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Popular Electronics

FIFTY CENTS / DECEMBER 1970

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NRI "hands-on" training in TV-Radio, Electronics can give you as much as 2 years of on-the-job experience.

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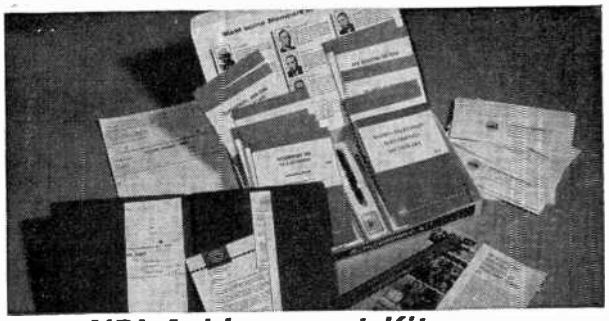
NRI Communications training programs will qualify you for a First Class Commercial Radiotelephone License issued by the FCC. If you fail to pass the FCC examinations for this license after successfully completing an NRI Communications course we will, on request, refund in full the tuition you have paid. This agreement is valid for the period of your active student membership and *for six months* after completion of your training. No school offers a more liberal FCC License agreement.

Experience is still your best teacher



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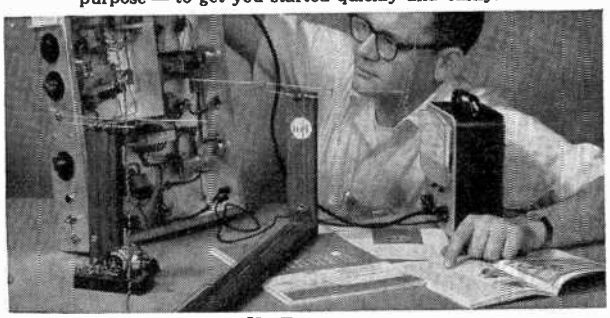
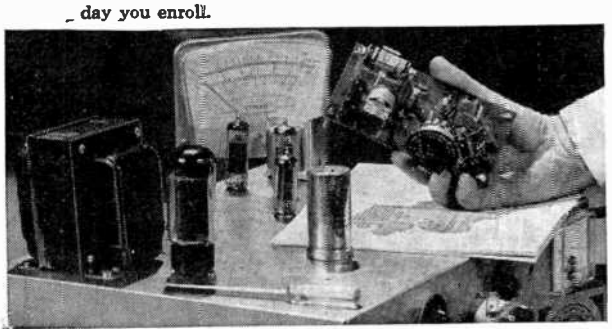


"Bite-Size" Texts average an easily-digested 40 pages of well-illustrated, scientifically prepared subject matter in the course of your choice. Questions in each book are carefully hand-graded and returned to you with helpful instructional notes. You get unlimited personal help from the day you enroll.



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Like this phone-cw transmitter (Kit #7 in the Communications course) is engineered from chassis up to demonstrate principles you must know. NRI does not use modified hobby kits for training, but the finest parts money can buy, professionally and educationally applied.

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Ask any teacher, job counselor, engineer, technician or prospective employer about the need for practical application of theory in Electronics. He'll tell you Electronics is as much a "hands-on" profession as dentistry or chemistry. That's how you learn at home with NRI. You prove the theory you read in "bite-size" texts, by actual experimentation with the type of solid-state, transistor and tube circuits you'll find on the job today — *not* hardware or hobby kits. You introduce circuit defects, analyze results, discover quickly the kind of trouble-shooting and design techniques that will make you employable in Electronics.

Train with the leader—NRI

NRI lab equipment is designed from chassis up for effective, fascinating training — not for entertainment. The fact that end results are usable, quality products is a bonus. In Communications, for example, you build and analyze, stage by stage, your own 25-watt phone/cw transmitter. It's suitable for use on the 80-meter amateur band, if you have an interest in ham radio. In TV-Radio Servicing your practical training gives you your choice of monochrome or color TV sets. All training equipment is included in the low tuition — you pay nothing extra. Discover for yourself the ease, excitement and *value* of NRI training. Mail postage-free card today for new NRI Catalog . . . or use the coupon below. No obligation. No salesman will call on you. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

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VOLUME 33 NUMBER 6 **DECEMBER 1970**

Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

FEATURE ARTICLES

DEPARTMENTS

POPULAR ELECTRONICS is Indexed in the Readers' Guide to Periodical Literature

This month's cover photo by Justin Kerr

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Thousands of electronic values!

Allied Radio and Radio Shack have joined forces to form the largest electronics distributing company in the world! This new 1971 460-page catalog offers you the best of both companies: famous-name brands, exclusive new products you'll find nowhere else (including some items you didn't even think were invented yet), and special money-saving prices that only the *combined buying power* of these two great companies could offer!

World's Largest Electronic Department Stores. Over 800 stores in 48 states. See your phone book for store nearest you.

Mail Coupon To Address Below

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DIVISION OF TANDY CORP.

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Fourth in a Monthly Series by Oliver P. Ferrell, Editor

IT TAKES ALL KINDS!

After the introduction of this monthly editorial, I was besieged by readers requesting "action" on an assortment of pet gripes. Many readers felt that this page was an auspicious location to publicize some dubious business practices. After some investigation, I must agree that a couple of things have happened in the past few months that are fairly reprehensible.

Topping my list is a cute trick that at least one mail order supplier has instituted—probably without the knowledge of the ownership and top management. It is penny ante stuff, but sufficiently irritating to POPULAR ELECTRONICS readers to have been brought to my attention on several occasions. The scheme works like this: a buyer orders a two-channel walkie-talkie (for example) and, when the unit arrives, it is discovered to be a single-channel model. The buyer complains and instead of getting the proper product, he gets a discount refund of a couple of dollars. It sounds innocent enough, but the buyer could have bought the single-channel model initially for less than his out-of-pocket investment (original price of the two-channel model less the discount)! Apparently, if the buyer continues to complain to the supplier, the whole deal is rectified, but by that time the majority of buyers are either disgusted or willing to forget the whole thing.

The second "trick" is difficult to pin-point—so I am going to go along with several readers who spotted the same thing. They say that they have been buying IC's from distress or surplus dealers, but the IC's are impossible to solder to a printed circuit board. Upon inspection they find that the thin gold plating on the leads has been removed—probably by a gold reclaimer—and the raw metal that is exposed is either unsolderable or requires so much heat in soldering that the interior of the IC is permanently damaged. The obvious solution is to use IC sockets, but the seller doesn't say anything about that in his advertisements for IC's at very attractive prices.

Personally, I haven't been able to prove or disprove this missing gold business and it may be localized to a dealer or two on the West Coast. The distress IC's available here on the East Coast seem to be perfectly legit.

All of this goes again to verify the adage that it's best to know the supplier you are dealing with. Certainly 99% of the mail order suppliers are OK, but don't be too surprised when you run into an occasional rotten apple.

INTERFACE

"MEGGER"—A TRADEMARK

Our attention has been drawn to the article in POPULAR ELECTRONICS, August, 1970, p 50, titled, "Make Your VTVM a Megger Too." We would inform you that the word "Megger" is a registered trademark belonging to this company and is registered in all major countries of the world including the United States.

DR. G. F. TAGG
Evershed & Vignoles Ltd.
Acton Lane Works, Chiswick
London, W4, England

IT'S THAT TIME OF YEAR

One of the first signs that the fall months are approaching is the release of the 1971 catalogs from the various mail order suppliers. Itemizing hundreds of new products and components (all at higher prices) I think that these catalogs should be labeled: Warning! May be hazardous to your wealth!

M. OLENSKI
Milford, Conn.

ANY VOLUNTEERS?

In February I am planning a visit to New York City and would like to start a correspondence with fellow electronics kit builders in the New York City area—with the objective in mind that my correspondent might be able to show me around the city. I may be reached at P.O. Box 151, San Nicolas, Aruba, Netherlands Antilles.

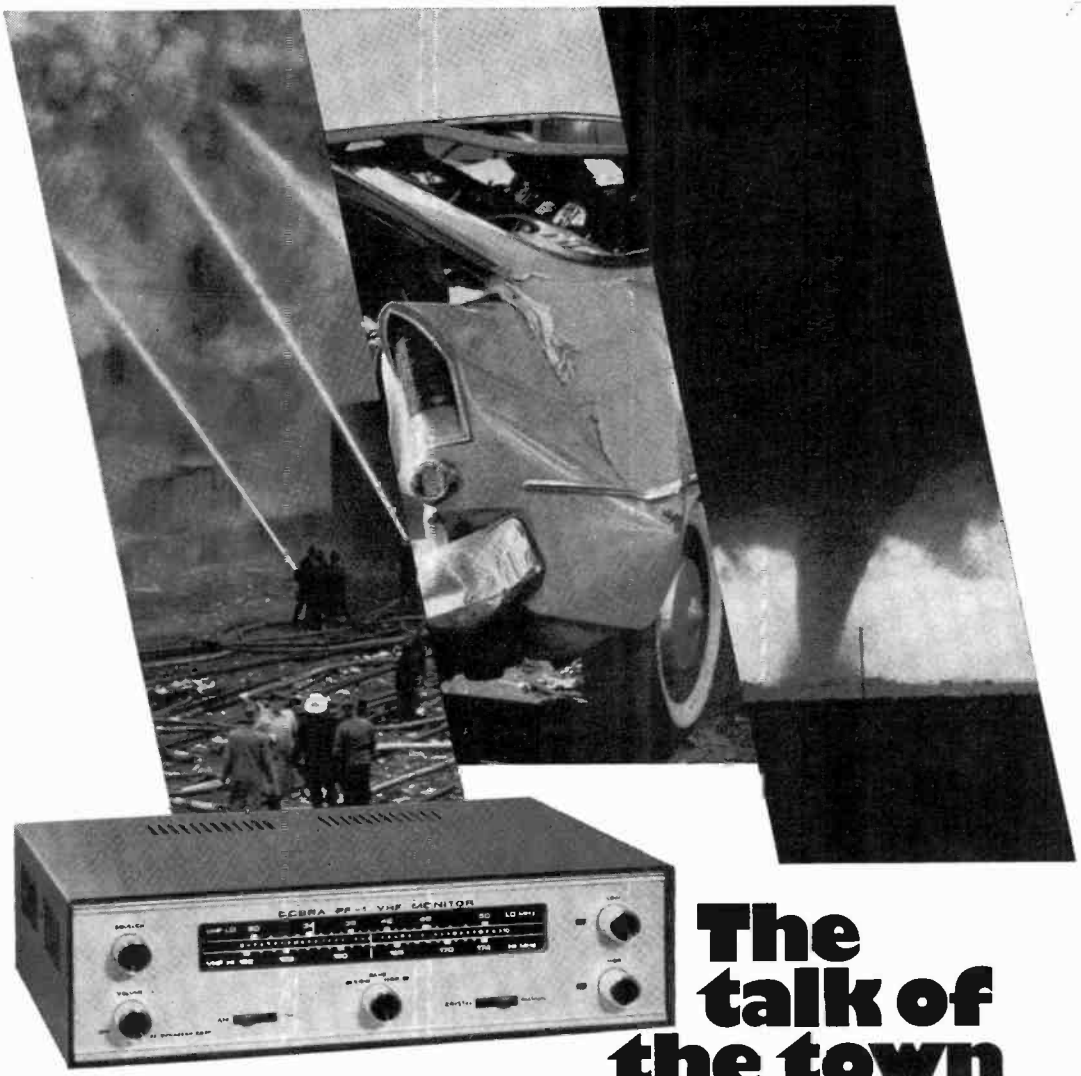
ERIC F. TCHONG
West Indies

NO FI LIKE HI-FI

The story, "Experiment That Saved Hi-Fi," (September issue) echos the thesis of a noted writer and acoustic engineer who espoused that true hi-fi was the sound that pleased the ears of the customer. A graphic illustration of this occurred in 1952 when I returned from a trip to New York City and had been able to procure from the Cortlandt St. "radio row" a paper cone for a collector's item RCA 1924 console. This straight TRF was used by an old lady who wept from pure joy when she heard the clear tones so familiar to her when the speaker to that 35-year-old radio had been fixed!

Sometime later I had the amusement of solving a complaint from a young, but tone deaf, hi-fi enthusiast who had invested in a

(*Continued on page* 97)



The talk of the town

New Cobra PF-1 AM/FM Police/Fire Monitor

Now you can hear about all the exciting events in your town *as they happen.* Traffic jams, robberies, dangerous criminals at large. Exact details of the latest fire. Hazardous storm warnings . . . before it's too late.

It's amazing! The new Cobra PF-1 monitors government VHF channels and lots more. Does it better than any other radio of its kind. All at a price you can afford.

Unlike other monitors, you receive both AM and FM high and low bands without an extra set of crystals. And in addition to manual tuning, you get crystal control option for a high and low pre-selected frequency—a feature usually available only in the most expensive radios.

So why settle for less? Exclusive noise limiting circuits reduce ignition interference and insure quiet operation. And the ultimate in new solid state circuit design gives you top reach and selectivity.

You even get a modern decorator-styled exterior suitable for any decor or auto interior.

Ask your dealer about the exciting new Cobra PF-1. Or write us for complete details. And you'll know all the talk of the town!

Cobra PF-1 $119.95

All solid state with IC, 2 tunable VHF bands (30MHz to 50MHz & 152MHz to 174MHz), independent tuning knobs for each band, dial scale calibration, crystal control option for high and low band preselected frequency (your choice of crystals, $5 each), reverse polarity protection for DC operation, exclusive dual noise limiting circuits, antenna and mounting bracket for mobile use included. 117 volt AC or 12 volt DC. Unique circuit permits application of AC and DC simultaneously. If AC fails, DC power source takes over.

Cobra

Product of

DYNASCAN CORPORATION

1801 W. Belle Plaine

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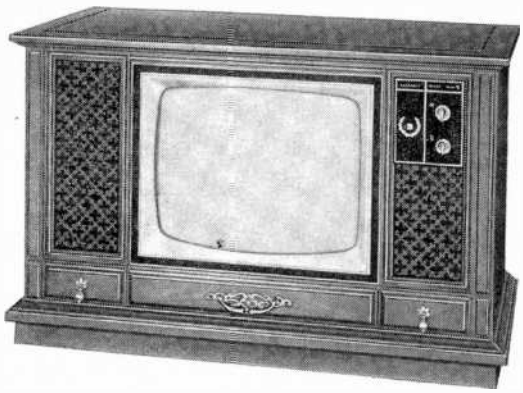
CIRCLE NO. 10 ON READER SERVICE PAGE

New from Heath...in time

New Heathkit® solid-state modular color TV

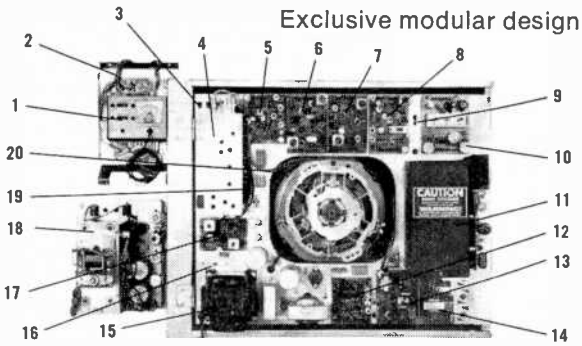


The result of over five years in research and development, these sets represent one of today's greatest color TV values. Here's why: a total of 45 transistors, 55 diodes, 2 silicon controlled rectifiers, 4 IC's containing another 46 transistors and 21 diodes plus 2 tubes (picture and high voltage rectifier) combine to deliver performance and reliability unequalled by any conventional tube set. Other features include: MOSFET VHF tuner; high-gain 3-stage solid-state IF; emitter-follower output; automatic fine tuning; VHF power tuning; built-in degaussing plus manual degaussing coil; automatic chroma control; adjustable noise limiting and gated AGC; "instant-on"... sound instantly, picture in seconds; bonded-face, etched glass picture tubes; adjustable tone control; exclusive hi-fi outputs; and 48-hour factory service facility for modules. The sets are designed to be owner-serviced ... the only sets on the market with this exclusive feature. A built-in dot generator, volt-ohm meter, and modular snap-out epoxy circuit boards make routine adjustments and service a snap ... virtually eliminating service calls and offering significant savings over the life of the set. It all adds up to the color TV buy of a lifetime in the GR-270 and GR-370 ... ready now for Christmas giving!

Kit **GR-270,** 227" 20V tube, 114 lbs. **$489.95***
Kit **GR-370,** 295" 23V tube, 127 lbs. **$559.95***
Kit **GR-370MX, GR-370** with RCA matrix tube, 127 lbs. **$569.95***

- Modular plug-in circuit board construction
- MOSFET VHF tuner and 3-stage IF
- Pushbutton channel advance
- Hi-fi sound outputs — for amplifier
- Designed for owner-servicing

Exclusive modular design

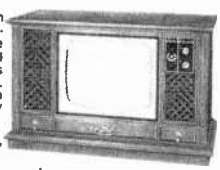


1 Exclusive check-out meter
2 Tilt-out convergence/secondary control panel
3 Gun shorting switches
4 3-stage IF assembly
5 Plug-in AGC/Sync circuit board
6 Plug-in 3.58 MHz oscillator circuit board
7 Plug-in Chroma circuit board
8 Plug-in Luminance circuit board
9 Service and Dots switches
10 Plug-in Video Output circuit board
11 High voltage power supply
12 Plug-in Vertical Oscillator circuit board
13 Plug-in Horizontal Oscillator circuit board
14 Plug-in Pincushion circuit board
15 Conservatively-rated power supply components
16 Circuit breaker protection
17 Plug-in Sound circuit board
18 Master control panel
19 Hi-fi sound output
20 Plug-in wiring harnesses and connectors for faster assembly

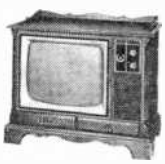
Choice of factory-assembled cabinets

3 models in 295 sq. in.

Luxurious Mediterranean Cabinet...factory assembled of fine furniture grade hardwoods and finished in a flawless Mediterranean pecan. Statuary bronze trim handle. 30-½" H x 47" W x 17¾" D. Assembled GRA-304-23, 78 lbs. $129.95*



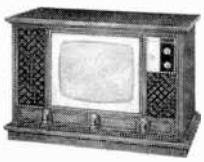
Deluxe Early American Cabinet...factory assembled of hardwoods & veneers and finished in classic Salem Maple. 29½" H x 37¼" W x 19¾" D. Assembled GRA-303-23, 73 lbs. $114.95*



Contemporary Walnut Cabinet...factory assembled of fine veneers & solids with an oil-rubbed walnut finish. 29½" H x 35⅛" W x 19⅞" D. Assembled GRA-301-23, 60 lbs. $74.95*

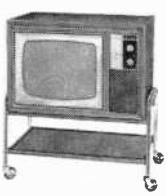
3 models in 227 sq. in.

Exciting Mediterranean Cabinet...assembled using fine furniture techniques and finished in stylish Mediterranean pecan. Accented with statuary bronze handle. 27½" H x 41⅞" W x 19¾" D. Assembled GRA-202-20, 85 lbs. $114.95*



Contemporary Walnut Cabinet and Base Combination. Handsome walnut finished cabinet sits on a matching walnut base. Cabinet dimensions 20½" H x 31¼" W x 18⅜" D. Base dimensions 7¾" H x 27¾" W x 18⅜" D. Assembled GRA-203-20 Cabinet, 46 lbs. $49.95* GRS-203-6 above cab. w/matching base, 59 lbs. $59.95*

Handy Roll-Around Cart and Cabinet Combination. Features the GRA-203-20 walnut cabinet plus a walnut-trimmed wheeled cart with storage shelf. Assembled GRA-203-20 Cabinet, 46 lbs. $49.95* GRA-204-20 Roll-Around Cart, 19 lbs. ..$19.95* GRS-203-5 Cart & Cabinet Combo, 65 lbs. $59.95*



for Christmas giving

New Heathkit Electronic Oven

...only $399.95*

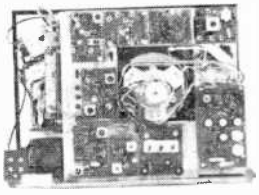
Now, through the miracle of microwave energy, a cooking revolution that frees you from conventional kitchen drudgery forever!

Imagine a baked potato in 4 minutes; baked beans in a little over 6 minutes; a five-pound roast in 45 minutes. This is the miracle of microwave cooking. And now Heath brings you this modern miracle for the first time in money-saving, easy-to-assemble kit form. For busy families on the go, meal preparation is a matter of minutes. You can cook on china, glass, or even paper dishes since only the food becomes hot. Your cooking dish can be your serving dish. Frozen foods can be defrosted in minutes for quick spur-of-the-moment frozen meals cooked right in their own containers. And there is not the slightest cause for concern about the safety of your Heathkit electronic oven. Exclusive door design prevents microwave leakage from the oven cavity. And with a SAFETY INTERLOCK SYSTEM UNIQUE IN THE INDUSTRY, not only does the oven stop cooking if the door is opened, but the door can't be opened unless the interlock is operating properly. A second independent door interlock is also provided for maximum protection. And all interlock mechanisms are tamperproof. Assembled in accordance with the manual, the GD-29 meets all the new federal standards for safety and radio interference. No special precautions are required when operating. The Heathkit electronic oven is as safe as your conventional oven! Quality components are used throughout: magnetron tube by Litton, the uncontested leader in the field; avalanche diode circuitry for longer tube life; simplified wiring harness with push-on quick-connectors for reliability and ease of assembly. GD-29 prototypes endured grueling "life-tests" equivalent to over 60 years of continuous service...further assurance of uncompromised reliability. Another feature is portability: the Heathkit electronic oven operates on regular household current. Plug it in anywhere...on a countertop, a wheeled cart, in the kitchen, on the patio, at the cottage...anyplace a grounded 120V AC power outlet is available. Make this a Christmas to remember by putting a Heathkit electronic oven under the tree. It's a gift your wife will thrill to...and a present the whole family will enjoy...meal after meal after meal.

Kit **GD-29,** 80 lbs. **$399.95***

New Heathkit portable solid-state color TV

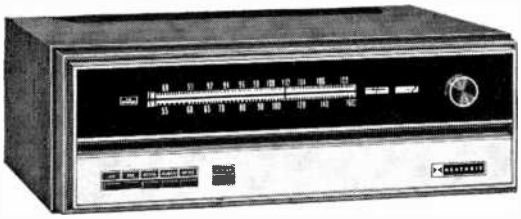
- Big set performance, portable convenience
- MOSFET VHF tuner & 3-stage IF
- Modular, self-service design
- 102", 14 V picture tube



What do you do for an encore after you've created the solid-state GR-270 and GR-370 big-screen sets? Simple. Make them portable. That's virtually what's been done in the new Heathkit GR-169 solid-state portable color TV. Heath engineers took the same cool-running solid-state circuitry from the large screen chassis and packaged it in an easy-to-assemble compact chassis...with the same nine plug-in glass epoxy circuit board modules used in the big sets. In fact the only difference is the smaller preassembled horizontal deflection and high voltage power supply. The same MOSFET tuner and high gain 3-stage IF found in the big sets offer superlative color performance. And, as in the larger sets, complete owner-service features are provided by inclusion of built-in dot generator and degaussing along with an exclusive volt-ohm check-out meter. 48-hour factory service facilities for modules are also provided with the GR-169. Other features include: built-in antennas and connections for external antennas; instant picture and sound; complete secondary controls available behind the hinged door on the front panel; high resolution circuitry for sharp, crisp pictures; adjustable noise limiting to keep external interference to a minimum. If you're looking for big set color fidelity and performance with portable convenience...put the new Heathkit GR-169 on your Christmas shopping list now!

Kit **GR-169,** 48 lbs. **$349.95***

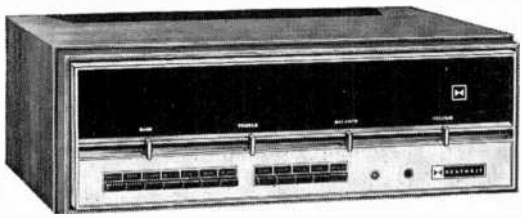
New Heath-gift ideas... for



New Heathkit® AJ-29 AM-FM-FM stereo tuner

This is the feature-packed tuner section of the famous Heathkit AR-29 stereo receiver . . . now available as a stereo "separate." The pre-assembled, factory-aligned FM tuner boasts 1.8 uV sensitivity for whopping station pulling power using FET design for superior overload characteristics. Three IC's in the IF section offer superior AM rejection, hard limiting, temperature stability, and outstanding reliability. Other features include a computer-designed 9-pole L-C filter for greater than 70 dB selectivity; new "blend" and "mute" functions; and a built-in AM rod antenna that swivels for best reception.

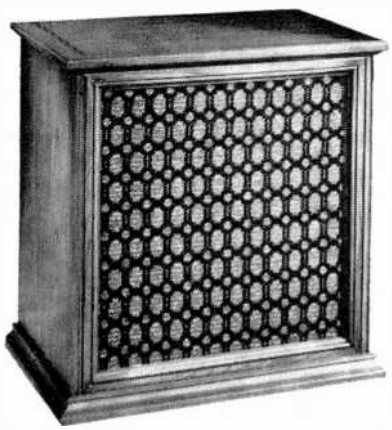
Kit **AJ-29,** 19 lbs., less cabinet **$169.95***
Assembled **AE-19,** oiled pecan cab., 9 lbs. **$19.95***



New Heathkit® AA-29 100-watt stereo amplifier

Power-packed amplifier section of the Heathkit AR-29, the AA-29 stereo "separate" marks another milestone in superior Heathkit amplifier design. Its 70-watts of continuous power is more than enough to drive even the most inefficient speaker systems. A massive, fully-regulated and filtered power supply, 4 conservatively heat sinked output transistors and the best IM and harmonic distortion specifications in the industry add up to sound fidelity you never expected to hear outside the theater. Modular plug-in circuit boards make assembly easier . . . snap out in seconds for future servicing.

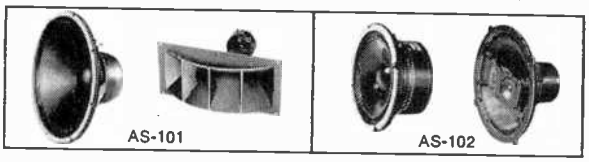
Kit **AA-29,** 27 lbs., less cabinet **$149.95***
Assembled **AE-19,** oiled pecan cab., 9 lbs. **$19.95***



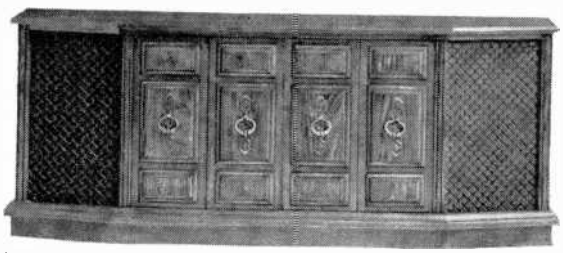
New Heathkit® floor model speaker systems

In the new Heathkit AS-101 and AS-102 speaker systems, Heath engineers have combined the best of both worlds of sound and beauty. The AS-101 Heath/Altec-Lansing 2-way system features a 15" woofer and sectoral horn delivering from 35 to 22,000 Hz with uncompromising accuracy. The AS-102 Heath/Bozak 3-way system uses a 12" woofer, 6" mid-range, and two 2½" tweeters in an infinite baffle design to produce clean natural reproduction from 40 to 20,000 Hz. Both systems are housed in assembled Mediterranean pecan cabinets, 29⅝" H x 27¾" W x 19⅞" D.

Kit **AS-101,** 53 lbs. **$259.95***
Kit **AS-102,** 39 lbs. **$259.95***



New Heath stereo equipment credenza



Romantic Mediterranean styling in wife-pleasing one-piece console design . . . yet with plenty of room for your favorite separate stereo components. Six-and-a-half feet of solid craftsmanship executed in North American Hickory veneers and solid oak trim, finished in oiled pecan. Completely assembled and finished, ready for installation of Heath or other components. Speaker enclosures are ducted port reflex design, pre-cut for 12" speakers. An adjustable shelf has room for stereo receiver, cartridge or cassette tape player or separate tuner and amplifier. Below the shelf is room for your turntable and record storage. Accessory matching drawers on ball bearing slides are available for turntable and tape player.

Model **AE-101,** 90 lbs. **$189.95***

home, shop and ham shack

New Heathkit® IC 15 MHz frequency counter...199.95*

A highly accurate, low cost frequency meter for anyone requiring accurate frequency measurements. Compare these features to counters selling for over twice this low price: accurate counting, 1 Hz to over 15 MHz; integrated circuitry; automatic trigger level for wide range input without adjustment; five digit readout with Hz/kHz ranges and overrange indicators for eight digit capability; high input impedance; storage circuitry for non-blinking, no-count-up readout; computer-type circuitry, no divider chain adjustment; temperature-compensated crystal time base oscillator; BNC input with cable; double-sided, plated-thru circuit board with sockets; three-wire, removable line cord; heavy-duty aluminum case handle/tilt stand and die cast zinc front panel; no special instruments required for accurate calibration.

Kit **IB-101**, 7 lbs. **$199.95***

IB-101 SPECIFICATIONS: Frequency Range: 1 Hz to greater than 15 MHz. **Accuracy:** ±1 count ± time base stability. **Gate Times:** 1 millisecond or 1 second with automatic reset. **Input Characteristics: Sensitivity:** 1 Hz to 1 MHz, less than 100 mV rms. 1 MHz to 15 MHz, less than 250 mV rms. After 30 minutes warmup. **Trigger Level:** Automatic. **Impedance:** 1 Meg ohm shunted by less than 20 pf. **Maximum Input:** 200 V rms, DC–1 kHz. Derate at 48 V per frequency decade. **TIME BASE: Frequency:** 1 MHz, crystal controlled. **Aging Rate:** Less than 1 PPM/month after 30 days. **Temperature:** Less than ±2 parts in 10^6/degree C. 20 to 35 degrees C after 30 minutes warmup. ±.002% from 0 to 50 degrees C. **GENERAL: Readout:** 5 digits plus overrange. **Temperature Range: Storage;** −55 to 80 degrees C. **Operating;** 0 to 50 degrees C. **Power Requirements:** 105-125 or 210-250 VAC, 50/60 Hz, 8 watts. **Cabinet Dimensions:** 8¼" W x 3⅛" H x 9" D not including handle. **Net Weight:** 4½ lbs.

See these and 300 other Heath-gift suggestions at one of the following Heathkit Electronic Centers:

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Milwaukee, Wisc. 53216
5215 W. Fond du Lac

Minneapolis Area
Hopkins, Minn. 55343
101 Shady Oak Road

New York, N.Y. 10036
35 W. 45th Street

Philadelphia, Pa. 19149
6318 Roosevelt Blvd.

Pittsburgh, Pa. 15235
3482 William Penn Highway

St. Louis, Mo. 63123
9296 Gravois Ave.

San Diego Area
LaMesa, Calif. 92041
8363 Center Drive

San Francisco Area
Redwood City, Calif. 94063
2001 Middlefield Road

Seattle, Wash. 98121
2221 Third Avenue

Washington, D. C. Area
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5542 Nicholson Lane

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During 1971, consult Heathkit Catalog Supplements and local newspapers for announcements of new Heathkit Electronic Centers opening in these places:

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Westbury, New York

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San Francisco Area
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Cincinnati, Ohio

Los Angeles Area
Woodland Hills, California

Atlanta, Georgia

Prices listed are factory mail order. Retail prices are slightly higher.

... or send for your FREE factory mail order catalog

New Heathkit® HW-101 SSB transceiver

The Hams at Heath have done it again... with an uprated version of the Heathkit HW-100, one of the most popular pieces of ham gear on the market! The HW-101 features improved receiver circuitry resulting in better than 0.35 uV sensitivity for 10 dB S+N/N. Image and IF rejection are better than 50 dB. Other improvements are a new 36-to-1 ball-bearing dial drive; new selectable SSB or CW filters and attractive new front-panel styling.

Kit **HW-101**, 23 lbs. **$249.95***

New Heathkit wattmeter/SWR bridge

Two switch-selected ranges allow measurement of RF output from 10-200 W and 100-2000 W. Built-in calibrator permits 10% accuracy throughout the 80-10 M ham bands.

Kit **HM-102**, 3 lbs. **$29.95***

HEATHKIT a Schlumberger Company

HEATH COMPANY, Dept. 10-12
Benton Harbor, Michigan 49022

☐ Enclosed is $_____, plus shipping.

Please send model (s) _____

☐ Please send FREE Heathkit Catalog. ☐ Please send Credit Application.

Name _____

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*Mail order prices; F.O.B. factory.
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CIRCLE NO. 14 ON READER SERVICE PAGE

NEW LITERATURE

To obtain a copy of any of the catalogs or leaflets described below, fill in and mail the Reader Service blank on page 15 or 95.

Available on request to Canadians from *Gladstone Electronic Supply Co.*, 1736 Avenue Rd., Toronto 12, Canada, is a 112-page electronic parts and equipment catalog. In addition to an extensive listing of basic electronic components (capacitors, resistors, etc.), Catalog No. 6 also features such consumer items as hi-fi systems, tape recorders and players, TV receivers, shortwave receivers, and electronic test equipment. Among the brand-name items represented are Garrard, Kenwood, EICO, Electro-Voice, BSR McDonald, Shure, and Mallory. Technical descriptions and prices are given for all items listed.

Circle No. 74 on Reader Service Page 15 or 95

Described and illustrated in a 16-page, four-color brochure (No. P/N 11-1247) obtainable from *Koss Electronics, Inc.*, is the company's entire line of dynamic and electrostatic headphones. The brochure devotes a section to explaining the sound of headphone listening and how it is achieved, including cutaway illustrations and line drawings to support the text explanations. Another section lists and describes such accessories as a connector box, connector plate, adapter cables, extension cord, and chairside and remote listening stations that add versatility to the stereophones.

Circle No. 75 on Reader Service Page 15 or 95

Alco Electronic Products, Inc., has just released three catalogs that describe the company's line of "Elfin" neon display devices and associated hybrid decoder/drivers; Alco-Display incandescent readouts; and Alco-Lite miniature indicator lamps and assemblies. The cold-cathode indicators in the Elfin line are described in detail with specifications, ratings, and physical dimensions given. The incandescent readouts include five families of miniature single-plane numeric and symbol indicators. Decoder/drivers with memory or counter are described for each family. The "Brite Glo" panel lamps listed range from lamps with 10" leads to lamps with metal bases. There are also miniature transistorized neon lights that operate from a low-voltage supply source.

Circle No. 76 on Reader Service Page 15 or 95

Popular Electronics

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Here's an easy and convenient way for you to get additional information about products advertised or mentioned editorially (if it has a "Reader Service Number") in this issue. Just follow the directions below... and the material will be sent to you promptly and free of charge.

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THE VERSATILE OP AMP

by Michael Kahn

This practical textbook covers the fundamentals and significant applications of the operational amplifier. Explanations are fully detailed and accompanied by numerous worked-out problems. The first half of the book discusses the fundamentals of amplification and deals with the amplifier on a "black box" or module basis. The basic concepts pertinent to amplifiers are all covered, but here they are applied specifically to an amplifier which is manufactured in a single package. Review questions are given at the end of each chapter, and an answer key for odd-numbered questions is provided in the rear of the book.

Published by Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York, NY 10017. Hard cover. 227 pages. $10.

HANDBOOK OF ELECTRONIC CHARTS, GRAPHS AND TABLES

by John D. Lenk

Here is a convenient and comprehensive guide to quick, accurate answers to the most important calculations employed in modern electronics. Many valuable graphs link the theoretical and practical aspects of electronics; and instant answers to the most frequently encountered problems are given. Most notable are the graphs that handily convert rectangular to polar coordinates for impedance and related calculations, Smith charts for microwave calculations, and many others used in circuit design and parametric determinations.

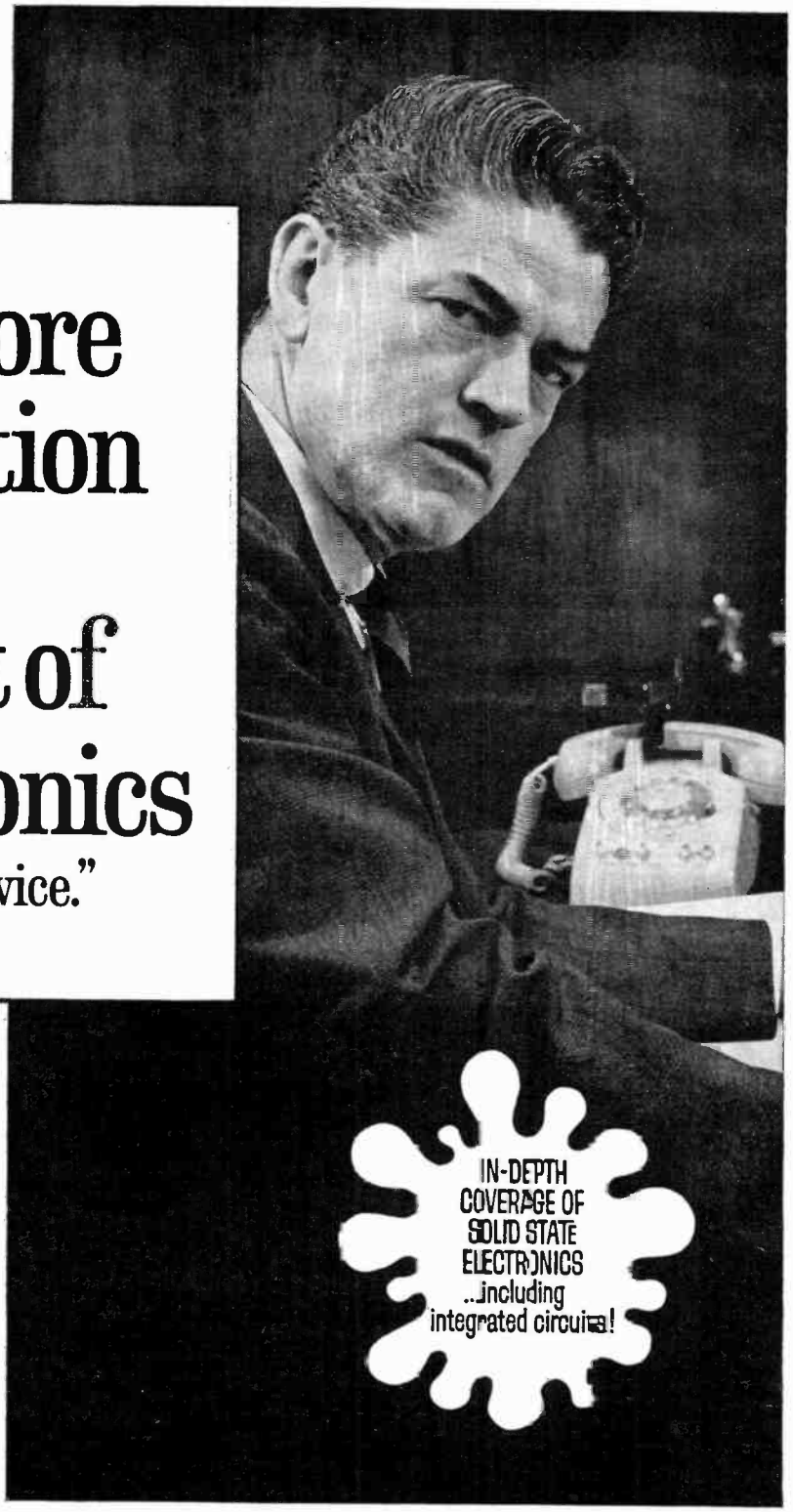
Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. Hard cover. 224 pages. $10.95.

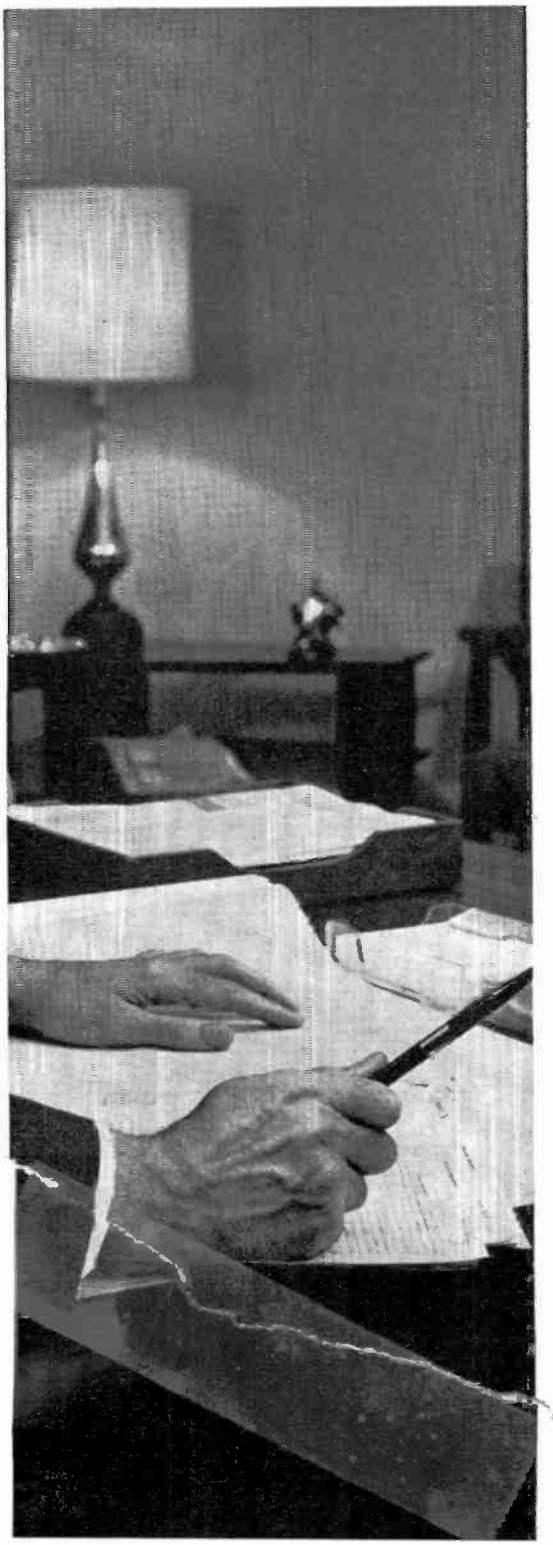
INTRODUCTION TO SWITCHING CIRCUIT THEORY

by Donald D. Givone

In this book, the author attempts to find a medium between the extremes of considering switching circuit theory as a set of logic design procedures and that of considering it as a purely mathematical study. To attain this goal, the two extremes are integrated. The fundamental math principles for switching circuit theory are given first; then the mechanics of logic design are presented as a direct consequence of theory. Since this book is designed to be used in a first course

(*Continued on page* 99)


"Get more education or get out of electronics
...that's my advice."
IN-DEPTH COVERAGE OF SOLID STATE ELECTRONICS ...including integrated circuits!



Ask any man who really knows the electronics industry.

Opportunities are few for men without advanced technical education. If you stay on that level, you'll never make much money. And you'll be among the first to go in a layoff.

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NEW PRODUCTS

Additional information on products described in this section is available from the manufacturers. Each new product is identified by a corresponding number on the Reader Service Page. To obtain additional information on any of them, circle the number on the Reader Service Page, fill in your name and address, and mail it in accordance with the instructions.

GENERAL RADIO STROBOSCOPE—Trouble-shooting your car's or boat's engine is made easier and cheaper with a new low-cost 1542 Strobomite electronic stroboscope from *General Radio Co.* The 1542 provides bright white-light xenon flashes from 180 to 3780 flashes per minute in a single range with constant image illumination at any flash rate. Flash duration can be as short as five millionths of a second and beam angle is 40° at the half-intensity points. Setting the flash rate to coincide with the machine motion provides a "stopped" image while the equipment is working; a slight variation in strobe flash rate permits slow-motion analysis of the machine.

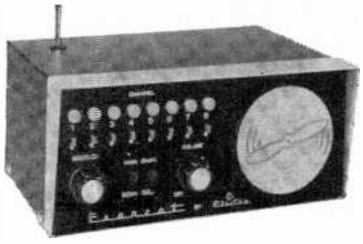
Circle No. 77 on Reader Service Page 13 or 95

KNIGHT-KIT STEREO RECEIVER—Factory-built features are now available in a kit. It's *Allied Radio Shack's* Knight-Kit Model KG-996, 240-watt stereo FM-AM receiver. With a FET front end providing 2 microvolts sensitivity and integrated circuits in the i-f stage, the receiver has a rated response of 20-30,000 Hz ±1 dB. Stereo separation is over 30 dB and signal-to-noise ratio is 50 dB. Assembly is simplified by modular construction and critical adjustments have been made at factory.

Circle No. 78 on Reader Service Page 15 or 95

ELECTRA AIRCRAFT SCANNER—Bearcat Model BCA, made by *Electra Corp.*, covers both ground and air communications in the 118-136-MHz range. The scanner stops for any communication and then continues the signal search when the transmission ends. Rated sensitivity of one microvolt is achieved over any 10-MHz spread within the range. Channel switches permit selection of only those frequencies of greatest interest.

Circle No. 79 on Reader Service Page 15 or 95



MARANTZ STEREO AMPLIFIER—A new entry for *Marantz Co.* in the stereo field is an integrated amplifier/preamplifier Model 30. The amplifier delivers 120 watts rms at 8 ohms with both channels driven at, or below, rated distortion of 0.15% at any audible frequency. A "variable overlap drive circuit" eliminates crossover notch distortion frequency found in solid-state amplifiers. A time-delay circuit eliminates turn-on and turn-off noise.

Circle No. 80 on Reader Service Page 15 or 95

SONIC FREQUENCY COMPENSATOR—The SONEX 100, made by *Sonic Research Co., Inc.*, compensates (in play-

back systems) for the frequencies reduced during recording and reproduction. Lows and highs are boosted while midrange frequencies are unaffected. Frequency response with controls set flat is 20 Hz to 30 kHz ± 1 dB. Four frequency controls are continuously variable. As an example, the high treble boost is a maximum of 13 dB at 20 kHz. Total hum and noise is better than 75 dB below rated output of 2 volts.

Circle No. 81 on Reader Service Page 15 or 95

BOMAN FM CONVERTER—Conversion of an automobile radio from AM to FM is made simpler with the *Boman Astrosonix* Model AT-6000 which is small enough to fit under most any dashboard. The 4" x 1⅞" x 5⅞" unit uses eight transistors and requires a 12-volt negative ground supply. It has an illuminated dial and comes complete with mounting hardware.

Circle No. 82 on Reader Service Page 15 or 95

REGENCY 2-METER TRANSCEIVER—Growing interest in the amateur band of 144-148 MHz for personal and civil defense applications has prompted the introduction by *Regency Electronics, Inc.*, of a mobile 10-watt FM transceiver for the band. Operation can be on any of 6 transmit and receive channels in the band, while a simple modification permits operation on any of 12 duplex combinations. Receiver is double-conversion with ceramic filter for operation on wide- and narrow-band signals.

Circle No. 83 on Reader Service Page 15 or 95

SONAR LOW-BAND TRANSCEIVER—Two-way communications in the business band of 32-50 MHz will get a boost from the new *Sonar Radio Co.* Model 2303A transceiver. For police and fire departments and other public services, the all solid-state unit has an output power of 1.6 watts, separate transmit and receiver channels, squelch, and external connections for antenna, earphone, and battery charger. It is supplied with crystals for either the 32-41-MHz or 42-50-MHz band.

Circle No. 84 on Reader Service Page 15 or 95

ALTEC WIDE-RANGE AUTOMOBILE SPEAKER—Motorists who aren't happy with the sound they get from FM radios or cassettes in their cars because of poor speaker sound will welcome the *Altec Lansing* Model 405A Dia-Cone speaker. The 4-in., 8-ohm unit has a frequency range of 60 to 15,000 Hz and will handle 10 watts. The cone is water resistant and the thin profile allows for shallow mounting.

Circle No. 85 on Reader Service Page 15 or 95

LAFAYETTE 8-TRACK STEREO TAPE DECK—The Model RK-890 stereo 8-track cartridge recorder/player tape deck from *Lafayette Radio Electronics Corp.* is all solid-state with 13 transistors and 12 diodes and built-in preamplifiers. An exclusive automatic cartridge ejector operates when unit is turned off to protect tape heads and cartridge rollers. Frequency range is from 30 Hz to 12 kHz with wow and flutter less than 0.3% and channel separation more than 40 dB.

Circle No. 86 on Reader Service Page 15 or 95

Discovery in the art of performance

Find *your* sound! The Starmaker collection not only includes microphones for many different applications, but —even more important—microphones to enhance the personal techniques of professional performers as well.

You can choose characteristics like "flat" frequency response. Tapered low-frequency response. Switchable Bass Roll Off. A host of others. To make "today's" sound come alive—close up or far out.

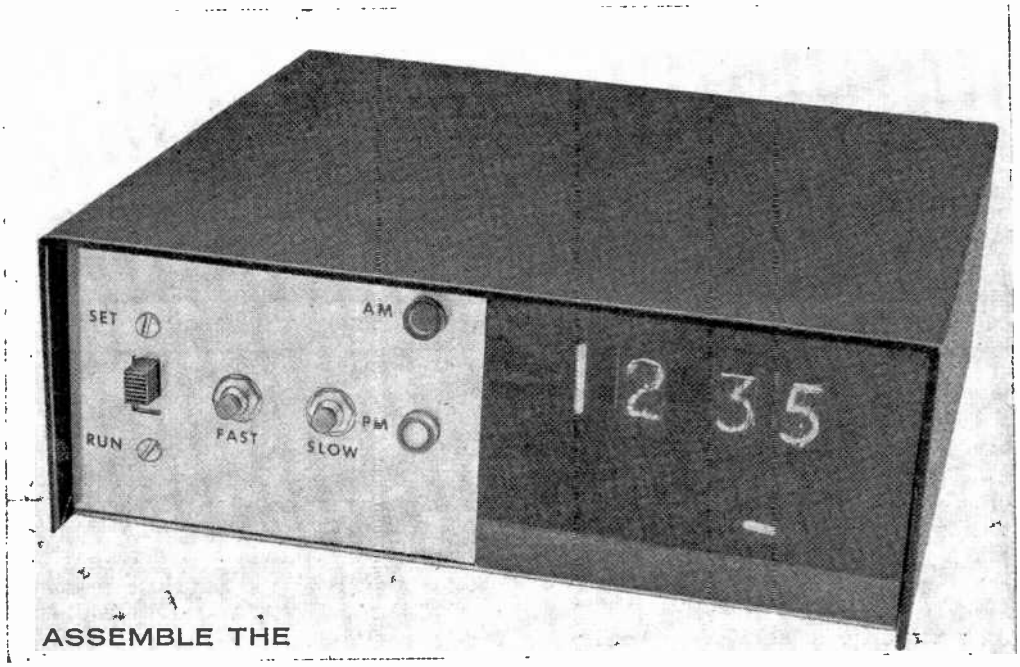
That's the way it goes up and down the Starmaker line (at optional list prices from $12 to $93). For pop, rock, and classical performers. At concerts, theatres, night clubs. In reel-to-reel and cassette home recordings. For discussion/panel, paging, P.A., CB, and ham applications...you name it.

To get specific, ask for the new Starmaker brochure 1S1056 at your RCA microphone distributor or, write: RCA Electronic Components, Commercial Engineering, Section /J10, Harrison, New Jersey 07029.

RCA

And, remember, for further professional needs, RCA also produces the renowned BK and SK microphone lines.

CIRCLE NO. 33 ON READER SERVICE PAGE



ASSEMBLE THE

Popular Electronics DIGI-VISTA

A TRUE ELECTRONIC DIGITAL CLOCK

This is the first of two very similar digital readout clocks. The basic difference is in the manner of handling "seconds." In this model, the seconds are not read; but an indication of clock operation is provided by an on-off neon lamp. Next month a follow-up version of this design will read seconds.

THERE ARE many types of digital clocks on the market today—most of them employing electrically or electronically driven mechanical displays. The latter are subject, of course, to the troubles which are inherent in precise mechanisms. What everyone wants is a totally electronic digital clock—including the readout. Since POPULAR ELECTRONICS first started featuring various types of electronic digital readouts, the project most often requested was a digital clock.

Recent reductions in the cost of transistor-transistor logic (TTL) devices and improvements in the reduction of noise to their operation have enabled the design of the "Digi-Vista" clocks described here. Two models are presented. The first (which can be built for about $110 and whose construction will be detailed next month) has six digits indicating seconds, minutes, and hours with an a.m./p.m. indicator. The latter function is important when using the optional alarm circuit which is also described in this article. The second clock (about $85 and described in this article) has four digits, indicating minutes and hours with an optional blinking seconds indicator as well as the a.m./p.m. feature.

Both versions of the Digi-Vista use the 60-Hz commercial power line as the timing source. This line frequency is usually very close to 60 Hz, though at any given instant it can be off by 0.1%. However, errors tend to cancel each other over a period of time. Unless you need extreme accuracy, the commercial power line is the best and most practical source of frequency.

COVER STORY BY CHARLES G. KAY AND DANIEL MEYER

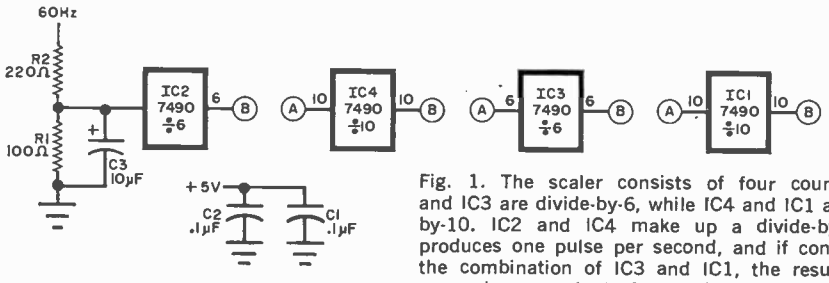


Fig. 1. The scaler consists of four counters—IC2 and IC3 are divide-by-6, while IC4 and IC1 are divide-by-10. IC2 and IC4 make up a divide-by-60 that produces one pulse per second, and if connected to the combination of IC3 and IC1, the result will be one pulse per minute for use by the four-digit clock.

The use of small printed circuit boards in the Digi-Vista keeps the size to a minimum and permits the builder to use almost any type of enclosure for the finished clock.

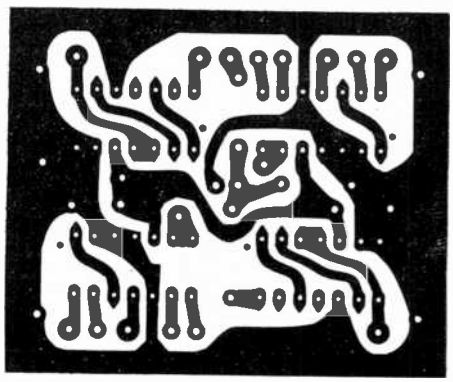
The basic circuit for the clocks contains a scaler to generate the required timing information; a power supply; a combination of conventional Nixie® decade counters (see "All-Purpose Nixie Readout," POPULAR ELECTRONICS, November 1968); a modulo-6 Nixie counter to indicate to 5 and then reset; and a "ten's" board to supply the "1" for the hours from 10:00 to 12:59. The latter board also includes the a.m./p.m. indicator.

As shown in the block diagram in Fig. 1, the scaler uses the 60-Hz reference to drive a divide-by-6 counter (*IC2*). The other three IC's in the scaler can be interconnected to divide-by-60 (divide-by-6 in series with a divide-by-10) to generate only one pulse per second for the six-digit clock or to divide-by-3600 (divide-by-60 in series with a divide-by-60) to produce one pulse per minute for the four-digit clock. As an example of how this works, if the B6 output of *IC2* is coupled to the A10 input of *IC4*, then the B10 output of *IC4* is one pulse per second. If the B10 output of *IC4* is coupled to the A6 input of *IC3* and the B6 output of *IC3* to the A10 input of *IC1*, then the B10 output of *IC1* is one pulse per minute.

In either case, the same foil pattern (Fig. 2) is used for the scaler board. Figure 2 also shows the component and jumper installation on the top of the board. The three capacitors, two resistors, and jumper are used in both versions. If you are assembling the four-digit clock, install only *IC2* and *IC4*, taking care to observe the notch and dot code on the IC's. If you are making the six-digit version, install all four IC's. Use fine solder and a low-power soldering iron. After construction, inspect the board for clean soldering and make sure there are no solder bridges between foil sections.

Power Supply. The power supply, whose schematic is shown in Fig. 3, can be built on a piece of perf board (except for the transformer which is mounted on the chassis) or you can fabricate a PC board. A heat sink should be used for *Q2*.

Readouts. Two types of Nixie readouts are used in the clock: a modulo-10 that indicates from 0 to 9 and then resets to 0, and a modulo-6 that indicates from 0 to 5 and then resets to 0. The two types are required to dis-



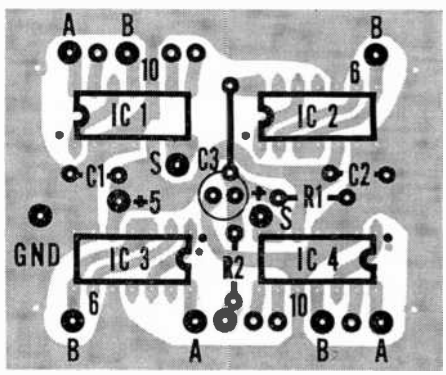


Fig. 2. Actual size foil pattern is shown above and component installation for the scaler below.

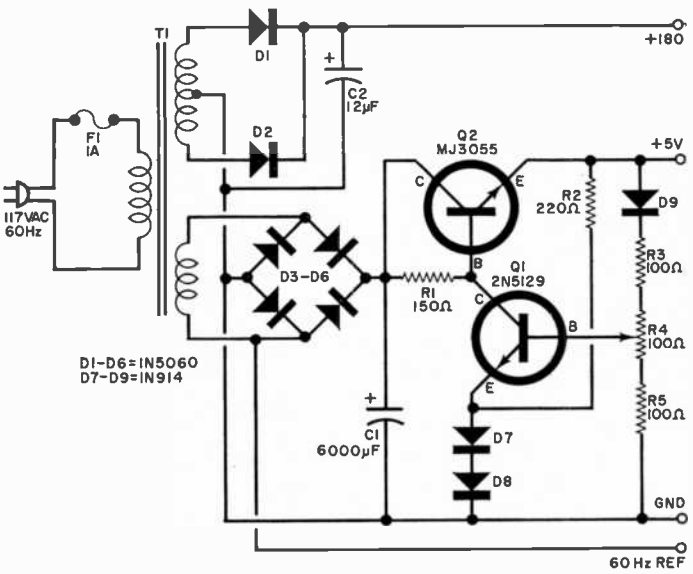


Fig. 3. The power supply can drive the six-digit version. It can be assembled on perf board, or on a commercially available PC board. Use a suitable heat sink for Q2 and mount T1 on the chass

PARTS LIST
POWER SUPPLY

C1—6000-μF, 10-volt electrolytic capacitor
C2—12-μF, 250-volt electrolytic capacitor
D1-D6—1A, 400V PIV silicon rectifier (1N-5060 or similar)
D7-D9—1N914 diode
F1—1A fuse
Q1—2N5129 transistor
Q2—MJ3055 transistor (Motorola)
R1—150-ohm, ½-watt resistor
R2—220-ohm, ½-watt resistor
R3,R5—100-ohm, ½-watt resistor
R4—100-ohm, PC-type trimmer potentiometer (IRC X-201 or similar)
T1—Power transformer; secondaries: 6.3V at 1A, 300V CT at 25 mA
Misc.—Heat sink for Q2, spacers, mounting hardware, etc.
Note—The following are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216: etched and drilled PC board #169-PB at $2.45 postpaid; complete kit of parts including PC board #169-C at $11.55 plus postage for 4 lb.

play such values as 59 seconds or minutes. The modulo-10 readout is identical to that described in the November 1968 POPULAR ELECTRONICS, referred to above. The modulo-6 is the same except for some minor circuit changes which are shown in the foil pattern in Fig. 4.

For the unit hours readout, the indicator must progress from 0 to 9, through 0,1, and 2 and then back to 1 to pick up the count. In this way, the indicators can display 9:00, 10:00, 11:00, 12:00, and 1:00. To achieve this effect, you have to alter the wiring of the Nixie tube to the unit hour board so that the tube indicates ahead two digits. That is, the Nixie "2" should be connected to the "0" terminal of the board, with "3" on the "1", "4" on the "2", and so forth up the decade. When the unit hours board is so modified and properly connected to the tens counter board, the clock will indicate 12:59; and at the next pulse, 1:00.

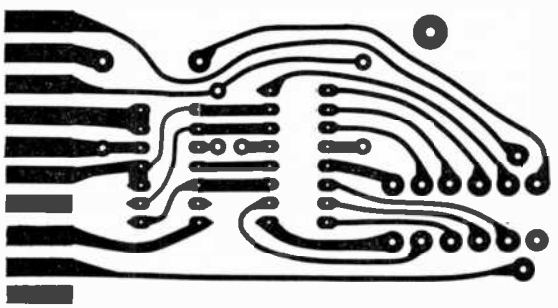
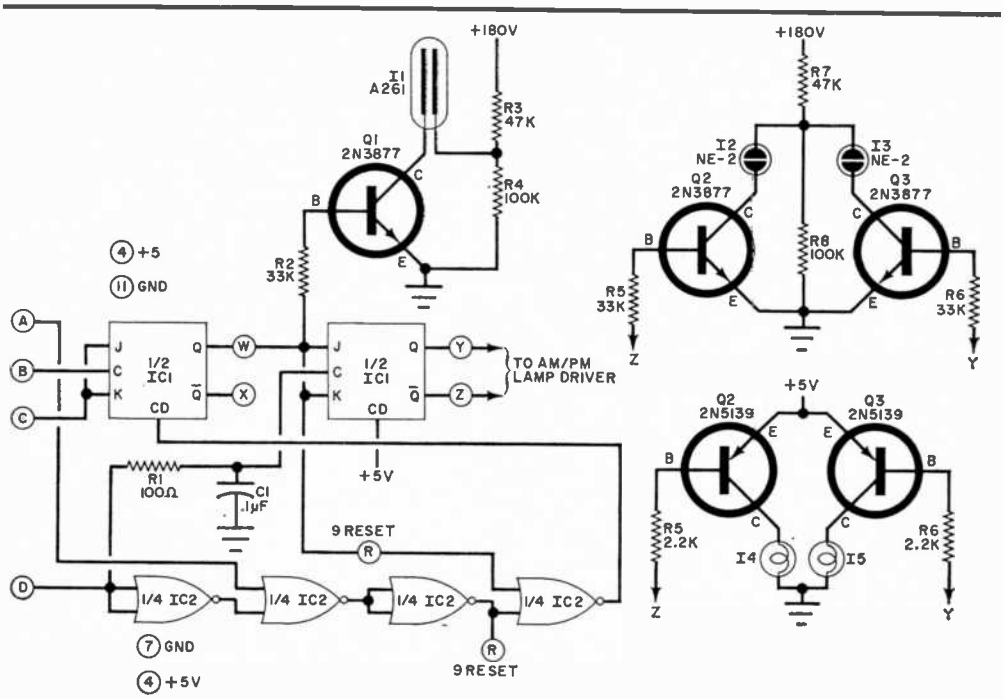


Fig. 4. Foil pattern for the modulo-6 stage. Component and jumper installation are the same as those shown for the decade counter in the November, 1968 issue.



PARTS LIST
TENS COUNTER

C1—0.1-μF, 12-volt disc capacitor
I1—Neon lamp (Signalite A-261 or similar)
IC1—7473 dual flip-flop
IC2—7400 quad two-input gate
Q1—2N3877 transistor
R1—100-ohm, ½-watt resistor
R2—33,000-ohm, ½-watt resistor
R3—47,000-ohm, ½-watt resistor
R4—100,000-ohm, ½-watt resistor

For neon a.m./p.m. indicators
I2,I3—NE-2 neon lamp
Q2,Q3—2N3877 transistor
R5,R6—33,000-ohm, ½-watt resistor
R7—47,000-ohm, ½-watt resistor
R8—100,000-ohm, ½-watt resistor
For incandescent a.m./p.m. indicators
I4,I5—6-volt, 50-mA miniature incandescent lamp
Q2,Q3—2N5139 transistor
R5,R6—2200-ohm, ½-watt resistor
Misc.—Plastic covers for two lamps, mounting hardware, etc.

Fig. 5. The ten's counter accepts inputs from the unit hours board, and turns on the "1" neon lamp (I1) at the correct pulse. It also generates the correct reset pulse for the unit hours board. The constructor is given the option of using neon or incandescent lamps for the a.m./p.m. indicators.

The circuit for the tens-of-hours lamp and the a.m./p.m. indicator is shown in Fig. 5. Note that either of two types of indicator can be used for the a.m./p.m. function—neon lamps or conventional incandescent lamps. The foil pattern for this board, shown in Fig. 6, has provisions for the options. For neon indicators, omit the jumper at *J1* and install jumpers at *I1* and *I5*. For incandescent indicators, install jumpers at *J1*, *I2*, and *I3*.

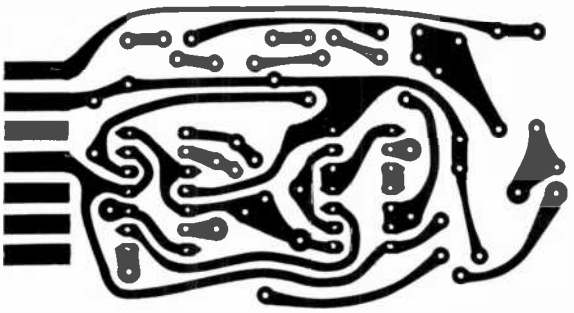
Assembly. The overall schematic of the four-digit clock is shown in Fig. 7.

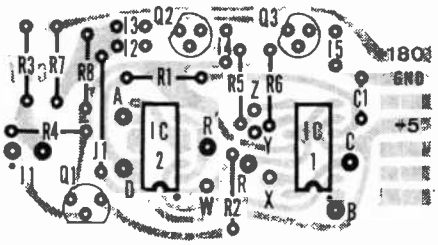
The prototype shown in the photographs was constructed in a conventional two-piece metal chassis with cutouts for the readouts. The cutout is covered with a piece of polarized plastic to reduce the glare and improve legibility. The a.m./p.m. indicator lamps are mounted in snugly fitting plastic holders with the letters marked or press-typed on the front window.

The power transformer and fuseholder are mounted on the bottom of the chassis with the PC boards mounted on spacers. In the prototype, the scaler and power supply were mounted horizontally, readouts vertically.

Each PC board should have its ground return and +5-volt supply connections made with individual leads to the power supply. Do not use the chassis as a common ground return.

Fig. 6. Foil pattern and component installation for ten's counter board. Note that provisions are made for either neon or incandescent lamp indicators. Text explains where to connect required jumpers.



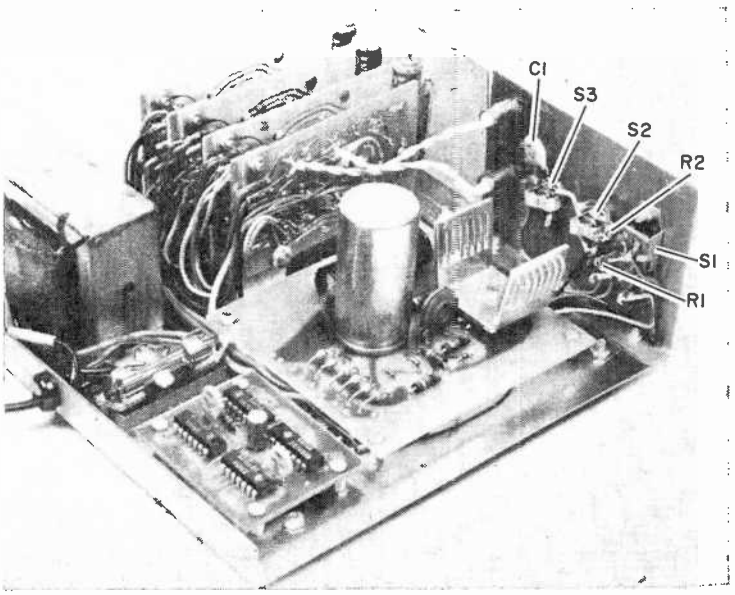


Note that the usual carry-to-input series circuit is used between the DCU's except for the connections between the unit hours board and the tens of hours board. In this case, the A, B, C, and D logic line of *IC1* (decade counter SN7490) of the unit hours DCU (pins 12, 9, 8, and 11 respectively) are connected to the A, B, C, and D inputs of the tens of hours board.

The +180-volt line to the Nixie tubes should be very carefully installed as this voltage can damage components if wrong connections or shorts occur.

Operation. Plug the power line into a 117-volt 60-Hz outlet and note that the Nixies come on and either the a.m. or p.m. lamp is glowing. Adjust *R1* of the power supply so that the 5-volt supply is correct. Place the SET-RUN switch on SET and depress the FAST button. The minutes readouts in either clock will start to cycle and at 11:59, the a.m. and p.m. indicators will switch over. Cycle the clock through a 24-hour period to clear all of the counter units. With the SET-RUN switch on RUN, use the FAST button to bring the clock to within a few seconds of the actual time,

The original clock was built in a conventional metal chassis having a cutout for the readouts, and the operating controls on front panel. Any other type of mounting may be used, and controls hidden; once set, they are not needed for clock.



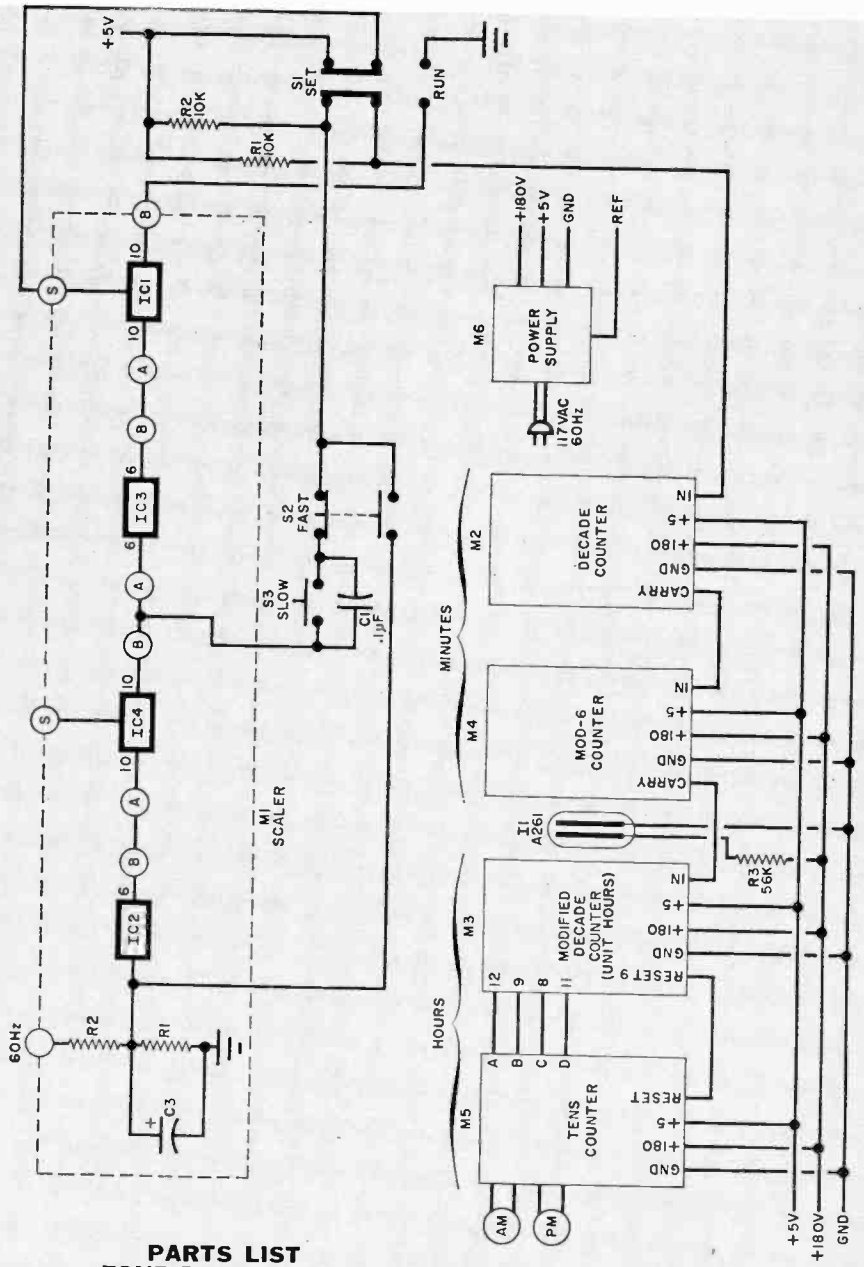
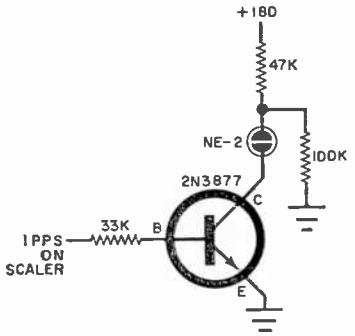


Fig. 7. Overall wiring of the four-digit clock. Lamp I1 is used to make a colon between the minutes and hours indications, and a narrow black band around the center of the lamp breaks up the neon glow into two glowing dots. In the slow set position, the clock is driven from the one-pulse-per-second point, while in the fast set, the drive is from the 60-Hz line. When the time shown is correct, place S1 to run.

PARTS LIST
FOUR-DIGIT CLOCK

C1—0.1-μF capacitor
I1—Neon lamp (optional) (Signalite A-261 or similar)
M1—Scaler module
M2,M3—Decade counter module
M4—Modulo-6 counter module
M5—Tens counter module
M6—Power supply module
Misc.—Suitable chassis, polarized plastic glare shield, spacers, mounting brackets, hookup wire, etc.
Note—The following are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216: decade counter module NX-10 at $15, postpaid; modulo-6 counter module NX-6 at $15, postpaid; tens counter module CL-1 at $8.50, postpaid (specify neon or incandescent lamp); scaler module SC-10-4 at $14.75, postpaid; power supply module 169 at $11.55, plus postage for 4 lb; polaroid plastic at 25¢/sq in. (specify size required).

Fig. 8. This optional electronic "tic-toc" is connected to the output of scaler IC4 and blinks on and off to indicate that the clock is operating.



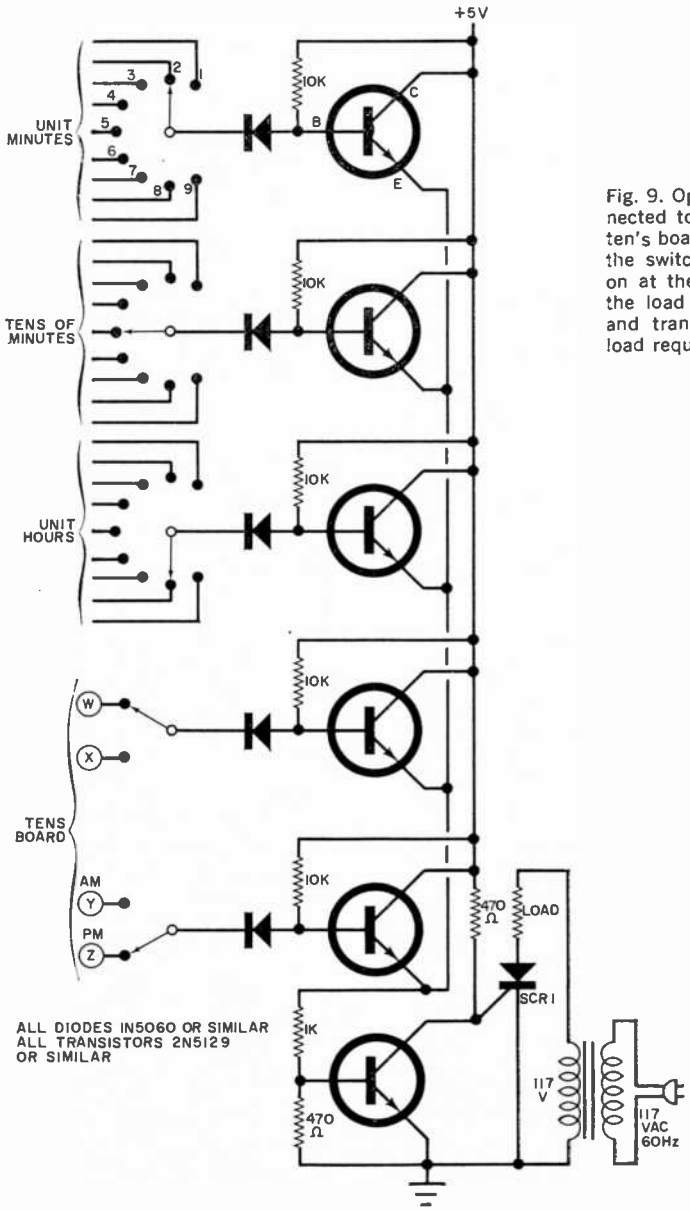


Fig. 9. Optional alarm system can be connected to the three readouts and to the ten's board as shown here. By positioning the switches properly, the SCR will turn on at the selected time, thus energizing the load (bell or other alarm). The SCR and transformer are selected to match load requirements of voltage and current.

THEORY OF CIRCUIT DESIGN

The unit hours board is modified so that the Nixie-tube indicates ahead by two digits. This results in a "2" being shown when the counter would normally show a "0". This is done to simplify the logic needed to count to 12:59 and reset to 1:00. The operating cycle is as follows.

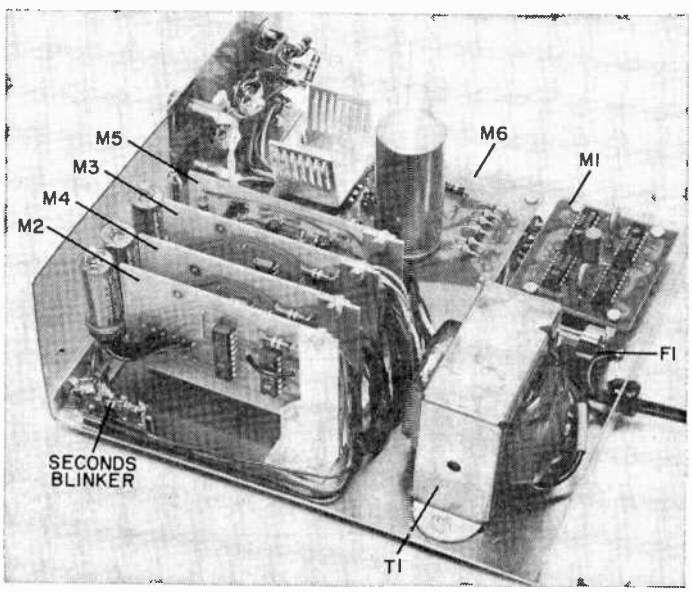
The counter is reset to "9" through the nine-reset input on the board. This results in a "1" being displayed. The count then proceeds up normally. After the count of "9", we must reset the counter to "0" and turn on the "1" lamp to indicate a "10". The "1" lamp is operated by the C and B lines coming into the tens counter board. When the displayed numeral on the unit hours board goes to "0", C and B both go to a logical zero state, and IC1 of the tens counter changes state. This turns on Q1 and ignites the "1" neon lamp. This then forms the number "10". The count then proceeds through 11 and 12. When the counter reaches 11:59, the next pulse causes the D line to go to a logical zero. This causes the second half of IC1 to change states and switch the AM and PM lights.

When the counter reaches 12:59, the system must be reset to 1:00. This requires a reset pulse to the "9" reset terminals of the unit hours counter, and to the first flip-flop of the tens counter, to reset the circuit and turn the "1" neon lamp off. This reset pulse is generated at the proper time by decoding the output of the first flip-flop of the tens counter which controls the "1" lamp, and lines A and D on the unit hours counter. When the output of this flip-flop is at logical 1, and A and D occur at the same time, a reset pulse is generated to reset the counter and the flip-flop.

then use the SLOW button to set the time exactly. Place the SET-RUN switch on RUN.

Options. In building the four-digit clock, the optional seconds blinker circuit shown in Fig. 8 may be used. The circuit can be built on a terminal strip with the neon lamp lying horizontally below the actual time indicators. The input to this circuit comes from the B10 output of *IC4* on the scaler board. Operation is such that the neon lamp glows for one second and is off for one second. Although it is an accurate time marker, this indicator only serves to show that the clock is working and is the optical version of a "tic-toc."

The optional alarm circuit shown in Fig. 9 can be used to turn on an external alarm at any desired time of the day or night. Any type of switch may be used, though the prototype used conventional rotary switches. The bottom two switches are ordinary dpst types. The alarm circuit is a NOR logic system and all inputs must be at a logic zero before the alarm will work. At this time, all the transistors will have low voltages on their emitters and the gate switching transistor will have no base current drive. This transistor then turns off and the SCR (or triac) conducts to supply power to the external circuit. The transformer secondary voltage should match the required drive for the external circuit. The diodes in series with the transistor bases block the voltages from the Nixies when they go above 5 volts. This prevents destruction of the NOR transistors. -30-



Arrangement used in the prototype may be duplicated or any other layout may be used. The optional neon lamp seconds blinker is mounted horizontally under the four indicators so that it is clearly visible when viewing the clock from the front.

Build A Three-Channel Time Receiver

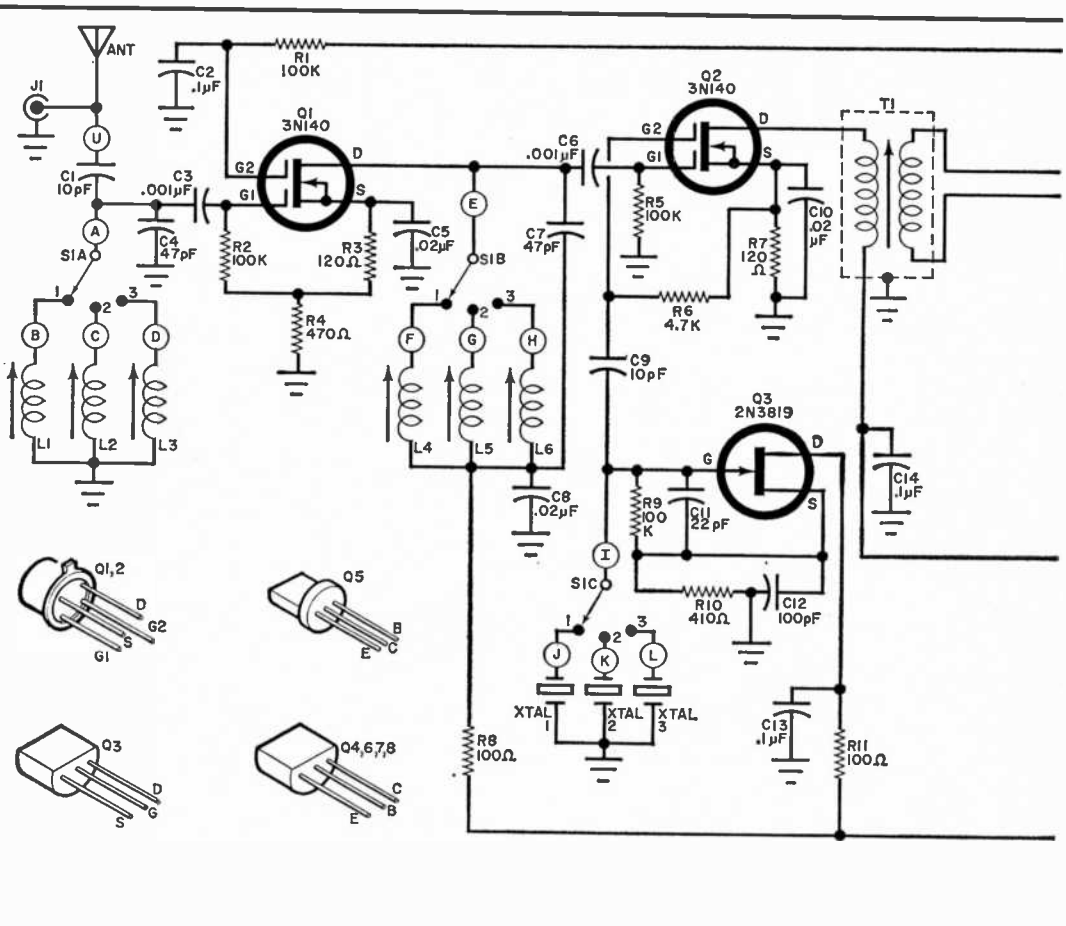
ACCURATE TIME SIGNALS FROM WWV OR CHU

Using dual-gate MOSFET's, this receiver has a sensitivity of 0.25 microvolts for a 10-dB (S + N)/N ratio. Self-contained (except for power) it offers the selection of one of three possible crystal-controlled receive channels. The version illustrated is set up for WWV, but the builder can adapt the circuit for a "mix" of WWV and CHU frequencies.

WHAT DO amateur astronomers, jewelers, boat owners, and radio and TV stations have in common? The need for accurate time. How about radio amateurs, 2-way radio service shops, and electronics labs? Many of them must also make accurate frequency measurements. If your requirements are for accurate time or frequency, build this supersensitive receiver and tune in on the standard time/frequency broadcasts of WWV or CHU (in Eastern Canada and along the East Coast). A choice of three crystal-controlled frequencies assures uninterrupted reception, day or night. You can build this sophisticated 10-transistor superhet receiver in just a few hours and you don't need any test equipment.

The National Bureau of Standards transmits standard time and frequency information continuously on several frequencies via stations WWV in the continental United States and on identical frequencies from WWVH in Hawaii. In Canada, the Dominion Observatory station, CHU, transmits standard time continuously. The program format of WWV varies from that of CHU. While WWV transmits a "tick" each second and a digital and voice time announcement every five minutes (along with meteorological information), CHU broadcasts a tone-type "beep" each second and a voice time announce-

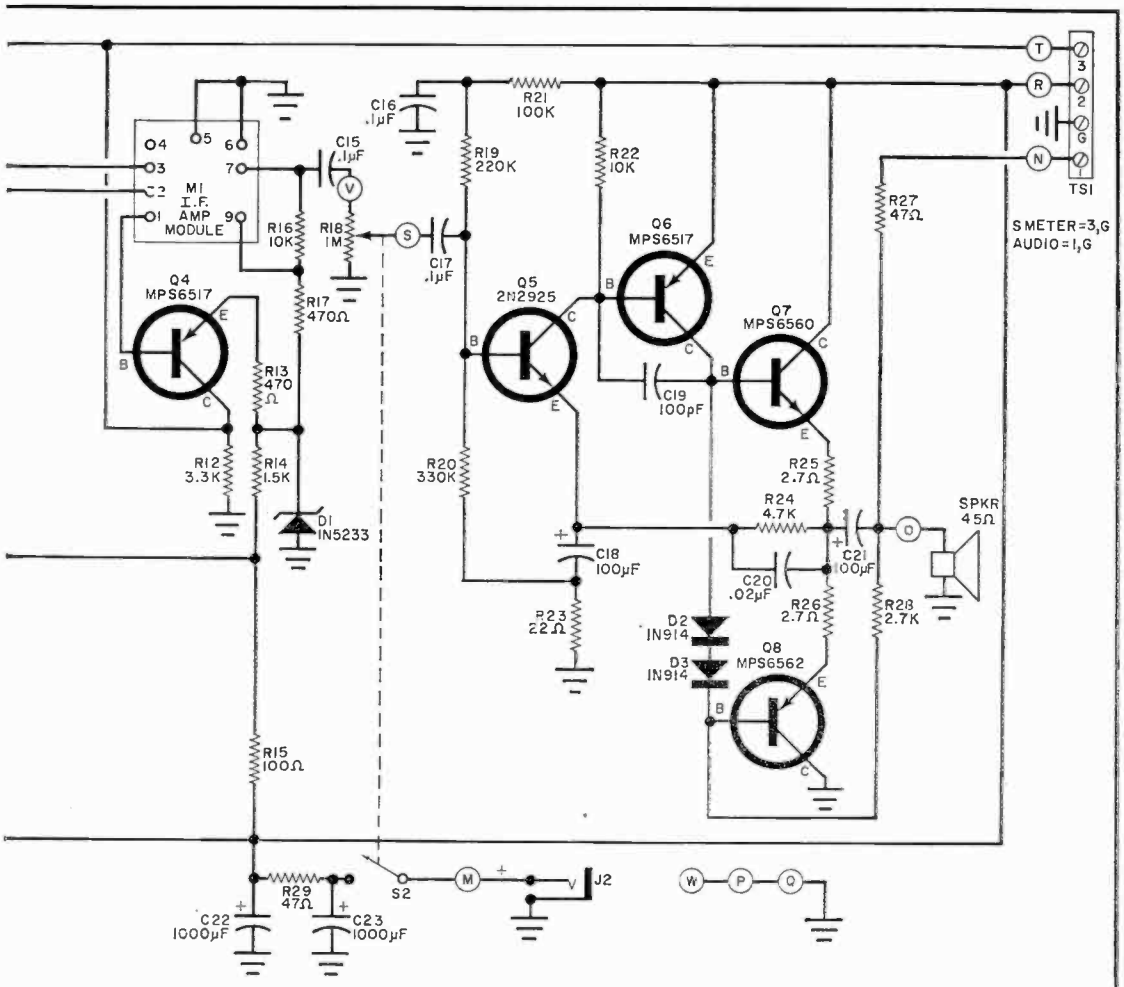
COVER STORY BY CHARLES CARINGELLA



PARTS LIST

C1,C9—10-pF, dipped silvered mica capacitor
C2,C13-C17—0.1-μF miniature disc capacitor
C3,C6—0.001-μF ceramic disc capacitor
C4,C7—47-pF dipped silvered mica capacitor
C5,C8,C10,C20—0.02-μF miniature disc capacitor
C11—22-pF dipped silvered mica capacitor
C12,C19—100-pF dipped silvered mica capacitor
C18,C21—100-μF, 15-volt miniature PC electrolytic capacitor
C22,C23—1000-μF, 15-volt miniature PC electrolytic capacitor
D1—6-volt, 500-mW zener diode (Motorola 1N5233 or similar)
D2,D3—1N914 silicon diode
J1—Phono jack
J2—Miniature phone jack
L1,L4—For 5.0-MHz WWV, 10.0-18.7-μH adjustable PC r-f coil (J.W. Miller 23A155-RPC); for 7.335-MHz CHU, 5.6-10-μH adjustable PC r-f coil (J.W. Miller 23A826-RPC)
L2,L5—For 10.0-MHz WWV, 2.4-4.1-μH adjustable PC r-f coil (J.W. Miller 23A336-RPC)
L3,L6—For 15.0-MHz WWV, 1.65-2.75-μH adjustable PC r-f coil (J.W. Miller 23A226-RPC); for 14.670-MHz CHU, 1.65-2.75-μH adjustable PC r-f coil (J.W. Miller 23A226-RPC)
M1—I-F amplifier module (J.W. Miller 8902-B)
Q1-Q2—Dual-gate MOSFET (Motorola 3N-140 or similar)
Q3—N-channel FET (Texas Instruments 2N3819)
Q4,Q6—Transistor (Motorola MPS6517)
Q5—Transistor (GE 2N2925)
Q7—Transistor (Motorola MPS6560)
Q8—Transistor (Motorola MPS6562)
R1,R2,R5,R9,R21—100,000-ohm
R3,R7—120-ohm
R4,R10,R13,R17—470-ohm
R6,R24—4700-ohm
R8,R11,R15—100-ohm
R12—3300-ohm
R14—1500-ohm
R16,R22—10,000-ohm
R19—220,000-ohm
R20—330,000-ohm
R23—22-ohm
R25,R26—2.7-ohm
R27,R29—47-ohm
R28—2700-ohm

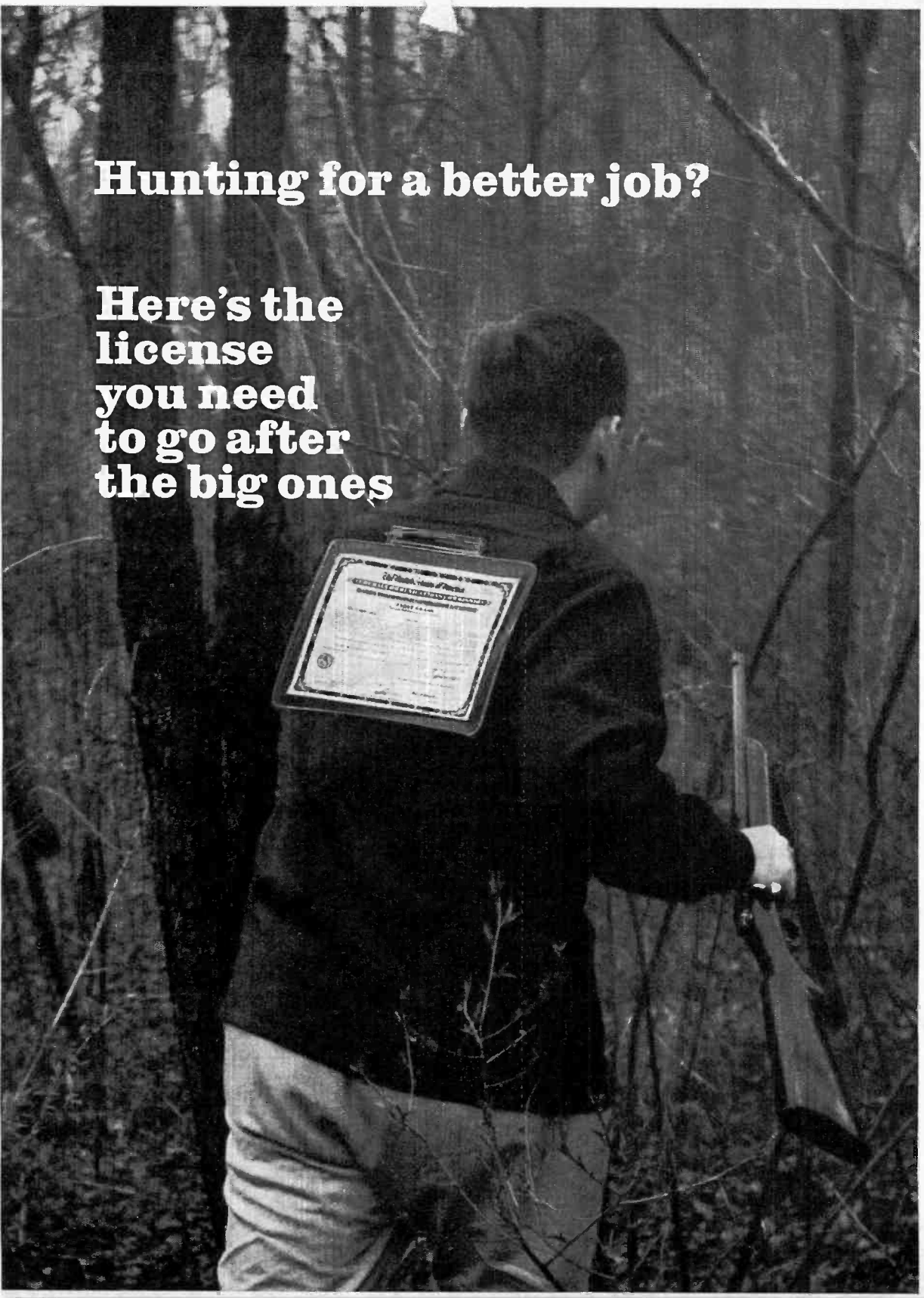
All resistors ½-watt 10% tolerance



R18—1-megohm potentiometer with spst switch (S2)
S1—Special 2-section rotary switch with shield between sections; 3-pole, 3-position switch, first section 1 pole, second section 2 poles
S2—Spst switch, part of R18
SPKR—3" PM speaker, 45-ohm coil (Quam 3A07Z45 or similar)
T1—I-f transformer (J.W. Miller 8901-B)
XTL1—For 5.0-MHz WWV, 5.455-MHz 0.01% crystal, HC/6U holder; for 7.335-MHz CHU, 7.790-MHz 0.01% crystal, HC/6U holder
XTL2—For 10.0-MHz WWV, 9.545-MHz 0.01% crystal, HC/6U holder
XTL3—For 15.0-MHz WWV, 14.545-MHz 0.01% crystal, HC/6U holder; for 14.670-MHz CHU, 14.215-MHz 0.01% crystal, HC/6U holder
Misc.—Crystal sockets, telescoping antenna, knobs, angle brackets, ⅛" spacers, terminal strip, chassis, solder lug, insulating washers, rubber feet, hardware, solder, etc.

Note—The following are available from Caringella Electronics, Inc., P.O. Box 327, Upland, CA 91786: special 2-section rotary switch at $3.95; etched and drilled printed circuit board at $6.95; assembled power supply at $5.95; complete kit of parts for S-meter, including matching cabinet, at $11.95; complete kit of all parts for receiver less power supply and S-meter, including PC board, chassis, and one set of coils and crystal for 10.0-MHz WWV at $54.95. Add $7.95 for each additional set of coils and crystal (specify frequency). All prices postpaid. California residents add 5% sales tax.

Fig. 1. The receiver uses dual-gate MOSFET's for minimum noise, highest gain, and lowest cross modulation. All of this contributes to extremely good sensitivity and selectivity of the receiver. Crystal-controlled local oscillator (Q3) eliminates tuning problems.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Here's the license you need to go after the big ones

A Government FCC License can help you bring home up to $10,000, $12,000, and more a year. Read how you can prepare for the license exam at home in your spare time—with a passing grade assured or your money back.

IF YOU'RE OUT TO BAG A BETTER JOB in Electronics, you'd better have a Government FCC License. For you'll need it to track down the choicest, best-paying jobs that this booming field has to offer.

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An FCC License is a legal requirement if you want to become a Broadcast Engineer, or get into servicing any other kind of transmitting equipment—two-way mobile radios, microwave relay links, radar, etc. And even when it's not legally required, a license proves to the world that you understand the principles involved in *any* electronic device. Thus, an FCC "ticket" can open the doors to thousands of exciting, high-paying jobs in communications, radio and broadcasting, the aerospace program, industrial automation, and many other areas.

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Eugene Frost, Columbus, Ohio, was stuck in low-paying TV repair work before enrolling with CIE and earning his FCC License. Today, he's an inspector of major electronics systems for North American Aviation. "I'm working 8 hours a week less," says Mr. Frost, "and earning $228 a month more."

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If you'd like to succeed like these men, send for our FREE 24-page book "How To Get A Commercial FCC License." It tells you all about the FCC License ...requirements for getting one... types of licenses available... how the exams are organized and what kinds of questions are asked... where and when the exams are held, and more.

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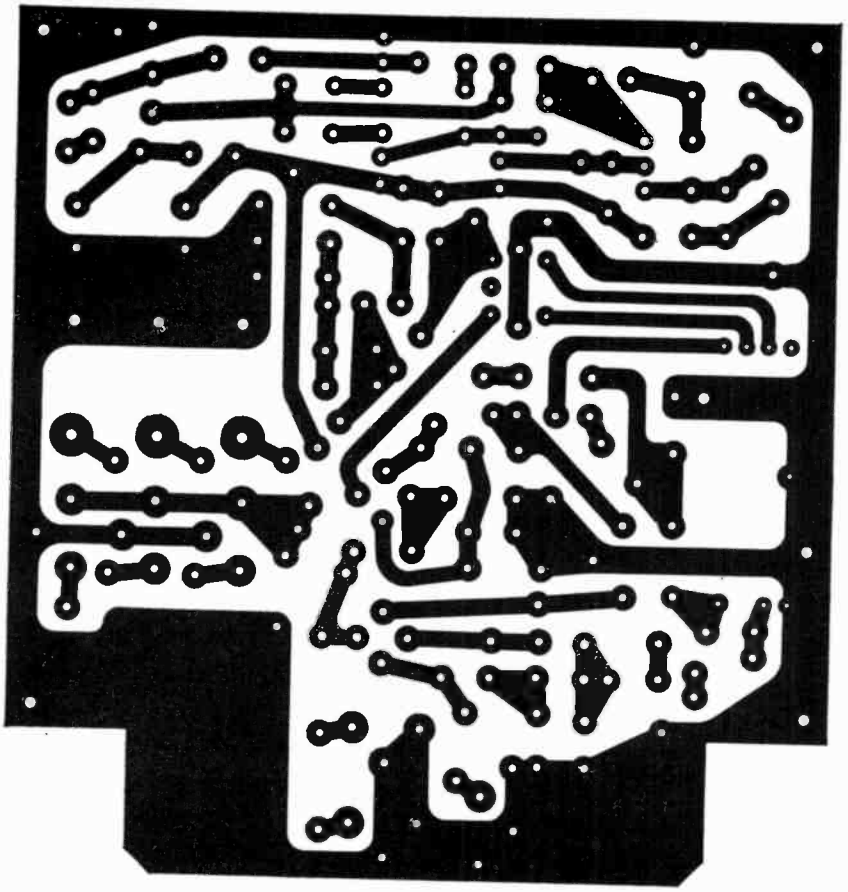


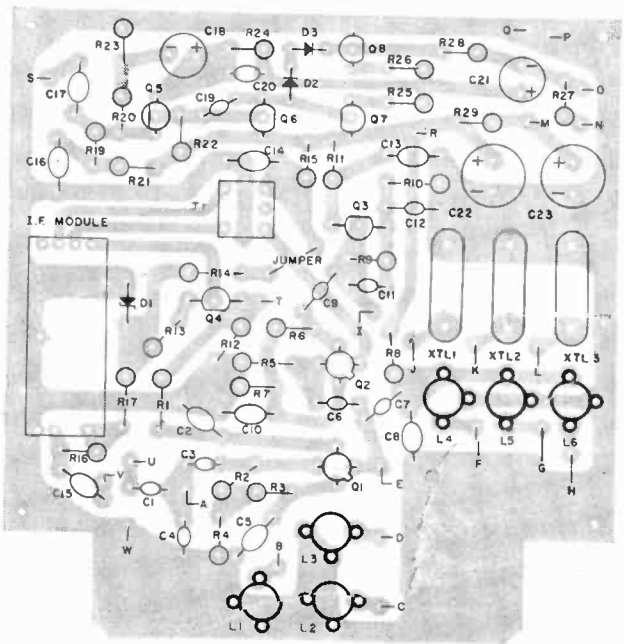


Fig. 2. Actual-size foil pattern and component installation for the receiver. Note that many components are mounted "on end" with the other lead bent over to the appropriate hole in the board. Observe the polarities of electrolytics and diodes and re-read the precautions before wiring the MOSFET's into the circuit (see text).

ment every minute in both English and French.

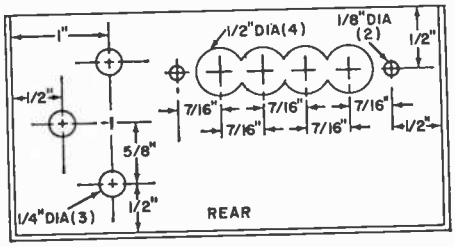
The complete Standard-Time Receiver can be built for about $75, with power supply, crystals, telescoping antenna, and built-in speaker. The circuit (see Fig. 1) consists of an r-f amplifier, mixer, crystal-controlled oscillator, pre-assembled i-f amplifier with built-in detector, and push-pull complementary-symmetry audio amplifier.

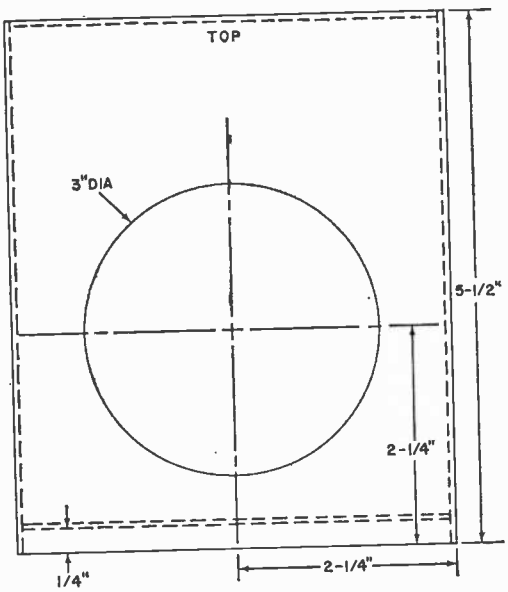
The receiver operates from any 12-volt dc source and, therefore, can be used in an automobile, boat or airplane. It will also operate on 12 volts from flashlight batteries, making it completely portable. Power consumption is 70 mA. For ac operation on the workbench all that is required is a conventional 12-volt filament transformer and four silicon rectifiers in a full-wave bridge configuration. Filtering is provided within the receiver.

A sensitivity of 0.25 microvolt for 10-dB (S+N)/N ratio makes this unit one of the hottest receivers around. A 2′ telescoping antenna is all that is needed in most locations. A jack on the back panel can be used for an external antenna should one be required for mobile operation. Provision has also been made for an external S-meter circuit.

Construction. The receiver is constructed on a printed circuit board as shown in Fig. 2. You can make your own board or purchase it as mentioned in the Parts List. Start by cutting off pin 8 on the preassembled i-f module; this pin is not used. Mount the i-f module and i-f transformer *T1* on the circuit board. To avoid damaging the MOSFET's, use a low-power (50 watts or less) soldering iron—not a gun.

Next, install the coils, crystal sockets, and the jumper wire. Mount all resistors at right angles to the board with one end of the resistor in contact with the board and the lead on the other end folded down to the other hole. After all resistors have been installed, start on the capacitors, being careful to observe the polarities on the electrolytics. Diodes *D1, D2,* and *D3* are also mounted vertically with a heat sink to protect them during the soldering operation. Using care, install transistors *Q3* through *Q8,* again with a heat sink on the leads during soldering. Transistors *Q1* and *Q2* require special handling. Note that they are supplied with a shorting ring on the four leads. Substitute a wire loop for the shorting ring, and remove the loop after the transistor has been soldered in the board.





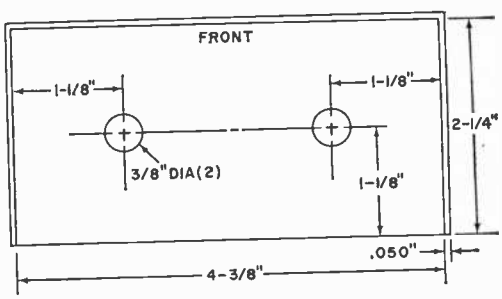
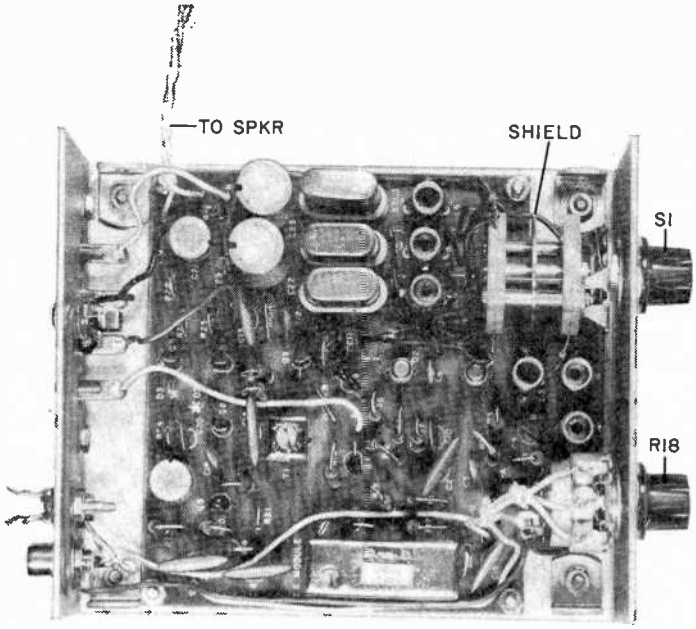


Fig. 3. If you want to duplicate the author's prototype, a metal chassis can be created using the construction information shown above. Thin sheet aluminum was used for the original two-piece chassis, which was formed in two U-shaped sections.

Handling or soldering MOSFET's with the leads unshorted can cause permanent damage.

The prototype receiver shown in the photos was fabricated from 0.050″ sheet aluminum formed into two U-shaped pieces. The front panel, rear apron, and top are



It is recommended that a shield be located between the two segments of S1 to avoid coupling. The collapsible antenna is attached to a pair of insulated fuse clips mounted on the rear apron. The speaker is fixed to the upper part of the chassis, while the four angle brackets secure the two chassis sections.

dimensioned and machined as shown in Fig. 3. Small threaded angle brackets in each corner hold the two parts of the chassis together. The speaker, on the top, is protected by a piece of perforated metal. Other components are mounted as shown in the photos. The antenna mounting clips can be made from a fuse holder, insulated from the metal chassis. No matter what type of chassis is used, make the distance between the board and selector switch *S1* as short as possible to keep the leads to a minimum.

Connect the various leads to the PC board as shown in Fig. 1. And mount the board on ⅛" spacers on the bottom of the chassis. Recheck all wiring and then plug in the crystals making sure that *XTAL1* operates with *L1* and *L4*, *XTAL2* with *L2* and *L5*, and *XTAL3* with *L3* and *L6*.

TECHNICAL SPECIFICATIONS

Sensitivity: 0.25 microvolt for 10-dB S + N/N
Frequency: 5.0 MHz WWV or 7.335 MHz CHU
10.0 MHz WWV
15.0 MHz or 14.670 MHz CHU
Audio Power: Approximately ⅓ watt into built-in 45-ohm speaker
Selectivity: 5 kHz at 6 dB
I-F Frequency: 455 kHz
Power Requirement: 12 volts dc at 70 mA

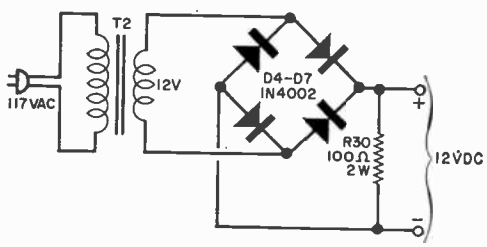


Fig. 4. This simple power supply can be used to power the receiver. No filter is shown as this is provided by components mounted on the PC board.

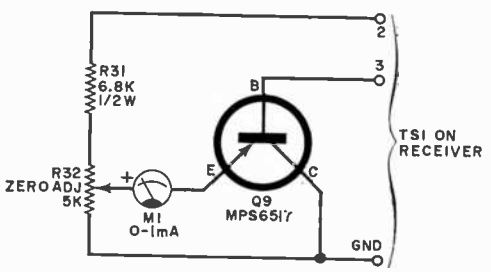
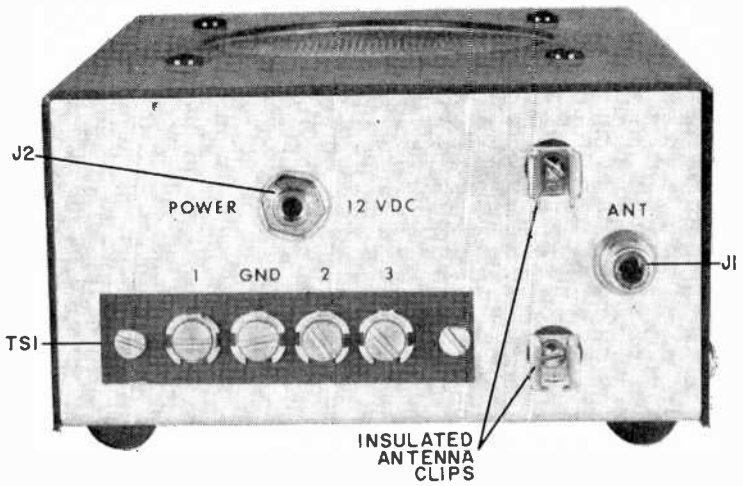


Fig. 5. This simple S-meter circuit is used when aligning an external oscillator with selected WWV.

CHU Conversion. The 5-MHz WWV channel can be converted to receive CHU on 7.335 MHz by replacing *XTAL1* with a 7.790-MHz crystal and *L1* and *L4* with 5.6-10-μH printed circuit adjustable r-f coils (see Parts List). The 15-MHz WWV channel can be converted to receive CHU on 14.670 MHz by replacing *XTAL3* with a 14.215-MHz crystal and realigning *L3* and *L6*.



Although the author used a conventional phone jack for connecting to the external power supply, almost any type of two-terminal connector may be used. The terminal strip may be omitted if you have no need for either the external audio or optional S-meter.

Power Supply and S-Meter. Any type of 12-volt dc power supply may be used with the receiver. One suitable circuit is shown in Fig. 4. Note that no filtering is shown since there are filters on the receiver PC board.

An optional S-meter attachment is shown in Fig. 5. This meter circuit provides a visual aid to obtain precise zero beat when calibrating external oscillators to the extremely accurate WWV signals. The connections shown in Fig. 5 mate with those of TS1 in Fig. 1.

Alignment and Operation. Attach the telescoping antenna to the clips on the rear of the receiver and connect the power source. The receiver can be aligned directly from "on the air" signals as the local oscillator is crystal-controlled. Tune each pair of coils for maximum signal or background noise if the signal is not present. There are also tuning adjustments on the tops of the i-f module and the i-f transformer. They should be touched up to get maximum volume.

Signal strength will depend on the propagation conditions at the time. If the 2′ telescoping antenna does not provide satisfactory reception, attach a longer antenna to *J1*. Reception of WWV on 5, 10, and 15 MHz should be reasonably good throughout most of the U.S.A., and at least one of these frequencies should be audible day or night. Reception of CHU on 7.335 MHz is confined primarily to the East Coast of North America, while reception of CHU on 14.670 MHz extends into the Midwest during daylight hours and into the Far West in the evening. -30-

THEORY OF CIRCUIT DESIGN

The pair of dual-gate MOSFET's *(Q1, Q2)* used in the front end offer high gain with low noise, as well as lower cross modulation and greater dynamic range than either conventional bipolars or single-gate FET's. MOSFET *Q1* serves as the r-f amplifier with the incoming signal applied to gate 1 and the age voltage applied to gate 2. The crystal-controlled local oscillator *(Q3)* consists of a conventional n-channel FET used as an untuned crystal-controlled oscillator.

Switch *S1* selects the desired tuned circuits and the crystal for the selected channel. This switch should have a shield between the switch sections to isolate the input tuned circuit from the output circuit in the r-f amplifier. Otherwise, the r-f amplifier could become extremely unstable and might possibly oscillate due to the high gain within the stage.

After the i-f transformer *(T1)*, the signal is amplified by a commercial miniature preassembled and pre-aligned module that contains two transistors, three i-f transformers, and a diode detector. Transistor *Q4* serves as the age amplifier for the r-f stage as well as provided the driving voltage for an optional, external S-meter circuit.

The recovered audio signal is developed across volume control *R18* and fed to a four-transistor audio amplifier that can deliver about ⅛ watt to the speaker. The audio is also available at a rear apron terminal strip for headphones.

The external 12-volt dc source need not be filtered since *C22, C23* and *R29* perform this function.

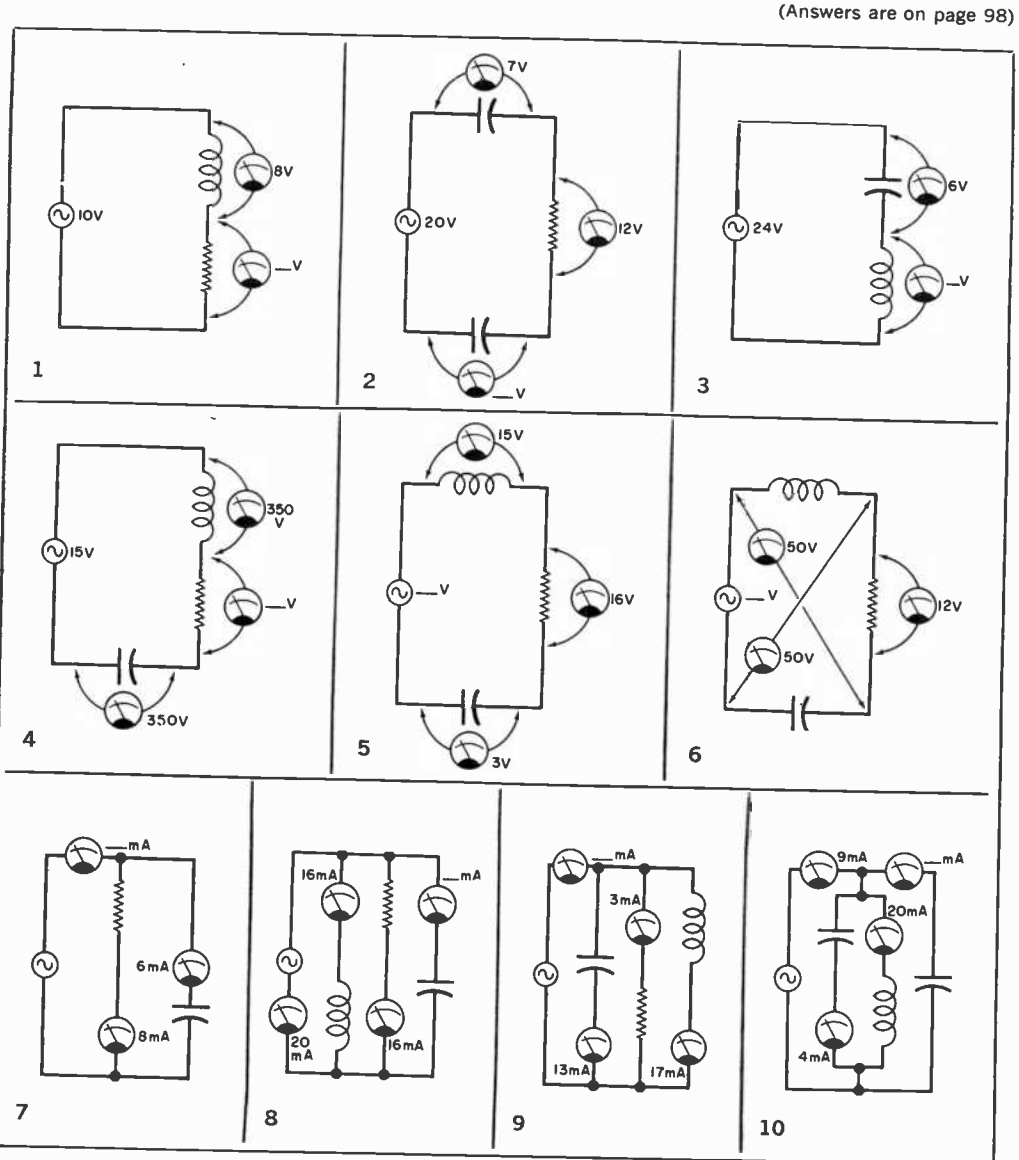
QUIZ ON AC CIRCUIT THEORY

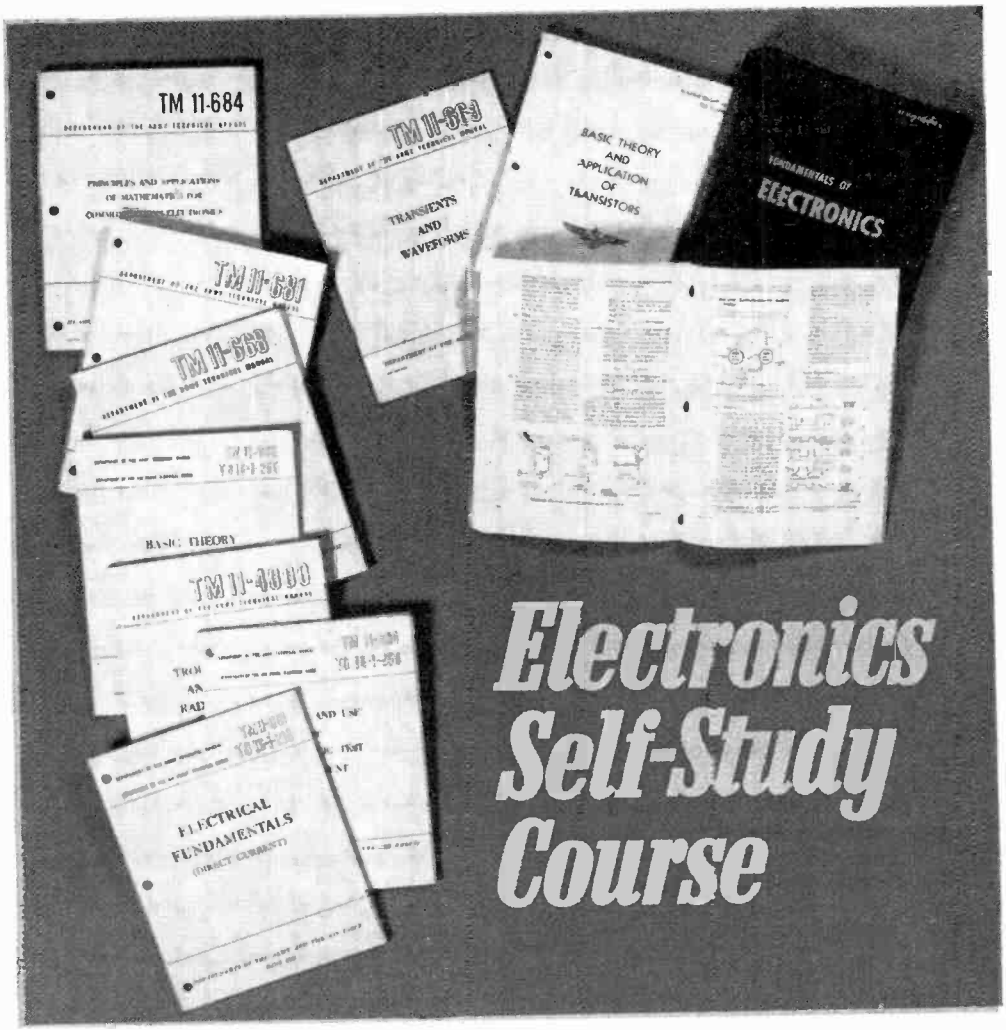
BY ROBERT P. BALIN

Voltage measurements made in a series ac circuit seldom add up as simply as they do in a dc circuit. You may even find the voltage across a coil or capacitor to be greater than the supply voltage! Nevertheless, Ohm's Law and Kirchhoff's Law do apply, and careful measurements will show that the supply voltage and the various voltage drops around a series ac circuit are related in an unusual way: the square of the supply voltage is equal to the square of the difference between the voltage on the coil and the voltage on the capacitor, plus the square of the voltage on the resistor. This relationship, $(VT)^2 = (VL\text{-}VC)^2 + (VR)^2$, can be used to find any unknown voltage if all others are known.

In parallel ac circuits, the currents add up the same way as voltages do in a series ac circuit. Brush up on your ac theory and see if you can solve the missing voltage or current in the circuits below. Where necessary, the voltages and currents are related by the 3:4:5 ratio to provide easy, whole number answers. Only simple algebra is required. Vectors, phasors, and quadratic equations are not necessary to find the solutions.

(Answers are on page 98)





SETTING UP A TRIAL HOME-STUDY PROGRAM

COURTESY OF THE GOVERNMENT PRINTING OFFICE

IT'S AN ESTABLISHED FACT that money spent on an electronics education is a wise investment. Of course the most common—and most highly recommended—avenues of obtaining an electronics education are through resident and formal home study courses. There are, however, several reasons why you might not wish to commit yourself to a "formal" educational program.

A hobby interest in electronics, for example, might not justify the cost of the training. Or, you might lack sufficient exposure to electronics and its career opportunities to have a firm incentive. You might even be in a disadvantaged situation where technical training is simply a luxury.

Whatever your reason, the main objection is likely to be the rather large monetary commitment for something that might not pan out. However, there is one more avenue you might give thought to trying: informal, or "go-it-alone," home study. Self-study is fraught with built-in disadvantages, admittedly. But with proper guidance and a wise choice of study materials, you *can* gain a firm understanding of the theories employed in electron-

BY KENNETH J. ENGLERT

ics, using this knowledge as a stepping stone to bigger and better things. If electronics, on the other hand, is not your cup of tea, you will find this out, too—without losing much more than pocket money.

The one major advantage to self-study is that the monetary investment is minimal. All you really have to pay for are the materials used for studying—in this case a generous supply of textbooks. Beyond this, your only investment will be the time you use to apply yourself to studying. There are no consultation or guidance fees to add to your "tuition."

A Realistic Program. Just grabbing a book off a shelf and reading it is no guarantee that you will learn anything or that you will learn enough of anything to give you a broad enough scope. Going one step further, an indiscriminate selection of study materials can do you more harm than good. The texts in most electronics books presuppose either prior electronics training or that the reader will have available some form of guidance. Few books, other than those written in a "programmed" format, are truly tailored to the needs of self-study programs.

The immediate aim, then, is to select the best possible study materials that can be obtained on a very limited budget. Fortunately, military training manuals (available from the U.S. Government Printing Office) admirably meet both demands. Listed in the Study Materials Table (see below) are twelve training manuals that, when taken together, can provide a complete course in modern electronics technology. Yet, the cost of the entire package of books comes to only $18.55, including postage and handling.

The twelve military training manuals selected to make up a self-study course cover not only the basics that are common to all areas of electronics, but they also cover such advanced topics as pulse and switching circuits, transients and waveforms, oscilloscope and other test equipment circuitry, wideband amplifiers, microwaves and radar, etc. In fact, the material presented in these manuals covers every area of the technology.

The training manuals contain a great deal more than just "dry theory." They are well organized and profusely illustrated for easy understanding. And, although they were originally intended for use in a classroom environment, the Department of Defense has successfully used them in many thousands of non-classroom situations. This is due primarily to the fact that the material is presented in an easily understood language so that it can be quickly absorbed by the average military trainee. Even if you are still a high school student, you should experience little difficulty in understanding the material.

Once you have the training manuals (you need not buy them all at once since the first three manuals listed in the Table will see you

STUDY MATERIALS TABLE

MANUAL NO.	MANUAL TITLE	GPO CAT. NO.	PRICE*
AF-101-8	Fundamentals Of Electronics	D301.7:101-8	$4.00
TM-11-661	Electrical Fundamentals (D.C.)	D101.11:11-661	$1.00
TM-11-662	Basic Theory And Application Of Electron Tubes	D101.11:11-662	$1.25
TM-11-664	Theary And Use of Electronic Test Equipment	D101.11:11-664	$ .75
TM-11-6668	F Transmitters And Receivers	D101.11:11-668	$1.50
TM-11-669	Transients And Waveforms	D101.11:11-669	$ .50
TM-11-671	Cathode Ray Tubes And Their Associated Circuits	D101.11:11-671	$1.25
TM-11-672	Pulse Techniques	D101.11:11-672	$ .55
TM-11-681	Electrical Fundamentals (A.C.)	D101.11:11-681	$2.25
TM-11-684	Principles And Applications Of Mathematics For Communications-Electronics	D101.11:11-684	$1.25
TM-11-690	Basic Theory And Application Of Transistors	D101.11:11-690	$2.25
TM-11-4000	Troubleshooting And Repair Of Radio Equipment	D101.11:11-4000	$2.00

*Send check or money order in full with order to Superintendent of Documents, U.S. Government Printing Office, Division of Public Documents, Washington, D.C. 20402.

Manuals are updated as required. Superseding material and directions for use are supplied with appropriate manuals in the form of addends sheets.

through quite a few study sessions), leaf through them and examine their tables of contents. You will note that there is a wide diversity of topics and that each topic is treated to an in-depth discussion.

The reason for selecting twelve books in preference to a single all-encompassing volume is that the repetition of the material covered is an important facet of the learning process. Furthermore, since most subjects are discussed more than once and from slightly different points of view, any questions that might arise will usually be anticipated so that your progress will not be impeded.

A program of study using the twelve manuals listed should be based on a logical selection and order of topics. If you wish, you can send 25¢ to this magazine (to cover postage and handling) for a 167-lesson program, an excerpt of which is shown on page 48, that will let you make full use of your materials. This program is simply too lengthy to publish in the pages of this magazine; so it is offered separately. Bear in mind that the program is designed *only* for the manuals and not electronics books in general.

About the Manual Program. While the program for the self-study course is planned for those people who have no experience or previous background in electronics, the student with some knowledge or experience must judge for himself what material he thoroughly understands and can skip. Most of the manuals have review questions at the end of each chapter that can serve as a guide. If you can unhesitatingly answer these questions, you can safely bypass the material of the subject the questions refer to. Also, the same applies to your study efforts; if after studying a chapter you can answer the review questions with certainty, you can go on to the next chapter.

The importance of a solid understanding of the basics cannot be overemphasized. You must resist the temptation to skim over this very vital part of your studies. It is not until these fundamental concepts are fully understood that you can hope to master the more complex theory and circuitry that you will encounter as you progress in your studies. Even if you are more advanced, you should take advantage of the excellent lessons on basic electronics theory.

As mentioned earlier, the manuals that make up this course are profusely illustrated, including several large fold-out schematic and block diagrams that help to clarify the text material.

Electronics is a branch of the physical sciences and as such is best explained and understood through mathematics. But don't let the word "mathematics" scare you off. A little of it is necessary for the comprehension of some of the more advanced topics. The manual chosen to teach you math, TM 11-684, is one of the finest tutorial math books available today. It presupposes that the student has had only small exposure to mathematics and starts off with percentages, ratios and proportions, and powers and roots. Then, step by step, it explains in detail algebra, geometry, and trigonometry. All this is done in such a way that your absorption of mathematics will be practically painless.

Besides the many clear example problems presented in each chapter of TM 11-684, exercise problems are provided for you to work out on your own. Answers for the exercise problems are given in the rear of the book so that you can check your progress as you go along. Lessons on how to use the slide rule and

SAMPLE OF COURSE OUTLINE*

Lesson No.	TM or AF No.	Chapter	Chapter Title
59	101-8	17	Parallel AC Circuits
60	11-684	11	Radians
61	101-8	18	Resonance
62	11-684	12	Vectors
63	11-681	4	AC Circuits With Inductance, Capacitance and Resistance
109	11-664	9	Signal Generators And Oscillators
110	11-668	2	Principles of FM
111	11-690	5	Bias Stabilization
112	11-664	10	Frequency Measurement
113	11-668	3	Methods Of Producing FM
137	11-669	1	Analysis Of Non-Sinusoidal Waveforms
138	101-8	23	Cathode Ray Tubes
139	11-669	2	Transient Response
140	101-8	33	Basic Radar Principles
141	11-669	3	Response Of R-L Circuits
142	101-8	34	Microwave Oscillators

*See text for availability of complete course outline.

the binary number system, which is the basic language of computers, are also included.

Course Limitations. It would be unfair to tell you that this is the "ultimate" course of study for obtaining an electronics education. In spite of the extremely low cost of the self-study course, it should be pointed out that it is no substitute for a good resident course or home study training through an accredited school.

One of the more serious limitations of the course is its lack of practical training. The Department of Defense backs up the training manuals with solid laboratory and on-the-job training experience. As a private individual, you will have no such facilities available to you and must look elsewhere for practical experience.

Secondly, there is no "feedback" from instructors or teachers in the form of exams for you to gauge your rate of progress. If you get stuck on a particular topic or idea propounded in the manuals, there are no consultation services for you to appeal to. Your only recourse here would be for you to find someone who might be able to help; say, someone from a local radio club.

Another disadvantage is that the low monetary commitment and lack of formal guidance might induce you to slacken your incentive as you go along. (This is not an uncommon ailment even with formal study programs, but you will probably be more prone to it since you will lose very little if you decide to discontinue your studies.) The only answer to this problem is to practice self-discipline. Set up a study schedule and allow nothing to interfere with it. Do not allow a day to pass without applying a certain predetermined minimum of time on your studies. Slacken once and you are almost certainly going to back slide.

One final disadvantage of any self-study course is that no diploma or certificate of completion is forthcoming when all of the work is behind you. However, you can obtain a side benefit which will attest for your proficiency in electronics. You can apply your knowledge toward obtaining a Federal Communications Commission Radiotelephone License. This document, especially if it is a First Class "ticket," is a formidable document when you apply for a job. And once you have that job (be fair and tell your employer that your knowledge of electronics is limited only to the theory; you will gain practical experience on the job) you can enroll in a formal course that will yield you a diploma.

Self-study *is* a means of obtaining an education in electronics. But it is up to you to decide whether or not you are satisfied to sit back and marvel at the wonders of electronics without getting involved. Only you can make up your mind to become an active participant.

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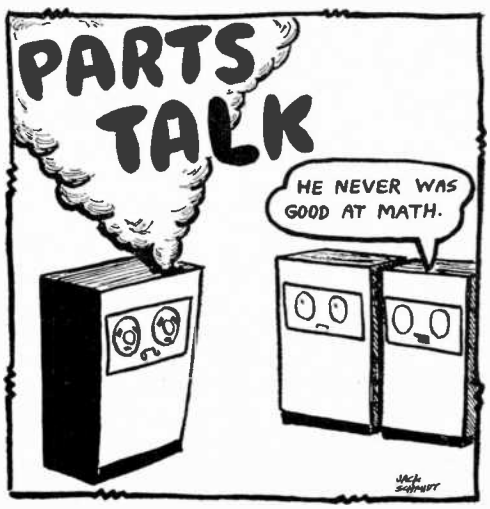
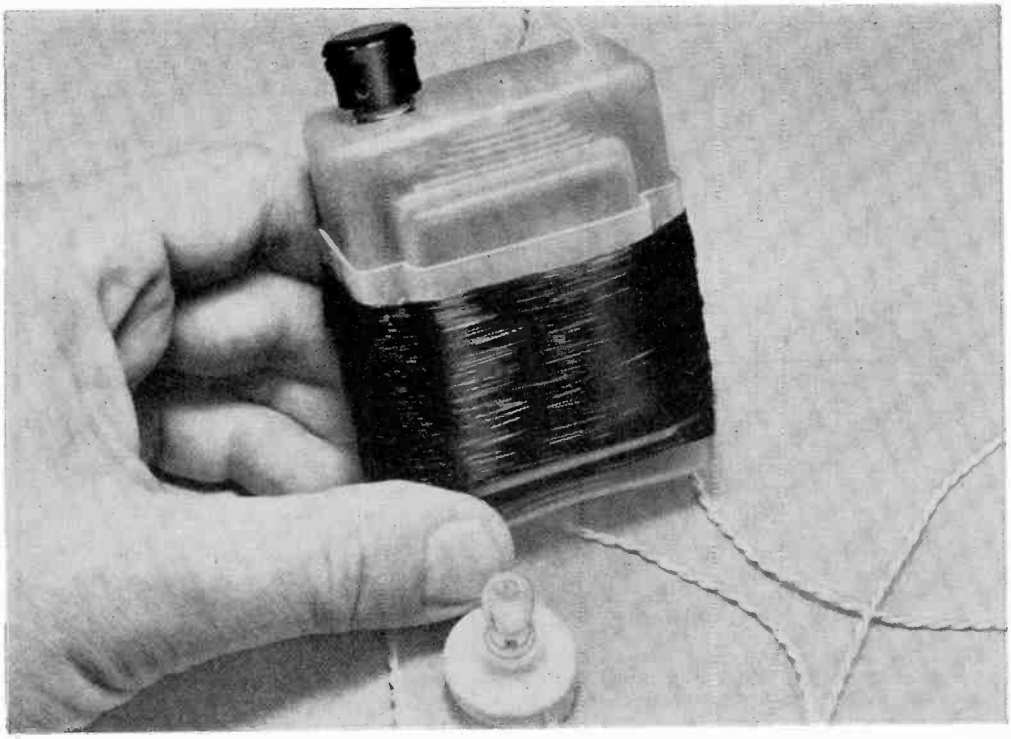




BUILD THE LIBERATOR

KEEPS YOU IN TOUCH WHILE ON THE GO

Built inexpensively and easily in a plastic cigarette case, this handy project "liberates" you from the necessity of sticking by your receiver when calls are few and far between. An integrated circuit and printed circuit board make construction foolproof.

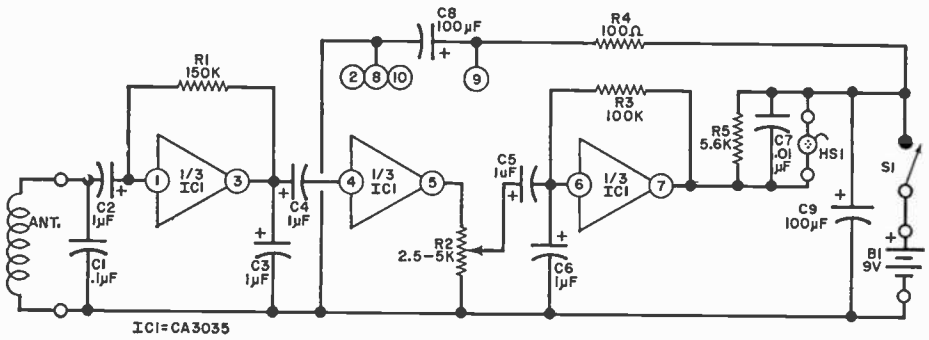
THERE ARE TIMES when it becomes an impossible task to remain glued to a communications receiver if you are a ham, CB'er or SWL. Having to sit waiting for an identification to be made or a call to come through can be quite boring. The "Liberator," a shirt-pocket-size induction (not r-f) receiver, permits you to move about the house, office, or even a large area away from the receiver and still hear everything that is going on at the receiver.

The Liberator can also be used for private, individual listening to conventional radios or audio systems. This is a particular advantage if one person in a group likes to hear loud music and the others don't.

Theory of Circuit Design. The complete system can be considered to be a form of audio transformer. The receiver or amplifier drives current through an ordinary wire transmission loop that is strung around the area of interest and produces a magnetic field that varies at the audio rate. This forms the primary of the transformer.

The receiver (see Fig. 1) has an "antenna" which forms the secondary of the transformer and detects the varying magnetic field. This

BY C. P. TROEMEL



PARTS LIST

B1—9-volt battery
C1—0.1-0.47-μF capacitor (see text)
C2-C6—1-μF, 10-volt electrolytic capacitor
C7—0.01-μF capacitor
C8, C9—100-μF, 10-volt electrolytic capacitor
HS1—Crystal earphone (Lafayette 99E25512 or similar)
IC1—Integrated circuit (RCA CA3035)
R1—150,000-ohm, ½-watt resistor
R2—2500-5000-ohm miniature replacement potentiometer with switch (Lafayette 99E60-196 or similar)
R3—100,000-ohm, ½-watt resistor
R4—100-ohm, ½-watt resistor
R5—5600-ohm, ½-watt resistor
Misc.—Battery clip, plastic cigarette case, #24 or #26 enamelled wire, knob, wire for loop, switch for loop.

Fig. 1. The circuit is basically a high-gain IC amplifier whose input is a loop "antenna", which forms the secondary of the induction system. With the transmitting loop wound around the main floor, excellent reception was obtained from basement to attic of a typical three-story brick structure.

signal is then amplified by an integrated circuit (*IC1*) to drive an earphone. The antenna and *C1* resonate within the audio range to reduce the effect of interference from nearby r-f transmitters. The frequency response is limited to reduce noise from both 60-Hz power lines and emissions from TV receiver sweep circuits. A crystal earphone is used to prevent feedback between it and the receiving antenna. The IC contains three independent amplifiers and has an overall gain of approximately 100,000 (100 dB). Resistors *R1* and *R3* bias the first and last amplifiers for linear operation.

Transmitter. The transmitting loop consists of a length of insulated wire surrounding the area to be covered. Inside a building, the loop may be concealed in the wall moldings, under a large rug, or taped to the walls or ceiling. For outside use, the wire can be supported on insulators on posts or just simply strung (off the ground) around the area. The actual configuration depends on the location. Keep the coil off the ground and make sure it is insulated from metal surfaces. If the loop is to be located some distance from the amplifier, connect the two with ordinary two-conductor lamp cord or TV twin lead.

Usually, one turn of wire around the area should be enough. However, two things should be kept in mind: the current in the loop and the number of turns determine the strength of the field; and do not overload or short circuit the transmitting amplifier by connnecting a loop having too low a resistance.

Survey the area to be covered by the loop and calculate how long the wire will have to be to make the loop. Then determine the output impedance of the amplifier used (usually specified on the amplifier or in the instruction manual). The loop dc resistance can then be made approximately equal to the amplifier output impedance by choosing the correct wire size. Resistances of the more common wire sizes are given in the Table. Pick the wire whose resistance for the length required comes

RESISTANCE (OHMS) OF WIRE

Wire Length	Wire Size			
feet	#20	#22	#24	#26
25	0.26	0.40	0.64	1.0
50	0.51	0.80	1.3	2.0
100	1.0	1.6	2.6	4.1
150	1.5	2.4	3.9	6.1
200	2.0	3.2	5.1	8.2
300	3.0	4.8	7.7	12.2
400	4.1	6.4	10.2	16.3
500	5.1	8.0	12.9	20.4

closest to the output impedance of the amplifier. If the finished loop has less resistance than that required, a small fixed resistor can be added in series with the loop to make up the difference. However, since signal will be lost in this resistor, consider using a double loop around the area, with a larger-diameter wire.

To power the transmitting loop, simply switch the normal output leads that go to the speaker to the loop (see Fig. 2).

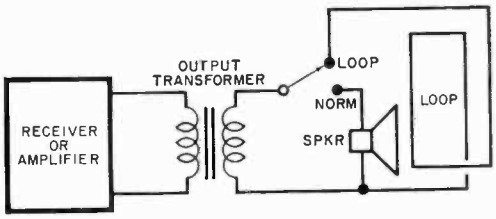


Fig. 2. If you wish simultaneous loop and speaker operation, hook a low-impedance speaker in series with the loop, so that the total load is the same as normally used with the particular transformer.

Receiver. The circuit of the receiver is shown in Fig. 1. It can be constructed on a printed circuit board using the foil pattern shown in Fig. 3. Once the board has been made, install the components, taking care to observe the polarity of the electrolytic capacitors and the orientation of the IC.

The prototype was built in a common plastic cigarette case with the board supported by the mounting hardware of potentiometer *R2*. A small hole, just large enough to accommodate the twisted-lead cable from the earphone, is made on the same side as the *R2* mounting.

Before installing the board in the case, the receiving antenna must be made. Drill two small holes at the end of the larger of the two plastic halves and feed about six inches of the end of #24 or #26 enamelled wire through one hole. Wind 150 to 200 turns of the wire around the plastic case and feed the other end of the wire in through the second hole. Leave about six inches on this end also. Coat the winding with cement or tape to hold it in place.

After connecting the earphone and battery leads and the two antenna wires to their proper holes on the PC board, slide the board into the plastic case. Locate the position of the shaft of *R2* and drill a suitable hole for it. Insert the board and secure it in place with the mounting hardware of *R2*. Put a knob on the potentiometer and turn the switch off. The battery is stored in the antenna half of the case.

Operation. With the earphone in your ear, turn on the Liberator. You should hear some hum, which can be made a maximum by orienting the antenna in different directions. The hum will be loudest when the Liberator is held near a fluorescent lamp.

Apply power to the transmitting loop by having some program material properly set up on the transmitter amplifier. Turn the amplifier gain up slightly. Switch its output to the loop position. If the Liberator is turned

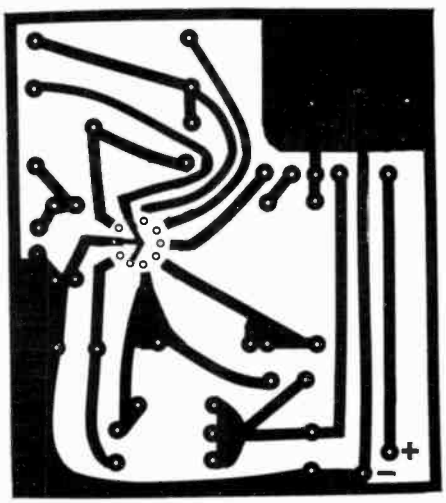
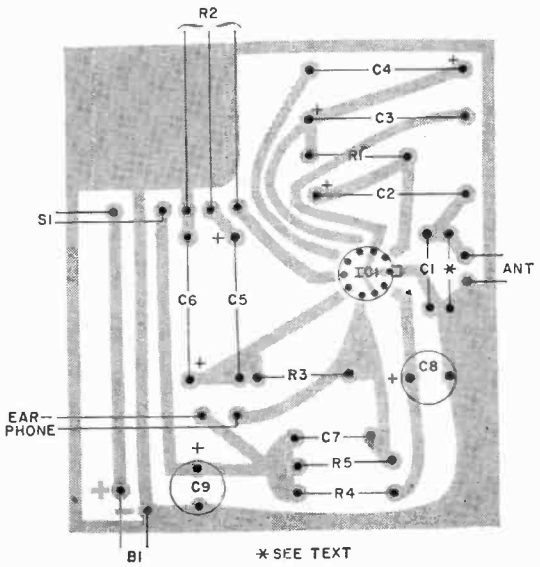
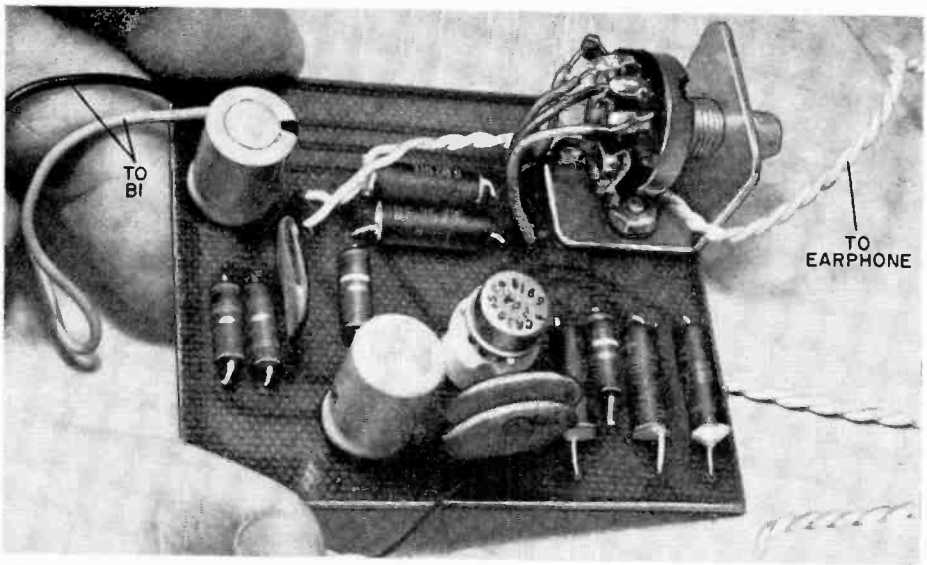
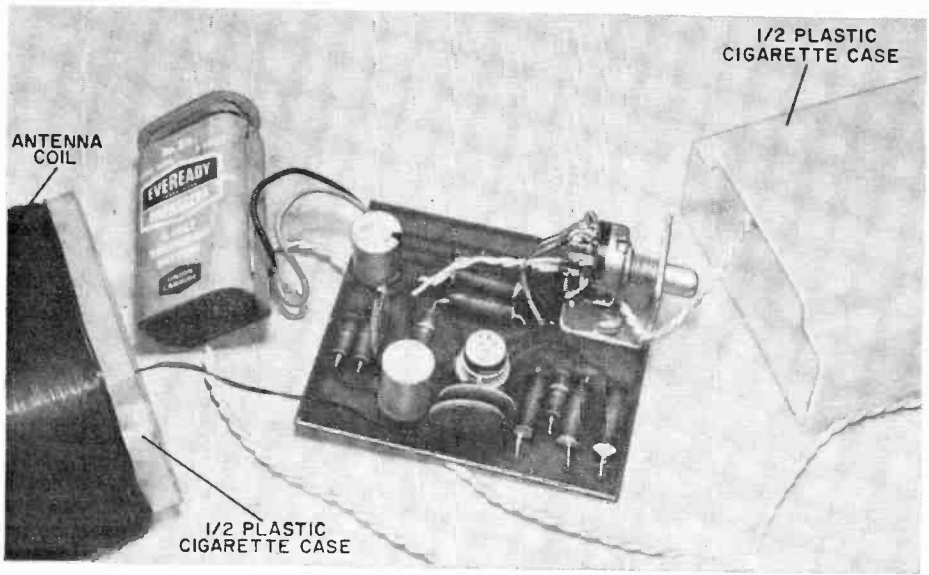


Fig. 3. Actual size foil pattern and component installation. Observe the placement of IC1 and the polarity of the electrolytic capacitors.





Although presently as small as a cigarette pack, the receiver can be made smaller by tightening up on the foil pattern, eliminating the IC socket, and using smaller physical sizes for C8, C9 and R2. A hearing-aid battery can be substituted for the 9-volt transistor radio battery, and a ferrite loopstick can be tried in place of the coil. Any number of receivers can be used on one loop.



on, you should hear the program on the earphone. You will get the best reception when the plane of the Liberator antenna coincides with the plane of the transmitting loop, and you are within the loop. Adjust the transmitting amplifier's volume for minimum distortion; gain can be adjusted on the Liberator. If you are using battery powered gear for the transmitter, keep its volume control down to conserve power.

Modifications. To improve low-frequency response, the values of coupling capacitors *C2*, *C4*, and *C5* can be increased. However, the pickup of unwanted 60-Hz noise will be increased. Shunting capacitors *C3*, *C6*, and *C7* control the high-frequency gain and amplifier noise. Smaller values here will improve the high-frequency response, but will also increase the noise.

(*Continued on page* 98)

BUILD AN SCA ADAPTER FOR FM RECEPTION

Phase-Locked Loop Technique Simplifies Design

One of the inherent advantages of integrated circuits is the manufacturer's ability to design a complex circuit that would otherwise necessitate scores of discrete components on a single chip. This circuit is built around the Signetics NE-565 IC in a phase-locked loop configuration. This is the first hobby use of this IC to appear in a national electronic experimentation magazine.

MANY FM STATIONS broadcast special educational material and music (without commercials) on the SCA subcarrier. This programming material is used (on a subscription basis) by commercial institutions for background music. The normal home receiver cannot pick up the SCA program without a special adapter. It is illegal to use such an adapter in a commercial establishment; but you can do so for your own personal pleasure at home.

The SCA subcarrier frequency is 67 kHz—which is high enough not to interfere with either the main carrier or the stereo subcarrier sidebands. A suitable filter and detector may be used to extract the SCA subcarrier, but because the modulated frequency deviation of the SCA subcarrier is such a large percentage of the subcarrier center frequency, it is difficult to make an FM detector using tuned circuits. In most cases, the very low Q that would be required to get linear demodulation using this method would result in a very low detected output. Also, the exacting alignment of the filter and detector requires special equipment and critical adjustments. All of these problems can be alleviated by using a "phase-locked loop" (PLL) detector to demodulate the SCA subcarrier. Using such a concept and taking advantage of a new integrated circuit to simplify the design and construction, it is possible to construct a modern SCA adapter that has no critical adjustments and is easily coupled to any good FM receiver.

Theory of Circuit Design. A phase-locked loop such as that shown at Fig 1A consists of three elements: a phase comparator or detector, a low-pass filter, and a voltage controlled oscillator. The phase detector compares the phase of the incoming signal with the phase of the signal from the voltage-

BY VINCENT WOOD

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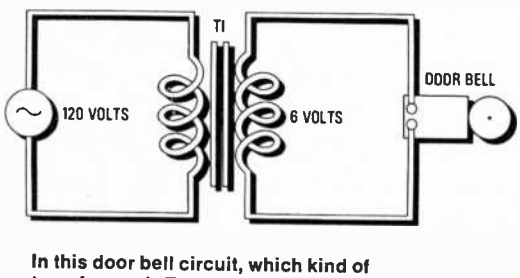

In this door bell circuit, which kind of transformer is T_1—step-up or step-down?

Note: if you had completed only the first lesson of *any* of the RCA Institutes Home Study programs, you'd easily solve this problem.

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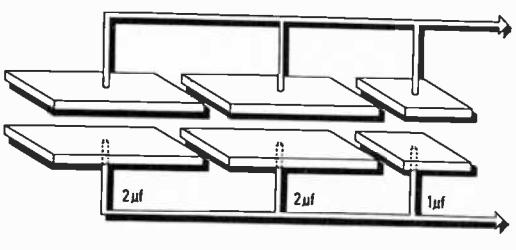

What is the total capacitance in the above circuit?

Note: you'd know the solution to the problem if you'd taken only the first two lessons in RCA's new Communications Electronics Program.

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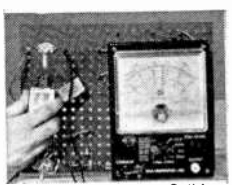

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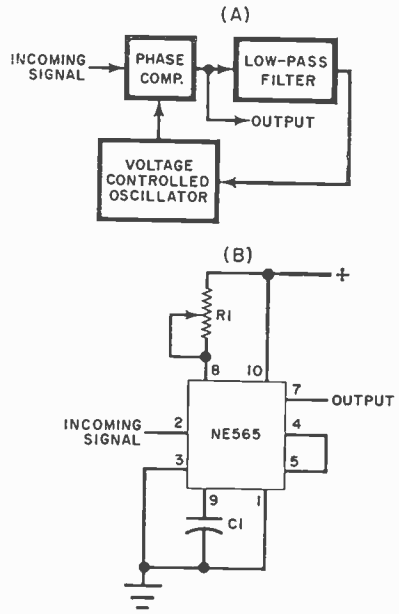


Fig. 1. The VCO tries to lock to the frequency of the incoming signal because of error voltage coming from the phase comparator. The filter removes the audio leaving the dc component. Error voltage varies with the SCA signal and becomes the audio.

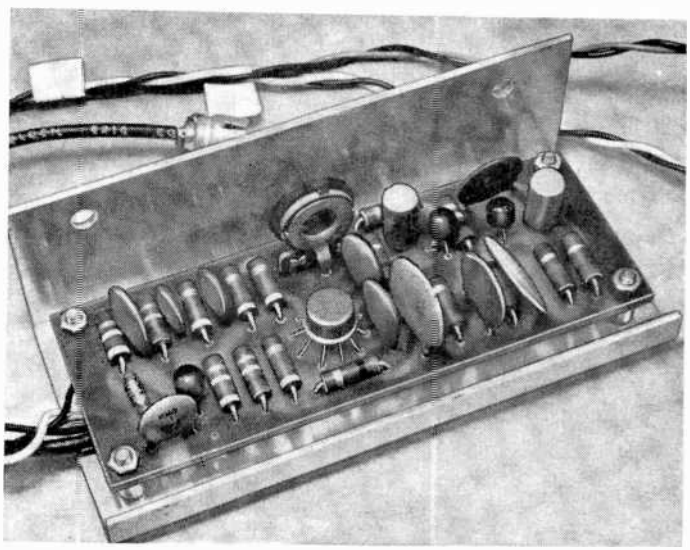
controlled oscillator and generates an output voltage that is proportional to the phase difference between the two. This voltage is filtered and applied to the oscillator so that it always tries to reduce the phase difference between the two signals. The loop is "locked" when the control voltage causes the oscillator frequency to equal the average frequency of the input signal.

Most television receivers use a similar phase-locked loop in the horizontal sync section. The phase detector in the TV set compares the frequency of the horizontal oscillator with a large number of horizontal synch pulses and adjusts the horizontal oscillator frequency so that the average phase difference is very small. The effect of any noise that may be present is greatly reduced by the phase-locked loop since it is an averaging process.

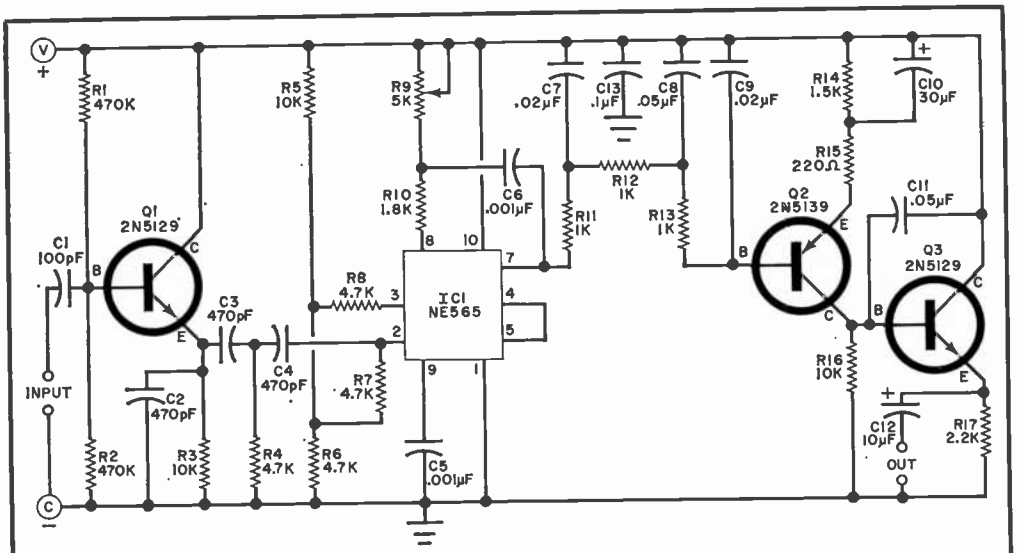
Note that the oscillator frequency tries to track the incoming frequency if the latter should change for any reason. Since the input to the PLL SCA system is a signal with some noise and the output of the VCO is clean, noise coming in is rejected.

The integrated circuit used in this project contains all of the elements necessary for the phase-locked loop and can provide highly linear FM demodulation over a range of 60% of the center frequency. Linearity is typically within 0.5% and the IC can be used to 300 kHz.

The VCO portion is set to oscillate at approximately the frequency we desire to demodulate by changing the values of *R1* and *C1* as shown in the simplified circuit in Fig 1B. When a frequency-modulated input is applied to pin 2, the output at pin 7 consists of the error signal generated by the phase difference between the VCO and the incoming signal. This error signal is exactly the same as the frequency modulation of the incoming signal, less noise; and, after proper de-



The SCA adapter is small enough to be mounted within the FM receiver being used, with a small bracket for support. The low power requirements enable this unit to be directly connected to the 9-to-18 volts usually used in solid-state receivers. The text explains a simple circuit to be installed if you use a vacuum-tube unit.



PARTS LIST

C1—100-pF polystyrene capacitor
C2-C4—470-pF ceramic disc capacitor
C5, C6—0.001-μF ceramic disc capacitor
C7, C9—0.02 μF ceramic disc capacitor
C8, C11—0.05-μF ceramic disc capacitor
C10—30-μF, 6-volt electrolytic capacitor
C12—10-μF, 15-volt electrolytic capacitor
C13—0.1-μF ceramic disc capacitor
IC1—NE565 integrated circuit (Signetics)
Q1, Q3—2N5129 transistor
Q2—2N5139 transistor
R1, R2—470,000-ohm
R3, R5, R16—10,000-ohm
R4, R6-R8—4700-ohm
R10—1800-ohm
R11-R13—1000-ohm
R14—1500-ohm
R15—220-ohm
R17—2200-ohm
R9—5000-ohm trimmer potentiometer (IRC X-201 or similar)
Note—The following are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216: etched and drilled printed circuit board #179 at $2.15, postpaid; complete kit of parts #179C including PC board at $14.55 plus postage and insurance for 8 oz.

Fig. 2. Phase-locked loop IC is connected through an emitter follower (Q1) to remove any loading on the FM detector. Once R9 is properly adjusted, there are no further adjustments to be made.

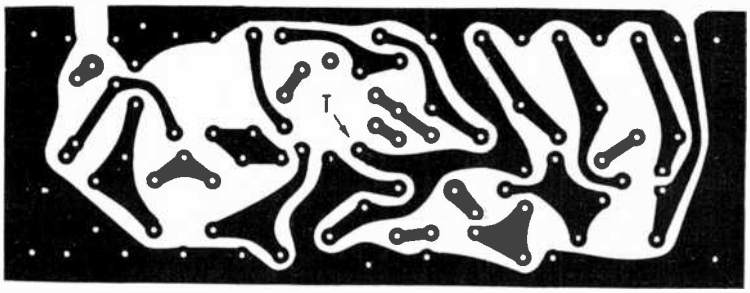
emphasis, it can be used to drive an audio amplifier.

Transistor *Q1* is a high-input-impedance emitter follower which prevents loading on the tuner output. The signal is filtered by *R3, R4, C3,* and *C4* to remove as much signal below 50 kHz as possible. This makes it much easier for the PLL system to lock on and retain the SCA subcarrier at 67 kHz.

The demodulated output at pin 7 is passed through another filter to remove any high-frequency noise and provide de-emphasis, before voltage amplification (to 1 volt) by *Q2*. Transistor *Q3* is a conventional emitter follower used to drive the outboard audio system. The top of the frequency range of the entire system is approximately 7 kHz, which is sufficient for the type of programming usually carried on the SCA subcarrier.

Construction. The schematic of the adapter is shown in Fig. 2. The entire circuit is assembled on a printed circuit board as shown in Fig. 3. All parts, with the exception of the transistors and the IC, should be pulled down firmly against the board with their leads bent over and soldered to the foil. Leave about ⅛" of lead exposed on each transistor and be sure pin arrangement is correct before soldering them in place. The leads of the IC must be separated and bent to form a "spider" arrangement. Again be sure the leads are properly oriented before soldering it in place. The "T" on the foil pattern indicates where the tab should be. Use a low-power soldering iron and fine solder (resin flux).

The adapter circuit board can be mounted on a support within the existing tuner or receiver or it can be mounted separately on a



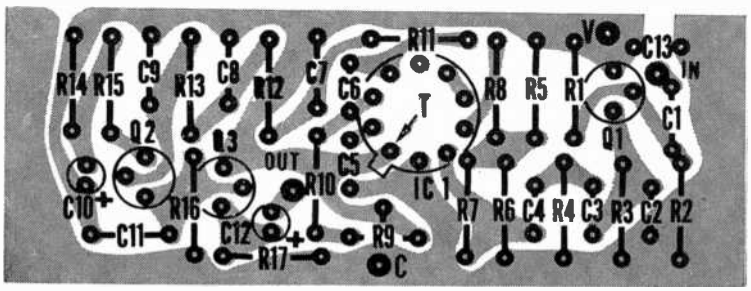


Fig. 3. When installing the components on the board, make sure the IC is oriented properly by noting exactly where the tab is located. Also observe the polarity of the electrolytics and the transistors.

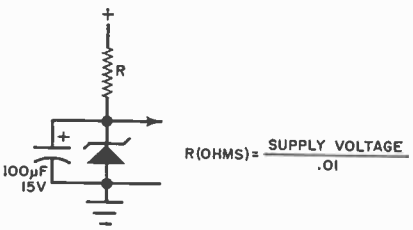
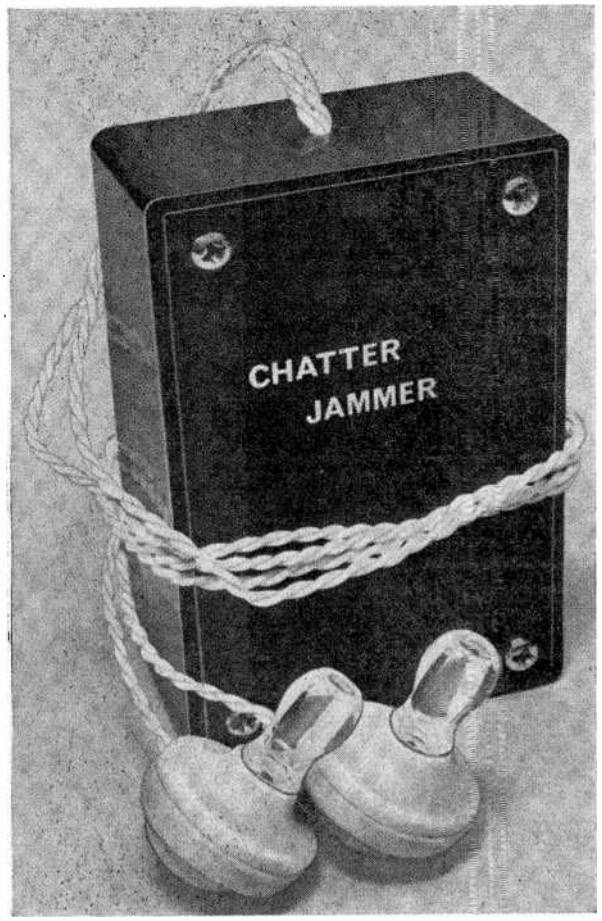


Fig. 4. This circuit is used if you happen to have a vacuum-tube receiver with its high dc voltage. After selecting a 9-to-18-volt zener, and allowing about 10 mA for it, calculate the resistor value.

small metal support. It requires 9 to 18 volts dc at 5 mA, which can be obtained from almost any solid-state tuner or receiver. If you have an older tube-type receiver, a voltage-dropping network such as that shown in Fig. 4 will be necessary. The resistor should be selected to supply approximately 10 mA to the zener diode with the available voltage supply. The zener can be any type within the 9-to-18-volt range.

Operation. The adapter is connected to the FM tuner at the output of the FM detector, before the internal de-emphasis network. It will not work on either stereo output jack. If the tuner or receiver contains a stereo multiplex circuit, the adapter can be connected to the same point where the multiplex circuit is connected.

The output of the adapter is connected to one of the high-level inputs of the audio amplifier. Tune in a station known to have SCA and adjust *R9* until the sound is clear. Once the center of lock range is found, the control may be left alone for all other stations. If you hear some feedthrough during pauses in the SCA transmission, the cause is probably insufficient bandwidth, improper alignment of the tuner i-f strip, or FM detector nonlinearity. In some areas, stations often turn off their SCA subcarrier when not in use. When this happens, the adapter will produce typical interstation noise. -30-



BUILD A PINK NOISE GENERATOR

CUT OUT NOISE POLLUTION AND KEEP YOUR COOL

This article is about a unique device that masks disturbing noises by substituting the gentle "rushing" sound of pink noise. Self-contained, the pink noise generator can be assembled in less than an hour. Its masking effect should not be underestimated.

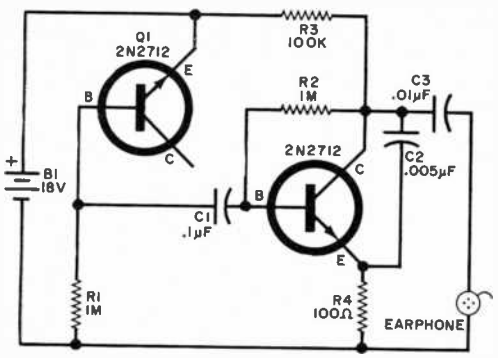
EVERY FAN of spy movies knows that the best way to keep hidden mikes from picking up top-secret information is to repeat the information only while you've got a shower running. Why? Because the sound of the shower covers up the conversation. Probably any sound, such as jack hammers or rock and roll music would do, but a real pro spy will settle only for a shower because it simulates a thing called pink noise.

Pink noise is a special case of a large general class of signal called white noise. Whereas white noise is a Gaussian (equal probability) distribution of all possible frequencies, pink noise is a distribution which is weighted toward the audio spectrum.

Besides being able to mask outside sounds, white noise has some other interesting properties. For instance, many people find a rain storm relaxing; and, while other effects such as the high concentration of ionized air may have some effect, at least part of the general feeling of well-being can be traced to the sound of the falling raindrops—a type of pink noise. The same is true of the sound of the ocean.

Some years ago a group of dentists experimented with the use of pink noise in the place

BY JOHN S. SIMONTON, JR.



PARTS LIST

B1—Two 9-volt transistor batteries connected in series
C1—0.1-μF disc capacitor
C2—0.005-μF disc capacitor
C3—0.01-μF disc capacitor
Q1,Q2—2N2712 transistor (see text)
R1,R2—1-megohm, ½-watt, 10% tolerance resistor
R3—100,000-ohm, ½-watt, 10% tolerance resistor
R4—100-ohm, ½-watt, 10% tolerance resistor
Misc.—Crystal earphones (2); printed circuit board (optional); plastic or Bakelite case; hookup wire; solder; etc.
Note—The following items are available from PAIA Electronics, Inc., P.O. Box 14359, Oklahoma City, OK 73114: etched and drilled printed circuit board for $1.00; complete kit of parts, including PC board but not including batteries for $4.75.

Fig. 1. Operated in avalanche, Q1 serves as pink noise source. To preserve constant-level signal characteristic of pink noise, C2 shunts appropriate levels of high frequencies away from earphone.

of local anesthetics. The results were questionable but in some patients the noise seemed to create a definite reaction on the nervous system so that pain sensations were blocked. Finally, several rock and roll groups mix a little pink noise in with their recordings to add body to the sound—which may be why so many of them are unintelligable.

The point of all this is that, if you must work in a noisy environment and sometimes have trouble concentrating or if you're just "up tight," you might want to try the "Chatter Jammer," a cheap, shirt-pocket-size generator of pink noise that not only keeps the noise out but will probably soothe your nerves as well.

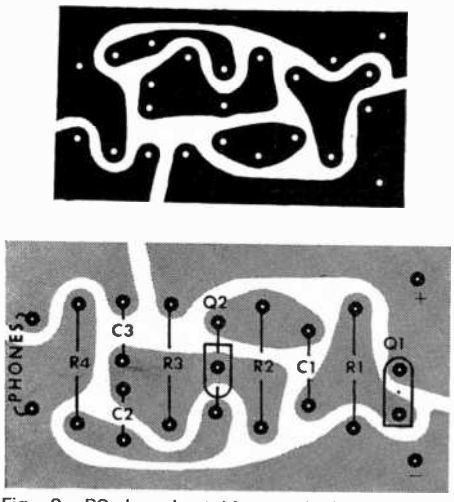


Fig. 2. PC board etching and drilling guide at top is shown full size. Directly above is components placement and orientation diagram.

Theory of Circuit Design. As can be seen from the schematic diagram in Fig. 1, the circuit of the Chatter Jammer is very simple. Transistor *Q1* is a silicon type that has a low emitter-to-base breakdown voltage rating. The base-emitter junction is reverse biased by the two series-connected 9-volt batteries that make up *B1*. In this setup, the base-emitter junction is operated in an avalanche condition.

Resistor *R1* in the base circuit of *Q1* limits the current flow through the junction and also serves as the load resistor for the shot noise which results from the avalanche process. The random ac voltage fluctuations produced by the avalanche effect are coupled into a single common-emitter amplifier stage, *Q2*, through capacitor *C1*. Once the signal is amplified, it is coupled through *C3* to the crystal earphones where it can be heard as a "rushing" sound similar to the sound you would hear if you held a seashell to your ear.

Capacitor *C2* shunts some of the high-frequency signal amplitude away from the earphone. As a result, all sound frequencies reaching the earphone are at one signal voltage level, giving the sound its "pink" characteristic.

Construction. There are only a dozen parts that make up the circuit of the Chatter

Jammer, including the earphones and battery pack. Add to this the fact that there are no high frequencies involved that could cause assembly problems, and you can readily see that just about any method of construction can be used. A printed circuit board, however, makes the project more compact and rugged. So, if you make your own circuit board, use the etching and drilling guide and components placement diagram in Fig. 2.

During construction, there is one point that you should be aware of. There is the remote possibility that the first transistor you try for *Q1* might not be a good noise source. Some transistors may not avalanche at all, while others may produce a very "grainy" sound. About 95 percent of all 2N2712 transistors will give the proper results; so, if you buy two for the project, at least one and probably both will work fine.

A power switch is not used on the Chatter Jammer for a very good reason. The current drain of the project's circuit is in the low-microampere region which means you will obtain essentially shelf life from the batteries even if the project is left on at all times.

Since the life of most 9-volt transistor batteries is so long, there is no reason why you should not simply solder leads from the batteries into the circuit instead of using battery clips that add to the project's cost. If you use stiff wire for the power leads, the leads can also support the circuit board.

The whole circuit, including board and batteries, fit neatly into a 3¼" × 2⅛" × 1⅛" plastic or Bakelite box (see photos). First drill a small exit hole for the earphone leads in one end of the box. Pass the leads of two crystal earphones through the hole and tie a knot about 2" from the free ends of the leads. Solder the leads to the appropriate points on the circuit board. (Note: Two earphones are used with the Chatter Jammer to increase the project's effectiveness. The addition of the second earphone will not affect the life of the battery supply.) A thin piece of Styrofoam can be cut to fit inside the case to keep the battery pack from working loose.

How To Use. Once the Chatter Jammer is operating properly, the only operation involved is to plug the earphones into your ears. You should immediately hear a rushing sound. Don't be surprised if it takes a minute or so to get used to the sound and feel of the earphones. After a short time, you will not be conscious of the rushing sound, nor will you be disturbed by extraneous sounds.

Musicians can try using the Chatter Jammer as a noise source by leaving the earphones off and connecting the output of the project to an unused high-impedance input of their instrument amplifiers. For a really strange effect, try passing the pink noise through a variable passband amplifier such as the "Waa-Waa" (POPULAR ELECTRONICS, Jan. 1970).

After you have used the Chatter Jammer for a while, you will be resorting to it whenever conditions prevent concentration or relaxation. It's sort of like having your own soothing rain sounds wherever and whenever you seem on edge. —30—

To keep batteries in place and prevent circuit board from rattling, place piece of rigid foamed plastic, cut to size, under circuit board as shown.

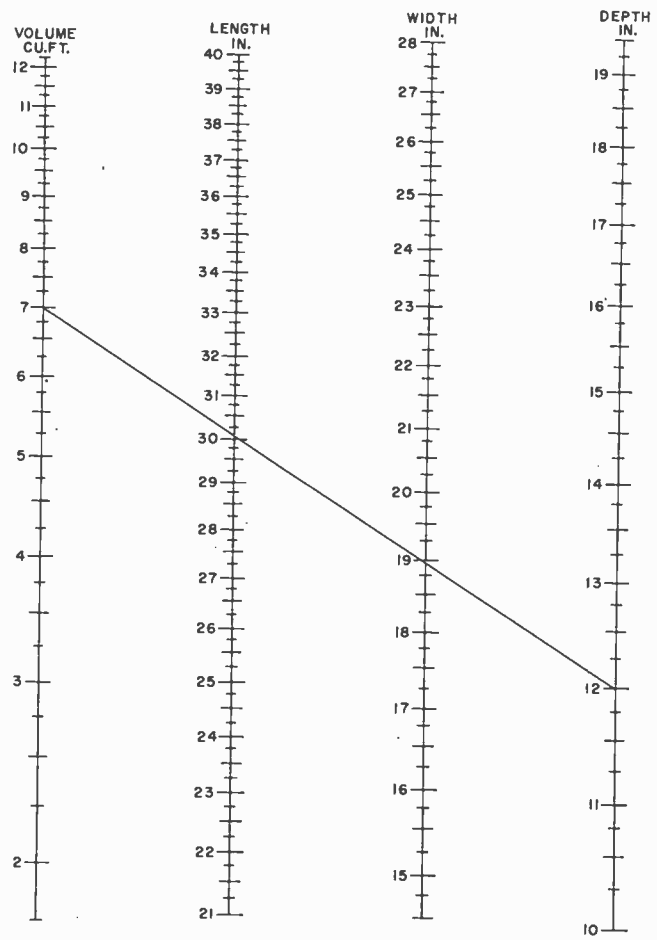
AN EASY WAY TO DETERMINE

Reflex Enclosure Dimensions

BY E. G. LESCAULT

DESIGNING your own reflex speaker enclosure is really very simple (see "Rally Round The Reflex," November 1969) if you don't have to juggle numbers. The nomograph on this page lets you determine the optimum enclosure dimensions—without mathematics—for a given enclosure volume in cubic feet. The scale calibration marks are set up to provide direct readout of length, width, and depth in inches for a given volume, all the while preserving the optimum 1:1.44:2.08 dimension ratio.

To use the nomograph, simply lay a straight edge down so that it intercepts the appropriate cubic-foot figure in the Volume column and the other three columns for the most convenient dimensions. For example, the line drawn across the nomograph indicates a length of 30", width of 19", and depth of 12" for a 7 cu ft enclosure volume. -30-



Second Guessing The Heathkit IG-72

HOW TO GET A ZEROBEAT

BY D. W. PALOMAKI

IF YOU OWN a Heathkit Model IG-72 audio generator, you already have an excellent piece of equipment. But you might not be able to zerobeat the IG-72 with a signal from another source. This is because the IG-72 has a switch-selectable discrete frequency output. However, for less than $5, you can modify your IG-72 to provide zerobeat capability with continuously variable or the original discrete-frequency output. The modification is easy to perform and requires very little time. (The Heath Company engineers agree with the modification described in this article and point out that this idea is an integral part of their updated Model IG-18 and IG-18W solid-state sine-square-wave audio generator.)

The output frequency of the IG-72 is determined by a bridge-T network in a feedback circuit as shown in Fig. 1. The multiplier (1, 10, 100 and 1000) is determined by the values of capacitors *C1* and *C2*. The significant figures are selected by the "cycles" switches on the front panel of the instrument. These switches change the resistances of *R1* and *R2*. For the "tens" range, the values of *R1* and *R2* are determined by parallel-connected resistors, effectively 100,000 ohms per step. The "units" range values are set by 1-megohm parallel-connected resistors, each of which is selected in discrete increments. Hence, a 4700-Hz signal setting would be the equivalent of four 100,000-ohm and seven 1-megohm resistors in parallel, with a multiplier setting of 100.

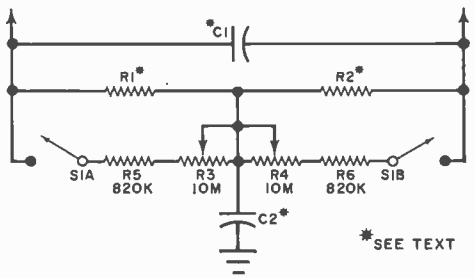


Fig. 1. Modification components to be added to IG-72 circuit are S1 and R3 through R6.

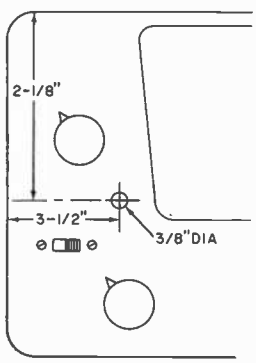


Fig. 2. Before drilling R3/R4 mounting hole, check for adequate behind-panel clearance.

Now, the modification in the IG-72 allows you to obtain a continuously variable frequency output by adding a variable resistance in parallel with the resistance selected by the "cycles" switches. With the values given in Fig. 1, a range of 10.82 megohms to 820,000 ohms is available. This has the effect of providing a variable third significant figure that is continuously adjustable between 4709 and 4920 Hz.

The overlap of ranges is required for two reasons: First, it allows for the variation in tolerances of component values to insure full coverage. The second reason is due to the nature of available potentiometers; the ideal would be a pot with values that range continuously from infinity to 1 megohm, but 10 megohms is the best that can be had for the high end. This prevents attainment of zero with the third significant figure unless the switch is thrown to remove the added resistors from the circuit.

To increase the overlap range, the values of *R5* and *R6* can be reduced. Using 680,000-ohm values provides the variable function over a range of 0.094 to 1.45. The use of 500,000-ohm values extends the high end to 2.0 for an overlap of one full step in the units range.

The details for making the modification installment in your IG-72 are shown in Fig. 2. Switch section *S1* and pot sections *R3* and

R4 must be wired to provide a dpst-switched 10-megohm dual-pot arrangement. (This is a single part consisting of a dual-put with an add-on dpst switch attachment.) The dual-pot is then mounted through a ⅜"-diameter hole previously drilled in the front panel at the location shown. (Note: Be sure to check for proper clearance behind the panel before you drill this hole.)

When installing the modification components, bear in mind that *C1, C2, R1* and *R2* represent a simplified version of the original bridge-T network in the IG-72 generator. You will be adding the modification components to the circuit without breaking any of the original circuit's lines. Hence, only three short lengths of hookup wire from the new circuit will complete wiring.

To operate the new circuit, just turn the control knob clockwise past the click, varying the setting as required to obtain zero-beat. Turning the control knob counter-clockwise past the click restores the circuit to normal operation.

The rated frequency accuracy of the IG-72 is 5%, although most generators operate within tighter tolerances. This means that if you select a 2500-Hz output, it could be as low as 2375 Hz or as high as 2625 Hz and still meet the rated specification. So you can see that calibration of the newly installed control would serve no useful purpose since, by calibrating it, you might know that you have added, say, 0.6 times the third significant figure in Hertz without knowing the absolute frequency of the output signal. —30—

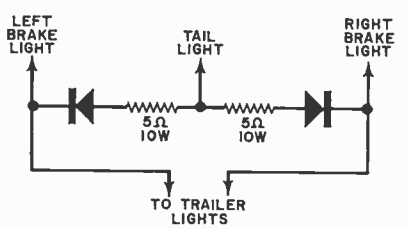
Single-Filament Tail Light Converter

BY MARVIN BEIER

MUST YOU RESTRICT your trailer hauling to daylight hours because you don't have the safety lights required by law for night hauling? If so, a simple converter circuit, installed in your trailer lamp circuit, can allow any single-filament trailer light to operate as tail and brake lights, four-way safety flashers, and individual turn signal indicators.

The converter circuit, shown in the schematic diagram, consists of two 10-watt resistors and two 25-volt, 5-ampere silicon diodes. These few components can be housed in a 4" × 2" × 2" metal utility box, which can then be bolted in any convenient location near the trailer lights. Connections to and from the converter circuit should be through a screw-type barrier block.

The cables from your car brake and tail lights and to the trailer lights should be #16 or heavier wire. Use spade lugs on the ends of the wires that connect to the barrier block.



Only "hot" lead hookups are shown; circuit must be completed by connecting a cable between trailer and car chassis.

Once installed between the car and trailer lights, the converter operates as follows: with the car lights turned on, current flows through the tail light lead and both pairs of resistors and diodes to the trailer lights. The brilliance of the trailer lights is somewhat subdued as a result of the voltage drops across the resistors.

Now, when the car brake is operated, current flow bypasses the resistors and diodes, going directly to the trailer lights via the left and right brake-light leads. Here, full current is delivered, and the trailer lights operate at full brilliance. The diodes are in reverse bias, preventing current from circulating through the diode/resistor circuit.

When the directional signal or four-way safety lights are operated, the trailer lights again glow at full brilliance. Each lamp can operate singly since the diodes again restrict the current flow in one direction.

You will notice from the schematic diagram that only one connection is shown to each of the trailer lights from the car. The diagram assumes that the trailer and car grounds are coupled together to complete the circuit. —30—

THE PRODUCT GALLERY

Third in a Monthly Series by "The Reviewer"

EVERY NOW AND THEN, after visiting a friend's house, I come away mumbling to myself that color TV should have never been foisted on the American public. Not only wasn't the public ready for it, but they are asked to contend with so many variables in terms of tints and color tones that anything seen in most homes resembling "good" color TV is strictly accidental.

To some extent, the problem of obtaining "good" color presupposes that the broadcasting station is transmitting optimum color values in the first place. Possibly half of the stations transmit a good color signal, but the other half have a "Captain Video" whose eye is the colorimeter that sets skin tones and color values. Of course, all of this ignores the fact that live programming, tape and film each have color values of their own. The demise of Captain Video is within the foreseeable future, however, and with the introduction of the Heathkit Vectorscope Model IO-101, any color TV receiver can be optimized; putting the burden of good color back where it belongs—at the doorstep of the transmitting station.

Heathkit Model IO-101 Vectorscope. This is a specialized oscilloscope designed to display a petal-shaped pattern that is a representation of the burst phase angle and the phase angles and magnitudes of the color signals in a TV receiver. The Vectorscope itself is used in conjunction with a color bar generator so a bar generator similar to the IG-28 has been built in. With this integrated instrument, the user can quickly and accurately align or tune every circuit in the chroma sections of the receiver. The Vectorscope process requires only a logical interpretation of the petal display and it is easier to use and generally agreed to be more accurate than other color alignment methods.

About a year ago, this department spoke very highly of the Heathkit Model IG-28, noting particularly the applications of digital IC logic design, full pattern capability (including Heath's exclusive 3×3 and 9×9 display functions), crystal control, operator conveniences, and last, but far from least, low cost. The color bar/dot generator in the IO-101 bears a strong resemblance to the IG-28 and offers all of the same flexibility and stability.

The Vectorscope sub-section of the IO-101 is designed to provide a visual display of the 10 color bars generated in the instruments, amplified and demodulated by the color TV receiver under test. Thus, the Vectorscope comes into operation only when the function switch is in the "Color Bars" position.

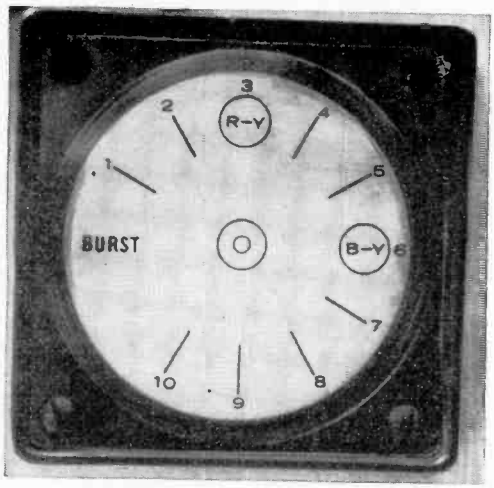
Assembly. The IO-101 kit can be assembled in about 16 hours. There are no difficult construction problems although some builders may find wiring the front panel a little tricky since tight spaces are involved.

There is one change immediately apparent on the divider circuit board. In the IO-101, IC sockets have been replaced by ingenious discrete IC pin clips. The innovation has its advantages, not the least of which is that it helps eliminate the problem of the IC's working loose.

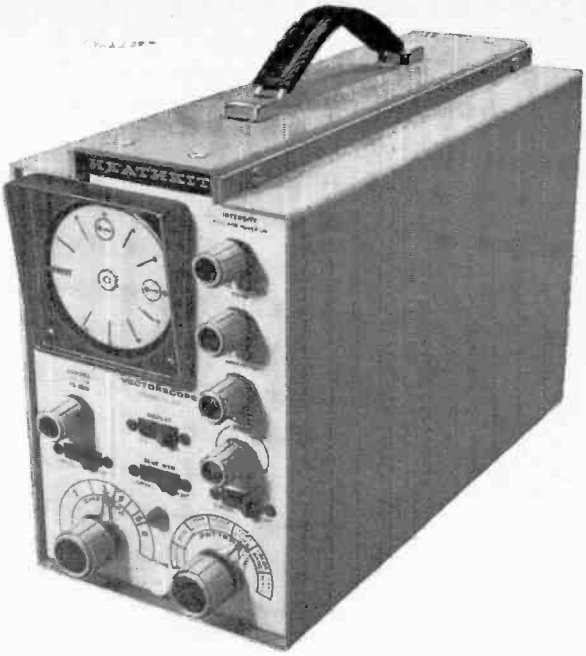
You will be surprised to find that the IO-101 Vectorscope weighs less than 10 lb. This is an obvious attraction for the color TV technician and when the price tag of $125.00 is considered by the electronics hobbyist, it is not hard to imagine that this instrument will be found in many workshops where color TV alignment (and repair) is a sometime thing.

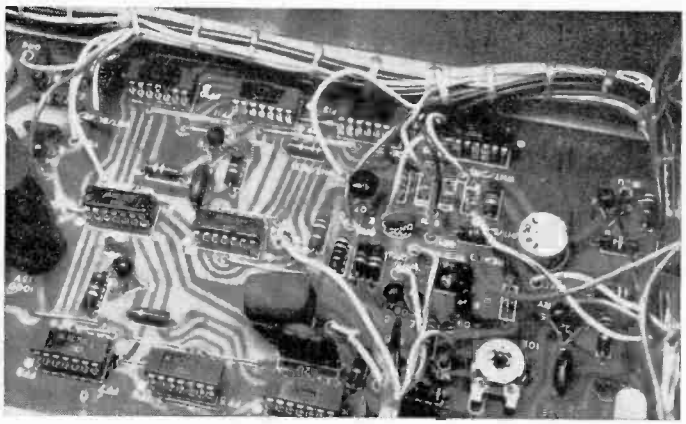
Connections and Use. The user connects the Vectorscope to a color TV receiver through a gun-shorting cable assembly. Alligator clips on the ends of the cable assembly are connected to the picture tube socket assembly and either the cathode or grid CRT feed (depending on the receiver).

When the interconnections are made, the display pattern is an exact presentation of the phase angles and intensities of the chroma signals being fed to the guns of the



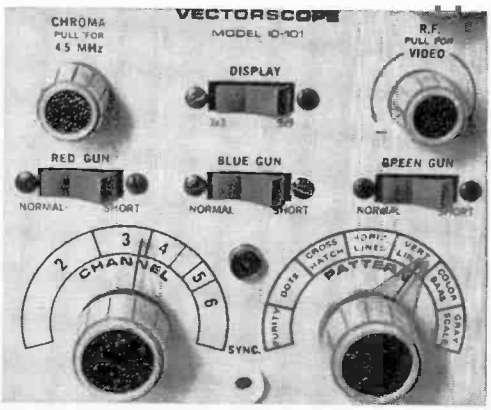
Vectorscope face numerals correspond to 10 bars from built-in generator. In 3x3 pattern the petals indicate deficiencies in display of red, green and blue bars.





The Heathkit IO-101 Vectorscope is a lightweight self-contained test instrument for setting up convergence, purity, and gray scale of any color TV receiver. Much of the wiring (to left) is on a printed circuit board and relatively easy to handle. Rear of the instrument has hooks for retaining necessary interconnecting cables to color TV receiver. Note "chroma" switch which permits use of Vectorscope with any picture tube feed circuit arrangement.

Controls shown below pertain to functions of the built-in Vectorscope color bar generator.



CRT. The instruction manual with the Vectorscope kit goes into extensive detail on how to interpret the petal display pattern and how the pattern is used to diagnose troubles and the alignment of chroma circuits. From the size, shape, and angle of the petals displayed, you can determine if a color is missing or weak. For alignment purposes you can adjust the burst and phase transformers, reactance coil, etc., precisely and accurately by simply observing the petal display.

I cannot help but be enthusiastic about the Vectorscope. Here at last, is a test instrument that will permit the knowledgeable electronics enthusiast with a color TV receiver to establish his own shading and skin tones as theory indicates they should be.

Ungar IC De-Soldering Tools. Printed circuit boards are a mixed blessing to the manufacturer and the serious electronics experimenter. I say "mixed" because some of the advantages go down the drain when defective components must be replaced. The multi-lead IC has aggravated the removal-replacement problem.

Evidently, the boys at Ungar (Div. of Eldon Industries, Inc.) were not only aware of the problem, but able to come up with a brand new line of desoldering tools that simplifies the life of everyone working with a PC board. What Ungar has done is take one of their low-wattage heating elements and make some new screw-in tips. One tip has a rimmed rectangular shape that can simultaneously de-solder all the pins of a dual in-line IC. A second type is a rimmed circular tip that fits around the clipped ends of conventional transistor pin arrangements. Then there is a slightly larger circular tip that can be used to de-solder circular pin configurations of some IC's (0.6" diameter).

The new tips represent a partial solution to the removal problem but Ungar was able to turn some attention to IC and transistor extraction also—not everyone is born with a third hand. Ungar has solved the removal problem with a pair of spring-loaded extractors—one for in-line IC's and the other for various TO's. To remove an IC or transistor you simply attach the extractor to the component and heat up the connections on the foil side of the PC board. As soon as enough heat gets to the pins to "unstick" the solder, out pops the transistor or IC.

If you have some of the Ungar handles or low-wattage irons, all you need to convert them to de-soldering tools is the #1235 drilled and tapped heating unit—which screws into the #776 soldering iron handle. Then, depending on the type of work you are doing, select the necessary extractors and de-soldering tips from the manufacturer's Princess line.

Not Strictly as Advertised Department. Last July, the editor dropped on my desk a press release concerning a "New Electronic Intrusion Alarm." It said, in part, that any movement within its 20' detection range immediately sets off the alarm. That it could be hidden anywhere, even in the dark and that an adjustable electronic sensor cell circuit gives continuous protection. It was $19.95 postpaid from Johnson Smith Co., 16535 E. Warren, Detroit, MI 48224.

A peek at the photograph accompanying this release revealed that it was our old friend the "Sentray" from AMF-Paragon. For those who may not have followed the in's and out's of burglar alarm development, the Sentray is a photocell device that operates from three size C flashlight cells. The circuit is on a PC board with a single transistor controlling the gate of a C106Q1 SCR which triggers a not-too-loud buzzer. To operate the Sentray, you aim the end that has the photocell (which peeks through a ⅜" hole) at a light source—which really means that the room to be protected must be illuminated since the circuit operates when a shadow falls on the photocell.

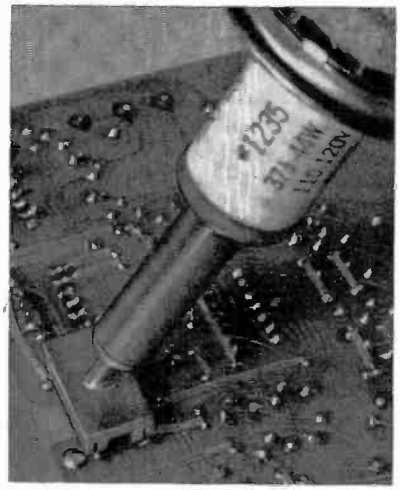
Although the promotional copy distributed by Johnson Smith is not a "distortion," neither is it written to protect the gullible. Getting the Sentray to work at a 20' range takes some fancy doing. It requires a very strong light and quite obviously the light source must be shining on the photocell.

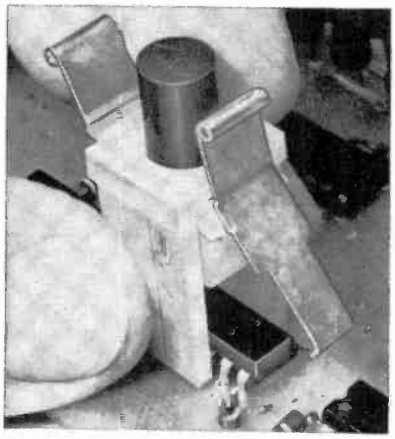
The "operating instructions" from AMF-Paragon are well-written, clear and concise. In fact, they give all possible malfunctions and no effort is made (once the unit has been purchased) to hide any potential deficiencies—something this reviewer can't say for the promotional copy. -30-

(Photos Overleaf)

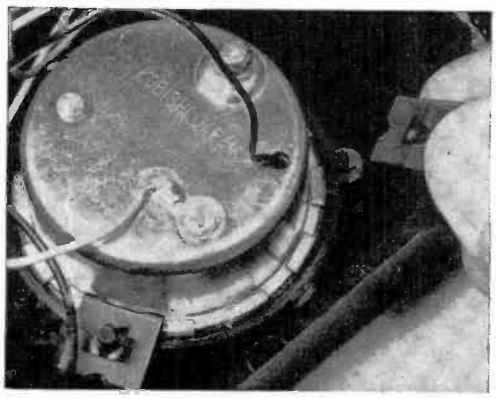
FOR MORE INFORMATION
Vectorscope—Circle No. 87 on Reader Service Page 15 or 95.
Ungar—Circle No. 88 on Reader Service Page 15 or 95.
Sentray—Circle No. 89 on Reader Service Page 15 or 95.

Ungar's "Princess" line of de-soldering tools are in blister packages and they fit easily into the basic Ungar handle. Two photos below show how the in-line de-soldering tip is applied to the foil side of board to heat the connections to the IC, while the spring-loaded removal clip is attached to the IC itself. It's a 1-2 operation, requires no third hand, and won't damage rest of board.





Johnson Smith & Co. electronic intrusion alarm is Sentray system manufactured by Paragon Electric. A CdS photocell at the other end of the plastic case must be illuminated. Slide switch breaks SCR circuit to silence buzzer during setup. Our purchased test unit arrived with buzzer held in place by one and one-half plastic pins and one push-on speednut (below). Two speednuts and another plastic pin were rattling around inside the alarm's plastic case.



Fourth in a Monthly Series by J. Gordon Holt

ONE OF THE LETTERS I received in response to my first column here (September 1970) was from a young man who said "It's all very well to be idealistic about super-fidelity and patronizing about mass-market components, but what about those of us who can't afford a $1000 system, let alone a $2000 speaker?"

If my column gave the impression that I scorn anything that is less than super-fi, let me set the record straight. I practically *love* super-fi, and I feel vaguely unfulfilled when listening to anything less, but that doesn't mean I'm an audio snob. Like most people, I can't afford to be. My exposure to top-of-the-line equipment is a result of the cooperation of manufacturers who loan me things for testing. I am able to keep them just long enough to appreciate how good they really are, and then—sadder but wiser—return them.

Most of the components I do call my own are what would be considered upper-level moderate-cost equipment, which is very enjoyable to listen to once I've recovered from the trauma of parting with a $2000 loudspeaker system. I also own an antique Granco FM radio and it may shock some readers to learn that I enjoy listening to that, too, when my mood is more for good music than supersonics.

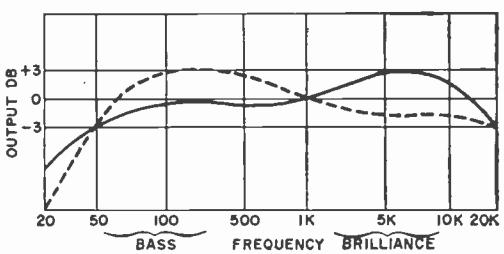
I find that my own reaction to reproduced sound has a great deal to do with the *pretensions* of the reproducer. When listening to an $800 system, I *expect* it to have a rather wide range and respectably clean and uncolored sound. If it doesn't it annoys me much more than do the same deficiencies in a system that doesn't pretend to be hi-fi. Much of what I enjoy in music is very nearly as audible from a small system as from a super-rig, so the former suffices when it is inconvenient to listen to the latter.

What does this digression have to do with the equipment buyer? Simply this: since all components fall short of perfection in different ways, your own personal reaction to any component will depend more on the things *you* are most critical of than on the actual objective quality of the unit.

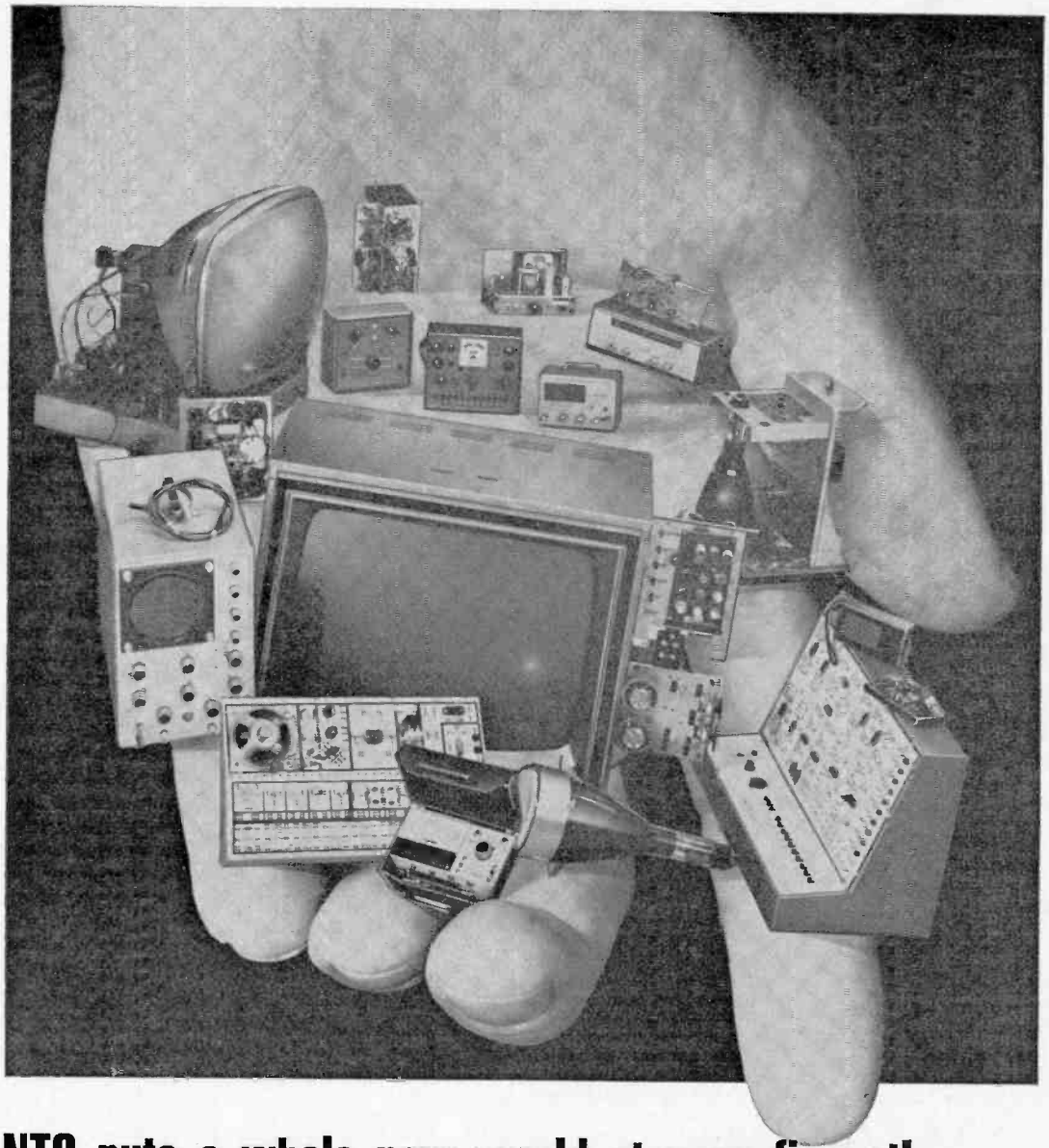
Loudspeakers have wide variations in "character," and even the top-of-the-pile speakers are so different in sound that any expert who names one speaker as the "best" is climbing out on a rotten limb. What he means is either "this measures the best" or "this sounds the best to me." Neither tells you what you need to know: will it sound "best" to you?

In the middle- and low-price ranges, where deviations from perfection are much more pronounced, there are almost as many expert opinions as there are experts. For this reason —and several others that I won't go into now—tabular listings of recommended systems in various price ranges should be viewed as opinions and nothing more.

Self-Analysis. There are a few questions you should ask yourself before you start to think in terms of brands and model numbers. Determine what kind of a system would best suit your needs. Do you plan to use music



Averaged frequency response curves of two hypothetical loudspeakers, both of which have "identical" measured response of ±3 dB from 50 Hz to 20 kHz. Quite obviously, they will not sound even remotely alike, and only you can determine which you will prefer when you hear them side-by-side.



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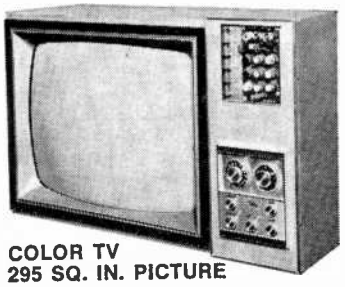

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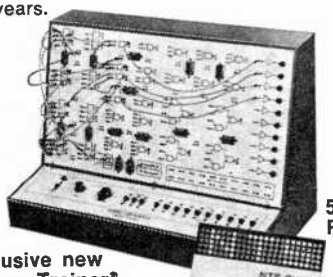

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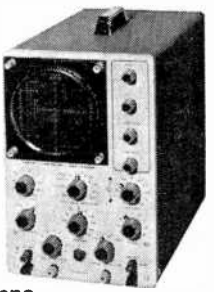

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merely as a background for other activities (audible wallpaper) or will there be times when you expect to listen to it intently? One way you can tell this in advance is by your reaction to an offer of free tickets to a live musical concert. If you choose to attend instead of doing something else, you'll probably want to listen *to* music (instead of just at it) in your home, and this means you should consider things like amplifier power and loudspeaker smoothness. For background listening, practically any reproducing system will suffice.

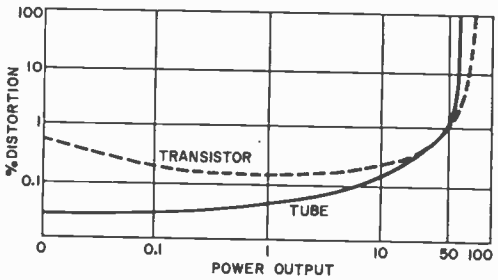
If you *are* the attentive-listener type—what kinds of music will you be listening to? And how loud? Do you like classical music heard from a front row seat? If so, you'll want a high-powered amplifier (50 to 100 watts per channel) and a moderately efficient and "forward-sounding" speaker. If you prefer a first-balcony seat, you'll need moderate amplifier power (35 to 70 watts) and a more neutral- or distant-sounding speaker.

For chamber music heard from a reasonable distance, a moderate-powered amp and a neutral speaker are indicated. while in-the-room re-creation of non-electronic instruments or high-intensity rock will call for highly efficient speakers and as high-powered an amplifier as the speakers can handle with safety. Remember, though, that overly loud music can be just as damaging to your ears as moonlighting in a boiler factory. On the other hand, the proximity of unappreciative neighbors may frustrate your desire for traumatic deafness unless you resort to headphone listening.

Generally, folk music or folk rock is best reproduced at a level just loud enough to allow spoken conversation at a distance of 2 to 3 feet. Amplifier power requirements are fairly low (20 to 40 watts) and the speakers should be neutral or a shade close-sounding. You can of course make a lot of noise with a 10-watt amplifier driving fairly efficient speakers, but it probably won't sound too good. This isn't because the amp lacks power—indeed, you can produce concert-hall levels from high-efficiency speakers with a mere 5-watt amplifier—but because low-powered amplifiers are not usually designed for the very low distortion of high-power units. In fact, the more powerful the amplifier, the better it usually sounds, even at listening levels well below the lesser amplifier's overload point. So it pays to aim high, if only for your in-the-future "dream system."

It's easy to say "I don't need that kind of fidelity; my hearing isn't all that acute," until you've cut your teeth (ears?) on a good component rig. If you're a listener who really listens, it's a good idea to view your budget system as only a first step toward perfection, and plan accordingly.

For example, whether you opt for discs or one of the tape media, I strongly suggest that you *not* skimp on the purchase of your playback unit. The rest of the budget system can be junk for the time being, but a good phono cartridge or tape machine will help to ensure that your music collection will still be in good condition by the time you graduate to a system that is capable of reproducing every nuance of music—and distortion.



Typical distortion-vs-output curves of a good tube-type amplifier and an early solid-state amp, both of which are rated "identically" at 1% distortion for 50 watts output. Statistically, most signals occur below 1 watt, where the amplifiers have quite different distortion characteristics.

Even if you have been buying discs and tapes, your first decision before embarking on a serious system purchase should be "disc or tape, or both?" Open-reel 4-track tapes look like a dead issue as far as 1971 commercial releases are concerned—even if 4-channel does give it a brief shot in the arm. Cassettes and cartridges are comparable as to convenience, but you can't rewind a cartridge, whereas you can't let a cassette run all day nonstop *without* rewinding it—although automatic rewind of cassettes narrows the distinction. Cassettes are shaping up as the tape medium for the attentive listener, whereas cartridges are being promoted for the people who want background or incidental music. Discs are easily damaged by casual handling or by playing on mediocre equipment, but they allow easy "spotting" of individual selections, and you can be reasonably assured that every recording issued for some years to come will be issued on disc. If you can't decide, you can always go for all three media and buy a player for each—but don't speak to me about budgets.

The Components. The phono turntable or player need not be any great shakes, as long as its rumble and speed variation are low enough so as not to drive you up the wall. Some otherwise excellent phono car-

tridges are sensitive to inductive hum interference, though, so check this aspect of compatibility. The phono pickup cartridge itself should be of top quality, for the better its tracking ability (at a given contact pressure), the easier it will be on records. And since there is evidence that elliptical styli are harder on records than sphericals, I'd advise flying in the face of fashion and buying a spherical.

The tone arm (if you go to a turntable instead of a player) need not be of the very best, at least not to start with. You may end up with a Rabco SL8E eventually, but in a budget system, the most important thing is freedom from pivot friction. You can check the pivots by taping enough coins to the empty head shell to allow the arm to be balanced to zero grams, and then blowing gently on it from above and from the side. It should swing smoothly and easily in all directions (although slowly, if viscous-damped). Any hesitation indicates pivot problems.

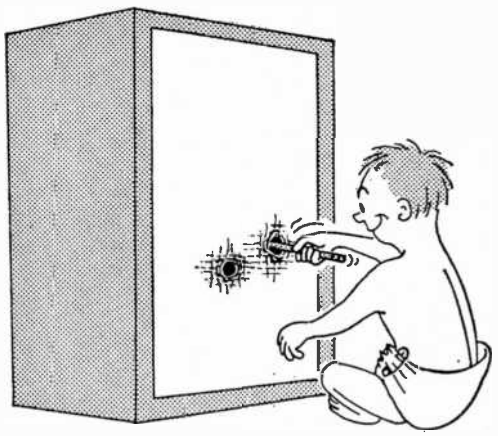
Get into the habit of caring for discs properly. You've been told that dust is destructive to discs, but you have to hear what a scratched, dirty record sounds like on a good system before you can appreciate what your pristine new discs will sound like one year hence if you don't take care of them. Of course, dust particles can be removed at any time, but you can never remove the gouges and pot-holes caused by the stylus grinding the particles into the groove walls. You should keep your fingers off the playing surfaces, and either clean each side *carefully* before playing or, preferably, use a perpetual cleaner like the "Dust Bug." Do *not* use a dry brush or pad, nor any of the silicone-impregnated cloths sold in most record stores. The best record cleaners I know of are the Cecil Watts devices marketed by ELPA Industries.

If you're going the tape route, your player should be able to handle the longer-playing cassettes or cartridges with adequate gentleness and, in the case of cassettes, it should have some form of protection against end-of-rewind tape pulloff or recorder damage due to motor-stalling.

In a modest system, the amplifier should be the next-best component after the player unit. A good, low-distortion amplifier will sound pretty good through a rather lousy loudspeaker, but a good loudspeaker reveals things about a poor amplifier that are best left unheard. This is why the speaker should usually be the *last* thing to be upgraded from one "quality level" to another.

Since you can expect to pay a relatively substantial amount of money for the amplifier, it is wise to try and get one that will have some tradein value. Although this is impossible to predict with certainty for any particular model, you can generally trade in those amps from manufacturers who don't obsolete their models every year or so. A component that has been in production for several years is a fairly good bet for relatively low depreciation in future, particularly if you elect to sell it while it is still in the manufacturer's catalog.

I do not recommend buying a stereo receiver for a budget system because, apart from the initial cost (which must be borne in one fell swoop), you won't be able to upgrade your tuner, preamp or amplifier individually until you can afford an even bigger outlay to replace the whole receiver. And although there are fine receivers available, you can get *better sound for the money* from a well-chosen trio of individual components. Magazine equipment reports are your best source of information about what is good in each component category, even if you are sometimes obliged to "read between the lines" in order to divine what the reviewer *really* thinks. Watch for the case of two different publications agreeing about a certain component. Three or more agreements are the next best thing to a guarantee of quality.



In used speakers, holes in the grille cloth may indicate that the cone itself has been damaged.

What to Buy? Many dealers have some sort of "audio comparator" gadget that allows them to switch from one component to another so you may make listening comparisons. This reveals gross differences, but not much more. And if you are not thoroughly familiar with the sound of live music, you will invariably choose from an A-B-C comparison that system which is either the loudest or which best meets your peculiar concept of how hi-fi should sound. How, then, can you be reasonably assured of starting out with a passably good system?

(*Continued on page* 94)

CITIZENS RADIO (CB)

CeeBRON Gets Under Way—A new CB organization claiming that "representation" is its prime goal is making a charter membership drive. Calling itself Citizens Band Radio Operators National (pronounced CeeBRON) the new group is based in Washington, D. C. President of CeeBRON is John Gonella, a legislative consultant and recently assistant for Congressional liaison to President Johnson. General Counsel of CeeBRON is Robert M. Lowe, attorney and consultant on communications policies. CeeBRON is to publish a newsletter cóntaining a variety of items of interest to CB'ers. For further information write CeeBRON, 2135 Wisconsin Ave., Suite 100, Washington, DC 20007.

SHORTWAVE LISTENING

WPE Becomes WDX—*Final plans for the transition of WPE monitor identifiers to the new WDX prefix have been announced by Hank Bennett. All WPE certificate holders will have until December 31, 1972 to apply for and receive a new WDX certificate bearing the original area coding suffix and identifier. A nominal handling charge is being made and full details are available from Monitor & DX Headquarters, P.O. Box 333, Cherry Hill, NJ 08034.*

AMATEUR RADIO

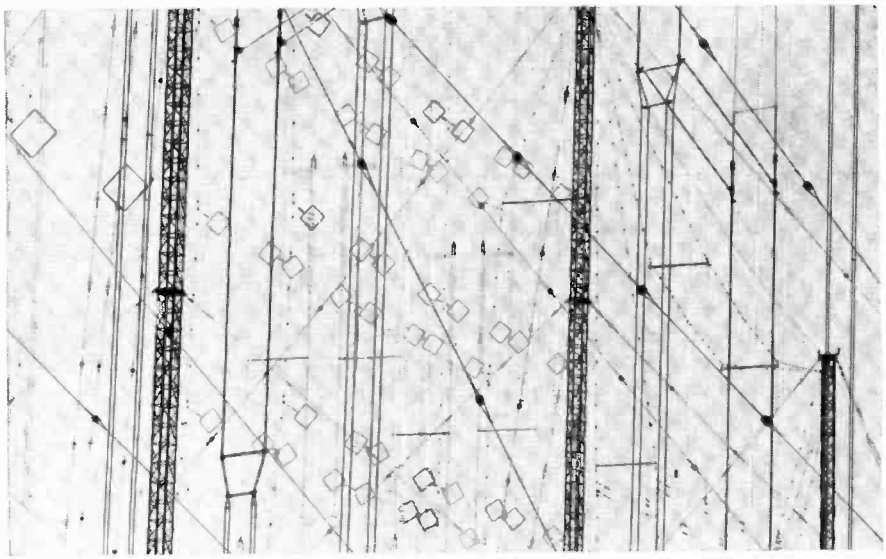
Clearing 40-Meter QRM—As of October 9th the FCC has added Resolution 10 of the Geneva 1959 meeting of the International Telecommunications Union convention to the amateur radio Rules & Regulations (Part 97). The Resolution acknowledges that the range 7000-7100 kHz is for the exclusive use (world-wide) of radio amateurs and that 7100-7300 kHz is authorized for hams in the Americas. The latter spectrum is however assigned to the broadcasting services in the remainder of the world; thereby creating a monumental interference problem because many stations beam transmissions to the Americas contrary to international agreement. The FCC hopes that by making the Resolution "official" it will discourage broadcasting and commercial incursions into the 40-meter ham band. (Submitted by Herb Brier, W9EGQ)

SHORTWAVE LISTENING

New Relay in South Pacific?—A well-known international shortwave broadcaster is quietly making inquiries about setting up several relay transmitters on Nauru Island. Unknown—except for their phosphate deposits—Nauru Islanders recently began to assert their independence under their President Chief Hammer Derouburt. Aware that the phosphate may run out by the year 2000, Chief Hammer is said to be receptive to any long-range source of revenue that will simultaneously "glamorize" Nauru. Practically unknown on shortwaves (a few radio ham expeditions have been made), Nauru is 500 miles northeast of the Solomons.

(*Continued on page* 80)

ETLF, Addis Ababa, Ethiopia



The attractive designs above are formed by the curtain antennas of ETLF, beamed to India, Ceylon, the Far and Middle East, eastern Africa, and Madagascar. The "floating" squares are spreaders in the transmission lines. The station has two 100,000-watt transmitters (see below).

Broadcasters from other parts of Africa come to Addis Ababa to prepare programs. The Nigerian announcer, Rev. Udo Etuk, is seen here working with Ethiopian production technician Befekadu Desta.

ETLF broadcasts on the following frequencies: 6065, 9680, 9695, 11850, 11910, 15265, 15270, 15310, 15400, 15425, 17775 kHz.

ETLF, Radio Voice of the Gospel, is largely operated by trained African electronics technicians. Vittorio Bonfanti and Yemane G/Egzeabher—both Ethiopians—get ready to switch over to a different curtain array. Sign says "Check Antenna Crew FIRST!"

SHORTWAVE LISTENING

1971 Communications Handbook—The ninth edition of the annual COMMUNICATIONS HANDBOOK, assembled by the Editors of POPULAR ELECTRONICS, has just been published and is now on the newsstands. Feature shortwave listening and mediumwave material was written by Dr. Richard E. Wood. A special catalog of receivers ranging in price from $60 to $4500 has been added to the new edition. A detailed listing of SWL clubs and associations is also included.

CITIZENS RADIO (CB)

Raising Antenna Heights—*CB'ers are cheering the surprise petition entered before the FCC by the Electronics Industries Association to void the 20' antenna height restriction. Present CB Rules prohibit erecting an antenna that extends more than 20 feet above an existing structure. Although this Rule is obviously violated by thousands of CB'ers, the EIA has spoken out in favor of making the Rules more realistic. In the petition, the EIA points out that TV receiving antennas are often 100 feet above ground level and recommends a new limit of 60'.*

SHORTWAVE LISTENING

ISWC Station Popularity Poll—The International Short Wave Club (England) is conducting its 1971 Station Popularity Poll. Held every third year, the poll is considered a barometer of the esteem in which international broadcasters are held by serious SWL's. Listeners are asked to send a list of their 5 most popular shortwave stations (in order of popularity) to ISWC, 100 Adams Gardens Estate, London, S.E. 16, with a note (not more than 30 words) telling why they chose No. 1. Votes for pirate broadcasters are not allowed or counted. Deadline is December 31. Winners will be announced in February.

VHF MONITORING

Weather Bureau Goes Tone Alert—*The nationwide network of 162.55- or 163.275-MHz weather radio broadcasting stations is being equipped with "tone-alert" devices. A distinctive 3-to-5-second audio tone will be added to the routine broadcasts to assure positive notice of severe weather changes—such as hurricanes, tornados, thunderstorms, etc. In early September, weather bureau stations equipped with tone alert were located at Boston, New London, Atlantic City, Washington, Norfolk, Charleston, Jacksonville, Miami, Tampa, New Orleans, Galveston, Cleveland, Akron, Los Angeles, San Francisco, and Honolulu. The New York City station (KWO-35) was to have tone alert installed by early December. New weather bureau stations—with tone alert—are being installed at Brownsville, Tex., Seattle, Wash., and Portland, Wash. All of the weather bureau stations transmit narrow-band FM with a power rating averaging 300 watts and vertical antenna polarization.*

SHORTWAVE LISTENING

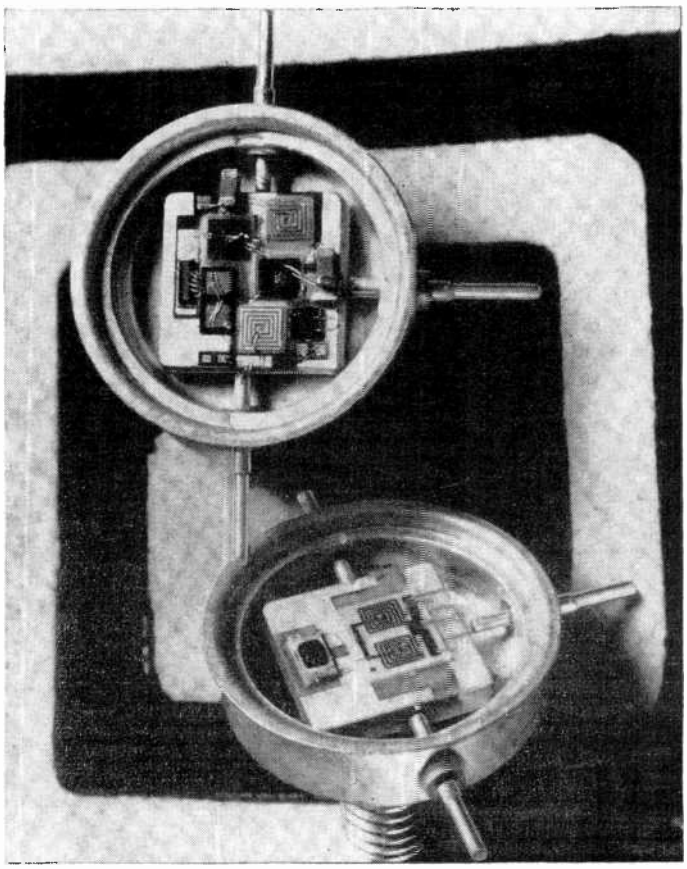
BBC Uses New Interval Signal—About half of the shortwave broadcasters (and nearly all international broadcasters) transmit an interval signal 5 to 15 minutes before a scheduled program. This interval signal serves the dual purpose of permitting the listener to find and tune in the signal before the program commences and also serves notice to other broadcasters that that particular frequency or channel is occupied. SWL's soon learn to identify 20-30 different interval signals and thus are able to pin-point a DX station with considerable ease. Interval signals may be a few bars of music, bells, chimes, bird calls, etc. For years the BBC World Service has used "Bow Bells", but in September switched to a few bars of "The Bells of St. Clements". A nice distinctive tune, but somehow not as "British".

SOLID STATE

One Hundred Seventy-Fifth in a Monthly Series by Lou Garner

ALTHOUGH TWT's, klystrons, BWO's, and magnetrons are still being used extensively by equipment designers, and the exotic UHF/microwave vacuum-tube market is far from "dead," the popularity of these devices is under increasingly heavy pressure from the solid-state industry. While it is unlikely that microwave vacuum tubes will disappear from the technical scene within the foreseeable future, there is a good chance that—within a few years—an overwhelming majority of new microwave equipment designs will feature solid-state devices in part, if not exclusively.

Two major trends are responsible for the economic-technical pressure on the microwave tube market. One is the substantial, and continuing, improvement in the state-of-the-art relating to the design, fabrication, production, and application of discrete semiconductor components. The second is the development of efficient, lightweight, compact, and reliable microwave integrated circuits (often identified as "MIC's").



Two new hybrid microwave IC's developed by RCA are shown at right. UHF power amplifier is at top, while below it is combiner/divider. Shown uncovered, these IC's are fraction of the sizes of discrete versions, hundreds of times smaller than vacuum tube circuit versions.

Today, the design engineer or advanced experimenter can choose off-the-shelf solid-state devices operating well into the gigahertz range and supplying power outputs up to the multiwatt level.

As far as transistors are concerned, Hewlett-Packard's (1501 Page Mill Road, Palo Alto, CA 94304) type HP35806E probably is typical of the upper-range, small-signal devices now available. Selling for less than fifty dollars in single quantities, this unit has a gain-bandwidth product of 7.0 GHz and can deliver 50 mW output with a 9.5 dB gain at 2 GHz. Where relatively high power is needed, the designer might select a TRW (TRW Semiconductor Division, 14520 Aviation Boulevard, Lawndale, CA 90260) type PT8610, which can provide 10 watts output at 2 GHz, or the MSC (Microwave Semiconductor Corp., 100 School House Road, Somerset, N.J. 08873) type MSC 1100, a device with a 35-watt power dissipation rating and capable of delivering peak powers of 100 watts at 1.09 GHz in pulsed applications.

Gunn-effect diodes, varactors, LSA (Limited Space-Charge Accumulation) devices, Schottky-barrier diodes, and various avalanche devices, in general, can be used at even higher frequencies than available transistors. Experimental LSA units, for example, have delivered as much as 20 mW CW at 88 GHz and have a projected upper frequency limit of, perhaps, 500 GHz.

At least one firm is now offering *complete* solid-state microwave oscillator assemblies at prices considerably lower than those of the more exotic vacuum tubes. If you're a manufacturer developing a new commercial microwave product intended for mass-production, for example, Fairchild's Microwave and Optoelectronics Division (2513 Charleston Road, Mountain View, CA 94040) can sell you Gunn diode X-band (8-12 GHz) 50 mW signal sources for about *five dollars* each in lots of 100,000 units. Even the single unit price is less than that of a good dinner with cocktails and wine at a better restaurant.

MIC's are offered by a number of manufacturers, including Avantek, Inc. (2981 Copper Road, Santa Clara, CA 95051), American Electronic Laboratories, Inc. (P.O. Box 552, Lansdale, PA 19446), and RCA (Electronic Components, 415 South Fifth St., Harrison NJ 07029).

For the most part, currently available MIC's are hybrid devices using chip transistors, diodes and capacitors and thin-film inductance and resistance elements, although some work has been done with monolithic designs. Physically, the typical MIC is assembled in a package about the size of a multiwatt power transistor or high-power SCR.

A pair of typical MIC's is RCA's recently introduced TA7702/7703 UHF power amplifier and TA7747/7748 three-port hybrid power combiner/divider. The TA7702/7703 is a thin-film lumped-element design featuring a silicon *npn* "over-lay" power transistor and integral input and output networks designed to match a 50-ohm source and load. Intended for operation in the 225-400 MHz range, the device(s) can furnish a nominal output of 16 watts at 350 MHz with a 6-dB gain, using a 28-volt dc power source. With an efficiency between 50% and 75%, the amplifier features a gain variation of less than 1 dB for output powers from 4 to 16 watts. It can be used in AM applications with greater than 85% modulation and less than 10% distortion by the use of a feedback modulation system and low-pass r-f filter.

An extremely interesting device, the TA-7747/7748 is a unique integrated circuit capable of combining or dividing the power of UHF signals in the 225-400-MHz range. It is equipped with three "ports" (terminals), each having an impedance of 50 ohms. As the power amplifier, the device is fabri-

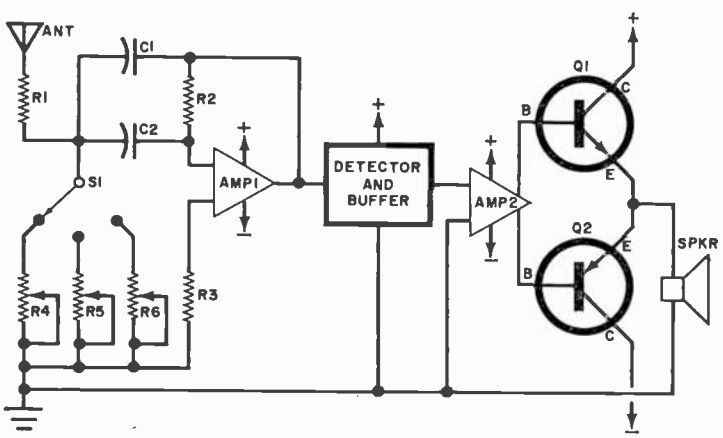


Fig. 1. Reader's proposed radio receiver circuit design uses Amp 1 as active filter/amplifier; Amp 2 as straight amplifier. Amps are integrated circuits.

cated using a lumped-element hybrid design.

In operation, UHF power applied to one port is divided into two equal signals and supplied through the other two ports. On the other hand, if two signals with the same frequency, phase and amplitude are injected into the nominal "output" ports, their power will be accurately combined and furnished at the "input" port.

Capable of handling up to 40 watts input (or output), the TA7747/7748 may be used to divide a UHF signal for, say, driving different elements of a directional antenna array or, conversely, for combining the outputs of two amplifiers to achieve higher power levels. Typically, the device might be used to combine the outputs of two TA7702/7703 amplifiers to deliver 32 watts.

An exciting and interesting field, microwave experimentation can offer substantial intellectual rewards to the advanced hobbyist willing to acquire the special knowledge and skills needed to work at UHF and GHz frequencies. Among other things, he'll learn that some aspects of extremely high frequency phenomena are at variance with his experiences at lower frequencies.

For example, one normally can assume that a high frequency transistor will provide improved performance, higher gain, and greater power output when used at lower frequencies. A 5-MHz transistor, for example, may be more efficient when used at audio values. This assumption is *not valid* at GHz frequencies, however. As a general rule, a typical advanced GHz power transistor can operate at higher power levels at or near its specified design frequency than at much lower values.

Reader's Circuit. Reviewing the specifications of commercially available linear IC amplifiers, SP4 Mark Mondt (478-69-4366, HHT 3d Sqdn, 7th Cavalry, APO New York 09033), discovered that many of these devices have frequency responses extending well into the MHz ranges. RCA's CA3020, for example, can be used to frequencies as high as 8 MHz with a resistive load, while their CA3023 is useful to 16 MHz. Realizing this and knowing that an amplifier can be used as an active filter with a suitable feedback network, Mark has theorized that an R-C tuned receiver might be a feasible project. He submitted the tentative circuit given in Fig. 1 to illustrate his thoughts, suggesting that other readers might like to experiment with this approach to receiver design.

An R-C tuned feedback network consisting of *C1*, *C2*, *R2* and a switch-selected trimmer resistor (*R4*, *R5*, or *R6*) are used to operate IC AMP 1 as an active filter/amplifier. Different frequencies (stations) are pretuned by trimmer resistor adjustment and selected by *S1*. AMP 1's output is applied to a detector and buffer amplifier (DET/BUFF), and the resulting audio signal is a second IC amplifier section, AMP 2, which provides audio gain. Finally, a complementary push-pull power amplifier, *Q1-Q2*, is used to drive the loudspeaker.

Although Mark's idea has merit, several modifications in his suggested circuit may be necessary to achieve satisfactory performance in a practical receiver.

First, we suspect that a different type of feedback network would be required to achieve optimum filter operation. Most of the active filter designs we've seen and used successfully employ parallel-T networks. Naturally, the R-C values would have to be chosen to provide a peak response at the desired r-f (station) values.

Second, Mark may find that the receiver's overall selectivity leaves a bit to be desired as far as the crowded AM broadcast band is concerned. Q's of 10 or more can be achieved without too much difficulty with currently available IC operational amplifiers used as active filters, but we feel it may be necessary to cascade several R-C tuned stages to obtain reasonable selectivity.

Third, there may be some problem with cross-modulation where strong and weak stations are on nearby frequencies. The basic design does not lend itself to an effective agc arrangement and, therefore, optimum bias for maximum gain to receive weak signals may lead to overload, distortion, and cross-modulation when strong signals are present.

But with all factors considered, Mark's suggested approach should prove to be an educational project for those experimenters who enjoy trying "off-beat" designs. Before tackling actual circuit design and construction, however, we recommend that interested readers first obtain and study Fairchild's excellent Application Brief No. 132, *Active Filters with Gain* (contact Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, CA 94040).

Manufacturer's Circuit. Featuring monolithic Darlington silicon devices, the audio amplifier circuit illustrated in Fig. 2 was abstracted from Application Note AN-483-A, published by Motorola Semiconductor Products, Inc. (P.O. Box 20912, Phoenix, Arizona 85036). Entitled "15 to 60 Watt Audio Amplifiers Using Complementary Darlington Output Transistors," the eight-page publication was prepared by Motorola applications engineer Richard G. Ruehs. In addition to the circuit shown, the paper describes a number of other practical designs, including a 15-to-20-watt 4-transistor amplifier, a 15-to-60-watt circuit with ac coupled output, and a reliable overload protection circuit.

In each case, component values, supply voltages, and device type numbers are specified for various modes of operation to achieve different power levels and for both 4- and 8-ohm load impedances.

Except for its 10-μF input coupling capacitor, our featured circuit employs dc coupling throughout. A dual-transistor differential amplifier (*Q1-Q2*) is used as a predriver. Providing approximately 60 dB voltage gain, *Q3* serves as the gain/driver stage; a 50-pF feedback capacitor is included

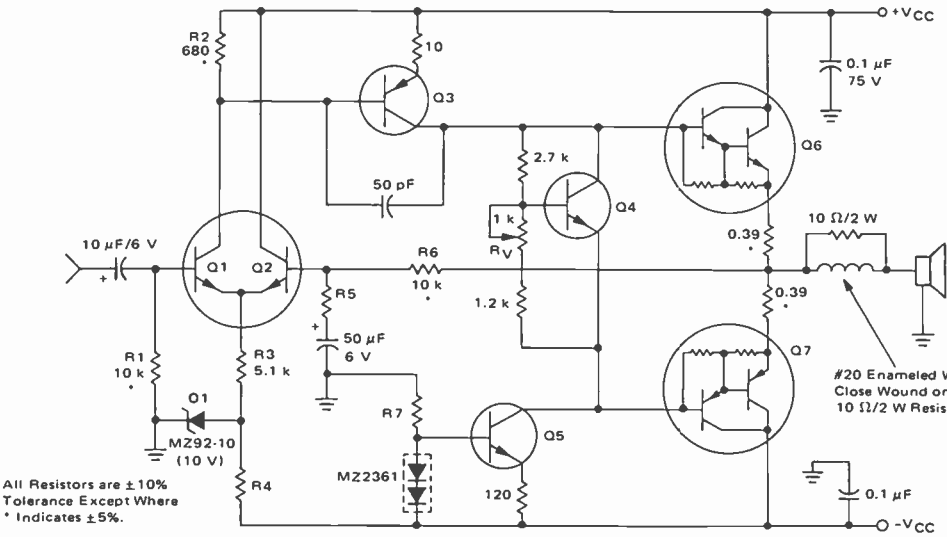


Fig. 2. Described as being capable of delivering from 15 to 60 watts of power, this Motorola audio amplifier circuit employs complementary Darlington output transistor design.

across the device to prevent high-frequency parasitic oscillation. The output stages are forward-biased by $Q4$ to eliminate crossover distortion, while constant current source $Q5$ precludes the need for boot-strapping $Q7$'s base, thus insuring minimum distortion at low frequencies. Dc stability is assured by providing 100% dc feedback through $R6$ to $Q2$'s base and using a 10-volt zener diode ($D1$) in conjunction with emitter resistor $R3$ to establish the input bias. A handwound series output choke is included to prevent high-frequency oscillation with capacitive loading.

According to Motorola's Application Note, the basic amplifier has a typical idling current of 20 mA and an input impedance of 10,000-ohms. It requires an input signal of 1.0 volt, rms, for rated power output, and its frequency response is flat within 1 dB from 10 Hz to 50 kHz. The amplifier's harmonic and intermodulation distortion figures are 0.15% and 0.1%, respectively.

Final component values, supply voltage, and device types depend on the amplifier's desired maximum output power level and load impedance. For 60-watt operation with an 8-ohm load, a dual 36-volt, well-filtered dc power supply is required. Under these conditions, $R4$ would be 8200 ohms, $R5$ 430 ohms, and $R7$ 33,000 ohms. The dual transistor used as a pre-driver would be type MD-8002, $Q3$ type MPS-A56, $Q4$ type MJE-520, $Q5$ type MPS-A06, $Q6$ type MJ-3001, and, finally, $Q7$ type MJ-2501.

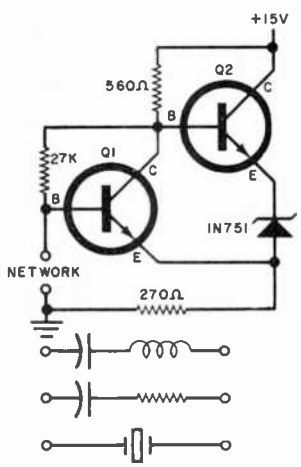


Fig. 3. Ultimate oscillator can generate square, sawtooth, or sine waves over wide frequency range.

Ultimate Oscillator? Submitted by Mrs. Dorothy L. Zachary, of Richardson, Texas, the oscillator circuit shown in Fig. 3 can generate square, sawtooth, or sine wave-

forms over the range from a fraction of a Hz to MHz. The active portion of the oscillator does not contain any frequency-dependent components, with the exception of parasitic elements. The two transistors are npn planar epitaxial types—2N918 or similar. The power supply used should be of the low-impedance type since it also acts as the ac ground return.

Either RC, LC or a piezoelectric network can be used to create the oscillations. Functionally, the oscillator goes into operation when the base of *Q1* is "grounded" by the selected series-tuned network. The voltage variations at the collector of *Q1* are coupled to its emitter by the emitter-follower action of *Q2*. Since the circuit has a closed-loop voltage gain greater than one under these conditions, it begins to regenerate. The waveform depends, to a great extent, on the Q of the network used. A very high Q will result in a square wave, a low Q produces a sinusoidal wave.

This circuit has performed as a crystal-controlled oscillator from 18 kHz to 15 MHz, a pulse generator operating from 0.001 to 0.5 Hz, and a general-purpose test oscillator from the low audio range to 40 MHz. The output can be taken from either the collector, emitter, or base of *Q1*, preferably through some form of isolation circuit.

Low-cost Logic Lab. Would you believe a practical basic course in computer logic complete with an operating solid-state computer circuit lab for a mere $39.00, postpaid? Such a course and lab are available from

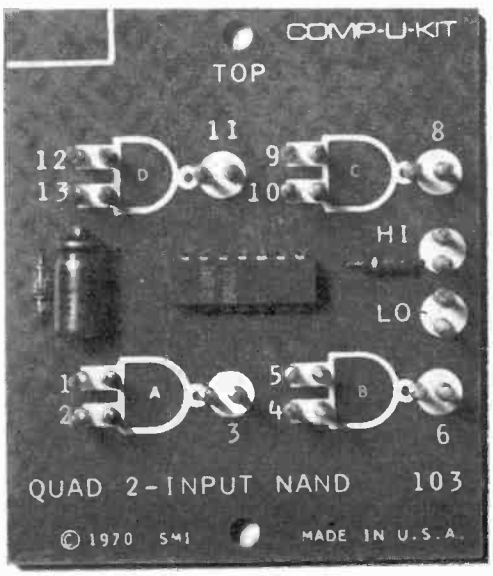


Fig. 4. Photo shows one of modules that make up Comp-U-Kit Logic Lab Model 103. Shown is preassembled quad two-input NAND gate module setup.

Fig. 5. Comp-U-Kit modules assemble on support rails which double as power supply buses. Circuit interconnections are made via flexible jumpers.

Scientific Measurements, Inc., 9701 N. Kenton Ave., Skokie, IL 60076, as their Comp-U-Kit Logic Lab I, Model 10.

Actually an instruction manual entitled "An Introduction to Computer Logic," the "course" covers both basic theory and practical experiments. Starting with fundamental definitions and discussions of such topics as analog and digital computers, digital devices, and binary systems, the book then describes the "Logic Lab" in detail, outlines power supply requirements, and gives step-by-step assembly instructions. Later chapters describe a number of practical experiments for demonstrating switch, inverter, gate, clock, flip-flop, scalar, storage element, shift register, display, and ring counter operation. Other chapters and experiments cover the logic equation, Boolean algebra, truth tables, and binary arithmetic. Several "fun" projects are described, including an electronic coin flipper and a game-like reaction timer.

The "Lab" itself consists of a number of individual circuit modules assembled on PC boards similar to the quad 2-input NAND gate illustrated in Fig. 4. Up-to-date TTL circuitry is employed, with some modules featuring commercial IC devices, others discrete component construction.

The complete kit includes a clock-switch

module, flip-flops, NAND gates, and a 3-bit lamp display using built-in transistor driver amplifiers. These modules are assembled on support rails which also serve as power supply busses, with circuit interconnections made by using plug-in jumpers, as shown in Fig. 5. All the modules are designed for 6-volt dc operation, thus permitting the use of a lantern battery or inexpensive line-operated dc supply as the power source.

Laser Breakthrough. Scientists at the Bell Telephone Laboratories (BTL), Murray Hill, N. J., have devised a new solid-state laser, smaller than a grain of sand, that can be powered by ordinary dry cell batteries. It emits a beam of near-visible infrared light.

Designed by BTL scientists Izuo Hayashi and Morton Panish with the aid of co-workers P. W. Foy and S. Sumski, the new semiconductor laser can operate continuously at normal room temperatures (75-80°F). With a current level of approximately 3000 amperes per cm^2, the device delivers approximately 20 mW, and has a power efficiency of about 1.5 to 2%.

In the past, the heat generated by semiconductor lasers was too great to permit operation at room temperatures for more than a minute fraction of a second. The heat results from passing the large currents needed for lasing operation through a very small area. Even when mounted on heat sinks, room temperature operation was limited to about one ten-thousandth of a second. As a result, semiconductor lasers have been used only in pulsed applications and continuous operation was virtually impossible.

BTL's new device is a double hetero-structure diode comprised of four layers of gallium aluminum arsenide alternating with gallium arsenide and doped with tin, silicon, zinc and germanium. Two of the layers, each about 60 millionths of an inch thick, confine laser light to a thin central layer of the structure. This "active region" layer is about 20 millionths of an inch thick.

Measuring about 15 thousandths of an inch long by about 3 thousandths of an inch wide, the new laser diode is actually smaller than the smile on Lincoln's profile on a U.S. common cent. Still experimental, the new laser diode may one day find widespread commercial application in high-capacity optical communications and data transmission.

Device News. RCA Electronic Components (Harrison, N.J. 07029) has launched a new standard line of microwave solid-state power sources. Known as transferred-electron oscillators (or TEO's), the new line consists of four families of microwave devices: C-Band (4 to 8 GHz) CW, C-Band pulse, X-Band (8 to 12 GHz) CW, and X-Band pulse.

Employing bulk-effect epitaxial gallium-arsenide diodes, the new TEO's can be operated from single-voltage, low-level power supplies. Power outputs of up to 120 mW CW or 10 watts pulsed are possible.

Potential applications for the new devices include handheld radars, fuzes, police radars, intrusion alarms, auto collision avoidance equipment, IFF systems, altimeters, signal generators, marine radars, missile guidance gear, weather radars, remote television pick-ups, industrial telemetry, weapon location beacons, commercial transponders, phased array antennas, municipal vehicle control, short range and mobile communications, downed pilot locators, pollution detectors, blind guidance, auto toll systems and other products.

In addition to the new TEO's, RCA recently has introduced a number of new discrete semiconductor devices, including a pair of UHF/VHF high-power transistors, two new dual insulated-gate MOS/FET's, and a series of sensitive-gate silicon triacs.

Featuring emitter-ballasted overlay construction utilizing refractory metallic connections, RCA's new UHF/VHF transistors, types TA7706 and TA7707, can deliver a minimum power output of 30 watts at 400 MHz with a minimum gain of 5 dB. Similar except for packaging, both units are silicon npn planar devices.

Designated types 3N187 and 3N200, the new MOS field-effect transistors are n-channel silicon depletion types with insulated gates and integrated back-to-back diodes for gate protection. With superior cross-modulation performance and greater dynamic range than comparable bipolars or junction-gate FET's, the two units are designed for rf amplifier aplications at up to 300 MHz (type 3N187) and 500 MHz (type 3N200).

Intended for low-power phase control and load switching applications, RCA's new series of 2.5-ampere sensitive-gate triacs includes types 40766 and 40767 for low voltage circuits, 40691 and 40761 for 120-volt line operation, and 40692 and 40762 for 240-volt power designs. The devices are offered in both modified TO-5 and heat-radiator packages suitable for printed circuit boards.

TRW's Semiconductor Division (14520 Aviation Blvd., Lawnsdale, CA 90260) has announced the addition of a new hybrid power amplifier to their microelectronic product line. Identified as the HMD 2000, this versatile new device can be operated in either a linear or switching mode with capabilities of delivering 3 amps peak current from dual power supplies of up to 25 volts. Assembled in a TO-3 package, the unit is intended for such applications as switching, class B servos, hi-fi audio amplifiers and motor drivers. —*Lou*

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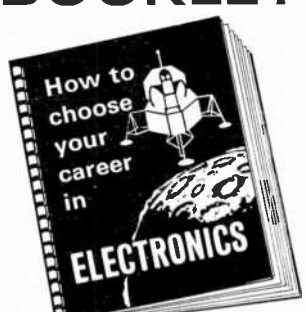

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STEREO SCENE

(*Continued from page 77*)

One good way of choosing speakers is to listen to a couple of the most expensive models in the store (adjusting volume so that all are equally loud), and then A-B'ing some of the systems you can afford (also at the same volume) until you find one that sounds to your ear the most like the top-priced speakers. Arrange to take your chosen speakers home on approval, and listen to them for a week or so at your leisure. If nothing about their sound is starting to annoy you at the end of this approval period, then buy them. Don't worry at this point about the possibility that there might be others you'd prefer. This may be the case, but you will be far better qualified to know what you *do* prefer after you've lived with your first choice.

If you're interested in literal fidelity as well as what sounds "good" to you, get out and hear live music as often as you can, and see whether it sounds like what you hear at home. If you can't hear the difference to begin with, you will eventually, and once you do, you'll be well on the way to equipping yourself with a really good system, whatever price ceiling you've decided to set.

That's the time to face the question "How good a system do I really need?" Nobody else can answer this for you, and you can't really answer it yourself until some exposure to a component system in your own home reveals your listening habits and preferences.

One way to acquire a good system at minimal cost is to buy used equipment. This offers a bonus in that you can get a generally better grade of components than you could otherwise afford.

Used loudspeakers are as good as brand-new speakers, unless obviously defective. And speaker defects are rarely subtle! Check the tweeter level controls, though, to make sure they aren't scratchy-sounding or intermittent; this is the commonest "hidden" problem with elderly speakers. Also, if the grille cloth looks ratty, hold a flashlight against it and peek at the cone, to make sure nobody has poked holes through it with a pencil.

Used tone arms, too, are generally a safe buy, but check the pivots as described previously. A sudden interruption of swing suggests dirty pivots, which you may or may not feel qualified to repair yourself, but should certainly give you a price-bargaining lever if you choose to try.

Never buy a used cartridge unless you can replace the stylus. The elastic suspension

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in most styli stiffens with age and there is no guarantee that the pickup will function satisfactorily unless that particular model wasn't on the market a year ago.

Mechanical devices like used tape recorders and used disc players may be poor risks because with typical owner neglect they go steadily downhill during their working life, and may be costly to repair. An experienced audiophile, with a "feel" for properly functioning players and recorders can often choose a good used item, but it's risky, and even a used professional tape recorder of outstanding durability may require appreciable servicing.

The Other Side of the Coin. A buyer of used preamps, amplifiers and tuners is faced with the obverse side of the depreciation coin—the lower the unit's depreciation rate, the more you'll pay for it. Most early solid-state amplifiers should be shunned, even if the price looks good. They may be in new condition, but the highly touted "transistor sound" of the early solid-state stuff was due mainly to excessive distortion, as witness the fact that today's best transistor amps sound very much like the best of the vacuum-tube amps.

If you spot a used solid-state component that has received consistently good reports in magazines within the past three years, buy it if the price is right. Otherwise, I'd advise a tube-type unit. Since the buying public has been brainwashed into believing that transistors are inherently better than tubes, you can often get a used tubed component for less money than you'd pay for an inherently inferior solid-state one. It may need some new tubes, and possibly some bias adjustments, but these minor ministrations will usually restore it to new condition.

Don't fret over the unanswerable question, "Why did the original owner sell this?" He may have sold it because he didn't like its appearance, or because he was about to be drafted or jailed for malicious empathy. The reason is of no concern to you, because your tastes in sound are not his. No dealer will guarantee that you will *like* a used-component purchase, but any reputable dealer should at least guarantee that what you buy is not downright defective, and be willing to service it free or take it back for a full refund if it is. The whole point of buying inexpensive equipment is that, since you're likely to make some mistakes the first few times around, it's better to make them on modest purchases than on costly ones.

Of course, if you have the means at your disposal, you can always pay an expert to come in and equip you with a $5000 custom installation. But try and get a written guarantee that the resulting sound will suit your personal taste. Just try! —30—

INTERFACE

(*Continued from page 8*)

new speaker that he insisted was cutting off sharply at 16,000 Hz. Laboratory measurements proved that the speaker was flat (as claimed by the manufacturer) out to 20,000 Hz, but the listener was deaf to everything above 9,000 Hz.

HOWARD ADAMS
Norman, Oklahoma

EDISON, AMONG OTHERS

I read Fred Shunaman's article, "A Question of Semantics" (October issue) with great interest. However, may I draw to your attention that I feel the Indian scientist and Professor Jagdishchandra Basu warrants consideration as the inventor of wireless. Professor Basu never cared to patent his inventions and discoveries or cash in on them in terms of monetary rewards.

ROHIT ZAVERI
Pittsburgh, Pa.

A search of biographical material and the various published histories on wireless and radio reveal no mention of Prof. Basu. POPULAR ELECTRONICS *would welcome the opportunity to learn more about Prof. Basu's activities—especially since it is reported that he may have had contact with Marconi (in England) prior to the first long distance demonstration of radio communications.*

MORE ON THE "NEW LOOK"

I want to commend you on your "New Look" and the material organization in the October issue. I particularly like your new tests—complete with graphs—on the construction projects.

D. WAGNER
Chattanooga, Tenn.

I have been a reader since 1954 and I must say that the "New Look" is the most fantastic thing that has happened in all these years. Keep up the good work.

R. N. WILLIS
Camp Lejeune, N.C.

Far better than many previous issues. I found nearly every article in the September issue of interest instead of the usual one or two.

E. MORRIS
Dearborn Heights, Mich.

Your "New Look" may very well be outstanding in the experimentation field, but I think the "Communications" section is a dud!

J. GONZALEZ
San Antonio, Texas

LIBERATOR

(*Continued from page* 52)

Do not substitute a magnetic earphone for the crystal unit. If you do, oscillations may set up and possible damage to the IC can result.

If 60-Hz pickup is a serious problem, wrap the antenna with aluminum foil, leaving a small gap somewhere so that the antenna is not completely shielded, and connect the foil to the circuit ground. To optimize signal pickup, the antenna may have to be tuned. Experiment with various capacitors in parallel with *C1* (provisions for this are made on the PC board) to get best results with the antenna on the package. If you want to remove the 200-turn antenna from the outside of the plastic case, try a common ferrite loopstick in its place, experimenting with various values of *C1* to get maximum signal.

How much power do you need to cover an area? The author used a conventional transistor pocket radio to power a 30′ by 50′ loop. The 100-mW audio output from the radio was more than sufficient to do the job and a good magnetic field was found 25′ above the loop. (It might have been higher but the house wasn't.)

If you want speaker and loop operation at the same time, select a speaker with a lower impedance than normally used and couple it in series with the loop so that the total resistance is approximately the same as the output impedance of the amplifier. —30—

CIRCUIT QUIZ ANSWERS

(*Quiz appears on page* 44)

1. $(10)^2 = (8)^2 + (VR)^2$; VR = 6V
2. $(20)^2 = (7+VC)^2 + (12)^2$; VC = 9V
3. $(24)^2 = (VL-6)^2$; VL = 30V
4. $(15)^2 = (350-350)^2 + (VR)^2$; VR = 15V
5. $(VT)^2 = (15-3)^2 + (16)^2$; VT = 20V
6. $(50)^2 = (VL)^2 + (12)^2 = (VC)^2 + (12)^2$; VL = VC
   $(VT)^2 = (VL-VC)^2 + (12)^2$; VT = 12V
7. $(1T)^2 = (6)^2 + (8)^2$; IT = 10 mA
8. $(20)^2 = (16-IC)^2 + (16)^2$; IC = 4 mA
9. $(IT)^2 = (17-13)^2 + (3)^2$; IT = 5 mA
10. $(9)^2 = (20-4-IC)^2$; IC = 7 mA

LIBRARY

(*Continued from page* 16)

in switching circuit theory on the undergraduate level, the math is developed in full detail. An entire chapter is devoted to the universal NAND and NOR logic operators. And fundamental mode and pulse mode sequential circuits are studied concurrently to emphasize their similarities and differences.

Published by McGraw-Hill Book Co., 330 West 42 St., New York, NY 10036. Hard cover. 494 pages. $14.50.

20 SOLID STATE HOME AND HOBBY PROJECTS

by R. M. Marston

The circuits described in this book cover a wide range of interesting applications. In addition to the almost mandatory baby alarm and light-operated switch, such circuits as a metal detector, motor speed control, and photographic timer are presented. Each circuit diagram is accompanied by a detailed parts list, a circuit description, and construction details. A very interesting feature of the book is that, where applicable, printed circuit board etching guides are given. The choice of semiconductor devices around which each project is built includes Triacs, SCR's, IC's, UJT's and FET's, as well as the more familiar silicon planar bipolar transistor. The book is well illustrated and even has photos of some finished projects.

Published by Hayden Book Co., Inc., 116 West 14 St., New York, NY 10011. Soft cover. 112 pages. $3.75.

RADIO HANDBOOK, 18th Edition

by William I. Orr, W6SAI

It has been three years since publication of the 17th edition of "the other" Handbook; and as might be expected, the changes in ham radio equipment design are reflected in this new edition. If you skip through the first 300 pages (practically all theory), you will start spotting numerous brand-new construction projects—each photographed and diagrammed for ease of duplication. Printed circuit boards have made their appearance and considerably more emphasis is placed on solid-state equipment than in the 1967 edition. Bill has new ideas for SSB linears and VHF gear that should attract many hams.

Published by Editors & Engineers, Ltd., c/o Howard W. Sams & Co., Inc., 4300 West 62St., Indianapolis, Ind. 46268. Hard cover. 896 pages. $13.50.

DIGITAL COMPUTERS MADE SIMPLE

by Saul Heller

Computers, already in widespread use, are now profoundly affecting our lives and will continue to do so in the future. Obviously, some knowledge of them is desirable. Although many books have already been written on the subject, few if any are tailored to suit the layman with no knowledge of computers. This book attempts to rectify that oversight. Only one chapter (the last one that deals with basic computer circuits) is technical in nature. The remainder describes computer numbering systems; computer language; computer systems in brief; input and output devices; computer memory; and computer programming.

Published by Ameco Publishing Corp., 314 Hillside Ave., Williston Park, L.I., NY 11596. Soft cover. 128 pages. $1.75.

WORKSHOP IN SOLID STATE

by Harold E. Ennes

Providing a rapid, effective, and practical method of making the transition from vacuum-tube to solid-state circuitry, this book presupposes that the reader has already received training in basic electronics principles. The text approach is about midway between the simplified "serviceman" and the sophisticated mathematical and equivalent-circuit approaches. Hence, the transition is fairly broad-based. The text is written to provide a learning pace that is consistent with a practical study of circuit analysis and fundamental design.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Hard cover. 382 pages. $9.95.

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$15.95

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Full 9′ length. The bottom 5′ is specially developed Gatorglass . . . designed for military use on tanks and jeeps. It is super strong . . . won't lay back or take a set, stays erect for better radiation. Gatorglass won't split, run or peel like ordinary fiberglass. It will stand up under corrosive atmospheres and retain its smooth white finish. We have set a highly conductive copper strip right into the fiberglass for high power handling. A new bonding technique permanently sets the whip into the mounting base. The 4′ stainless steel top slides into the Gatorglass section and is secured with all stainless steel and chrome fittings making it instantly tunable. This stainless steel whip stops fraying and breakage in case you should hit an overhead obstacle.

TECHNICAL ADVANTAGES: Tunable to 1.1: 1 VSWR, getting maximum power out of your set into the air . . . Can be tuned from 25 to 40 HMz for business use . . . Will take 200 watts of power . . . Standard ⅜-24 thread fits all popular body and bumper mounts . . . Full one year warranty against defects in materials or workmanship.

Boost performance 25%. Co-phasing 2 GATORWHIPS with an Avanti AV-504 harness will give 25% more performance without becoming directional (if properly spaced less than 6′ apart as per instructions).

avanti

33-35 WEST FULLERTON AVENUE,
ADDISON, ILLINOIS 60101

AVANTI RESEARCH & DEVELOPMENT, INC.

THE PACESETTER IN HIGH PERFORMANCE ANTENNAS

CIRCLE NO. 3 ON READER SERVICE PAGE

LOUD MOUTH!

The new E-V Eliminator.

The first Eliminator was built to prove a point. Because young musicians, in a search for more volume, were literally driving the guts out of some very good speakers mounted in some very poor enclosures.

It started an intensive investigation into the failure of speakers (ours and the competition) used by guitars and organs. The testing was very rugged. For instance, we took miles of high-speed motion pictures while test speakers destroyed themselves with sound.

We found out a lot about how to improve our speakers. But we also learned that by simply putting our SRO/15 speaker in a folded horn enclosure we created a combination that was unbeatable for efficiency, high power handling capacity, low distortion, and extended bass. It was an important first step.

Of course, this now meant we needed a solid high end. So we added the time-tested 1829 treble driver and 8HD horn, or (optionally) a T25A treble driver plus a pair of T35 super tweeters. These combinations were a revelation to musicians. They got more sound power per watt than they thought possible. And they could use the Eliminator for both vocals or instruments.

But we weren't satisfied. If the Eliminator was good for popular music, what would it do with other kinds of program material? So we tested it in good rooms and bad rooms. With test instruments and with live audiences. And we decided that the Eliminator was too good to sell only to the young.

For example, in one test installation in a difficult domed building, four E-V Eliminator I speakers far out performed an elaborate multicell installation in naturalness of sound for voice and music, in uniform sound pressure level throughout the listening area, and in the ability to reproduce the extremes of loudness of a big, driving jazz band with ease.

Granted, the E-V Eliminators have a flash of chrome. But don't be misled. They perform to beat the band. And they solve problems. Get turned on to the great sound of the E-V Eliminators today.

ELIMINATOR I 3-way system: Response 55-15,000 Hz; Power Handling Capacity 100 watts RMS (white noise shaped to stringent lead guitar frequency spectrum); Dispersion 100°; Sound Pressure Level 122 db at 4' with full power input; Suggested Resale $465.00.

ELIMINATOR II 2-way system: Response 55 to 10,000 Hz; Power Handling Capacity 100 watts RMS (shaped to stringent lead guitar frequency spectrum); Dispersion 100°; Sound Pressure Level 123 db at 4' with full power input; Suggested Resale $370.00.

ELECTRO-VOICE, INC., Dept. 1206P
630 Cecil Street, Buchanan, Michigan 49107

Electro-Voice®
a GULTON subsidiary

CIRCLE NO. 4 ON READER SERVICE PAGE