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JANUARY • 35¢

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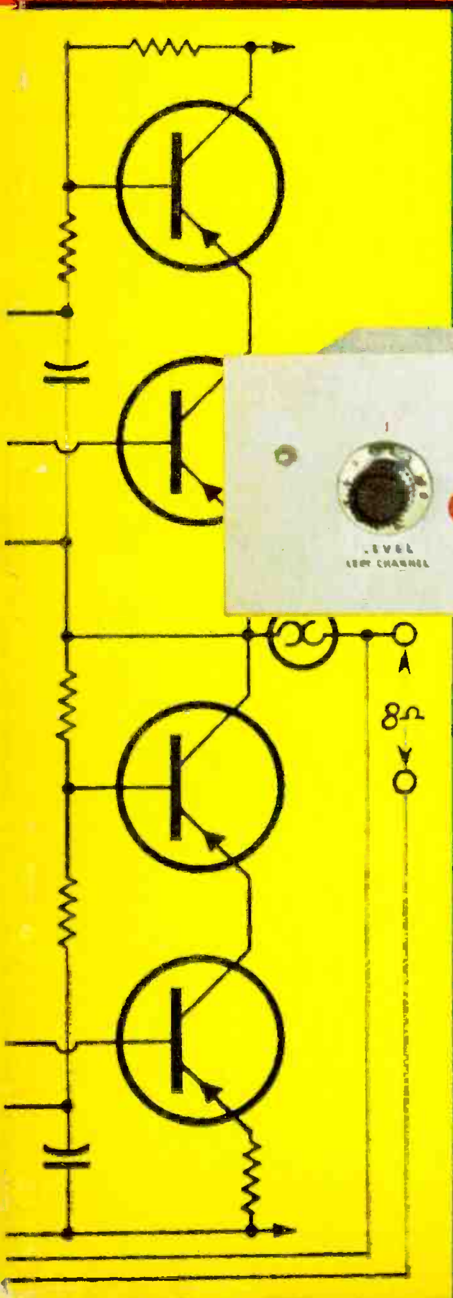

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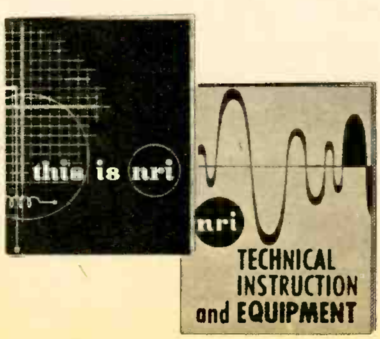

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JANUARY 1964 A Fawcett Publication Vol. 7, No. 1

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Special Construction Projects

Radio: CB • Amateur • SWL

Audio & Hi-Fi

Theory & Practice

Regular Departments

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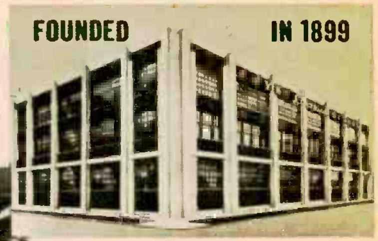

No matter what branch of electronics you prefer, you'll have no trouble landing just the job you want—*provided you get the right kind of training.*

Without this training you'll not get far. *With* it most of our graduates start right out with a beginner's salary of $100 a week or more. Once you've started, you can move ahead fast to more important jobs that pay as much as $14,000 a year.

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Who pays this kind of money to beginners? You'd be surprised at how many fine openings there are for Coyne trained men—in small towns and big cities everywhere all year 'round. For example, the airlines are always on the lookout for men who can fill jobs as radio mechanics, aircraft electricians and electronic systems technicians, to mention only a few. From a good starting salary, a trained man can quickly boost his income to $8,000 a year. And that is by no means the limit.

THE MISSILE INDUSTRY

Another field where employers are clamoring for trained men is the missile industry—an industry growing so fast as to be almost unbelievable. Here there is a constantly increasing need for trained men. Every day these companies are hiring electronic technicians, laboratory technicians, electronic assembly inspectors and field service engineers. A field service engineer *with minimum experience* can easily demand and get $8,000 a year—plus extra compensation in the form of living expenses and incentive pay.

COMPUTERS—Data Processing

A tremendous field. Men with basic electronic training are welcomed by manufacturers to receive further training—while on salary in—the operation and maintenance of their specialized equipment. Opportunities unlimited. No ceiling on salaries.

TV and RADIO Manufacturers

Perhaps the biggest opportunities of all are to be found with the large electronic manufacturers. With these giants, job opportunities are practically without limit.

And the same thing can be said of salaries. These radio and TV manufacturers are expanding into new fields and are growing at an unheard of rate. Any man with ability and ambition can grow with them, earn promotion after promotion. With these promotions come frequent pay raises as he continues to step from one important job to one still more important.

OR, YOUR OWN BUSINESS

Hundreds of graduates have gone to work for *former* graduates, servicing TVs and Radios, Air Conditioners, Refrigerators, other household appliances—then, after learning business methods have branched out and started their own shops. Others have started their own shops immediately upon graduating. Profits as independent business men, after taxes and other business expenses, are as high as $10,000 to $20,000 a year.

These are not dreams. They are realities. But don't try to break into Electronics "on your own." You can save years of struggle and disappointment by first getting the necessary training at the great shop-laboratories of the Coyne School in Chicago.

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Don't get the idea that coming to Chicago to learn with Coyne is a costly or complicated undertaking. *Nothing could be further from the truth.* With modern transportation, *Chicago is "close by" no matter where you live.* High living costs? Not at all. We find a place for you to live—a place where, in many cases, your room and board cost no more than you would pay at home. And don't forget that you have every opportunity to earn money while you learn. Our employment department helps you get a part time job if you need extra money.

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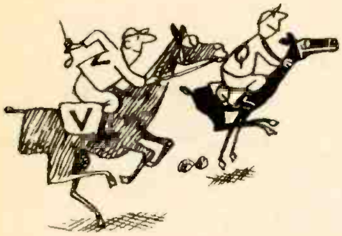
FEEDBACK from our readers

Write to: Letters Editor, Electronics Illustrated, 67 West 44th Street, New York, N. Y. 10036

● HORSE SENSE



Enjoyed reading WHAT'S WRONG WITH TRANSISTOR AMPLIFIERS? (Nov. EI). But doesn't it all boil down to the fact that a much smaller horse (the transistor) can accomplish the same task as that clumsy, outmoded, overweight workhorse of the past (the vacuum tube)?

Vic Williams
New York, N. Y.

Could be, Vic. But the race isn't over yet.

● CHEDDI AGAIN

I am always glad to get news and hints on how to pick up stations broadcasting English programing from the Communist satellite nations (THE LISTENER, Nov. EI). I feel, however, that you are being unkind to Jagan by suggesting that since he is a Marxist ergo he is a Communist. It may be "the neatest trick of the decade," but certainly many of the great men and women of the past (Eugene Debs, G.B.S. and Jane Addams, to name a few) accepted some of the Marxist ideology without being die-hard communists.

R.A.W.
Ann Arbor, Mich.

● AHH!

At last! A real meaty column for the honest-to-goodness audio fan. I'm glad to see that HI-FI TODAY will be a regular in every issue of EI.

Dave Mitchell
Boston, Mass.

● BIG OAKS

I read with displeasure in EI AT LARGE (Nov. EI) that the IRE and the AIEE have merged. This is only another sign of the continuing trend toward greater bureaucracy in American life, with the attendant drop in individual initiative and creativity. The IEEE may be gargantuan, but the intimacy and *elan vital* of the small professional group will be lost, I assure you.

J. F. McGregor
Chicago, Ill.

You're forgetting, J. F., that there's no stopping an acorn—it's gotta grow!

● NEW LOOK?

Glad to see EI finally broke out of the mold and introduced a new and very readable typeface on page 96 of your November issue. Was this a mistake or are you doing some experimenting?

J. M. Warnke
Toronto, Ont.

● A HAM'S HAM

I always knew my husband was stagestruck, but I thought the closest he would ever get to the footlights would be talking about it with his cronies over his ham radio. Your article, HAMS ON TV (Nov. EI), launched him on his acting career. And believe me, he puts on some show.

Mrs. C. M.
Cleveland, Ohio

[*Continued on page* 8]

FEEDBACK

Continued from page 6

● SMOOTH TALKER

As a college speech major, I would like to register my objection to the opening statement in THE AMPLI-MIKE (Nov. EI). The well-modulated, trained voice of a radio announcer is not going to "knife through the airwaves." In fact, the thinner and squeakier the voice, the better, if communication is your only concern.

Martin Walters
Seattle, Wash.

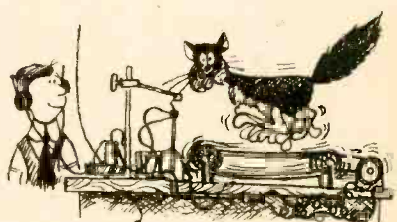
But who wants to listen to a newscast by Alvin the chipmunk?

● LILY GILDING

The limit for fancy worthless electronic equipment was reached when Lawrence Glenn came up with his STEREO BALANCER (Nov. EI). If you've got a pair of ears, who needs it?

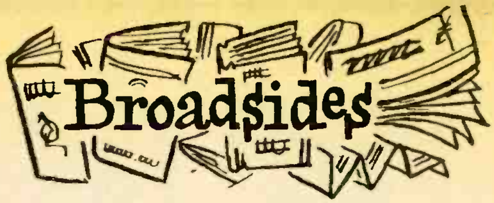
Sheldon Gains
Bridgeport, Conn.

● FONDER ABSENCE



I certainly enjoyed your spread of pictures entitled WHEN PAW WAS A BOY (Nov. EI). Although my own dad wasn't very keen on building equipment (he got his kicks out of logging all kinds of stations in the wee hours), I had an Uncle Harry who was a real pro. He made everything from coal detectors to cat whiskers in a little shed out behind the family homestead in Duluth, Minnesota. Thanks for letting me refresh my memory about those good old days.

Robert Miller
Minneapolis, Minn.



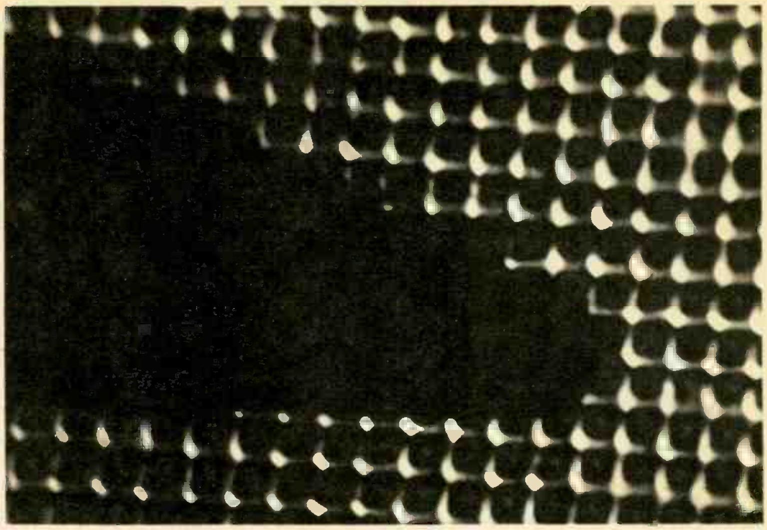
Pamphlets, booklets, flyers, application notes and bulletins available free or at low cost.

Primarily for engineers, but also of interest to hobbyists is Cornell-Dubilier's **Ceramics Selector**—a 17x22-inch wall chart listing 20 different ceramic capacitor types. Values, voltages, operating temperatures, etc., are given for each type, as well as applications and construction details. The chart is available free from C-D, 50 Paris St., Newark 1, N. J.

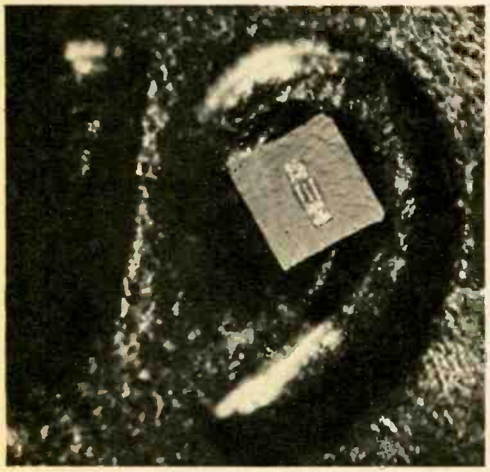
Another free chart—this one put out by Stancor Electronics, Inc., 3501 W. Addison St., Chicago 18, Ill.—tabulates the operating characteristics and applications of **audio output transformers.**

Over 4,000 **tubes and semiconductors** available from Thor Electronics are listed in a new purchasing guide that can be had by writing Thor, 287 Morris Ave., Elizabeth, N. J. The free catalog gives prices and ordering information on a variety of radio and television tubes, as well as transistors and other semiconductors.

It's about that time again—when we all start wondering what the new year will bring in the way of electronic equipment. The **1964 catalogs** have some of the answers—and copies are free of charge from Allied Radio, 100 North Western Ave., Chicago, Ill.; Heath Co., Benton Harbor, Mich.; Lafayette Radio, 111 Jericho Tpke., Syosset, N. Y., Newark Electronics, 223 W. Madison St., Chicago, Ill., and Radio Shack, 730 Commonwealth Ave., Boston, Mass.



PIN POINT . . . You'd never guess it, but that's the tip of a common pin superimposed on the image of a 1,000-mesh screen. And the whole picture stems from something the General Electric Co. calls "photo-plastic recording." Actually a new technique for shooting pictures, photo-plastic recording permits instant development, and you even can erase and re-use the plastic film. Since the image is "frozen in" by cooling the plastic, re-heating it erases the image. And just to prove that they've really got something, the GE people say the dry-processed pictures are grainless. It takes a million of these tiny squares to occupy just one square inch.



Big Niner . . . A whale of a lot of copper goes into all the pennies in the country, but get a load of how little silicon goes into Fairchild's 2N2894 transistor! That's an unmounted 2N2894 you see resting on the "nine" of an ordinary penny. Had we shown the whole coin, you'd have missed the 2N2894!

Easy Does It . . . Figuring out a way to make certain that drivers see traffic officers at New York's Triborough Bridge didn't stump Madigan Electronic. The answer: a light-generating belt using a new flexible electroluminescent lamp of crystallized phosphors. Only 1/32-inch thick, the lamps in each belt flash on and off about 60 times a minute. They'll last up to 10 years.

[*Continued on page* 16]

...electronics in the news

Eavesdropper . . . Listening in on Davy Jones' locker is exactly what this device is intended for. An underwater microphone for detecting sound in the deepest parts of the sea, the hydrophone is designed for use in oceanographic research and submarine detection. The unit is simple enough in operation—sound traveling through the water is picked up by the rubber-covered bottom and sent to a listening post via the attached cable. Yet engineers at ACF Electronics, the firm responsible for the device, say it does all right for itself. Previous hydrophones, they argue, have been unable to detect sound accurately at deep levels because they couldn't stand the pressure at such depths.

9,999 Channels To Go . . . How to have enough free radio channels under front-line conditions is a problem that's been plaguing the military for years. But Raytheon's 10,000-channel combat radio may be the answer they've been looking for. An SSB set rugged enough to work

under the worst field conditions, yet sensitive enough to pick up signals hundreds of miles away, the unit tips the scales to a mere 28 lbs. And that's getting pretty much on the slim side, especially when you consider that the figure includes batteries—and all those 10,000 channels.

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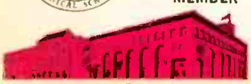

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I cannot praise N.T.S. enough. I've just graduated and already I have started repairing radios and servicing TV's . . . At 53, I'm starting a new life and my diploma from National Technical Schools is my proudest possession.

William E. Eckenrod

As field director of Berean Mission Inc., I have complete charge of our radio work. With the expert advice and training I am receiving from you I can do my own repairs on our recorders and P.A. systems, besides keeping our radios going. My training from N.T.S. helps keep us on the air. I feel privileged to be a member of such a fine institution.

Rev. Enoch P. Sanford

Thanks to N.T.S. I have a business of my own right in my home. I have paid for all my equipment with money earned servicing TV sets. Yes, N.T.S. gave me my start in television.

Louis A. Tabat

I have a TV-Radio shop in Yorkville, Illinois, about 4 miles from my home, and it has been going real good. I started part-time but I got so much work that I am doing it full-time. Thanks to National Technical Schools.

Alvin Spera

SEE OTHER SIDE

ALL 8 PHASES IN ONE MASTER COURSE

PHASE 1 TELEVISION INCLUDING COLOR TV
90% of homes have at least one set. Color TV is becoming more popular daily. TV Stations grow in number, need technicians. Maintenance and repair offer big opportunities.

PHASE 2 RADIO—AM & FM
Radios in homes, cars, schools, all need expert upkeep. Stations expand as FM becomes popular. Now transistors boom entire field.

PHASE 3 INDUSTRIAL ELECTRONICS
Computers, Data-Processing machines, Electronic Controls, Guided Missile Systems are new fields where Electronics play a vital role.

PHASE 4 SOUND SYSTEMS
New popularity of Hi-Fi-Stereo, as well as industrial sound systems and business intercoms make this a highly specialized and important field.

PHASE 5 FCC LICENSE PREPARATION
FCC License holders have a wide range of top jobs open to them. FCC License now a requirement for most Communication jobs.

PHASE 6 RADAR AND MICROWAVES
These are the communications systems of the future, already used in tracking and contacting satellites.

PHASE 7 AUTOMATION & COMPUTERS
Automation and Computer electronics are the new tools of industry and commerce. Skilled Technicians in these fields are in great demand at top pay.

PHASE 8 BROADCASTING & COMMUNICATIONS
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It is exciting to look at a gem and know everything about it. To know how to identify it—how to tell the perfect from the imperfect. Learn all about the countries of origin. Learn how the gems are mined. Learn the many valuable uses. In short, you will have enough information to know any gem inside out.

All of this knowledge is yours when you develop an interest in collecting gems. It's a fascinating hobby for every age group. For youngsters, their interest may later develop into more serious studies of the Natural Sciences. For you, it becomes a stimulating experience and in a very short time, you will design and make your own jewelry at your own price.

Here, at last, is a kit for those with inquisitive minds—for those who like to ask questions, for those who are curious and for those who are looking to develop a new interest. Working with the famed International Gem Corporation, we have selected 250 Carats of genuine precious and semi-precious gems. *Diamond from Africa, Sapphire from Burma, Ruby from Ceylon, Emerald from Colombia, Precious Topaz from Brazil.* These are the five precious gems in the kit. Every bit as glamorous and as colorful are the twenty semi-precious gems collected from countries all over the world. Although some of the names may not be familiar to you, the gems are all being used today in rings, charms, necklaces, etc. You will recognize them when you see them.

Remember. These are not just chips or tiny stones. Every gem is a good large size, perfect for scientific and display purposes. Some weigh as much as 20 Carats.

Now, do not be misled. Although every gem is absolutely authentic and genuine, they are in rough form, neither cut nor polished, which gives them an unusual beauty of their own. They are not perfect. Experienced eyes will be able to detect the flaws of Nature. Perhaps someday your hobby will develop to the point where you have a perfect, flawless collection which will be worth thousands of dollars.

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With each kit comes a booklet which tells you how to identify the gems, tells you about the countries of origin and all the other details you need to know. Along with the gems, the kit includes a Mounting Board, a Jeweler's Tweezers, a powerful Magnifying Glass, a special Glue and two special Bonus Offers. After the gem has been studied and identified, it is placed on a Mounting Board in the space designated for it. Who will be the first in your home to make the correct identifications? The entire family can take part and you will spend many evenings gaining knowledge while you are having fun. Educational and unusual, the kit contains everything to start you or your youngster on a fascinating study of the universe of gems.

The International Gem Kit can be purchased only by mail and only from Hamilton House. We hope to have enough kits to satisfy everyone but, just in case, we suggest you order now. Specially priced at $4.95 and that includes everything.

A complete and unqualified guarantee goes with each kit. It must be everything we say it is or you get every cent refunded immediately. *And you keep the beautiful, polished, good luck 10 Carat genuine Jade Nugget with our compliments.*

Bonus: Every gem in your kit can be made into a piece of jewelry. Identify and select your favorite and write the name on the special certificate enclosed with your kit. For only $2.50 you will receive the same gem from our collection, mounted on a Sterling Silver circular charm for pendant, bracelet or keychain.

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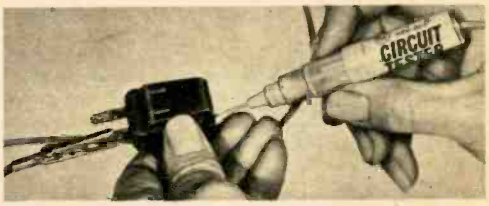

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Electronic Analyst . . . Like the people who operate them, electronic gadgets sometimes need a bit of analysis—and the TE-46 capacitance-resistance analyzer does the job. A factory-wired

and tested instrument, it has four direct-reading scales which indicate capacitance from .00002 to 2000 mf and resistance from 2 ohms to 200 megohms. It's supplied complete with test leads. $37.50. Lafayette Radio, 111 Jericho Tpke., Syosset, N. Y.

Maritime Rig . . . Motor boats, sailing craft and even the land-locked automobile can be mobile headquarters for Heath's MW-33 CB transceiver kit. The rig transmits and receives on five crystal-controlled channels. It has variable receiver tuning, an RF stage and a power supply for 6- or 12-volt batteries

and 117 VAC household current. The MW-33 also features a crystal filter, built-in low-pass filter to reduce TVI, PTT circuitry, adjustable squelch and noise limiter. The kit comes equipped with a microphone and crystals for one channel. $89.95. Heath Co., Benton Harbor, Mich.

Parley Voo Fransay?

A LITTLE while back we published a piece about Canadian radio and included a list of the more powerful stations for the benefit of our radio listeners. There appeared in our mailbag soon afterward a letter from one of our readers who said our directory was great, but please send along a handy

guide on how to translate French so he could understand what he was hearing.

Most of our own listening to Canadian radio had involved the big C stations and the government's overseas transmissions, many of which are in English. And most of the Canadians we had met either spoke English only or were bilingual. That was our idea of Canada.

On a late vacation swing through the country to the north we found out how wrong we were. The English-only/bilingual idea *is* fairly true for most of Canada, but it certainly does not hold for Quebec Province, known to some people as the "other Canada."

We crossed the border from upper New York State and were coming up on Montreal along a good two-lane highway that looked like it had been transplanted bodily from our own Mid-West of the thirties, when we pulled in at a gas station, fueled up and asked directions to a particular section of the city. Getting only a blank stare, we repeated the question. It finally came to us. The man didn't speak English. That was our introduction to the "other Canada."

After Montreal, we crossed over to Quebec City, then swung around the [*Continued on page* 117]

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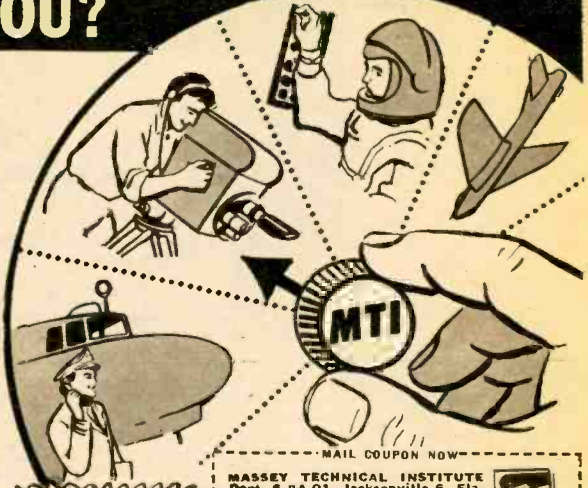

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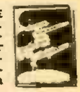

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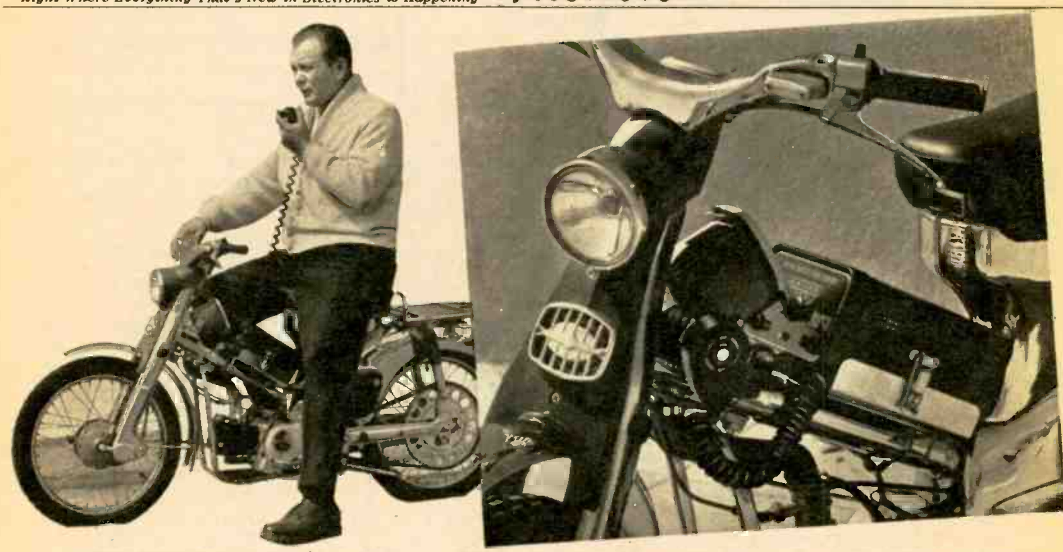

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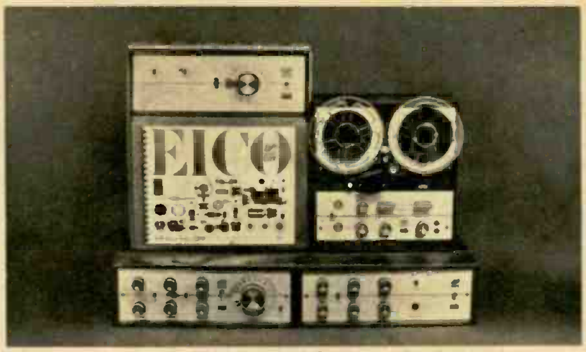

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ELECTRONICS ILLUSTRATED
JANUARY 1964

so you're going to buy a TAPE RECORDER

FOR THOSE who like statistics, it's a simple matter to chart the current tape recorder picture: the number of recorders on the market jumps about 50 per cent every year—or so it seems. But this nice round figure doesn't make life any less confusing for buyers of tape equipment. Not only is there a bewildering number of recorders to choose from these days, but there are new kinds of machines—and new variations on old standbys—to take into consideration.

It's easy, though, to turn this situation to your own advantage. The trick is to do some homework before heading for an audio or electronics parts store. Assuming you can get your requirements into preliminary focus, it's simpler than ever to find the recorder you want at a price you can afford. Let's begin with a look at the kinds of tape equipment now on the market.

Until fairly recently, the first order of business was to choose between a "complete" tape recorder and a tape "deck." The complete machine came with a built-in amplifier and speaker. It could be carried around in its reasonably portable case, set up wherever an AC outlet was handy, and relied on for mediocre but adequate fidelity.

Shopping for a tape recorder is like shopping for anything else: "you pays your money and you takes your choice." It's true that tape machines come in an overwhelming variety of types and styles these days. But the fact remains that the more you know about what to look for, the better your chances of ending up with a machine that's going to fill the bill.

The deck, in contrast, had no amplifier or speaker of its own. Instead, it was nothing but a basic tape-drive mechanism, designed for audiophiles who didn't want to duplicate any of the equipment already in their hi-fi rigs. It couldn't be listened to outside a living room (unless another hi-fi system was available for plugging into). Nor could it be used to make recordings away from home. But its sound over a modest hi-fi rig usually was better than that from the best complete recorders.

All of this is a little too nicely theoretical, however. For the distinction between decks and complete recorders began to blur almost from the outset. Complete machines began to include outputs both for external speakers and external hi-fi rigs. Decks began to come both with optional carrying cases and with preamplifiers for monitoring recordings. The differing purposes of the two machines were still visible, though not to buyers who weren't too familiar with the differences between decks and

so you're going to buy a TAPE RECORDER

complete recorders in the first place.

The arrival of stereo—more specifically, *four-track* stereo—further complicated matters. The four-track tape head actually is a *pair* of miniature heads in one housing. And it soon became popular for mono as well as stereo recording, since it doubled the playing time available from any tape. For use in a mono recorder, all it required was a switch to actuate one of the miniature heads for recording two of the tracks (one in each direction of tape travel) and the other for covering the remaining two tracks.

But once the head was built into a mono machine, it was tempting to provide a separate output from one of its two sections. This meant that a recorder could be used by itself for mono recording and playback. And it also could be used in conjunction with an external amplifier and speaker for playing back stereo tapes.

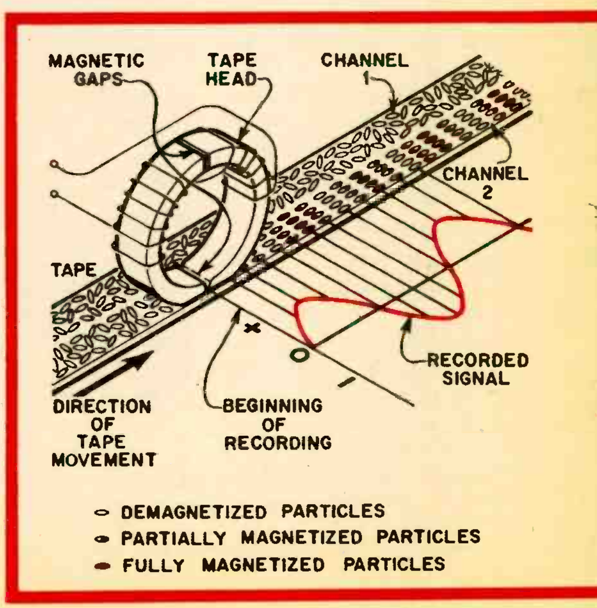
All of this is to sneak up on the point we're about to make: that many of today's "complete" recorders are not what the term implies. There *are* several machines that will record and play back stereophonically entirely on their own. But there are more machines of the hybrid variety. Some are essentially mono recorders that will play back pre-recorded stereo tapes with the aid of external equipment. Others contain the second preamp required to record stereo, but you still must buy a companion amplifier/speaker or use your hi-fi rig to play back.

If you find all this confusing, don't dismay—it is. But there is a good way to tackle the problem of how "complete" your recorder should be. And you can start by investigating today's tape decks. Reason: some current decks are available with enough optional extras to become "complete" recorders on their own. But they still are designed with the component approach. In other words, they allow you to build systematically toward whatever end you have in mind, without duplicating equipment and wasting money.

On a rock-bottom budget, for instance, you can begin with a basic tape transport. Such a machine has no built-in electronics at all, just outputs from the tape heads. But it can be used to play back pre-recorded tapes via a hi-fi rig, and you can add record preamps as your finances permit.

Or you can begin with a deck that already has its own record and playback preamps, make it a fixture in your hi-fi system and eventually buy a portable amplifier/speaker (or just a pair of earphones) to take it out on location.

Whatever your starting or ending point, the accessories you add will match the basic deck. In most cases,



they simply will plug in without requiring any internal wiring changes. And a deck isn't necessarily restricted to use with a hi-fi system. It can be a valuable and inexpensive adjunct to a CB rig, a short-wave receiver or a full-fledged ham shack.

When it's time to go shopping, though, two *new* kinds of recorders—both of which are designed for specialized uses—may attract your attention. The first of these, the tape-cartridge recorder, is as convenient and easy to use as the average record player. In addition to offering the traditional advantages of tape over disc (longer life and freedom from record scratch are two), the cartridge recorder threads, plays and rewinds its own tapes.

Of many cartridge systems that have been test-marketed over the past two years, the newest (a product of CBS and the 3M Company) seems the most promising (see EI's report on this new machine elsewhere in this issue). The cartridge in the CBS/3M system is slightly larger than a pack of cigarettes and about a quarter-inch thick. And it contains a new tape with a special oxide coating designed for full frequency response at low tape speeds.

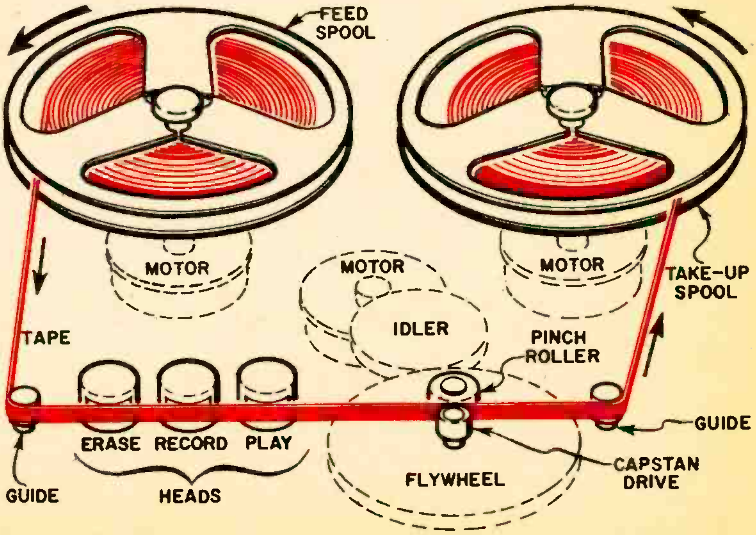
The other of the new recorders is meant as specifically for *recording* as

Two essential tools for tape-recorder care are the head demagnetizer (the small, pointed instrument in the foreground) and the bulk eraser (the large device holding the reel of tape in the photo). Used periodically, the head demagnetizer cancels residual magnetism on tape heads. And the bulk eraser completely removes signals from tapes, reducing head wear and leaving tapes in like-new condition.

the cartridge machine is for playing tapes in record-changer fashion. This is the miniaturized recorder, designed to be toted around like a camera for candid, on-the-spot recordings.

The portable machines we are talking about are the transistorized recorders in the $100-$200 price range. For the man who would like to use a recorder in camera style, these are the equivalent to the kind of equipment now available for amateur movie-making. But don't

If you're a little rusty on how a tape recorder works, it's best to refresh your memory before you buy. Actually, a tape head can serve any one of three functions. The head at left is recording, but the principle is the same whether the head is putting a signal on the tape (as in this case), picking up a signal (as in playback) or aligning the particles on the tape in a highly uniform arrangement (as in erasing). Tape machines vary widely from the basic deck at right, but this unit has all the essentials. Three motors are better than one, since each is serving a specific purpose. But one motor can suffice, just as a single head can both playback and record.



so you're going to buy a TAPE RECORDER

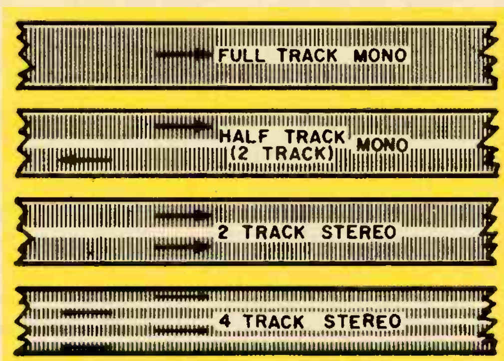
confuse them with the $29.95 recorders that have been appearing in equal or greater numbers. The latter can be wonderful toys (their fidelity is just about enough to provide the same sensation Edison got from his tin-foil phonograph). But that's about all.

If your own interests are specialized enough to make you incline toward either the tape-cartridge or the transistorized recorder, it's fairly safe to rely on a common-sense appraisal of the machine that catches your eye. But some of the signposts that point to good performance in conventional recorders and decks are applicable.

Most of today's recorders remain two-speed (3¾ and 7½ ips) machines, with the higher speed still the standby for maximum fidelity. But a few machines produce some remarkable results—at least on non-musical material—at a speed of 1⅞ ips, and a very few recorders do tolerably well at a $\frac{15}{16}$-ips speed.

It's unwise, though, to allow an extra speed or two to influence your choice of a recorder unless other matters are equal. True, better tape heads have made for wider frequency response at slower speeds. But the likelihood of wow and flutter—always the most annoying faults in any tape mechanism—is still far greater at low speeds.

Tape economy is no longer as potent an argument for extra speeds on standard recorders, either. Due to the four-track tape head, even the 7½-ips speed yields an amazingly extended playing time for a standard 7-inch reel (over two hours' worth of mono recording).



Much of the confusion about tape recorders stems from tape itself. Originally, recorders covered the full, ¼" width of the tape. Later, twice as much material was put on the same tape by recording on only half the tape, then turning the reel over and recording the other half. Stereo again required use of the entire tape until the advent of 4-track machines.

And it's doubtful that you will have many occasions to want more than the four hours of mono recording you can get at 3¾ ips.

As a result of improved motors and drive systems, few of today's recorders (except for the $29.95 variety) will give you that seasick feeling produced by a machine that wanders blatantly on and off speed. But if you are in the market for a budget-priced recorder, take time to listen closely for flutter and wow in a showroom demonstration.

If possible, *don't* judge by listening to a commercial pre-recorded tape, since this will tell you only how the machine performs on playback. Actually, it's the *total* amount of speed variation during recording and playback that you should find out about before you take a recorder home. Should a salesman insist on dazzling you with a pre-recorded tape, pick out one of piano music. A sustained piano chord will reveal wow quickly and mercilessly.

While you are involved in a demonstration, make sure you "handle" the recorder yourself. Its controls should be positive and easy to understand. Furthermore, it should have a foolproof provision for preventing accidental erasure of a tape (the usual way is to force you to use two interlocked controls to put a machine into its record mode).

Watch for any tendency of a recorder to "creep" when it should be at a dead-stop. And be sure to check its fast-forward and rewind actions—simply

[*Continued on page* 104]

SWR METER FOR CB

By David Walker

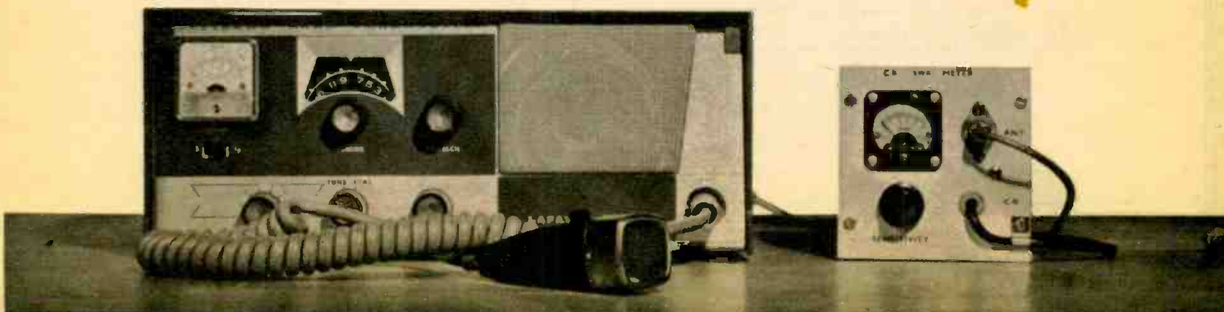
BEEN getting poor signal reports from your own mobile and other Citizens Band stations? Before you set about retuning your final or installing a new RF output tube, consider your antenna and transmission line. A mismatched antenna system sets up what are called standing waves on the line and wastes watts by reflecting power back to the transmitter. Knock down the SWR (standing-wave ratio) and the signal from your antenna goes up. (See WHAT SWR MEANS TO YOU, July '63 EI.)

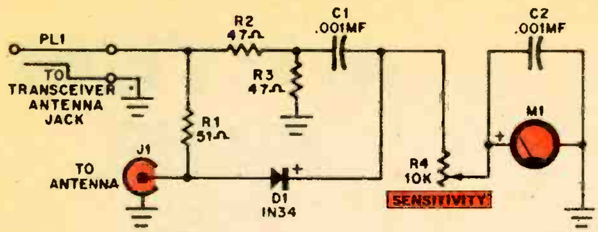
An SWR meter will tell you how well your antenna, transmission line and transceiver are matched. It will reveal coax cable that's withering from the weather and disclose damaged antenna elements. It will enable you to determine the exact length for mobile antennas having adjustable elements. It will show you when a home-brew antenna is perfectly matched to the line. Finally, it will permit you to make periodic checks of the entire antenna system to find out if it's working at peak efficiency. No need to climb the roof, either. Our SWR meter will detect all these things at the transceiver. Construction details are covered in the caption on the next page.

Calibration and Use. The SWR meter should be calibrated each time it is to be used. Though CB antennas are rated at 50 or 52 ohms, calibration with a 51-ohm resistor (the nearest standard value) will prove sufficiently accurate.

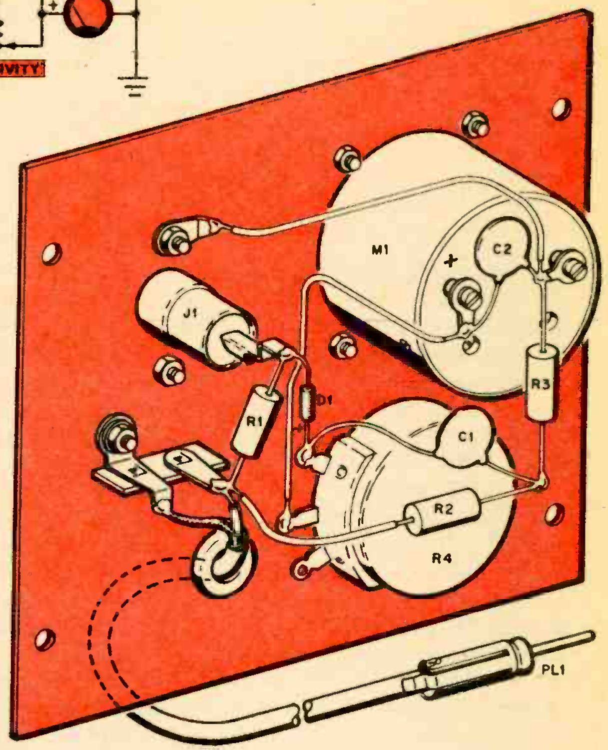
Connect your transceiver's output to J1 and the 51-ohm resistor between the shell and the center pin of PL1. Set the transceiver to transmit and adjust sensitivity control R4 so the meter deflects full scale. Do this quickly or the 51-ohm resistor may overheat.

Next, plug PL1 into the transceiver's output jack and connect the 51-ohm resistor between the shell and center lug of J1. When you turn on the transceiver, the SWR meter should indicate about zero. Remove the resistor and insert your antenna plug into J1. If the antenna and line are in good condition, they will present about the same load to the meter as the 51-ohm calibrating resistor; the

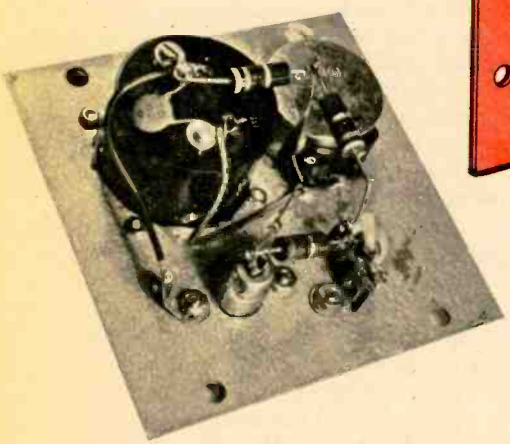




Schematic of bridge which indicates the lowest SWR rather than the absolute value of SWR. When making antenna adjustments, the object is to obtain readings as close as possible to a null or zero.



R2 and R3 are mounted at right angles to each other. Transfer of energy between these components, which compare voltages to and from antenna, leads to inaccurate readings. Leads from R2, R3 and C1 are twisted together and soldered and not connected to a terminal strip. Anchor point for incoming coaxial cable is a two-lug terminal strip with one lug serving as a ground for the shield (scrape paint from panel for good grounds). Dress shield close to coax jacket to prevent shorting hot lug. Choice of plug and jack depends on your CB transceiver. Author's model uses auto-radio connectors. Use coax type for PL1, J1 to match those on your rig.



PARTS LIST

R1—51-ohm, 1-watt, 5% resistor
R2, R3—47-ohm, 1-watt, 5% resistor
R4—10,000-ohm carbon potentiometer
C1, C2—.001 mf, 500 V ceramic disc capacitor
D1—1N34 diode
M1—0-1 ma DC milliammeter
PL1—Antenna plug (to match CB transceiver output jack)
J1—Antenna jack (to match CB antenna plug)
Misc—51-ohm, 1-watt, 5% calibrating resistor, 4x4x2-inch aluminum cabinet (Premier AC-442 or equiv.), two-foot length of RG58/U coaxial cable.

meter should stand near zero.

To simplify construction, the meter was designed to give relative readings only. That is, make adjustments to the antenna system to produce the lowest meter indication. However, the SWR can be determined approximately from the values in the table at the left.

Meter Indication (ma)	SWR
0	1:1
.2	1.5:1
.3	2:1
.4	2.5:1
.5	3:1

For practical purposes, an SWR of 2:1 or less is acceptable. Lost power at this value is negligible. Since the chart is only a rough guide, it's best to determine your own reference. After calibrating the meter, note the reading. Future checks should produce about the same

[*Continued on page* 104]

what's new in SEMICONDUCTORS

By John R. Collins

NEW SEMICONDUCTOR devices with vastly improved frequency, power and temperature characteristics now are available—in many instances, at remarkably low prices. To be sure, military and defense demands of one sort or another still dominate the quality semiconductor market. But large production quantities have brought prices down, and many new types of high-performance transistors and diodes are entering the consumer field.

Transistors seem to be the coming thing for auto ignition systems and hi-fi equipment. High-frequency types are being used more and more in auto radios and in FM and TV tuners. And silicon switching devices are appearing in hand tools, just as heavy-duty silicon rectifiers are replacing tubes in battery chargers and power supplies.

Similarly, electronic controls utilizing semiconductors are becoming more common in household appliances and fixtures. For instance, there's a device for automatic dryers which senses the moisture content of clothes and shuts off the machine when the clothes have reached the desired degree of dryness. Likewise, there are transistorized gadgets for controlling the dimness or brightness of household lighting circuits.

Of course, with all this going on, electronics experimenters and hobbyists are making wider use of semiconductors in their gear. But understanding exactly what's what in the semiconductor field requires some knowledge of how semiconductors are made.

For example, each specific type of transistor has its own special qualities. And to fully appreciate these features, it's necessary to know precisely how they're poured into the unit at the manufacturing end.

During the fabrication process, semiconductor materials are "doped" with impurities of other elements—arsenic, antimony, indium and so on—to provide an excess of either positive or negative charges. As far as transistors are concerned, the heart of their construction lies in uniting N-type (negative) material with P-type (positive) material to form PN junctions. The principal methods in current use are alloying and diffusing.

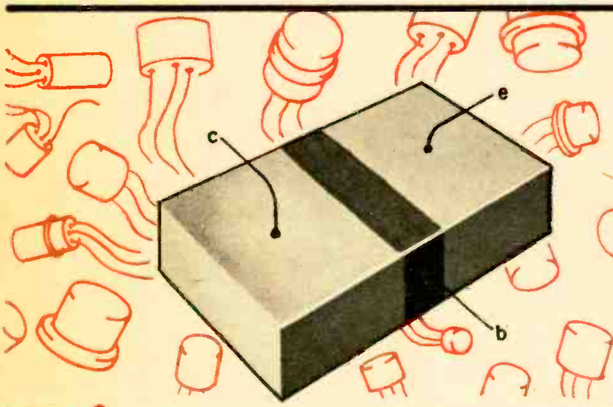
In alloying, a thin wafer of N-type germanium which forms the base is placed between two pellets of indium; these pellets become the emitter and the collector of an alloy transistor. Manufacture begins by raising the assembly to a high temperature. As a result, the indium melts, alloys with the base material to form P-type germanium, and, on cooling, leaves two PN junctions. In this way, a complete PNP transistor is formed.

Diffusion, on contrast, is a slow process in which atoms of either N- or P-type material in gas or liquid form penetrate into a semiconductor slab at high temperatures. Because the process takes hours or even days, it is easier to control than alloying. This means that it's possible to form junctions of exact thickness and precisely graded impurity levels. Such junctions are especially useful for high-frequency operation.

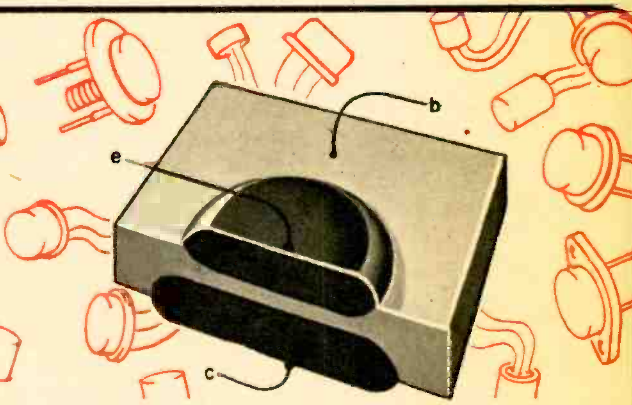
face to form the base contact. In addition, an aluminum stripe also is evaporated onto the surface. The aluminum causes rectification and thus serves as the emitter.

Though originally developed for high-speed switching in electronic computers, mesa transistors are useful in all circuits where high-frequency amplifiers or oscillators are needed. Short-wave receivers, CB transceivers, television sets and FM receivers are among the items in which they are beginning to appear.

But this isn't the end of the mesa story—the performance of a mesa transistor and of several other recent types can be



GROWN JUNCTION transistor dates from 1951. N- and P-type regions are produced in rectangular bar of germanium by "doping" bar with chemical impurities during manufacture. Unit suffers from poor high-frequency response and is no longer in wide use.



ALLOY JUNCTION transistor is today's most popular type. Device is made by alloying small bits of metallic impurity elements—usually indium—to either side of a thin wafer of semiconductor material, such as germanium. Wafer acts as transistor base.

However, transistors for high-frequency use must have a very narrow base region. This is hard to obtain in the types we've mentioned without using a base slab so thin that the device would be excessively fragile. Power capacity also would be limited, since it's difficult to dissipate much heat from a structure of this kind.

These difficulties largely are eliminated with the mesa construction. In a typical case, the collector is formed of a slab of P-type material on which is diffused a thin layer of N-type germanium which constitutes the base. A gold stripe is evaporated onto the sur-

improved greatly through the addition of an epitaxial layer in the production process.

In the ordinary mesa transistor, the resistance of the collector is a compromise between the high resistance needed to prevent collector leakage and the low resistance required to avoid undue power loss and heating. However, a marked improvement can be achieved by growing a high resistivity film on a low resistivity substrate at the start of the manufacturing process.

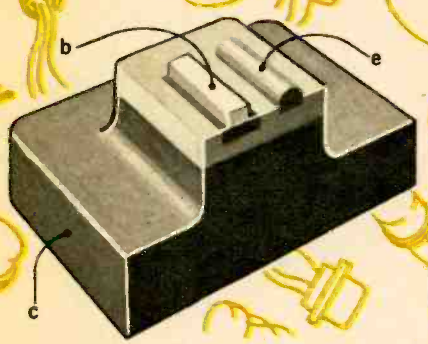
Such films are called epitaxial, since the atoms are aligned in a continuation of the original crystalline structure. This results in a single crystal pellet of quite different levels of resistivity.

The base then is diffused into the thin film, and the rest of the fabrication is the same as that for the conventional mesa transistor. The epitaxial film permits operation at higher frequencies or faster switching speeds at higher current levels than otherwise would be possible.

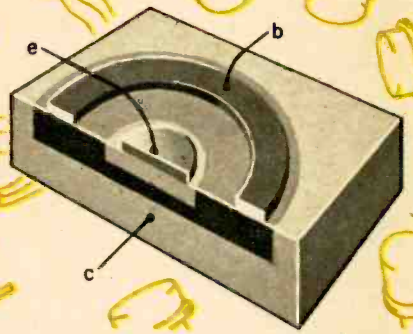
Like mesas, planar transistors are formed by diffusing the base directly onto the collector slab. However, instead of alloying, the emitter then is formed by diffusing it onto the base. The advantage of the diffused emitter is the same as that of the diffused base—diffusion

and it's made along the same lines as the alloy transistor already discussed. However, depressions are etched into the wafer before the collector and emitter dots are added, which means that they usually are much smaller than in the conventional alloy transistor. Like the meltback transistor, the surface-barrier type is capable of improved high-frequency response.

As for power transistors, the silicon types are quite expensive, especially those for high-frequency applications (many cost $50 or more). However, where high temperatures and high-frequency capabilities are unimportant,



MESA transistor takes its name from the Spanish word for table. Both base and emitter contacts are contained in table-like structure on top, while large rectangular section is collector. Unit is made by combination of alloying and diffusing techniques.



PLANAR transistor is improved mesa type made by diffusion process. Rectangular layer of semiconductor material forms collector, and base and emitter are produced by diffusing P- and N-type impurities into this layer in a semi-circular arrangement.

provides a more accurate means to control penetration and concentration of impurities.

Though there's not much point in trying to cover every type of transistor now on the market, at least two others should be mentioned. One, the meltback, is made in somewhat the same manner as the now virtually obsolete grown-junction transistor. But the rate growing is performed on a very small physical scale. This results in thinner base regions, and thus a transistor which is capable of higher-frequency operation.

The other transistor worth keeping in mind is called the surface-barrier type,

germanium power transistors may be obtained at very reasonable prices. Typical uses for germanium types include DC-to-DC converters, voltage regulators, automotive ignition systems and even power output stages for stereo amplifiers and hi-fi sets.

Solid-state rectifiers of both germanium and silicon are becoming more popular, too. Their advantages over the selenium type include longer life and lower forward voltage drop. Silicon rectifiers now are available in plug-in form for replacing all popular vacuum-tube rectifiers. They require no heater supply, of course, and therefore provide cooler operation and need no warmup time.

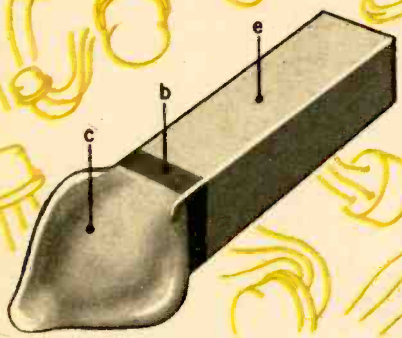
Special silicon breakdown diodes (also called avalanche or Zener diodes) are designed to conduct freely in the reverse direction when the reverse voltage reaches some specified value. Since any attempt to increase voltage beyond the breakdown point merely results in greater current flow, avalanche diodes are used as voltage regulators to stabilize voltage at a desired level despite large changes in current.

There are avalanche and Zener diodes available for regulating voltage at most any desired level, though high-voltage and very accurate types are relatively expensive. Such units also are used extensively as voltage limiters to protect delicate circuits, since breakdown levels can be selected which will prevent the voltage from exceeding a safe limit.

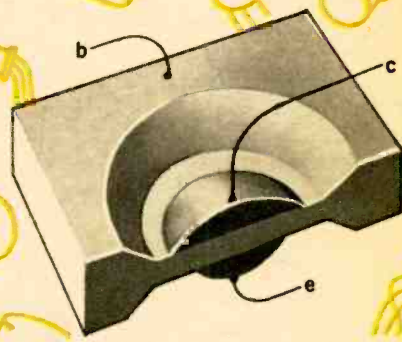
Several manufacturers also are making special diodes which can be used as capacitors. By way of explanation, all junction diodes have a certain amount of capacitance, which is determined by the size of the so-called depletion layer at the junction of the P-type and the N-type material.

It usually is desirable to keep this capacitance as small as possible, as you might guess. But use such a diode as a capacitor, and you have a unit whose value can be varied simply by changing the voltage. Since semiconductor capacitors are biased in the reverse direction, their capacitance decreases as voltage is increased.

Still another device of special interest to hobbyists is the silicon-controlled switch. In essence, it is a combination of two rectifiers which form a PNPN junction. A small control voltage will trigger the unit, causing it to act as a relay in much the same manner as a thyratron tube.



MELTBACK transistor is variation on grown-junction type, since it is made from single bar containing both N- and P-type elements. When one end of bar is melted, then heated, P-type elements at that end concentrate in thin layer, forming base region.



SURFACE BARRIER transistor is somewhat like alloy-junction but is produced by electrochemical means. Electrolytic solution etches opposite sides of semiconductor material. Reversing polarity causes solution to plate two dots—the emitter and collector.

Now that you have a better grasp of some of the latest developments in semiconductors, why not pick up a handful of these devices and try a little experimenting on your own? Though the prices on many new semiconductor devices are steep enough to shock you into forgetting a heat sink or two, most units fall within range of the hobbyist's pocketbook in a surprisingly short time. But whatever the price, you'll find Mr. Solid-State's many innovations both challenging and rewarding. And you'll be partaking of what promises to be one of the great revolutions in the history of electronics.

THE LISTENER

SWL-DX NOTES

BY C. M. STANBURY II

LOCATION LOGIC . . . Where is Radio Libertad, "The Anti-communist Voice of America" which relays Radio Free Russia (NTS) in this hemisphere? Since no one really seems to know, the location of NTS's outlet on this side of the world remains one of the most intriguing SWBC puzzles of the day. Extensive checks with EI's FRAUD FINDER (May '63 EI) on Radio Libertad's 9325-kc outlet suggest that Venezuela is the most likely location, but who can say for sure?

Just to be on the safe side, we even played Radio Libertad against Western European stations via the Fraud Finder, using RL's transmissions on both 9325 and 7315 kc. The case for Venezuela was borne out to some extent, since Fraud Finder readings of RL and European stations were consistently different.

But so much for the dry technical evidence. Though extremely helpful, the Fraud Finder couldn't eliminate two other rumors about RL's real location. One theory, very popular in DX circles, has it that Radio Libertad is aboard a ship traveling from the Florida Keys to the South American coast. Since 9325 kc is audible only on occasions, it seems quite possible that all Fraud Finder measurements were made while our mythical ship was near Venezuela.

However, RL's broadcast band transmitter, announced as 1550 kc but actually varying from 1555 to 1560, contradicts this theory. The Medium Wave signal is weak even in Dixie, and therefore it's unlikely that this station ever transmits from the Florida Keys area.

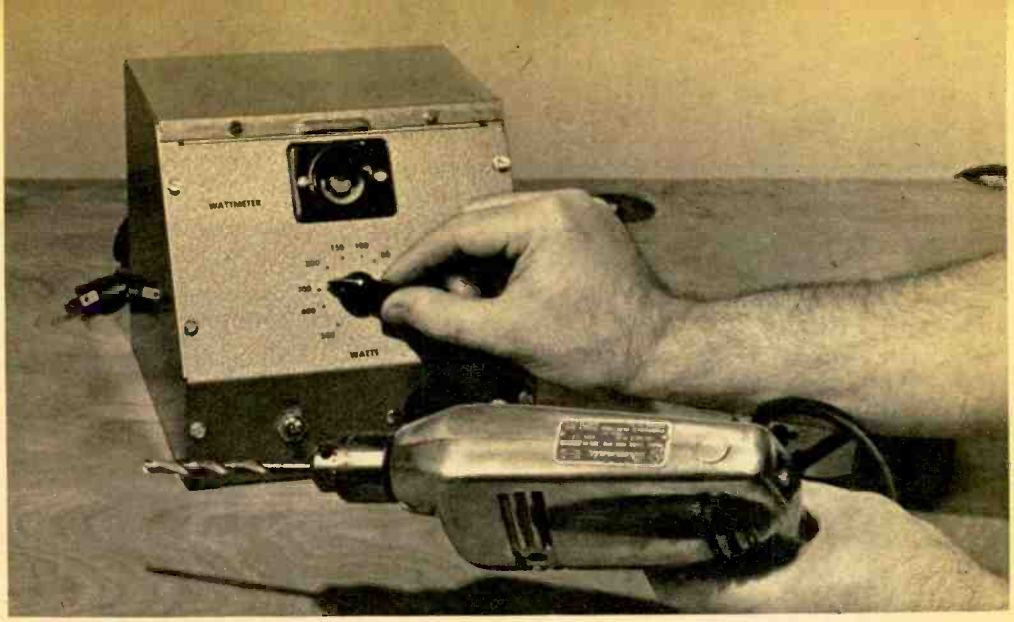
Another possibility is that all the various RL transmitters are not at the same location. For example, the 9325-kc transmitter could be in Venezuela, while the 15050-kc counterpart might be in Santo Domingo.

Such an arrangement would be unusual but not unique, since some Communist clandestine broadcasters already use such a system. And there's no doubting that Radio Libertad is a "Communist clandestine": our illustration shows one of RL's QSL cards, which, except for a typed-in "via Radio Libertad" qualification on the reverse side, is an NTS card through and through.

But all in all, if your scribe had to bet on one of these three possibilities for RL's true location, Venezuela would carry our money. Anyone have any better ideas?

Random Notes . . . If you're looking for a good chance to log some of the rare Latin American outlets, keep in mind that they stay on very late Christmas Eve, well into the wee hours of December 25th itself. We're not suggesting you scare Santa away, but Christmas Eve *is* an unequaled opportunity for top-rate DXing. Even the BCB is full of promise, and DXers who specialize in foreign Medium-Wave reception often make a real night of it.

In any case, it's something to keep in mind.



Magic Eye WATTMETER

Easy-to-build test instrument measures the power consumption of electronic equipment and appliances.

By Chet Stephens

WANT to know the actual current consumption of equipment that keeps popping fuses? Need a quick way of determining when that intermittent turns up in the gear you're servicing? Are you sure your home-brew project is fused properly? How about being able to figure in advance what it will cost to operate a new appliance? EI's Magic Eye Wattmeter will give you the answer to these and other power consumption problems, quickly, easily and accurately.

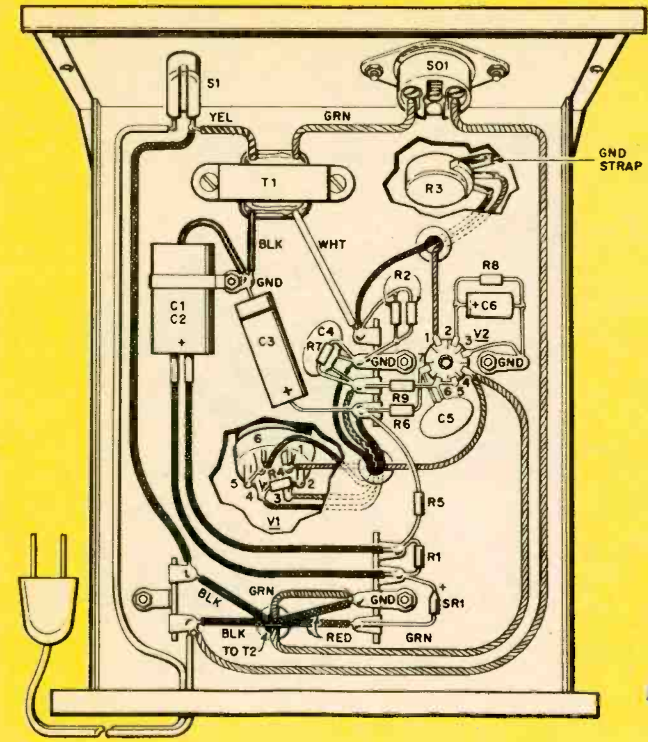
The wattmeter has a range of 15 to 1,000 watts. To determine a device's power consumption, just plug it in test receptacle SO1, turn R3 until the magic eye tube's shadow closes, then read the power directly on the dial.

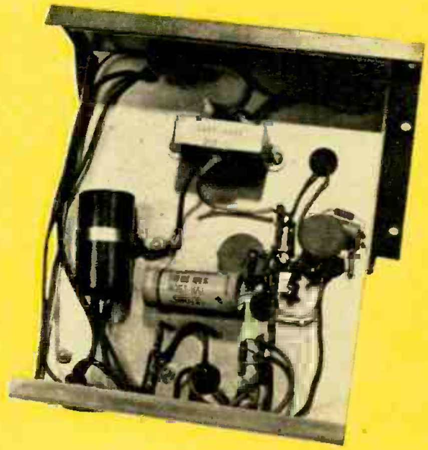
If the wattmeter looks a bit more complex than others you've seen it's because of its extra stability and expanded dial. The calibration will hold indefinitely and the low-power calibration marks are not squeezed together. We've included a three-prong receptacle for appliances with a three-prong plug.

Construction

The wattmeter is built in a 6x6-inch sloping-panel cabinet. Since wiring is not critical, any layout can be used. The ground lug of SO1 need not be connected to the chassis as the three-prong socket is used merely to save you from buying a three-prong plug adaptor.

T1 is a special current transformer and there is no substitute. (Contrary to what you may have read in the past, do not try to use a 2.5-volt filament transformer for T1.) T1 is available only from Allied Radio





Chassis is shown in cutaway in pictorial to indicate connections to V1's socket and R3. Use a standard chassis-mount AC receptacle if your appliances don't have three-prong plugs. Note carefully the connections to SO1 and be sure you don't connect one side of the AC line to the ground lug.

and should be ordered exactly as specified in the parts list.

Since T1 is connected on the instrument side of S1, the appliance under test is turned on and off with the wattmeter. If testing is limited to 500 watts, S1 should be rated for at least 4 amperes at 115 VAC. If you want to measure up to 1,000 watts, S1 must be rated for at least 9 amperes at 115 VAC.

R1 must have a logarithmic taper or both the high- and low-wattage dial markings will be bunched together. For extra sensitivity in the 5-to-25-watt range, remove one of the 100-ohm resistors (R2). V1 must be a 6E5 or it will be impossible to make accurate low-wattage measurements. Don't substitute a 6U5 or one of the older tube types marked 6E5/6U5.

V1 is mounted in an Amphenol tuning eye assembly which consists of a bezel, bracket, tube clamp and prewired socket (R4 is wired in the socket).

Calibration

Without an appliance plugged into SO1, turn on S1. After a few seconds V1 will glow green except for a dark shadow area approximately 45 degrees wide. Adjust V1 so its shadow is at the bottom. Next, rotate R3. There should be no change in the shadow angle. If V1 fails to glow or if rotating R3 changes the shadow angle, check your wiring.

Rotate R3 fully clockwise and mark a zero on the panel opposite the pointer knob. Should the knob become loose on the shaft, reset it to this mark.

You can calibrate the wattmeter with household light bulbs but use standard, quality brands. Some of the so-called lifetime bulbs consume less than the marked wattage. Connect a 100-watt bulb to SO1 and advance R3 until V1's shadow just closes. Be sure the shadow edges don't overlap. Mark 100 watts on the panel opposite R3's pointer. For higher-wattage calibrations, connect several bulbs in parallel up to 1,000 watts.

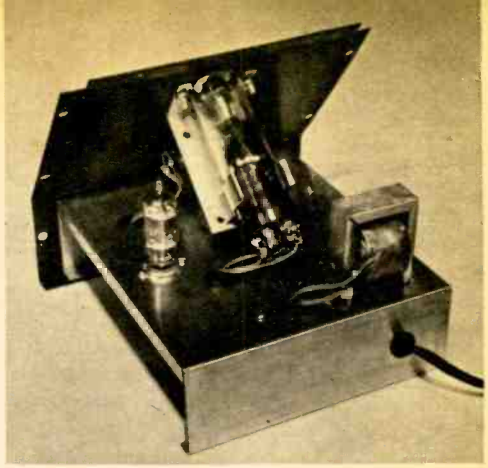
When you advance R3 don't go beyond the point where the shadow closes. It takes a second or two for V1's shadow to open when you back off R3, making it difficult to find the point where the shadow closes. Always start with R3 fully counterclockwise and advance it slowly to prevent shadow overlap.

Using the Wattmeter

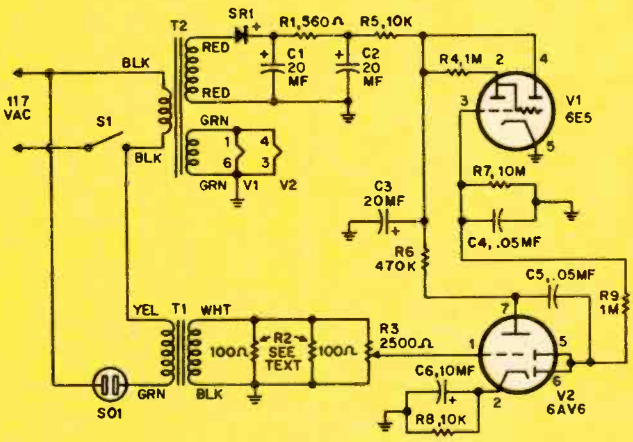
Often an intermittent in electronic equipment will be reflected by an increase in power consumption. By adjusting R3 so the shadow opens just slightly, the intermittent will cause the shadow to close. This spares you the job of keeping close tabs on the equipment waiting for the intermittent to reappear.

To determine the correct size fuse for a home-brew project, measure the power consumption and use the formula $I = W/E$ (I is current, W is power consumption in watts and E is the line voltage).

In testing to determine fuse size you also may solve the problem of having fuses pop for no apparent reason in equipment that is operating normally otherwise. It is not unusual for aging equipment to consume more power than it did when it was new (deteriorating filter capacitors and changing resistance values will increase current consumption enough to blow the fuse.



Top-chassis view. Wattmeter could be built in a smaller cabinet if portability is important.



Load, in series with primary of current transformer T1, produces a voltage across secondary of T1 proportional to current consumption of appliance under test. Negative voltage on V2's diode plates (pins 5 and 6) is coupled to grid of V1. The greater the load, the greater the DC voltage applied to V1, the narrower the shadow angle. In operation, the setting of R3 is changed in proportion to current consumption of load so the same voltage is applied to the grid of V1, causing its shadow angle to be zero degrees. From 500 to 1,000 watts scale is crowded, so take care in marking dial or use larger knob.

PARTS LIST

Resistors: ½ watt, 10% unless otherwise indicated
R1—560 ohms
R2—100 ohms (see text)
R3—2,500-ohm log-taper potentiometer (see text)
R4—1 megohm (see text)
R5,R8—10,000 ohms
R6—470,000 ohms
R7—10 megohms
R9—1 megohm
C1,C2,C3—20 mf, 250 V electrolytic capacitor
C4,C5—.05 mf, 500 V ceramic disc capacitor
C6—10 mf, 10 V electrolytic capacitor
SR1—Silicon diode, 100 ma, 200 PIV
T1—Current transformer. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. Stock No. 39 A 842. $1.03 plus 65 cents postage.
T2—Power transformer: 117 V primary, 125 V @ 15 ma and 6.3 V @ .6 A secondaries. (Allied 61 G 410 or equiv.)
S1—SPST toggle switch (see text)
SO1—AC receptacle (Amphenol 160-2)
V1—6E5 tube
V2—6AV6 tube
Misc.—Magic eye tube mounting assembly (Amphenol 58-MEA6; Lafayette CM-49)

THE HAM SHACK

BY ROBERT HERTZBERG W2DJJ

THE Other Foot . . . It's an old story for hams to be accused of causing TVI when they themselves are all wrapped up in Gunsmoke or Bonanza. But I just made what must be a new record. While I was rambling through Europe recently, a family moved onto my block and apparently experienced TVI immediately.

Spotting the big beam on my roof, the husband naturally decided I was the culprit and left a pointed little note in my mail box that told me so. Several weeks later we met our very red-faced neighbors who had found out where the QRM really originated—from an overly active local oscillator in the receiver of their own radio-controlled garage-door opener!

Hams Afloat . . . Have you noticed how many maritime-mobiles are operating from U.S. naval vessels—especially those of the 7th Fleet in the Mediterranean? The practice evidently is receiving official encouragement because of its great morale value. You see, cruising around the golden beaches of the Riviera tends to get pretty dull—for sailors, that is—and there's nothing like a few conversations with the folks at home to break up the boredom.

Unloved . . . There are many exasperating characters on the air—but the ones who get my vote for the bestest of 'em all are those who deliberately break into long-distance phone patches. While working 20 meters recently, I heard K4JSS in Orlando, Fla., desperately trying to hook EL2E in Monrovia, Liberia, into the land line for an important personal call.

Every time he let the mike go, half a dozen stations in the Far West started yelling "Break, Liberia; break, Liberia." Both K4JSS and EL2E were too polite to tell those interlopers to cut it out, but I wasn't. And, with a few choice words that just evaded FCC regulations concerning indecent language, I managed to stun them into temporary silence. All I can say is, there oughta be a law. . .

White House Ham? . . . It's not impossible! The political situation being what it is, there is a ghost of a chance that the next occupant of 1600 Pennsylvania Ave. will be none other than K3UIG. The white hope of the Republican Party and a ham of long standing, Barry Goldwater wouldn't need a special "hot line" to Moscow. He'd just fire up his SSB kilowatt!

You Asked for It . . . "You're always running pictures of other shacks," writes W6PXH. "How about one of your own—just to prove your station is for real?"

Okay, here it is! The set-up is compact, simple, workable and very real. On the desk are a Collins 73S-3 receiver, a 32S-1 transmitter, an ancient key that does the trick and an Electro-Voice 605 mike. On the rear shelf, left to right, is the rest of the gear: a rotor control for Mosley's three-band beam; a speaker for the receiver with a 24-hour clock on top; Heath's SWR bridge which is under a Knight code oscillator; a Heath monitor scope and the Heath Mohican utility receiver.

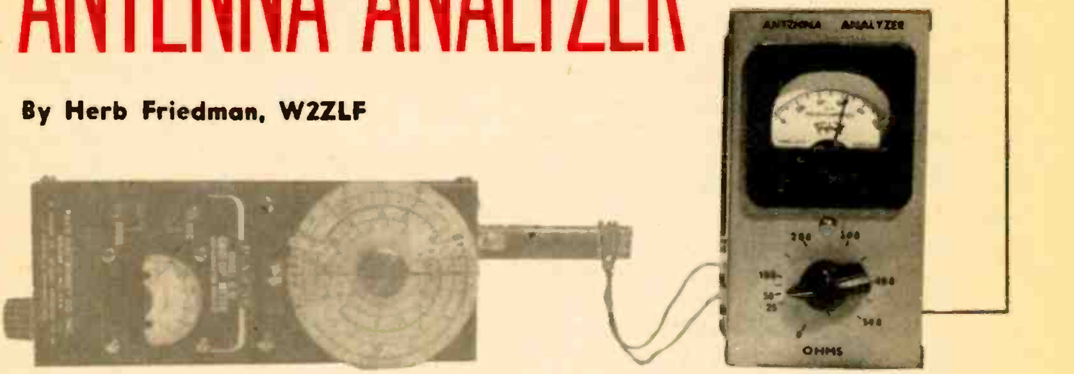
Oh yes, the fellow seated at the controls also is real—he mans the shack and writes the Ham Shack column, too.

Posing for pictures is no picnic, and this shot finds W2DJJ, proprietor of EI's Ham Shack, just a trifle camera-shy. Desk and wall shelf hold all gear.

For more sock in your signal, build our

ANTENNA ANALYZER

By Herb Friedman, W2ZLF



WE know a fellow who abandoned his ham gear for a while to spend his time sticking pins into the effigy of his next-door neighbor. Why? Because the neighbor's flea-power rig outperformed his super-duper, high-priced outfit every time.

If he had spent less time with the pins our friend might have realized all he had to do was get his antenna system tuned to a razor's edge. Think it's a task to be dreaded? Well, listen. EI's Antenna Analyzer can determine antenna and feedline resonance, system impedance, SWR and radiation resistance (antenna impedance) quicker than you can say voodoo!

The Analyzer (which may also be used by CBers) requires an input signal which can come from your VFO (variable-frequency oscillator) or GDO (grid-dip oscillator). A one- or two-turn coil placed near one of your transmitter's low-power stages or near the output tank of a CB rig will pick up a sufficient signal for the Analyzer.

The Analyzer's range extends up to 30 mc and it will work with twinlead or open-wire line. If you use coaxial cable, build the adaptor shown or replace SO2 with a coax connector.

Construction. Except for M1 and SO2, use the components specified. If you use short direct leads and are careful about parts placement, the range can be extended up to 54 mc. But on 2-meters, both M1 and R2 must be individually shielded with aluminum foil. Mount M1 as close as possible to the top of the U-section of a 5¼x3x2⅛-inch Minibox. This will leave the greatest panel area for the knob and calibrations.

M1 should be at least a 200-microampere meter. If you can afford a 100-microampere meter, so much the better. Such meters are still available on the surplus market at low prices. Don't use an inexpensive imported meter in this application—they are too stiff for critical adjustments.

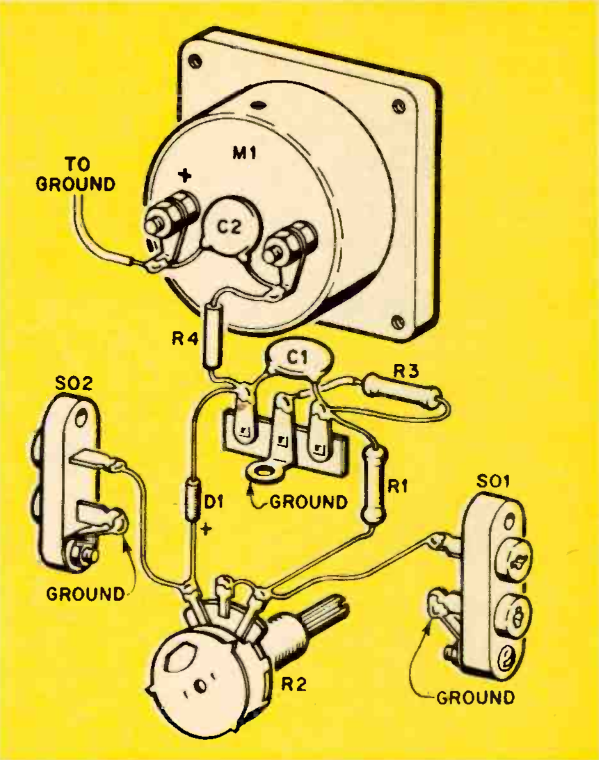
R2 must be insulated from the cabinet with a half-inch length of ⅜-inch I.D. plastic tubing. Cut the tubing so the ends are squared off. Coat R2's mounting bushing with Q-dope, taking care that it does not get into the control. Push the insulator onto R2's bushing (screw the mounting nut all the way on R2 first) and set it aside for a few hours. When the Q-dope is half-hard, carefully unscrew the plastic tubing and let the Q-dope in it dry overnight. When the Q-dope dries, one end of the tubing will have threading molded in it. Re-coat R2's bushing with Q-dope and force the *unthreaded* end of the plastic insulator on R2. When the Q-dope dries, the insulator will be permanently attached to R2. Then push the plastic shaft into R2 and fasten the assembly to the panel with a standard ⅜-inch panel bushing as shown in the pictorial on the last page of this story.

Position input connector SO1 and antenna socket SO2 so their lugs line up with R2's terminals. Make certain D1's polarity is correct and take care that it is not overheated when soldering. Complete all wiring except the connection from R2 to SO1 which will be made after calibration.

Calibration. If you plan to use a GDO as a signal source, use the resistor specified for R4. However, if you use your VFO or a link pickup from the transmitter, M1 may be driven off scale. To prevent this, change R4 to 47,000 ohms. If you think you may use either a VFO *or* a GDO, R4 should be a compromise of about 24,000 ohms.

Set R2 full counterclockwise and connect an ohmmeter across it. Rotate R2 until the ohmmeter indicates 25 ohms, then put the 25-ohm mark on the front panel. Do the same for 50, 75, 100, 150, 200 ohms, etc., up to 500 ohms. Since R2 is linear, in-between points can be easily added. If you are only interested in a limited range of impedances (such as 25 to 100 ohms for CB work), use a 100-ohm pot for R2 (Mallory UA12L, Allied stock No. 28 M 000). Full clockwise rotation will now correspond to 100 rather than 500 ohms.

After calibration connect R2 to SO1 and check the calibration by inserting *carbon* resistors in SO2. Connect the signal source to SO1. A VFO can be fed



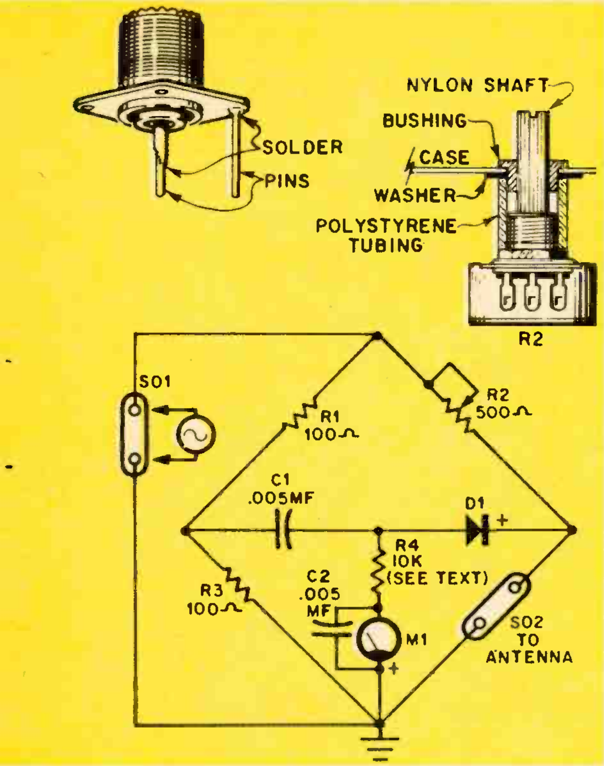
Lead to ground from M1 is soldered to lug under M1's mounting screw. Scrape paint from outside of cabinet under SO1's and SO'2s mounting screw.

directly to SO1. If you use a GDO, connect a one- or two-turn coil to the Analyzer and slip it over the GDO's coil as shown on the first page of this story. Move the loop over the GDO's coil until you get a maximum deflection on M1. Rotate R2 until M1 indicates a null. If the resistor connected to SO2 is 50 ohms, R2 should be opposite the 50-ohm mark. If the unit is correctly wired, the null will be at absolute zero or very close to it. If you get only a partial null, the wiring in the Analyzer may be sloppy. If the calibration is consistently off, readjust the knob on R2's shaft or re-mark the dial. If calibration is off badly, look for a wiring error.

Operation. You'll get greatest accuracy from the Analyzer when it is connected to the antenna through a half-wavelength (or multiple of a half-wavelength) feedline. The half-wavelength line acts as an impedance-matching transformer (See HOW TO CHOOSE

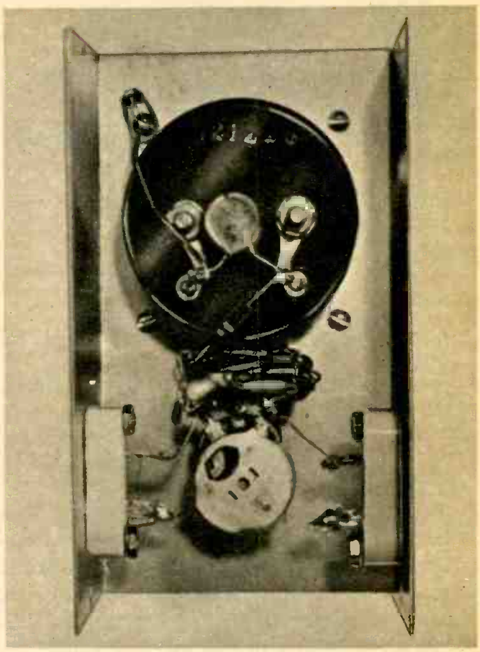
PARTS LIST

R1,R3—100-ohm, ½-watt, 1% resistor (IRC type DCC. Allied Radio 1 MM 492)
R2—500-ohm, linear-taper carbon potentiometer (Mallory UA52L and SN1000 nylon shaft. Order Allied Radio 28 M 001 and 28 M 081)
R4—10,000-ohm, ½-watt, 10% resistor (see text)
C1,C2—.005 mf, 500 V disc capacitor
D1—1N34A diode
SO1—Crystal socket (Millen 33102. Allied 72 S 035)
SO2—Crystal socket (Millen 33102) or SO-239 chassis-type coaxial connector (Allied 40 H 352)
M1—0-100 micromameter (see text)
Misc.—⅜-inch I.D. polystyrene tubing (Allied 43 H 178)



Adaptor (left) should be made if you use both twinlead and coaxial cable. The details of how R2 is mounted are shown in cross section at right.

Simple bridge circuit is balanced when antenna-system impedance is same as resistance of R2. Input voltage does not have to be held constant.



Note parts placement in author's model. When shielding M1 and R2 for 2-meter operation, be careful not to short parts with aluminum foil.

THE RIGHT TRANSMISSION LINE, Sept. '63 EI). If you connect a 50-ohm impedance to one end of the feedline, the other end will appear as 50 ohms. (To keep the power-transfer loss low, feedlines should always be a half-wavelength, or multiple thereof, long.)

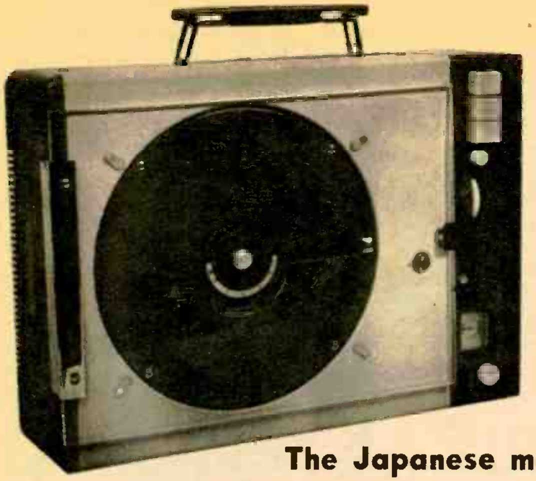
Here's how you use the Analyzer to determine the exact length of the half-wavelength feedline. Cut the line a little longer than the calculated length. Connect the line to SO2 and feed a signal at your operating frequency to SO1. Set R2 to zero ohms and short the open end of the line. M1 will indicate up-scale. Cut off small sections of line then short the line. When the line is exactly a half-wavelength long, M1 will null. (The length of a quarter-wavelength section of line is determined the same way except the free end is *not* shorted.)

Now for antenna measurements. Connect your antenna to the free end of the half-wavelength feedline and rotate R2 for null. This setting is the antenna's radiation resistance (impedance). A complete null means the antenna is resistive and is precisely tuned to your operating frequency. If the null is not perfect, the antenna is reactive and not resonant at the operating frequency.

SWR can be determined by dividing the antenna impedance by line impedance. If the antenna impedance is 100 ohms and you are using a 50-ohm line, the SWR is 100/50 or 2. If the answer comes out less than 1, invert the formula so the larger number is on top.

To use the Analyzer to peak-tune an antenna or matching network, connect the antenna (with a feedline) to SO2 and set R2 to the desired impedance. Feed a signal at your operating frequency to SO1. When you have adjusted the length of the antenna or its tuning device (gamma-match) and obtained a null, the system will be properly tuned.

[*Continued on page* 106]



EVER HEAR OF A SHEET RECORDER?

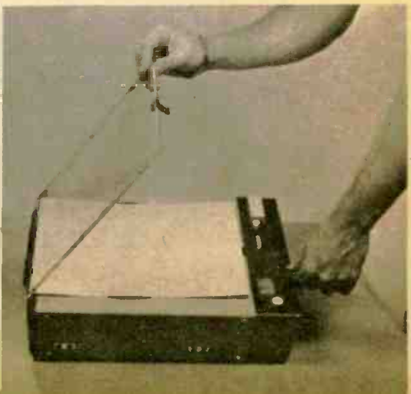
The Japanese make one, and you might say it's a half-disc, half-tape recorder, all rolled into one.

THAT TAPE RECORDER of yours probably handles a 7-inch or maybe even a 10½-inch reel of magnetic tape as nice as you please. But did you ever stop to think that there's no more reason to buy tape on a reel than there is to play every tape you own at 3¾ ips? True, the gap on the record head has to rest snugly against magnetic particles of some description if it's going to record. But it couldn't care less whether those magnetic particles are imbedded in standard, quarter-inch magnetic tape or in a sheet of paper that's flat as a pancake. And it's just such a sheet that the Toshiba-Canon device pictured here uses as a recording medium.

First thing that catches your eye on the gadget is a turntable about 9 inches in diameter. Closer inspection reveals a slot in the turntable with a record/playback head mounted on end at the outer edge of the slot. And that's all—no take-up or supply reels, no rollers, no capstan, no erase head. Place a blank sheet (cost: about 3 cents) on the turntable, close the plastic pressure plate to keep the sheet flat and you're all set to record. The sheet remains stationary, but the turntable revolves the tape head, which also feeds down the slot, tracing a spiral "electronic groove." When you've finished recording, pushing the reset button stops the turntable and returns the head to the outer edge, ready to play back the sheet.

Tested in the EI lab, the Toshiba-Canon sheet recorder came through with some flags flying, though other flags were not to be found. Wow and flutter were so severe that no one could dream of using the device for music. But the designer obviously didn't have music in mind when he produced this oddity. [*Continued on page* 112]

Big feature of the Toshiba-Canon sheet recorder is the fact that sheets can be folded, mailed, unfolded, then replayed. Unit we tested had a frequency response within 5db from 150 to 5,000 cycles, but wow, flutter and dropouts made the device totally unsuitable for music. As for prices, machine sells for well over $100, an eraser is an additional $70 or so and a printer for copying the recorded sheets is another $100-plus.



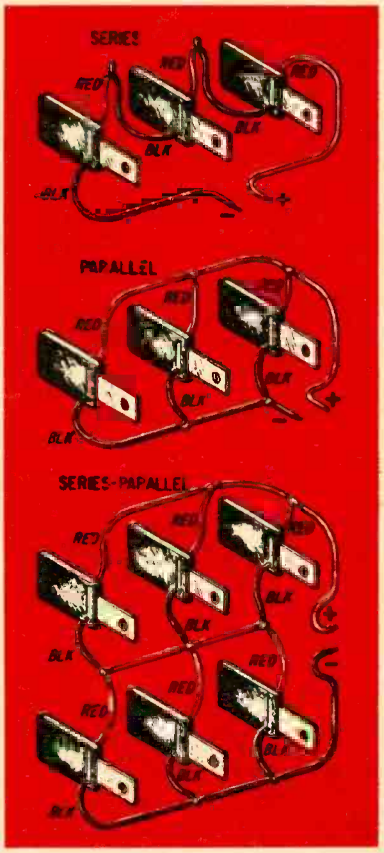
BEGINNERS PAGE

SOLAR CELLS

WHETHER you call it a solar cell, sun battery or photocell, this special semiconductor performs the interesting trick of converting light into electricity. The most popular type, the self-generating selenium or silicon, can be used in place of batteries to power electronic projects or a small radio.

Because of low output, solar cells usually are limited to simple transistor projects. The open-circuit voltage of the International Rectifier B2M sun battery is about half a volt in average sunlight. But the voltage must be considered in terms of the load connected to the cell. If the circuit draws a lot of current, the output voltage drops. Put a 100-ohm resistor across the cell and its output drops to a few tenths of a volt. The current available under load usually is a fraction of a milliampere. What do these ratings mean in terms of practical use?

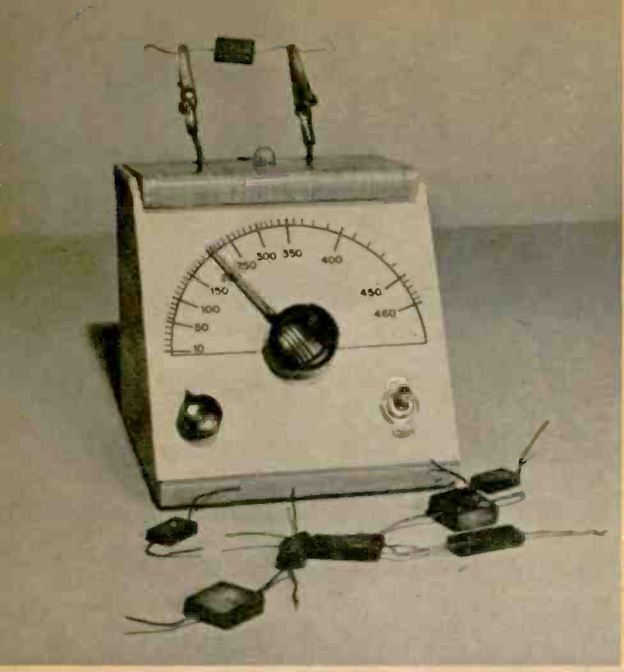
One application for a single solar cell is a 1-transistor radio. With modest current requirements (measured in microamperes) the cell can power the circuit to produce good headphone volume. If transistors are added for increased audio output, several cells must be used to beef up the volume. Solar cells, like batteries, can be connected in series, parallel and series-parallel.



The series connection, shown at the top of the illustration, adds the cells' voltages and is the most common. If the leads are not color coded, the lead from the black, or light-sensitive surface usually is negative. Three cells in series may deliver about a volt in sunlight if the project consumes less than 100 microamperes. Such a project might be a 1-transistor code-practice oscillator or an audio transistor driving a headphone.

Connect the cells in parallel and their individual *currents* add. Since the voltage will be the same as that of a single cell, you can connect the cells in series-parallel to boost both current *and* voltage. Six cells connected in this way should deliver about 1 volt at 200 microamperes. It's still low in terms of what you get from a battery, but sufficient for many transistor projects that don't use a speaker or relay.

To operate a small transistor portable radio (which might require 9 volts at 10 or more milliamperes) you'd need dozens of solar cells. The total number of cells could be reduced by using more efficient silicon cells, but they're expensive. Yet three or four selenium cells in the $1 price range should provide ample power for many simple projects. Check the experimenter pages of parts' distributors' catalogs for information on other type cells.—*H. B. Morris*



the Mickey-Mike

Micromicrofarads are easy to measure with this device.

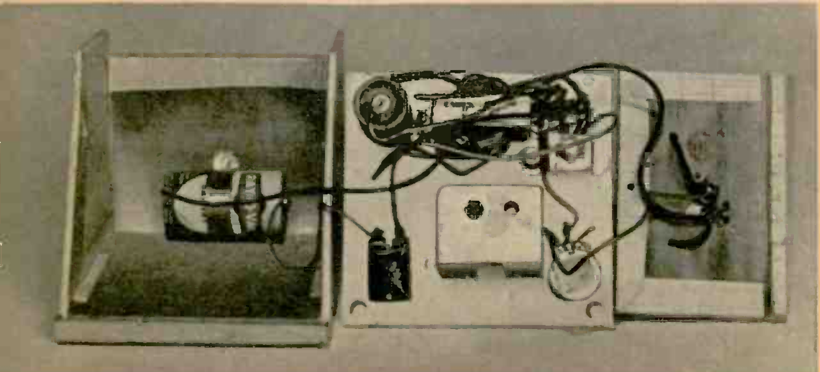
By Martin H. Patrick

MANY capacitor checkers just can't quite make it when called upon to measure the value of those smaller-than-small discs and micas. But the Mickey-Mike is at home with capacitors as small as 10 mmf. And it's simple to operate too. You merely connect the capacitor to a pair of alligator clips, turn a pointer knob until the neon lamp comes on, then read the value of the capacitor from a dial. The Mickey-Mike's range runs from about 5 mmf to 500 mmf but it also can go as high as 1,000 mmf.

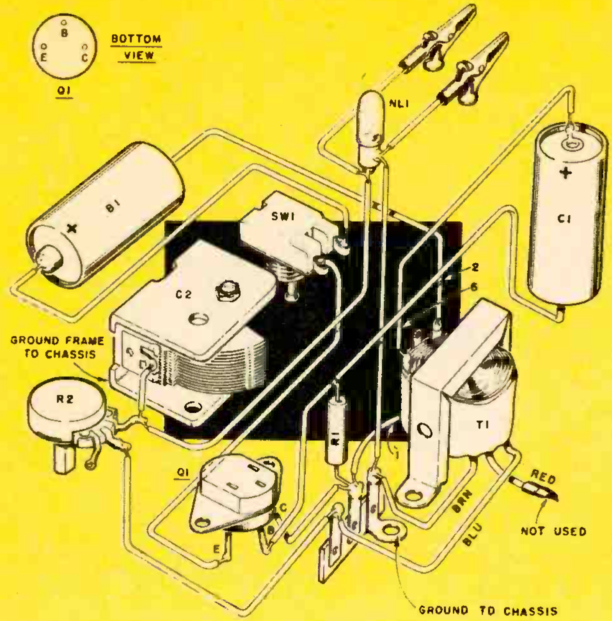
Build the Mickey-Mike following the instructions in the captions and using the parts layout shown in the pictorial and photo.

Calibration. With C2 fully meshed and without a capacitor connected to the clips, adjust R2 to the point where NL1 just goes off. Open C2 fully and let NL1 glow for a minute or two. Check NL1's extinction point again by opening and closing C2. NL1 should still go off when C2 is completely meshed. If it doesn't, readjust R2.

Connect a capacitor of known value (about 50 mmf) to the clips and turn C2 until NL1 comes on. Put the value of the capacitor on the dial. Remove the capacitor but don't touch C2. Adjust R2 again until NL1 goes off. Connect the 50 mmf capacitor to the clips again and adjust C2 until NL1 comes on. Now mark 100 on the dial. Continue in the same way (removing the capacitor, re-adjusting R2 to extinguish NL1, reconnecting the capacitor, then readjusting



Mount all parts on a metal panel with T1 at top. The metal panel shields the circuit against body capacitance. As NL1 is photosensitive near its firing and extinction points, put a non-metallic hood around it to shield it from direct light. Keep all leads short; the clip leads should come out of the circuit at the rear, away from the panel.



After building the Mickey-Mike following the layout in this pictorial, temporarily install a 5,000-ohm potentiometer for R1. Then turn R2 to its minimum-resistance position and adjust R1 until NL1 glows brightest. Measure the resistance of R1 and substitute for it a fixed half-watt resistor of same value.

PARTS LIST

R1—See text
R2—1-megohm potentiometer
C1—20 mf, 150 V electrolytic capacitor
C2—15-409 mmf variable capacitor (Allied Radio 13 L 524 or equiv.)
NL1—NE-51 neon lamp
T1—Universal output transformer (Lafayette TR-12)
SW1—SPST toggle switch
B1—1.5-volt battery
Q1—PNP audio transistor (Lafayette SP-146)
Misc.—Alligator clips

C2 to turn on NL1, etc.) until the dial is calibrated.

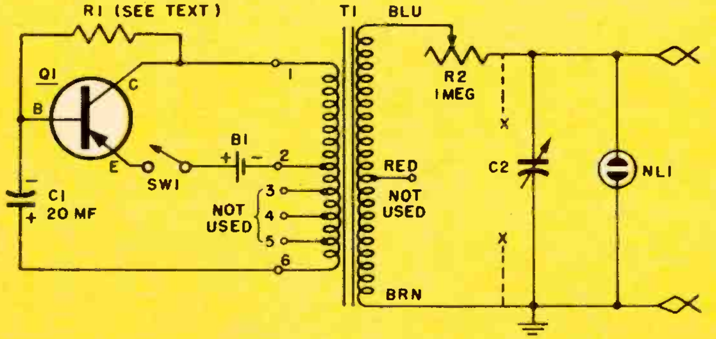
After the entire dial is marked in steps of 50 mmf (or whatever the value is of the capacitor you have selected), add intermediate points by interpolation. Take into account the fact that the space between the dial divisions becomes greater as you go clockwise.

Using the Mickey-Mike. Close C2's plates and adjust R2 until NL1 goes off. Connect the unknown-value capacitor to the clips and turn C2 slowly until NL1 comes on. Read the value of the capacitor on the dial.

To measure extremely small capacitors (5-10 mmf) proceed as follows: set R2 so NL1 goes off when C2 is set at any point on the right side of the scale where the markings are spread out. Connect the unknown-value capacitor and turn C2 until NL1 comes on. The value of the capacitor is the *difference* between the two settings on the dial. For example, if you want to check a capacitor whose value is between 5-15 mmf, set the pointer to around 300 and adjust R2 so NL1 goes off. Connect the capacitor and turn C2 until NL1 comes on. If the pointer is opposite 312, the value of the capacitor is the difference between 312 and 300, or 12 mmf.

The most accurate part of the Mickey-Mike's range is from 5 to 500 mmf. When you go above 500, you must know the *approximate* value of the unknown capacitor and the *exact* value (about 300

[*Continued on page* 104]



For greater convenience in measuring large capacitors, connect 300 mmf, 600 mmf, and 900 mmf capacitors, each in series with an SPST switch, between points marked X. To measure capacitance, close switch for desired range and follow procedure for larger-value capacitors.

the Stereo 120

120 watts of the cleanest sound this side of the concert hall.

By Harry Kolbe

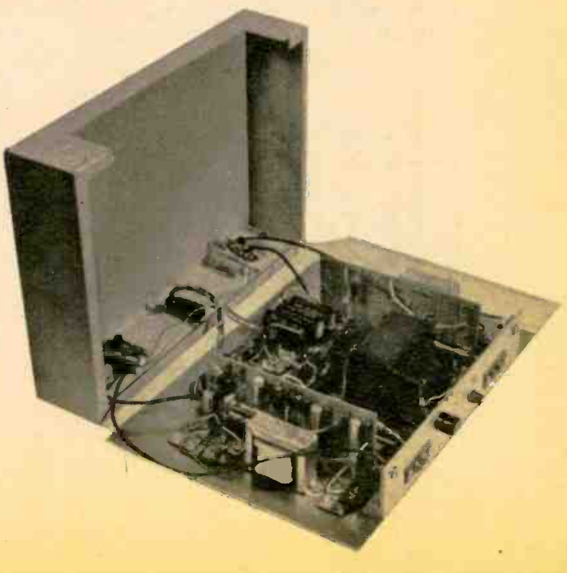
DROP into your hi-fi dealer's showroom or take a look through a hi-fi catalog and you're going to reach one conclusion: the transistor stereo amplifier has arrived. Right out front with the best going is EI's Stereo 120—a solid-state stereo power amplifier with awe-producing specs you'll find hard to match. Just look at them: Both channels can deliver 60 watts of 1,000 cps sine-wave power simultaneously to 8-ohm loads. The sensitivity is 200 rms millivolts for full output. Frequency response at 1 and 55 watts is flat within 1db from 5 cps (limit of test instruments) to 50 kc. Total harmonic distortion at both 1,000 cps and 20 kc is 0.75 per cent at 1 watt and 0.6 per cent at 55 watts. IM (intermodulation) distortion is below 1 per cent at rated power (60 cps and 7 kc, 4:1). Since the Stereo 120's input impedance is 400,000 ohms, it can be driven by a vacuum-tube preamp.

Other outstanding features include excellent transient response, a damping factor that is uniform over the audio spectrum, zener-diode protection of the output transistors against switching transients and circuit-breaker protection of the output transistors against overdrive or shorted output terminals. Diodes mounted in the base plate (which serves as a heat sink for the output transistors) compensate for temperature rise of the output transistors.

You have your choice of building a mono or stereo version. EI has arranged for the author to supply a kit of parts which includes the transformers, matched power transistors and zener diodes (see Parts List).

Construction. Don't feel that the construction of a high-power transistor stereo amplifier is going to be a difficult undertaking. The Stereo 120's layout and component selection were made with an eye toward simplifying things. If three rules are carefully adhered to you should not run into any problems. **Rule 1:** Be neat and take your time; this

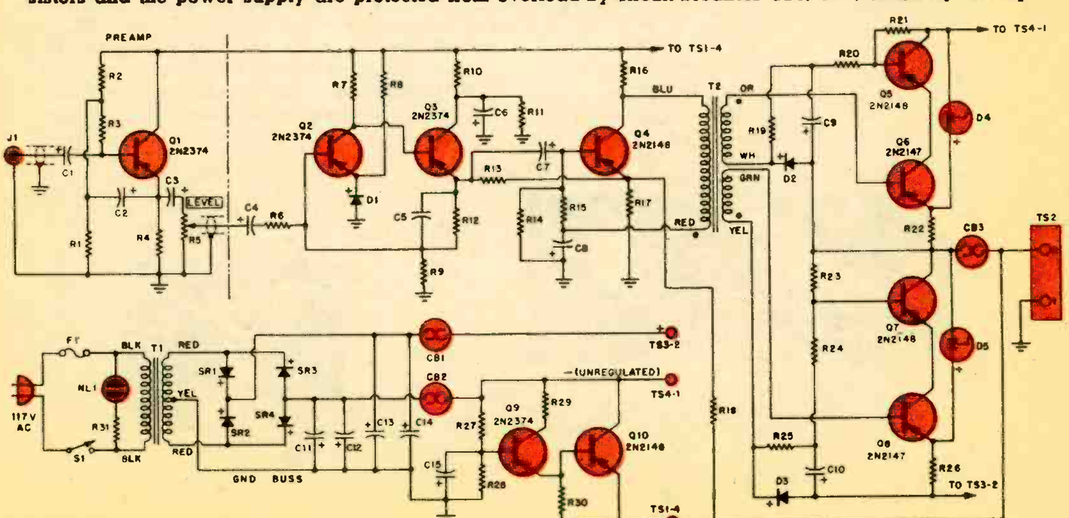
Fig. 1—Amplifier is built on a piece of 10x14x⅛-inch thick aluminum. Cover, on which are mounted level controls, preamps, power switch, pilot lamp, is a standard 10x14x4-inch aluminum chassis.



PARTS LIST

Resistors: ½ watt, 10% unless otherwise indicated
R1,R2—27,000 ohms
R3,R12—47,000 ohms R4—5,600 ohms
R5—10,000 ohm, logarithmic-taper potentiometer
R6—6,800 ohms R7,R27—18,000 ohms
R8,R9—10,000 ohms
R10—330 ohms, 2 watts R11—330 ohms
R13—220 ohms R14—180 ohms
R15—3,300 ohms
R16—270 ohms, 2 watts
R17—6.8 ohms, 1 watt, 5%
R18—150 ohms, 2 watts, 5%
R19—120 ohms, 1 watt, 5%
R20,R24—100 ohms, 1 watt, 5%
R21,R23—240 ohms, 2 watts, 5%
R22,R26—.51 ohm, 1 watt, 5% (or two 1-ohm, ½-watt resistors in parallel)
R25—120 ohms, 2 watts, 5%
R28—82,000 ohms R29—470 ohms
R30—68 ohms R31—100,000 ohms
Capacitors: All electrolytic unless otherwise indicated
C1—2 mf, 25 V C2—50 mf, 10 V
C3—50 mf, 25 V C4—50 mf, 3 V
C5—62 mmf, 500 V ceramic disc
C6—100 mf, 15 V C7—500 mf, 3 V
C8,C9,C10—200 mf, 15 V
C11-C14—500 mf, 50 V
C15—50 mf, 50 V
D1—1N2858 diode (RCA)
D2,D3—1N2326 diode (RCA)
*D4,D5—Zener diode (Sarkes Tarzian .25T75A)
SR1-SR4—750 ma, 400 PIV silicon diode (Lafayette SP-241 or equiv.)
CB1-CB3—Thermal circuit breaker, Sylvania MB315 (Allied Radio 34 B 075)
Q1,Q2—2N2374 transistor (Philco) or 2N2614 (RCA)
Q3,Q9—2N2374 transistor (Philco) or 2N591 (RCA)
*Q4,Q5,Q7,Q10—2N2148 transistor (RCA)
*Q6,Q8—2N2147 transistor (RCA)
S1—SPST toggle switch
NL1—NE-51 neon lamp and holder
F1—2 A fuse and holder
*T1—99P10 power transformer
*T2—99A10 driver transformer
J1—Phono jack
Misc. — Motorola MK-15 power-transistor mounting kit, silicone grease, terminal strips, 10x14x4-inch aluminum chassis, fuse holders for SR1-SR4 (Lafayette EL-374)
*Starred parts are available in a kit from Harry Kolbe, P. O. Box 3, Cooper Station, New York 3, N. Y. ($40 for stereo, $30 for mono. Postage extra.)

Fig. 2—Since left and right channels are the same, circuit for only one channel is shown. Output transistors and the power supply are protected from overload by circuit breakers CB3, CB1, CB2, respectively.



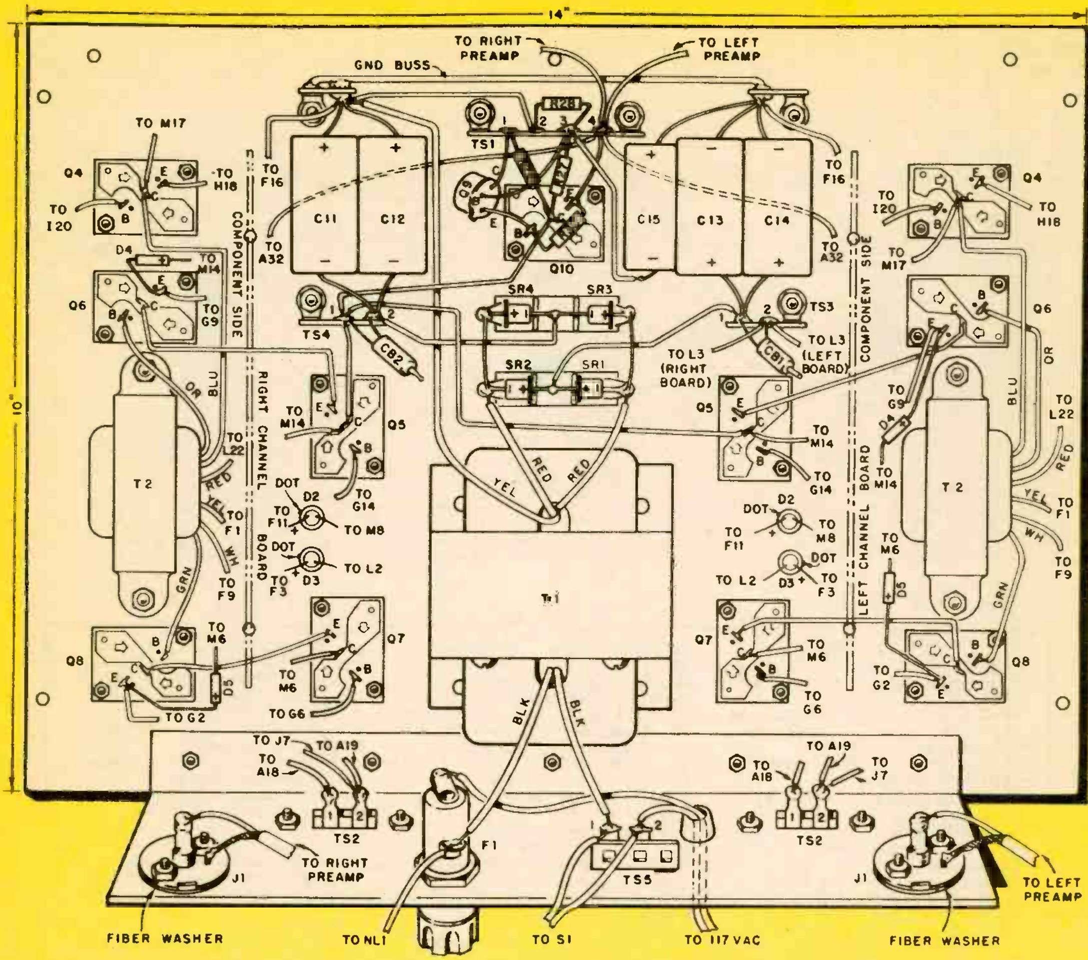


Fig. 3—Parts and their position are drawn to scale. To prepare base plate, take dimensions from here and multiply by 2.5 for full-size layout. Or, have this drawing photostated up to 10x14 inches for template. Left and right channels are electrically identical so we used the same parts designations for both.

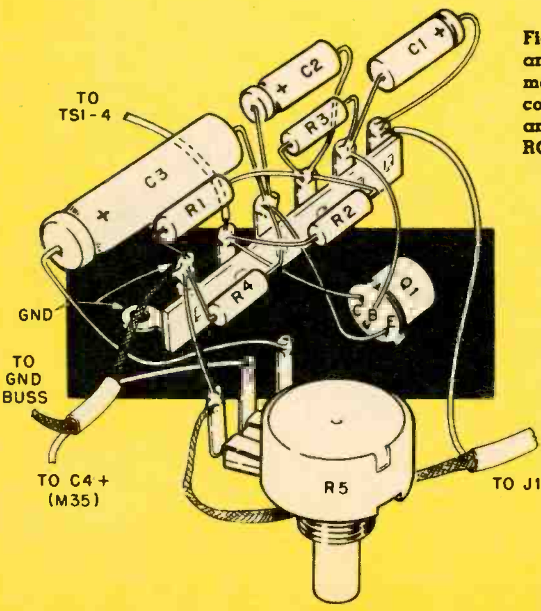
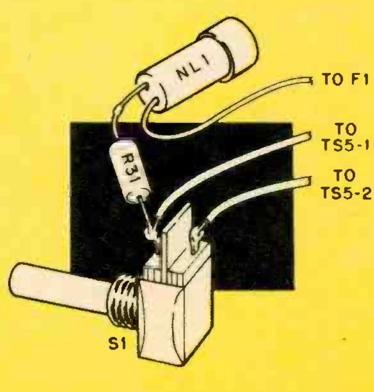
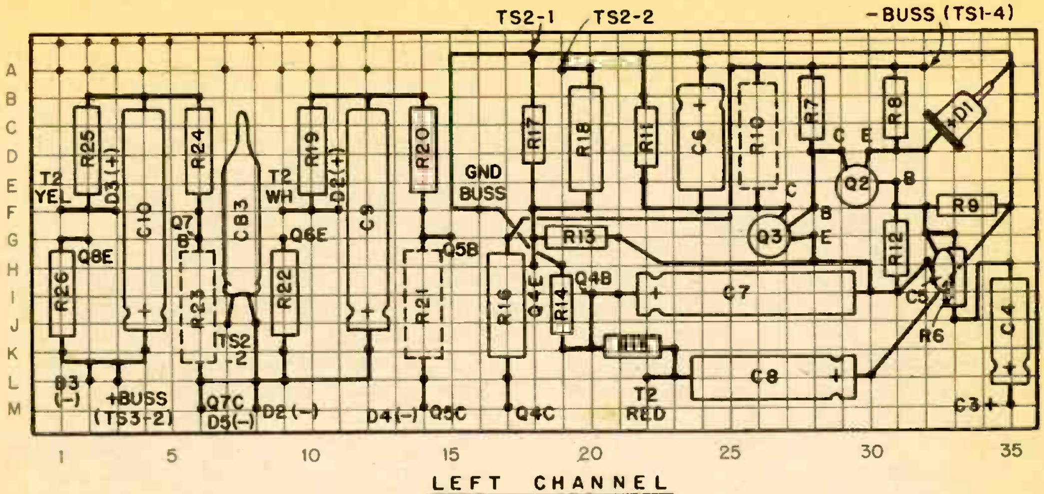


Fig. 4—Preamp (left) components are mounted on an eight-lug terminal strip and, with R5, are mounted on the inside of the chassis cover. Note common-ground point for shields of wires to C4 and J1. Shielded cable to and from preamps is RG174/U. Power switch and pilot lamp are below.





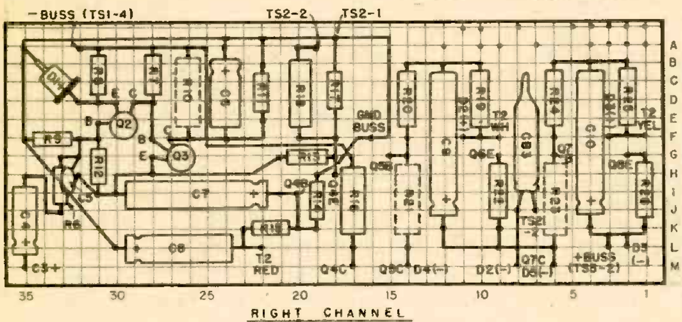


Fig. 5—Front of left-channel (top) and right channel (left) circuit boards. Grid network in gray aids in making connections from components on base plate. To find point designated G14, go down left column to row G, then go right to column No. 15. Point is junction of R20, R21. Right channel board is mirror image. R10, R21 and R23 are mounted on rear.

is not a project to break speed records. Dress all wires as shown in pictorials. **Rule 2:** Check and double check each connection against the pictorials and schematic. After completing a major section, such as a circuit board or the power supply, check it again. And after the entire job is completed, check it from beginning to end. **Rule 3:** Don't make any modifications or parts substitutions. This means use the part values and tolerances specified in the Parts List. Some latitude is permitted, but only if you have the electronic know-how to realize the consequences of what you are doing.

The first and most tedious job is laying out and drilling the base plate. The base plate is a 10x14x⅛-inch thick piece of aluminum (alloy 2024-T3). It *must* be this thick as it serves as a heat sink for the power transistors that are mounted on it. We recommend you have the plate cut to size where you buy it. The low minimum cutting charge is well worth it as it is not easy to cut ⅛ aluminum with a hacksaw.

Using a T-square, steel ruler and a sharp scribe, rule guide lines for the eleven power-transistor sockets. The Motorola MK-15 transistor socket kits are supplied with two adhesive-backed drilling templates. One is for the bottom of a chassis and the other is for the top of a chassis. The *top* of the base plate corresponds to the *bottom* of a chassis, so use the template marked *back of chassis.* Orient the templates on the *top* of the base plate as shown in Fig. 3.

Scribe hole centers for T1, T2, D2, D3, TS1, TS3, TS4, the ground-buss terminal strips, the rear bracket, the chassis cover, the two fuse holders for SR1-SR4 and the two circuit boards. When you have finished marking the base plate there should be (including six holes for each of the 11 transistor sockets) exactly 102 hole centers. The list below shows the number of holes required and their sizes.

Power transformer T1—4 #10 holes
Driver transformer T2—4 #18 holes
Rear bracket—5 #28 holes
Left- and right-channel circuit

boards—2 #18 holes each
SR1-SR4 holders—1 #18 hole each
Terminal strip TS1—2 #28 holes
Terminal strips TS3 and TS4—1 #18 hole each
Cover—7 #28 holes
Ground-buss terminal strips—1 #18 hole each
Diodes D2, D3—4 holes (see text)

The number and size of the holes for the power-transistor sockets are stated on the drilling templates.

Base-plate drilling requires great care. The transistor socket holes must be drilled carefully or the transistor pins may short to the base plate. Use a sharp center-punch—do not hit it too hard or it will slip—to start the holes. The best way to drill the holes with home-workshop equipment is to start them with a small pilot drill. Drill D2's and D3's holes slightly smaller than the diameter (0.240 inch) of their case—more about these holes later.

After all holes have been drilled, deburr them, polish with emery cloth, and wash both sides of the base plate with scouring powder. Rinse the plate, dry with a clean cloth and wrap it for later use.

The rear bracket is a 10¾-inch long by 2x2-inch aluminum angle bracket from one leg of which you must cut 1¼ inch. Layout, center-punch and drill holes for TS2 (2) TS5, F1, J1 (2) and the line cord on it. The holes for J1 (2) must be large enough so a phono plug's outer shell won't touch the bracket. Set the bracket aside until later.

The left- and right-channel circuit boards are 6¾x2½-inch pieces of perforated phenolic board 15 rows high and 36 columns long (Lafayette MS-849).

Except for R10, R21 and R23, all the components are mounted on the side of the board facing you (Fig. 5). Push component leads through the holes and bend them in the directions shown. (Use spaghetti on all leads that cross each other.) The black lines in Fig. 5 are on the reverse side of the board. R10, R21, and R22 must be mounted ¼ inch away from the *reverse* side of the board. Mount Q2 and Q3 ½ inch away from the board on the side *facing* you.

Connect wires to the points on the circuit boards indicated in Fig. 5 (Q4B, Q6E, for example). Tag each lead with small adhesive label. The only leads you cannot connect at this time are T2 yel, wh, red; D3 (+, −); D5 (−); D4 (−); D2 (+, −) and C3 (+). Install two #6 spade lugs on the bottom of each circuit board.

Unwrap the base plate now, and keep it as clean as possible. Mount the 11 power transistor sockets with 6-32 round head (small head) screws. Also mount the two ground-buss terminal strips, TS1, TS3 and TS4. Install the #16

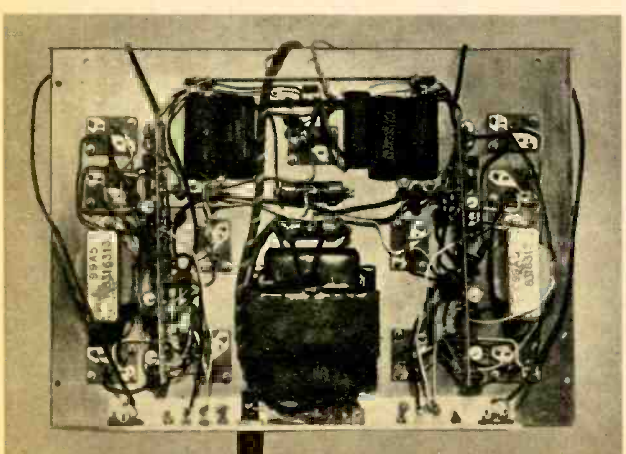
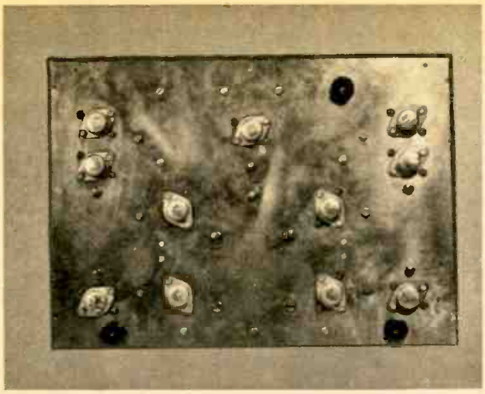


Fig. 6—Top view of amplifier. Left- and right-channel component layouts are mirror images of each other. Heavy line, top center, is ground buss made of #16 wire. Make all connections between base-mounted transistors, terminal strips and rear panel before installing left- and right-channel circuit boards in place. Be very careful when connecting the speaker leads to the output terminal strips. A frayed piece of wire shorting the terminals could damage or possibly destroy output transistors.



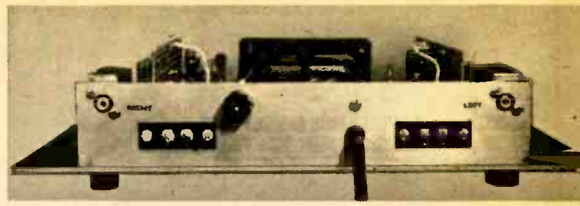


Fig. 7—Rear of amplifier (top). Note size of holes that must be drilled for input jacks so shell of plug will not touch panel. Underside of amplifier (left). Going from top to bottom, left column (3 transistors) to right, transistors are Q4, Q6, Q8, Q7, Q10, Q5, Q7, Q4, Q6 and Q8. The mounting feet should be at least ½ inch high for ventilation.

ground-buss wire, Q9, R27, R28, R29, R30, C11-C15 SR1-SR4 and CB1 and CB2 as shown in Fig. 3.

Very carefully enlarge the holes for diodes D2 and D3 with a tapered hand reamer. The holes must be large enough so that moderate pressure will push the diodes into the hole for a snug fit. Push them into the holes from the top just far enough so they are flush with the bottom of the base plate.

Connect wires between Q7E and Q8C and between Q5E and Q6C. Mount T1 with 10-32 screws. Connect T1's red and yellow leads.

Mount the circuit boards and connect the leads from them to the base plate components. Connect the leads from D2, D3, D4 and D5 to the circuit boards then mount and connect the driver transformers.

Turn the base plate over—it will rest safely on the top of T1 and the circuit boards. Install the 11 power transistors as follows: In each of the sockets' corner holes put a white plastic insulating bushing. (Plastic bushings, a mica washer and mounting screws are supplied in the Motorola MK-15 transistor mounting kit.) Carefully apply a small amount of silicone grease to both sides of the mica insulating washer and position it on the base plate. Plug the transistor in and secure it taking care not to strip the mounting threads on the socket.

On the rear bracket, mount F1, TS5, the input jacks and the speaker terminal strips. Fasten the bracket to the base plate with five 6-32 screws. Install the line cord and connect it to TS5 and F1.

The last construction step is the cover and the preamps. The cover is made from a 10x14x4-inch aluminum chassis. On one long side drill holes for the level controls, power switch, pilot lamp and preamp terminal strips.

On the other long side of the chassis, cut out a 10¼x1⅞-inch section, as shown in Fig. 1, to clear the rear bracket. Mount eight-lug terminal strips near the level controls and build the preamps using the layout in Fig. 4. For now, do not connect the leads to and from the preamps.

Checkout. Before turning on power you must make resistance measurements in the output stage. This will prevent destroying the output transistors because of a wiring error. But before making the measurements it is neces-

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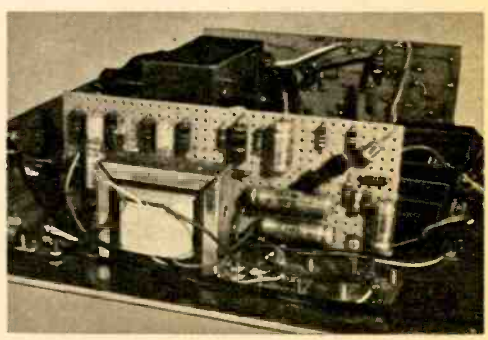


Fig. 8—Left-channel board. Driver transformer T2 (foreground) in author's model is unshielded. Transformer in parts kit will be in metal case.

GOOD READING

By Tim Cartwright

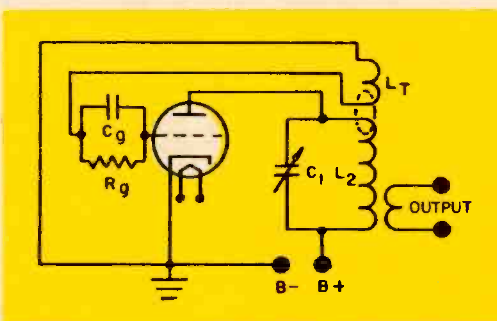
CB RADIO CONSTRUCTION PROJECTS. By Len Buckwalter. Howard W. Sams & Bobbs-Merrill, New York & Indianapolis. 111 pages. $2.50

If you are a veteran CBer and already have more equipment than a commercial radio station, this book is not for you. But if you are in the early stages of setting up a CB rig and would like to extend its range, efficiency and life expectancy for the lowest cost, I suggest you sample the 13 projects presented here. They are well thought out, easy to tackle and practical.

BASIC ELECTRONICS. By Lawrence A. Johannsen and Russell P. Journigan. Delmar Publishers, Albany, N. Y. 288 pages. $6

Since it is a text designed for classroom use along with a teacher's manual and some lab experiments, this book isn't easy to evaluate by itself. But it's worth mention simply because it is one of the best "basic" treatments I've ever seen.

Not only is the book well organized and concisely written, but it's easy to read and excellently illustrated as well (our drawing, taken from the book, shows the circuit of a plate-tuned Armstrong oscillator). I don't know whether you might want to tackle this text on your own, but if you plan to take a course or two in electronics, I hope you run across it in a classroom.



TRANSISTORS. A Self-Instructional Programed Manual. Prepared by the staff of the Federal Electric Corp. Prentice-Hall, Englewood Cliffs, N. J. 430 pages. $12

This book has provided my first exposure to programmed (or, as everyone else seems to spell it, "programed") instruction. And it has been quite an experience. I now know more about transistors than I ever wanted to know, and it all came about painlessly.

You no doubt have heard about programmed instruction and how it differs from ordinary class-room techniques. And, comparing this volume with the usual electronics textbook, I have to admit that the idea of programming has some telling points in its favor.

Biggest thing here, I suppose, is the fact that the reader has no chance to sit back and be bored by a complex subject. Whether he wants to or not, he has to keep filling in those blank spaces in the text, and he remains involved in the subject at all times. Equally important, he has practically no opportunity to be scared away from the subject as it grows more complex. Thanks to the careful planning of the "program" itself, there is no idea—however complicated—that the reader hasn't been prepared to handle by the time it comes up.

Aside from the basic idea of programming, another great strength of this book is that it sticks to its subject: transistors. There are no comparisons with the workings of vacuum tubes, nothing to unlearn as you proceed. Every type of circuit is handled as though transistors were the sole devices that could be used. And it may well be that this is the only way to learn about transistors with real success.

To put it mildly, I'm impressed by this book. If you would like a thorough, painless education in transistor theory, sample it for yourself. The program is all there, no matter how you spell it.

CB CORNER

BY LEN BUCKWALTER KBA4480

the case of the UNOPENED DOOR

LOCKOUT . . . With a stinging rebuke, the FCC ordered a Pittsburgh CBer to cease operations and turn in his license for cancellation. The misdemeanor, a first for CB, was the lockout. The long and the short of it was that the CBer had refused to permit FCC officials to inspect his station. And the power to inspect is provided for in Section 19.73 of the rules.

There's no mistaking FCC reaction to being refused entry. The Commission didn't mince words in saying that it considers such refusal a "serious challenge" to, and "frustration" of, FCC authority. Reason for the strong language: the Commission declared that refusal to permit inspection prevents gathering information on interference problems that may affect public safety. Nor did the fact that the attempt to inspect occurred during late hours lessen the penalty. Such inconvenience, the Commission feels, is one of the consequences of operating a station in the home.

Fines dominate other recent FCC actions. Seven Georgia CBers were served notice to pay $100 each. Six were hit with "unauthorized communications," while the seventh failed to answer an official letter.

Big Buttonmaker . . . Mel Baer claims that no CBer attending a jamboree is fully dressed without one of his outsize card-swapper pins (see photo). Measuring 2¼" in diameter, the bright red disc is designed to attract attention and QSLs for your collection. Price is a quarter, but clubs pay a dime. If the big button catches your fancy, write to Baer, 6429 North Glenwood Ave., Chicago 26, Ill. Just be sure you have enough QSL cards on hand to handle the onslaught of swappers!

Army Surplus . . . provides great buys for the ham, headaches for the CBer. Reader L. M. Hatton, a school principal in Henderson, N. C., asks about converting a walkie-talkie for use in his Boy Scout program. On numerous counts, army surplus is unsuitable for CB. For one thing, such equipment usually cannot maintain frequency tolerance within .005%—even if regular CB crystals are used. Then, too, modulation may be FM (illegal), the power too high and bandwidth (audio) in excess of 8,000 cycles.

Still another potent reason for not using a surplus walkie-talkie is simply that most available units contain tubes. Both the cost of batteries and physical size just about double when compared with transistor types. All in all, you're best advised to steer clear of surplus and go for one of the many transistor transceivers now on the market. Surplus may seem cheap, but it's expensive in the long run.

Noise . . . in your mobile rig can pop up from strange sources. Take this example which occurred in two different cars. To the amazement of one CBer, steady spark-plug noise in his receiver quieted down when he turned on the car headlights. In similar fashion, the owner of a small foreign car noticed that

[*Continued on page* 104]

The BATTERY ANALYST

At a glance you get a battery's terminal voltage and current drain under simulated load.

By Bert Mann

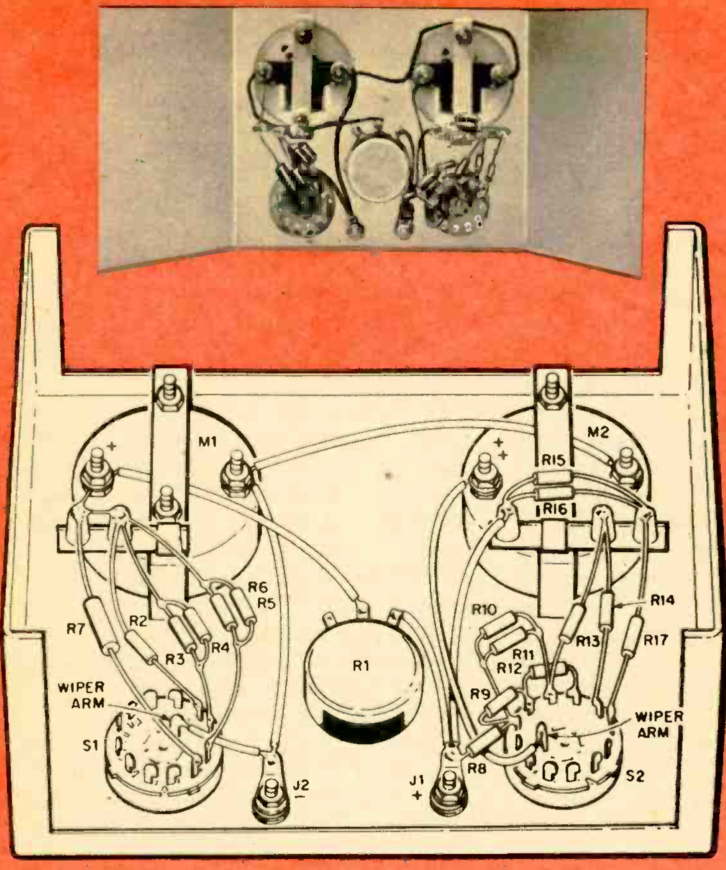
IT'S always a surprise to test dead flashlight batteries and find they check out at 1.5 volts—the same voltage as that of fresh replacements! Unusual? Not when you consider that it's also common to measure 9 volts across the terminals of a transistor-radio battery, even though the radio won't play. Until a battery is destroyed by chemical decomposition, it's always possible for it to give a reading at its rated voltage.

The explanation is simple. Any battery's voltage will measure normal without a load. But when called upon to deliver current when you connect a load, a *defective* battery's voltage drops.

To test a battery meaningfully, the terminal voltage *must* be measured with a load. EI's Battery Analyst simulates actual operating conditions by loading a battery to produce up to a 300 ma current drain.

The tester has two parts. The first, the load section, controls and indicates (in ma) the current drawn from the battery. You can test a D-size battery with as little as a 3-ma drain (to simulate the drain of a code-practice oscillator) or a 200-ma drain (to simulate a flashlight). There are five full-scale ranges of 3, 9, 30, 90 and 300 ma.

The second section is a voltmeter with full-scale ranges, chosen so common batteries will produce from one-half to full-scale deflection—the most accurate part of a meter scale.



Cabinet may be made of wood, plastic or metal so long as front panel is at least 5x6 inches. Wiring is not critical. Take care not to damage plastic meter cases with soldering iron. The range switches, S1 and S2, have 12 positions. The unused terminals can be hooked up for extra voltage or current ranges if necessary.

PARTS LIST

Resistors: ½ watt, 5% unless otherwise indicated
R1—10,000-ohm wirewound potentiometer (see text)
R2—270 ohms R3, R4—110 ohms
R5—33 ohms
R6—36 ohms
R7—5.1 ohms, 1 watt
R8, R13—1,000 ohms
R9—3,000 ohms
R10, R11, R15, R16—16,000 ohms
R12—10,000 ohms
R14—39,000 ohms
R17—91,000 ohms
M1—0-3 ma Shurite type 850 meter (Lafayette MT-129)
M2—0-1 ma Shurite type 850 meter (Lafayette MT-128)
S1, S2—Single-pole, 12-position rotary switch (Mallory 31112J)
J1, J2—Five-way binding posts

To keep the cost down (about $15) yet provide good accuracy, we used low-cost meters and 5 per cent multiplier resistors. For greater accuracy eliminate the voltmeter section (M2, S2 and resistors R8-R17) and use your own VOM or VTVM.

Construction. Resistors R2-R7 were chosen to provide ranges of 3, 9, 30, 90 and 300 ma with the 0-3 ma meter specified. Do not substitute a different meter or the calibration will be incorrect. Since MI's dial has markings at 1, 2 and 3 ma, add transfer-type numbers 3, 6 and 9 above 1, 2 and 3, respectively, for the other ranges.

R1, a 10,000-ohm potentiometer, will handle batteries up to 90 volts. However, it must be adjusted carefully when testing low-voltage batteries at low current (a 1.5-volt battery at 10 ma). If you don't plan to test batteries larger than 22½ volts, change R1 to 5,000 ohms to make low-current adjustments easier.

The voltmeter section uses a 0-1 ma, 1,000-ohms-per-volt meter whose scale can be used for the 10- and 100-volt ranges. Again, apply transfer numbers on the scale for the 2-, 5- and 50-voltage ranges. It's helpful to add a .8-volt designation (for the two-volt range) above the .4-ma point on the scale. This will be the reject voltage for 1.5-volt batteries.

The value of the multiplier resistor (resistor in series with M2) for additional voltage ranges is equal to the desired voltage range times 1,000 minus 1,000. For example, a 20-volt range would require a 19,000-ohm resistor [(20 × 1,000) −1,000]. A 40-volt range would require a 39,000-ohm resistor [(40 × 1,000) −1,000].

Using the Analyst. Set S2 to the voltage range just above that of the battery to be tested. Set S1 to the highest current range (300 ma) and turn R1 fully counterclockwise. Connect test leads to the battery and adjust R1 for the desired load current. (See the table below for current ranges, and HOW TO CHOOSE THE RIGHT BATTERY, Nov. '63 EI, for additional current ranges.)

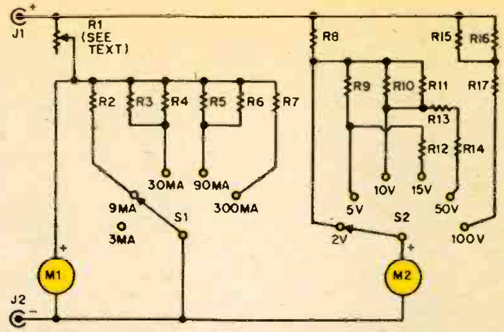
Consider the battery *good* if the voltage is 80 to 100 per cent of its nominal rating. A 1.5-volt battery would be good if its voltage under load is 1.2 volts or higher. A battery is *usable* if the voltage is 55 to 80 per cent of its nominal rating (.825 volts or higher for a 1.5-volt battery). If the voltage is below 55 per cent, discard the battery.

Note that transistor-equipment bat-

Battery Test Currents

Voltage	Test Current (ma)	Voltage	Test Current (ma)
1.5 (D)	270	9.0	100
1.5 (D)*	50	9.0*	9
1.5 (C)all	50	13.5	9
1.5 (AA)all	50	22.5	30
4.5	100	22.5*	2
4.5*	50	45	9
6.0	50	90	15

*Electronic Applications Type



Load section of analyst consists of M1, S1, R1 and shunt resistors R2 to R7. Voltmeter section includes M2, S2 and multiplier resistors R8 to R17.

teries are tested at lower current. For example the run-of-the-mill D-cell is checked at 270 ma while the electronic applications D-cell, such as is used in transistor radios, is checked at 50 ma. As a general rule, batteries used in transistor equipment or to supply the B+ voltage in tube equipment, are checked at the transistor values.

Just because a full-current test rejects a battery, this does not necessarily mean it always has to be discarded. The battery that checks bad with a 200-ma drain still can provide service for many months if used in experimental projects in which the current drain is low. A crystal calibrator or code-practice oscillator are examples of devices which the author powers with "dead" batteries.

And talking about dead batteries this is how they "die." Because the material of which batteries is made is not a perfect electrical conductor, all batteries have what's called internal resistance. A way to understand this is to think of a battery as a combination of a source of voltage in series with a resistor.

The internal resistance of a new battery is very low as long as the recommended current drain is not exceeded. As the battery is used, the internal resistance increases. The result is that the voltage drop across the internal resistance (that theoretically built-in series resistor) becomes so great that the battery's terminal voltage falls to a level too low to supply current to the load. Looking at it another way, the increased internal resistance limits the current the battery can supply to a circuit in which it is a series element.

HAM

Orderliness is a habit with Charles T. Zlatkovich, K5PPY, whose compact and tidy shack speaks for itself. A long-time ham, K5PPY, Austin Tex., was licensed back in 1938 as W5HJK. Inactive during the war years, Chuck resumed hamming in 1958 when his son became interested in getting a Novice ticket. As the photo shows, equipment at K5PPY is tucked into a wooden rack, the doors of which double as a mike stand and a bulletin board for a batch of QSL cards. Neat eh?

PRIZE SHACKS

PROUD of your ham, CB or SWL shack? Want to win $20, and see a photo of you and your shack in EI to boot? You can—if your photo is one of the lucky winners in EI's Prize Shacks contest. Just send your photos to EI Prize Shacks, 67 West 44th St., New York, N. Y. 10036. Include some information about yourself, your equipment and your activities, and write your name and address on the back of each photo. We prefer 8x10-inch glossies, and non-prize-winning entries will be returned. All set? Then let's see those Prize Shacks photos roll in!

SWL

Devils Lake, N. D., is home base for Larry Marshall, who has been one of the nation's foremost SWL's for years. Larry's equipment includes a Hallicrafters S-108 receiver, a Realistic tape recorder, a Q-multiplier and a crystal calibrator; antennas consist of a 20-meter dipole and a 50-ft. longwire. There's no doubting that his dial-twirling pays off: Larry is the proud possessor of more than 500 veries from BCB and SWBC stations scattered round the world.

CB

Here's a CBer who's not a CBer—at least not if you want to be technical about it. A Canadian, Moe Edwards is licensed under Canada's General Radio Service, which is that country's equivalent to the U.S. Citizens Band. Moe's call letters are XM52255 (base) and XM52254 (mobile), and he operates from a point about 20 miles south of Montreal, Que. His transceiver is a Lafayette HE-20C.

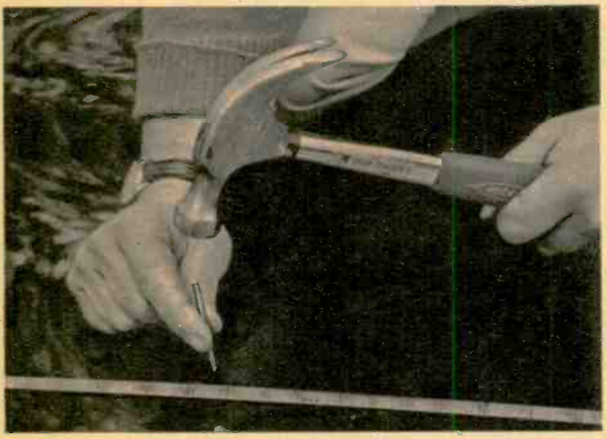
Give your mobile signal real punch with a CAR-TOP CB ANTENNA

By Len Buckwalter
KBA4480

Best performer of all mobile antennas, the car-top whip is the last choice of CBers. Reasons are that few car owners want to mar the roof with a hole, and installation is a little more involved than a bumper mount. But the disadvantages are far outweighed by the greater transmission range you get. The roof forms an excellent ground plane that keeps your signal constant in all directions. And the source of signal, the whip's bottom, is high and in the clear.

Installation is easiest through the dome light which provides access to the roof and permits the transmission line to be snaked through the headliner. First, lower the dome light and snake a piece of stiff wire toward the car's right front-window post. Aim the wire to the right side of the roof, then coax it toward the front to avoid the cross-bows in the roof. Remove the trim piece on the window post so the wire can come out. To help pull the wire out of the headliner, insert a second hooked wire and fish around for the first one. The route continues down the post to the underside of the dash.

Once the stiff wire is in place, use it to pull the transmission line through the same route. After connecting the stiff wire securely to the end of the cable, a little gentle tugging may be necessary to bring the cable completely across the roof and down the window post. Do not re-install the dome light yet. It will be necessary to have access to this area until the antenna is completely installed and a check is made of its performance.



It isn't necessary to locate the hole directly over the dome light. Since the antenna mount is tightened from the outside, it can be pushed through the dome-light hole with a screwdriver to the roof hole. After locating the center of the roof with a tape measure, use a metal punch to start the hole before you reach for the electric drill.

Apply light pressure when drilling to prevent damage to the headliner under the roof. The size of the hole to be punched (below) is determined by the antenna. A nine-pin tube-socket punch will make a 5/8-inch diameter hole. The Mark Heliwhip HWR-42 antenna requires a 13/16-inch hole.

Before installing the mount, remove the paint from the underside of the hole in the roof with a file or emery paper to assure a good ground connection between the mount and the car. The resistance between the whip and the hot lead of the antenna plug should be less than one ohm.

If your antenna cannot be easily tuned to the center of the 27-mc band, insert an SWR meter in the transmission line. Lengthen the whip if bringing your hand near the antenna lowers the SWR. Shorten whip if SWR increases. Or, adjust length for maximum field-strength meter reading.

By Ron Mitchell

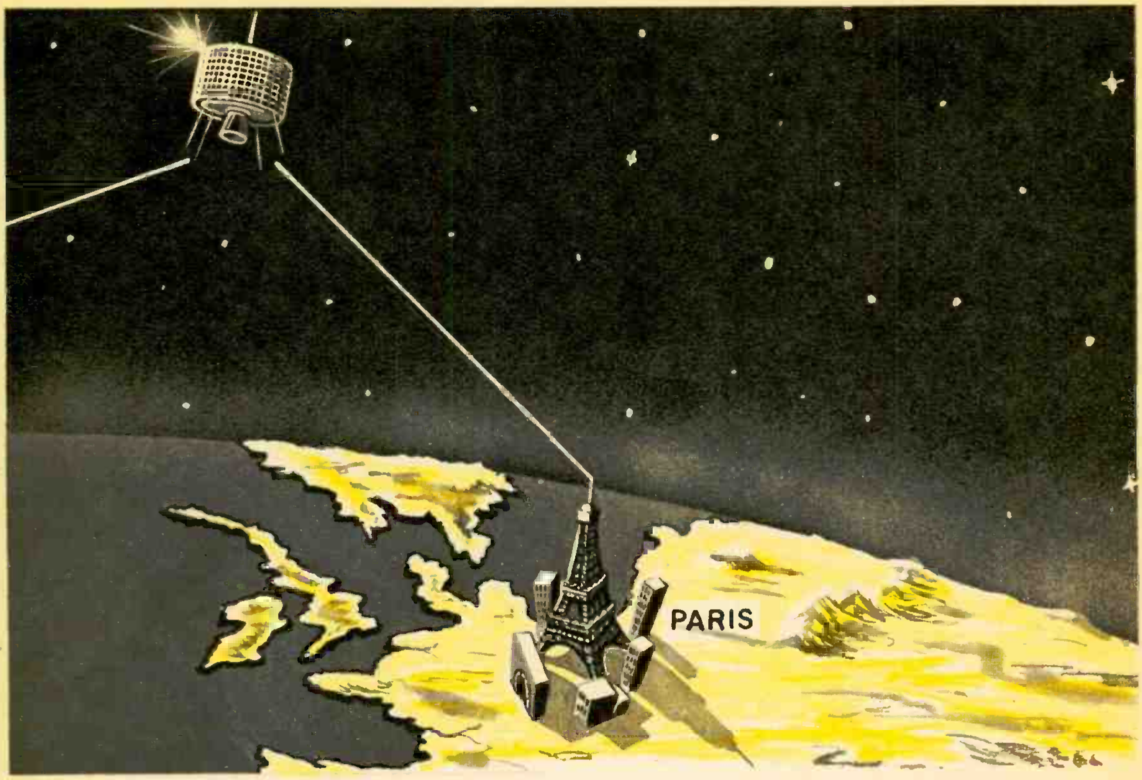
Getting the

Uninterrupted 24-hour communications between continents is the goal scientists hope to achieve with satellites such as Syncom. Shown here being aligned by engineer David Kamm, the Syncom satellite now is in orbit over the Atlantic Ocean.

THE BIG POND—which is what radio amateurs affectionately call the Atlantic Ocean—may not be the biggest ocean around. But as anyone who has sailed across can tell you, it's much more than a pond, and a mighty big one at that.

Getting Cristobal Colon and his little crew across way back in 1492 was a wearying exploit that relied on little more than coins for Columbus' coffers and winds for his sails—the former the courtesy of the Spanish court. Columbus' voyage also occupied more days and weeks than we'd care to mention—at least insofar as getting a message across is concerned.

Things got a little better when the Atlantic finally was spanned successfully with a cable (1866). But it really was Guglielmo Marconi, that Italian as dear to the heart of the radioman as Columbus is to the sailor, who set the



message across

ball rolling. As everyone knows, Marconi got a message clean across the Atlantic in 1901. And he did it without ships *or* cables.

Today, there's hope for still another way of getting messages across the Big Pond—and with greater reliability than ever. That hope lies in Syncom, the world's first communications satellite to hover over the same area of the earth. Launched last July 26, Syncom, in the words of the director of the National Aeronautics and Space Administration, is "one of the outstanding feats in the history of space flight." To understand just why, let's take a minute to see how Syncom differs from previous communications satellites.

The thing that makes Syncom a satellite with a difference is the fact that it's the first to be synchronous. In other words, though it has an orbit, just as does any other satellite, that orbit is such that it matches the speed of the earth's rotation. Result: Syncom effectively stands still in the sky.

This means that there's no need to wait until Syncom reaches the proper point in its orbit to relay a signal. Though the current Syncom traces a figure 8 over the mid-Atlantic from about 33 degrees S. Latitude to 33 degrees N. Latitude, for practical purposes it is hovering at about the same point above the earth's surface.

In this respect, Syncom is a very much more promising animal than two earlier communications satellites you may remember—Telstar I and Telstar II. Both these satellites were of the low- to medium-altitude type, and it would take 30 to 50 of them to insure world-wide communications. Reason: one always would have to be in sight over the horizon, or no messages could get across.

Syncom, by contrast, is a high-alti-

Getting the message across

tude satellite, orbiting at a height some 22,300 miles above the earth's surface. Thanks to its eagle-like view, a satellite such as Syncom can see New York and Paris without batting an eye. Better yet, the Syncom satellite now in orbit already has linked California and Africa —points a full 8,000 miles apart, a distance comprising one-third the surface of the globe.

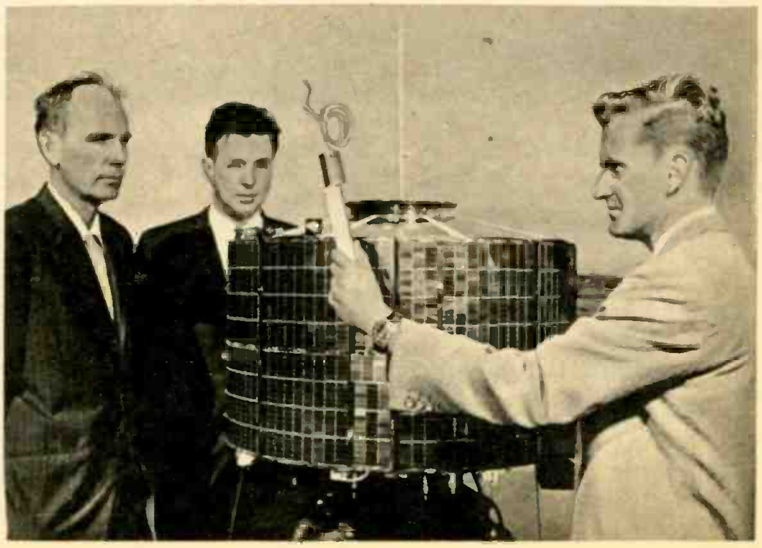
Put a more complex satellite this high, and you can have direct, line-of-sight communications straight across the Atlantic, any time of the day or night. In fact, researchers estimate that three satellites of the Syncom variety could be spaced in such a manner that they would be in line-of-sight contact with just about all inhabited parts of the globe.

Though the first Syncom satellite is an experiment, scientists hope it may pave the way toward a complete intercontinental communications setup using only three such satellites. Like Syncom, these satellites would be controlled from the ground. And, like Syncom, they would be spin-stabilized, maintaining their position in space much as a gyroscope does. Their only moving parts would be tiny gas jets, controlled from the ground, and used to move, "park" and orient the satellites.

As for Syncom's figure-8 pattern, scientists feel they could take care of this, too. Because Syncom was launched from Cape Canaveral (which, of course, is north of the equator), Syncom's orbit is not parallel to the equator but at a 33-degree angle from it. As a result, its orbit takes it back and forth across the equator twice a day. But future models of Syncom, launched into orbit directly over the equator, could be truly stationary, hovering over a single point on the earth.

The trick lies in getting satellites of the Syncom variety to achieve a stationary orbit. And there's doubt in scientific circles whether this is feasible at the present time. As a result, some space scientists think the world's first operating satellite system well may be made up of lower-altitude satellites of the Telstar type.

But the greater economy and efficiency of the synchronous satellite system are so attractive that scientists won't give up easily. In fact, Syncom well may prove to be as important to future communications as that letter S Marconi got across the Atlantic only 60 some odd years ago.



Designed and built by the Hughes Aircraft Co., Syncom is a drum-shaped spacecraft only 28 in. in diameter and 15½ in. in depth. This photo was taken before the satellite was launched and pictures three of the engineers responsible for its development: Thomas Hudspeth, Dr. Harold A. Rosen and Donald D. Williams. The traveling-wave tube which Williams holds in his hand is identical to those in Syncom's two transmitters. Each transmitter delivers a minimum of 2 watts on 1815 mc.

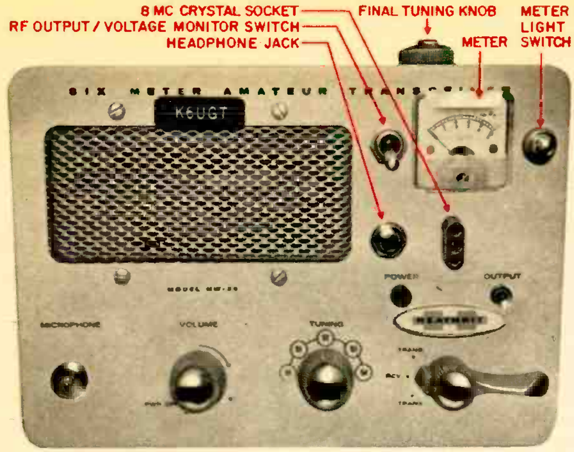


Fig. 1—Callouts point to additions to Model HW-29 Sixer. Meter-light switch turns on lamps in meter. Holders for 8-mc crystals can be added on left side of the cabinet.

Deluxe your HEATH SIXER

By Fred Blechman, K6UGT

Seven changes and modifications for greater operating luxury.

THE Heath Sixer, a popular, top-performing 6-meter transceiver, can be given added versatility with a few simple modifications that cost only about $8. The dress-up will provide bandspread, an RF output/power-supply-voltage meter, a headphone jack, a convenient way to tune the final and a change that enables you to use inexpensive 8-mc crystals instead of the more costly fifth-overtone type.

• **Bandspread.** Since almost all activity is on the first two megacycles (50-52 mc) of the 6-meter band, which extends from 50-54 mc, bandspread will eliminate coverage of the dead upper half of the band. The modification requires a capacitor be installed (C1, Figs. 2 and 5) in series with the existing tuning capacitor (C108 in the HW-29, C18 in the HW-29A). By using a 10-mmf capacitor for C1 you can reduce the receiver tuning range to about 1.7 mc, anywhere in the band. This effectively doubles the area that a selected portion of the band will occupy on the dial. Station tuning will now be less critical. If you don't want to spread the band out that much on the dial, use a 15-mmf capacitor for C1. For more bandspread, use a 7-mmf capacitor. Install C1 as shown in Fig. 5 between C108 (C18 in the HW-29A) and detector coil L102 (L5 in the HW-29A). Readjust the slug of L102 so 51 mc falls at about the 52.3-mc mark on the dial. If C1 is 10 mmf, the receiver tuning range will now be about 50.1-51.7 mc. The original dial readings will no longer be correct, but this won't take long to get used to.

• **8-mc Crystals are Cheaper.** The Model HW-29 uses expensive fifth-overtone crystals in a sometimes unstable oscillator circuit. (The HW-29A has an additional tube and uses 8-mc crystals.) Eight-mc crystals can be purchased for as little as fifty cents each. To modify the HW-29, disconnect the four wires attached to oscillator coil L201. Remove the coil from the chassis and unwind all the wire from the form. Evenly wind 29

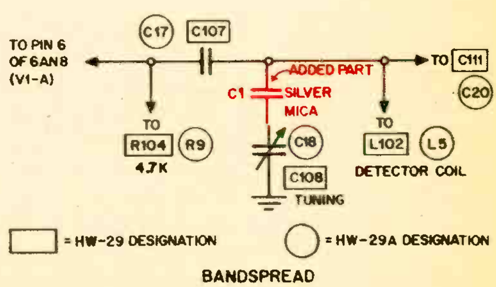


Fig. 2—A 10-mmf capacitor in series with tuning capacitor spreads half the band over entire dial.

Deluxe your HEATH SIXER

turns of #22 enameled wire in the same space of the coil form, scrape the enamel from the ends of the wire then solder to the lugs. Replace L201 and solder the four wires to the lugs they were on before.

Install, the crystal socket on the front panel as shown in Fig. 1. Solder #16 wire, covered with spaghetti, to the lugs on the new socket and force them in the contacts in the old crystal socket. Do not use coax or twisted-pair between the two sockets. The 8-mc crystal frequency should be one-sixth the desired transmitting frequency. For example to transmit on 51 mc, use an 8,500-kc crystal. To tune up the final, plug a dummy load (#47 pilot lamp) in the antenna jack

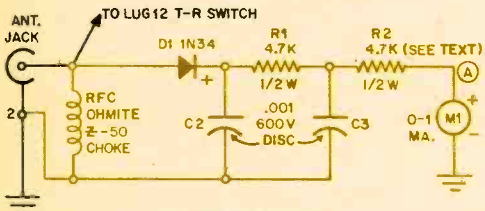


Fig. 3—RF-output-meter circuit shown in color. Be sure of the polarity of D1 before installing.

and turn on the power. Set the mode switch to transmit, and using a plastic alignment tool, adjust the slug of L201 for maximum lamp brilliance. Then detune slightly for stability. Adjust the final tuning slug in L202 for maximum lamp brilliance.

Ideally, the slug of L201 should be in the center of the coil form. If it is too low, remove a few turns from L201 and retune. If it is too high, rewind the coil with a few more turns of wire and retune. A grid-dip meter tuned to three times the crystal frequency will indicate the correct slug position when the coil is installed and the transmitter is operating.

The 8-mc crystal oscillates on its third overtone. The output of the oscillator

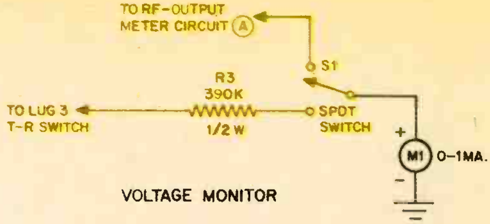


Fig. 4—Power-supply voltage-monitoring circuit requires S1 be added to the circuit in Fig. 3.

is then doubled in the final to produce the 50-mc output. However, some tripling may occur in the final which may interfere with TV reception on channel 5. A good low-pass filter designed to cut off above 52 mc, installed on the back of the Sixer, will suppress such interference.

• **RF Output Meter.** The plate current dip in the Sixer is difficult to determine. A much more accurate tune-up can be achieved by using a meter that reads RF voltage. Mount the meter on the front panel as shown in Fig. 1. The circuit is shown in Fig. 3 and the installation of the rectifier-filter network (already built in the HW-29A) is

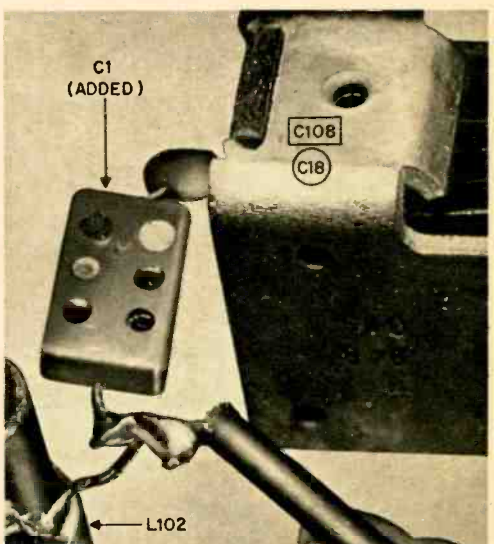


Fig. 5—Bandspread modification. Leads formerly going to C108 (C18 in HW-29A) are connected to one side of C1. Other side of C1 goes to C108.

shown in Fig. 8 at the right.

The value of R2 is determined by the sensitivity and internal resistance of the meter, the efficiency of D1, power output of the transmitter and the standing wave at the metering point. If the meter pins, use a higher-value resistor for R2. If the indication is too low, decrease the resistance of R2. Do not use a meter less sensitive than 0-1 ma, as it will reduce the transmitter output power. The RF power lost in driving the 0-1 ma meter will not be noticed in terms of the brilliance of the dummy-load lamp when the meter is disconnected during transmit.

Since the meter measures RF voltage at a particular point on the transmission line it is subject to the effect of the standing wave at that point. The meter therefore, is to be used only to indicate a maximum point when tuning and not for qualitative measurements. The indications from one antenna to the next will differ considerably (and inconclusively), and should not be a matter of concern. When modulating, you may notice movement of the meter needle. This indicates carrier shift and will not be noticed by someone listening to you on the air. Move your mike away from your mouth to prevent excessive needle movement.

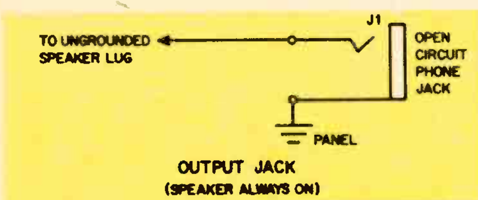


Fig. 6—The Sixer speaker will always be on if you use this circuit to add a jack for headphones.

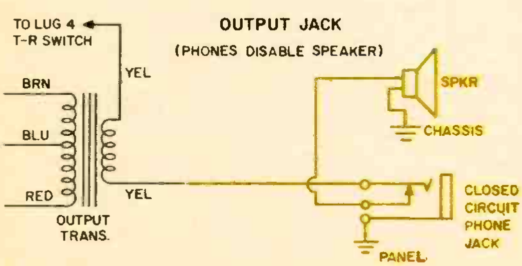


Fig. 7—Use this circuit and the headphones will automatically turn off speaker when plugged in.

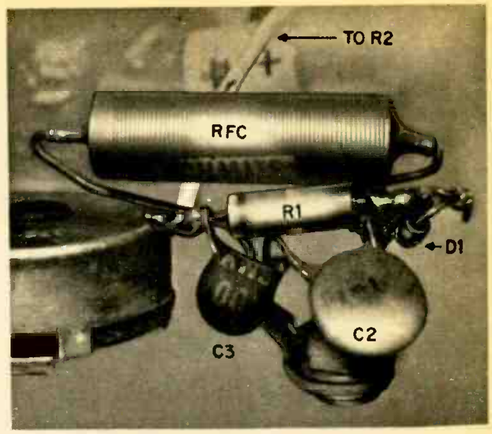


Fig. 8—RF-output-meter parts are located on rear chassis apron near regeneration control R106 (left). Don't apply excessive heat when soldering to D1.

• **Power-Supply Voltage Monitoring.** Since power-supply voltage is an important indication of proper operation, add a switch and resistor (Fig. 4) to the previously installed circuit to monitor power-supply voltage in both the transmit and receive modes. The actual voltage is not really important, but a radical voltage change is a clue to trouble. Normally S1 is left in the voltage-monitor position. For tune-up, set S1 to the RF output position.

• **Tuning the Final (HW-29 only).** Now that you have a front-panel RF meter and crystal, it will be a cinch to tune for maximum output with each crystal you use. Just drill a hole in the cabinet above final coil L202 and tune for maximum output on the RF output meter with a plastic alignment

[*Continued on page* 106]

PARTS LIST

C1—10 mmf, 5% silver-mica capacitor (see text)
C2, C3—.001, 600V disc capacitor
D1—1N34 diode
J1—Non-shorting phone jack (see text)
M1—0-1 MA. milliammeter (Lafayette MS-454 or equiv.)
R1, R2—4,700-ohm, 1/2-watt resistor
R3—390,000 ohm, 1/2-watt resistor
RFC—Ohmite Z-50 choke
S1—SPDT toggle switch
Misc.—Fused plug, #22 enameled wire, 8 mc crystals (U.S. Crystals, 1342 South La Brea Ave., Los Angeles 19, California) Crystal socket

AUTOMATIC CQ SENDER

By Len Buckwalter, K1ODH

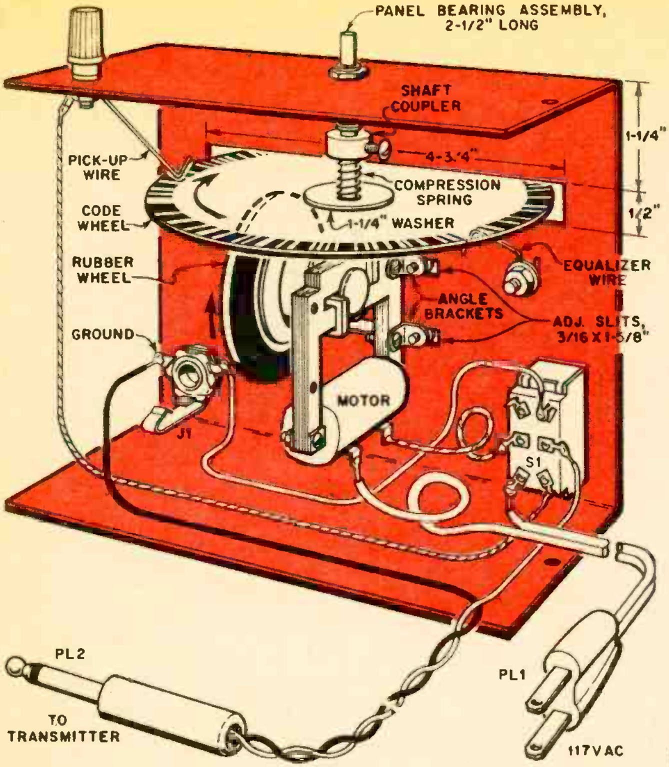
PIN down even the most avid brass pounder and he will admit that sending a string of CQ's is a tiresome ordeal. A CQ call is a long message (the author's for example, is *CQ CQ CQ DE K1ODH K1ODH)* and becomes quite a bore when you have to keep repeating it—especially when the band is quiet.

Our Automatic CQ Sender will convert those drawn-out minutes into useful time. While you make time and date entries in your log, it will repeatedly key your transmitter with this message: *CQ CQ CQ DE* (your call twice). When it snares a contact, you flip its front-panel switch to manual and send a *K* with your key. Flip the switch back to automatic and you can send another string of CQ's. You can vary the speed of the call from about 6 to 22 words per minute.

Primarily mechanical, the Sender consists of a standard clock motor and a code wheel. The springs, bearings, and other mechanical parts are standard and are readily available from electronic parts distributors. The code wheel is actually a home-made switch made of copper-clad printed-circuit board on whose rim are etched code characters. As the wheel turns under a pick-up wire, the transmitter keying circuit is completed.

Construction. Let's start with the clock motor. Check the bargain section of electronic parts catalogs for a 60-cycle synchronous type with a speed of about 3 to 4 rpm (a common Telechron clock motor's speed is 3.6 rpm). If you can obtain only a complete clock, strip it down to the basic motor shown in Fig. 3. However, do not remove the small brass gear. Place a half-inch diameter metal washer on the gear and put the two-inch diameter rubber wheel on top of the washer. Solder them both to the gear at the same time.

Slip machine screws through the *unthreaded* holes of two angle brackets and secure them to the motor. Insert 6-32 screws through the slits in the front of the Minibox and then into the *threaded* holes of the brackets. To change the Sender's operating speed, you merely loosen the screws and slide the motor assembly left



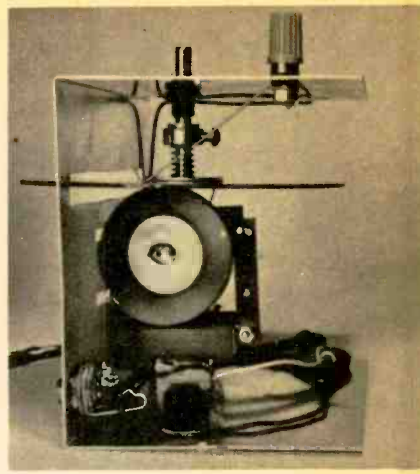
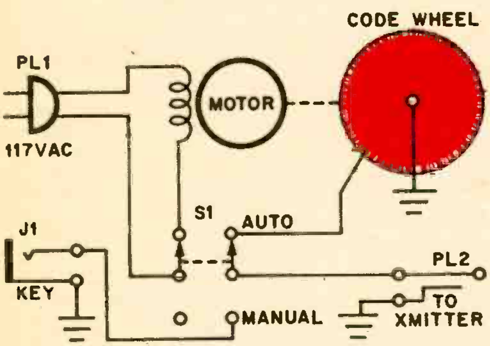


Fig. 1—Slits in U-section of 4x5x6-inch Minibox (left) permit motor to move left or right to change code-wheel speed. Pick-up wire is insulated from cabinet by binding post. Note in Fig. 2 (above) how pick-up and equalizer wires keep code wheel pressed firmly against the rubber wheel.



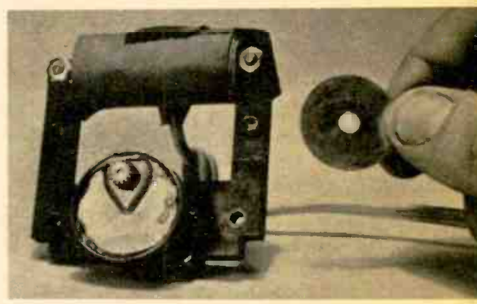


Fig. 3—Strip clock (top) down to basic motor and solder flat washer and rubber wheel to drive gear. Schematic of CQ sender is shown at the left.

DE K1ODH K1ODH CQ CQ C

PARTS LIST
S1—DPDT toggle switch
PL1—AC plug and line cord
PL2—Phone plug J1—Phone jack
Motor—117 VAC, 60-cycle synchronous clock motor. Approximately 4 r.p.m.
Code Wheel—Copper-clad laminated printed-circuit board, laminated on one side. (Lafayette MS-510 or equiv.).
Misc.—4x5x6-inch Minibox; angle brackets, one hole threaded for 6-32 screw, one unthreaded hole; etchant solution (Lafayette MS-729 or equiv.); compression spring, General Cement No. H440-F assortment; ¼-inch to ¼-inch shaft coupler; panel bearing assembly, 3-inches long, ¼-inch diameter shaft (Lafayette MS-193 or equiv.); 2-inch diameter rubber phono idler wheel (Walsco 1442-02); flat washers

AUTOMATIC CQ SENDER

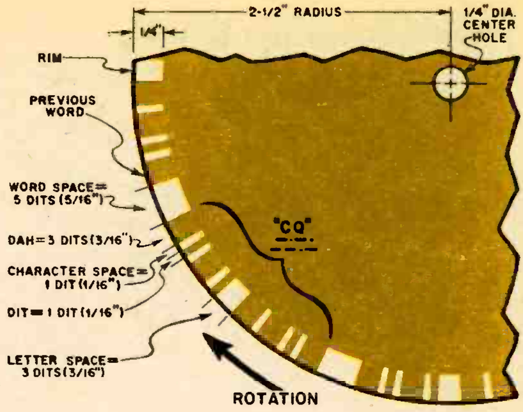


Fig. 4—Portion of code wheel shown in color was covered with tape and is the copper that remains after etching. Start at diameter line and work counterclockwise when marking and cutting code characters in tape. Remove the tape within the 4½-inch diameter inner circle.

or right then tighten the screws.

Now to the code wheel. Cut a five-inch diameter disc out of the copper-clad board and drill a ¼-inch diameter hole in the center. If the disc has a rough edge, mount it in an electric drill. Hold a file against the edge to smooth it down as it rotates. And it's a good idea to clean the copper surface at this time by holding a piece of steel wool against it.

Refer now to Fig. 4. To prepare the code characters, cover the outer edge of the wheel with black plastic electrical tape such as Scotch No. 33. But before you can notch the tape, you must determine how wide to make the code characters.

The width of the code characters and the spacing between them is based on the length of a dot (dit). A dash (dah) equals three dits. The space between a dit and dah in a *letter* is a dit. The space between letters is three dits, and the space between words is five dits. (Consider *CQ, DE* and your call individual words.) Next convert your message to dits and total them up—we had 264 in ours (*CQ CQ CQ DE K1ODH K1ODH*).

Since the code wheel is five inches in diameter, its circumference is 15.7 inches (circumference = diameter × 3.141). We divided 15.7 by 264 and got .059 (.06) inch (approximately $\frac{1}{16}$th inch) as the width of the dit at the rim of the wheel.

Draw a line in pencil on the copper foil through the exact center of the code wheel. Using a compass, draw a 4½-inch diameter circle on the plastic tape. This circle is the inner limit to which the code characters will be cut in the tape.

Using a steel ruler and single-edge razor, cut the tape for the complete message (*CQ CQ CQ DE* your call twice) starting at either end of the diameter line. The first code character C (— • — •) begins with a dah. Hold the ruler against the edge of the code wheel at the diameter line and measure .18 ($\frac{3}{16}$) inch (three dits) going counterclockwise. *Do not* remove this section of tape. Measure $\frac{1}{16}$ inch counterclockwise from the last mark on the wheel's edge and remove the tape from this section between the 4½-inch diameter circle and the outer rim. This section will be the space between the first dah and following dit. Proceed in the same fashion around the wheel until the entire message is completed.

After all the tape is removed, check the spacing by running a pencil around the rim of the code wheel. You should be able to hear the sound of the dits and dahs. Errors can be corrected by recovering the copper with small pieces of tape.

Completely cover the copper on the area within the 4½-inch diameter circle with tape and place the wheel in a tray of printed-circuit-board etchant solution until all the exposed copper has been etched away. Wash the wheel in running water and remove the remain-

[*Continued on page* 110]

And now...

EI DX AWARDS FOR HAMS!

- **New certificate is for two-way communications**
- **A third Award Period is declared**

THOUGH A NUMBER of hams have received DX Awards from EI's DX Club, to date there never has been an EI DX Award just for hams. But a new certificate now has been created which will be granted specifically for two-way communications. Like EI's older DX Award that so many SWLs have earned, the new Award for hams is based on the number of different countries for which the recipient holds valid QSLs. But unlike the older Award, the new certificate states that the recipient "has conducted two-way communications with amateur stations in the number of countries noted hereupon. . ." However, the older certificate, which states that the recipient "has received radio transmissions from the number of different countries noted hereupon," still is as valid as ever.

The third Award Period, which will run through April 30, 1964, is expected to attract a greater number of applicants than any previous Award Period, primarily because both SWLs and hams now may qualify. The requirements are similar in both instances. SWLs must prove that they have received radio transmissions from 10, 15, 50 or 100 different countries, and they must give the frequencies of all the stations involved. Hams, likewise, must prove that they have conducted two-way communications with stations in 10, 50 or 100 different countries. But hams need not list a specific frequency—a meter band, such as 40 or 20 meters, will

EI DX AWARDS FOR HAMS!

Both SWLs and hams now may qualify for DX Awards issued by EI's DX Club. The Awards are identical in size, and both are based on the number of countries QSLed. Hams must prove two-way communications.

be quite adequate for the ham Award.

By qualifying for one of EI's DX Awards, a ham or an SWL automatically becomes a member of EI's DX Club. And if you're a regular EI reader, you already know how much prestige EI's DX Club has gained in the few years it has been in existence.

In contrast to most clubs, EI's DX Club has no officers, no regular meetings, no dues. Its sole purpose in life is to issue EI's DX Awards. And because EI's DX Awards must be *earned*, an Award is issued only when an applicant has proven that he can qualify. Furthermore, since there is absolutely no charge for an Award, no applicant can feel that he is "buying" a certificate for his shack.

Both of EI's DX Awards—those for hams and those for SWLs—are handsome certificates, ready for framing. Predominant colors on the SWL certificate are red and green, while those on the ham Award are blue and gold. The certificates are identical in size, measuring 5⅜x8⅜ inches. Each certificate bears a stamp showing the number of countries the recipient has DXed, in the case of the SWL Award, or the number of countries the recipient has communicated with, in the case of the ham Award.

Both types of Awards actually are a series. SWLs may apply for their Award in any one of four Classes: the Special, which requires 10 countries; the Broadcast Band, which requires 15 countries; the General-50, which requires 50 countries; or the General-100, which requires 100 countries. The only one of these Awards with any kind of frequency limitation is the Broadcast Band Class. Any QSL advanced for this Award must be from a station operating on the Broadcast Band—535 to 1605 kc.

Similarly, hams may apply for their Award in any one of three Classes: the Special, again requiring 10 countries; the General-50, again requiring 50 countries; or the General-100, again requiring 100 countries. Obviously, the Broadcast Band Class does not apply to the series of Awards for hams.

To apply for either type of EI DX Award, simply clip the application form from this issue. Carefully print your name and address, using a ball point pen, and be sure to check the type of Award you are applying for: either SWL or HAM. In addition, be certain to print in the class of Award you are applying for. As mentioned earlier, this can be the Special, Broadcast Band, General-50 or General-100 for SWLs. And for hams, it can be the Special, the General-50 or the General-100.

The balance of the application form must be filled in in its entirety. However, hams may list a meter-band rather than a specific frequency, as already stated. Though you should not include QSLs with your application, you must keep them on hand. You may be asked to produce them at some later date.

When you have completed the application form and checked it over carefully for completeness and accuracy, place it in an envelope and mail it to

EI's DX Club
67 West 44th Street
New York, N.Y. 10036

If all is in order, you will become a member of EI's DX Club, and your handsome SWL or HAM DX Award will reach you after processing.

Good luck!

EI DX CLUB LOG

NAME .... ADDRESS ....

CITY .... STATE ....

TYPE OF AWARD { ☐ SWL ☐ HAM

CLASS OF AWARD ....

INSTRUCTIONS. Clip along broken line at left. Under *Type of Award*, check *SWL* or *HAM*, depending on the type of award you are applying for. Under *Class of Award*, write class of award you are applying for (see text). Fill in *all* items on each entry line below. Under *Date*, use figures (such as 10-1-63); all log entries must be dated January 1, 1950, or later. Under *Time*, use local standard time and 24-hour clock (0000 to 2359 hours). To list second 50 countries, make up additional log pages in similar style. Third Award Period ends April 30, 1964.

	DATE (local)	TIME (local)	FREQUENCY (kc)	STATION	LOCATION (city)	COUNTRY	TYPE OF QSL (check one)
1							card ☐ letter ☐
2							card ☐ letter ☐
3							card ☐ letter ☐
4							card ☐ letter ☐
5							card ☐ letter ☐
6							card ☐ letter ☐
7							card ☐ letter ☐
8							card ☐ letter ☐
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17							card ☐ letter ☐
18							card ☐ letter ☐
19							card ☐ letter ☐
20							card ☐ letter ☐
21							card ☐ letter ☐

	DATE (local)	TIME (local)	FREQUENCY (kc)	STATION	LOCATION (city)	COUNTRY	TYPE OF QSL (check one)
22							card ☐ letter ☐
23							card ☐ letter ☐
24							card ☐ letter ☐
25							card ☐ letter ☐
26							card ☐ letter ☐
27							card ☐ letter ☐
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KIT EI REPORT

TUNED SIGNAL TRACER

CONAR 230

ANYONE that has serviced stereo amplifiers, AM tuners and marine-frequency short-wave radios will tell you that locating the trouble is more than 90 percent of the job. And nothing can help you locate the trouble faster than a signal tracer.

The idea behind a signal tracer is simple. First, you feed a signal into the equipment being tested; any signal will do—audio, RF from a signal generator or even a signal from the antenna. Then, working from either the input or output, you check each stage until you find the one where the signal gets lost or distorted. Once you have isolated the defective stage it's an easy matter to locate the bad component with your VOM or VTVM.

One of the best signal tracers we've seen of late is the Conar 230 (Conar is a division of the National Radio Institute, 3939 Wisconsin Avenue N.W., Washington 16, D.C.). It costs $39.95 in kit form and $57.50 assembled. The 230 differs from the usual signal tracer in that instead of using an insensitive probe for RF work it uses a two-stage *tuned* amplifier—actually a TRF receiver. Its sensitivity is high, and you can even pick up a signal at the antenna coil (or antenna) of a radio. To avoid detuning RF circuits, the 230's cathode-follower probe isolates the tracer from the circuit being tested.

The 230 covers 170-500 kc (IF frequencies) and the standard broadcast band in two ranges. By using the 230's calibrated gain controls in conjunction with its built-in magic eye tube, you can measure the gain of each RF and AF stage.

The quality of sound from the 230 is exceptionally good, making it easy to trace distortion in an amplifier or radio. To insure that distortion caused by overload of the *tracer* does not mask distortion of the equipment under test, the magic eye is calibrated to indicate when the 230's gain should be reduced.

Conar's instruction manual contains a thorough discussion of signal tracer servicing, with particular attention to transistor radios. While the assembly instructions are good, the pictorials leave something to be desired. Since there are times you must refer to three separate pictorials for a single step. We suggest cutting them up, and grouping them together.

Assembly time is about six hours and another 15 or 20 minutes are required for calibration. Instructions are provided for calibration using either a signal generator or a common table radio. There are no tight corners and the probe is supplied completely wired.

As well designed as the kit is, a word of caution is necessary. The hardware is counted with devastating accuracy. If you lose one screw or nut you're stuck. Also, Conar supplies lockwashers instead of starwashers. You can cut component mounting time by using your own #6 lockwashers.

All in all, the Conar 230 is a quality test instrument both in terms of construction and performance. It will make servicing those tough jobs routine work.

THE 2 FACES

FACE NO. 1: PRIVATE

In the years before World War II, dozens of commercial stations dotted the short-wave bands. Avid SWL's could tune in direct on foreign broadcasts which emanated from private stations, not from government-controlled master radio centers. But while government-sponsored stations have grown faster than a hive of bees, the number of private SW stations has dwindled to a meager handful. Some private SW stations are supported by commercial advertisers, much like stations on the AM broadcast band. Other private SW stations are kept on the air by institutions, like many stations on the FM broadcast band. But whatever their backing, the few private SW stations that remain face a major problem—adequate financing—if they are to survive at all.

TUNE the short-wave bands and hear the voices of the world . . . true or false? True, you say? Yes, but only with some qualifications. It's true to some degree if you're talking about Latin America. It's also fairly true if you are talking about the world's governments. But over most of the globe you'll find virtually no such thing as an independent or "free" SW broadcaster. Which brings up two vital questions about the whole SWBC picture: why does this situation prevail? And is it good, bad or both?

Before answering these questions, let's look at the two faces of SWBC—government vs private—around the world. Starting at home, the U.S. presently has three independent international broadcasters. One, WRUL, is a commercial venture, with studios in New York City. Another is KGEI in San Francisco, a station now operated by the Far East Broadcasting Co. (a religious organization). Still a third is WINB, which we'll discuss a little later.

North of the border, all international services in Canada are operated by the Canadian Broadcasting Corporation, a government agency. However, five private stations do maintain low-power regional transmitters on 49 meters.

In Latin America, in contrast, the majority of SW transmitters, both on regional and international bands, are under private ownership. There are some government services, but they fall into the minority category.

Elsewhere the picture is much like it is in the U.S. In all of Asia there are only three privately owned international operations. The FEBC, in addition to station KGEI already mentioned, maintains extensive facilities in Manila; Tokyo boasts the Nippon Broadcasting System; and from Formosa a religious organization transmits the Voice of Righteousness. Commercial but strictly regional stations also operate in the Philippines and Formosa. Meanwhile, in Oceania, we find no private SW at all.

OF SWBC

Crossing to Europe, there are a pair of stations in Andorra; two in Monaco (including the religious Trans World Radio); two each in Spain and Portugal; and that mainstay of private SWBC, Radio Luxembourg. All are more or less regional.

The outlook appears to be similar in Africa. There are religious SWBC organizations in Ethiopia and Liberia; the Radio Clube de Mozambique which, like a private SWBCer in Angola, is not permitted to air news and commentary in any way contrary to those views held by the Portuguese State; and, finally, the Liberian Broadcasting Corporation, which is another regional setup.

But to get back to our big questions, why is there so little private SWBC? A major factor working against private short wave, of course, is financial. Remember, SW profits are slim at best and it is quite a feat to break even. Outside the tropics, where an extremely high noise level forces many otherwise casual listeners to SW, there are three sources of money: 1) independent religious organizations or lone-wolf evangelists who pay for their air time, 2) huge international firms wishing to promote good will (and trade) and, 3) donations to non-profit broadcasting organizations like FEBC.

Still another reason for government domination of the SW bands is technical. There just aren't enough SWBC channels to go around. In addition, sloppy technical standards create much opposition to private SWBC.

Now, is the situation good or bad? First consider this—if a government-controlled station becomes spokesman for a certain cause, the cause rises or falls with that regime. This can be disastrous. Ghana is an extreme example. Having taken the lead in speaking for African nationalism and racial equality on that continent, it also is sole voice for the Ghanian people.

But now with financial difficulties besetting it (brought on by the cost of

FACE NO. 2: GOVERNMENT

During and after World War II, more and more governments around the world took to the SW bands. The result is that today's SWL is forced to listen to government stations whenever he tunes in SWBC. And this is the case whether he chooses to lend an ear to Radio Moscow, the Voice of America or the BBC. Nor are the Big Five of the world's governments alone in their attitude toward SWBC. Most governments ardently assert their rights to the airwaves, and even many smaller nations work to keep SW exclusively in government hands. Case in point: the Danish government was so determined to maintain Radio Denmark as a state monopoly that it seized the independent, marine-based Radio Mercur in international waters.

THE 2 FACES OF SWBC

One private, one government SWBC station represent the two sides of the SWBC coin in these photos. The studio at left belongs to WRUL, an independent, advertiser-supported SWBC station which is unique in the U. S. Now known as Radio New York Worldwide, the station's major appeal is its claim that its programs are both interesting and believable because they are free from "propaganda." Radio Denmark, in contrast, is but one of the several state-controlled broadcasting monopolies. The Danish State Radio House above was the work of government funds, as are Radio Denmark's programs.

Radio Ghana and similar projects), the government has turned to totalitarian methods. And because Radio Ghana is government-owned, the entire campaign is being discredited. Had the task been allocated to private organizations, other broadcasters would not be enjoying a field day.

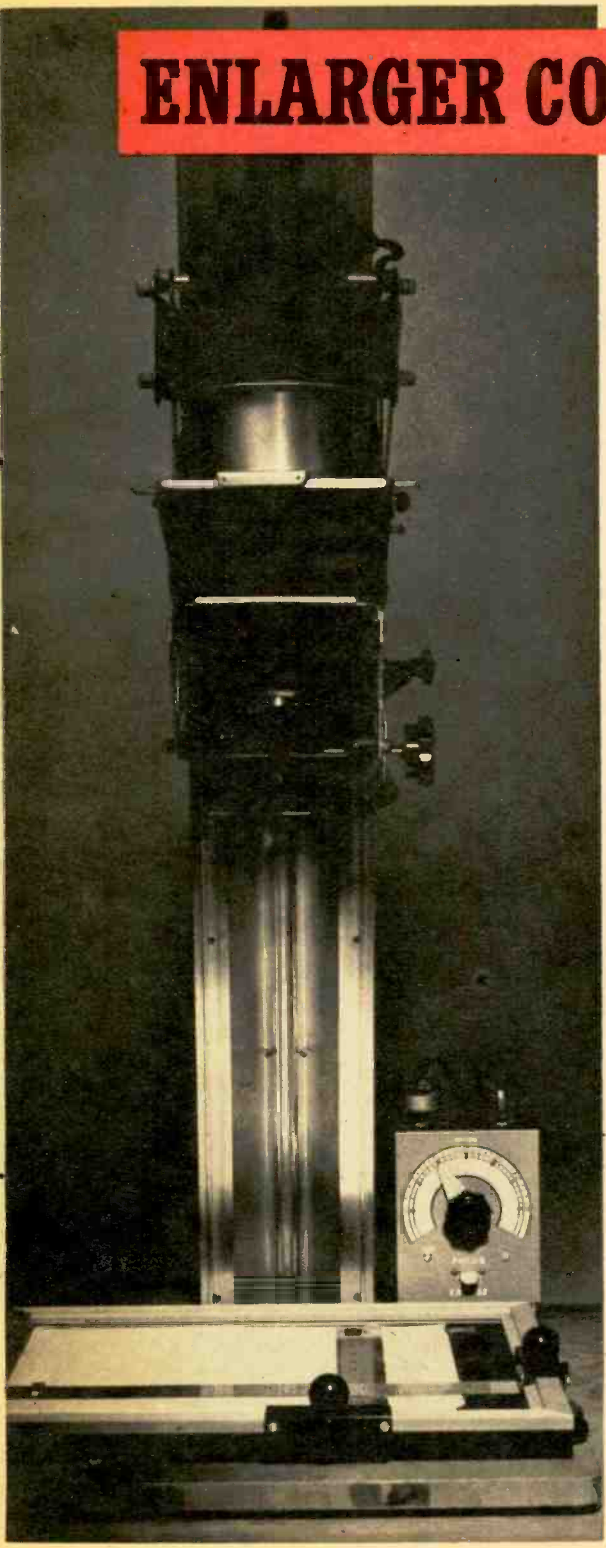
On the other hand, short wave plays a vital part in *every* nation's foreign policy. The United States itself is judged at least partially by American SW transmissions. What would happen to our image abroad if a U.S. station capable of reaching foreign audiences started airing extreme views on race relations, politics or religion? Those views, of course, soon would be identified with the whole country in the minds of listeners.

That other-than-moderate voices can get on the air in this country is proven by the cases of WGCB and WINB, Red Lion, Pa. WGCB is a veteran broadcast-band outlet specializing in evangelism. Included in its programs are the Christian Crusade, now famous for its far-right views, and the Prisoner's Bible Broadcast. The latter was a major distributor of highly biased views during the 1960 presidential campaign and continues to espouse such views today.

WGCB is owned by John M. Norris, who also owns America's newest shortwave station, WINB (17735 and 11785 kc). At present, WINB is carrying a daily broadcast by Dr. Carl McIntire. This program, the Twentieth Century Reformation Hour, features attacks on the UN, the National Council of Churches, the Ecumenical Council (shades of the Mexican station XERF!) and the U.S. State Department.

No, the second question hasn't been answered, but it has been reduced to three broader issues. When, if ever, should freedom of speech be sacrificed for the national image? At what point does free speech become slander? And on the technical side, would increased interference brought on by more independent broadcasters be justified by broader listening opportunities for the SWL?—*C. M. Stanbury II*

ENLARGER CONTROL CENTER



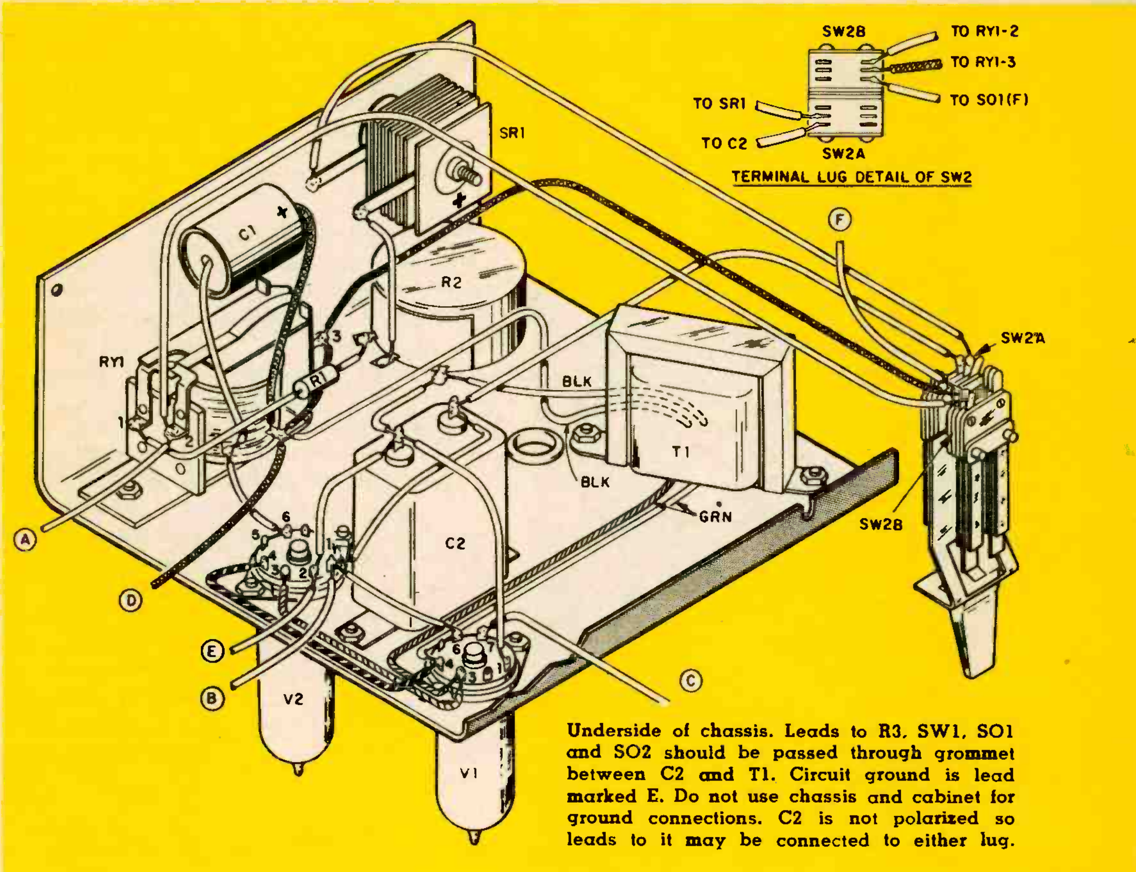
By Harvey Pollack

IF THE initial excitement of making your own photo enlargements has been lost in the grind of operating a multitude of switches and devoting too much attention to a timer, here's the accessory that will put the pleasure back in darkroom work.

Designed for both enlarger and print box, our Control Center's operation makes enlarging this simple: First, set its pointer to the desired exposure time on the large, easy-to-read dial. Then, flip the control lever up and the enlarger comes on and the safelight goes off simultaneously so you can focus the enlarger. Push the lever down to its center position and the safelight comes on and the enlarger goes off allowing you to place the paper in the easel. Depress the lever, release it and the enlarger is turned on for the exact time you've set. And if you have to make several enlargements from the same negative, just keep depressing the lever for identical multiple exposures.

Construction. Since wiring is not critical you may arrange the parts to fit any size cabinet. Our Control Center was built in a 4x5x6-inch Minibox. To duplicate it, make a 4¾x3¾-inch chassis of scrap aluminum with a half-inch front apron, and a two-inch rear apron as shown in the pictorial. File two U-shape notches in the front apron.

Hold the chassis in the main section of the Minibox so the notched apron is up against the front panel and the bottom of the rear apron touches the bottom of the Minibox. The notches will determine the location of two holes that must be drilled in the front panel later. The front-panel cut-out for switch SW2 should be just above the bottom of the Minibox. This will keep SW2 far away from the parts under the chassis. Drill a hole for R3 in the front of the Minibox about 1½ inches above the *chassis*. All wiring under the chassis,



Underside of chassis. Leads to R3, SW1, SO1 and SO2 should be passed through grommet between C2 and T1. Circuit ground is lead marked E. Do not use chassis and cabinet for ground connections. C2 is not polarized so leads to it may be connected to either lug.

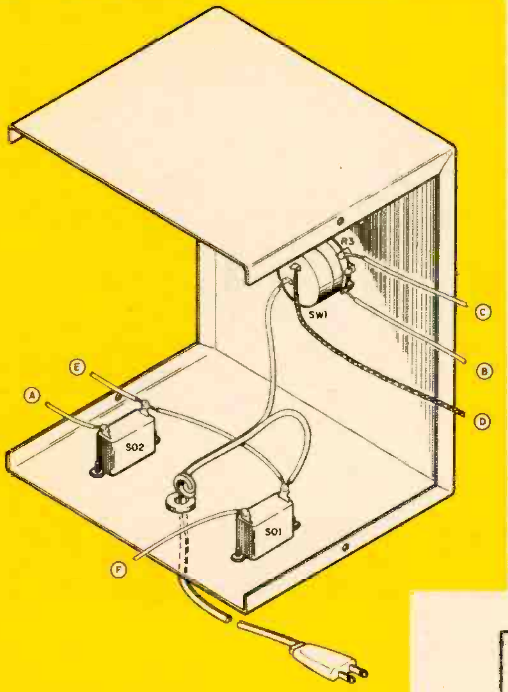
including SW2, should be completed before mounting the chassis in the cabinet. (Do not use the chassis of the cabinet as a circuit ground.)

Locate calibration potentiometer R2 near the rear of the chassis to permit access to its knob through two half-inch diameter finger holes in the back of the Minibox. This will permit you to calibrate the unit and at the same time prevent accidental change of the calibration.

After the chassis has been wired (including SW2 which floats) bring out color-coded leads for connection to the two AC receptacles (SO1, SO2) in the top of the cabinet, the AC line cord, the on-off switch (SW1) on the back of R3, and the terminals on R3. Secure the chassis in place in the cabinet with two screws through the front of the cabinet and the U slots on the front apron of the chassis. Mount SW2 on the front panel with the sheet metal screws supplied with it.

Calibration. Plug the enlarger or print box in socket SO2 and the safelight in SO1. Install a pointer knob on R3's shaft so when SW1 is off the pointer is at the seven o'clock position. Turn on the power and set the pointer straight up. Push down SW2's lever then release it. Using a clock's sweep-second hand, measure the time the enlarger is on. Adjust R2 so the enlarger is on exactly 15 seconds when the pointer is straight up. Rotate R2 clockwise to increase the time interval and counterclockwise to decrease the time. Once set, R2 should not have to be touched.

Calibrate the scale to the left and right of the 15-second mark in five-second intervals. Except between the one and two-second marks, the calibra-

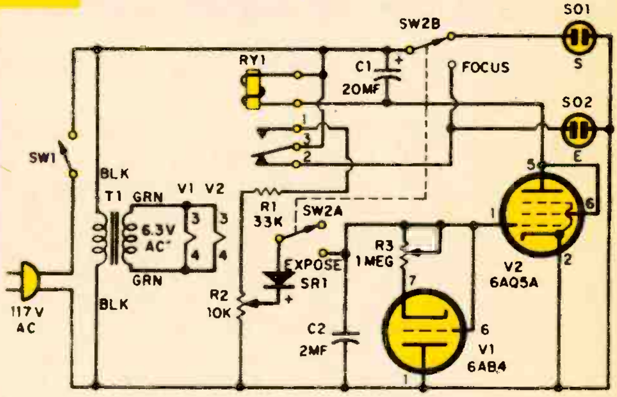


Inside of main section of Minibox (shown upside down) shows location of AC receptacles for safelight (SO1) and enlarger (SO2). Mount R3 so the lug to which the lead marked B is connected points straight up.

PARTS LIST

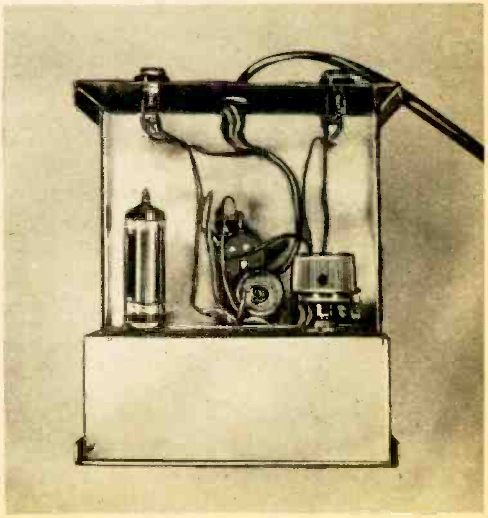
R1—33,000-ohm, ½-watt, 10% resistor
R2—10,000-ohm, wirewound potentiometer
R3—1 megohm, linear-taper potentiometer
C1—20 mf, 150 V electrolytic capacitor
C2—2 mf, 150 V non-polarized capacitor (Lafayette CF-114 or equiv.)
RY1—SPDT, 5,000-ohm coil relay (Potter and Brumfield LB5 or equiv.)
SW1—SPST switch on R3
SW2—4PDT three-position lever switch (Lafayette SW-68)
SO1,SO2—AC chassis receptacles (Cinch-Jones 2R2)
T1—Filament transformer: 117 V primary, 6.3 V 1 A secondary
SR1—65 ma, 400 PIV silicon rectifier
V1—6AB4 tube
V2—6AQ5A tube
Misc.—4x5x6-inch Minibox, seven-pin tube sockets, pointer knob, aluminum chassis.

SW2 is shown with lever centered: safelight is on, enlarger is off. When lever is up (focus), SW2B turns enlarger on safelight off. When lever is depressed (expose), SW2A applies power to timing circuit which turns on the enlarger.

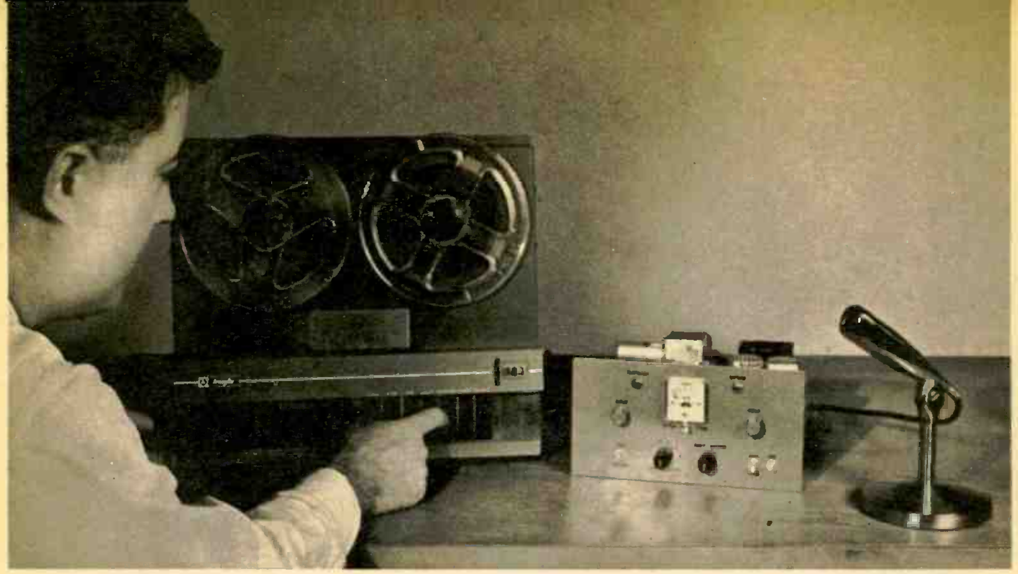


tion will be linear allowing the five-second intervals to be divided evenly into one-second intervals (four equally spaced lines between each five-second line). To determine the intervals up to two seconds, you'll need the clock with the sweep-second hand again.

If you find the time intervals are not accurate or change frequently, there may be a leakage path across the contacts of R3 or the socket of V1. Or, there may be a leakage path between C2's lugs. Clean these areas to remove any traces of solder flux. If this does not correct the problem, try replacing V1 or C2.



Rear view of Control Center. V2 is at left, V1 is behind it. Calibration pot R2 is at right.



build a TAPE RECORD PREAMP

By Dick Flanagan and Herb Friedman

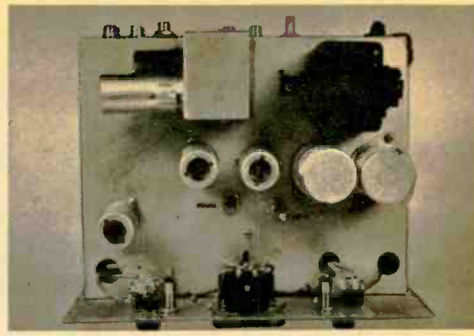
WHAT WITH tape recorders heading for the dime-a-dozen category these days (all right, $100 a dozen would be a little more like it), you're probably wondering why you should take the time and trouble to put together your own tape record preamp. The answer is easy: because you'll end up with a much better unit than the corner-cutting, full-of-compromises variety contained in most of today's tape recorders. Then, too, you'll learn more about the ins and outs of magnetic recording than you might uncover in months of reading on the subject. And your interest in tape likely will be sparked to the extent that you'll dig after information to fill in what you don't find out.

EI's tape record preamp sports a host of features you won't find in other tape preamps costing much, much more. We've purposely made it as versatile as possible so that it can be used with just about any tape deck on the market. Though we set it up and tested it out with the Knight KN-4000 tape deck (available from Allied Radio), the EI tape record preamp can be adjusted to match most any deck. Because of the generally superior results that three heads afford, we'd naturally advise you to use a three-head deck, such as the Knight unit already mentioned. But operation with two-head decks also is feasible, if you make a few wiring changes.

Before we take up some hints on construction and adjustment, let's review a little of the theory behind magnetic recording and see how EI's record preamp fills the bill. Recording on tape really is a remarkably simple process, but you need a preamp that will do at least three things: 1) deliver enough voltage to drive the record head at low distortion, 2) equalize the input signal to take care of the treble losses that are inherent in any magnetic recording system, 3) supply a clean, undistorted bias waveform at the proper level for top-quality results.

EI's tape record preamp handles all three of these jobs in first-rate fashion and tosses in some other notable features along the way. First of all, it provides plenty of clean signal to drive any record head, even

Completed tape record preamp makes an attractive addition to any hi-fi installation. Self-contained preamplifier tube feeds into record preamp for recording or into external amplifier for playback.



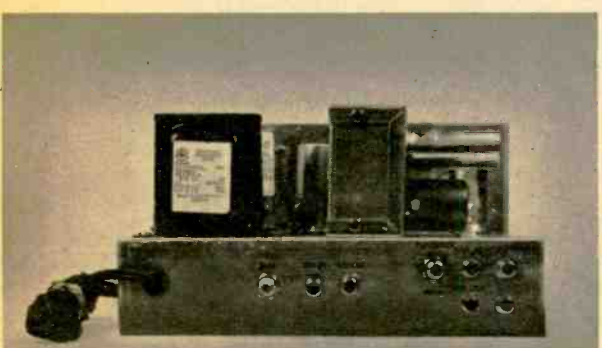
Top view of unit shows relative placement of all major parts. Power supply is at right side of unit, auxiliary pentode preamplifier stage at left front, bias oscillator at left rear, tubes V1, V2 in center.

those on full-track machines. And it supplies the necessary treble pre-emphasis (the equalization we mentioned earlier) in a manner that's proven superior to any other we've seen. Treble boost is achieved by means of a parallel-T network in an inverse feedback loop around tube V2A. The circuit is low in distortion and free from the ringing that plagues many of the more common LC treble-boost circuits. As for the bias signal, a push-pull oscillator in a circuit supplied by the Nortronics Co. provides an output that's clean as a whistle at a frequency—65 kc—high enough for professional results.

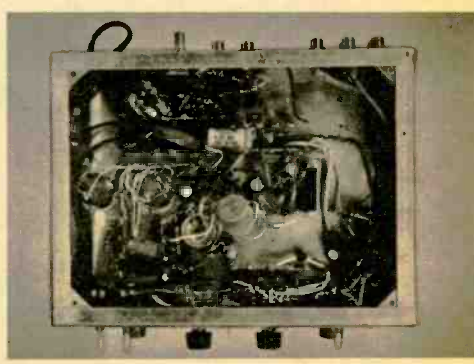
But perhaps the biggest features of the EI record preamp are those we haven't yet mentioned. Two high-level inputs (jacks J1 and J2), each with its separate level control (potentiometers R2 and R1), allow you to mix signals on tape to your heart's content. A switch (S2) selects the right amount of pre-emphasis for recording either at 7½ or 3¾ ips. Two potentiometers (R8 and R18, respectively) enable you to trim the amount of treble pre-emphasis and the amount of drive to the record head and thus match the characteristics of the tape deck you're using.

Another potentiometer (R41) allows you to adjust the bias to the exact level needed for optimum results. And another switch (S6), hooked up to a real VU meter, provides a means to check both the record and bias levels so you *know* that everything is working just the way it should be.

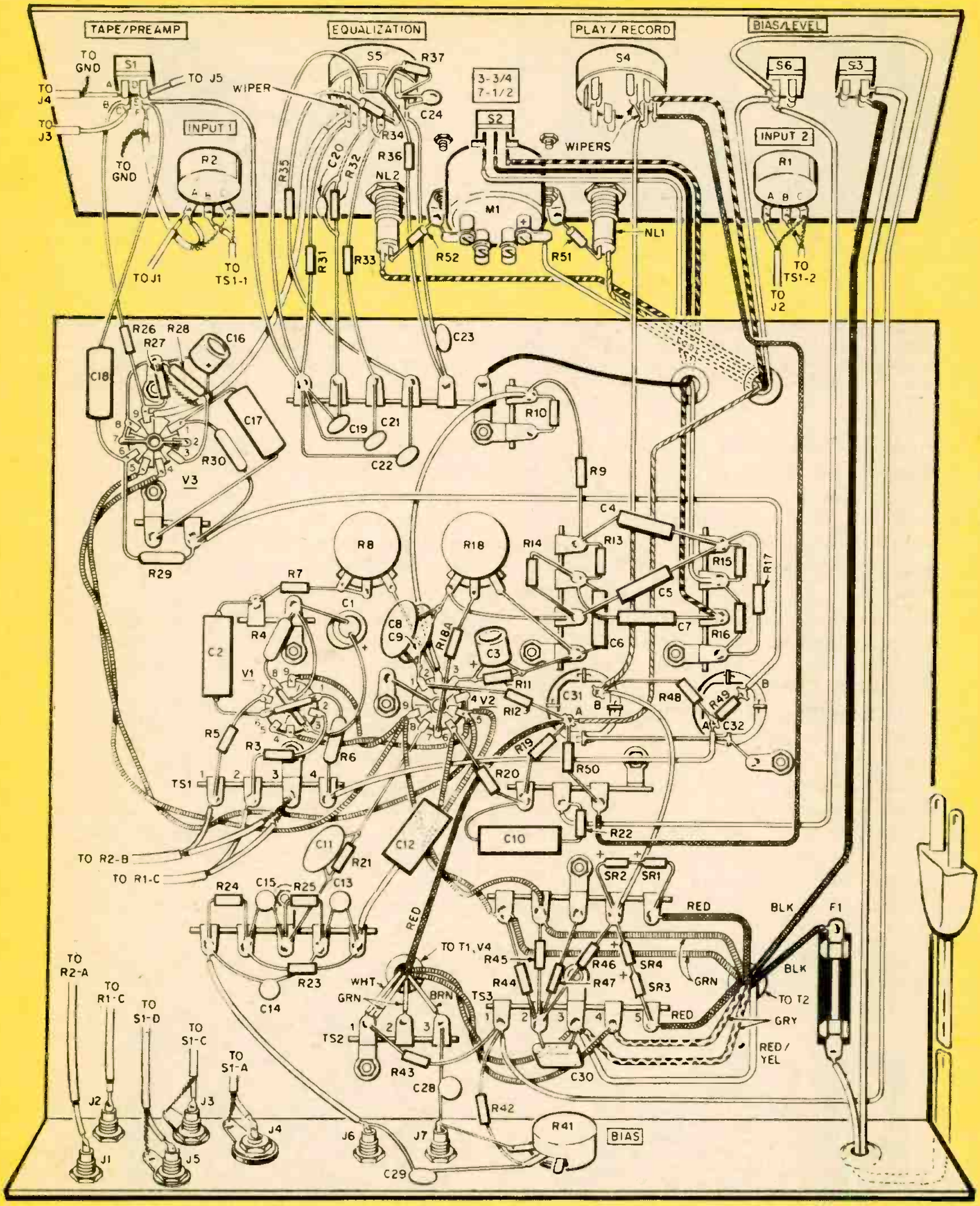
For recording from low-level inputs,



Rear view indicates placement of bias adjustment control R41 as well as jacks J1 through J7. For minimum hum, tubes should be shielded, heater leads twisted, grounds made to a single point.



Bottom view reveals a relatively neat, uncluttered chassis. Barely visible in top right hand corner are two holes for self-tapping screws which support shield over output parallel-T network (see text).

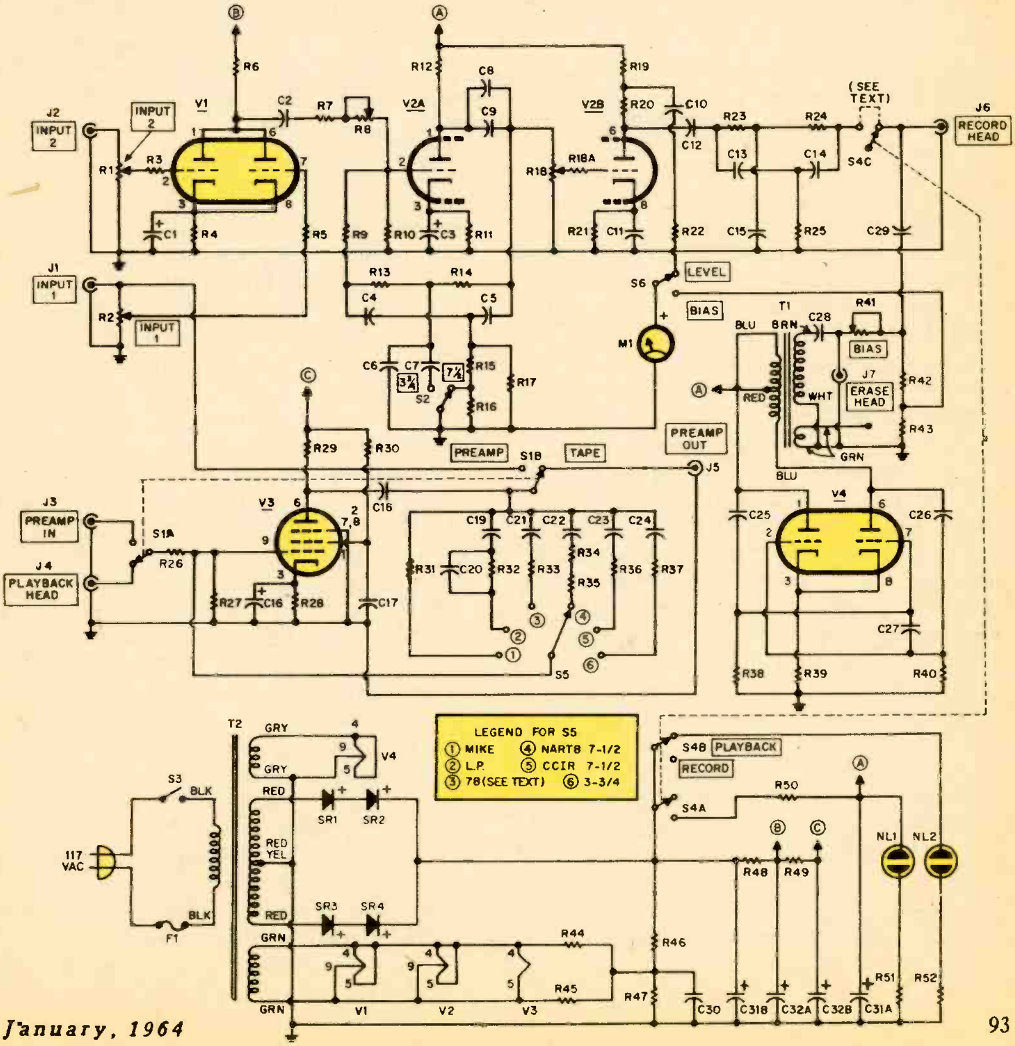


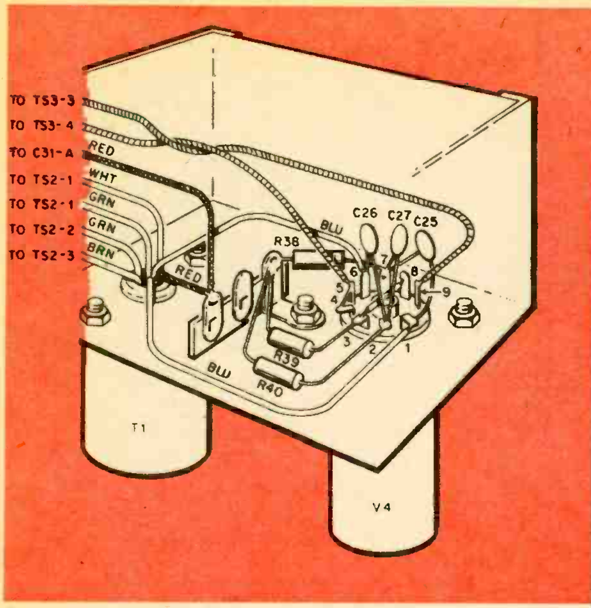
Pictorial and schematic diagrams of tape record preamp differ slightly: three-head machines will not require switch S4C, as explained in text. Since parts sizes and placement will depend to some extent on components purchased, pictorial diagram is intended only as an aid to wiring up the unit. Schematic diagram shows high-voltage outputs from power supply as circled letters (A,B,C); these points must be connected to corresponding letters in preamplifier proper. Note that preamplifier tube V3, like bias oscillator V4, will function independently and therefore can be checked out separately following construction.

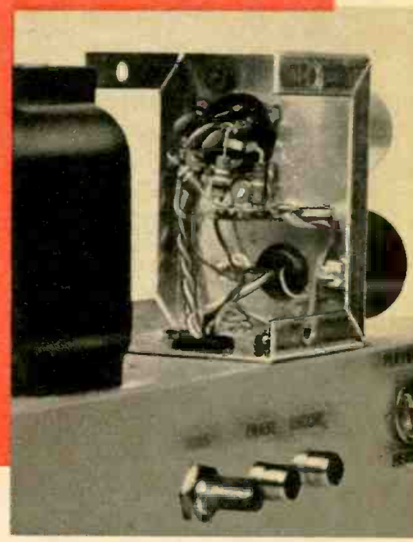
PARTS LIST

Resistors: ½ watt, 10% unless otherwise indicated; all values in ohms
R1,R2—100,000, audio-taper potentiometer
R3,R5,R18A,R49—22,000
R4—750-ohm, low-noise (IRC Type DCC or equiv.)
R6—47,000, low-noise (IRC Type DCC or equiv.)
R7,R9,R19,R20,R43—47,000
R8—200,000, linear-taper potentiometer
R10—270,000
R11,R21,R39,R50—2,200
R12—82,000
R13,R14—15,000
R15,R16—7,500, 5%
R17—3,300 (see text)
R18—500,000, audio-taper potentiometer
R25,R34—10,000
R22—see text
R26—100,000
R23,R24—20,000, 5%
R27,R37—1-meg.
R28—2,200, low-noise (IRC Type DCC or equiv.)
R29—220,000, low-noise (IRC Type DCC or equiv.)
R30—1-meg., low-noise (IRC Type DCC or equiv.)
R31—10-meg.
R32—560,000
R33,R36,R46,R51,R52—470,000
R35,R42—220,000
R38,R40—100,000
R41—250,000, linear-taper potentiometer
R44,R45—47-ohm
R47,R48—33,000

Capacitors: Ceramic disc, 500 V or higher unless otherwise indicated
C1—200 mf, 3 V electrolytic
C2,C10—.1 mf, 600 V paper
C3—100 mf, 3 V electrolytic
C4,C5—750 mmf silver mica
C6,C7—1500 mmf silver mica
C8,C9—.05 mf
C11—.01 mf
C12—.25 mf, 600 V paper
C13,C14—120 mmf
C15—240 mmf
C16—50 mf, 3 V electrolytic
C17,C18—.1 mf, 400 V paper
C19—560 mmf
C20—150 mmf
C21—1200 mmf
C22,C23,C24—220 mmf
C25,C26,C28—470 mmf
C27,C29—1,000 mmf
C30—.25 mf 75 V
C31A,C31B—40/40 mf, 450 V dual electrolytic
C32A,C32B—40/40 mf, 450 V dual electrolytic
F1—1 amp, 3AG fuse
J1,J2,J3,J4,J5,J6,J7—Phono jack
M1—VU meter (Lafayette TM-10 or equiv.)
NL1,NL2—Neon indicator assembly (Lafayette MS-478 or equiv.)
S1—DPDT toggle switch
S2—SPDT toggle switch
S3—SPST toggle switch
S4—4-pole, 2-position rotary switch (see text)
S5—1-pole, 12-position rotary switch
SR1,SR2,SR3,SR4—Silicon diode, 100 ma, 400 PIV or higher (Lafayette SP-196 or equiv.)
T1—Bias oscillator coil (Nortronics T60-E or equiv.)
T2—Power transformer: primary, 117 VAC; secondaries, 500 VCT @ 20 ma, 6.3 V @ 1.2 A and 6.3 V @ .6 A (Stancor P-8174 or equiv.)
V1—ECC83 or 12AX7 tube
V2—ECC81 or 12AT7 tube
V3—EF86 or Z729 tube
V4—12BH7A tube
1—7"x9"x2" aluminum chassis
1—2¼"x1¾"x2¾" Minibox
Misc.—Tube sockets, tube shields, shielded wire, hookup wire, knobs, line cord and plug, fuse holder, terminal strips, grommets, solder lugs, decals, etc.







Bias oscillator subassembly is made up of separate chassis box mounted on top of main chassis. Bottom cover has been removed from subassembly in photo at right.

such as a mike or a magnetic phono cartridge, there's a separate preamplifier tube (V3) with switch-selected equalization to match most anything. This preamp is arranged in such a manner that it can be used either for recording or playing back—it all depends on which input jack (J3 or J4) you use and on the position of switch S1.

As for other features, there's even a second parallel-T network in the output to the record head. This network performs the important function of rejecting the bias voltage from the plate of the driver stage (tube V2B). Of course, one thing you can't do with this preamp is record stereo. But that shouldn't worry you—just build two!

Construction. Putting the EI tape record preamp together isn't a very difficult task if you've had previous experience wiring high-quality audio circuits. Hum and bias pickup are two things to avoid like the plague. However, since the bias oscillator itself is housed in a separate Minibox on top of the main chassis, stray bias is kept to an absolute minimum throughout the entire assembly.

All grounds for a given stage should be made to a single point, of course, and all input leads should be shielded. Ground the shields at one end only, except that from jack J4, the tape head input, which is grounded at both ends. Note, too, that jack J4 is insulated from the chassis with fiber shoulder washers.

Hum and bias pickup by the heaters can be eliminated to some extent by twisting all heater leads. In addition, capacitor C30, connected from the junction of resistors R46 and R47 to ground, bypasses most of the bias that *is* picked up on the heater leads.

Another trick to prevent bias pickup is to use a shield around the parallel-T network associated with tube V2B. Either scrap aluminum or a section from a tin can may be used, but both the top and the side must be shielded.

The jumper across the lead to jack J6, by the way, is labelled "see text" for good reason. You can wire it in place and forget about the other connections to switch S4C, so long as you're using a three-head machine (this is the way the unit is wired on the pictorial). But for a

[*Continued on page* 108]

HI-FI TODAY

By John Milder

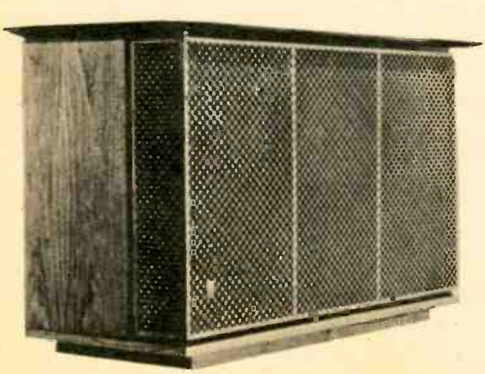
- *More speakers in complementary combos*
- *What hope for 45-rpm stereo?*
- *Transistors advancing on all fronts*

IT'S NEVER quiet for long on the loudspeaker front, and you're going to hear a lot about a new development in the months ahead. Whether you call it an "energizer/transducer" (as J. B. Lansing does—see photo below) or a "frequency-contoured speaker" (KLH's term for it), it's a specially tailored combination of speaker and amplifier. And it makes a lot of sense.

The principle behind the new systems is easy enough to understand. You simply match an amplifier and speaker to each other, instead of designing both for arbitrary "flat" response. What will such an amplifier/speaker combination do?

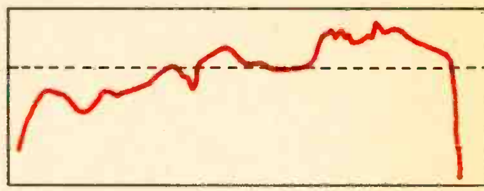
Unfortunately, it *won't* do the one thing we'd all most like to see: flatten out those notoriously bumpy speaker response curves (see drawing at right). But it will help handle a problem that the average listener doesn't know much about—the drop in bass response that any speaker suffers when it's over-damped.

Here's the story. Since a speaker's voice coil moves back and forth in a magnetic field, it naturally generates electricity as well as sound waves. This induced voltage opposes the incoming signal from the amplifier, but in a way that's far from uniform. Reason: The opposition is strongest at low frequencies, where the coil moves over the greatest distance and cuts the most lines of force from the speaker's magnet.



J. B. Lansing makes this amplifier/speaker combination. Level controls are mounted on rear panel.

Up to a point, this is fine. The coil's movement is damped—and damped best



at the low frequencies where it is most likely to act up. But once you "critically damp" a speaker, any attempt to get high efficiency with a stronger magnet makes the speaker's bass response drop off.

Here we have something that an amplifier can handle. If you supply a compensating bass-boost (tailored to do the job more precisely than the usual tone control), you can use a proportionately stronger magnet either to increase efficiency or provide better transient response—or both. The possibilities get very interesting.

Yes, the built-in amplifiers in all the new systems are transistorized. But not for any "miracle drug" purposes. The reason simply is that transistors get around the biggest problem—microphonics—in installing an amplifier in a speaker cabinet. And they obviously won't work loose (in non-existent sockets) as the speaker vibrates. Both of these factors probably helped defeat earlier amplifier/speaker combinations that used tubes.

It's not dangerous at this early stage to predict that many new speaker/am-

[Continued on page 110]

KIT
EI
REPORT

EICO 430

3-inch Oscilloscope

ONE of the most useful multi-purpose test instruments, the oscilloscope, too often is missing from many test benches. Why? Probably because many hobbyists mistakenly feel its cost is too high, its operation complicated and its patterns difficult to interpret. But if you think of a scope's cost in terms of what it can do, it's not expensive. And a scope is not much harder to operate than a VTVM.

Here are the jobs it can do: measure voltage and frequency; determine phase difference of two signals; trace signals to simplify troubleshooting radio, TV, hi-fi, CB and ham equipment. And as a bonus to hams and CBers, it can be used to monitor modulation.

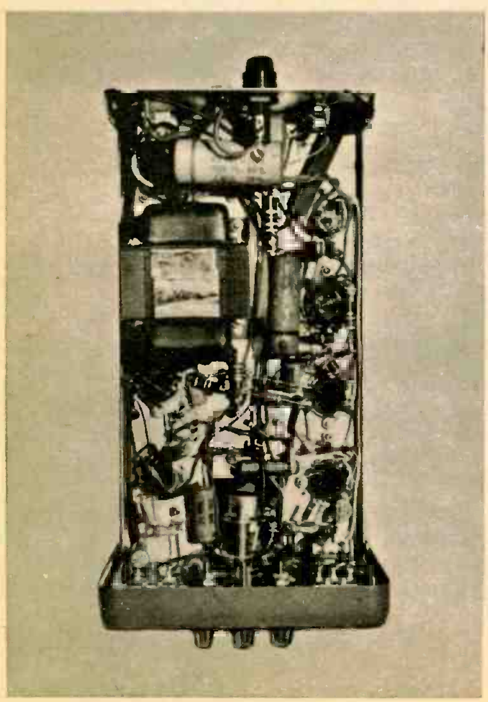
The newest oscilloscope on the market is the three-inch EICO Model 430. Selling for $65.95 as a kit ($99.95 wired), it's a cinch to operate and perfect for both hobbyists and advanced home workshops.

The 430's eye catcher is its small size. Measuring 8½ inches high, 5¾ inches wide and 11¼ inches deep, it weighs in at only 11 pounds. The 430 is lightweight baggage on service calls and can be tucked away in the smallest corner of a crowded workbench.

Though the 430 is small, EICO put every cubic inch of it to good use. In addition to its 3DEP1 flat-face cathode-ray tube (around whose neck is a mu-metal shield), there are eight tubes. And equally important, the scope has retrace blanking, automatic sync, a regulated power supply and a 100:1 compensated vertical attenuator.

There are no jumper wires to remove for modulation monitoring. Simply insert leads in jacks at the rear, flip a switch, and you're connected directly to the CRT's vertical plates. An intensity-modulation signal can be applied conveniently at another rear-panel jack.

Underside of 430. Component density is high but there are no troublesome spots. Make sure that all leads are short, direct and properly dressed.



There are four overlapping sweep-frequency ranges: 10-100 cps, 100 cps-1 kc, 1-10 kc and 10-100 kc. A vernier control permits fine adjustment of the frequency within each range. The sweep range switch also applies a 60-cycle sine-wave voltage to the horizontal amplifier and in another position it permits you to feed an external sweep voltage to the horizontal amplifier.

Other front-panel controls are for focus, intensity, vertical and horizontal position and vertical and horizontal gain. The astigmatism control is accessible through a hole in the side of the cabinet. A scale in front of the CRT is ruled with 1-cm vertical and horizontal lines.

Assembly will be easy if you've been successful in building complicated hi-fi kits. Although we built the 430 in about 11 hours, it could take a bit longer. EICO provides two construction manuals; one includes 17 pictorials and the other covers the construction steps. Occasionally we had to flip back and forth from one pictorial to another but it was a minor inconvenience. Also, we found that to be on the safe side, it's a good idea to check exactly where each hookup wire is to go before cutting it, or you may find after it has been properly routed it won't reach its destination.

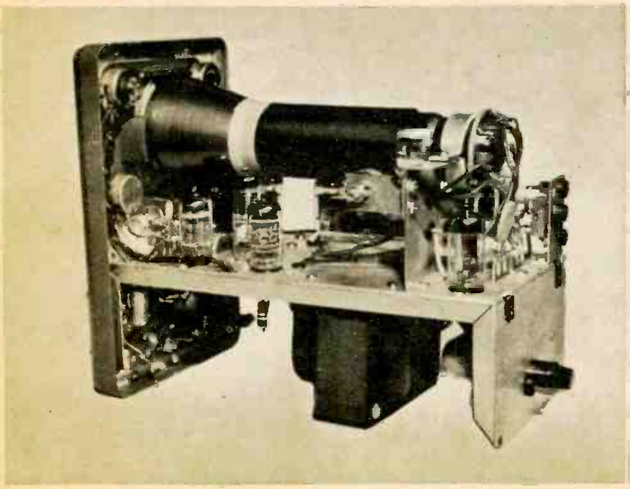
In checking the 430 we found that the sweep frequency went from 10 cps to 200 kc—twice as high as claimed.

The sensitivity of the vertical amplifier (measured at 1,000 cps) was 24 rms millivolts per centimeter, somewhat better than claimed. The sensitivity of the horizontal amplifier, also measured at 1,000 cps, was 0.4 rms volt per centimeter—not quite up to spec.

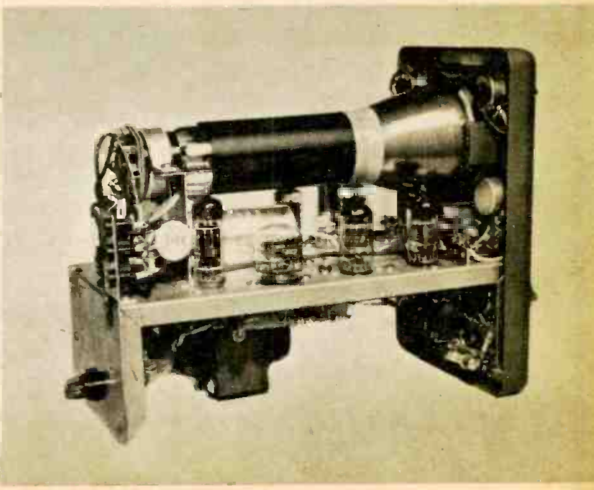
The response of the vertical amplifier with the compensated vertical attenuator out of the circuit was flat from 5 cps to about 100 kc. Beyond this point, the response fell off to −4.3db at 500 kc. With the compensated vertical attenuator in the input circuit, the response was down 4db at 500 kc. In both cases, the figures fall short of claimed specs. The response of the horizontal amplifier was flat from 5 cps to about 100 kc. It was down 1.6db at 300 kc.

Sync is very good at all levels of input signal and the trace is bright and sharp. Focus and intensity controls are effective only in the last third of their rotation. At low-intensity levels, however, you may lose part of the trace because of a rather critical astigmatism-control adjustment. The 430's operating manual includes a brief discussion of oscilloscope applications in servicing TV and audio equipment.

Note the mu-metal shield on CRT's neck and astigmatism control above transformer. Intensity modulation and vertical-plate jacks are at the rear.



Triple-triode compactron, third from right, combines functions of sweep generator, sync amplifier. It also provides blanking voltage to CRT.



TAPES YOU NEVER TOUCH

LOTS OF so-called new developments end up being slightly less than new. You might say they're variations on a theme, and sometimes an old one at that. But when someone comes up with a machine that handles a stack of tapes in the same way a changer takes care of a pile of phonograph records . . . well, that's worth crowing about. And you can expect to hear a lot of crowing in the months ahead over the new Revere stereo tape cartridge system.

The Revere Camera Co., the 3-M subsidiary that makes the new tape machine, argues that the Revere unit "is to tapes what the record changer is to discs." And they're right: you can stack up to 20 tape cartridges on its loading platform, punch the *play* key and sit back for a full 15 hours of music.

Now don't get us wrong: we're not suggesting that you're going to want to struggle through a solid 15 hours of music any more than you listen to a stack of ten 12-inch LP's on your record changer. But this is what the Revere machine can do, and you'll have to admit it's something to get excited about.

Heart of the Revere unit is the cartridge, of course. And it's here that that much-touted word *new* can be used deservedly. Developed by CBS, the tape cartridge is a 3¾" square of completely enclosed plastic. Inside is up to 450 feet of magnetic tape that's slightly more than half as wide as the tape your present recorder uses—0.146 inches, to be exact.

Because the tape is so narrow, two rather than four tracks are used for recording. But the ultra-slow tape speed—1⅞ ips—allows up to 48 minutes playing time per stereo recording or up to 1 hour and 36 minutes per mono recording. And in spite of the unbelievably

Revere stereo tape cartridge system is a complete stereo recorder and needs only a 117 VAC source to operate. Cartridges are placed in left of chamber at rear, slide to right after playing and rewind.

slow tape speed, the unit's frequency response is claimed to be within 3db from 40 to 15,000 cycles. Even more phenomenal are the specifications for wow and flutter: they're stated to be a low 0.3% or less.

As you already may have gathered, the Revere machine uses tapes you never touch. You do have to press the *play* button in order to start the machine, as we've already mentioned. But once you've done so, everything is automatic from there on. The machine threads the tape, plays it, rewinds it, rejects the cartridge, then drops another cartridge in place. This done, the cycle starts all over again.

Though it's an ultra-compact 7x14½x 14¼ inches, the 32-lb. unit packs an 18-watt stereo amplifier. And there are input and output jacks for just about everything. You can feed a mike, a tuner or most anything else into the Revere. Connecting external speakers or an auxiliary stereo amplifier takes a few seconds.

The Revere's performance in the EI lab was pretty much everything the manufacturer claimed it would be. Since the unit is at once extremely complex, compact and fully automatic, we couldn't resist giving it a cold-water test to see just how foolproof it was. Without a single cartridge on the platform, we pressed the *play* key and sat back with cynical interest to see whether the machine would be up on the trick we were trying to pull.

It wasn't. It began its cycle anyway, stopping in the tape-sensing mode, and no amount of button-pushing would convince it that there wasn't any tape there to sense. A telephone call to the Revere people put all in order again (they advised us to lift the lid on the machine and manually rotate the function indicator until the machine was again in the load position).

This little failing didn't lead us to conclude that the machine itself was a failure, but it does spell out something that should have been obvious all along. In doing with tapes what a record changer does with discs, the Revere is little short of phenomenal. But it also is an incredibly intricate mechanical-electronic complex. Its design is such that a child could operate it, but it also is hardly a machine to give a child to play with.

In short, the Revere tape cartridge system seems to be aimed at the man who wants from tape exactly what he now gets from his record changer. While it can record stereophonically, we doubt that it ever will replace today's reel of tape or today's reel-to-reel tape recorder. But as tape's answer to the phonograph record, the Revere machine comes closer than anything that has preceded it. Cost is its only failing. Do you happen to have $450 handy?

Intricate interior of this automatic tape-cartridge machine is revealed on lifting lid. Circular dial at upper right inside unit is function indicator; nameplate on front also serves as carrying handle.

Platform tilts after tape is rewound, forcing cartridge to right of tape-cartridge chamber. Reject lever at right center can be operated at any time, causing tape to rewind and next cartridge to play.

PHOTOELECTRIC automatic volume limiter

No more overloaded public-address loudspeakers with this $4 project

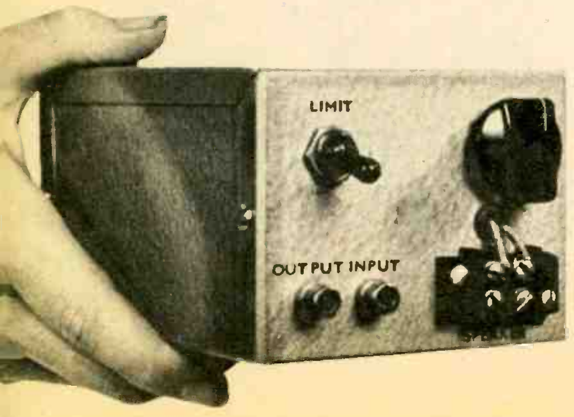
By STEVEN HAHN

PUBLIC-address loudspeakers can be driven to dangerous overloads and can suffer serious damage if you have the habit of moving suddenly toward the mike to shout at your audience. And acoustic feedback, if not quickly checked, also can send a loudspeaker off to its happy hunting ground.

One way of solving the problem would be to keep your hand constantly on the amplifier's volume control. But a better method is to use EI's Photoelectric Volume Limiter, which licks the problem automatically.

The operation of the limiter is based on the characteristic of a cadmium-sulfide photocell whose resistance varies inversely with the intensity of light striking its face. The cell has a resistance of approximately 200 ohms when subjected to a light intensity of 100 foot-candles. In total darkness resistance rises to about 10 megohms.

The circuit couldn't be simpler. The photocell is connected between the input of a public-address amplifier and ground. Directly in front of the light-sensitive surface of the photocell is a pilot lamp connected in series with a potentiometer and across the amplifier's speaker terminals. When the amplifier's output exceeds a safe level, the pilot lamp lights, lowering the resistance of the photocell, which then shunts part of the input signal to ground.



We must point out that most limiters are non-linear devices that introduce distortion in limiting dynamic range. Because of its thermal characteristics, the pilot lamp in our limiter cannot respond instantly to voltage-level changes. That is, a short time is required for the lamp to come on after a voltage is applied to it. And there is a time lag between the removal of the voltage and the total extinction of the lamp. This characteristic is generally referred to as attack and decay time and depends on the type of signal fed to the lamp and the lamp's filament construction. Attack and decay time may introduce slight thumping sounds, so try several lamps for best performance. Because of the distortion it introduces, our limiter must be regarded primarily as a safety device and should not be used with a hi-fi system.

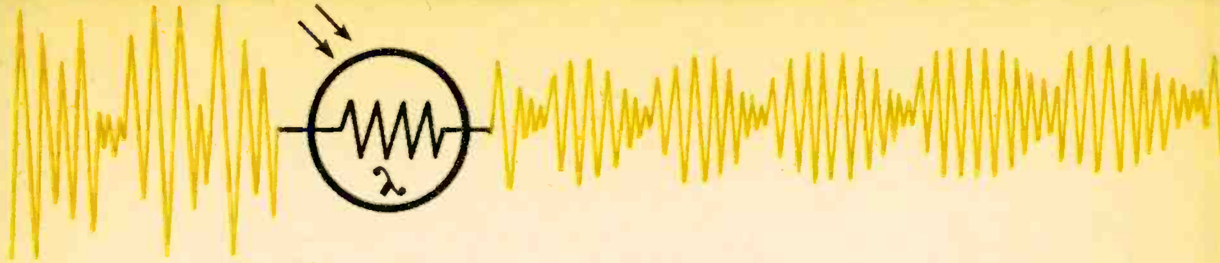
Construction

The limiter can be built in a small Minibox. Our model is built in a 3x4x5-inch box. If you are short on space, it is possible to squeeze the parts in a 3¼x2⅛x1⅝-inch Minibox. Parts placement is not critical, but the input and output jacks should be kept close together. The photocell is supported by its own leads, which are soldered to a two-lug terminal strip. P1 must be mounted so its filament is in front of the cell.

To enable you to observe the limiter's operation when the PA system's volume levels are being established, drill a small hole in the Minibox in front of the pilot-lamp's filament. Once the PA system's level control and R1 have been set, the hole and edges of the box should be covered with opaque electrical tape to keep all light out.

Operation

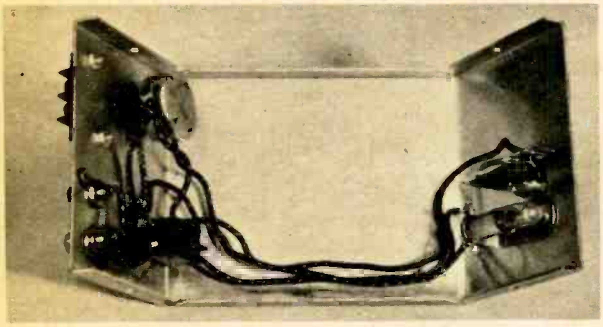
Connect the PA system's mike to input



jack J1 and connect output jack J2 to the amplifier's input with a shielded wire. Connect a wire from the amplifier's speaker terminals to TB1 on the limiter. When S1 is open, as shown in the schematic, the limiter is out of the circuit. When S1 is closed, the photocell and pilot lamp are switched into the circuit.

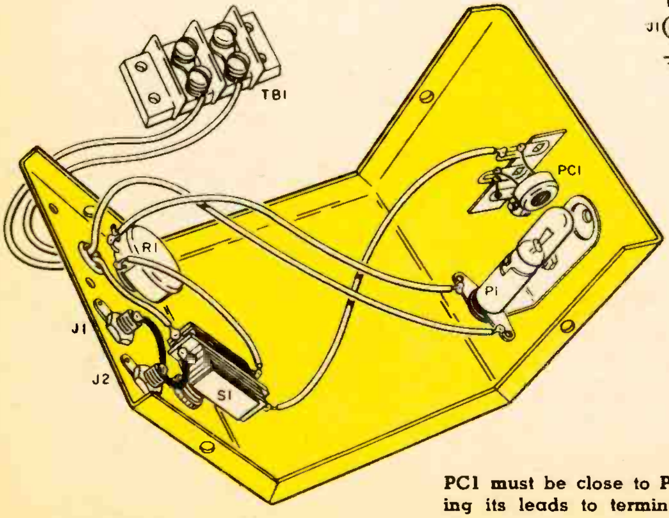
Turn the amplifier's volume control to a normal setting and set R1 so P1 barely flickers on volume peaks. If you want limiting at low-volume levels but cannot achieve it even with R1's resistance completely out of the circuit, use a 2-volt pilot lamp. If this doesn't work and the speakers are connected to the 4-ohm output tap on the amplifier, connect the limiter to the 8-ohm tap. Or, if the speakers are connected to the 8-ohm tap, connect the limiter to the 16-ohm tap. This will provide a slightly higher voltage to the pilot lamp.

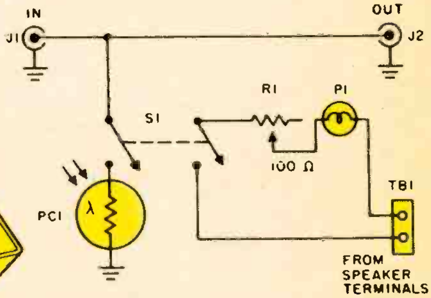
But be careful of the setting of R1. If it is set so its resistance is very low, P1 may accidentally be burned out by a sudden high-volume power peak. If you're pushing the speakers to their limit, they may be destroyed. So take it slow and the result should be a successful project.



Jacks, switch, pot are at the left in author's model. Photocell and pilot lamp are at the right.

PARTS LIST
R1—100-ohm, 4-watt wirewound potentiometer
S1—DPST toggle switch
P1—Pilot lamp, 6 volt (#47) or 2 volt (#49) (see text)
PC1—Cadmium-sulfide photocell (Lafayette MS-922)
J1, J2—Phono jacks
TB1—Barrier terminal strip
Misc.—Minibox, pilot-lamp socket





Closing S1 puts photocell between input and ground and connects P1, in series with R1, across the speaker line.

PC1 must be close to P1's filament. PC1 is supported by soldering its leads to terminal-strip lugs, one of which is grounded.

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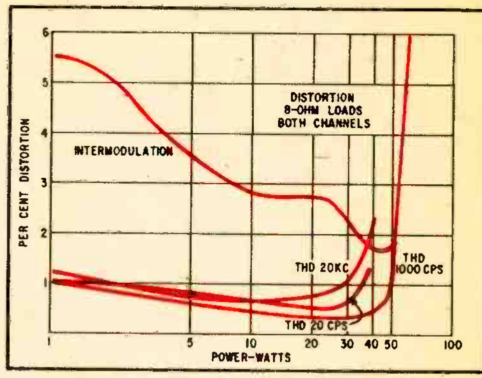
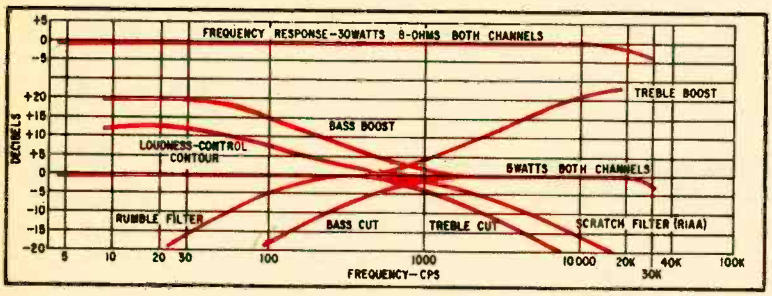
Those Transistor Amplifier Curves

IN the November EI we reported on four transistor amplifier kits. The curves for the Lafayette KT-900 and Realistic 208 were interchanged inadvertently. All other information about the amplifiers was in proper order. Here are the curves in correct position.

Lafayette KT-900

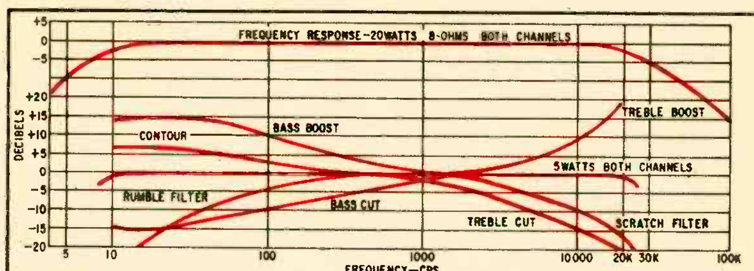
The distortion curves for both channels driving 8-ohm loads. Note that IM distortion is high at low power levels but drops as power increases.



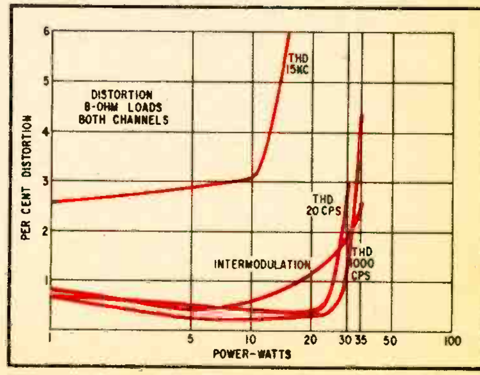


Curves show frequency and power response at 5- and 30-watt power levels. Bass and treble boost and cut are rather fast. 3db-down point of rumble filter is between 150 cps and 200 cps, depending on position of volume control. 15db of bass cut between 35 and 46 cps depends also on volume control.

Realistic 208



Curves show power and frequency response at 5-watt and 20-watt power levels. Bass and treble controls are losser-type. Rumble and scratch filters are R-C type. Loudness control provides bass boost (maximum of 15db). Frequency response at 20 watts is down 5db at about 30 kc.



Distortion of both channels. THD is quite high at all power levels, ranging from 2.6 per cent at 1 watt to 6 per cent at the 15-watt level.

CB Corner

Continued from page 63

plug noise dropped when he flicked on the directional signals.

The peculiar tie-in between lights and spark-plug interference is readily explained—and cured. Long wires running from light switches often pick up strong RF interference generated by plugs. Acting as antennas, the leads radiate energy far beyond the vicinity of plug and distributor wires. When lights are turned on, these leads become shorted for RF and the antenna effect virtually disappears. The remedy: use capacitors to bypass RF to ground.

With the motor and receiver on, touch the terminals of a 0.5 mf capacitor between ground and various light-switch terminals. Install the capacitor where the noise is lowest.

SWR Meter

Continued from page 34

reading if the antenna system is good.

To use the SWR meter for determining antenna length or for antenna adjustment, you'll need a field-strength meter. The technique is to peak the transmitter's final while watching the field-strength meter. Then adjust the antenna's length for lowest SWR and retune the transceiver if necessary. The interaction between the two readings will be reduced as the antenna is matched to the transmission line. Remove the SWR meter before going on the air.

The Mickey-Mike

Continued from page 53

mmf) of another capacitor.

Connect the capacitor whose value you know to the clips, close C2's plates and adjust R2 to the point where NL1 just comes on. Then back off R2 so NL1 goes off. Remove the capacitor and connect the unknown-value capacitor. Turn C2 until NL1 comes on. *Add* the value on the dial to the known capacitor value. The sum is the unknown capacitance.

Buying a Tape Recorder

Continued from page 32

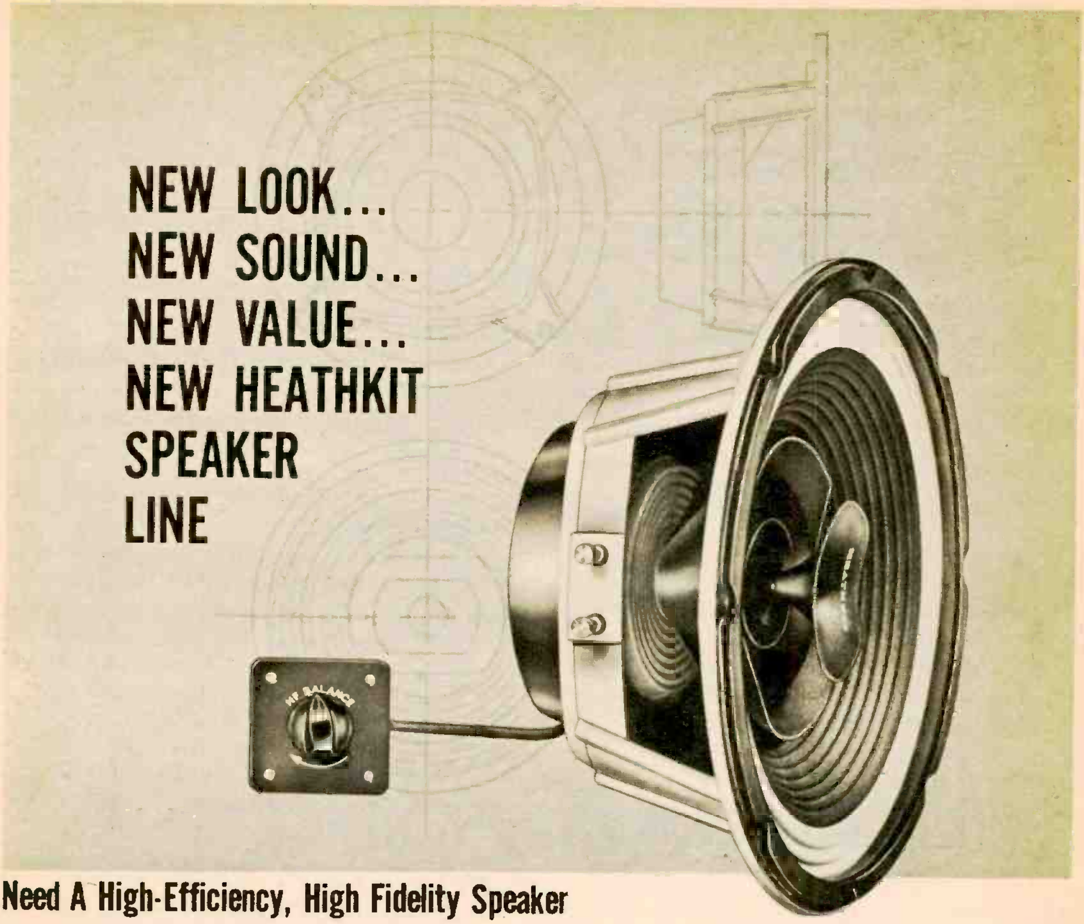
stop the machine in one of its high-speed modes and look for signs of tape-snarl or breakage.

Assuming you are after full-blown fidelity, there's no question that current tape decks remain a good bit better than complete (or semi-complete) recorders. The makers of complete machines know that the overall sound quality of their recorders will be limited by their built-in amplifiers and speakers. Therefore, they often justifiably are tempted to make compromises that won't show—unless a recorder is connected to an external hi-fi rig.

The compromise in sound quality involved in most complete recorders doesn't make fools or philistines out of those who buy them. But if a complete machine appeals to you, it's worthwhile to ask yourself whether you ever may want to incorporate it in a hi-fi system. If the answer is yes, think twice before proceeding. When it's connected to a hi-fi rig, all the minor compromises in a recorder suddenly may become very apparent. For example, the hum and hiss from a complete recorder may be intolerable in a hi-fi setup.

Once you have managed to narrow down your choice of recorders to a particular price range, the machines you focus on will start to look very much alike—instead of seeming bewilderingly different from each other. That's the point at which to hunt unashamedly for the most for your money. After all, some of the features that can mean the most to you at home may well be hidden in a showroom.

With all the above tactics, the main thing is to ask yourself in advance what you want in a recorder. Not only are there more recorders on the market than ever before, but they are more tailored to the specific needs of specific buyers. If you do your preliminary homework—and do your shopping in a store where you can see a representative range of machines—you won't have to be an engineer to find the recorder you want and need.—*John Milder*



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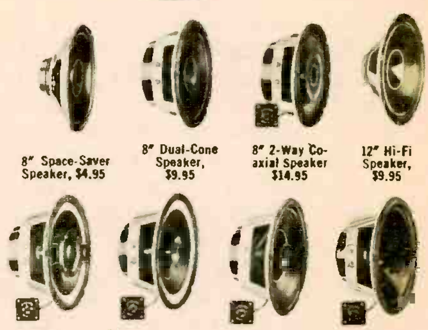

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DeLuxe Your Heath Sixer

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tool left in position permanently. Since the slug of oscillator coil L201 can be adjusted for a broad range, tune it to a spot which covers the crystals you plan to use the most and touch-up only the final tuning when you change crystals.

• **Universal Fusing.** The Sixer requires an 8-amp fuse for mobile operation but only a 1.5-amp fuse for AC-line operation. If you use the Sixer both fixed and mobile, you may forget to install an 8-amp fuse. Or, you may leave the 8-amp fuse in all the time reducing the protection when operating fixed. To simplify this problem, install a fuse-plug on the AC line cord with 1.5-amp fuses. Leave an 8-amp fuse in the Sixer all the time.

• **Headphone Jack.** If you would like to use headphones or a remote speaker add a phone jack on the front panel. The speaker will always be on if you follow Fig. 6. The phone will disable the speaker if you follow Fig. 7.

Antenna Analyzer

Continued from page 49

Sometimes (as with mobile whips) you do not know what the antenna's resonant impedance should be. To determine it, connect the antenna to the Analyzer with a half-wavelength section, and set the generator to your operating frequency. Adjust the antenna as you turn R2 back and forth (at this time you are not interested in exact impedance) until you obtain a null at some setting of R2. The antenna is precisely tuned at the null. R2 indicates the antenna's radiation resistance. Knowing this you can use the tables in the ARRL Antenna Book to determine the length of transmission line needed for a *matched* antenna system. Remember, it's only when the antenna system is matched and tuned for resonance that all transmitter power is coupled to the antenna. Don't forget that the Analyzer must always be connected directly (or through a half-wavelength line) to the device under test.

The Stereo 120

Continued from page 59

sary to determine the polarity of the test leads of your VOM or VTVM.

The following simple test will quickly indicate the lead polarity: 1) Select a 2N2148 power transistor and position it with the pins facing you (note that the pins are off center) and *above* the horizontal center line of the transistor. In this position the left pin is the base and the right pin is the emitter. 2) Connect the negative test lead of the VOM or VTVM to the metal case (collector) of the transistor and the positive test lead to the base pin. Switch the ohmmeter to the Rx10 or Rx100 scale. Note the resistance. 3) Reverse the test leads, connecting the negative one to the base pin and the positive test lead to the case. Note the reading. 4) If you obtained a much lower resistance with the *positive* test lead connected to the base pin, consider this test lead negative. 5) If you obtained a much lower resistance reading with the *negative* test lead connected to the base pin, the ohmmeter test leads' polarity is correct.

Connect the negative test lead to the chassis and connect the positive test lead to the points specified below. A variation greater than 20% from the values given indicates a wiring error or defective output transistor.

Transistor	Resistance to ground (ohms)		
	Emitter	Base	Collector
Q5	410	500	260
Q6	210	160	150
Q7	380	460	290
Q8	670	670	380

If all resistances are correct, connect the leads to and from the preamps, power switch, and pilot light to the circuit boards and base mounted components. Carefully install the cover.

The output impedance of the Stereo 120 is 8 ohms. If your speakers' impedance is 4 ohms, install a 4-ohm, 20 watt resistor in series with one of the speaker leads. Sixteen-ohm speakers can be connected directly to the output terminals.

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Tape Record Preamp

Continued from page 94

two-head machine, you'll have to remove the jumper and wire the wiper on switch S4C to jack J4.

Setting Up. Once you've given the unit a preliminary checkout and put all in order, the next step is hooking it up to your tape deck and setting the bias level.

Begin by connecting a volume indicator (any type will do) to the output of the playback channel (jack J5). Connect the erase head to jack J7, the record head to jack J6 and the playback head to jack J4. With master gain control R18 full on, switch S1 set to *tape* and switch S4 set to *record*, feed a 1,000-cycle sine-wave signal into jack J1 or J2, and monitor what's being put on the tape. (With a two-head machine, you'll have to switch from record to play as well as rewind the tape in order to find out what's already been recorded.)

Starting with the bias control (R41) fully counterclockwise, slowly advance R41 clockwise. As you increase the setting (and the bias), you'll notice that the output will increase, even though the input level remains constant. At some setting of R41, the output will peak, and increasing the bias beyond this point will result in a decrease in output. A recommended setting for R41 is that position which drops the output ½db after the peak has been reached.

Once you've established the correct bias level, throw switch S6 to the *bias* position and note the reading on meter M1 (since we're after only a relative indication, don't concern yourself about the fact that we're reading bias on a VU scale).

In time, as the tubes age, the bias will fall, usually impairing performance. However, since you know the relative bias reading, all you have to do is adjust R41 for the noted VU reading to restore the correct bias level.

The proper value for resistor R22 (the one in series with the VU meter) can be determined after you have completed the above adjustments. Simply use a trial-and-error approach until you hit upon a value for this resistor which will cause the VU meter to indicate 0 on peaks of program material. If your record head requires very little drive, you may have to add a resistor in series with the lead going to the record head (jack J6) in order for the VU meter to function properly. A 47,000-ohm resistor was sufficient for the Knight tape deck.

Master gain control R18 can be adjusted at the same time to compensate for differing resistor values. For example, backing off the control slightly will bring a too-high meter reading down to the desired 0 VU level. For optimum adjustment, though, resistor R18 should be set for maximum output at minimum distortion from the tape *before* you select a value for resistor R22.

In any event, don't use a sine-wave tone for the preceding adjustments, since M1's internal damping will allow a higher signal level on program material and everything will come out distorted.

One other adjustment remains to be made before you can sit back and enjoy the fruits of your labors. The value of resistor R17 (the one across the parallel-T network in the treble-boost circuit) must be determined for the particular tape head you're using. Having hooked up a 10,000-ohm potentiometer in place of this resistor, slowly reduce its setting until you achieve maximum output at 14,000 cycles.

Taking care not to disturb the setting of the pot, remove it from the circuit, measure its resistance, and connect the closest value ½-watt resistor in its place. A signal generator is recommended for making this adjustment, but make certain you don't overload the amplifier.

If you don't own or can't borrow a signal generator, simply adjust the pot for maximum brilliance on program material. In any case, final smoothing of the high-frequency response is accomplished with R8, the resistor feeding the treble-boost stage (tube V2A).

Position 3 on switch S5, incidentally, is for taping 78's. But you may choose to use this position for some other purpose—if so, simply replace capacitor C21 and resistor R33 with whatever network meets the needs you have in mind.

Good taping!

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Hi-Fi Today

Continued from page 95

plifier combinations will hit the market. The idea has so much in its favor that it can't miss, particularly for producing good low-priced speakers. (I've already spoken to one designer who has a low-priced combination almost ready to go.)

Speaking of transistors, these little fellows keep invading audio circuits in conquering hordes. Everyone seems to have transistorized equipment either on the market or in the last stages of planning. But in case you haven't noticed, no one is plugging for miniaturization of components for the moment. The big heat-sinks that currently are needed to protect transistors don't make for peanut-sized amplifiers.

Don't blame your favorite manufacturer for not using those "self-cooling" transistors that make heat-sinks unnecessary. If he did, it might bring about some interesting advertisements: "Now you can buy a 5-watt transistor amplifier for only $8,000 in factory-wired form." I'd rather see those big heat sinks, and I rather expect I will—at least for the next few years.

It's noteworthy that Acoustic Research now offers its excellent turntable in a two-speed version. But the addition of the 45-rpm speed isn't for the sake of Elvis and Fabian fans. Instead it's an implied compliment to the new 45-rpm LP. Whatever happens to the two companies (Connoisseur Society and Quarante-Cinq) that are plugging the 45 speed for LP's, I hope it is picked up by bigger labels.

As far as I'm concerned, the 45-LP's in my collection (and one 33 that was cut directly without the use of tape) are the best-sounding records I've ever heard. And since the 45's play as long as most 33's, I can't see any reason (except inertia) for other companies not experimenting with the higher speed. Manufacturers may prefer uniformity of product (remember how long it was before the first American compact cars appeared?), but I have a hunch that diversity is more appealing to the buyers in the crowd.

Automatic CQ Sender

Continued from page 78

ing tape. If there are rough edges between the dits and dahs, smooth them with steel wool.

When mounting the wheel on the panel-bearing assembly, note that the wheel merely slips over the shaft. It is held in place by a compression spring which presses down on a large washer over the wheel (the spring also provides the keying-circuit ground return). A shaft coupler above the spring adjusts its tension. The pickup and equalizer wires, made from the springy wire is used in model airplanes, also keeps the code wheel under proper tension, horizontal and pressed firmly against the motor's rubber drive wheel.

The pickup wire, which is connected to a binding post insulating it from the metal case, makes electrical contact with the dit and dah strips on the rim of the code wheel.

Adjustment and Operation. Before making preliminary adjustments, tape the exposed terminals that carry AC power. Move the motor assembly so the rubber wheel is close to the *center* of the wheel (the highest speed setting). Since the motor's torque is lowest in this location, it's best for all adjustments. Be sure that the front-panel screws are vertical when tightened so the entire surface of the edge of the rubber wheel touches the code wheel. Slide the coupler down until the compression spring presses the code wheel firmly against the rubber wheel. Bend the pickup and equalizer wires to make the code wheel horizontal.

The Sender is designed to work with typical cathode-keyed ham transmitters. We use it with a 60-watt rig, but 100- watt RF amplifiers should not raise problems. If used with very-high power transmitters, excessive sparking at the code wheel may shorten contact life. If the foil contacts on the code wheel become pitted, move the pickup wire sideways a fraction of an inch to a better surface on the wheel. If the problem persists use the Sender to operate a keying relay.

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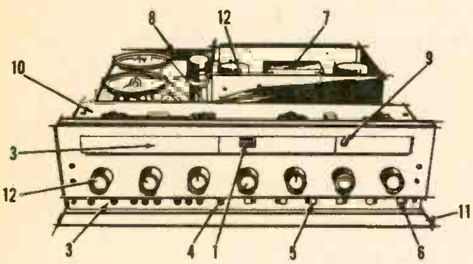

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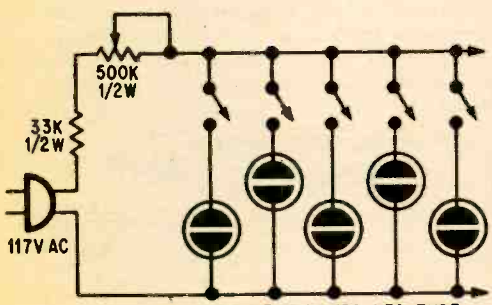
QUIZZES and other audience participation games frequently require a judgment as to who responds first with the answer. Since the job of umpire is usually a thankless one, here is an inexpensive little electronic circuit that will do the job for you. As soon as the first bulb is switched on, no other bulb can light.

As can be seen from the schematic, the only components required are a 500,000-ohm half-watt potentiometer (any taper), a 33,000-ohm resistor and as many SPST switches and neon lamps as there are contestants.

The circuit works this way: when any one of the switches is closed, voltage is applied to the series-connected neon lamp which lights. The current flowing through this lamp causes a voltage drop across the resistors so that the voltage now available to the other lamps is below their firing point. Since neon lamps will stay lit at a lower voltage than is initially required to fire them, the bulb first fired stays on.

Adjust the pot so that the first switch to be closed fires its bulb, but none of the other lamps will ignite when their



ALL NEON LAMPS NE2 TYPE

switches are closed. Larger neon lamps may be used for a more spectacular display and the 33K resistor omitted.

Sheet Recorder

Continued from page 50

The unit's signal-to-noise ratio of about 35db puts it in a class with the old 78-rpm record, but 35db is more than adequate for voice work. So, too, is its 150- to 5,000-cycle frequency range. Results on voice were just about what we expected—wholly satisfactory, and better than most dictating machines.

On the negative side of the ledger, the Toshiba-Canon has some serious shortcomings that most users of dictating machines wouldn't want to put up with. Total recording time per sheet is about 5½ minutes—long enough for a Gettysburg address or two, but far too brief for Paul Revere's night-time ride. Worse yet, there's no way to play back a given section of a sheet. Unlike a phono arm, which you can pick up and position, the head on the sheet recorder goes smack back to the beginning every time you recycle.

Still another strike against the machine is the fact that it has no provision for erasing, though its weight would suggest it incorporated well nigh every function under the sun. While Toshiba-Canon will supply an erasing machine for some $70, you could pick up a bulk eraser for perhaps $10 which also would do the trick. But either approach seems like a lot of trouble to go through just to erase a sheet.

Perhaps the strongest points in the unit's favor relate to the sheets themselves. Because the sheets are flat, copies can be stamped out as quickly and easily as doors for a Ford Falcon. And unlike standard recording tape, the uncoated side of the sheet is there for whatever use you want to make of it.

For example, a schematic or a parts list can be penciled on the sheet nicely as you please. And since this is the top side of the sheet, a friend in Tacoma or Timbuktu could look at your schematic while he listened to the accompanying comments you had recorded on the other side.

The machine, which is interesting mainly as a way-out gadget, is not being exported to this country at present.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● Antenna Weight – 12.5 lbs.
● Boom Length – 12 ft.
● Impedance Point – 52 ohms
● Max. Element Length – 18' 8¾"
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● Radiation – Uni-directional
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Continued from page 26

Gaspe Peninsula. Being inveterate radio listeners, we kept the car's set on most of the time. The farther east we got, the rarer became the English-language stations on our dial. Finally, when we were far out along the St. Lawrence, there came a time when *all* the English stations disappeared and we heard nothing but French.

As a matter of fact, for three and a half days we spoke to no one who knew our native tongue. The experience was at first unsettling, and then pleasant. We'd studied French 15 years ago and forgotten it, but the words started coming back. Before we got home we could make ourselves understood and even understand some spoken French.

Radio French, it turned out, was a little more difficult than the street variety, but there were phrases that had readily identifiable meanings. Commercials were a bit of a surprise. A good many of them had as much drama as a blow-by-blow fight narrative. A rolling of drums, a clatter of tom-toms would be followed by an announcer shouting, "Attention! Attention!" (It's pronounced ah-tawn-sy-ahn.) Next would be a loud and fast-paced harangue and, finally, some catch phrase.

Since we hadn't lugged along an all-band portable to pick up short wave, a Gallic broadcast band was our radio fare until we came around the eastern tip of Gaspe. Then we began picking up CFCY at Charlottetown, Prince Edward Island, and later CKBC at Bathurst, New Brunswick. KBC has a strange way of shifting periodically from French to English with no explanation in either language. CFCY is mostly all English.

Content-wise, Canadian programs tend to feature disc jockeys who perform about the same chores as those of their U. S. counterparts of ten years ago. They introduce records. The "good-music" formula hasn't yet come to Canadian radio, and comment-and-chatter jocks apparently haven't been exported. We have them all right here, more's the pity.—*R.G.B.*

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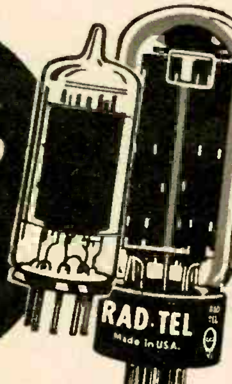

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___1T4	.72	___6BF5	.90	___6T4	.99	___12DT7	.79
___1U5	.65	___6BF6	.44	___6T8	.85	___12DT8	.78
___1X2B	.82	___6BG6	1.70	___6U8	.83	___12DW8	.89
___2AF4	.96	___6BH8	.98	___6V6GT	.54	___12DZ6	.62
___3AL5	.46	___6BJ6	.65	___6W4	.61	___12ED5	.62
___3AU6	.54	___6BJ7	.79	___6W6	.71	___12EG6	.62
___3AV6	.42	___6BK7	.85	___6X4	.41	___12EK6	.62
___3BC5	.63	___6BL7	1.09	___6X8	.80	___12EL6	.50
___3BN6	.75	___6BN6	.74	___7A8	.68	___12EZ6	.57
___3BU8	.78	___6BQ6	1.12	___7AU7	.65	___12F8	.66
___3BY6	.58	___6BQ7	1.00	___7EY6	.75	___12FA6	.79
___3BZ6	.56	___6BU8	.70	___7Y4	.69	___12FM6	.50
___3CB6	.56	___6BX7	1.11	___8AU8	.90	___12FR8	.97
___3CS6	.58	___6BZ6	.55	___8AW8	.93	___12FX8	.90
___3DG4	.85	___6BZ7	1.03	___8BQ5	.60	___12GC6	1.06
___3DK6	.60	___6C4	.45	___8CG7	.63	___12J8	.84
___3DT6	.54	___6CB6	.55	___8CM7	.70	___12K5	.75
___3GK5	.99	___6CD6	1.51	___8CN7	.97	___12L6	.73
___3Q4	.63	___6CG7	.61	___8CS7	.74	___12SF7	.69
___3S4	.75	___6CG8	.80	___8EB8	.94	___12SK7GT	.95
___3V4	.63	___6CL8	.79	___8FQ7	.56	___12SL7	.80
___4BQ7	1.01	___6CM7	.69	___9CL8	.79	___12SN7	.67
___4CS6	.61	___6CN7	.70	___11CY7	.75	___12SQ7GT	.91
___4DT6	.55	___6CQ8	.92	___12A4	.60	___12U7	.62
___4GM6	.60	___6CR6	.60	___12AB5	.60	___12V6	.63
___5AM8	.79	___6CS6	.57	___12AC6	.55	___12W6	.71
___5AN8	.90	___6CS7	.69	___12AD6	.57	___12X4	.47

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Qty. Type	Price	Qty. Type	Price	Qty. Type	Price	Qty. Type	Price
___5AQ5	.54	___6CU5	.58	___12AE6	.50	___17AX4	.67
___5AT8	.83	___6CU6	1.08	___12AE7	.94	___17DQ6	1.06
___5BK7	.86	___6CY5	.70	___12AF3	.73	___18FW6	.49
___5BQ7	1.01	___6CY7	.71	___12AF6	.67	___18FX6	.53
___5BR8	.83	___6DA4	.68	___12AJ6	.62	___18FY6	.50
___5CG8	.81	___6DE6	.61	___12AL5	.47	___19AU4	.87
___5CL8	.76	___6DG6	.62	___12AL8	.95	___19BG6	1.39
___5CQ8	.84	___6DJ8	1.21	___12AQ5	.60	___19EA8	.79
___5EA8	.80	___6DK6	.59	___12AT6	.50	___19T8	.85
___5EU8	.80	___6DN6	1.55	___12AT7	.76	___21EX6	1.49
___5J6	.72	___6DQ6	1.10	___12AU6	.51	___25AX4	.70
___5T8	.86	___6DT5	.81	___12AU7	.61	___25C5	.53
___5U4	.60	___6DT6	.53	___12AV6	.41	___25CA5	.59
___5U8	.84	___6DT8	.94	___12AV7	.82	___25CD6	1.52
___5V6	.56	___6EA8	.79	___12AX4	.67	___25CU6	1.11
___5X8	.82	___6EB5	.73	___12AX7	.63	___25DN6	1.42
___5Y3	.46	___6EB8	.94	___12AY7	1.44	___25EH5	.55
___6AB4	.46	___6EM5	.77	___12AZ7	.86	___25L6	.57
___6AC7	.96	___6EM7	.82	___12B4	.68	___25W4	.68
___6AF4	1.01	___6EU8	.79	___12BD6	.50	___32ET5	.55
___6AG5	.70	___6EV5	.75	___12BE6	.53	___35C5	.51
___6AH4	.81	___6EW6	.57	___12BF6	.60	___35L6	.60
___6AH6	1.10	___6EY6	.75	___12BH7	.77	___35W4	.42
___6AK5	.95	___6FG7	.69	___12BK5	1.00	___35Z5	.60
___6AL5	.47	___6FV8	.79	___12BL6	.56	___36AM3	.36
___6AM8	.78	___6GH8	.80	___12BQ6	1.16	___50B5	.69
___6AQ5	.53	___6GK5	.61	___12BR7	.74	___50C5	.53
___6AS5	.60	___6GK6	.79	___12BV7	.76	___50EH5	.55
___6AT6	.49	___6GN8	.94	___12BY7	.77	___50L6	.61
___6AT8	.86	___6H6	.58	___12BZ7	.86	___70L7	.97
___6AU4	.85	___6J5GT	.51	___12CN5	.56	___117Z3	.85
___6AU6	.52	___6J6	.71	___12CR6	.67	___807	.75

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