radio and hi-fi have made AM wireless mikes look like toys. The transmission range of AM mikes was limited, their signal was subject to interference, audio response was a joke and they were unstable. So why not a wireless mike for FM radios, with all the familiar advantages of FM? There's no reason at all, why not!

Right up with the best-quality FM broadcast transmitters is EI's License-Free FM Transmitter. With the exception of its low output power, its measured performance figures read like the spec sheet of a good professional FM transmitter. The quality of its transmission easily will match the capabilities of the best hi-fi system. By using temperature-compensating capacitors for C22, C23, C19 and C18, we found that transmitter drift was undetectable over a period of several days. With a sensitive FM tuner, its range is 500 to 600 feet, and this is legal, too. Look at what you can do with it:

- Wireless PA. Put a mike and the transmitter on a speaker's podium and broadcast to an FM tuner connected to a remotely-located PA amplifier to save yourself the job of stringing mike wires. Overflow audiences in nearby rooms can hear the speech on an FM receiver or hi-fi system.
- Play records through FM tuners and receivers at different locations in your home.
- Use it as a baby sitter when visiting a neighbor.
- Use it as a low-power broadcast station at a school dormitory or at camp.
- Providing you really know how to use it and know how to service FM tuners, it's a good signal source for peaking the IF's of an FM tuner or radio.

The FM transmitter operates between 88 and 90 mc. Here are some of its other fea-

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FM TRANSMITTER

PARTS LIST

Capacitors
C1—.01 mf, 50 V ceramic disc
C2, C7—.02 mf, 500 V ceramic disc
C3, C4, C15, C17—.01 mf, 500 V ceramic disc
C5A, B, C—40/40/80 mf, 300 V electrolytic (Sprague TVL-3583)
C6—.05 mf, 500 V ceramic disc
C8—1,000 mf, 500 V silver-mica
C9—220 mmf, 500 V silver-mica
C10, C11—.001 mf, 50 V ceramic disc
C12—2 mf, 50 V electrolytic
C13—.002 mf, 500 V ceramic disc
C14—1,600 mmf, 500 V silver mica
C16—470 mmf, 50 V ceramic disc
C18—47 mmf, 600 V temperature-compensating type N750
C19—2.2 mmf, 600 V temperature-compensating type NPO
C20—2.3-15 mmf miniature variable (Hammarlund MAPC-15)
C21—2.2 mmf, 500 V silver mica
C22—100 mmf, 600 V temperature-compensating type N750
C23—10 mmf, 600 V temperature-compensating type N750
C24—470 mmf, 500 V ceramic disc
F1—½-A, 3AG fuse and holder
J1, J2—Phono jack
L1, L2, L3—3.3 microhenry subminiature RF choke (J. W. Miller 70F336A1; Newark Electronics Corp. stock No. 59F218)
L4—Tank coil (see text)
L5—1.5 microhenry subminiature RF choke (J. W. Miller 70F156A1; Newark Electronics Corp. stock No. 59F214)
M1—VU meter (Lafayette TM-10)
Resistors: ½ watt, 10% unless otherwise indicated
R1, R14—470,000 ohms
R2, R11—100,000 ohms
R3, R20—47,000 ohms
R4, R8, R22—1.2 megohms
R5, R12, R29—1,000 ohms
R6, R28—1 megohm
R7—150,000 ohms
R9, R31—22,000 ohms
R10—200-ohm potentiometer
R13—68,000 ohms
R15—1-megohm, audio-taper potentiometer
R16—4.7 megohm, 5%
R17—330,000 ohms, 5%
R18—1,000 ohms, 1 watt
R19—2,200 ohms
R21—3,900 ohms
R23—680 ohms
R24—10,000 ohms
R25—6,200 ohms, 5%
R26—47,000 ohms, 5%
R27—4,700 ohms
R30—470 ohms
R32—18,000 ohms, 1 watt
S1—SPST toggle switch
S2—2-P, 3-pos. rotary switch
T1—Power transformer; 117 V primary; secondaries, 250 V c.t. @ 25 ma, 6.3 V @ 1 A. (Stancor PS-8416 or Allied Radio 62 G 008)
V1—6C10 tube V2—6X4 tube
V3—ECC85 (6AQ8) tube
Misc.—7x5x2-inch chassis, feed-thru insulator, RG174/U coaxial cable

tures: there are high- and low-level input jacks which, in conjunction with selector switch S2, permit the use of a variety of program sources. With S2 in the phono position, a magnetic cartridge with a 2-millivolt output connected to the low-level input (J1) will produce 100 per cent modulation. The other section of S2 provides RIAA equalization, which is accurate within 1 per cent from 20 to 20,000 cps.

When S2 is set to *mike*, equalization is switched out and J1's input impedance is changed from 47,000 ohms to 100,000 ohms. The 2-millivolt sensitivity is more than enough for a high-impedance, low-output mike. Sensitivity also is sufficient for low-impedance mikes, but a matching transformer should be used.

Connect high-output crystal mikes to high-level input J2. At J2 the input impedance is 500,000 ohms and there is 20db attenuation. Program sources such as a preamp, or the preamp output of a tape recorder, also should be plugged into J2 and then S2 should be switched to the *aux*. position.

VU meter M1 is necessary for establishing transmitter modulation level. A 100 per cent indication means the modulation level will be within 10 per cent of the FM broadcast standard deviation of ± 75 kc (100 per cent FM modulation).

The audio-frequency response of the FM transmitter is flat within 1db from 50 cycles to 15,000 cycles. (The transmitter signal incorporates the standard 75-microsecond pre-emphasis.) Distortion at 100 per cent modulation is less than 0.5 per cent. The price for all this is less than $20.

Construction. In order to meet legal requirements for this type of transmitter, you *must* use the parts values specified and must *not* make circuit changes. All parts were selected for physical size and electrical characteristics to insure optimum performance, frequency stability and legal output power. Where we specify temperature-compensating or silver-mica capacitors they must be used. A ceramic disc will not do.

Install all parts where shown in the pictorial, particularly around V3, the modulator/oscillator tube. Oscillator tank coil L4 is 5½ turns of #16 enameled or formvar-coated wire wound on a ¼"-dia. rod. Transmitter output is fed to the antenna through a polystyrene or porcelain feed-thru insulator.

Tightly twist the wires to the tube filaments

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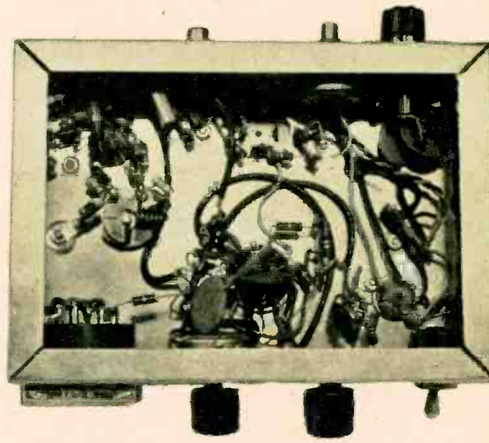
and to the pilot light terminals on M1. *Do not* use the chassis for one side of the filament circuit. And note in the pictorial that the shield at one end *only* of each shielded lead (RG174/U coax) is grounded.

After you're satisfied that all wiring is correct, turn on the transmitter, allow it to warm up for ten minutes and attach a 7-inch piece of wire to the antenna terminal. (The antenna must not be longer than 7 inches or the radiated power will exceed legal limits and transmitter frequency may be lower than 88 mc.)

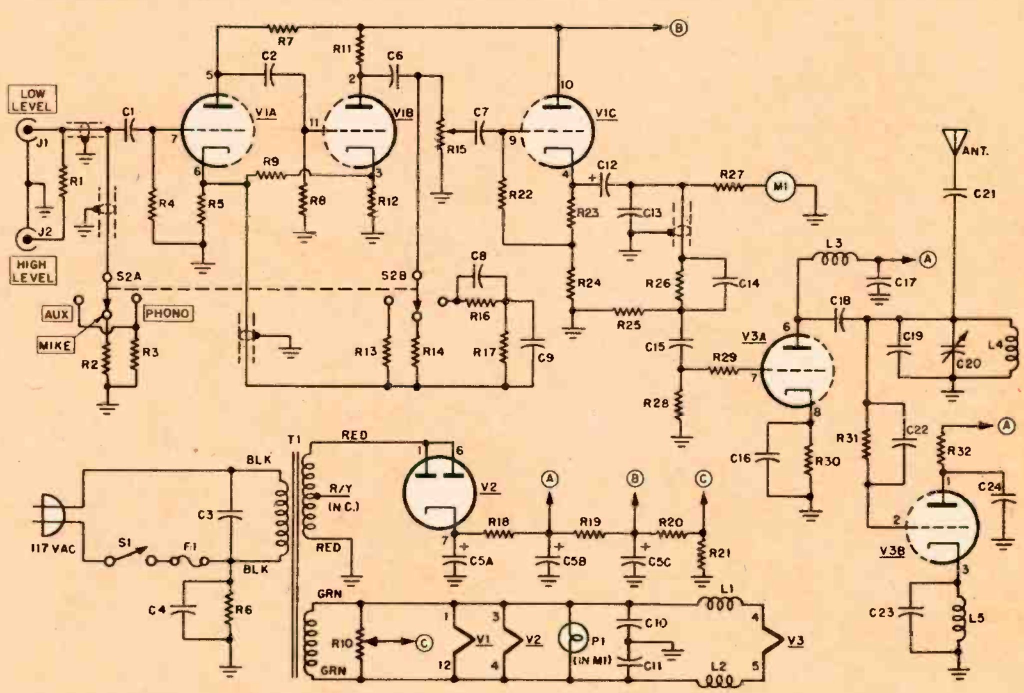
Adjust C20 so its plates are half meshed. Tune an FM receiver or tuner between 88 and 90 mc to find the transmitter signal. If you can't pick up the signal, spread or compress L4 slightly until the signal comes in.

On average program material, level control R15 should be set so the meter indicates between 30 and 40 per cent. A higher indication will cause distortion because on audio peaks the bandwidth of the transmitted signal will exceed the bandwidth of the receiver. Adjust R10 for lowest hum at the receiver.

Modulator/Oscillator Operation. The heart of the transmitter is modified Colpitts oscillator V3B. The capacitive voltage divider which appears in all basic Colpitts circuits



Transmitter underside. Install filament wiring (tightly-twisted leads) first, then build modulator/oscillator in upper left corner of chassis.



V1A, V1B make up audio preamp. Positive feedback from cathode of V1B via R9 to cathode of V1A increases the gain. Negative feedback from plate of V1B via C6 and S2B to cathode of V1A reduces distortion, determines equalization. S2A establishes input impedance. V1C drives meter and modulator.

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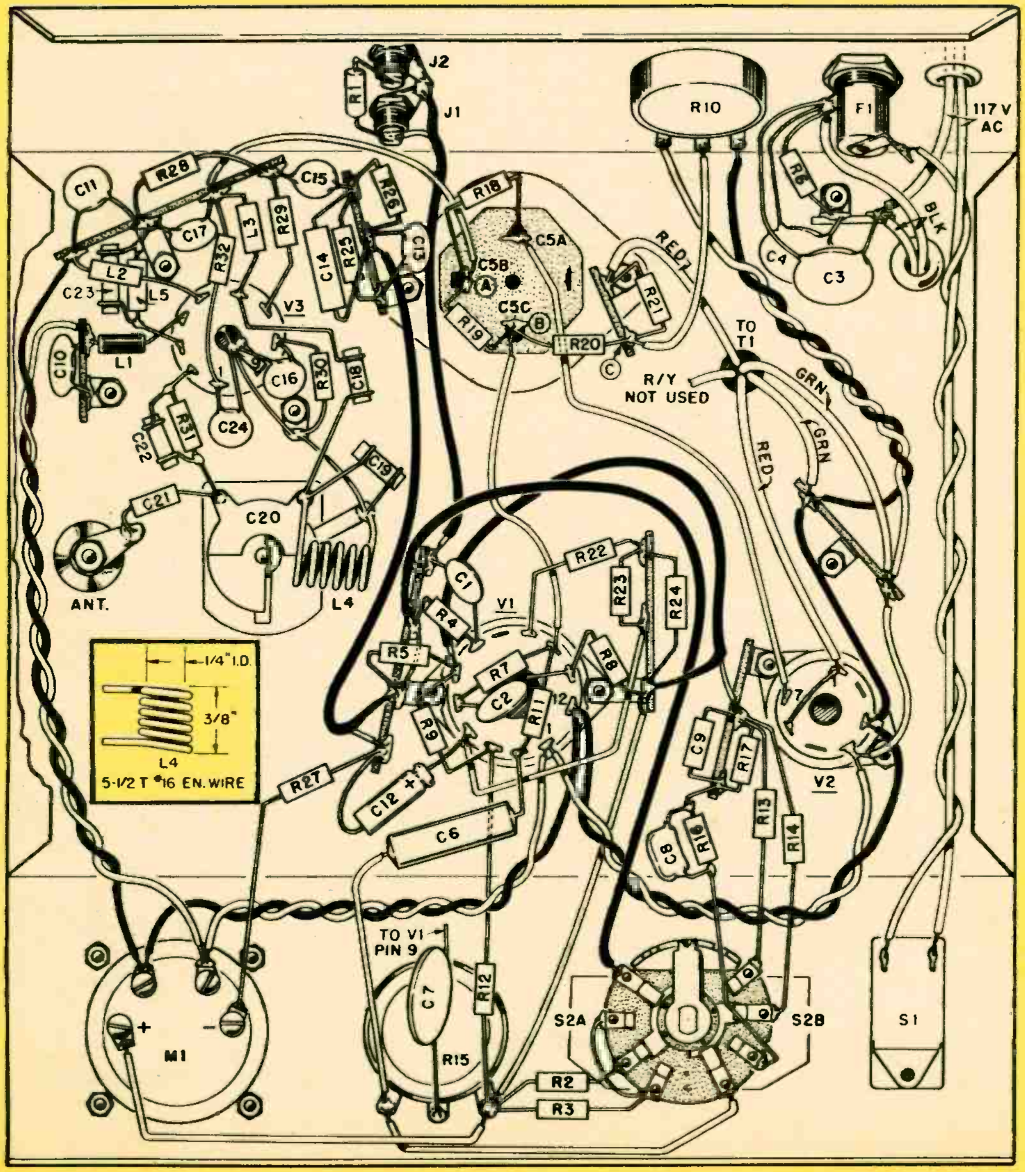
FM TRANSMITTER

isn't obvious at first glance. Here it is formed by V3B's grid-to-cathode capacitance, cathode-to-ground capacitance and C23. The circuit that determines the oscillator's frequency consists of oscillator tank coil L4, C19, C20, the interelectrode capacitances of V3B, the capacitance of V3A and all stray wiring and antenna capacitance in parallel with L4.

V3A, the left half of V3, is what is called a reactance-tube modulator. The characteristic of V3A in this circuit is that it can be made to appear as a capacitive or inductive reactance by changing the voltage on its grid. Since V3A is connected in parallel with the oscillator tank through C18, V3A's reactance

[*Continued on page* 102]

Our transmitter fit on a 5x7x2-inch chassis without crowding. Parts jam in smaller chassis could cause trouble. If larger chassis is used, don't spread out parts around V3—lead lengths here are critical. Note carefully which ends of shielded leads (four black wires) are grounded and where.



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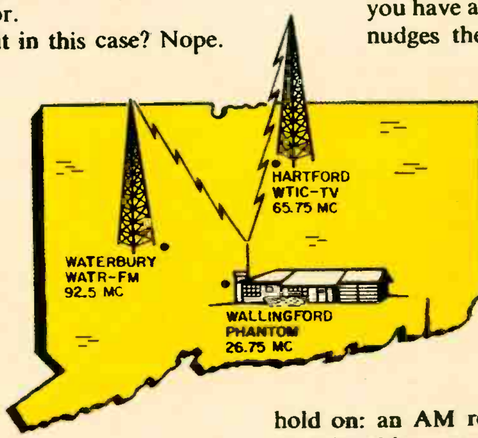
BY LEN BUCKWALTER KBA4480

A PHANTOM STRIKES

WHODUNIT . . . "Mushy audio from a neighbor's TV set comes in on my CB receiver," writes Kenneth Reuben of Wallingford, Conn. "Makes signals unreadable. How can I cure it?"

Before pointing an accusing finger at TVI in reverse, let's give the matter a little of the Sherlock Holmes treatment. What is known as ITV, or interference *from* a television set, usually comes about when a receiver or other gear picks up birdies generated by the TV set's horizontal oscillator.

But is ITV the culprit in this case? Nope. Unless Reader Reuben's neighbor has rewired his TV for laughs, chances of its radiating audio on 27 mc are about as good as finding a brass band in a barber shop. The real source of trouble here isn't a TV set but a TV station. The whole thing represents a curious conspiracy of signals, as we'll see in a moment.



Most common cause of hearing other services on CB is an image. Strong signals outside the 27-mc band spill into the receiver and create the correct frequency needed by the IF stages. In this fashion, police, aircraft, radioteletype and other signals sometimes are heard. But in our correspondent's case, the TV channel is so far removed from the 27-mc frequency that an image is but a slim possibility.

Since Reader Reuben apparently doesn't have an image, what are the chances of a phantom frequency being the culprit? Some investigation revealed these facts: Connecticut-based Mr. Reuben is located near the cities of Hartford and Waterbury. As shown in our drawing, Hartford has a TV station on channel 3, while a Waterbury FM station broadcasts on 92.5 mc. Both signals, therefore, occur in the CB antenna.

And there's the rub. It's possible for the TV and FM frequencies to mix, either in a poor joint somewhere in the CB antenna system or directly in the CB rig's mixer stage. The result: a new signal which lies precariously close to the CB channels.

As it happens, the sound for TV channel 3 is transmitted on 65.75 mc. Combine this with the FM signal on 92.5 mc, and you have a difference frequency that nudges the bottom of the Citizens Band. It's on 26.75 mc which — you guessed it! — is the spot where our phantom lies. And the fact that it exists barely outside the band actually aids the interference.

Here's why. TV sound is transmitted via FM; the CB set responds to AM. But hold on: an AM receiver can reproduce an FM signal by means of slope detection. This requires that the FM carrier be slightly off the frequency to which the AM set is tuned. And it results in sound that tends to be mushy, exactly as reported.

How come the FM-station audio isn't heard too? Simple. In a mixing process, the modulation on the weaker of the two carriers tends to predominate. This relationship would exist in this case.

There are at least two tricks for trying to get rid of our phantom and, once vanished, there's slim chance of its returning, even on Halloween. If a poor joint in the antenna system is acting as our RF mixer, all antenna connectors and connections should be checked and made shiny clean. And if the receiver mixer stage itself is to blame, the interfering frequencies should be killed in the antenna circuit. [*Continued on page* 104]

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THE HAM SHACK

BY ROBERT HERTZBERG W2DJJ

NEW NUMBERS . . . Washington has been playing the numbers game again. How? Well, this time it's three important FCC documents that have been renumbered. Part 12, Amateur Radio Service, now is Part 97; Part 19, Citizens Radio Service, now is Part 95; and Part 20, Disaster Communications Service, now is Part 99. None is available separately—and never was—but the three together constitute what's known as Volume VI of the Rules and Regulations of the Federal Communications Commission.

We'd say every ham should have a copy of Volume VI and one can be yours, by subscription only, at the modest price of $1.25. It's available not from the FCC but from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20025. Since amendments are mailed out as they are adopted, you'll be able to keep up on all FCC actions affecting these three services.

Help for the Handicapped . . . Three cheers for the Metropolitan Ragchewers Club of Detroit. Reason: this public-spirited group has offered to aid any handicapped person in its area who wants a start in ham radio.

We think it's a great gesture and the idea is one that clubs everywhere might adopt with profit—not in terms of money, but in terms of personal satisfaction and public service. After all, you have only to QSO a blind or paraplegic operator to realize how much the hobby means to him or her.

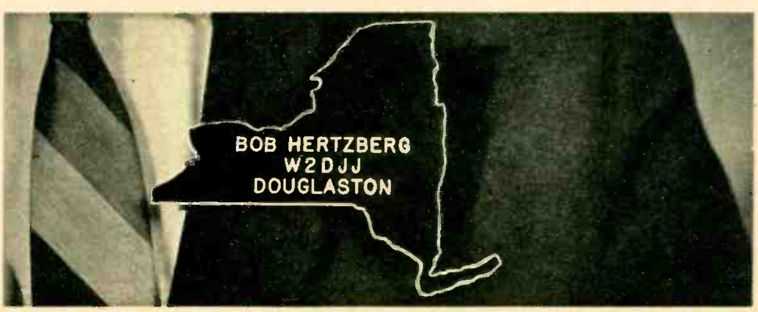
Ralph Peterson, K8PUS, 5336 St. Clair Ave., Detroit, Mich. is president of the MRC. He tells us he'll be happy to give interested officers of other clubs the scoop on the MRC operation. Come on now, fellows. All you have to do is ask!

Wise Guy . . . Seems a Mid-West ham refused to observe quiet hours and was raising pure hell with a bad transmitter. The FCC directed him to appear for re-examination as to his qualifications to hold a ticket. In a sassy reply he issued an ultimatum that all charges against him be dropped or his license be cancelled. One guess as to what the FCC did.

The OM Gamut . . . In ham lingo the term old man indicates any operator, without regard to his real age. However, the actual chronological spread among hams truly is surprising. We recently received a letter from W8OA of Battle Creek, Mich., who is 81 and first was licensed prior to World War I. In the same mail came a note from WN4OYX of Eastman, Ga., who now is 14 and as a Novice must have obtained his license when he was barely past 13. (Novice tickets are good for one year and cannot be renewed.) WN4OYX's handle, by the way, is Steve Whig*ham*.

Thin Ice . . . With many new countries covetously eyeing the ham frequencies, this hardly is the time to give anyone an excuse for disciplining us at international conferences. We refer particularly to those daredevil SSB nets that operate day after day just one kilocycle from the upper edge of the 80-meter band. It's skating mighty close to disaster, if you ask us.

Though lower sideband is the rule on 80, it doesn't take much monitoring to reveal that some transmitters have poor carrier and USB suppression. Anyone else in favor of moving down a notch or two and living less dangerously?



Worn on your lapel, this snappy ham ID tag gives an outline of the state you live in and displays your handle, call and city or town in bold cap letters. Chuck Baer, W9ACE, is the man responsible for this creation. More dope is available from Chuck at 6429EH N. Glenwood, Chicago, Ill. 60626.

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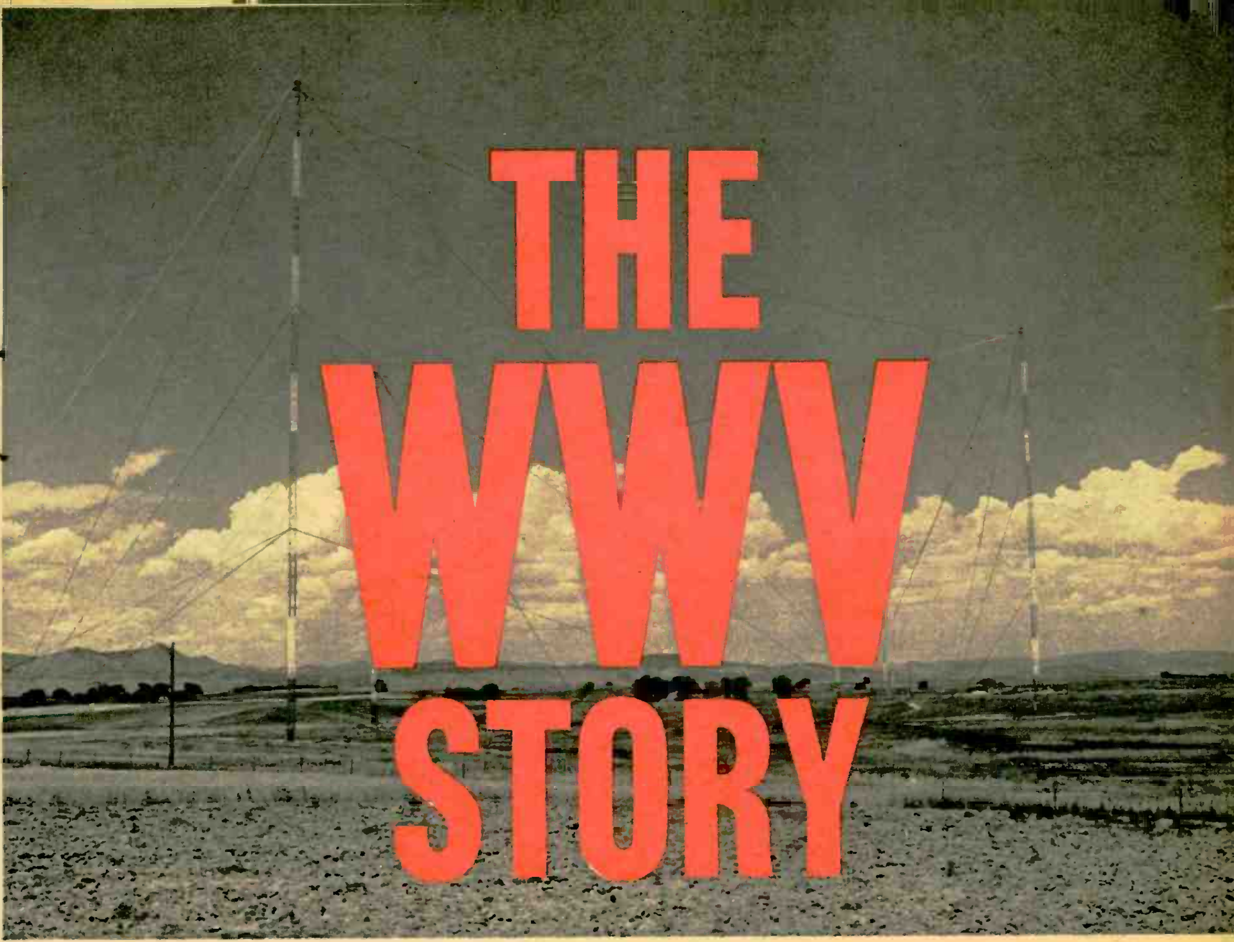
THE WWV STORY



By MARSHALL LINCOLN, K9KTL

"WHEN THE TONE returns, Eastern Standard Time will be . . . 20 hours, 40 minutes." Says who? Says an automated, never-say-die electronic clock-watcher over National Bureau of Standards station WWV. That's who.

Recorded voice announcements, such as that just quoted, issue every five minutes from WWV. The voice is that of a man, of course, but it's some complicated electronic gadgetry that turns him on and off. The announcements are followed by a clear musical tone and a series of evenly spaced clicks whose monotony can drive you batty. But that's WWV, and its transmissions are familiar to most every ham and short-wave listener in America.

But is WWV on the air only to let you know what time it is? What about the tone, the clicks and the occasional Morse code characters WWV puts out? Is there method to this click-and-whine madness?

There sure is. Most listeners have figured out that the clicks in WWV's signal are spaced precisely one second apart, and it doesn't take an Einstein to put this information to good use. But other data contained in these broadcasts are a little less obvious. Do you know, for example, that you can tune a musical instrument or calibrate an audio oscillator with WWV? Or that you can tell in advance how your luck will be with Brazzaville or Budapest, come time for your evening DX haul? Or that you can get advance warning of a magnetic storm or spectacular auroral display straight from the NBS? You can, and these are all part of the information that's available round the clock from the clicks, buzzes and whines of station WWV.

Four Stations. Though we've mentioned only one thus far, there actually are four stations in the National Bureau of Standards hookup. Station WWV itself, located near Beltsville, Md., went into operation in 1923. Station WWVH, at Maui, Hawaii, began broadcasting in 1948. Two other stations—WWVL at Sunset, Colo., and WWVB at Boulder, Colo.—also fall under NBS juris-

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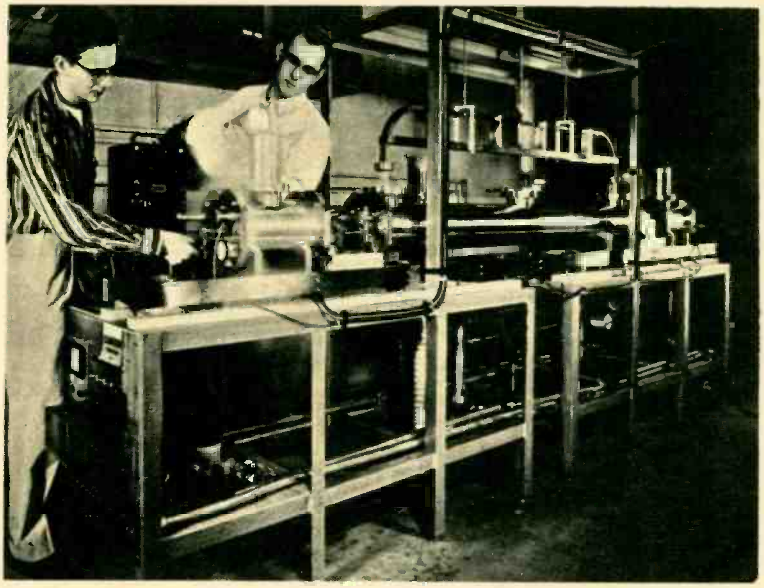


Atomic clock at NBS Boulder Labs keeps time so accurately it would lose less than one second in 3,000 years. Relying on a beam of cesium atoms to chart time, clock measures frequency and time intervals. Here, technician Roger Beehler adjusts the atomic beam detector as Charles Snider pours liquid nitrogen into a cold trap at one end of the instrument. Nitrogen helps form a vacuum so cesium atoms can be beamed through machine without running into molecules of air.

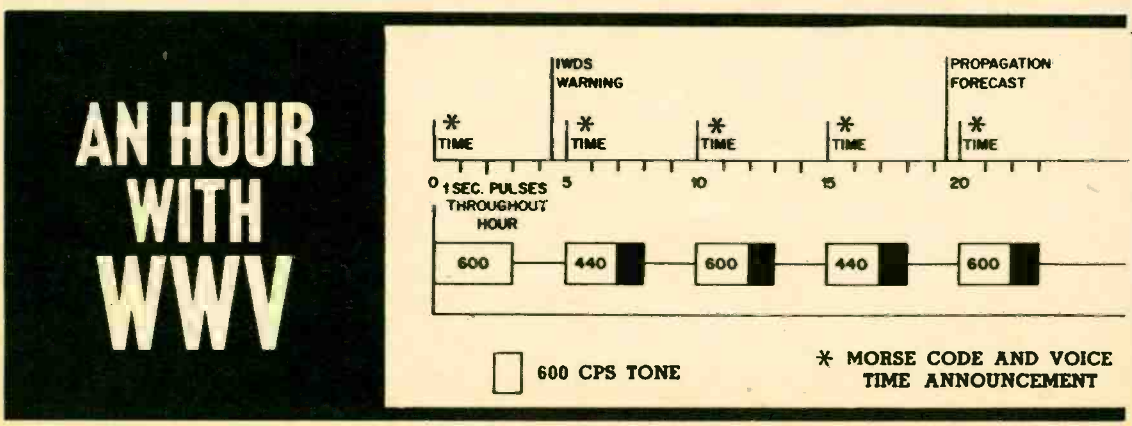
diction, though they aren't heard by most run-of-the-mill listeners. Operating at 20 and 60 kc, respectively, WWVL and WWVB are far too low in frequency to be picked up on ordinary receivers.

Station WWV operates on 2.5, 5, 10, 15, 20 and 25 mc; its sister station, WWVH, transmits on 5, 10 and 15 mc. And these frequencies form precise standards in themselves. All are kept under such tight control that they vary no more than one cycle in a billion. Matter of fact, atmospheric conditions probably alter the frequency of the received signals more than this gnat-sized deviation at the broadcasting end.

Not only are the frequencies held within extremely close limits, but they are precise with respect to one another. All carrier and modulation frequencies at WWV, for example, come straight from a single 2.5-mc quartz crystal. And each is checked against atomic frequency standards maintained by the NBS. In short, if you're about ready to align or adjust a piece of equipment, you have available some frequencies that are as accurate as modern technology can make them—straight from WWV.

Wide Coverage. No matter where you are in the nation, you should be able to hear at least one of the transmitters from either WWV or WWVH any time of the day or night. You even may be hearing WWV and WWVH simultaneously, though their signals are so well regulated you won't realize it.

All three transmitters at WWVH radiate 2 kilowatts of power. At WWV, the 2.5- and



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What NBS Stations Offer the Listener				
Call	WWV	WWVH	WWVB	WWVL
Location	Beltsville, Md.	Maui, Hawaii	Ft. Collins, Colo.	Ft. Collins, Colo.
Frequencies	2.5, 5, 10, 15, 20, 25 mc	5, 10, 15 mc	60 kc	20 kc
Services				
Standard Radio Frequencies	X	X	X	X
Time Signals	X	X		
Standard Audio Frequencies	X	X		
Standard Musical Pitch	X	X		
Radio Propagation Forecasts	X	X		
Geophysical Alerts	X	X		

Four stations at four different locations comprise what might be called the NBS network. Mainstay of the system is station WWV, though station WWVH broadcasts the identical data. Low-frequency stations WWVB and WWVL provide standard frequencies only, but both will broadcast time signals in the near future. Because low-frequency signals are not subject to ionospheric reflection, signals from WWVB and WWVL are much more accurate than those from WWV and WWVH.

20-mc transmitters put out 1 kw, the 5-mc rig puts out 8 kw, the 10- and 15-mc rigs 9 kw and the 25-mc rig a mere 100 watts. The 2.5-mc signal from WWV and the 5-mc signal from WWVH come from vertical quarter-wave antennas, but vertical half-wave dipoles handle all other transmissions from both stations.

Time Signals. A few seconds before the beginning of each five-minute period on the clock, you hear WWV's call given twice in Morse code. This is followed by another set of Morse characters—four in number—announcing what the correct Eastern Standard Time will be at the start of the tone.

Next comes a voice recording that says, "National Bureau of Standards, WWV. When the tone returns, Eastern Standard Time will be . . ." Shortly thereafter, a musical tone is heard. At the beginning of this tone, it is exactly the time stated by the recording—within the almost infinitesimal deviation permitted by the NBS, of course. All times, by the way, are based on the 24-hour clock system.

There is one exception to this time-signal schedule, however. Beginning at 45 minutes after the hour, the WWV transmitter remains silent four minutes. And three minutes of silence is observed by WWVH beginning precisely on the hour and on each quarter hour.

If the time is on the hour, the tone continues for three minutes, with the one-second pulses superimposed. Then the tone ceases and the pulses continue for two minutes. If

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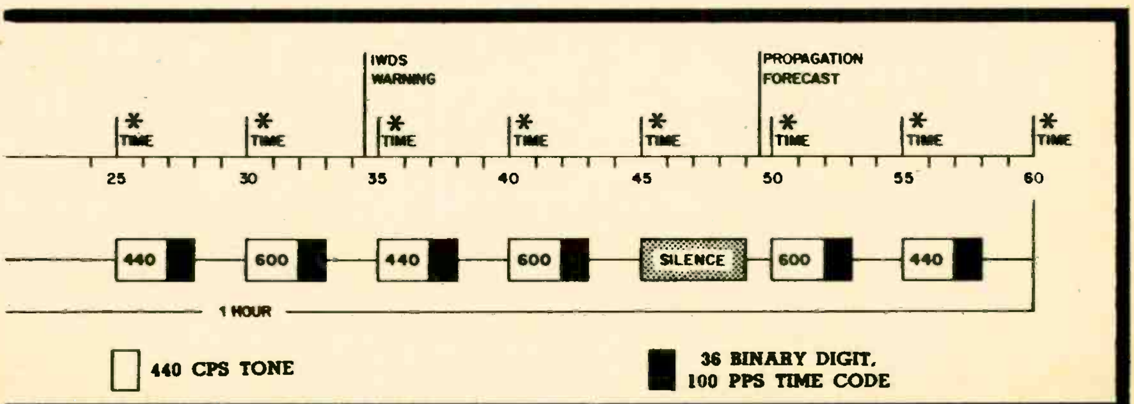

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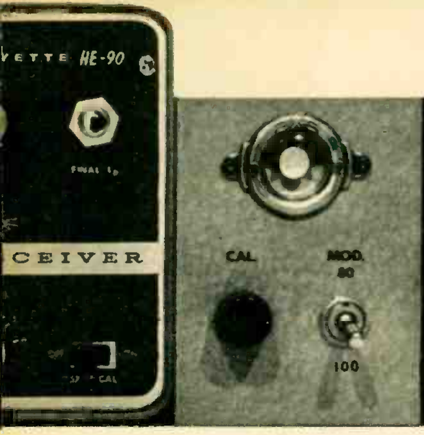


Big I
CB Modulation Monitor

THE Citizens Band has become so crowded that mike preamps, compressor/limiters and clippers—once considered accessories—have become musts if you want your signal to slice through the QRM.

But the addition of any of these little helpers may cause overmodulation and, though your signal will end up sounding louder, it may also be unintelligible. Conversely, if signal boosters aren't adjusted properly your modulation level could come out lower than it would be without them.

The best-sounding signal will be the one whose peaks you can monitor as you talk. All it takes to monitor it this way is EI's Big-I CB Modulation Monitor, which warns you visually when your modulation level exceeds either 80 or 100 per cent. Since there is no important difference at the receiving end between 80 and 100 per cent modulation, setting the gain control on your rig to produce 80 per cent will make your signal an effective one with a good margin of safety.

The Big-I is designed to indicate negative modulation only. Why? Because it is negative modulation — and not positive — that can cause distortion and illegal sideband splatter when the level goes above 100 per cent.

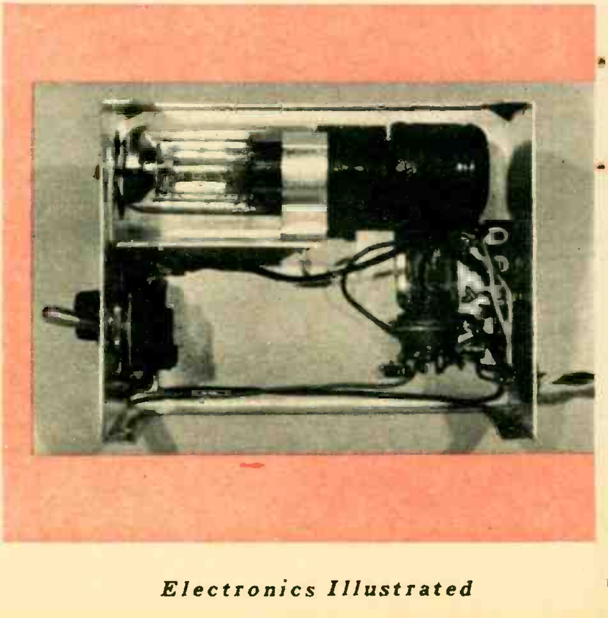
The Big-I is designed for CB rigs whose B+ is 275 V or less. If your set's B+ is higher than 275 V, do not try to use the Big-I with it.

Construction. Our Big-I is built in the main section of a 3x4x5-inch Minibox. While the layout isn't critical, try to follow the pictorial as closely as possible. Magic-eye tube V2 is mounted in a standard Amphenol tuning eye assembly which you must modify by removing the green and orange wires (some assemblies may not have an orange wire). Then solder R1 between pins 3 and 4, making certain its leads do not touch other terminals or the socket cover.

Mount V1 on a small L-bracket made from scrap aluminum or tin. For ventilation, drill several small holes in the Minibox over V1 and below its base. *Do not* substitute silicon diodes for V1.

Connection and Calibration. Connect the leads from V1's and V2's heaters to the CB transceiver's 12-volt filament supply. (If your rig has a 6-volt filament supply, substitute a 6AL5 for V1 and a 6U5 for V2.) Connect the Monitor's lead X to the point we've marked with an X in our typical schematic shown on the second page of this article. This is plain B+. Connect lead Y to point Y (which is modulated B+). Point Y is near the final RF stage. Studying the partial schematic we present here will help you find points X and Y in your own transceiver.

Turn on the transceiver and hold it on



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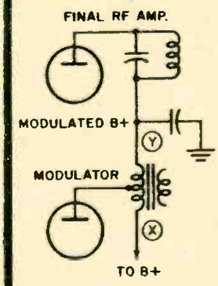
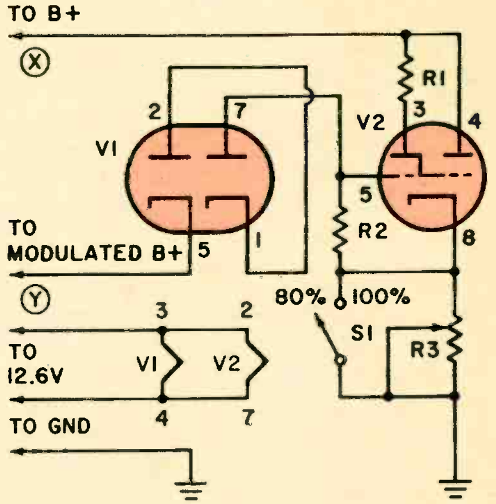


Portion of a schematic typical of most CB transceivers. With the schematic of your rig at hand, locating points X and Y won't be difficult. Connect lead X of the Monitor to point X (B+) in transceiver and then connect lead Y to point Y (modulated B+).

transmit. Using a VOM, measure the voltage between point Y and ground. Next, set S1 to 80 per cent, connect the VOM across R3 and adjust R3 until the VOM indicates *half* the voltage you measured between point Y and ground. The Big-I is now calibrated to indicate modulation over 80 per cent. The 100 per cent modulation calibration is taken care of automatically when you set S1. To prevent changing the setting of R1 accidentally, use a screwdriver-adjust type pot.

Using the Big-I. When S1 is set to 80 per cent, V2's shadow will flicker only when the modulation *exceeds* 80 per cent. Set S1 to 100 per cent and V2 will flicker when your modulation exceeds 100 per cent. The best modulation level is one that causes the eye to flicker almost continuously at the 80 per cent setting of S1 but causes no flicker at the 100 per cent setting. —*Bert Mann*

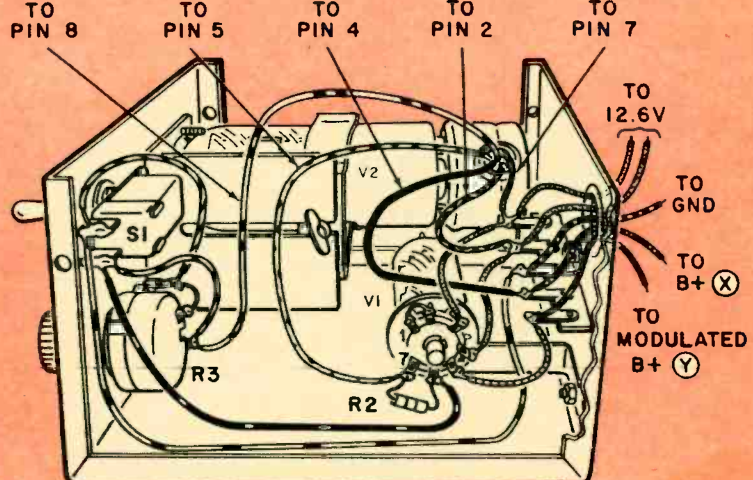


With S1 in 80 per cent position, both halves of V1 conduct when modulation exceeds 80 per cent. Plate of right half of V1 and grid of V2 go negative with respect to ground and V2 flickers.

PARTS LIST

- R1—1 megohm, ½-watt resistor
- R2—220,000-ohm, ½-watt resistor
- R3—200,000-ohm potentiometer
- V1—12AL5 or 6AL5 tube (see text)
- V2—1629 or 6U5 tube (see text)
- S1—SPST toggle switch
- Misc.—Tuning eye assembly for 1629 tube: Amphenol type 58-MEA 8 (Lafayette CM-50) or tuning-eye assembly for 6U5 tube: Amphenol type 58-MEA 6 (Lafayette CM-49); cabinet; terminal strip.

Mounting bracket for V2 is supplied with Amphenol tuning-eye assembly. Mount it as high as possible in cabinet to allow room for V1, whose socket is mounted beneath it with small L-bracket. Resistor R1, which is not shown here, is installed between lugs 3 and 4 on socket of eye-tube V2.



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HI-FI TODAY

By John Milder

✔ *Something to watch when choosing speakers*

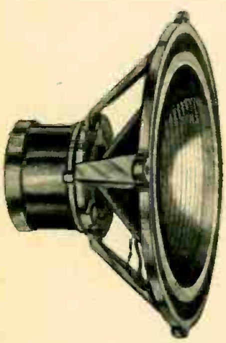
✔ *The bugs come out of transistor amplifiers*

✔ *Putting the stylus-angle theory into practice*

NEW SPEAKERS in all sizes and prices continue to flood the market, and some people have resurrected an old cliché on how to choose one. The story goes that you really can't measure a speaker's performance on paper. In other words, a speaker's overall sound quality can't be revealed by response and distortion charts.

If you accept this premise and look at speaker design as some kind of black magic, you move on to an even older cliché. That one makes choosing a speaker purely a matter of personal taste. In the final analysis, everyone is his own best expert on what sounds good . . . or so the argument runs.

I'm not in full agreement with these points of view. In fact, I think speakers have improved over the past few years largely because manufacturers have realized that you *can* measure some critical aspects of speaker performance quite precisely. And it's ironic that people who should know better are going back to the old everyone-to-his-own-taste approach at a time when more and more manufacturers are filling in more and more blanks in the speaker-design picture.



This isn't the place for a long dissertation on speakers, but I would like to outline at least one way to size up a speaker's performance from a spec sheet or a test report. I won't begin by belaboring the need for flat response. It's enough to say that good speakers show no sudden or severe dips or peaks on their response curves. Probably the only permissible variation is a dip near a crossover frequency, which seems to have little audible effect.

All speakers, of course, have some bumps on their response curves. Which ones count? And how do you distinguish between two speakers that look reasonably similar at first glance? A good place to start is at the top. If two speakers seem to have extended high-end response, the place to look for important differences in their sound is in the dispersion patterns.

For smooth, listenable highs, a speaker's response must look good not only when it's measured directly on-axis in front of the speaker, but also a number of degrees off axis. Otherwise, you're going to end up with a beam of highs that's straighter than a tightrope-walker's balance stick.

When it comes to selecting speakers, by all means choose the one that sounds best to you. But don't ignore those curves while you're at it. Sure, you'll get nowhere fast trying to make paper judgments of two speakers whose best (i.e., on-axis) response is given by itself. But curves that give you overall dispersion patterns *will* give you some helpful guidelines.

It looks as though manufacturers are starting to get the hang of de-bugging transistor amplifiers. Most of the new ones have reasonably foolproof provisions for protecting output transistors against no-load conditions and short circuits. And there also is protection against shunting DC to a speaker's voice coil. All of this is good news, of course, and nobody seems to doubt that these features will be standard on even the least expensive transistor amplifiers before long.

A few months back I had a bit to say about the stylus-angle problem in stereo records. What it boiled down to was that I hoped to see both cartridge and record manufacturers get around to accepting the RIAA's proposal for a standard 15-degree vertical angle for cutting and playing stereo discs. Well, there's been some progress worth reporting. The cartridge makers, at least, have started to

[*Continued on page* 102]

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BEGINNERS PAGE

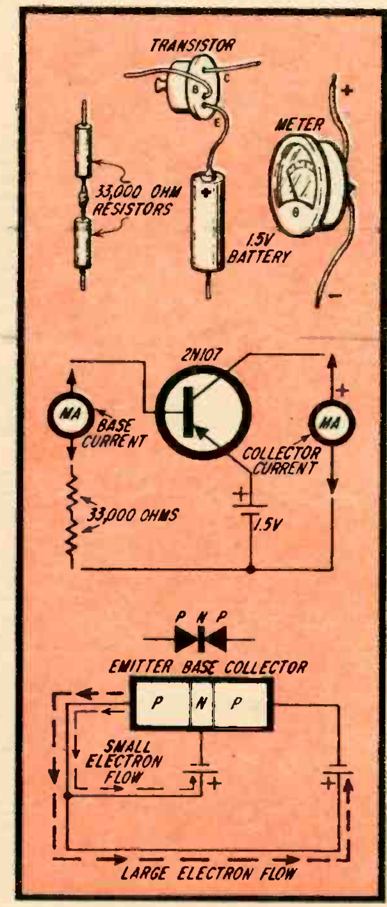
THE TRANSISTOR

THE transistor's job is amplification—increasing the strength of a small signal, such as at a transistor-radio's antenna, several million times so it can drive a speaker. Let's see how this works out with a 2N107 transistor and a few other parts.

First, we'll feed a small current into the transistor. Look at our drawings and make the following connections: collector lead (C) to the negative end of the battery, positive lead of the 0-1 ma meter to the base (B) of the transistor and negative meter lead to the top resistor.

Now, connect another lead from the negative end of the battery to the bottom resistor. The meter needle should move to the first small dial marking. Touch the negative battery lead to the junction of the resistors and the needle should move to the second small dial marking. These two currents, about 20 and 40 microamperes, are the currents to be amplified.

Let's see what happens at the transistor's output. Hook the meter's positive lead to the collector lead and its negative lead to the negative end of the battery. Connect the base to the top resistor and the bottom resistor to the negative end of the battery. The indication will be about 0.4 ma. Touch the negative end of the battery to the junction of the resistors. The meter indication will double. These larger currents at the output are produced by the transistor's amplifying action.



Compare the readings you obtained in the experiments and you'll see that both small currents are amplified the same amount—about 20 times (i.e., 0.4 ma output current/20 microamperes input current=20).

The schematic and diagram below it show what's going on. Electrons from the negative end of the battery flow up through the resistors and the meter to the base (dark vertical bar). They continue through the base to the emitter (arrow) and return to the positive battery terminal. This is the emitter-base, or input, circuit. In the output circuit, electrons flow up through the meter at the right, to the collector, down through the base to the emitter, and back to the battery.

It is in the base, through which electrons in both the input and output circuits flow, that control is exercised. As we saw, a small signal applied to the base controls a much larger electron flow between the collector and the emitter. And when a small signal controls a large signal we have amplification.

Actually, the base acts like a variable resistor. The word transistor comes from *tran*sfer and re*sistor*. This is because the input circuit transfers small-input current changes to larger changes in the output circuit by varying the resistance between the collector and emitter. Electrons get from the collector to the emitter because the base is extremely thin.—*H. B. Morris*

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KIT
EI
REPORT

A BUILD-IT-YOURSELF COLOR TV RECEIVER


Heath's color TV set as it is presented in company's ads and promotion pieces.

EI reports on the Heathkit GR-53.

THE most striking bit of information about Heath's Model GR-53 kit lies in its identification—a color television receiver. There are some mighty sophisticated pieces of electronic gear around today but amongst consumer products nothing compares in complexity with color TV. The idea of selling something that complicated in kit form is an audacious thought. Yet Heath has done it—and with marked success.

The leading question for the average person probably is: do I know enough to put a kit like that together? The answer, according to our experience, is yes for just about everybody, electronic hobbyist or not. In our opinion, assembling the GR-53 becomes more of a mechanical project than an electronic one. You don't have to know what a resistor is for to get it in the right place. You simply must be able to read and follow instructions. However, we do not recommend Heath's color TV set as a first kit for anyone. The prospective builder should have two or three kits behind him—preferably including at least one major-size job—before tackling the GR-53. A little experience can make parts identification easier, it gives you more confidence that the set will work properly when you finish, and it equips you to face up to the large number of components involved here.

EDITOR'S NOTE

In its regular reports on electronic kits, EI normally presents wide variety, both in products and manufacturers. However, one firm, the Heath Co. of Benton Harbor, Mich., recently introduced two outstanding new kits within a relatively short time. Each of the kits, a one-band single-sideband transceiver and a color TV receiver, holds sufficient interest for our audience to merit a report. Therefore, EI here goes contrary to usual practice and presents major reports on two kits by the same manufacturer.

The kit, when ordered with cabinet, comes in four impressive shipping cartons. One is a desk-size monster containing the cabinet. A slightly smaller box holds the cathode-ray tube and the two smallest cartons require all the work, for they hold the chassis and myriad components. The GR-53 which we built tunes only VHF stations and is priced at $349 without the cabinet, which costs $49 extra. All kits manufactured after April 1 are designated GR-53A and, as required by the new federal law, tune both VHF and UHF. The GR-53A's basic price is $399 plus cabinet. The GR-53 will be available only so long as the supply lasts.

Can you save money by buying color TV in kit form? The answer in general is yes but it would depend partly on the value of your time and whether you make a model-for-model comparison. Color TV as we know it was invented by RCA and many of the circuits are patented by the company. In any color set you will find a lot of RCA, just as in any radio you will find a lot of Armstrong circuits. The Heath receiver uses many basic

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COLOR TV RECEIVER

RCA circuits (on license) and an RCA picture tube.

When you buy the GR-53A with cabinet you get a de luxe console receiver for roughly $450 plus 25 hours or more of work. Comparable factory-assembled consoles by Zenith run from $580 to $755 (New York prices) and RCA consoles range from $579.95 to $755 (FOB Indianapolis). Zenith offers a table-model color set, which can't be compared directly with the Heathkit, for $479.95 (New York) and RCA markets one for $525 (FOB Indianapolis).

In its promotion and advertising, Heath claims you can put its color TV together in 25 hours. For a builder with some experience, the claim seems justified.

Our builder was a novice with only a little experience. He is the slow, careful type, too. According to his figuring, he spent 26 hours and 40 minutes in wiring the GR-53, another two hours in unpacking the kit at the beginning and four hours and 30 minutes getting the whole thing together in the cabinet. That adds up to 33 hours and ten minutes.

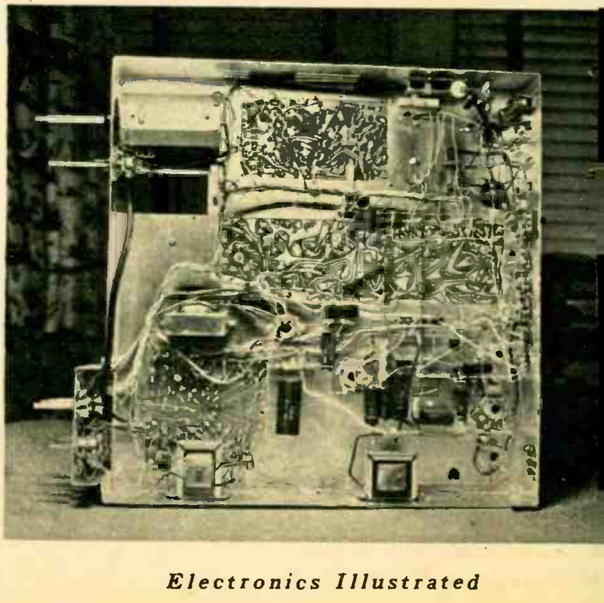
At that point our builder turned the set on for the first time and got a slight dent in his ego. The sound came on in fine fashion but there was nothing on the screen. Troubleshooting turned out to be relatively painless in this case with an easily-read schematic provided by Heath. Our builder, neophyte though he is, can count pins on a tube. His checking indicated low voltages on some of the pins of the picture tube. Two hours of looking turned up a focus anode lead that was connected to ground rather than to a 3,000-volt line where it was supposed to go. Correcting the wiring error produced a picture on the screen. Just a little later one of the main resistors in the power supply opened and the set went out again. Finding and replacing the component took an hour.

With an operating color set once more at hand, our builder started the convergence procedure. Color receivers have three electron guns in their picture tubes—red, green and blue—and, consequently, three images on the screen. Convergence means getting the three images together. Also involved is the process of getting the red beam to hit only the red phosphor dots, the green beam to hit the green dots and so on. Heath's procedure, repeated three times by our builder to obtain the best convergence possible, took four hours.

So, after spending 40 hours and ten minutes with the GR-53, our builder was ready. It was on a Sunday evening and Meet the

Color circuit board (shown at lower left) and sound-sync board (right) are wired by builder.

Completed chassis. IF circuit at top is already assembled by Heath, as is tuner at upper left.



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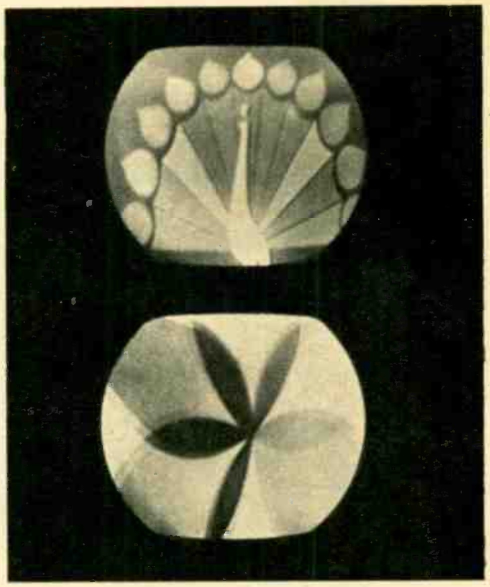
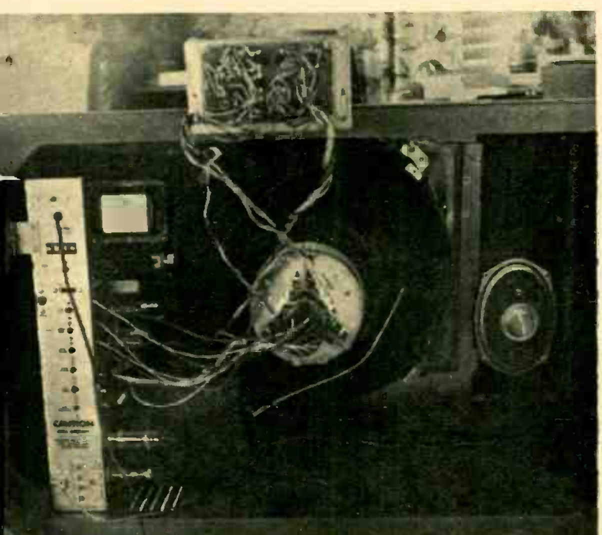
Picture tube of GR-53 is handled with great care by our builder, who has on goggles for safety.



These images, taken from the screen of the GR-53, appear in color preceding color programs on NBC.

Press was coming on in color on NBC. The family gathered around and at the right moment our chap flipped on the set. No one in the group was familiar with color TV and they were pleasantly surprised and impressed by what they saw. They discovered, as have tens of thousands of others, that color really does add an extra dimension to television enjoyment. That discovery has made for a boom in color TV, which seemingly took a long time to get off the ground.

Color TV set with chassis at left, CRT in center, speaker at right; convergence control is at top.



Heath has had a lot of experience with kits and manuals since they came out with a pioneering kit for an oscilloscope almost 20 years ago. Consequently, they should know how to put together instructions that are both readable and accurate. The GR-53 manual shows that they do. The book is a hefty one, weighing in at 1 pound 2 ounces and having almost 140 pages, counting cabinet instructions. It's an excellent one. We found no errors in the book and no obscure instructions. Assembly is in logical sequence and the steps leave no gnawing questions of interpretation.

Unlike most kits on the market, the GR-53 can be educational to a degree. The manual contains a discussion of color TV theory that runs to some 16 pages and can be studied before assembly begins. Also in the book are an 18-page description of the particular circuits in this set and a two-page section on servicing.

A particularly attractive and unique feature of the manual is two large fold-outs containing 32 full-color illustrations that are used

[*Continued on page* 115]

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KIT EI REPORT

Heathkit HW-12

SSB TRANSCEIVER

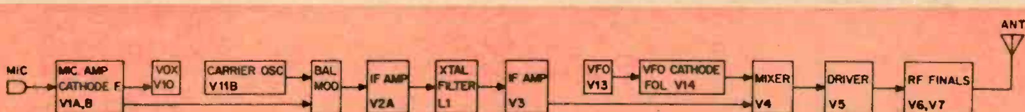
THE PLANS every ham has of going single-sideband (SSB) too often go astray because of the high cost and complexity of the equipment involved. Factory-built SSB stations can cost as much as a used car. But Heath's new one-band SSB transceiver kits (not available assembled) can turn the dreams of low-budget amateurs into reality.

Each of the three models for 20, 40 or 80 meters costs $119.95, less power supply, speaker and microphone. Any 8-ohm speaker will do. A matching PTT mike runs $6.95 extra. A solid-state AC power supply is available for $39.95 and a 12-volt job for mobile operation costs $59.95.

Input power of each model is 200 watts P.E.P., and operation is confined to top 200 kc of each band, where SSB stations normally are concentrated. The 20-meter Model HW-32 works only on upper sideband; the 40-meter Model HW-22 and 80-meter Model HW-12 operate only on lower sideband. There is no provision for sideband selection, AM phone or for CW. PTT and VOX circuits are built-in. By eliminating tuning coils, function switches and related components found in multi-band sets, Heath was able to simplify circuitry and construction to a great degree. Receiver sensitivity is said by Heath to be 1 microvolt for a 15db S/N ratio.

We built the 80-meter Model HW-12, which includes 14 tubes, in about 35 hours. The schematic is too large to print here, but the block diagrams below show the important circuit elements.

Hams who have built their own equipment or other large kits will find the HW-12 no trouble to get together. Most of the components mount on a printed-circuit board, and a pre-formed wiring harness takes care of most other connections. The manual contains a few errors, which the builder should



Transmitter. Balanced modulator mixes 2606.7-kc signal from V11B with audio. Lower sidebands only get through crystal filter to combine with VFO output at V4. Signal goes through V5, V6, V7 to antenna.

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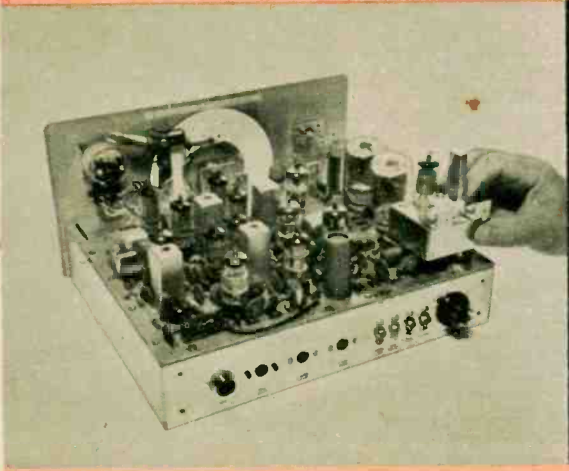
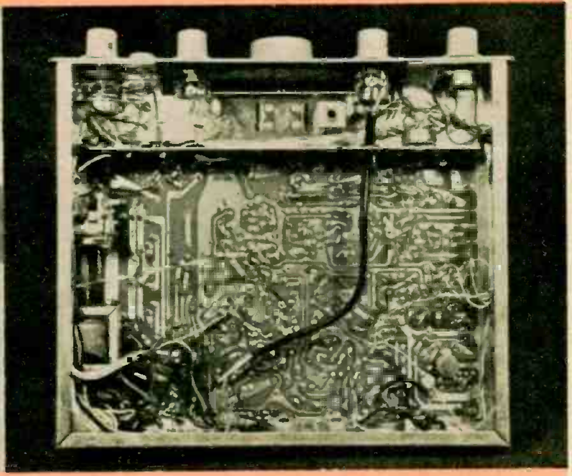




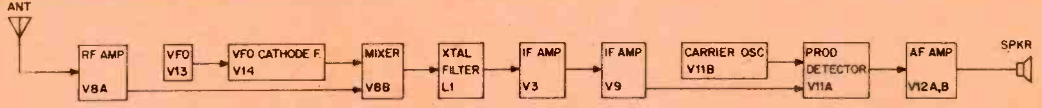
Completed transceiver (left) is packed with parts. Printed-circuit board is wired and then mounted on main chassis. Positions of components on board are well marked. Pre-formed cable harness fits inside chassis at edge (right photo). Hand-held unit at right side in left photo is plug-in crystal calibrator.

be able to catch easily. For example, the leads to the audio-gain control are reversed in a pictorial but are correct in the schematic.

Alignment, the bugaboo of all high-frequency equipment, has been pretty well solved. The only critical adjustment is the VFO but it is brought into rough alignment with a standard broadcast receiver (a procedure also is outlined in the manual for aligning the VFO with an amateur-band receiver). You just lay a piece of wire near the VFO cathode-follower tube and connect the other end to the radio's antenna terminal. You then tune the broadcast receiver to a station near 1495 kc and set the dial of the transceiver to 3.8 mc. Next, you turn the VFO tuning-coil slug until you hear a whistle from the broadcast receiver. The process is repeated at 1695 kc for 4 mc. While this technique won't produce exact VFO alignment, it will at least get the VFO in the ball park for final tune-up. Fine adjustment of the VFO's slug and trimmer capacitor is made by using the Heath HRA-10-1 100-kc crystal calibrator to establish band edges. It is sold as an accessory ($8.95) but it's a must.

Driver transformers L2 and L3, which are used for both transmitting and receiving, are factory-adjusted and don't have to be touched. With the VFO calibrated, some signals should get through the receiver. Final touch-up of the receiver's IF's can be made by ear or with the front-panel tuning meter. The transformers in the transmitter section use the carrier oscillator's output for tune-up. All that's needed as an indicator to tune up the final is a VTVM connected to a dummy load.

In its first quick on-the-air test, the HW-12 settled down to rock-like steadiness in about five minutes. Selectivity and stability were excellent and in all ways the HW-12 measured up to its stated specifications.



Receiver. Incoming signal mixes with VFO output at V8B to produce 2305-kc IF signal. L1 removes interference. Product detector V11A mixes IF signal with output of carrier oscillator V11B to get audio.

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AWARDS FOR THE HAM SHACK

By FRANK ANZALONE, W1WY

DEPENDING on what kind you might be thinking about, paper can be practically worthless or more valuable than diamonds. Take yesterday's newspaper and the United States Constitution as sample extremes. Or a paper napkin and a $1,000 bill.

Radio amateurs have their own kind of G notes which, at the same time, could be seen as perfectly worthless. It all depends on who does the looking. To a good many hams, frame-and-hang awards or certificates are almost as dear as life itself. The average non-ham would sooner have a paper plate and, so far as that goes, a lot of amateur licensees couldn't care less. To the certificate hunter, though, food and sleep and women are so much bother.

You might say ham awards are like college diplomas. No one but the person who gets one can know the hours and years that went into the quest.

Amongst awards, of course, the dyed-in-the-wool hunter sees some that are more desirable than others. A few ham certificates, like calendars, can be used to cover a spot on the wall. And others mean as much to a ham as the Davis Cup to a tennis player.

Few can be earned in an evening, since most demand the kind of skill that can come only from weeks, even years of the right sort of practice. And all take a goodly measure of stick-to-it-ivity, along with as much old-fashioned luck as you can scrounge up. In short, skill, perseverance and luck all go on the hook it takes to snag a ham award.

Soup to Nuts. Though there are more than 1,000 awards a ham might win, it's possible to group them into three big categories. Dwarfing every other class are those which are awarded for having established contact with a given number of other stations. Two other types of awards—those resulting from a competition of some sort and those based on what we'll call merit for lack of a better term, are far fewer in number.

Since both of the latter types are issued largely by the big ham organizations—the American Radio Relay League, for instance—we won't attempt to cover them here in detail. The competitions or contests take place only periodically and the merit awards ordinarily go to the real pros in the business.

Because the number-of-stations awards presumably are the easiest to obtain, they are by far the most popular. Matter of fact, there hardly is a radio organization or club in the world that doesn't offer a certificate of some sort for working a given number of stations

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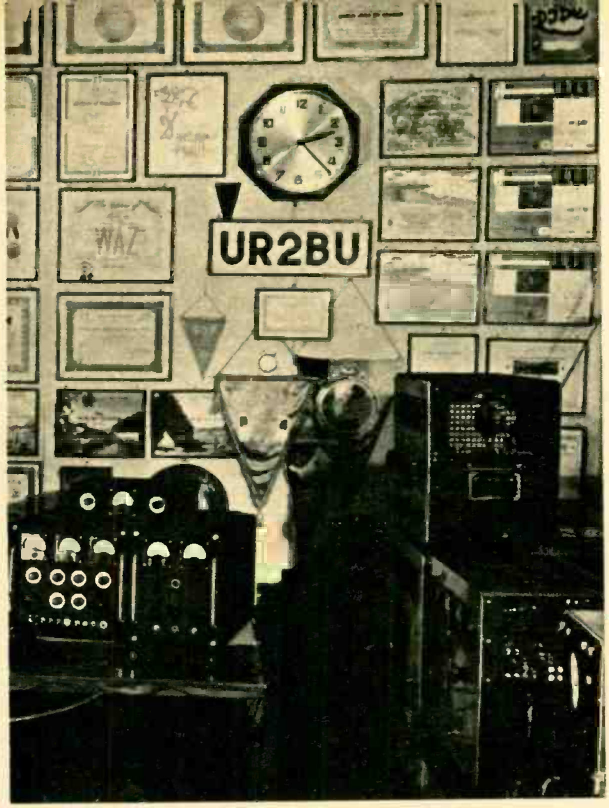

Those certificates are anything but wallpaper to amateurs, who'd no sooner part with them than with a left eyetooth. And, while the ionosphere is notorious for handing out luck on a strange basis, most awards are won by a combination of skill and sweat.

in some area or other. Then, too, many clubs offer awards to their own membership, based simply on one member having worked a certain number of other members.

A little investigation into the number-of-stations awards reveals that some are distinctly in the tough-sledding category, however. For example, one ham we know managed to qualify for the Michigan Week award, a one-shot affair, in less than half an hour. But it took him more than ten years to catch up with England's Magazine DX award, though it, too, was based on the number of stations worked.

Reason was that the first award required nothing more than contacting five Michigan stations, a feat that's ordinarily a snap for anyone who can pin down a W8 call when he hears one. But requirements for the English award were as tough as those for the Michigan award were easy.

To begin with, the English award demanded a minimum of 405 contacts with stations in 180 different countries. Worse yet, the contacts had to be made on each ham band, 10 through 160 meters, with the exception of the 15-meter band. Throw in the facts that DX on the 10-meter band varies from year to year with the sunspot cycle and that 160 meters is a poor DX bet in any season and the hurdles become pretty obvious.

Counties & Countries. Since requirements do differ markedly, which awards are the ones hams usually go after? First on the list to be considered are EI's own DX awards, which are based on the number of countries worked. Attractive certificates are awarded to hams for having conducted two-way communications with 10, 50 or 100 different countries.

Two other awards that seem to appeal to a great many hams are the WAC (Worked All Continents), issued by the International Amateur Radio Union; and the WAS (Worked All States), sponsored by the American Radio Relay League.

But the ultimate goals of most ham DXers are two awards that truly separate the men from the boys: the DXCC and the WAZ, issued by the ARRL's DX Century Club and CQ magazine, respectively.

The DXCC requires that two-way contacts be established with at least 100 different countries, just as does EI's own General 100 award. Since there are more than 300 countries in the latest DXCC listing, this isn't a particularly difficult achievement—though it does take a lot of concentrated effort. Nat-

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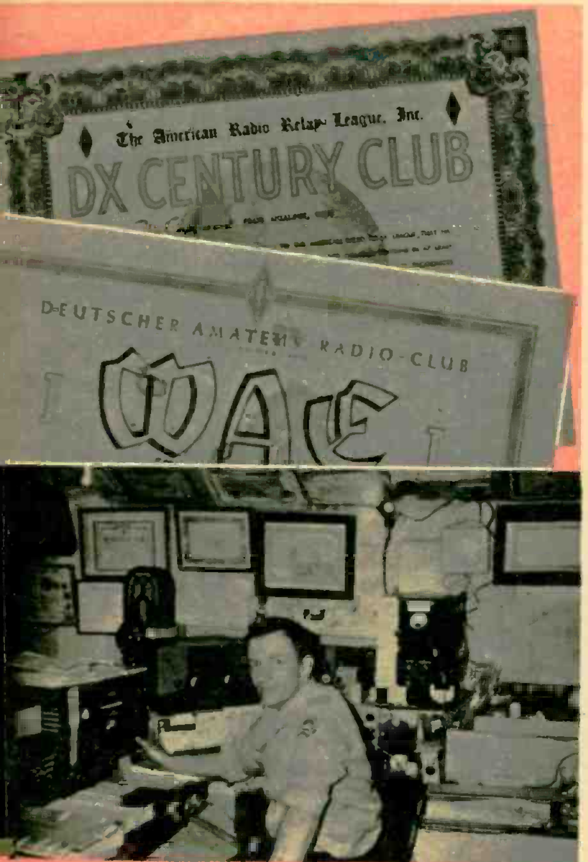
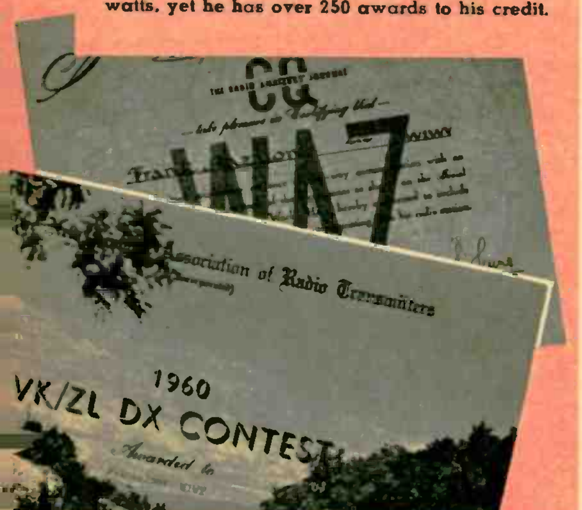
AWARDS FOR THE HAM SHACK



DXer Howy Bradley, W2QHH, runs a mere 55 watts, yet he has over 250 awards to his credit.



urally, a good deal depends on the operator's perseverance and know-how, as well as the caliber of equipment he has at his disposal. Then, too, getting a QSL card from every station you work can be time-consuming, if not downright frustrating. Nonetheless, the DXCC requires them as proof of contact, as do most other ham awards.

The WAZ award was created by CQ as being representative of true world-wide coverage. As it happens, the WAZ map arbitrarily divides the world into 40 zones, some of which include areas that are inhabited sparsely and therefore display little ham activity. In fact, Zone 23, which includes Tibet, Mongolia and a section of China, was long a stickler, save for one lone (and almost legendary) station.

Still another award issued by CQ is dubbed the WPX. Here, instead of the conventional country or zone requirements, the governing factor is a prefix. CQ has defined a prefix as the two- or three-letter/numeral combination which forms the first part of an amateur call, and it requires a minimum of 300 for a WPX certificate.

Latest of the awards from CQ is the USA-CA, given for working a minimum of 500 counties in the United States. Since there are something like 3,079 counties in the country, this again is an award most hams can earn, given patience and luck.

Over There. Having mentioned a few of the awards available here in the U.S., let's jump across the Atlantic to see what can be yours for the earning on the other side of the world. In the United Kingdom, the Radio Society of Great Britain and Short Wave magazine have at least a dozen awards between them. The RSGB's awards mostly stress working stations in the British Commonwealth; the latter's MDXA, already mentioned, probably is one of the most difficult certificates to obtain (only about a dozen have been issued).

France's REF and Germany's DARC also offer an excellent awards assortment. The REF's DUF-4, their top award, requires 16 countries of the French Union on all six continents and not only wins you a certificate but a silver medal, too. The DARC's WAE (Worked All Europe) award, in contrast, comes in three classes and is issued on a point system, depending on the number of European countries worked and the bands used.

[*Continued on page* 102]

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GOOD READING

By Tim Cartwright

***EDISON**. By Rex Beasley. Chilton Books, Philadelphia & New York. 176 pages. $4.50*

Ever stop to think that Thomas Edison was a Horatio Alger success story right down the line? He was, and he might have gotten nowhere without Alger's famed Pluck-and-Luck combination. How else to explain our young hero's arriving penniless in New York, scrounging a free sleeping place in the basement of the Gold Exchange building, making a Frank Merriwell repair of a broken stock ticker, then winding up a few days later as manager of the exchange's technical facilities?

To put it another way, the man who patiently catalogued 9,990 experiments before coming up with the electric light bulb might well have walked right out of the pages of Alger's Strive and Succeed. This being the case, it's almost inevitable that a book like Rex Beasley's reads at least a bit like one of Alger's. In fact, this is one of those old-fashioned books for boys, complete with slightly Victorian prose ("Edison bade his assistant . . .").

But this also is the kind of book that many a teenager can settle down with and enjoy after garaging his hotrod for the night. And the author's main point—that the odd young man who likes to find things out for himself may be tomorrow's genius as well as a character—is worth making at a time when individuality is suspect.

I'd say, give this book to the nearest teenager and see what happens. Sure, he may blow up the house with his first Edison-inspired experiment. But then, what else is insurance for?

***MODERN DICTIONARY OF ELECTRONICS**. Edited by Rudolf F. Graf. Howard W. Sams and Bobbs-Merrill, New York & Indianapolis. 435 pages. $6.95*

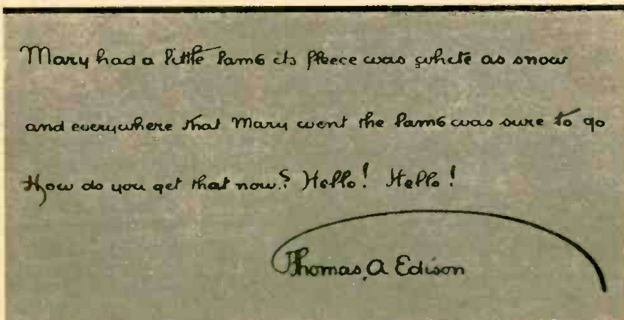
For an idea of what Edison helped get rolling, how's for a look at more than 12,400 terms in electronics today—with all the latest additions prompted by such new fields as microelectronics, data processing and semiconductor design? Don't confuse this volume with an encyclopedia, since its explanations just aren't that thorough. But don't underrate it, either, for it *is* a handy, reasonably comprehensive reference book. It's well updated from the previous edition that I've found useful on my own bookshelf, and I think it's a good investment.

***TRANSISTOR IGNITION SYSTEMS**. By Brice Ward. Howard W. Sams & Bobbs-Merrill, New York & Indianapolis. 128 pages. $2.50*

It's pretty seldom that an electronic development arouses as much widespread interest among hobbyists as the transistor ignition system. And the reasons aren't hard to find. After all, a transistor ignition can benefit jalopies and Avantis alike. What's more, conversion is relatively simple, not too expensive and can even be a fair amount of fun.

This book doesn't contain much information that I haven't seen scattered here and there over the past couple of years. But its

[*Continued on page* 104]



Most everyone is at a loss for words when it comes to speaking into a recorder, and Edison was no exception. This autographed note, taken from the biography of Edison reviewed above, contains the inventor's handwritten recollection of the words he spoke into the world's first phonograph. Though the nursery rhyme may never change, the handcrank and tinfoil of that crude device long since have given way to the synchronous motor and acetate.

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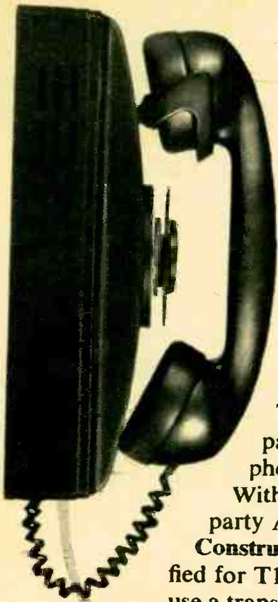

GREATEST bargains going these days are in surplus telephones. They're hard to beat for low-cost home intercoms or inter-plant systems and, as a means of bringing your wife's circle of chatty neighbors together, they'll pay for themselves in no time by keeping the gals off the regular phone.

Only problem is powering a pair or more of telephones. You could use batteries but they might be dead when needed most and they can't easily be used to ring the phones. Answer—EI's Telephone Intercom Power Pack. It's AC powered and automatically furnishes either AC ring current or DC power for the talk circuit. And the Power Pack lets you forget about complex switching circuits and modifications to the phones.

To keep the Power Pack simple and low in cost, we designed it for party-line operation. That is, turn the dial on one phone and all other phones ring together. And all phones are always on the talking circuit. With three or more extensions you can use coded ringing—one ring for party A and two rings for party B and so on.

Construction information is included in the captions. The transformer specified for T1 will handle up to three telephones. To ring more than three phones use a transformer whose 125-volt secondary winding has a higher current rating, say 50 ma. However, the high-voltage winding must not exceed 125 volts.

Relay RY1 controls the AC ring current. Do not substitute a different type for the one specified or it may not remove the ring current when dialing stops.

a power pack for your TELEPHONE INTERCOM

By HERB CENAN

Resistor R1 causes RY1 to open after you stop dialing and provides a high volume level when you talk. Do not eliminate R1 or change its value. If you use four or more phones R1 should be rated at 2 watts.

Capacitors C1-C6 are 160 mf each and are connected in parallel to keep the hum level down. If you find the hum objectionable, add six more capacitors. The diodes specified for SR1 and SR2 will power up to six phones. If you plan to use additional phones add a third diode with the same ratings.

To avoid improper connections, paint binding posts J1, J2 and J3 red, green and yellow, respectively, to correspond to the colors of most phone cables.

Two sources of supply for telephones are Lafayette Radio and Olson Electronics. All of Lafayette's phones are supplied with three wires. While some of Olson's phones have three wires, many don't. (You can tell if the *connection in the phone* is for two-wire operation if you can talk but can't ring the phone.) Converting a phone from two- to three-wire operation is a matter of changing one internal connection. Since surplus phones differ in construction, we can't describe the specific procedure for each type.

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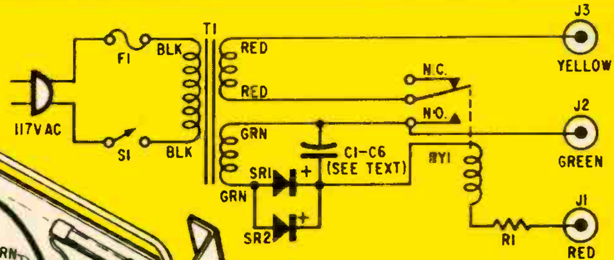

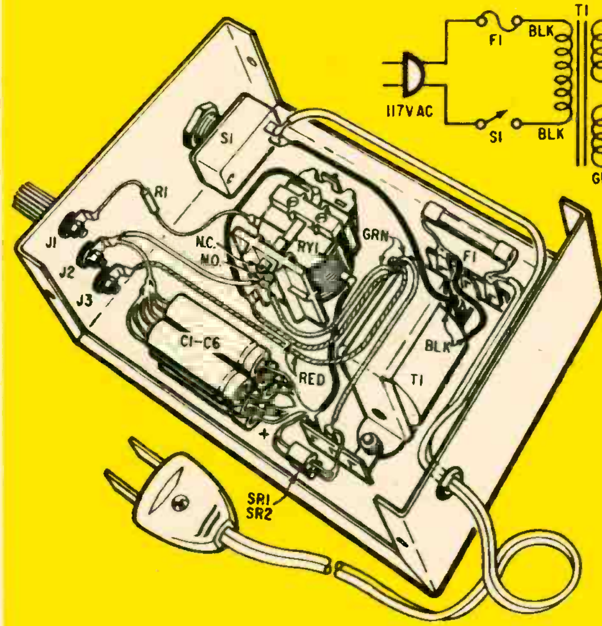

Turning telephone dial shorts J1, J2. This causes RY1 to close and apply 125 VAC to J2, J3, which rings all other phones that are connected on the line.

Our power pack is built in the main section of a 3x4x5-inch Minibox, but you can use a plastic or Bakelite cabinet. The wiring is not critical and the layout can be modified. For safety, do not use the metal cabinet for a common ground connection. Before making connections to RY1, be sure you know which lug is the armature and which is the normally-open contact. The normally-closed contact is not used here.

We recommend desk phones since some wall-mount models may have different dial switching. This could prevent RY1 from removing ring current after dialing stops.

Checkout and Operation. Connect the leads from all the phones to the corresponding colored binding posts on the Power Pack. When the handsets of all phones are hung up nothing should happen. If a phone rings check your wiring. Pick up either handset and whistle into the mouthpiece. If you don't hear yourself in the receiver check for a wiring error. (You should measure 2 to 4 volts DC across the red and green wires when the handset is off the cradle.) Turn the dial to the finger stop—the bell on the other phones should ring. If they don't and RY1 closes you probably have two-wire phones. But before you change the wiring in a phone reduce the tension on its bell's clapper spring.

To call someone simply pick up the handset and turn the dial down the number of times you want the phones to ring. All parties *must* be instructed not to answer the phone until it stops ringing. If low-impedance phones keep RY1 from releasing ring current, hang up all phones to silence bells.

PARTS LIST

C1-C6—160 mf, 15 V electrolytic capacitor (Lafayette CF-127 or equiv.)
F1—0.5 A pigtail fuse
J1-J3—Five-way binding post
R1—39-ohm, 5%, ½-watt resistor (see text)
RY1—SPDT, 6 VDC, 32-ohm coil relay. Potter & Brumfield KA5DY
S1—SPST toggle switch
SR1, SR2—Silicon diode: 25 PIV, 500 ma (see text)
T1—Power transformer; secondaries: 125 V @ 15 ma, 6.3 V @ .6 V.

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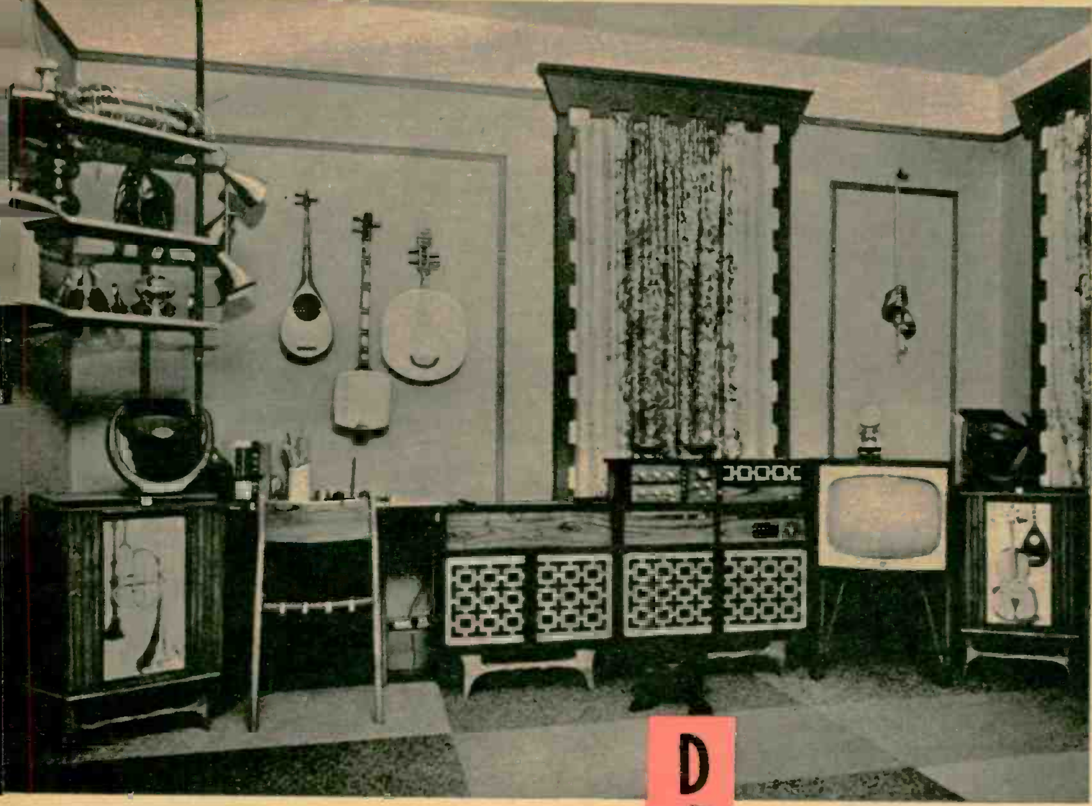

DESIGN for Listening

COMPONENT STEREO systems have a habit of looking like jig-saw puzzles that never got put together. But hi-fi components *can* add up to something other than an array of chassis and cables. All it takes is a genius of the kind old Thomas A. Edison used to talk about. Edison, as we all know, is the genius who invented everything from the phonograph to the flicks. And to Edison's way of thinking, 1 per cent inspiration and 99 per cent perspiration go into the making of a genius.

If the installation pictured here is any indication, old Tom well knew what he was talking about. Robert Ajaye, a native of New York City and a vice-president of the New York Audio Society, is no genius at decor. But he is the Edison kind of genius who perspired over this installation by building all the cabinetry from scratch. The outlay for materials, he says, was a mere $70.

Bob also assembled many of the components in his system. The tuner, preamp and power amplifier, which Bob built from kits, are Citation III-X, IV and V, respectively. No longer perspiring, Bob reports the completed setup reproduces every instrument from pipe organ to peanut whistle with astounding fidelity. And as for appearance . . . well, judge for yourself.

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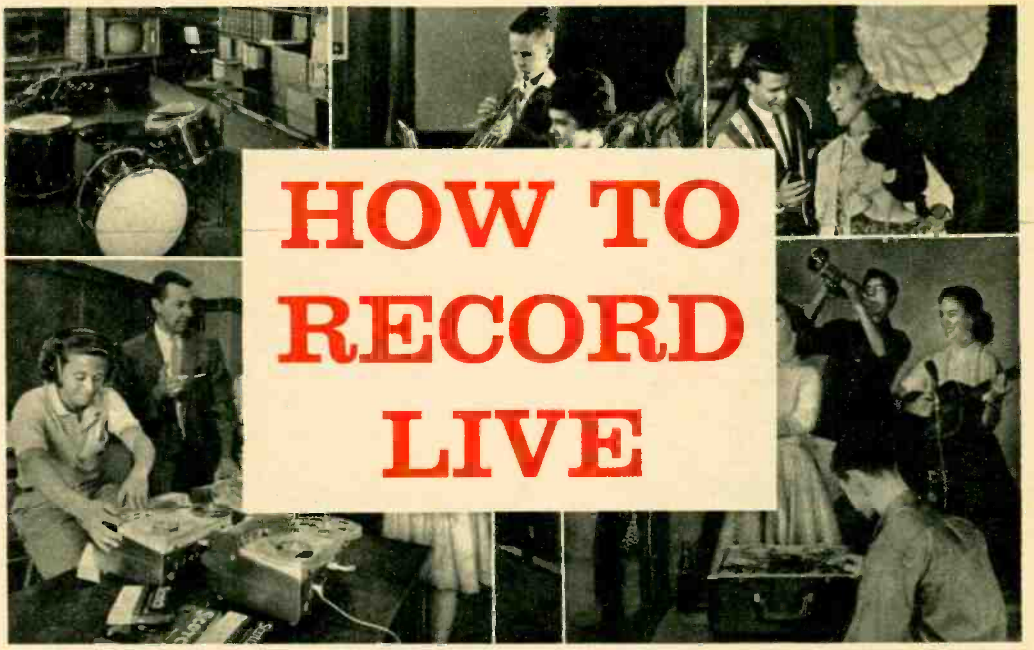


HOW TO RECORD LIVE

By JOHN MILDER

FEW ARE the people who ever persevere enough to make real use of the live recording capabilities of a tape recorder. And it may just be the first attempt that sours the matter, once and for all. It usually goes something like this. . . .

The occasion is the recording debut of an impromptu sing-along crew: mom and dad, the kids and the family dachshund. Our would-be recording engineer puts a reel of tape on the recorder, switches it on, turns up the volume control until the recording-level indicator shows signs of life, then holds up a mike—two for stereo—somewhere in front of the participants.

But when the family gathers round to listen to the playback, clouds soon mar the smiles. No one has much luck in picking out his own voice from the sodden mass of sound that issues from the tape. And the recorder, needless to say, is well on its way toward semi-retirement.

Admittedly, we've stacked the cards. Not all living-room recording sessions are that casual nor all results that disappointing. But most are. The overall sound on playback *is* murky. And no one, especially the performers, comes close to being happy.

Muddy & Muffled. Why do nine out of ten home recordings sound like a concert behind closed doors? There are a number of reasons but a lot of them center on the microphone. For one thing, the ceramic mike or mikes supplied with the average home recorder aren't half as good as the machine itself. Their fidelity is distinctly limited, though they do provide such important qualities as ruggedness, dependability and high electrical output.

Another basic weakness of the average mike is its omnidirectional pickup pattern. The mike accepts sounds from all directions with almost equal ease. At first glance, this might seem a blessing, making it a simple matter to place family performers so all can be heard on tape. Thing is, it just doesn't work out that way. Omnidirectionality almost always means a bassy, muddy sound on tape.

Why? Well, most of the sound that bounces around the average living room is at mid-bass frequencies. High frequencies, with their short wavelengths, tend to be lost in a room before they reach the mike. They decay quickly and they are absorbed by padded furniture, carpets and draperies. But the longer wavelengths of lower frequencies really go places. They make it to any mike from all directions, and they all but overwhelm an omnidirectional one.

Dim & Distant. The problem is aggravated by the fact that most home recordists tend

HOW TO RECORD LIVE

Proper mike placement is No. 1 secret to recording live. Mikes should be 8 to 10 in. from a soloist and from 18 to 24 in. apart.

to treat a mike as though it were a snapshot camera. They back off the mike in an effort to get every performer in the picture. The result is a sound that's distant and a performance that's muffled—with bass frequencies getting the upper hand.

This ill-advised practice leads to still another problem: double ambience. Technically, that's a rather inflated term describing the sound that comes from hearing room acoustics twice over. Obviously, if the mike is some distance from performers, it will tend to capture the acoustics of the room rather than the performers themselves. Assuming we record and play back in the same room (as most of us have to), we will hear these acoustics not once, but twice. As a result, whatever coloration the room imparts is doubled. And room acoustics, rather than the performance itself, truly become the order of the day.

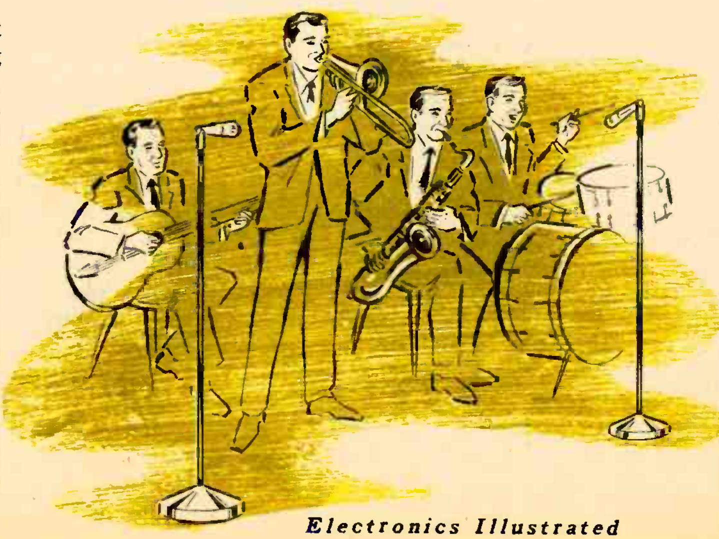
New Mike. As you might suspect at this point, the first home remedy to consider is the purchase of a new microphone. Best bet is a dynamic (moving-coil) mike of some kind. How much to spend on the mike is a matter to be decided in relation to your investment in a recorder. If you demand the most from live recording, it may not be outlandish to spend between $50 and $100 on a mike. But if your sights are lower and you own an average recorder, $10 to $20 may do the trick.

As for pickup patterns, a cardioid mike is particularly useful in rejecting extraneous noises that fill the average household. Its response to sound is such that it picks up only what's in front of it, thus cutting out a lot of unwanted noises. As an added advantage, the cardioid mike also helps get rid of the excess bass that double ambience can bring.

Multiple Mikes. Another way to improve on the mike bit is to go in for multiple mikes. While you don't have to buy an arsenal of microphones, the case for buying two mikes is strong. Even with a mike budget of $30 to $40, you can purchase two reasonably good omnidirectional dynamics and a transistor mixer for the price of a single good cardioid mike.

This strategy makes more sense when you consider that even a top-notch cardioid on its own may not be adequate for good group recording. The two-mikes-and-a-mixer arrangement, though, will give you enough flexibility to handle most any session you're apt to be faced with.

If you have no serious budget problems, there are other interesting possibilities with multiple mikes. You can, for instance, buy one omnidirectional mike and one cardioid type. Then, emulating the professional recordist's tactics, you use the cardioid for a sharp, close-up image of the performers. Meanwhile, the omnidirectional mike (set at much lower volume at the mixer) can be picking up some mellowing reverberation at another spot



Small dance band or combo is best arranged with soloists at one side, percussion instruments at the other. Place mikes at about 8 ft. from either side.

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Solo piano tapes well with mikes located about 8 ft. from longitudinal center of the instrument. Best sound seems to result when one mike is placed at end of keyboard, other mike at front or rear.

in the room. Or you can use the cardioid to spotlight one performer in a group. Assuming you can afford this arrangement, the tricks you can come up with, given a little imagination, are almost endless.

Of course, there is a hidden expense to discarding your original ceramic mike for a dynamic of any sort. You may have to add a mike preamp to make up for the dynamic mike's lower electrical output. But even if you do, you should be able to pick one up fairly cheaply by poking around in a parts supply house. Alternatively, such a preamp is a relatively simple do-it-yourself project.

Stunning Stereo. As the old saying goes, stereo is like mono, only you need two of everything. Though this never is quite true, it's even less so in recording live. In one sense, recording stereo is no more difficult than recording mono. In fact, it can be easier.

Because you have two mikes and an additional channel to start with, you stand a better chance of making a good-sounding recording. The extra channel goes a long way toward making up for the inadequacies of cheap ceramic mikes. And, while your recordings may not be as sharp as you would like them, they will have better detail and clarity than similar mono tapes.

All of the things we've suggested for mono recording are equally applicable to stereo, of course. But how much further you want to go is up to you to decide.

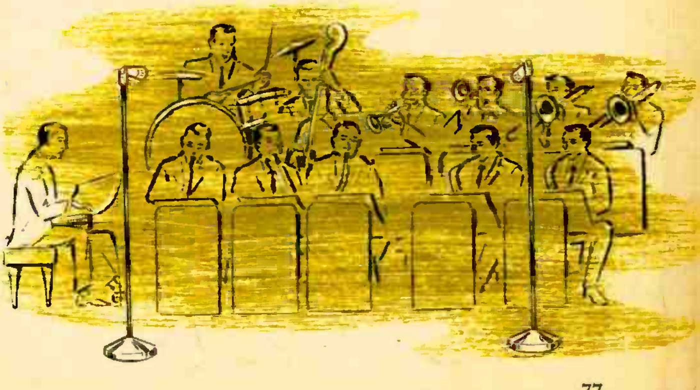
As in mono recording, never back the performers away from the mikes in an effort to get a nice, even spread of sound; you'll end up with the same washed-out sound you'd get in mono. And don't worry about having the performers too far apart, even if there are only two of them. Given the average living room, they're likely to sound much closer together in playback than you would have any reason to suspect.

Strong & Steady. As for holding and mounting mikes, never hand-hold a mike if you can avoid it. Instead, buy or build mike stands for both floor and table use. If a recording calls for the performers to move around or if someone is walking around in the next room, it's always a good idea to suspend a mike via piano wire. Never place a mike or a performer too near a room corner: standing waves may cause the sound to be bass-heavy. And always keep mikes out of range of the noises from the tape machine itself.

Though we have pushed hard for close-up miking, don't place a mike too near the works of a musical instrument—the strings on a guitar or the harp on a piano, say. You'll come up with a larger-than-life sound that will be just as unlistenable as it is spectacular.

Whatever your equipment and whatever you record, take time to experiment. And try always to keep one fact in mind. Neither a mike nor a recorder is much like the human ear. More often than not, what might seem artificial in the flesh ends up sounding like the most natural thing in the world on tape.

Equally important with mikes and mike [*Continued on page* 103]



Large band or small orchestra is treated much like combo at left. Soloist should sit with percussion section unless a third microphone is readily available.

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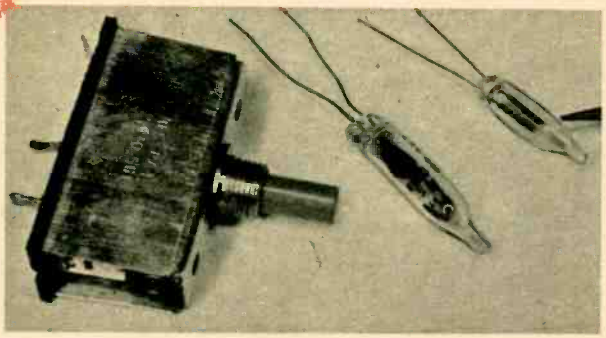
GIVE YOUR CIRCUIT A BREAK



Inexpensive circuit breakers for electronic applications shown with NE-2 neon lamp (right) are Mel-Rain (left) and a Sylvania Mite-T-Breaker (center).

By FRED BLECHMAN, K6UGT

CATS HAVE nine lives, the saying goes, but they're not the only critters around that can claim this distinction. Circuit breakers take the prize when it comes to fading away and turning up again. Matter of fact, they'll still be at it long after our feline friends have give up the ghost for good.

And circuit breakers are now being used more and more in home electrical systems in place of fuses. They are convenient and, in coming back to life over and over, they're cheaper in the long run than fuses.

What's good for home wiring also is good for electronic equipment—especially since low-power circuit breakers are now available for less than a dollar. Let's take a look at three types that can make life much simpler and save time and money to boot.

The least expensive (25¢) and smallest (see photo above and Fig. 2) circuit breakers for applications under 5 amps (up to 120 volts) are Sylvania series MB-200 and MB-300 Mite-T-Breakers.

The graph in Fig. 1 shows the relation between hold current and trip time. Hold current is the highest normal operating current at which a breaker remains closed. Trip time is the number of seconds it takes for a breaker to open when subjected to overload. Note that at 250 per cent overload, an MB-300 series breaker takes about 20 seconds to open. Unless the load is removed the breaker will cycle open and closed.

Here's the rule to keep in mind when selecting a Mite-T-Breaker: the maximum circuit current at which you want the breaker to open should be about twice the hold current. In other words, use a 1-amp breaker to protect a 2-amp circuit.

The series MB-200 breakers light up and stay open until the overload is removed. Their construction is similar to the MB-300, except there's a tungsten filament under the bi-metal element. When overloaded, the bi-metal contacts open and the full circuit voltage appears across the filament, causing it to light. The heat from the filament *holds* the contacts open. The current required to keep

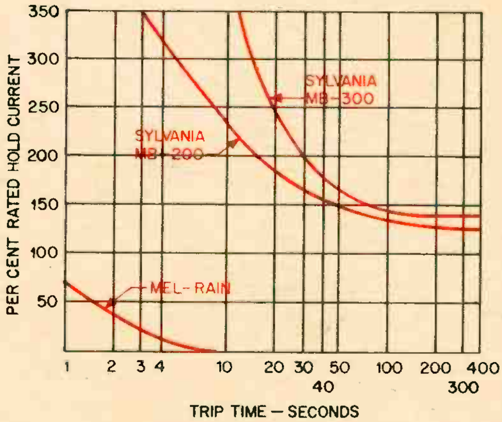


Fig. 1—A 1-amp MB-300 Mite-T-Breaker carrying 3 amps (200 per cent overload) takes 30 seconds to open. Mel-Rain breaker is faster. Figures at left refer to per cent overload of Mel-Rain.

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TABLE 1—EQUIPMENT POWER AND CURRENT CONSUMPTION					
Equipment	Input Power (watts)	Line voltage	Current (amps)	Breaker size	
				Sylvania	Mel-Rain
Stereo Amplifier*	120	120	1.0	1 A	1.65 A
50-watt ham transmitter	200	120	1.7	2 A	2.75 A
Base CB transceiver	50	120	0.4	—	750 ma
Mobile CB transceiver	50	12	4.0	2.5 A	—
TV set	150	120	1.3	1 A	2.25 A
1-amp battery charger**	—	—	1.0	1 A	1.65 A
4-amp battery charger**	—	—	4.0	2.5 A	—
Toy motors	—	3	0.5	—	750 ma
Tube auto radio	50	12	4.0	2.5 A	—
Transistor auto radio	12	12	1.0	1 A	1.65 A
Ham or SWL receiver	100	120	0.8	1 A	1.65 A

*Depends on power rating **Breaker at charger output

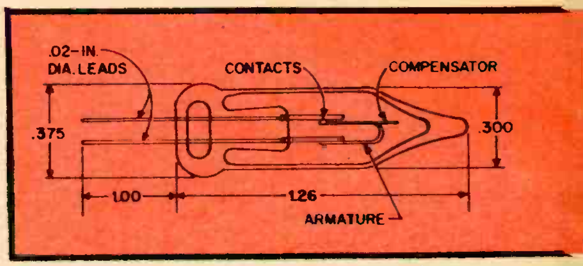

Fig. 2—Mite-T-Breaker. Excessive current in bi-metal armature causes it to bend down and open circuit. Cooled armature bends up and closes circuit. Cycle repeats if the overload remains.

the filament lit is 300 ma at 14 volts. Unfortunately for the hobbyist, the MB-200 series is limited to 6- to 30-volt applications, such as in automobiles, toy motors, marine equipment and battery chargers. The trip time for the MB-200's is shown in Fig. 1.

The long trip time and relatively high current ratings of the MB-200's and MB-300's make them unsuitable for transistor circuits. However, in some power-transistor circuits—such as inverters, power control and ignition systems—they may be used if normal current exceeds 1 or 2 amperes.

If you need a non-cycling, push-button-reset breaker that can be used in circuits up to 1,000 volts, Mel-Rain breakers will do the job. Some of these breakers have lower current ratings than the Mite-T-Breakers and their faster trip times enable them to be used in some transistor circuits. Their trip time versus overload is shown in Fig. 1. (In the case of Mel-Rain breakers, the figures at the left of Fig. 1 refer to *per cent overload.*) Note that the trip time is about 10 seconds at the rated current and less with only small overloads. The Mel-Rain breakers' rated current should be about 50 per cent higher than the normal maximum circuit current so that transients don't cause them to trip. If a circuit normally draws 650 ma, use a 1-amp breaker.

Mel-Rain breakers are easy to install since they are provided with a ⅜-inch diameter, ¼-inch long threaded bushing that mounts in a single hole just like a potentiometer. The breaker is 1¾ inches long, 1 inch deep and ¾ inch wide and has two solder lugs on the back for connections. To reset it after the cause of the overload has been removed, wait a short time and push in the red button. The snap-action armature is compensated so that its characteristics stay essentially the same up to 150 degrees Fahrenheit.

To determine the current consumption of a device, simply divide the power it consumes by the line voltage. (While this is not strictly true for AC circuits, it's close enough here.) For example, the average table radio consumes about 35 watts. If the line voltage is 120 volts, the current is 35/120 or 290 ma. Table 1 lists the current consumption of familiar equipment.

These breakers may not yet be widely available at parts distributors. However, Allied Radio has them. Since they are listed in Allied's Industrial (rather than Consumer) catalog use Table 2 for ratings, catalog numbers and prices (don't forget to add postage)

TABLE 2—CATALOG NUMBERS AND PRICES						
Mfgr	Mfgr's Number	Hold Current (amps)	Rated Current (amps)	Max. volts	Allied Stock No.	Price
Sylvania*	MB-315	1	—	125	34 B 075	.25
Sylvania	MB-316	2	—	125	34 B 076	.25
Sylvania	MB-317	3	—	125	34 B 078	.25
Sylvania	MB-318	4	—	125	34 B 079	.25
Sylvania**	MB-215	1	—	30	34 B 066	.36
Sylvania	MB-216	1.5	—	30	34 B 067	.36
Sylvania	MB-217	2.0	—	30	34 B 068	.36
Sylvania	MB-218	2.5	—	30	34 B 069	.36
Mel-Rain***	—	—	500 ma	1,000	33 B 978	.80
Mel-Rain	—	—	750 ma	1,000	33 B 979	.80
Mel-Rain	—	—	1	1,000	33 B 980	.80
Mel-Rain	—	—	1.65	1,000	33 B 981	.80
Mel-Rain	—	—	2.0	1,000	33 B 982	.80
Mel-Rain	—	—	2.25	1,000	33 B 983	.80
Mel-Rain	—	—	2.75	1,000	33 B 984	.80
Mel-Rain	—	—	3.25	1,000	33 B 985	.80
Mel-Rain	—	—	3.75	1,000	33 B 986	.80
Mel-Rain	—	—	4.0	1,000	33 B 987	.80

*Non-indicating **Indicating ***Push-Button reset

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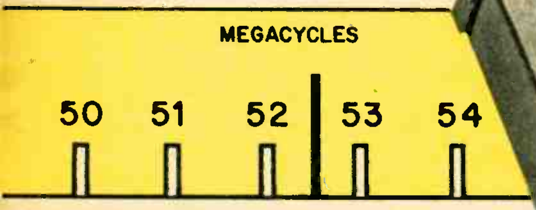
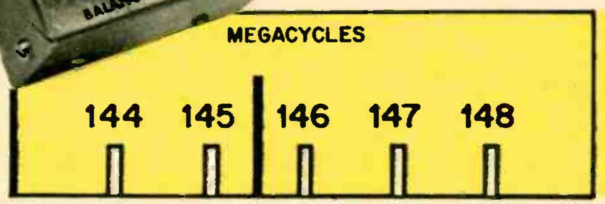
amplified FIELD STRENGTH METER for 6 and 2



You need an ultra-sensitive FSM like this one to tune up the antenna of low-power 6- or 2-meter ham rigs.



By HERB FRIEDMAN, W2ZLF

ASK the ham who's done it and he'll tell you there's nothing like working 6 or 2 meters. Here you find wide-open spaces and even a low-power rig can bring in a stack of wallpaper.

But if the antenna of a 5- or 10-watt transmitter for 6 or 2 isn't tuned as fine as a germ's toothpick your signal won't stir anybody's S-meter. In fact, a beam antenna should be fine-tuned *after* it's mounted. Factory dimensions alone won't necessarily give you a rock-crushing signal.

The one instrument you really must have to tune an in-place antenna properly is a field-strength meter (FSM) to indicate relative radiated power. When your FSM peaks, the antenna is tuned for maximum radiation. It's that simple.

But for really accurate field-strength measurements, the FSM must be placed a distance from the antenna—usually six to ten wavelengths. And this is where many commercial FSM's poop out. But EI's *amplified* FSM won't.

Because of its stage of amplification, our FSM has about ten times the sensitivity of the more common coil and capacitor resonant-circuit job. If you want super sensitivity, use a 50- or 100-microampere meter for M1.

Construction. Our FSM is built on the main section of a 5½x3x2⅛-inch Minibox. While layout isn't critical, keep L1, C1 and J1 close together.

Coil L1 is three turns of #18 enameled wire closewound on a ⅜-inch-diameter form. After taking the coil off the form, stretch it to a half-inch length by pulling *gently* on its *end* leads, taking extra care not to deform the coil. When connecting L1 to C1, don't make sharp right-angle bends. Round the bends slightly—a technique necessary for optimum performance on two meters.

Mount L1 exactly where shown—close to C1 and away from the cabinet. Note especially how C1 is grounded. You make the ground connection by running a wire from the rotor lug on the front of C1 to the terminal strip. A ground connection is not established through C1's mounting screws.

Since the jack supplied with the antenna isn't sturdy, use a standard banana jack or a five-way binding post for J1. Attach a banana plug to the antenna by heating the plug until you can fill its hole with solder. Apply

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heat continuously and when the solder is molten fit the antenna into the plug and let the solder harden.

Using the FSM. Turn R1 just enough for S1 to click on, then adjust balance control R2 for zero indication on M1. If M1 is a 50- or 100-microampere meter, the pointer may start out on either side of zero. If M1 is a 1-ma meter, the pointer will be to the left of zero.

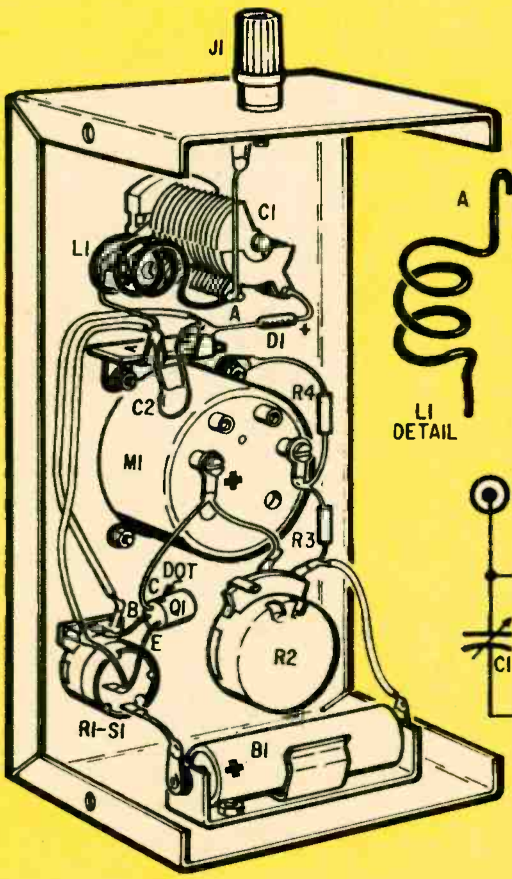
Extend the antenna, set R1 to mid-position, place the FSM near a signal source and adjust C1 for maximum indication on M1. If M1 is driven off scale, reduce sensitivity with R1.

Coil L1 may require adjustment. If C1 tunes 2 meters but not 6 meters (on both bands C1 should be able to tune *through* a peak), *compress* L1 slightly until C1 tunes through 6 meters. If C1 tunes 6 meters but not 2, *stretch* L1 in small increments until C1 tunes through peaks on both bands.

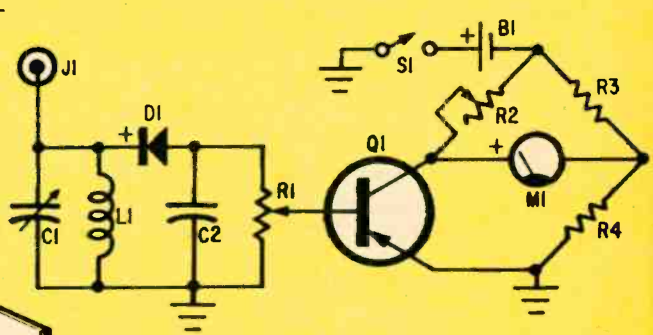
On 2 meters you'll get better performance if the antenna isn't extended the full length. Try it yourself since optimum length is somewhat determined by construction.

PARTS LIST

B1—1.5-volt penlite battery
C1—4.5-100 mmf miniature variable capacitor (Hammarlund MAPC-100B; Lafayette HP-39)
C2—100 mmf ceramic disc capacitor
D1—1N21A diode
J1—Banana jack or five-way binding post
L1—Coil (see text)
M1—0-1 ma DC milliammeter (see text)
Q1—2N217 transistor
R1—25,000-ohm potentiometer
R2—50,000-ohm potentiometer
R3,R4—1,000-ohm, ½-watt, 10% resistor
S1—SPST switch on R1
Misc.—Cabinet, terminal strip, antenna (Lafayette F-343).



Heat-sink D1's leads when soldering. Signal demodulated by diode D1 is applied to Q1. Q1 amplifies signal which unbalances bridge, causing M1 to deflect.



C1's rotor lug (front) is delicate so don't bend L1 around it. Insert L1 in lug's hole and wrap ground lead from terminal strip around lug. Do not solder connection until you have attached other end of L1.

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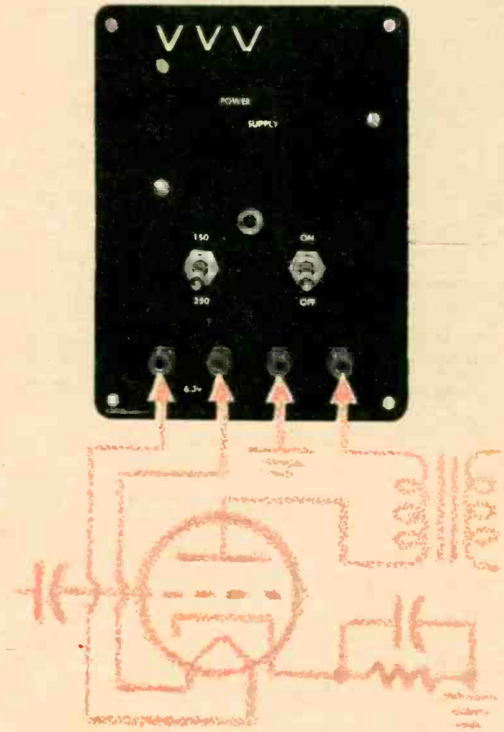
TRIPLE V POWER SUPPLY



By AL TOLER

NAME a dozen home-brew tube projects —preamps, converters, oscillators, etc. —and ask yourself what requirement they all have in common. The answer, of course, is a power supply that furnishes heater current and B+.

Because of this, you find yourself building the same power supply over and over, sometimes just to find out whether a breadboarded experimental circuit works or not. If you're an active experimenter you are likely to have all kinds of abandoned projects on your shelves, each with a small power transformer, silicon diodes and filter capacitors. You'd like to trade them for parts you really need, but who wants to trade?

The answer to this problem: spend ten bucks and build our Triple V Power Supply, then use it to operate *all* your experimental circuits. The Triple V provides 6.3 VAC at .6 A and either 150 or 250 VDC at about 15 ma—adequate for a host of projects. If you need more current or voltage, simply use a larger transformer than the type we've specified for T1.

Construction

So you can use the supply without worrying about shock hazard, build it on the underside of the cover of a Bakelite utility cabinet.

SR1 and SR2 can be low-cost silicon diodes rated at 500 PIV or higher. The current rating will depend on the transformer you use. Heat-sink each lead when soldering SR1 and SR2 in place.

Take particular care when wiring S2. In the 150 V position S2 connects the circuit components in a half-wave rectifier configuration. In the 250 V position, the circuit configuration is a full-wave voltage-doubler rectifier. Be sure that when S2 is in the 250 V position it connects SR2 to J2 (the common, or B—, jack) and T1's bottom red secondary lead to the junction of C1 and C2A.

Do not eliminate bleeder resistor R3. It is provided as a safety measure to discharge the filter capacitors after AC power is turned off. If you leave R3 out, you may get a lethal jolt when you touch J1 and J2, thinking it's safe to do so because you turned off the AC power. The capacitors can hold their charge long after the power supply is turned off. R3 will discharge the capacitors to a safe voltage in a few seconds.

Using the Supply

The current available from the transformer specified for T1 is low. While it will be adequate for one- or two-tube projects, do not try to use it to power anything like a 20-watt stereo amplifier. Always remember to set S2 to the desired B+ voltage *before* connecting the supply to the equipment it is to operate.

The common (B—) supply lead usually is connected to the project's chassis (or ground),

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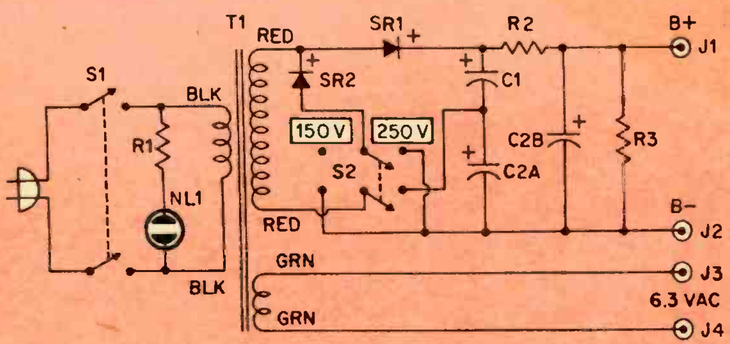
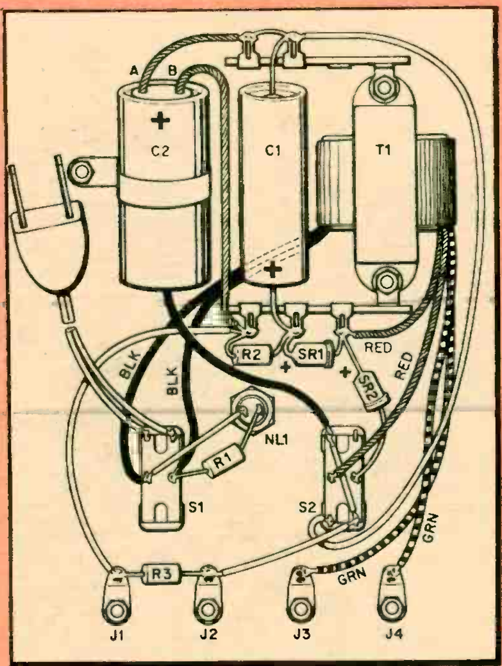
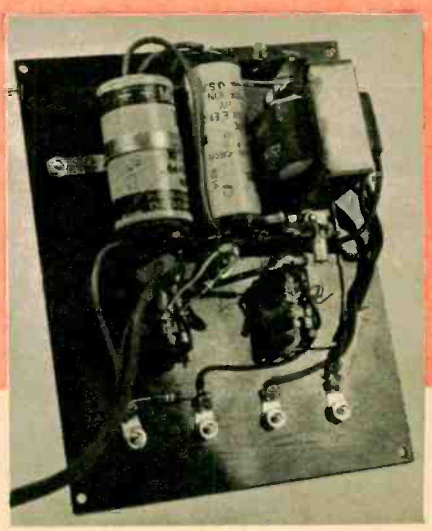
When S2 is in 150-volt position, circuit is half-wave rectifier. When S2 is in 250-volt position, C1 charges on first half of cycle and C2A charges on second half of cycle. Voltages across C1 and C2A are added, producing higher output. R3 discharges capacitors when power is turned off. Output voltage depends on current drawn by the load.





PARTS LIST
C1—40 mf, 250 V electrolytic capacitor
C2—40/40 mf, 250 V electrolytic capacitor
J1-J4—Five-way binding posts
NL1—NE-2 neon lamp and holder
R1, R3—100,000-ohm, ½-watt resistor
R2—680-ohm, ½-watt resistor
S1—DPST toggle switch
S2—DPDT toggle switch
SR1 SR2—Silicon diode, 100 ma, 500 PIV
T1—Power transformer: 117 V primary; secondaries, 125 V @ 15 ma, 6.3 V @ .6 A (Lafayette TR-121 or equiv.; see text)
Misc.—Bakelite cabinet (Lafayette MS-218).



All components will fit easily on the cover of a 6¾x5¼x2¼-inch Bakelite box. If you use a larger transformer it may be necessary to use a larger box. Be sure of the polarity of diodes SR1 and SR2 when you install them.

but since the power supply is in an insulated cabinet you can make a B— connection anywhere without fear of shock in case you touch the equipment chassis and the power supply.

If you want to increase the B+ output voltage, use a transformer with a 250-volt, 25 ma center-tapped secondary (tape the center-tap lead) and a 6.3-volt, 1-amp filament winding (Allied Radio 62 G 008).

The DC output voltages now will be about 300 volts and 500 volts. If you use this size transformer, the PIV of the diodes will have to be 750 volts and the rating of the capacitors should be at least 500 volts. For further information about half-wave and full-wave voltage-doubler power supplies and how to determine the PIV of diodes, see HOW TO USE SILICON DIODES, January '63 EI.

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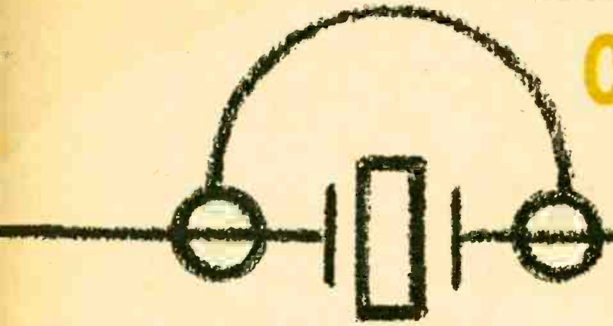
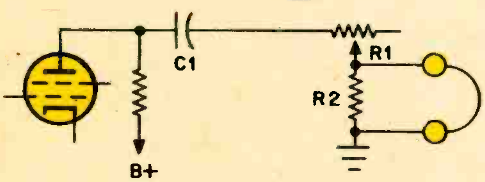
how to hook up CRYSTAL HEADPHONES



By WARREN COCCOZZA

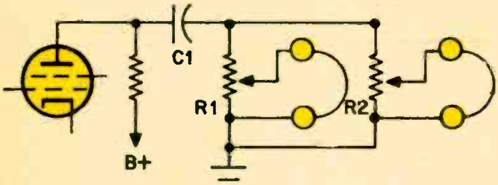
CRYSTAL headphones have it all over run-of-the-mill magnetics. They're more expensive but their smooth, low-distortion, free-of-peaks sound makes prolonged listening with them enjoyable rather than painful. It is not difficult to hook crystals to your equipment but, contrary to the case with magnetics, they can't be connected directly to the speaker output terminals of a hi-fi amplifier or SWL receiver. Instead, you need a little circuit using a capacitor, resistor and potentiometer. We show four variations of the hookup on this page.



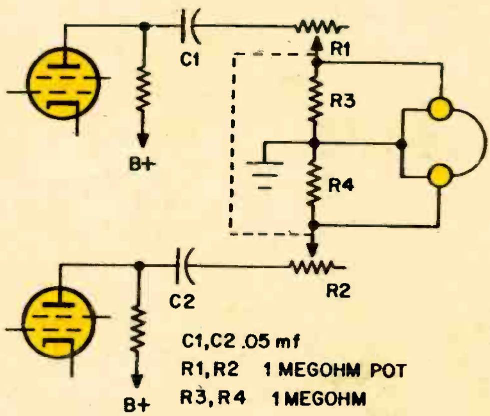
R1 500,000-OHM POT
R2 1 MEGOHM
C1 .05 mf

Simplest installation shows mono phones connected to audio-output tube. R1 is a tone control.

Connection of more than one pair of mono phones, each with tone control (R1, R2), to audio tube.



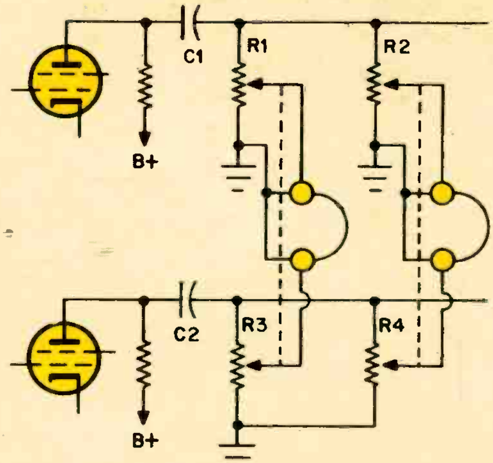
C1 .05 mf X NO. OF PHONES
R1, R2 500,000-OHM POT



C1, C2 .05 mf
R1, R2 1 MEGOHM POT
R3, R4 1 MEGOHM

One pair of stereo phones connected to output tubes. Tone-control pots R1, R2 should be ganged.

Multiple stereo-phone hookup. As in single-phone hookup, pots R1, R3; R2, R4 should be ganged.



C1, C2 .05 mf x NO. OF PHONES
R1-R4 500,000-OHM POT

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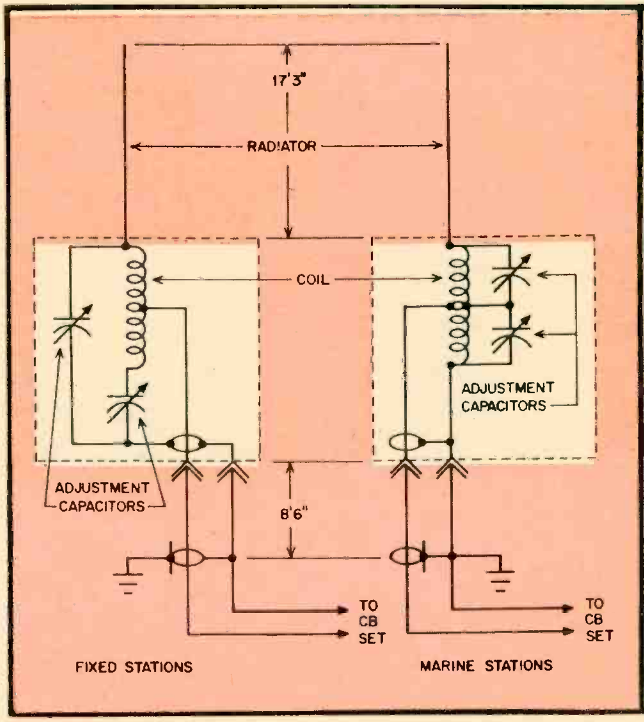

SWR REDUCER

New matching transformer for CB pulls SWR down, pushes efficiency up.

ANY Citizens Bander who wants to have a decent signal sooner or later gets around to worrying about the standing-wave ratio (SWR) of his antenna system. With that 5-watt power limitation, he knows, SWR becomes more important to CB than just about any other service. It controls to a great degree the amount of power that leaves his antenna as a signal. What he tries to do, of course, is get his SWR as close to perfect (1:1) as possible. And right there is where he can get help with a new matching transformer now on the market.

Made in two models—one for fixed stations and one for marine stations (see our drawings above), the transformer ordinarily is used with a 17-foot, 3-inch vertical radiator. But we found it can match a CB rig to most any antenna that happens to be handy—even a wire fence. Reason: its two screwdriver adjustments, one for matching into the coax and the other for matching into the antenna, enable you to bring SWR down to 1.1:1 or better in almost every case. Clip an SWR meter on the set end of your coax, adjust the transformer carefully and you can be pretty sure that maximum energy is going into your antenna and that little is being reflected back.

Both models are housed in aluminum cans and potted in epoxy to make them waterproof. Neither model needs an earth ground or a ground-plane setup to work against, though grounding the coax shield exactly 8½ feet from the transformer can increase gain by some 1.5db. Signal-to-noise ratio on receive is improved by about 3db. Even without a grounding system, the manufacturer claims, the transformer-antenna combo offers 1.5db more gain than that oft-mentioned theoretical dipole.

The transformer is manufactured by Gam Electronics, Inc., of Manchester, N. H.

—Leo G. Sands

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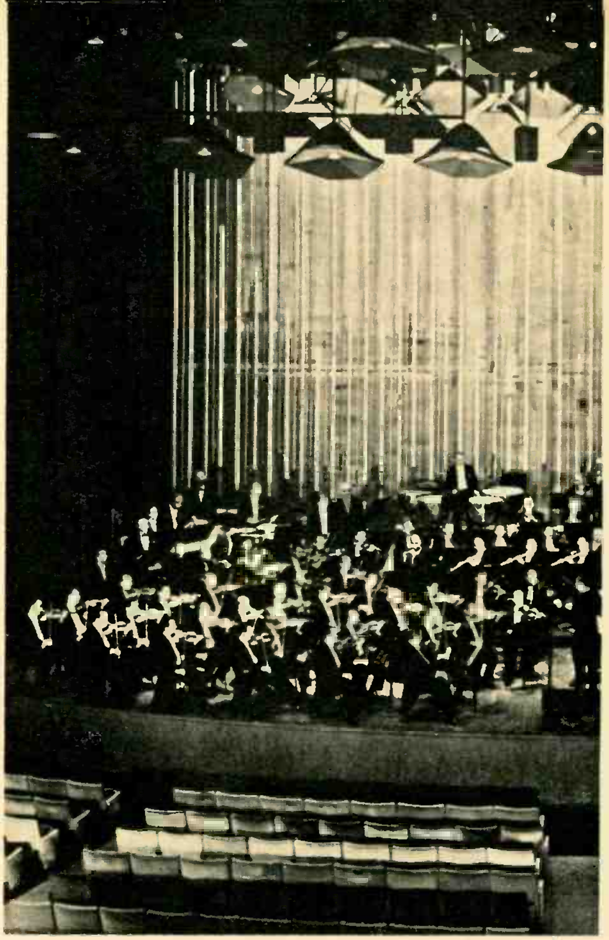
CAN NETWORKS SAVE FM?



SUNDAY, December 17, 1939, dawned bright, clear and cold in New York City. But by early afternoon, the temperature had climbed above the freezing point. And along 57th Street, concert-goers were making their way to Carnegie Hall for a regular Sunday afternoon concert by the New York Philharmonic.

Meanwhile, in cities and hamlets across the country, lovers of serious music were tuning in their radios to the broadcast of the concert over the Columbia Broadcasting System. To most of America, including members of the orchestra and its conductor, Sir John Barbirolli, the occasion was just another Philharmonic concert. But the opening bars of Otto Nicolai's overture to The Merry Wives of Windsor that afternoon were to make broadcasting history.

Bright Future? For in Hartford, Conn., some 120 miles away, small groups of broadcasting men and music critics huddled in front of specially designed receivers to catch the concert. "It was as if the symphony orchestra was in the room with us," the New York Sun's radio critic reported later. He and the others were gathered to hear the first network broadcast by frequency modulation (FM) stations. Their verdict: a resounding artistic and technical success.

"The day cannot be far off when this new static-free system of broadcasting will replace radio broadcasting as we know it," the technical director of the Yankee Network commented in a burst of enthusiasm. But can it?

FM radio today, as throughout much of its history, is in trouble—financial trouble. To a large extent, it's the chicken-and-the-egg affair all over. Many FM broadcasters simply don't have enough listeners to attract enough revenue. And because they don't have enough revenue, they can't create imaginative programs which, in turn, would attract more listeners.

How serious is FM's pecuniary problem? Well, let's take an example. During 1961—the most recent year for which complete figures are available—the Federal Communications Commission reports that a sample group of 91 stations located in metropolitan

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QXR Network includes many stereo broadcasts in its weekly program schedule—broadcasts which wouldn't be feasible without the combined resources of a network. In photo above is Peter Ustinov in QXR's production of Billy Budd. Though live concerts provide better fidelity than tapes or discs any day of the week, such broadcasts carry a sizable price tag. But an FM network can surmount some of the problems, and one network currently brings New York Philharmonic (photo at left) to homes across the country direct from Philharmonic Hall. And, whether Billy Budd or the Philharmonic, FM's greater frequency range and improved fidelity make for live broadcasts which are but one step away from the real thing.

areas produced total revenues of $3.9 million. But the cost of operating these stations came to $5.1 million—a deficit of $1.2 million.

Vicious Circle. Actually, the entire history of FM—from the experimental broadcasts by Major Edwin Armstrong in 1935 to the present—has been complicated by this very problem. In a nutshell, the dilemma is how to attract sponsors with audiences that are pitifully small and, conversely, how to build audiences with funds that are painfully limited. And for an idea of just how restricted those audiences are, keep in mind that even such hot FM markets today as New York, Los Angeles, Chicago and San Francisco have FM receivers of one sort or another in less than half the homes.

Some of today's trouble stems from the fact that conservative AM broadcasters and official indifference have knocked down FM at regular intervals. And there have been other hardships over the years. World War II, for example, stopped FM station construction cold in the big FM boom which followed the 1939 Philharmonic broadcast. After the war, the FCC's decision to shift the 700-odd FM broadcasters then on the air from the 40-mc band to the present 88-108-mc band didn't help much, either. In one fell swoop it rendered obsolete every FM receiver then in existence. Even television took a toll in the years following its inception in 1948. Who wanted to bother with a radio receiver when pictures on a fluorescent screen were all the rage?

Pleasing Progress. Finances aside, FM broadcasting today stands in better stead than ever before in its history. There are an estimated 1,200 stations on the air, more than twice as many as there were in FM's blackest hours in 1956; more even than the 1,100 in 1948. Of these, some 712 enjoy programming which is either wholly or partially independent of an AM affiliate.

Furthermore, there are 228 entirely non-commercial FM stations, many of them grouped into tape or relay networks. Then, too, FM has more listeners than ever before. Better yet, stations such as KPEN in San

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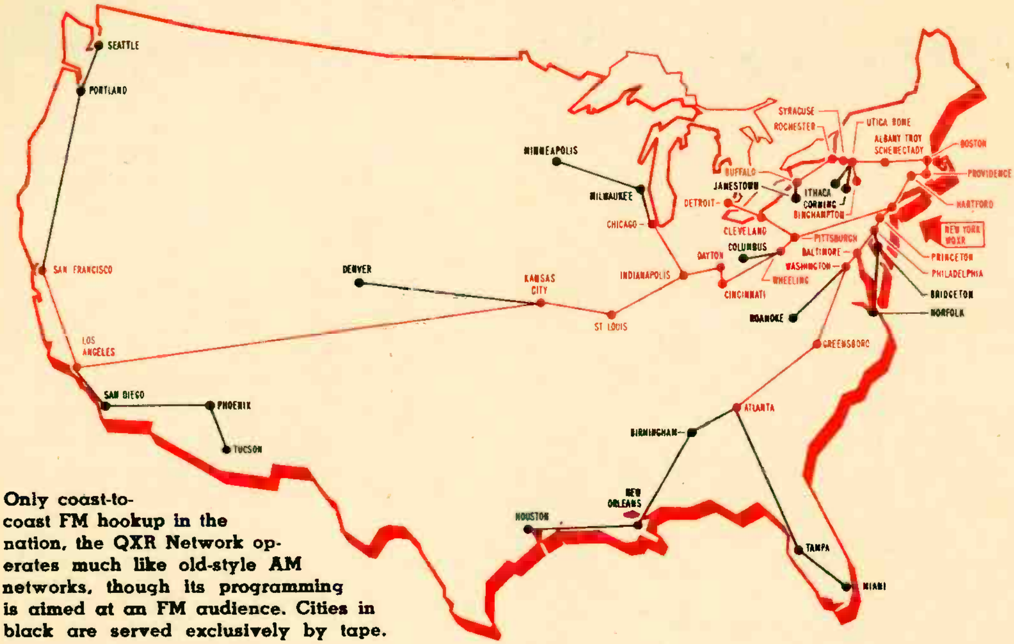

Only coast-to-coast FM hookup in the nation, the QXR Network operates much like old-style AM networks, though its programming is aimed at an FM audience. Cities in black are served exclusively by tape.

CAN NETWORKS SAVE FM?

Francisco and WFMT in Chicago consistently outrate area AM pop-music stations in numbers of listeners.

Another development, the advent of stereo FM (an estimated 450 broadcasters now have some stereo on the air), has attracted advertisers who find the medium effective. At the same time, the existing networks enable a music-lover in Columbus, Ohio, to enjoy the complete Salzburg Festival; a listener in Los Angeles to hear the Boston Symphony from Tanglewood in stereo; a schoolchild in Newark, N. J., to partake of Shakespeare performed by the University of Michigan drama group; an actor in Toronto to laugh along with the Comedie Francaise; a lawyer in Chicago to be a passive participant in a thought-provoking discussion from the British Broadcasting Corporation.

Finances Again. But the question, today as always, is the same: where is the money to come from? The superior sound quality which startled the 1939 music critics and broadcast engineers launched FM's first boom. And even then some broadcasters contemplated an FM network that would bring high-fidelity programming into every home in the Northeast. Ever since, the idea of FM networks has intrigued broadcasters as a way of financing live broadcasts of symphonic concerts, theater and other expensive programming.

Today, 25 years later, men still are hoping networks might solve FM's troubles. During those 25 years, however, some 40 FM networks have come and gone—and still another disappeared as this article was being written. Obviously, networks in themselves aren't the answer, though the right kind of networks with the right kind of programming—whatever that might be—conceivably could provide the solution.

The Networks. At the moment, there are, depending on your definition, some 18 commercial FM networks. And non-commercial stations have combined to form approximately ten more.

When you come right down to it, however, it's almost impossible to define an FM network because there are so many types. One of the most successful, the QXR Network, operates much as the old-style AM networks did. WQXR, its master station in New York City, provides full schedules of good music and news, while local stations elsewhere fill

[*Continued on page* 110]

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Those European Tube Numbers

YOU *can* tell the players if you happen to have a program, and the same is true of European tubes with their strange-looking numbers. Every letter and number in ECC83 (equivalent to our 12AX7A) says something about the tube. Here's the way it works. The first letter, E, means the tube has a 6.3-volt heater. The second and third letters, CC, mean there are two triode voltage amplifiers in the tube. The number 8 means the base is a nine-pin miniature. The last number is explained in the table below. Try it yourself on an ECLL800 which is used in the build-it-yourself amplifier in this issue.

Transmitting tubes have a different system as the table at the bottom shows. For example, the QQE-04-20 is a dual tetrode with indirectly-heated cathode.—*E. Tromanhauser*

RECEIVING TUBES

FIRST LETTER (Filament Voltage or Current)	SECOND AND SUBSEQUENT LETTERS (Tube Type)	NUMBERS (Base Type) *
A—4 V	A—Single diode	2—Loctal
C—200 ma	B—Double diode	3—Octal
D—0.5 to 1.5 VDC	C—Triode voltage amp.	4—European rim-lock
E—6.3 V	D—Output triode	
G—5 V	E—Tetrode voltage amp.	5—Misc. bases
H—150 ma	F—Pentode voltage amp.	6,7—Sub-miniature
K—2.0 VDC	H—Hexode or heptode	
M—2.5 V	K—Heptode or octode	8—9-pin miniature
O—No fil.	L—Power pentode	
P—300 ma	M—Electron-beam indicator	9—7-pin miniature
U—100 ma	N—Thyratron	
	P—Secondary-emission tube (third letter only)	*Second and third digits are serial Nos. that denote a specific design or development.
	X—Full-wave gas-filled rectifier	
	Y—Half-wave rectifier	
	Z—Full-wave rectifier	

TRANSMITTING TUBES

FIRST LETTER (Tube type)	SECOND LETTER (Filament)	THIRD LETTER (Cooling)
D—Rectifier	A—Tungsten, direct heated	G—Mercury filled
M—Triode	B—Thoriated tungsten, direct heated	L—Forced air
P—Pentode	C—Oxide coated, direct heated	W—Water cooled
Q—Tetrode	E—Heater/cathode	X—Zenon filled
T—Triode		
NUMBERS (characteristics)—No uniform notation.		

EI AT LARGE

Sign of the Times

THOSE pundits who keep talking about how electronics is one of the glamour industries could be right, after all. We never really disagreed with them; it was just that romance and high adventure always seemed to be visiting some other part of the business when we hove into view.

But now the hot breath of popularity is searing us, for electronics has got itself involved in some kind of doings that whisper of scandal. A decade and half ago it was deep freezers. Then it was vicuna coats. But now the real most to be embarrassed about when they find out you accepted it is something in the electronics line—a stereo phonograph, maybe. How times have changed.

Rosy Glow

WE were sitting around the other evening with a friend of ours, drinking coffee and talking, when we got introduced to the most modern of lamps—or maybe it's light bulbs. It turned out that our friend's company makes the things, which we had seen before but just never paid much attention to. What we're talking about is those little electric bulbs they call Flicker Flames. They are made to look like candles—which is the whole idea, our friend assured us—because the lighted part inside the bulb seems to flicker from time to time. The lamps draw only two or three watts and don't give off enough light to enable you to understand a Jayne Mansfield photograph. But they're popular with eating places because they look romantic, or something.

Inside the glass envelope, our friend told us, is either pure neon or neon mixed with some other gasses, a couple of coated metal rods and a 2,500-ohm resistor. The design was worked out with extreme care, said our friend, to simulate a candle's actions as closely as possible. And, though they won't run your electric bill up much, Flicker Flames do set you back a tidy sum when you go to buy them. We can just imagine what our great-great-grandmother, who had to make out with candles and kerosene lamps, would say if she caught us carrying home a high-priced gadget that couldn't do any better than pretend to be a candle.

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The LISTENER

C. M. STANBURY II

AFRICA, 1964 . . . With new nations the rule rather than the exception in Africa, short-wave listeners have at hand some interesting and unusual fare when they tune what used to be called the Dark Continent. The color rectangle on our map shows the location of five countries that just might be almost totally unfamiliar to you since none is out of its teens so far as age goes. And most seemingly still have some growing to do.

In the field of international broadcasting, Ghana came on strong a few years ago and was looked on as the spokesman for African nationalism. But Radio Ghana's position has been slipping of late—a development that probably can be linked directly with the country's transition from a democratic (after a fashion) state to a totalitarian one, Prime Minister Kwame Nkrumah's personal ambitions and some too-much-too-soon policies.

Today, R. Ghana's broadcasts—best received in North America on 11800 kc until approximately 1715 EST—by and large are pretty dull. However, a revolution *could* occur in this West African nation at any time, and there already have been several attempts on Nkrumah's life. In the event of further unsettling events or an organized revolt, R. Ghana probably would leave international frequencies. But North American listeners could try, after dark, for its regional channels—3366 and 4915 kc.

Of course, Mr. Nkrumah doesn't recognize that R. Ghana no longer is Africa's No. 1 voice. In fact, he's building a new super-powerful communications center at Ejura (all broadcasts presently are from Accra, the capital). But a new spokesman almost certainly will come along.

High in the running as successor to Ghana is R. Nigeria. At the end of 1963, R. Nigeria (operated by the government-owned Nigerian Broadcasting Corp.) began a series of tests with two brand-new 100-kw transmitters in the 19- and 25-meter bands. Frequencies included 15255, 15180 and approximately 11900 kc, with times ranging between 0900 and 1500 EST. Shortly now, a regular international service should be in operation.

It's significant, incidentally, that Nigeria is one of the few African states to permit private and semi-private broadcasting. Should you want to snag one of the semi-privates, your best bet is the Western Nigeria Broadcasting Service from Ibadan on 6185 kc. W.N.B.S., for the record, is owned half-and-half by a British firm and the provincial government.

To hear W.N.B.S. at all, however, will require all your DXing skill. And it will take an equal amount of skill and some luck as well to pick up the two private stations. Radio Kaduna on 6090 kc occasionally breaks through QRM at 1700 sign-off. And Eastern Nigerian Broadcasting Ltd. sometimes can be received at 0000 sign-on or at 1800 S/off.

Your DX Log . . . A common failing of many beginning SWLs and DXers is the log book that never got started. And, while there are many ways to set up a log, the important thing is that you *do* establish one. Every new station you hear and every station you intend to QSL should be recorded in your log. After all, a log can be invaluable for future reference, to settle disputes and when making out those EI DX Club applications. It's never safe to rely solely on QSLs, since they may lack much of the information you may need at a later date.

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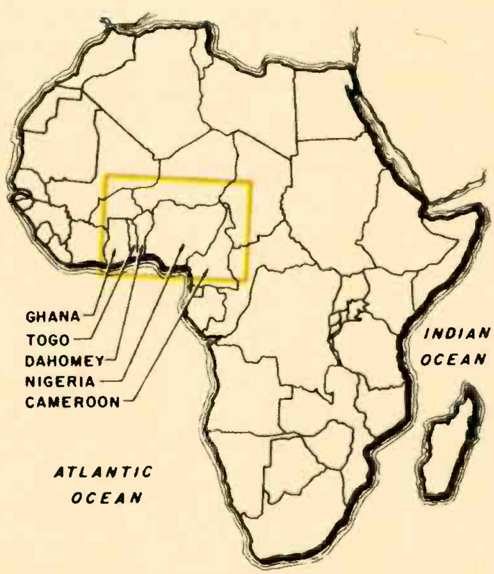

Africa offers choice tidbits for the DXer, especially from countries indicated. Ghana, Nigeria are discussed in text; Togo, Dahomey, Cameroon can be heard on 5047, 4875 and 6115 kc, respectively.

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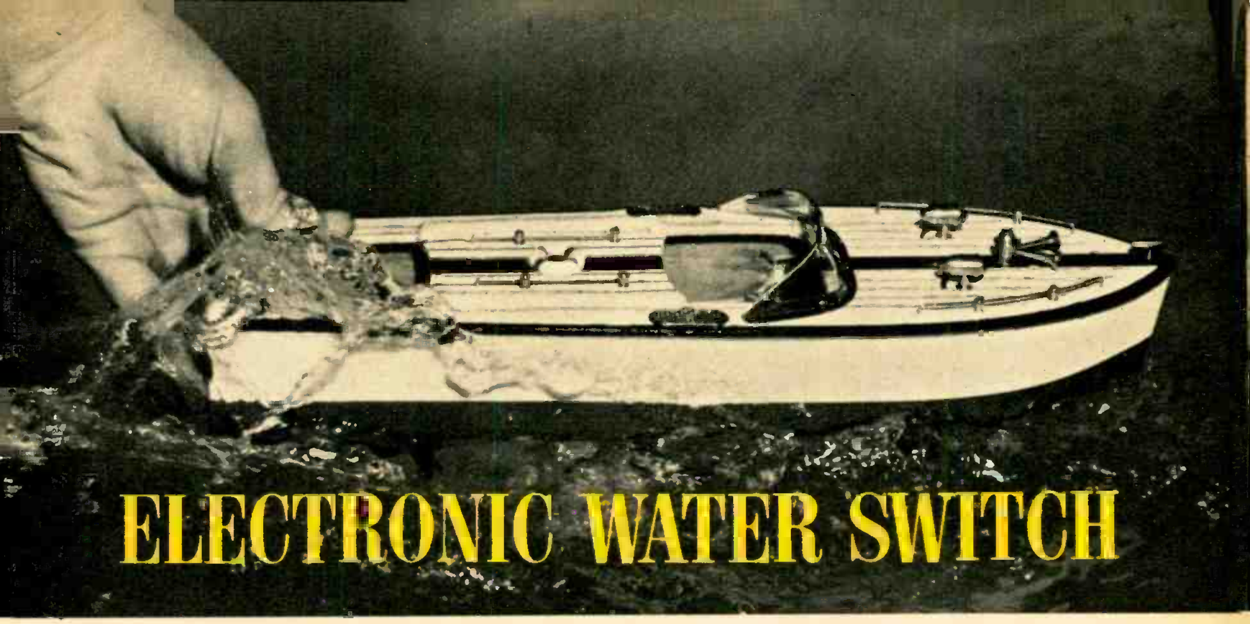


ELECTRONIC WATER SWITCH

Look what you can do with two transistors and a dash of water!

By FRED MAYNARD
11Q0846

WHAT will transistors be doing next? Their uses are familiar enough in radios, stereo amplifiers, TV sets, computers, missiles and communications satellites. Now we've come up with a way of connecting two of them to warn you when the cellar's flooding, the river's rising or the winter oil supply is low. The switch can also be used to start a model boat the instant it's put in water—or to stir up the best martini or Manhattan you've ever tasted.

When water or any conductive liquid comes in contact with the switch's sensing probes or elements, the circuit goes into action and will energize a bulb, relay or small motor connected to its output. It's the modern way of doing what a float and mechanical switch used to do.

In applications in which the switch is to be used as a liquid-level warning device, a sensitive DC relay would replace the motor shown in our schematic. In addition to energizing an alarm, the relay can be used to start a pump when the liquid level rises or falls beyond a set point.

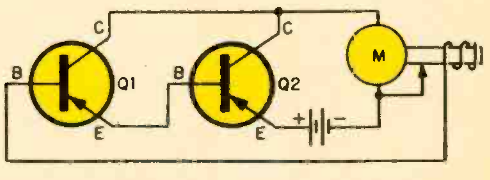
If the switch is to be used to warn you of a high liquid level, connect the alarm circuit to the relay's normally-open contacts. These contacts will then close when the liquid touches the probes.

To warn you of a low liquid level, connect the alarm circuit to the normally-closed relay contacts. When the liquid normally touches the probes, these relay contacts will be open. When the liquid level falls, the relay will be de-energized, the contacts will close and pump or alarm will go on.

How it Works. The water switch consists of two compound-connected transistors (sometimes called a Darlington circuit) with a motor or relay in the combined collector-to-emitter load circuit.

When the probes are immersed in a conductive liquid (not chemically pure) so that the resistance between them becomes 25,000 ohms or less, Q1 is forward-biased. That is, the negative battery voltage is applied to Q1's base because of the resistive path through the liquid. Both transistors then conduct and current flows through Q2 and the motor or relay. Because of the voltage drop across Q2, operate 1.5-volt motors at 3 volts.

The schematic here applies to a boat or drink mixer. Therefore, the sensing probe is



Q1 is forward-biased by negative battery voltage applied to its base via conducting liquid between motor shaft and loop; Q2 then conducts.

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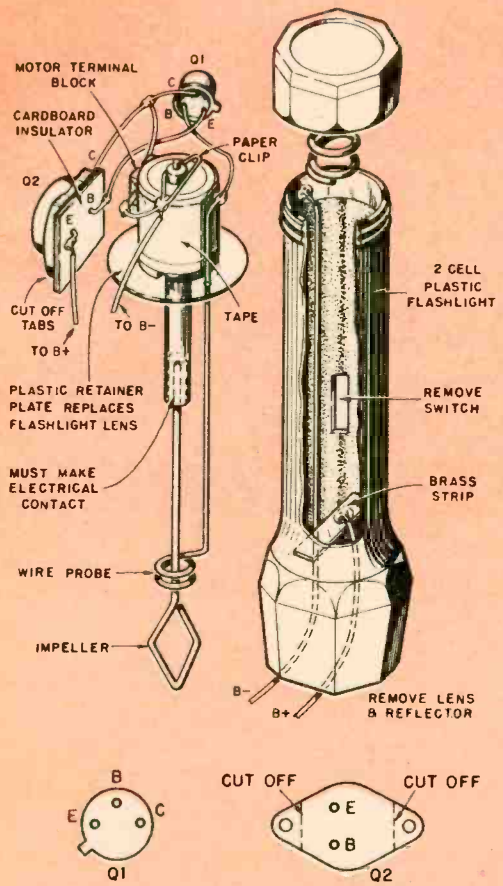

Automate a standard swizzle stick by adding water switch; install in two-cell flashlight.

PARTS LIST
Q1—2N741 or 2N1191 transistor
Q2—2N176 or 2N554 transistor
Batteries—Two to four 1.5-volt cells
Motor—Miniature DC (permanent magnet) model motor (Lafayette F-403, F-404, F-405; Olson Electronics MO-104, MO-105, MO-106)

Pickup loop is shown mounted around the propeller shaft of battery-operated model boat.

WATER SWITCH

shown as a coil mounted around the motor shaft. The closer the loop to the shaft, the more sensitive the switch. But don't let the spacing get too close. The arrow from the negative battery terminal to the motor shaft represents a spring steel or bronze electrical contact to the shaft. This is necessary as the motor shaft acts as one probe and usually is not connected internally to either of the motor's power terminals.

Contact to the shaft also can be made at the back of many small DC motors where the shaft protrudes slightly. In other applications, connect one sensing probe to the base of Q1 and connect the other probe to the negative battery terminal.

Applications. The photo below shows how the sensing probe is mounted around a boat's propeller shaft. Be sure the loop is rigid and spaced evenly around the shaft.

The diagram shows how to use the water switch to build an automatic drink stirrer in a two-cell flashlight case. First, get hold of a battery-operated swizzle stick at a bar-supply store or novelty shop. Remove the motor and impeller assembly from the swizzle stick and build it into the flashlight case as shown. The best way to go about getting all the parts in the limited space is to assemble them right on the motor as shown. They can be held in place with electrical tape.

It will be a tight squeeze and you may have to saw the mounting tabs off Q2, but all the parts will fit in the flashlight's head. Cover the underside of Q2 with a piece of cardboard so it doesn't touch the metal motor case.

Be sure the impeller rod makes good electrical contact with the motor shaft and that the wire probe doesn't contact the motor case. To prevent shorts, cover the motor with electrical tape. Note how we used a paper clip at the top of the motor to make contact between its shaft and the negative battery lead. And don't dunk the swizzle stick in water to wash it. Merely remove the impeller from its holder. Because of the motor's heavy current drain, the best batteries to use for long life are alkaline energizers.

Beyond these suggestions, it's hard to give more specific construction information as each application is different. But the circuit is so simple you can't miss.

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HAM

Though Ron Conley, K7LTV, is only 17 years old, he boasts a shack that's neat enough to make many a seasoned old timer mighty envious. Equipment at Ron's shack includes a Viking Ranger transmitter, National NC-109 and NC-303 receivers and a dipole for every band. Ron sends code at 35 wpm, puts out 70 watts and has 37 countries and six continents in his log. His QTH is Miles City, Mont.

PRIZE SHACKS

A LOT of time, though not necessarily a lot of money, goes into every neat and attractive shack, whether it belongs to a ham, a CBer or an SWL. Each of the three shacks pictured here is outstanding for its orderliness and appearance, and this is the reason each has won its owner a $20 prize. A careful study of these photos may uncover some ideas you can make use of in your own shack. But whether you pick up ideas or not, we are certain you will join with EI in bestowing a hearty congratulations on the respective owners of each shack for a job well done.

SWL

A DXer of some two years' standing, Ray Fronczak hails from St. Louis, Mo. Ray has pulled in over 71 countries on his National NC-105 receiver and he is the proud possessor of a General 50 award from EI's DX Club. Other equipment in his attractive shack includes a homemade preselector, a high-gain antenna tuner, a crystal calibrator and a tape recorder.

CB

This prize-winning CB shack belongs to Vincent Annabel, now KBI7362, of Cutchogue, N.Y. Vin is an active member of the Peconic Bay CB Club, and his shack is one of the neatest we've seen. Among Vin's gear is an International Executive 50, a Sonar E (which goes marine in summer), another Sonar E for mobile, a Magnum antenna and a Heathkit GW-31 receiver. An old RCA all-band receiver stands by for emergency use.

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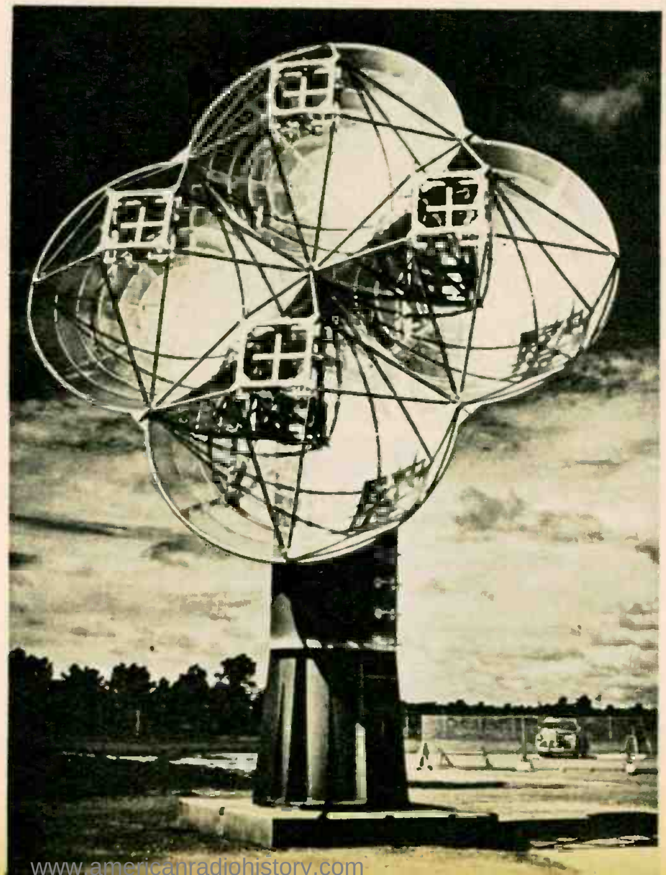
ONE-OCTAVE ORGAN—Thirteen tones—that's an octave if you remember to count the black keys, too—come from what must be the oddest electronic organ going. Actually, it's one of the electronic gadgets that students at the Technical University of Delft in The Netherlands dreamed up for an exhibit. It consists of 13 tape recorders, a one-octave keyboard, an amplifier and a speaker. Since each tape recorder produces a different note, a one-octave melody can be played on the instrument. Wonder exactly how many thirteen-tone tunes they know at TUD?

EI Picturescope



LUCKY FOUR-LEAFER—Though it looks like a giant four-leaf clover, this unusual antenna isn't the freak it seems to be. Radiation, Inc., developed the weirdy which, in addition to its clover shape, boasts some other special features. Its lightweight mesh construction makes it a natural for installation aboard ships and vehicles. Then, too, it can sweep the skies with a swiftness that makes for really fast tracking. But getting back to those four leaves . . . could the antenna's designer have been plain superstitious?

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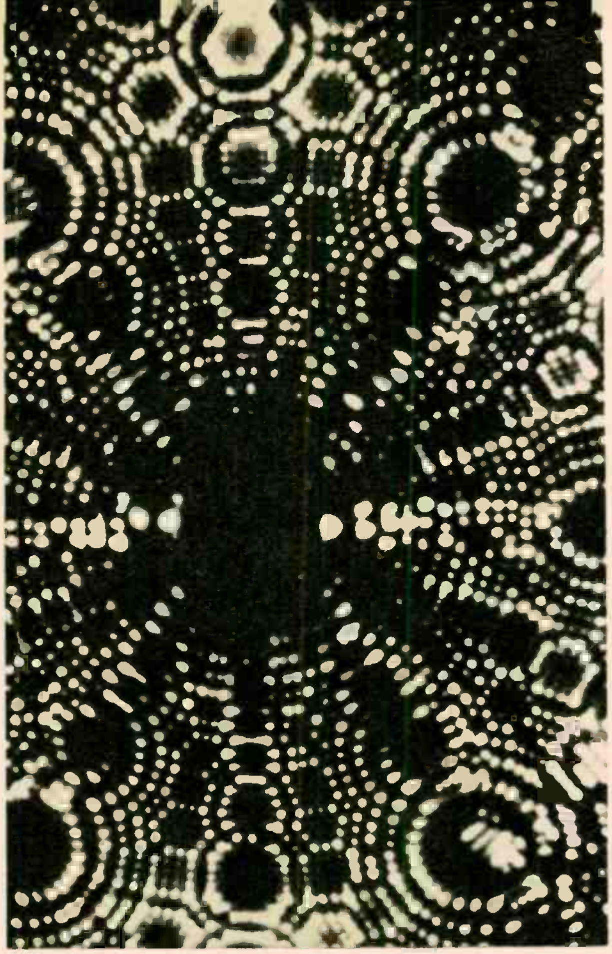
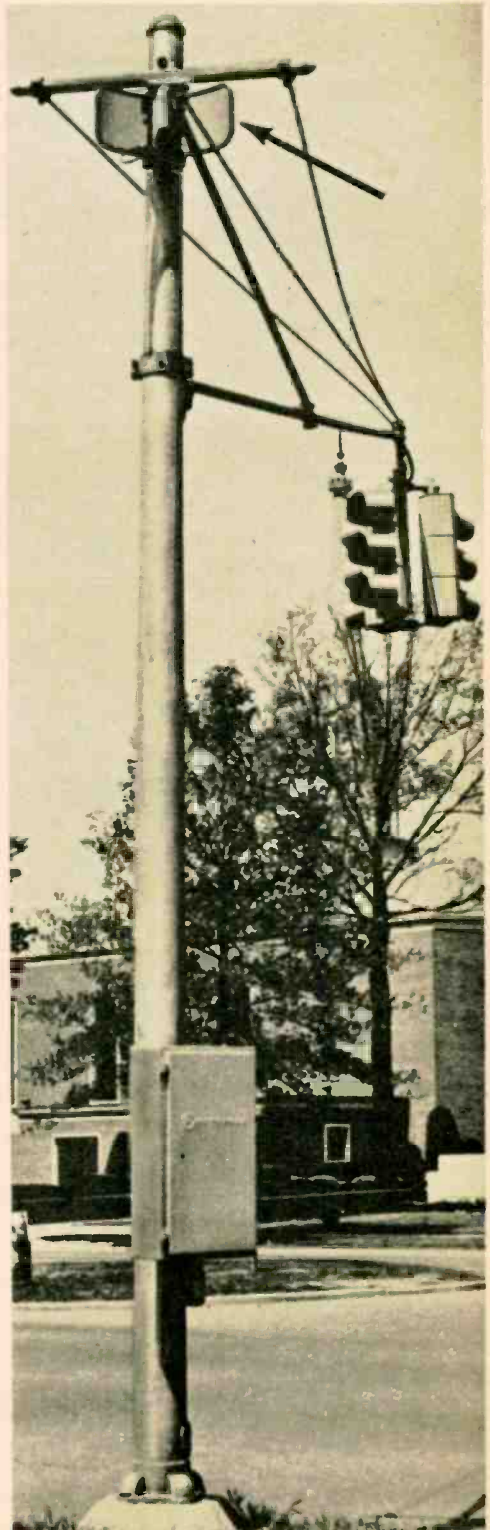


ATOM KALEIDOSCOPE—Magnified some 2.7 million times, the patterns in this photomicrograph represent our first clear view of atoms. In this case, they're the atoms in a nearly perfect crystal of tungsten. A super-powerful Muller field ion microscope being produced by the Central Scientific Co. made the photo possible. The instrument was invented by Dr. Erwin W. Muller of Penn State.



RADAR LIGHT—If it weren't for the traffic light attached to it, this pole might be a mast transplanted from a ship, complete with a radar screen. But it's really a radio-controlled traffic signal at a street intersection in Detroit. The "radar" screen (arrow) is an antenna that picks up signals from a master control center to change the lights.

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DIVERSITY

"AND so we come to the end of our broadcast schedule for tonight. You have been listening to station . . . in . . . Good night."

How many times has it happened? You stuck to that weak, fading signal for what seemed like hours, waiting for the station break. You suffered through endless concerts of weird, distorted music, through monologues of what was supposed to be English, through dialogues in a tongue like nothing on Earth. But you knew it wasn't from Mars.

You had hoped you were listening to that fabled mountain kingdom whose station goes on the air only when its temperamental prince feels the country should be heard from. Its QSL is rumored to be a certificate in gold leaf on parchment, signed by His Highness (the stamp is a collector's item, too). Or could the station have been that rarest of the rare on that chilly little island in the Southern Ocean?

You'll never know. The fading, already bad, was at its worst at station-break time.

In and Out. Fading, as you know, stems from shifts in the ionosphere, that high-up reflecting layer responsible for bouncing short-wave signals round the globe. These days, satellites beep through the ionosphere, supplying all kinds of fascinating information about Faraday Shifts and what not. But DX signals still fade in and out. And nobody knows what to do about it . . . or do they?

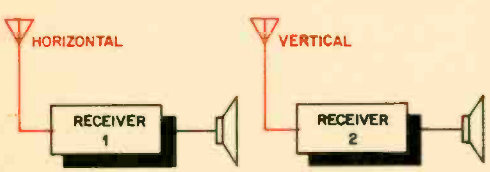

Fig. 1—Simplest setup uses two receivers and two antennas—one horizontal and one vertical.

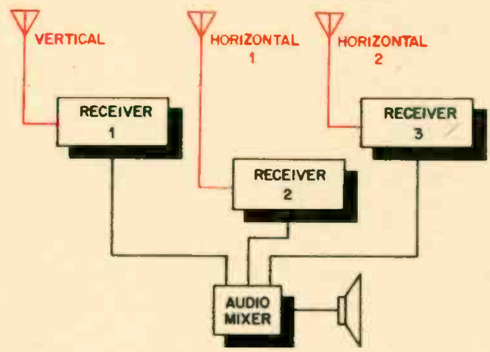

Fig. 2—Commercial receiving stations have a more complex setup. Three receivers feed one speaker.

Actually, there *is* a remedy. Commercial short-wave receiving stations have used it for decades. It's called *diversity reception* and in its usual form requires two or more receivers. If you have two receivers, you are almost in business. If you haven't, we'll show you some antenna tricks that can prove helpful to the ham, short-wave listener or even the CBer in certain cases.

Two receivers normally are used for diversity reception in order to take advantage of two antennas—which are not connected or coupled to each other. Fig. 1 tells the story. Ideally, the two antennas should be at right angles to each other. Your best bet probably is a horizontal antenna for one set and a vertical for the other—unless you have room for two separate horizontals. If you do, remember that the two *must* be rigged at right angles. Putting them parallel to one another would bring no benefits whatever.

Polarization and Phase. Why two antennas? Fading often is the result of polarization shifts in the signal, along with what are called phasing effects. You perhaps know that a signal is polarized as it leaves the transmitting site. It's vertically polarized if the

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RECEPTION

Two heads are better than one, or so the old saying goes. Two antennas also can be better than one—if you know some of the tricks involved.

transmitting antenna is vertical and horizontally polarized if the antenna is horizontal. But after the signal has been propagated some distance and taken at least one bounce off the ionosphere on the way, its polarization gets mixed up. In fact, the signal arrives at the receiving point with some of its energy horizontal, some vertical.

None of this really matters much, of course, so long as the polarization is constant. But if the ionosphere has any kind of ripple or turbulence in it, or if the earth's magnetic field is acting up, the polarization keeps changing. And this makes for polarization fading.

Fading from phasing effects is perhaps simpler to understand. It results from multipath transmission. Some of the signal reaches the receiver, say, via one reflection from the ionosphere. But some more signal energy arrives after having bounced from ionosphere to earth to ionosphere and back again. This makes one signal path longer than the other.

With two sets of waves coming in, everything is fine so long as their crests and troughs happen to match. If there is a slight mismatch the signal will be weaker, though still readable. But let the ionosphere get restless and wave crests may begin to overlap wave troughs. In this case, the signal will fade and even drop out at times.

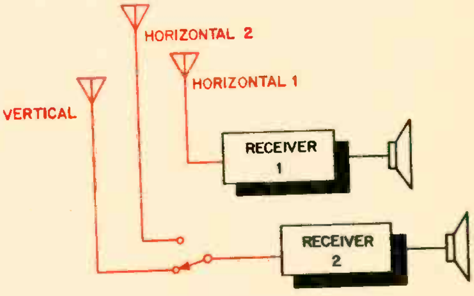

Fig. 4—Adding second receiver to installation at left below brings better all-round reception.

These fading effects can be dodged to some extent with two well-separated antennas or two neighboring antennas run at right angles. While two incoming wave trains may be overlapping the wrong way and cancelling at one antenna, they just may be arriving in step and adding at the other antenna. Comes the next ionospheric shift and the waves might start to add on the first antenna but cancel on the second. In this case, it's a simple matter to switch back again.

Three and Two. Commercial diversity installations go one better than the two-antenna setup of Fig. 1. They use three antennas, each permanently feeding its own receiver (see Fig. 2). The outputs from the three receivers are fed to a mixer and finally go through one audio amplifier and one speaker. But you don't have to get that fancy.

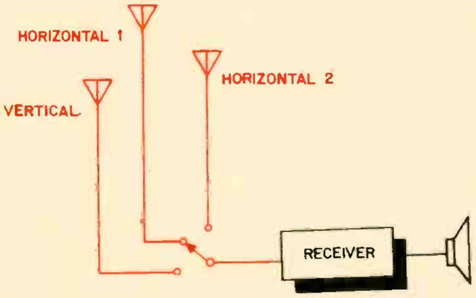

Fig. 3—Three antennas and one receiver typify cost-cutting hookup. Switch selects antenna.

Matter of fact, if you don't own two receivers, you can try the hookup in Fig. 3. Simply erect the additional antenna or antennas, and rig a low-loss ceramic switch so you can change antennas in a snap. Fades

[Continued on page 110]

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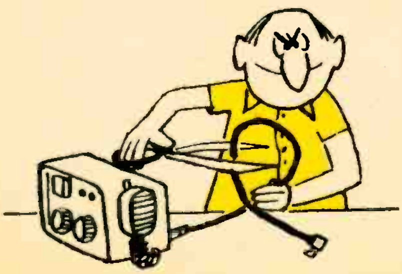
CB's MAMMOTH MYTHS

TUNE ACROSS the Citizens Band any evening and you more than likely will get a speakerful of technical nonsense. Worse yet, this bunkum—much of it so bad as to curl the ears of a high-school science student—is responsible for many well-meaning CBers debasing what basically is some pretty decent gear.

In actual fact, many of the twisted tips tossed from CBer to CBer not only convert a good signal to a poor one but often result in extensive damage to the transceiver as well. To make certain that you don't get trapped in a web of dangerous deceptions, let's take a look at the real truth behind the best of CB's myths.

MYTH. *You can reduce the standing-wave ratio (SWR) to 1:1 by trimming the feedline.*

TRUTH. Actually, the length of the feedline has no effect on SWR. After all, SWR is the ratio of transmission-line impedance and antenna impedance compared to 1. Trimming the feedline may *appear* to reduce SWR, though in point of fact conditions are being established which force the VSWR meter to indicate a low SWR—even when the actual SWR hasn't changed. (While this situation wouldn't be true with an impedance/SWR bridge or a comparison bridge, it is the case with the VSWR meters most CBers use.)



The thing to keep in mind is that if you can vary the SWR reading by trimming the line, you have a serious antenna mismatch—best cured at the antenna, not at the feedline. Look at it this way: most CB antennas are designed to be used with CB transceivers. Unless you err on the installation, the SWR normally will be low. In fact, you probably would have to try hard if you wanted to get a high one.

MYTH. *Since you have to squeeze every drop of RF out of a mobile rig, it's better to use low-loss RG-8/U coaxial cable rather than TV-type RG-58/U for the feedline.*

TRUTH. Problem with this myth is that it's based on a truth: RG-8/U *does* have less loss. But the fact overlooked is that the loss reduction on 11 meters is significant only with transmission lines more than 50 ft. in length. Assuming a line of approximately 12 ft., the advantage with RG-8/U is a mere 0.1db. And you couldn't see this improvement on an S-meter, let alone hear it from a speaker.

MYTH. *Those new short, loaded antennas are more efficient than the standard quarter-wave whips.*

TRUTH. The general rule to follow when making your decision about a mobile whip is: The more steel, the greater the radiated energy. While energy is radiated all along a quarter-wave antenna, it increases as you ap-

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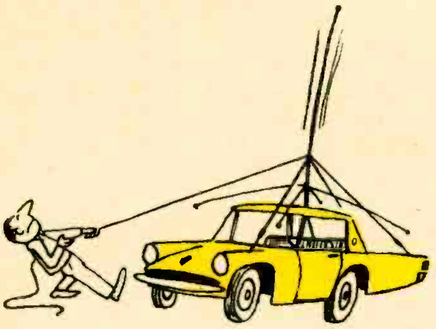

proach the bottom (base). Replace the lower half of a full-length whip with a loading coil, and most of the energy will be radiated inefficiently from the loading coil itself.

A loaded antenna in the center of a car roof, with the roof acting as a ground plane, might equal or outperform a full whip which is fender- or bumper-mounted. But it won't outdo the full-length whip mounted in the center of the roof and properly matched to the transmitter. Fact is, if you can get away with 108 inches of steel on your car roof, you're better off than you'd be with any of the quarter-wave loaded antennas now on the market.

MYTH. *If you lower the value of the resistors in the power supply, you'll get more B+ and, therefore, more input power to the final.*

TRUTH. The reasoning behind this one is correct, but the results are something else and perhaps even illegal. When you hear a CBer brag that this trick gave him the most powerful signal in the state, keep in mind that you must double the input power to the final before the receiving station can hear a slight increase in signal strength. In other words, if your rig puts out 2.5 watts, it's going to have to put out 5 watts before the receiving station will detect any change.

But even pulling all the filter resistors isn't going to double the input power. And if you do get an increase, it will be too slight to be noticed. What's more, there may not be enough drive to the final under these circumstances to produce full RF output. Even worse is the fact that the added drain from the final may overload the power transformer, while the reduction in filtering may cause hum in the signal. (Now you know where all the noisy signals come from!)

MYTH. *If you adjust your car's voltage regulator to give a higher charging voltage, you'll get a higher B+ and more input power.*

TRUTH. There are some veracities behind this one, but there also are more pitfalls than there are CB channels. Sure, you'll get more B+, maybe even 30 volts more, but this hardly will cause the S-meter to budge. Simultaneously, of course, you'll overload the power supply and the vibrator. Further, the higher voltage will shorten tube life and may damage both the battery and the voltage regulator. To put it another way, fooling with the voltage regulator can cause more expensive damage to the transceiver and the car's electrical system than any other wild idea we know of.

MYTH. *You get better all-round performance if you use hot or premium (industrial) tubes.*

TRUTH. This one stems from the early days of CB and should have been buried by now. It is true that many manufacturers used tubes which did not have top efficiency on 11 meters in that first rush to get CB rigs on the market. CBers, in turn, learned that certain substitutions for the tube in the transmitter final would give better performance on 11 meters—though this wasn't of any earth-shaking significance, since power output rarely, if ever, was doubled as a result.

However, all present-day manufacturers well know how to design a 5-watt transmitter, and about the only thing a tube substitution will do is cost you money. More output you won't get.

Receiving tubes are a different story. Many direct substitutions can soup up your receiver —but at what price? A good receiver (as

[*Continued on page* 110]

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A Ham's Greatest Thrill

A few spine-tingling moments stand out above all others in most any radio amateur's exciting career on the air.

AFTER WEEKS of trying to make the best of salvaged and surplus components, the eighth wonder of the world has been created—your very own homebrew rig, raring to blast forth on 40 meters with a mighty 75 watts of magnificent CW. Only a month ago, your phonograph was feeding strains of Dave Brubeck through a pair of 6L6's. Today, those same beam bottles comprise the push-pull final of your band-blaster.

This day is different for another reason. For this is the day that the postman delivered an envelope from the Federal Communications Commission containing one amateur radio license, Novice class, call sign WN2XOM (we'll say).

The crumpled envelope barely has come to rest at the bottom of the waste basket before you have the rig warmed up. Already the family has begun to gather in your citadel of communications. But now you are faced with a rippling wave of gooseflesh as your hand comes to rest on the telegraph key before you.

Nothing else to do but call CQ. Here goes. "CQ CQ CQ DE WN2XOM WN2XOM K." That's it! It was easy! Certainly the band will be crawling with stations from Tacoma to Togoland, all calling WN2XOM. Quickly you tune across the band—silence! This time you tune more slowly, carefully scrutinizing each shred of static lest it hide someone calling you. But no—only a little noise.

Now comes the time of gravest doubt. Yes, the plate dips, the antenna loads up, the relays close with a loud click, you've got the right crystal in the socket, the proper coils are inserted in the proper place—everything seems to be just as it should.

You are aware of a sensation of burning embarrassment as your family begins tsk-tsking and leaving the room, one by one.

There is nothing left to do but give the band another try, but

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hurriedly. After all, you'd like someone to come back to you before you're left sitting alone in the shack. "CQ CQ CQ DE WN2XOM WN2XOM K."

Half-heartedly you nudge the dial across the band. What's that? There's a station in there. What's he saying? "DE WN9XAL K." You missed the first part of his transmission. Perhaps it was for you. You wait. Silence. He never returns. You call him. Still silence. You tune again.

Here's another station. "WN2XOM WN2XOM WN2XOM DE WN8XZA WN8XZA." This is it! He's calling you! Now that there's actually someone out there in the great beyond waiting for you to say something, you can't think of a thing to say. Besides that, you seem to have forgotten all the CW you spent weeks and weeks learning. But you have to start your ham career somewhere, so here goes!

"WN8XZA WN8XZA WN8XZA DE WN2XOM WN2XOM QTH SANDS POINT MY NAME IS BILL. RIG IS 75 WATT HOMEBREW INTO LONGWIRE ANTENNA. RECEIVER IS APEX 8. UR SIGS RST 579 K."

Now, that wasn't so bad. "Wonder if he can tell that I'm on the air for the first time," you say to yourself. "Maybe my code was full of mistakes and he didn't understand me."

At last he returns, sending slowly. His handle is Bob. He lives in "Cflevefand," Ohio (someday you'll learn to distinguish between the letters l and f, you tell yourself), and he's running a homebrew rig with a 6146 in the final.

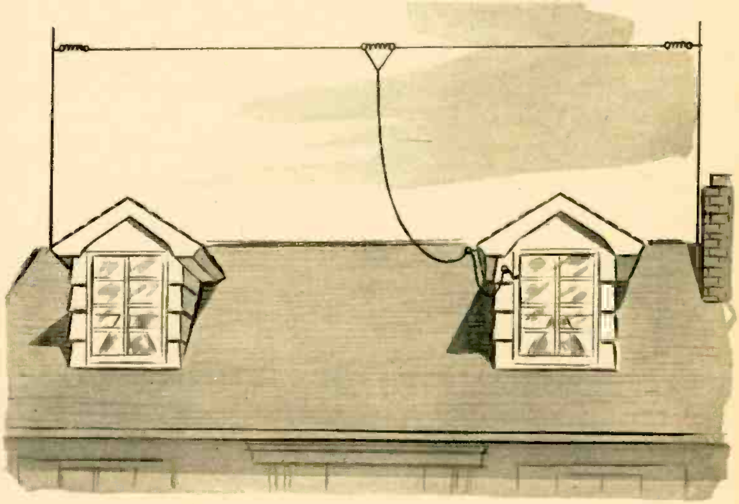
Well, what do you know! This is his first day on the air, too. He says that he called CQ for 20 minutes and that you are his very first contact.

By now the family has sauntered back up the stairs and surrounds you. Already you have described to Bob the trials and tribulations of scrounging up components for the transmitter, that you are about to graduate from high school and that your geometry is a bit on the weak side.

In turn, he has told you that he is a vice-president of a bank, that he became interested in ham radio as a result of his activity on the Citizens Band, that his wife's (XYL's) name ("handle") is Betty, that he has two kids—twin boys ("harmonics")—and that Betty is patiently watching the mail for her Novice ticket.

After 15 minutes, the band begins to get active and other stations are starting to clobber the contact. You sadly bid farewell to Bob, promising to send him a QSL card as soon as you have some printed, asking that he look for you again tomorrow at the same time.

As soon as you have signed with Bob,



you hear two other stations calling you, one in Michigan and one in Illinois. You go back to the Illinois station and, within a few minutes, you're busily chattering with him—without the least bit of nervousness. You're beginning to feel very much at home with a key, and you have more faith in yourself and your equipment. It's quite a thrill to be able to talk to Illinois.

But you will always remember Bob from "Cflevefand." Because nothing will ever quite equal the thrill of that very first contact—even if you're a ham for 50 years!

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Awards for the Ham Shack

Continued from page 70

In Switzerland, the USKA presents a most attractive certificate in its Helvetia 22, awarded for working all 22 Swiss cantons. Along much the same line is Sweden's WASM award, given for working all 24 laens (provinces) in the country.

Even Russia is in the award picture, with Moscow's Central Radio Club the sole source (this organization happens to govern all amateur radio activity in the Soviet Union).

Though we've given you only a sampling of the hundreds of awards available, your appetite no doubt already is whetted. For the complete ham award picture, you should obtain a copy of the Award Hunter's Bible, a directory of certificates and awards published by Clif Evans, K6BX, Box 385, Bonita, Calif. 92002. It contains every amateur award known to exist and it tells you how to go about applying for each and every one of them.

Meanwhile, here are the names and addresses of the organizations and clubs we've mentioned:

American Radio Relay League (ARRL)
225 Main St.
Newington, Conn. 06111

CQ Magazine
300 West 43rd St.
New York, N.Y. 10036

Deutscher Amateur Radio Club (DARC)
Igor Falster, DL1EE
85 Nurnberg
Tillystrasse 44, Germany

El's DX Club
67 West 44th St.
New York, N.Y. 10036

International Amateur Radio Union (IARU)
225 Main St.
Newington, Conn. 06111

Radio Society of Great Britain (RSGB)
28 Little Russell St.
London, W.C. 1, England

Reseau des Emetteurs Francais (REF)
Att: Lucien Aubry, F8TM
Boite Postale 42-01
Paris RP, France

Short Wave Magazine Ltd.
55 Victoria St.
London, S.W. 1, England

Swedish Amateur Radio League (WASM)
Att: Awards Manager
Enskede 7, Sweden

Union Schweiz Kurzwellen Amateure (USKA)
Henri Bulliard, HB9RK
St. Bathelemy 7
Fribourg FR, Switzerland

Hi-Fi Today

Continued from page 58

standardize, and they in turn are putting pressure on the record companies to do likewise. In the meantime, I've had a chance to experiment with the first of the 15-degree pickups, Shure's M44-5.

After listening to the M44-5 for a while, I can report that E. R. Madsen, the Danish engineer who first started talking about the angle problem, wasn't just nit-picking. The new Shure is good—so good that I don't think anyone can argue seriously that the angle problem isn't worth solving. My reaction to M44-5's sound was best expressed by my wife whose golden ears are legend in our crowd. When I tried out the cartridge for the first time, she put down her Horatio Alger novel she happened to be reading, listened attentively for a time and then announced, "That's clear sound."

And so it is. I'm not sure all the credit goes to the new tracking angle, but I am sure that the audible difference lies almost completely in the lower percentage of distortion. On London records, which are made on a Teldec cutter that's close to the 15-degree standard, the difference is phenomenal. The sound unquestionably is more detailed than I've ever heard before. Matter of fact, a slightly edgy quality on some Londons disappears with the new Shure. Now if we can get some standardizing from the record companies . . .

FM Transmitter

Continued from page 50

change will vary the frequency of the oscillator above and below its resting frequency in step with the audio signal on V3A's grid.

The operation of reactance-tube modulators is an involved subject. For a comprehensive explanation of how they work, we recommend any of the following:

FM Transmitters and Receivers (Department of the Army Technical Manual No. TM11-668, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20025, $1.50).

FM Simplified by Milton S. Kiver.

The Radio Amateur's Handbook (American Radio Relay League).

Radio Handbook.

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The Listener

Continued from page 90

A log should include date, time, station, location, frequency, program notes (to authenticate your reception) and reception conditions. Time can be either GMT or your local garden variety. GMT is best for international reports but the important thing is to pick one time system and stick with it. And play it like some of the railroads: *don't* switch to daylight saving time in the summer since this only confuses the issue.

Frequency can be in either kc or mc (we use only kc in THE LISTENER). To describe reception conditions, you can call on the SINPO system, which is preferred by some of the large international broadcasters. But simple English is more widely understood and can provide more information.

Turkey and Greece . . . During the recent Cyprus crisis many SWLs were looking for SWBC stations at Ankara and Athens. The Voice of Turkey can be heard in Eastern North America via the North American beam proper at 1800 EST on 9515 kc—but only through Mexico City's powerful XEWW. Sometimes, too, the program for England at 1700 EST can be picked up in the East on 7285 kc, occasionally with less QRM than is found around the 9515-kc transmitter. To listeners on the West Coast, English-language newscasts from Turkey are pretty scarce, though the 9515-kc outlet sometimes can be logged after XEWW signs off at 0015 (2115 PST).

Greece, too, can be logged, though again with difficulty. While it has a new and more powerful relay under construction, the VOA currently lays claim to two 35-kw relay bases on Greek territory. One, operating from the Courier, which is anchored off the island of Rhodes, occasionally is heard on 7130 kc prior to its 1745 S/off. The other, at Thessalonica, is pretty much a dead loss. Operating primarily on 49 meters (including 6185 kc), it's on only during what are daylight hours in North America.

Notes from EI's DX Club . . . Member Roger B. Light of Texas suggests a 25-country award, while California's H. L. Chadbourne would like to see one for 75 countries. Still another member is plugging for a TV award, based on states rather than countries. Why not let us know what *you* think about these suggestions? . . . For award purposes, we are putting R. Americas in International Waters and counting this whole category as one country. In other words, if you log and verify a ship in the mid-Pacific, it would count as one country, just as would a QSL from the Caribbean clandestine. Though dumping R. Americas in the middle of nowhere certainly isn't ideal, it's the best we can do so long as that strange secrecy continues to surround the station . . . On the basis of this Award Period's entries, it would seem that DXers are becoming better and smarter all the time. For example, many are using utility stations to add rare countries to their logs. To mention just a few, Eugene Atkins of Virginia bagged Puerto Rico via NAU3 at Port Allen—a station which operates on many frequencies. Similarly, eight out of ten QSLs from Robert H. French (Ohio) were of the utility variety, including GYR3 on 8594 kc (this happens to be the Malta Naval Radio and is operated by the British Admiralty). Back in this hemisphere, Lawrence J. Elkin (New York) verified the St. Pierre radio-telephone station on 12295 kc . . . This month's mail also brought at least two hoax entries. For example, one fellow submitted a list which contained stations like CHL3 at Gena, Egypt, on the 25-meter band.

How to Record Live

Continued from page 77

placement, of course, is the recorder itself. It's imperative that you know your recorder. In particular, learn to use its level indicators. Do a little experimenting to determine what actually is the optimum level. Remember that too low a level will bring on tape hiss, which easily can mask the subtleties of a recording. Too high a recording level—aside from causing distortion—will result in print-through. And no one we know wants to listen to distorted sound plus pre- or post-echoes that will become increasingly more pronounced as time goes by.

When the going seems rough, consider the professional recording engineer. Even with thousands of dollars worth of equipment, lots of experience and a good knowledge of acoustics, he still is never quite sure of what he's going to get on tape. But then, that's half the fun, isn't it?

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CB Corner

Continued from page 51

Best bet here is the low-pass filter already in many CB rigs.

Though designed to suppress TVI, this filter should work in reverse. In other words, it should short-circuit frequencies above 27 mc straight to ground. If your filter's not doing its job, check for proper filter adjustment as described in the instruction manual. Its effectiveness often can be improved significantly by running a heavy, direct wire between the rig and a good electrical ground (cold-water pipe or cover screw on an AC outlet). Should these steps fail, one of the commercially available low-pass filters can be installed in the transmission line where it meets the CB rig's antenna jack.

Punch . . . is one word to describe the new Side-Bander transceiver by Olson Electronics. A checkout of the recently introduced rig revealed a signal with surprising sock, yet with a much-reduced carrier. Secret here lies in the fact that RF energy normally wasted in transmission is injected into the sidebands where talk power actually resides.

The rig produces some novel effects not normally experienced in CB operation, due to its double-sideband reduced-carrier signal. Carrier output, for example, is a meager 1.5 watts—far less than you'd measure from a conventional set. But start talking into the mike, and the output meter swings way up. Why? Well, radiated power with DSB reduced carrier varies much more with modulation than is the case with conventional rigs.

This apparently low output can be deceptive to a distant station. Another CBer watching your signal on his S-meter is apt to report poor signal strength. He may be unaware that his S-meter is indicating carrier power rather than real talk power. Thus, when reporting to a DSB station, judge performance on audio level and not deceptive S-units.

The Olson transceiver, incidentally, has 23-channel transmit and receive in addition to a highly efficient modulation system. It also sports a handy front-panel knob for tuning the transmitter final. Model RA-590; sells for $214.95.

Crrraaack . . . goes the whip on some CB-equipped autos. And with it go smashed car windows and broken side mirrors. That's the report of Judy Clark, secretary of an Illinois-based club, the Ottawa 5 Watters.

As Judy explains it, innocent motorists keep complaining of being whip-lashed by passing CBers. Trouble is that outsize mobile antennas go into wild gyration at the slightest turn of the steering wheel or touch of the brake. Matter of fact, they dip down with enough force to neatly break a nearby car window or surgically slice off a side mirror. The club's recommendations: choose a good mounting spring and whip. This done, try not to mount them on the outer end of the bumper.

Good Reading

Continued from page 71

material is detailed, easy-to-follow and, best of all, safely secured between its two covers. And it gives you enough information to transistorize the ignition of most any car.

RCA PHOTOTUBES AND PHOTOCELLS. RCA, Lancaster, Pa. 192 pages. $1.50

Photosensitive devices are increasingly important these days in everything from space research to medical electronics, so what better than a bargain-priced handbook on their applications? This little book, covering gas, vacuum and multiplier phototubes as well as photocells, is intended for students, engineers and advanced hobbyists.

TEST EQUIPMENT MAINTENANCE HANDBOOK. By Robert G. Middleton. Howard W. Sams & Bobbs-Merrill, New York & Indianapolis. 160 pages. $2.95

If you're the kind of hobbyist who throws up his hands when something goes wrong with your test equipment, this book is for you. It offers everything you need to know to keep your equipment in top working order. And it even gives you some tips on how to keep it accurate after you've modified or updated its circuitry.

And make note of . . .

MOST-OFTEN-NEEDED 1964 RADIO DIAGRAMS. Compiled by M. N. Beitman. Supreme Publications. 192 pages. $2.50

MARINE ELECTRONICS HANDBOOK, Second Edition. By Leo G. Sands. Sams. 288 pages. $4.95

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5A

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Capacities from 5 mmf to 1000 mmf. Working voltages from 600 to 5000 volts. Parallel wire leads. Pkg. of 40. 6 oz. No. 39 A 688.

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6

Audio Power Transistors 2 for **79¢**

Bargain! Two 2N176 transistors; 3 amps @ 30 v.; DC Beta—25 v. Icbo; 3 ma. Pwr. gain—35.5 db. 6-12-28 v. 4 oz. No. 39 A 633.

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7A

Epoxy Silicon Rectifiers 2 for **77¢**

SAVE on rectifiers made by Sylvania to military specs. Rated 750 ma at 100 v. PIV. For power supplies, TV sets, kits, etc. Pkg. of 2. 3 oz. No. 30 A 669.

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8

3 9-Volt Batteries ONLY **59¢**

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9

Bargain Phone Plugs 3 for **78¢**

Standard ¼" plugs for extensions, speakers, headphones, monitoring equip.; 2 cond., unshielded. Pkg. of 3. 12 oz. Specify red or black handle. No. 39 A 020.

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10

Zener Diodes 12 for **$1.98**

Famous-brand Zener diodes, from miniature mw. units to stud-mounted 10-amp. types. 3-30 v. range. With diagrams. Pkg. of 12. 7 oz. No. 39 A 008.

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11

50 Tubular Capacitors ONLY **98¢**

Wax-impregnated capacitors; ranges from 100-600 WVDC in popular values. Various sizes. All values and working voltages marked. Pkg. of 50. 12 oz. No. 39 A 385.

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12

5-inch Round Speaker ONLY **98¢**

Quality PM replacement; good fidelity. Power cap. 3.5 watts. Imp. 3.2 ohms. Magnet weight 0.53 oz. EIA mounting dimensions. 12 oz. No. 39 A 009.

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13

12" Hi-Fi Speaker ONLY **$5.85**

Wide-range; with hi-frequency whizzer cone. 12 oz. magnet; 40-14,000 cps; cap. 25 watts; imp. 8 ohms; standard mountings. 7 lbs. No. 39 AX 742.

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14

2-Set Coupler ONLY **98¢**

Transformer-type TV-FM coupler. Permits operation of 2 TV or 2 FM sets (or one of each) from a single antenna. Size, 3¾ x 1 x 1¾". 3 oz. No. 39 A 760.

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15

100 Terminal Strips ONLY **98¢**

Less than a penny each! Brown bakelite strips, all ⅜" wide. Assorted length —1 to 6 terminals per strip; mixed lug and solder types. 12 oz. Pkg. of 100. No. 39 A 582.

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16

ONLY **98¢**

Handy Mini-Tester

Pocket-size neon-type voltmeter; measures AC/DC from 65-800 v.; determines grounded side of line. 4 oz. No. 58 A 426.

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The WWV Story

Continued from page 55

the time is any five-minute point after the hour (except on silent periods), the tone is on two minutes. This is followed by a minute of buzzing sound and two minutes of pulses.

Binary Code. That buzzing sound actually is the day, hour, minute and second given in binary code and intended for data processing machines. It's included in the WWV transmissions so scientists can make simultaneous recordings of the WWV signal and of some scientific phenomenon they are observing. This gives them a precise record, right down to the second, of when their observations were made.

Musical Pitch. If you have a sharp ear you may detect that the musical note transmitted by WWV isn't quite the same with each succeeding five-minute period. This is because the tones broadcast are alternately 600 cps and 440 cps. The 600-cps tone is heard for three minutes at the start of each hour, the 440-cps tone is heard for two minutes at the beginning of the next five-minute period and so on. Bear in mind, of course, that nothing at all is transmitted during either station's silent period.

In case you aren't up on your do-re-mis, 440 cps happens to be A above middle C on the musical scale. And the NBS has been broadcasting this standard musical pitch to help keep musicians on key since way back in 1937. Who says our scientists don't have a spark of artistic appreciation in them?

Propagation Forecasts. At certain times during the hour you hear additional Morse code characters on WWV and WWVH. One group of characters represents a radio propagation forecast, intended to tell radio operators about conditions in the ionosphere. The bulletins are so brief that anyone who doesn't know Morse might mistake them for some kind of interference. But one letter and one figure are all the NBS scientists need to give radio operators priceless information about radio conditions—present and predicted.

The letter of the letter/number combo denotes conditions at the time the forecast is made: a *W* signifies disturbed, a *U* signifies unsettled and an *N* signifies normal. The figure, in turn, indicates the propagation outlook for the six hours ahead: a *1* means useless; a figure *2* means very poor; figure *3*, poor; *4*, poor to fair; *5*, fair; *6*, fair to good; *7*, good; *8*, very good; and *9*, excellent. Thus, transmission of an *N5* would mean that conditions are normal and are expected to be fair during the next six-hour period.

Propagation forecasts from WWV apply to North Atlantic paths—circuits from New York to London, or Boston to Vienna, let's say. WWVH's forecasts apply to North Pacific paths, such as Los Angeles to Tokyo or Vancouver to Seoul. You'll hear these propagation bulletins on WWV at 19.5 and 49.5 minutes after each hour. WWVH broadcasts its propagation forecasts at 9.4 and 39.4 minutes after each hour.

IWDS Warnings. The other group of Morse characters aired by WWV is intended to inform scientists about certain geophysical events. This service was inaugurated during the International Geophysical Year 1957-58 and has been continued under something known as the International World Day Service (IWDS). These coded transmissions are made by WWV at 4.5 and 34.5 minutes after each hour and by WWVH at 14.4 and 44.4 minutes after.

If this IWDS message declares an alert, the letters AGI AAAA are broadcast twice hourly for the next 24 hours by both WWV and WWVH. An alert means simply that a significant magnetic storm has started, that an outstanding auroral display has been reported or is expected, or that an appreciable increase in cosmic ray flux has been observed.

The letters AGI followed by three long dashes means a "special world interval" is in progress. This signifies that an alert has been declared and, more importantly, that the phenomenon is of far more than routine interest.

When there is neither an alert nor a special world interval, the letters AGI EEEEE are transmitted.

Incidentally, the NBS isn't alone in providing standard frequency and time signals by radio. Fact is, stations from Lower Hutt, New Zealand, to Olifantsfontein, South Africa, broadcast much the same information for the benefit of scientists and radiomen in these areas. But for listeners in the Western hemisphere, WWV and WWVH more than fill the bill. Know anywhere else you can get standard radio frequencies, standard audio frequencies, standard time intervals, standard musical pitch, time signals and radio propagation forecasts all at the twist of a dial?

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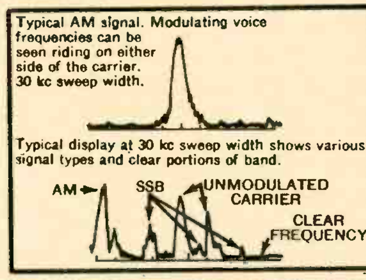
WATCH IT, HAMS & CBers

MODEL
HO-13



WITH THE NEW HEATHKIT® "HAM-SCAN" SPECTRUM MONITOR

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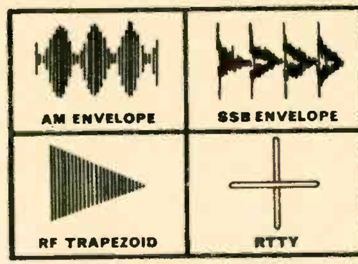
HO-10



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NEW! Heathkit "Ham-Scan" Spectrum Monitor ...HO-13

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Kit HO-13...11 lbs.......................... $79.00

SPECIFICATIONS—Receiver IF: 455, 1600, 1650, 1681, 2075, 2215, 2445, 3000, 3055, 3395 kc. **RF Amplifier—Response:** ±0.5 db at ±50 kc from receiver. IF. **IF—350 kc. Sensitivity:** Approx..100 uv input for 1" vertical deflection at full gain setting. **Horizontal deflection—Sweep generator:** Linear sawtooth, recurrent-type (internal). **Frequency:** 10 to 50 cps, variable. **Sweep width:** 30 kc or less, to 100 kc ±20%. Continuously variable. (Approx. 15 kc to 100 kc for 455 kc IF). **Resolution:** 1.5 kc (frequency difference between two 1" pips whose adjacent 3 db points coincide. Measured at slowest sweep speed and at 30 kc sweep width). **Power supply:** Transformer operated, fused at ½ ampere. **Low voltage:** Full wave voltage-doubler circuit provides 250 volts @ 20 ma, & 580 volts @ 6 ma. **High voltage:** Half wave circuit provides —1600 volts @ 1 ma for CRT. **Power requirements:** 120 volts AC, 50/60 cps, 40 watts. **Tube complement:** 3RP1 CRT (medium persistence green trace), 1V2 HV rectifier, 6AT6 detector 6EW6 RF amplifier, 6C10 sweep generator/horizontal amplifier, (2) 6EW6 IF amplifier, 6EA8 oscillator/mixer, (4) 500 ma silicon diode low voltage rectifiers, crystal diode, IN954 voltage-variable capacitor. **Controls:** On-Off/Intensity, focus, horizontal gain, sweep width, pip center, horizontal position, pip gain, vertical position, sweep frequency/AGC, astigmatism. **Dimensions:** 5¼" H x 7⅜" W x 11" D.

Heathkit Signal Monitor...HO-10

• Monitors transmitted & received signals • Displays envelope, AF & RF trapezoid patterns • Automatic switching on envelope patterns • Specially designed for amateur & CB radio use • Instructions included for low-power CB use • Requires no additional tuning on 160 through 6 meters • Handles power inputs from 5-watts to 1 kilowatt • Use with all tube-type receivers with up to 500 kc I.F. • Easy to install in antenna system feed line (50-75 ohm).

Kit HO-10...11 lbs.......................... $59.95

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AM-140R

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Stereo Amplifier

Continued from page 46

ance is not low, scrape the surface of the Copperprint to clean it.

After installing the balance control on the front panel, mount the remaining parts and install the ground buss wires shown in Fig. 5. Set the front panel aside for a while.

Drill the main chassis following the layout in Fig. 1, then mount the tube sockets, terminal strips, transformer, fuse holder and hum-balance pot R33. Capacitors C21/C22 and C23/C24/C25 must be mounted with the fiber washer supplied with them so their metal cans *do not* make contact with the chassis. Connect the power and output transformers and tightly twist the wires to all tube filaments. Do not use the chassis for one side of the filament circuit. Attach the front panel to the chassis securing it with the screws that hold the five slide switches.

Fig. 8—Front panel is a 14⅛x4¾x⅛-inch-thick piece of aluminum. After drilling, have panel sandblasted, and then letter it with transfer type.

Grounds. The only ground connection made to the chassis directly is at J5. All grounds are made to special points that are tied to the #14 ground buss bar. Follow Fig. 5 and these steps to be sure you get it right:

1) Install the ground buss under the chassis, connecting it to TS17 and the can lugs on capacitors C23/C24/C25 and C21/C22. Run another piece of buss wire from C21/C22 to terminal strip TS5. **2)** Connect a length of shielded wire from J5 (both channels) to both R2's (at V1), grounding the shield at J5 only. **3)** Connect a shielded wire from J1 (both channels) to S1, grounding the shield at the J1 end only. **4)** Connect insulated wires from the hot lugs on J2, J3 and J4 (both channels) to both sections of S1. **5)** Connect separate lengths of insulated hookup wire from the ground lugs on J1-J5 (both channels) and twist them around both groups of wires from the jacks to the front panel. Run these wires through the chassis and connect them underneath to the ground buss. **6)** Connect the insulated hookup wire from the ground buss on the rear of the front panel to the ground buss under the chassis.

Before installing components under the chassis, run the wires from the rear of the front panel under the chassis and connect them. There should be two shielded wires from the tone control circuits, two unshielded wires from the balance control and two shielded wires from the volume control. Note on the schematic that the shield on all shielded wires is connected at *one end only*. It is the end where the symbol for shielded wire appears.

After all wiring has been completed, install all other parts, following Fig. 4, taking great care around both preamp tubes (V1). Fig. 6, which shows the location of major parts near both V1's, should guide you.

After the amplifier is completed, turn it on, set S1 to *phono/tape head*, crank up the volume control and bass controls, center the balance control and adjust hum-balance pot R33 for lowest hum level. If the amplifier does not operate properly, a little trouble-shooting using the table of voltages below will clear up the problem in no time at all. Then put on your favorite record, sit back and enjoy really smooth stereo sound.

TUBE VOLTAGES (DC)*

Pin No.	1	2	3	4	5	6	7	8	9	10
V1	—	145	1.3	0.8	120	0.85	—	—	—	95
V2	130	—	1.4	—	—	135	—	1.4	—	—
V3	73	—	325	—	—	—	12.5	325	335	—
V4	—	—	—	—	—	—	—	335	—	—

*Measured with a VTVM. All readings ± 10%. Line voltage 117. Voltage at points A,B,C,D is 300, 285, 265, 210 respectively.

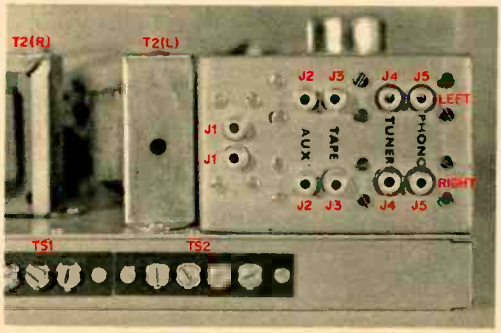

Fig. 9—Jacks mount in metal enclosure at rear of chassis. Drill all holes before bending the metal.

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Army

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Can Networks Save FM?

Continued from page 88

in with some supplementary programming.

The QXR Network utilizes high-fidelity land lines—as do AM stations—for most of its affiliates, though its stereo broadcasts are distributed solely via tape. And, since the QXR Network is national in coverage, it's presently necessary to service some remote areas exclusively by tape until land lines can be completed.

Another type of FM network might be called the program packager. Such networks range in size from the Triangle and Heritage networks through the British Broadcasting Corporation and the Broadcasting Foundation of America. In the main, they provide 10½-inch reels of tape. An engineer simply places one on a recorder, lets it play until completed, then plops on another. One network which operates largely by swapping tapes among its three stations is the listener-sponsored Pacifica Foundation, which has stations in New York City, Los Angeles and Berkeley, Calif.

Other FM networks, such as the Fine Music Group and the Good Music Broadcasters, are networks in another sense of the term. Most are sales organizations—selling time on a group of stations to national advertisers.

The Solution? But are networks the answer to FM's perennial problem of finding enough money? One spokesman, president Jim Shulke of the National Association of FM Broadcasters, says frankly that "the answer to FM's problem is money." But, he adds, "Some stations can get it through affiliation with a successful operation like the QXR Network. Others, like Chicago's WFMT and KPEN in San Francisco, can make it on their own by good programming and aggressive promotion."

The comments from one FM sales representative are much more one-sided, however. He puts it this way: "I'm concerned with national time sales. And it's a lot easier for me to get business from a station in Omaha if I can sell it in combination with stations in Houston and Minneapolis and Chicago and Denver than if I have to sell it separately. Where I can, I sell advertisers on the same program for all of these markets. I suppose you can call that a network."

Regardless of how you define a network, these observations well may hint at the shape of things to come. For, unlike the situation in many European countries, FM broadcasters in the U.S. receive no government support and must pay their own way all the way. Today, many FM stations are in the red. But tomorrow things may be different. For if present trends are any indication, networks—the right kind, whatever they may be—just might prove the tool that can turn the trick.—*Bob Angus*

CB's Mammoth Myths

Continued from page 99

most modern units are) relies on careful balance between its various stages. Soup up one stage—an IF amplifier, say—and you may upset two others. Oscillation, hard squelch or poor noise limiting may be the result. And, while some substitutions will improve receiver performance, this usually is true only with earlier, less-sophisticated circuits. The modern receiver is more likely to deliver *poorer* performance if you start using hot tubes.

Of course, if price is no object and you're interested only in extended tube life, premium tubes which really are direct replacements can be used. But just be certain they *are* direct replacements as recommended by the manufacturer and not by a voice in the night.—*Herb Friedman, KB19457*

Diversity Reception

Continued from page 97

often last several seconds—especially the deeper ones—and it takes only a fraction of a second to try another antenna. This means you probably will wind up catching what you want (like those all-important call letters). Besides, having this antenna-switching capability will enable you to determine which antenna is best for a given signal at any particular time.

If you do build this three-antenna setup and have another receiver handy, you might try the hookup in Fig. 4. This enables you to try the two horizontals and then each horizontal with the vertical to see which is the best combination.

—*Nicholas Rosa, W1NOA/6*

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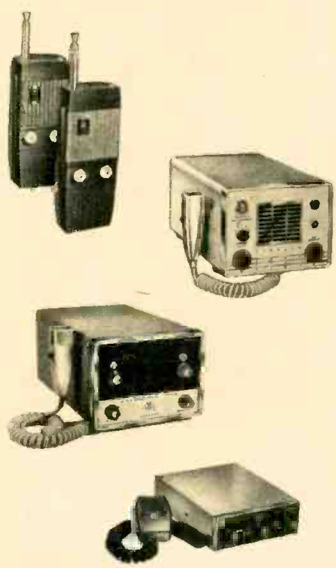

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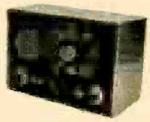

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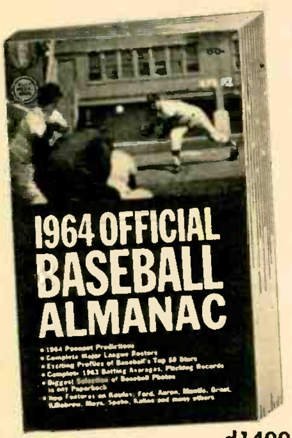

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CB CLUB DIRECTORY

[CONT'D]

ONE of the most comprehensive lists of Citizens Band clubs ever assembled appeared in the July 1963 EI. Lengthy though it was, our directory obviously could not hope to include every CB club in the country. Since our directory appeared, the following CB clubs have been added to our list.

Dixie Five Watters
Box 221
Piedmont, Ala.

South County Rebels
Box 1176
Fremont, Calif.

Community CB Club
839 Highland Ave.
San Mateo, Calif.

CB Monitors Club
Box 412
West Covina, Calif.

11 Meter Beaters
1342 Avenue Rd.
Toronto 7, Ont.

CB Radio Club
New London County
Box 764
Groton, Conn.

CROD
Box 7174
Jacksonville, Fla.

Midwestern CB Club
Box 883
Kokomo, Ind.

Relay Knights
9412 Adelphi Rd.
Adelphi, Md.

North Shore Crystallites
7 Elizabeth Rd.
Gloucester, Mass.

Tri-County CBers
Route 1
Coloma, Mich.

5 Watters CB Club
Box 9223
Lansing, Mich.

Hudson-Essex Chapt., CBRRL
1511 Rose Terr.
Union, N. J.

Natl. 11-Meter League
Greater Staten Is. Chapt.
1630 Castleton Ave.
Staten Island, N. Y.

Finger Lakes CB Club
32 E. Kendig St.
Waterloo, N. Y.

Tri-County CB Radio Club
906 Pender St.
Rocky Mount, N. C.

Wilsonian CB Club
Box 933
Wilson, N. C.

Citizens Radio League
1251 Huron St., S. E.
Massillon, Ohio

Oregon CB Assoc.
Box 5133
Montavilla Station
Portland, Ore.

Cumberland Valley CB Club
Route 2
Greencastle, Pa.

Delaware Co. Citizens Radio League
Box 523
Havertown, Pa.

5-C Club
324 Boise St.
Johnstown, Pa.

Sioux Empire CB Club
2417 E. 18th St.
Sioux Falls, S. D.

Clayter Lake CB Club
c/o Billy Hobbs
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☐ Kookie Lamp*	$ 6.80	

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Continued from page 65

as aids in the convergence procedure. The pictures show you what a good image looks like and illustrate the results of poor convergence or incorrect use of the front-panel controls.

The GR-53 could be called a semi-kit in some respects because a few circuits already are built for you. You merely install these modules. The high-voltage power supply comes factory-assembled, as do the IF circuit board and the VHF tuner (and UHF tuner in the GR-53A). The builder's main jobs are assembling the color circuit and the sound-sync circuit on two printed-circuit boards—and making interconnections between all the circuits. Wiring the two circuit boards is a simple matter of time and patience. The interconnection job is helped along by a wiring harness supplied with the kit.

In the production run that our kit came from, there was an extra hole in the sound-sync circuit board *beneath* the 2.2-megohm resistor near the 6HS8 tube socket. If you get a board with the extra hole, just ignore the hole. Heath will eliminate it in future production.

On the color circuit board there are two resistors that could be interchanged easily. Make sure you get them in the right place. One is a 2,700-ohm (2.7 K), 3-watt, 10 per cent film resistor, the other a 270-ohm resistor of the same type. It is easy to confuse the two.

Television buffs have made a great thing of the positioning of the deflection yoke, convergence assembly and purity magnet on the neck of the picture tube. Extremely critical, they say. Heath has solved the problem merely by giving you precise measurements. You take a ruler to the neck, place the components according to instructions and, when you're through, you have a passable picture. The parts then are moved around slightly while you watch the images in a mirror to achieve convergence.

Two cautions: *do* take extreme care not to break the picture tube when you handle it (safety glasses are an excellent idea) and *do* treat the high-voltage lines with deference.

In summary, if you want color TV and have an ounce of sporting blood in your veins, tackle the GR-53. The results are worth the work—and the price.

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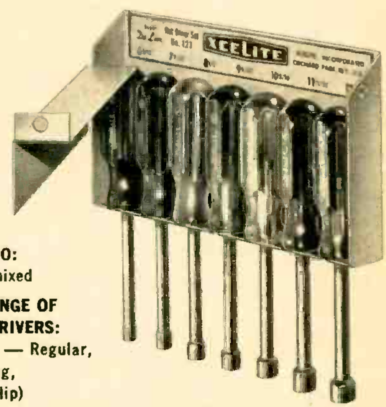

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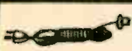

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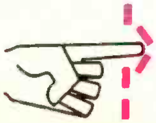

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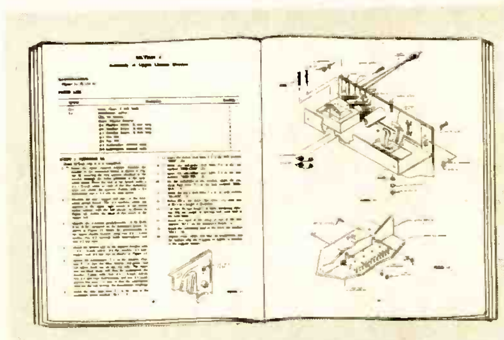

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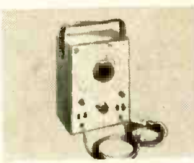

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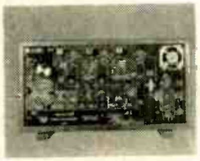

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