02396

ELECTRONICS HOBBYIST

SPRING-SUMMER 1972 $1.25

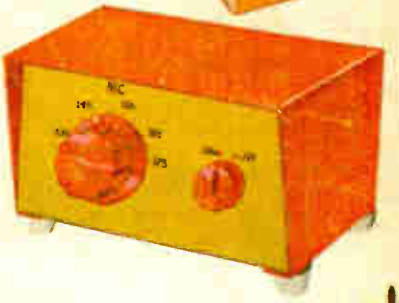
A Science & Mechanics Semi-Annual Publication

PROJECTS for EVERYONE

Home, Darkroom, Auto, Science Fair, Hi-Fi, SW Radio, Test Bench, Fishing and just fun!

Reflex Broadcast Band Receiver

Tune in the AM band with our sure-fire rig that anyone can build in a weekend!



Police-Fire Band Converter

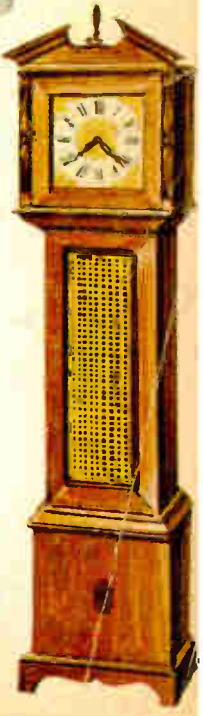
New solid-state gadgets designed and wired into a simplified, pre-tested circuit puts the hi-band on your FM receiver!

Light Meter for Strobe

Gets the guess work out of strobe lighting and makes f-stop fumble a job for our fool-proof Flash Master!

Grandfather Clock Sings Back

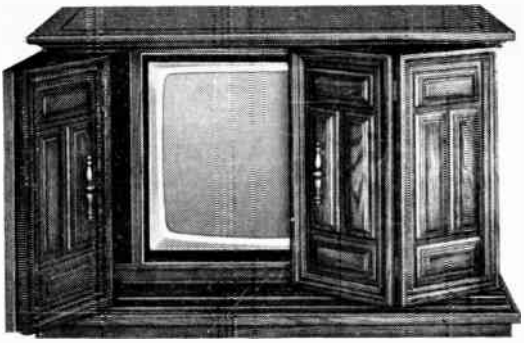
Weekend carpenters will enjoy building this handsome, easy-to-assemble clock with built-in speaker for background music!



Super Booster for Everyone

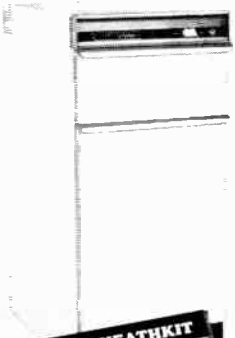
Convert any inexpensive AM receiver into a pro-like rig with one of two super-type projects described in this issue.

Seven new Heathkit products you can build (and service) yourself...and save!

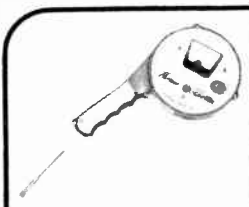


Heathkit GR-371MX, our biggest (25" diag.) ultra rectangular screen color TV with exclusive solid-state modular design that makes assembly & self-service a snap... now available in an exquisite **new Mediterranean console** with beautifully scalloped double-hinged doors that hide screen when not in use, fold neatly to the cabinet sides when opened. **Kit GR-371MX** (less cabinet) 125 lbs., **579.95***. Assembled **GRA-405-25** cabinet, 100 lbs., **179.95***.

New Heathkit AR-1500 Stereo Receiver. Successor to the famed AR-15 with impressive improvements. 180 watts Dynamic Music Power, 90 watts per channel, 8 ohm load. Less than .2% IM & .25% harmonic distortion. Greater than 90 dB FM selectivity & 1.8 uV sensitivity. Vastly superior AM. New, improved hinged circuit boards for easier assembly & service. **Kit AR-1500** (less cabinet) 42 lbs., **349.95***. **ARA-1500-1** walnut cabinet, 6 lbs., **24.95***.



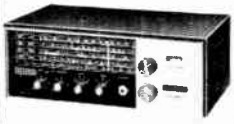
New Heathkit "Minimizer" waste compactor. A ton of force reduces trash to ¼ original volume...packs entire week's trash for a family of 4 in a single, strong disposable bag. Automatic deodorizing. Key lock switch & safety interlock. Includes 5 plastic-lined bags & 9 oz. can of deodorant. 34⅜" H x 15" W x 25½" D. Easy self-assembly & service! **Kit GU-1800,** 203 lbs., **199.95***.



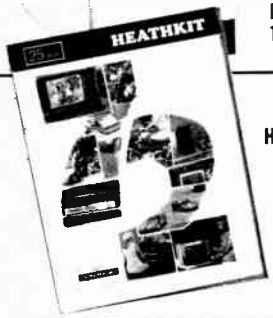
New Heathkit Thermo Spotter. Seeks out temperature where your favorite fish live, down to 100'. Solid-state. Battery powered. Take-up reel case. 2 hr. assembly. **Kit MI-104,** 3 lbs., **24.95***.

New Heathkit Automatic 10-amp Battery Charger... for 12V batteries. Foolproof operation...won't start if hooked-up wrong. Can be left hooked-up indefinitely. Simple check-by-step assembly. **Kit GP-21,** 13 lbs., **29.95***.

New Heathkit Timing Light. Completely self-contained, with extra-bright flash for working in direct sunlight. Adapter for connecting to distributor on cars with hard-to-reach plugs. **Kit CI-1020,** 3 lbs., **19.95***.



New Heathkit Solid-State Shortwave Receiver. Covers 550 kHz to 30 MHz on 4 overlapping bands. Bandspread tuning, BFO control, signal meter, headphone jack, noise limiter & built-in AM antenna. **Kit SW-717,** 10 lbs., **59.95***.



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*Mail order prices; F.O.B.
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CIRCLE NO. 1 ON PAGE 13

SAVE HUNDREDS OF DOLLARS!!

Buy an S & M Supersensitive Photometer

These unique exposure meters are utilized also for enlarging, slide duplication, ground-glass photography, readings off x-ray films, photomicrography and more!
Your present meter probably can't handle these different jobs because it doesn't have features like ours: four sensitivity ranges; EV-EVS-LV settings; ASA settings from 3 to 25,000; f/stops from 0.7 to 90; exposure times from 1/15,000 sec. to 8 hours; and special accessory probes. These lightmeters, operated by mercury batteries, with plug-in probes, have such enormous light-gathering capabilities that they give readings (as low as .00025 ft. candle) where other meters fail.
The Model A-3 Darkroom Meter with dial lamps and easel probe performs beautifully for exposures and paper speeds at the enlarger.

It eliminates guesswork—waste of prints and material—to give BIG profits in MONEY and TIME.
Here is your opportunity to use one free for 10 days without obligation. Mail the coupon today.

BUILD YOUR OWN DENSITOMETER WITH THE MODEL 102 LIGHTMETER

SCIENCE & MECHANICS As reviewed in the April issue of Camera 35
Instruments Division Dept. 333
229 Park Avenue South N.Y. 10003

Send the S&M Supersensitive Photometer checked below, including standard probe, computer and case. Complete instructions supplied to build your own densitometer. If not satisfied, I may return the meter within 10 days for a complete refund.
(Add 10% for Canadian and Foreign orders; N.Y.C. residents add 7% for sales tax.)

- ☐ Darkroom Model A-3 @ $75.00.
- ☐ Model 102 Lightmeter @ $57.50.
- ☐ Easel Probe @ $7.50.
- ☐ Mini Probe @ $7.50.
- ☐ Check or money order enclosed, ship ppd.
- ☐ Corporate purchase order attached.

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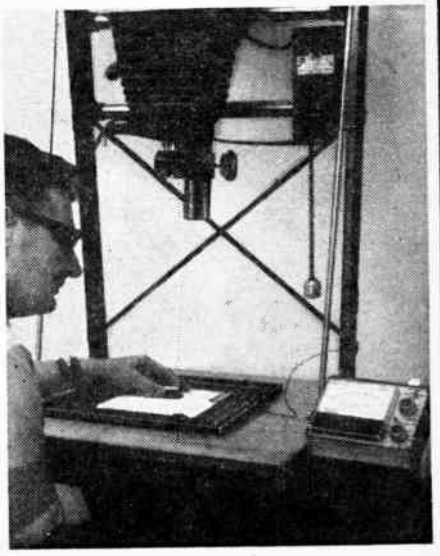


Model A-3 in Darkroom Application

Spring/Summer 1972 EDITION

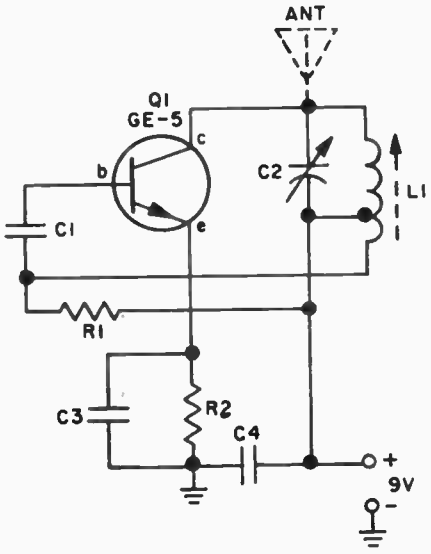
ELECTRONICS HOBBYIST

CONTENTS

Sideband—Sideman

Placed near a multiband transistor portable, this BFO allows reception of CW and SSB signals in addition to the normal reception.

The BFO is a Hartley oscillator tunable across the broadcast band. Oscillator harmonics extend to the higher shortwave frequencies where they "beat" against CW and SSB stations. It provides standard BFO tone reception of CW signals and reasonably good reception on moderate to strong SSB signals.



Once C2 is adjusted to the proper beat frequency, the BFO is positioned near the transistor radio for optimum reception. No antenna is needed if the unit is assembled in a plastic cabinet.

The BFO can also be used as a radiotype code practice oscillator with a range of approximately 20 feet. Connect a 10-ft. antenna on a nearby BC radio. To send Morse code, insert a key in series with one battery lead.

PARTS LIST FOR BFO FOR SIDEBAND SIDEMAN

C1, C3, C4—0.05uF, 25-VDC capacitor
C2, 360-pF variable capacitor
L1—Tapped BC antenna coil
Q1—GE-5 transistor
R1—2200-ohm, ½-watt resistor
R2—68-ohm, ½-watt resistor

SPRING/SUMMER 1972 EDITION

ELECTRONICS HOBBYIST

Dedicated to America's Electronics Hobbyists

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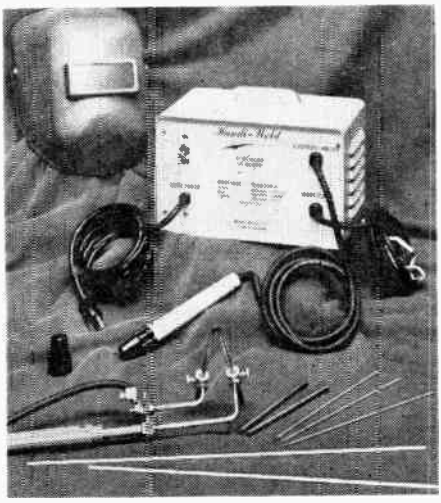
NEW PRODUCTS

Weld at Home

Introducing "Handi-Weld" a small AC Arc Welder weighing only 33 pounds. This Welder has been designed especially for the small shop mechanic, handyman, experimenter, sculptor, or most any amateur or professional that has periodic needs for a welder, but not often enough to warrant investing in a larger, more expensive machine. One of its most important features is



the fact that it can be plugged into any 115 Volt AC electric outlet, and so does not require the 220 Volt power needed by most welders. Priced at only $89.95 complete. A safety Welding Helmet is included as Standard Equipment with the Welder. For more information, circle No. 28 on Reader Service coupon on pages 13 or 104.

Freedom-Fone

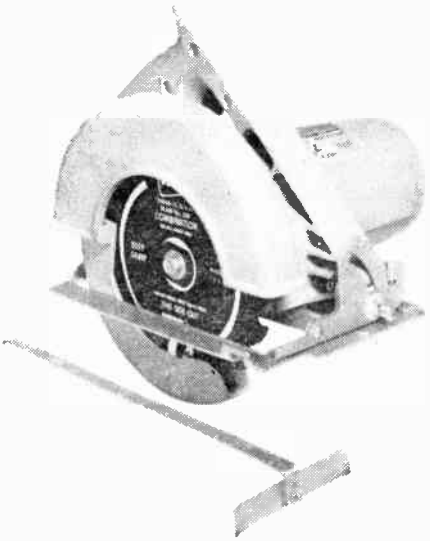
Superex's new wireless Freedom-Fone, Model FF-1 makes it possible for you the Ham, CB'er or SWL to have complete freedom of movement in the "Shack". It is no longer necessary to be tied to and dangling off your receiver like an

NEW PRODUCTS

astronaut at the end of his umbilical cord. The Freedom-Fone is a wireless headphone, which has a built in induction receiver, that gives you complete freedom of movement anywhere in the house within the range of the transmission loop. Now for the first time you can freely move about while waiting for that important "scheduled" call or that elusive identification to be made. The Freedom-Fone can also be used to listen to your TV or radio without disturbing other people in the room who may wish to pursue other interests. The Freedom-Fone Model FF-1 is a complete transmission and receiving system, consisting of 2 sections, the Receiver, built inside the headphones ear cup and the Transmission system. Full instructions for an easily constructed induction loop are included. The audio signal from the output of your receiver or amplifier is fed into the loop. This audio signal picked up by the "antenna" inside the headphone, is amplified by the solid state circuitry. The Superex headphones with the "Communication Taper" give you a quality signal that will make even the most difficult "in the mud" signals become a 5 x 5 QSO. Price $29.95. For more information, circle No. 29 on Reader Service coupon on pages 13 or 104.

Buzz Off

Wen will introduce this new 7¼-inch Circular Saw, Model 961 at the National Hardware Show that'll help you build your next speaker cabinet or work-bench. It's double insulated with a 2 HP motor—powerful and rugged yet light at only 8 lbs. The saw also features a rigid shoe plate



and fine balance, to help the professional or amateur saw a straight line. Other features are: safety-sured, shock-proof, hi-impact bright-red housing; powerful 11 A 2-HP motor, 5100 RPM-permanently lubricated bearings; extra safe slip clutch; and calibrated rip fence. Priced at $29.95. For more information, circle No. 30 on Reader Service coupon on pages 13 or 104.

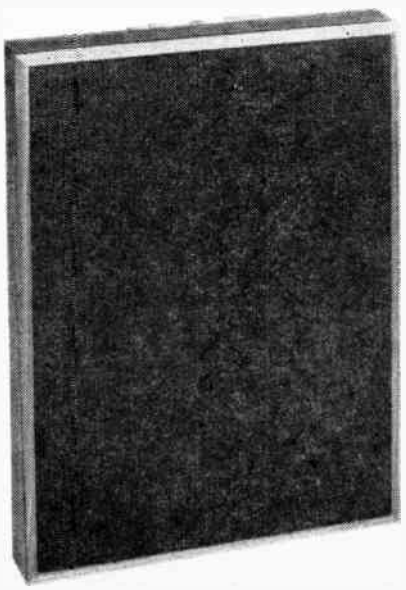
Phone Pickups

Two new low-impedance magnetic telephone pickups have been added to GC Electronics Audiotex line. The telephone pickups are designed to be used with the majority of today's transistor tape recorders and amplification de-

vices. One pickup, designated catalog number 30-6000, is a conventional suction-cup-type unit and may be attached wherever there is a reasonably strong magnetic field present in the telephone—at the top of the handset or adjacent to the coil block on the side of the telephone base. The pickup retails for $2.45. The deluxe model pickup, catalog number 30-6002, slips over the earpiece of the telephone handset. Because the unit is molded to slip over the earpiece with a glove-tight fit, there is no "wrong" position for it, and it minimizes extraneous noise pickup. The price of this pickup is $2.90. Both units terminate in a miniature phone plug and will fit almost all battery tape recorders. Audiotex products are sold by authorized high fidelity dealers, record, department and chain stores. For more information, circle No. 26 on Reader Service coupon on pages 13 or 104.

And 2 More Make 4

A new space saving speaker system in a convenient thin-line configuration is the Criterion W4—a thin-line 3-speaker system with unique



NEW PRODUCTS

"drone cone". Its no-compromise design utilizes a "drone cone" which reinforces and increases the low frequency capabilities normally minimized in an ultra thin enclosure. Bass response goes down to 50 Hz with the powerful 5-in. high-compliance woofer and 5-in. drone cone. The two high frequency tweeters disperse crystal clear, brilliant highs up to 19,000 Hz. Electrical crossover is present at 4 kHz. An ideal choice for rear speakers in 4-channel stereo systems where compact size and high quality sound is a must. Can be hung on walls, placed on bookshelf, or stood on floor (with legs supplied) if desired. Cabinet is hand finished in oiled walnut with a luxurious textuerd brown grille cloth. Impedance: 8 ohms. Built-in adjustable high frequency level control. Size: 19-13/16 x 14-27/32 x 2-15/32-in.D. Priced at $34.95. For more information, circle No. 27 on Reader Service coupon on pages 13 or 104.

Hot Tip

For hobbyists or professionals, Wen Products is now offering an all purpose Soldering Gun Kit, Model 222K25, in a compact, lightweight, unbreakable plastic carrying case to sell at $7.95. This new soldering gun, with 20 assorted

soldering lugs, fits in a protective custom-fitted case. Ready to take on hundreds of home soldering jobs, it is an equally effective tool for professional-type printed circuit work, wire splicing, TV, radio, appliance and other electrical repairs and industrial applications. The Model 222 Hot Rod Soldering Gun features exclusive Automatic Thermal Regulation, delivers up to 200 watts. of heat power on a current draw of only 55 watts. For more information, circle No. 31 on Reader Service coupon on pages 13 or 104.

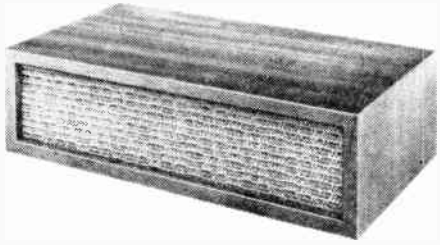
Makes Pickin's Easy

New economical tweezers of non-magnetic stainless steel with heavier stronger points which

may be used for everything from delicate electronic instrument assembly to jewelry making and other hobby handcrafts, have been introduced by EREM Corp. This newest addition to the firm's Precista line of precision hand tools is available in two styles: one made with serrated points; the other, smooth points. Overall length is 4¾ inches. Its almost unlimited applications include such fields as TV and radio, telephone, industrial, scientific research; vocational education; and consumer interests such as jewelry making, gem setting, model making and other hobby handcrafts. They are also popular with machine shops as well as for assembly and repair of electronic instruments and control systems. Priced for economy, the new tweezers range from $2.25 to $1.24 per pair, depending on quantity. Further details presented in Bulletin 312 can be had by circling No. 32 on Reader Service coupon on pages 13 or 104.

Sonic Alarm

The new Protector electronic security system from Radatron Corporation is designed to protect the home or office from intruders. It incorporates the features of a sophisticated commercial ultrasonic electronic security system while being small and economical enough to be used in the



home or office. The Radatron Protector emits ultra-sonic waves which blanket an average sized room . . . about 300 square feet. Once an intruder enters the protected area, he breaks the wave pattern and triggers the alarm. Almost any type of alarm . . . sirens, lights, bells . . . can be easily attached to the Protector. In addition, a special accessory alarm circuitry permits the installation of smoke, fire and gas detectors or peripheral alarm systems. The Protector looks like an ordinary table radio and its wood grain cabinet and handsome fabric front let it blend into any room decor.

The Radatron Protector comes fully assembled and a full line of accessories are available through Radatron dealers. For more information, circle No. 33 on Reader Service coupon on pages 13 or 104.

T for Two

For two persons who want to share the pleasures of stereo hi-fi listening with complete privacy

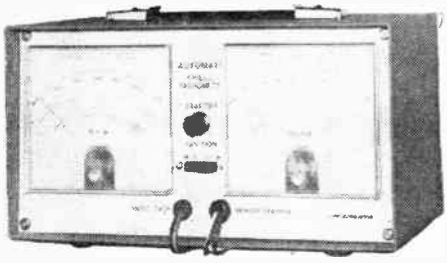
NEW PRODUCTS

provided by headphones, Switchcraft, Inc., Chicago, has designed a special stereo adapter that enables you to connect two headphones to a single amplifier output. The adapter (Part No. 353CP1) is designed for those who want to listen to their stereo unit without distracting others in the room or being distracted themselves by outside noise. The adapter also can be used to connect two stereo speakers to amplifier speaker

output jacks. The adapter, consisting of 3-conductor ¼-inch phone plug wired to two 3-conductor ¼-inch phone extension jacks simply plugs into the amplifiers' headphone or speaker output jacks. Headphones or speakers can then be connected directly to the adapter by means of the two phone extension jacks. Available at most electronic parts dealers. For more information, circle No. 34 on Reader Service coupon on pages 13 or 104.

For Weekend Mechanics

Weekend mechanics will find it easier than ever to tune up thir cars with the new Micronta Automatic Dwell Tachometer from Allied Radio Shack. This solid-state unit features two large 4½-inch double-jeweled D'Arsonval meters for simultaneous readings of engine speed and dwell angle. A built-in starter switch makes it possible

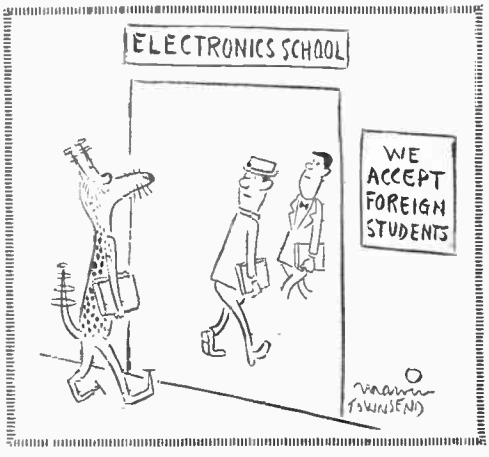


to start, stop or crank the engine from outside the vehicle. Meters read 0-3000 rpm and 0-45° on 8-cylinder engines, 0-4000 rpm and 0-60° on 6-cylinder engines and 0-6000 rpm and 0-90° on 4-cylinder engines. For 6, 12, or 24-volt electrical systems. Color-coded leads with insulated heavy-duty clips simplify connections. The Micronta Automatic Dwell Tachometer is priced at $29.95 with complete instructions and tune up chart. Metal case, 11¾ x 5⅛ x 6. Available at Allied Radio Shack stores. For more information, circle No. 35 on Reader Service coupon on pages 13 or 104.

There's Gold Out There

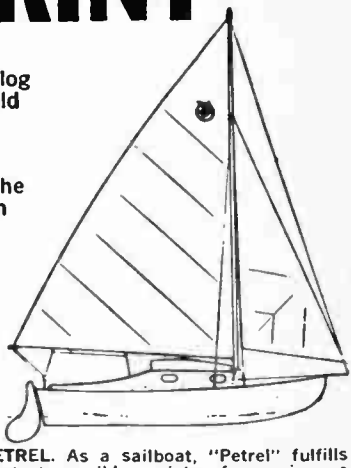
There is adventure, fun and profit in treasure hunting or prospecting with a revolutionary new featherweight metal and mineral detector, White's Electronics, Inc. Coinmaster IV. More sensitive and lighter in weight than most others in its class, the Coinmaster IV has a highly tuned semi-3 coil, ultra-sensitive 6-in. loop developed

for maximum depth efficiency when searching for coins, and other small metal objects. The device also is designed to detect at greater depths larger items such as treasure chests, iron pots, etc. Use of all transistor solid state circuitry makes the Model 4 a very compact and lightweight detector. It is a joy to women treasure hunters and youngsters. The detector weighs only 4-lbs. 6-oz., complete with loops and batteries, which reduces fatigue on extended searches. White's new all-transistor transmitter-receiver Coinmaster IV metal detector comes complete with mineral and metal samples, super-sensitive multi-coil 6-in. loop, detailed instructions and a two-year warranty. It is retail priced at $199.50 f.o.b. factory. For more information, circle No. 36 on Reader Service Coupon on pages 13 or 104 ■



NEW 1972 CRAFT PRINT CATALOG

The new 1972 Craft Print Catalog has over 100 great easy-to-build plans . . . Sail boats . . . recreational travel trailer . . . Biplane . . . and many home projects you can order. With the 72 Craft Print Catalog you can get top mailage from your own craft skills . . . outstanding design . . . utility value . . . and ease of construction. Each Craft Print is fully illustrated . . . step-by-step construction procedures . . . and complete material list.



Here are just 3 of the many great Craft Prints Plans included in the catalog.

255. MINIMAX. For minimum cost and maximum performance you can't beat "Minimax." Actually, it was built in one day at a cost of less than $30.00. It will carry two persons, take outboard motors ranging from 3 hp to 15 hp, and has a watertight air compartment that will support 900 lbs. even with the cockpit completely filled with water. As to performance, it will plane a 165 lb. man up to 15 mph with a 3 hp motor. With motors of 10 hp or more, "Minimax" just about rides on the engine's cavitation plate. Length, 8'; beam, 48"; weight, 68 lbs. Full size patterns No. 347 are available for "Minimax." $12.00

334. EAA BIPLANE. Completely modern in design, but based on the traditional one-man flying machine of yesteryear, is the EAA Sport Biplane. It's a real plane, adaptable to home construction at a cost of less than $2000 (with a used engine). She can carry a 230 lb. pilot at a rate of climb of 700' per minute to a ceiling of 11,500'. With an 85 hp engine, she can attain a speed of 130 mph. (Plans are $15.)

106. PETREL. As a sailboat, "Petrel" fulfills the greatest possible variety of uses in one model. It can be built as an open cockpit racing craft, or as a cabin cruiser with accommodations for overnight trips and shelter on fishing excursions. Cockpit seats four. Either model is constructed from the same basic design, and possesses unusual seaworthiness, stability, trim attractive lines, speed, and ability to handle well. Construction is easy and inexpensive, utilizing marine or exterior grade plywood. An outboard of up to 6 hp can be used for auxiliary power. Due to the simplified construction, ordinary carpenter's tools and only average skill are required to build this boat. Length, 16'; beam, 6'; depth, 23" amidships; draft with fixed keel, 24"; draft with centerboard down, 30"; weight 650 lbs.

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ASK HANK, HE KNOWS!

Hank Scott, our Workshop Editor, wants to share his project tips with you. Got a question or a problem with a project you're building—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Sorry, he isn't offering a circuit design service. Write to:

Hank Scott, Workshop Editor
ELECTRONICS HOBBYIST
229 Park Avenue South
New York NY 10003

Data Trouble

I am a computer operator. I have an 8-transistor radio in the computer room. The batteries will last from two to three months at home, but in the computer room they last only about a week or two. This is getting expensive, buying batteries. To make a long story short, to get away from batteries I tried an AM/FM/FM-Stereo radio which operates off the line. There was so much static from the computer that I couldn't hear the radio. What I would like to know is, is there a way to eliminate this static?

—A.B., Star City, Ark.

Ask your supervisor for permission to string an outdoor antenna for both AM and FM. Chances are he'll say, "No"! Your best bet for entertainment while you work is your own private *Musak* system. Bring an 8-track player to the office and buy your cartridge programs. No noise at all this way. If you can get your fellow workers to pitch in every payday, you will have a good music library in no time at all.

Silent Films

At present, the amplifier in my 16-mm sound projector has just about had it. I was wondering if there was some way that I could hook up the projector's photocell to a separate hi-fi amplifier and get it to work? So far, a direct line from photocell to the amp inputs with proper shielded cable just gives me one loud hum. Any suggestions?

—K.W., Flushing, NY

You can never tell, the photocell in the projector may be shot and you are using the defective component in a Rube Goldberg setup. Skip the hi-fi tie-in and look for the trouble in the projector circuit. The amps used in these jobs are very simple and easy to troubleshoot. So get to it! A screwdriver used as an audio signal injector should help you pin-point the defective part.

One More Stage—It's Iffy

I am happily overwhelmed by one of the IC projects in the Sept.-Oct. issue of ELEMENTARY ELECTRONICS *namely No. 8, the Shortwave Booster. (To all fellow Canadians who can't find the HEP-590, use a $2.25 Motorola MC1550G, or an Elcom IC-20). After seeing how the booster can soup-up the RF of my Knight-kit Star Roamer, I can't help wondering if this broadband beauty can doctor the single-tube IF stage in said radio. Can I hook it into the rig's innards, and how?*

—J.F., St. Laurent, Que.

Thanks for your kind letter. Too many readers think this column is the knock department. As for using our booster as an added stage of IF—don't. I've added IF stages to rigs before and came up bananas every time. However, if you want to add crystal or ceramic IF, there is where you can profit. Check the catalogs of your favorite mail order house. These little modular insets add a full IF stage with performance curves that look like cliffs. Results are great. By the way, we reprinted the shortwave booster circuit in this issue of ELECTRONICS HOBBYIST.

Junior Broadcaster

Can an AM receiver be converted into a transmitter? If so, how?

—W.C.C., Dunnellon, FL

The answer is yes, but I will not tell you how because you will only break the law! In every AM Superhet receiver there is a local oscillator circuit that produces a signal 455 kHz above the receiver's dial setting. This very low-powered transmitter can be used for transmission purposes provided it is keyed or modulated. It was rumored that German subs tuned in merchant seamen radios during WW II and sank same.

The FCC permits broadcasting on the AM band provided the transmitter meets rigid tests and your broadcasts do not interfere with the listening pleasures of others. It is, therefore best to purchase wired units.

Adventure!

Please tell me if it is possible to convert an old fashioned phonograph which only played 78 speed records, into a turntable which plays the three speeds, 78, 45 and 33⅓. I am not necessarily interested in cutting corners, but more or less adventurous.

—I.K., Richmond VA

(Continued on page 19)

ELECTRONICS HOBBYIST

READER SERVICE PAGE

• The Editor of ELECTRONICS HOBBYIST offers readers an easy way to get additional information about products and services advertised in this issue. Also, if you would like more information about any new product mentioned in our new products column, it's yours for the asking. Just follow the instructions below and the material you requested will be sent to you promptly and at no cost.

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Ask Hank, He Knows

It's all in the capstan drive. And the chances are that it's impossible to make a three-speed unit unless you are a machinist. The capstan (usually the motor shaft) will drive the turntable slower if its diameter is reduced. What I once did in the early days of the 45 disc was to put a file to the capstan. I constantly checked the speed until I counted 45 revs in one minute. Look at a standard 3-speed machine and see how the capstan has 3 different diameters near the shaft end. Duplicate the mechanism, if you can—good luck!

Wants a Book

Where can I buy the World-Radio-TV Handbook?

—P. F., Burbank, CA

Write to Gilfer Associates, Inc., P. O. Box 239, Park Ridge, NJ 07656. Ask them for price information and for a copy of their latest catalog. If you DX, you'll deal with Gilfer.

Needs a Diagram

I lost the diagram for my Hammarlund HQ-200. Where can I get a copy?

—L.S., New York, NY

Write to Hammarlund Manufacturing Co., Inc., 73-88 Hammarlund Drive, Mars Hill, NC 28754. And hang on to your HQ-200, it's a fine rig.

Wants a Multi-dipole Antenna

Okay, I need your help but don't tell me to read a radio parts catalog for information. What I want is a dipole job that'll take in most of the shortwave bands.

—P.S., Brooklyn, NY

Okay, Lazy, but half the fun is thumbing through the catalogs. Why, if I took my Sears Catalog away from my wife, she would leave me. The Mosley 7-dipole antenna. Model SWL-7, is for you (and me, too!) It tunes in the 49, 31, 25, 19, 16, 13 and 11 meter bands. You'll need about 40-feet of space to put it up. Price is about $27 and comes in do-it-yourself form.

Whatta Group

I would like to know how to wire a combination of eight 8-ohm speakers to obtain 8-ohms impedance. My amplifier operates on 8-ohms impedance. All of these speakers are 8-ohms. The front and the rear are 5" small speakers (woofers) and the sides are 6 2½-in. tweeters.

—A. L., Shawinigan, Que.

Here we go again mixing apples with pears. The best you can hope for is fruit salad! If all the speakers were identical, then the hookup would be *impossible* to get exactly 8-ohms with equal power delivered to all speakers. However, if you slip in an 8-ohm, high-voltage, non-inductive resistor in the group, then it's easy. See our diagram A.

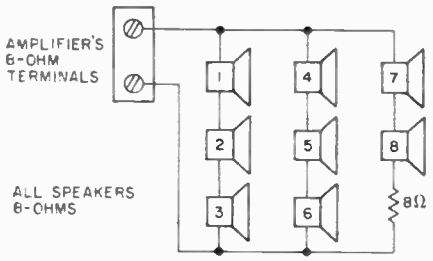

DIAGRAM A

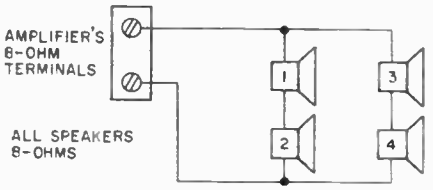

DIAGRAM B

But, two woofers and six tweeters require the use of a complex crossover network. Honestly, it sounds like your using salvage, low-cost speakers and trying for hi-fi sound—if so, you're a loser! Why not pick up four wide range, hi-fi speakers and connect them as shown in diagram B.

QRM in NYC

I own a Lloyds 5-band MB/AM/FM aviational police receiver. Please tell me how I can improve reception between 108 and 175 MHz. My antenna pulls in too much QRM. Can you help me?

—T.G.O., New York, N.Y.

Also living in New York, we know what you mean. In the first place, there are too many signals on the air in New York for a tunable receiver to operate without intermodulation interference. For good reception, you need a professional-grade receiver plus an array of filters, which is an expensive set-up.

Jackass Trains Dog

I wish to build a dog training collar—one that produces a low amperage, high voltage shock to my dog when I remotely signal via a miniature signal sending device. If there is a charge for detailed plans and specifications, I will be happy to reimburse upon your advice.

—C.W.J., Los Angeles, CA

There's only one way to train a dog and that's with love. You can beat a dog, starve it, torment it, torture it and it will obey, but in doing so you destroy the character of the

(Continued on page 16)

LITERATURE LIBRARY

61. *Heath's* new 1972 full-color catalog is a shopper's dream—chockfull of gadgets and goodies everyone would want to own.

62. *Edmund Scientific's* new catalog contains over 4000 products that embrace many sciences and fields.

63. Want some groovey PC boards plus parts for communication projects? Then get a hold of *International Crystal's* complete catalog.

64. Discover how you can do all kinds of jobs with *Xcelite's* new 19-piece midget reversible ratchet offset screwdriver set and 5-piece pocket kit.

65. *Olson's* catalog is a multi-colored newspaper that's packed with more bargains than a phone book has names.

66. Now available from *EDI (Electronic Distributors, Inc.)*: a catalog containing hundreds of electronic bargains.

67. Pick *Cornell Electronic's* 10th anni. catalog and discover yesterday prices. Tubes go for 36¢ and 33¢. Plus many other goodies!

68. A new free catalog is available from *McGee Radio*. It contains electronic products bargains.

69. It's just off the press—Lafayette's all-new 1972 illustrated catalog packed with CB gear, hi-fi components, test equipment, tools, ham rigs, and more.

70. Kit builder? Like wired products? *EICO's 1972* catalog takes care of both breeds of buyers at prices you will like.

71. For a whole packet of information on how to succeed in electronics, contact *Cleveland Institute of Electronics*. An application for enrollment is included.

72. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools, and instructions included.

73. *Hallicrafters'* literature features new SR-400A, "Cyclone III", 550 watts P.E.P., SSB/OW, 5 band transceiver for OM or YL amateur.

74. For CB'ers and SWL's, there is a free 12-page catalog from *Mosley Electronics*. Antennas for every need—base station verticals and beams, mobile, marine, SWL; also complete line of accessories is included.

75. Before you build from scratch, check the *Fair Radio Sales* latest catalog for surplus gear.

76. Two leaflets by *R. L. Drake Co.* are available. One is on their SPR-4 communications receiver; the other on the SW-4A international shortwave broadcast receiver.

77. *Allied Radio Shack's* new 1972 Electronic Equipment Catalog features all-new 4-channel quadraphonic stereo equipment. The 92-pages include their exclusive audio equipment.

78. *Custom Alarms* reveals how inexpensive professional alarms can really be. Install one yourself. Circle 78 for exclusive catalog.

79. If you want courses in assembling your own TV kits, *National Schools* has 10 from which to choose. There is a plan for GIs.

80. *Avanti's* catalog describes and illustrates their complete line—mobile/base CB antennas many others.

81. *RCA Experimenter's* Kits for hobbyists, hams, technicians and students are the answer for successful and enjoyable projects.

82. You can become an electrical engineer *only* if you take the first step. Let *ICS* send you their free illustrated catalog describing 17 special programs.

83. Radio monitoring enthusiasts, "You're in on the action" with *Petersen* monitors. Send for catalog having full descriptions of VHF and UHF models.

84. A pamphlet from *Electra* details the 6 models of the Bearcat III, a scanning monitor receiver.

85. *B&F Enterprises* has an interesting catalog you'd enjoy scanning. Goodies like geiger counters, logic cards, kits, lenses, etc. pack it. Get a copy!

86. Troubleshooting without test gear? Get with it—let *Accurate Instrument* clue you in on some great buys for your test bench.

87. Automatic scanning of lo and hi band VHF channels is featured in new *E. F. Johnson* "Duo-Scan" receiver. Many other products are displayed here as well.

88. *Dynascan Corp.* has released a new catalog of *B&K* precision test equipment for a variety of uses.

89. Want a deluxe CB base station? Then get the specs on *Tram's* super CB rigs.

90. Get the scoop on *Versa-Tronics'* Versa-Tenna with instant magnetic mounting.

91. Prepare for tomorrow by studying at home with *Technical Training International*. Get the facts on how to step up in your job.

92. Pep-up your CB rig's performance with *Turner's* new M+3 mobile microphone.

93. A fully illustrated brochure from *Midland* gives readers a look at their new, complete line of radio monitoring receivers and CB transceivers.

94. The Monitor antennas—keys to superior reception—are available from Antenna *Specialists* in their catalog.

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Ask Hank, He Knows

dog. If you want a robot to perform four-legged tricks, I suggest you start by crouching down.

Too Young to Snoop

Can you send me a schematic diagram of a police radar detector. This is a project for school.

—L.G., Wentzville MO

A cat souped up with Jonny Walker Black Label doing 105 m.p.h. will do a good job at detecting police radar traps. Do something tough like pulling in some difficult DX or building a home fire alarm, or whatever—but leave the cops alone. But, no matter, as a rule the Editors of ELEMENTARY ELECTRONICS do not supply diagrams or plans. There are just too many readers requesting this service and too few hours to answer the mail.

Future Yard Bird

I have an 11-transistor Wards Airline transceiver Model 62-574 which runs on CB channel 11 and is a 100MW transceiver, is there a way to increase the range by increasing the watts?

—F.L., Oakland CA

Sure, you may be able to increase your range to the nearest federal prison if you fool around with the transmitter section of your rig. The Editors suggest you pick up a copy of the 1972 CB Yearbook if you are interested in more than 100 milliwatts on channel 11.

Wrong Track

I have heard that Geiger counters operate on the microwave frequencies. Is this true? I would like to know because I am interested in constructing a radio telescope. I would also like to know where a Geiger tube can be obtained?

—K.C., Somers CT

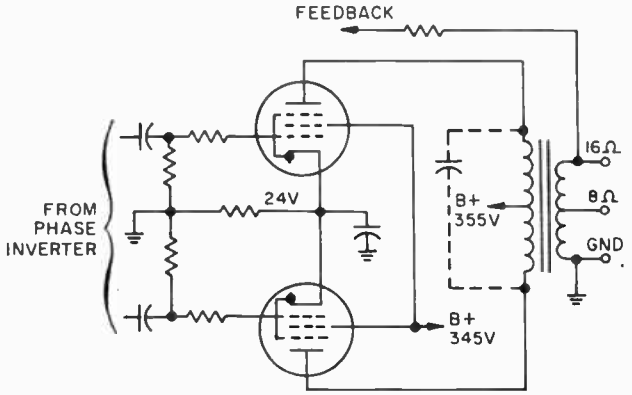
Nope, it's not true. Geiger counters detect and count high velocity particles and rays passing through the Geiger tube. Check your local library for the facts. If you are seriously interested in radio telescopes, I suggest you become acquainted with them by reading books before you proceed with construction. ■

Cherry-Red Plates

When I replaced the 7408 tubes in my stereo amplifier, I found that I had to try a dozen tubes to find one that would work. All tubes were tested in various tube testers. No matter into which socket I placed these tubes in the set, the plates would overheat. After the tubes were in the amplifier for ten minutes or more, the plates became cherry red. Up until this time all voltages and resistances checked OK. As the plates overheated, the cathode voltages built up past the rated 24 volts. So I unplugged the set for fear of damage. This happened even if the tubes were intermixed with the workable ones. The tubes now used work OK and all voltages and resistances are OK. I have ten new tubes whose plates overheat. Can you help me solve this problem?

—A.G., Linden, N.J.

Looking at the schematic you sent, it is evident that you have a well designed amplifier, except for one thing. The 7408 tubes are being operated at higher than maximum design ratings. Plate voltage should not exceed 350 volts, and



the screen should not have more than 315 volts. But according to your schematic, these voltages are 355 and 345 respectively. Under typical operating conditions, these voltages are both 250 volts, according to the RCA Receiving Tube Manual. If your line voltage is high, as we have found it to be in some parts of Jersey, the actual voltages could be considerably higher. Have the power company check the line voltage. Try a line-voltage reduction transformer to determine if excessive voltage is the problem. Your trouble could be due to oscillation. Try a capacitor across the plates, as shown in the diagram in dotted lines (0.002 to 0.01 mF). Be careful—the voltages are high. If this stops tube overheating, you may not have to leave the capacitor in. Just reduce the line voltage.

Switcheroo

Can I use an 8-ohm speaker in place of a defective 16-ohm speaker in my guitar amp?

—D.S.C., Rolla MS

Sure, provided you don't play it with volume control full out. If you want to play it safe, install a high-wattage resistor in series with the speaker. Anything from 2 to 10 Ohms will be alright provided it's non-inductive.

(Continued on page 103)

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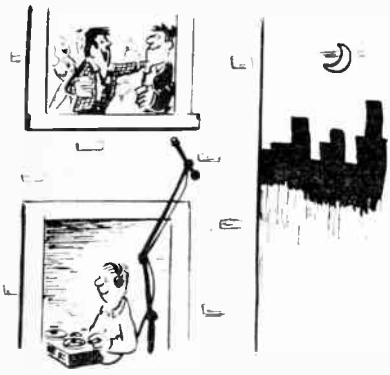
PARTY LINES

by Jack Schmidt

"The Johnson's are getting a new car, the Wilson's are moving and Joan is pregnant!"

"If I send over one of the kids, can I borrow a pound of sugar?"



"I dunno wha'sa matter... my dumb landlord is usually raising hell by now!"

"Would you mind slipping on this lapel mike and describe your sensations for us!"

"Before you come up, Harry, pick up a quart of milk, bread,..."

"I'm sure Miss Wilson doesn't care a bit about megahertz and things..."

ELECTRONICS HOBBYIST

Connect this novel circuit to your FM receiver, and listen to police and fire calls, weather, marine, emergency services!

TUNE IN THE ACTION WITH

VHF HIGH-BAND CONVERTER

by Charles Green

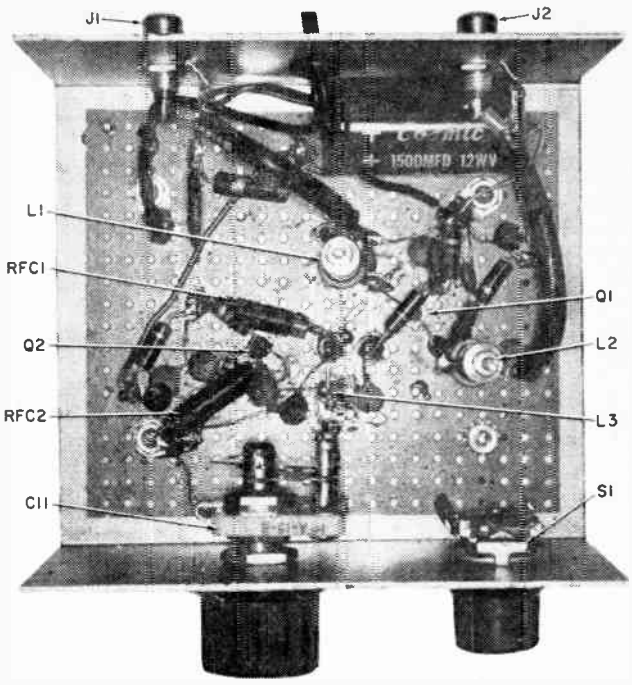
Cliff-hanging emergencies, weather forecasts, ham QSO's, law enforcement patrols in action, mobile radio telephones—two-way broadcasts make listening to the VHF High Band an ever-changing adventure. Our VHF High Band Converter covers from 135 to 175 MHz, and it pulls in public safety, industrial, marine, land transportation and the 2-meter ham band signals.

You can listen to the VHF High Band with our compact converter, which connects to an FM-band home broadcast receiver. The converter uses a dual-gate FET and a UHF-type transistor in a simplified solid-state circuit. The components are housed in a 4 x 4½ x 2⅝-in. aluminum cabinet, with perf-board construction for ease in building. You can build it—start today!

About the circuit. Signals from the antenna are connected via J1 to the L1-C1 turned circuit, and fed to gate 1 (g1) of the dual-ate FET mixer Q1. Gate 2 (g2) of Q2 is coupled via C2 to the oscillator circuit of Q2.

C11 tunes L3 (and the Q2 oscillator circuit) 88 MHz above the incoming signal frequency. The oscillator RF output is coupled via C2 to the Q2 Gate 2 (g2) and mixed with the incoming signals. The resultant 88-MHz RF output (the difference

VHF HIGH-BAND CONVERTER



Placement of components is critical, due to high-frequency operation. L3 is a U-shaped coil, as shown in the schematic on the opposite page.

frequency between the signal and the oscillator) is fed from the Q1 drain (d) to the C5-L2 tuned circuit, and then to J2 and the FM-broadcast receiver.

The required DC power for the converter circuits is supplied by the PS1 9-volt supply, and additional filtering is accomplished by R4-C8.

Construction. The VHF converter is built in a 4-in. deep x 4½-in. wide x 2 ⅝in. high aluminum cabinet. Most of the components are installed on a 3⅜-in. x 4-in. section of perforated board, with the remaining parts mounted on the front and rear cabinet panels. Because of the high-frequency operation, the component placement is critical. For best performance, follow our component layout as shown in the parts layout photo.

Variable capacitor C11 must be modified before installation. Remove rotor and stator plates until one rotor and one adjacent stator plate remains. Start construction by mounting C11 and S1 on the front panel in the same positions shown in the photo. Cut the PS1 cable hole and mount J1 and J2 on the rear panel. Mount the 3⅜-in. x 4-in. perforated board section on the box bottom with ¼-in. metal spacers at each corner.

Fabricate L3 from a length of No. 18 bus wire as shown in the schematic diagram, and mount with push-in clips close to the stator of C11. Make the connection between the C11 stator and L3 with a short length of No. 22 bus wire, then mount the oscillator circuit of Q2 and associated components closely around L3 as shown in the photo.

Position coils L1 and L2 and mount them inverted with push-in clips and short bus leads soldered to the coil terminals. Mount and wire the remaining circuit components as shown in the schematic diagram. Q1 is mounted inverted with short leads connected to push-in clips. Do not remove the shorting wire supplied by the manufacturer until all the wiring of the converter unit is completed. Use short lengths of RG-58A coaxial cable to connect the primary wind-

Suggested Frequencies for Listening

Service	Approx. Freq. (MHz)
2-Meter Ham Band	144-148
Tow Trucks	151
Taxicabs	152
Telephone calls	153
Fire	154
Police	155
Marine	157
Trucks	160
Weather	162

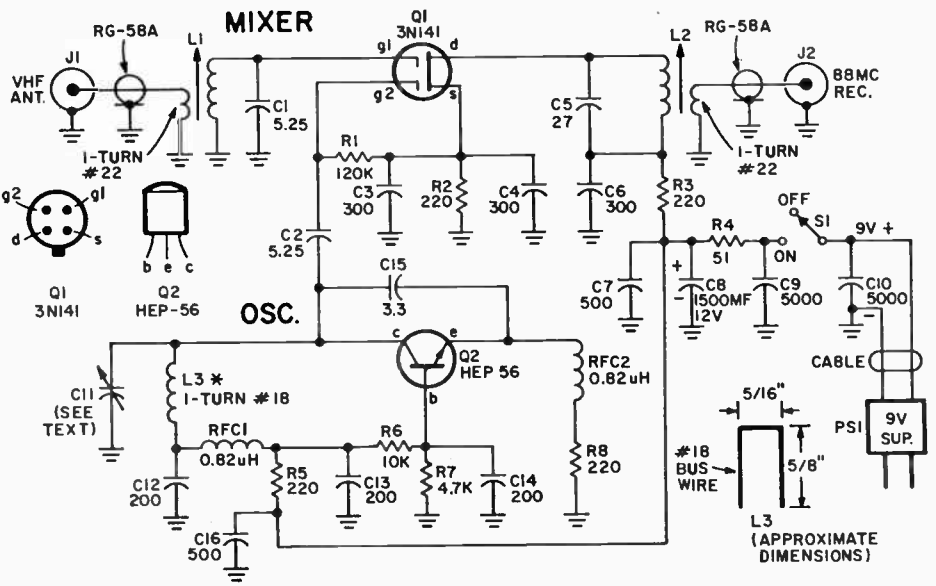
ing of coil L1 to J1, and the secondary winding of coil L2 to J2. These primary and secondary windings are made of one turn of No. 22 hookup wire, and are wound around the center of each of the L1 and L2 coils. Make all wiring as short and direct as possible, except the leads to S1. Position the S1 leads under the perf board and close to the box bottom.

Alignment and Calibration. Tune your FM receiver to a selected clear frequency at the low end of the band (our receiver was tuned to 88 MHz), and connect the converter's J2 to the receiver external antenna and ground terminals. Use coaxial cable for best results. If the receiver does not have external antenna and ground terminals, wind one turn of hookup wire around the antenna loopstick and connect these leads to the coaxial cable to J2. Be sure that there is no connection to the chassis of a transformerless (AC-DC type) receiver to prevent possible electrical shock. Connect P1 to the AC line and set S1 to ON.

Connect a signal generator to J1, and adjust the generator controls for a 150-MHz modulated output. Most FM receivers employ a ratio detector and will detect a strong AM modulated signal. Therefore, a standard AM-modulated signal generator will be OK for alignment of this converter. Adjust C11 until you hear the signal in the FM receiver,

PARTS LIST FOR VHF HIGH-BAND CONVERTER

C1,C2—5.25-pF, 12-volt ceramic disc capacitor
C3,C4,C6—300-pF, 12-volt ceramic disc capacitor
C5—27-pF, 12-volt ceramic disc capacitor
C7,C16—500-pF, 12-volt ceramic disc capacitor
C8—1500-uF, 12-volt electrolytic capacitor
C9,C10—5000-pF, 12-volt ceramic disc capacitor
C11—Modified Hammarlund HFA-15-B (original capacity 2.8 to 16 pF), plates removed to leave 1 rotor and 1 stator (see text). Lafayette 40F28411 or equiv.)
C12,C13,C14—200-pF, 12-volt ceramic disc capacitor
C15—3.3-pF, 12-volt ceramic disc capacitor
J1,J2—Phono jacks
L1—0.088 to 0.12-uH coil (J. W. Miller 20A107RB1 or equiv.)
L2—0.108 to 0.18-uH coil (J. W. Miller 20A157RB1 or equiv.)
L3—see text
P51—9-volt DC power supply (plug-in module type) (Calectro N4-057 or equiv.)
Q1—3N141 field-effect transistor (RCA)
Q2—HEP-56 transistor (Motorola)
R1—120,000-ohm, ½-watt resistor
R2,R3,R5,R8—220-ohm, ½-watt resistor
R4—51-ohm, ½-watt resistor
R6—10,000-ohm, ½-watt resistor
R7—4700-ohm, ½-watt resistor
RFC1,RFC2—0.82-uH RFC (J. W. Miller RFC-220 or equiv.)
S1—SPST rotary switch (Calectro E2-159 or equiv.)
MISC.—4 x 4½ x 2⅝-in. aluminum cabinet (LMB 442 or equiv.), perforated board, push-in clips, ¼-inch metal spacers, No. 18 and 22 bus wire, hookup wire, knobs, ground lugs, RG-58A coax.



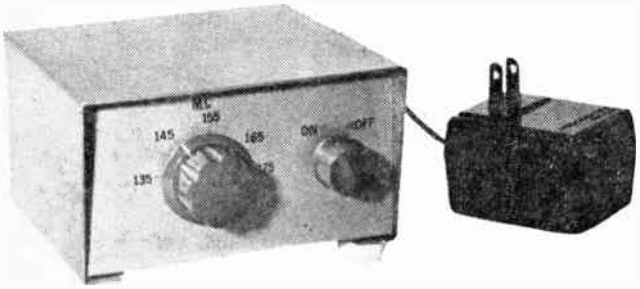
VHF CONVERTER

then adjust L1, L2 for maximum signal. Tighten L1 and L2 tuning screw nuts.

Tune C11 from maximum to minimum capacity, and calibrate the converter dial with the signal generator. Our converter unit is calibrated from 135 MHz to 175 MHz. The tuning range is dependent upon the circuit wiring and size of L3. If necessary, change the size of L1 to cover the range.

Operation. For best signal reception, use a ham 2-meter ground-plane antenna, or a commercial antenna that is designed to cover the 135 to 175 MHz range. The antenna should be mounted as high as possible, with a coaxial cable feed to J1. A whip antenna can be used to receive strong local signals.

The reception sensitivity and selectivity is dependent upon the FM receiver used with the converter unit, and a stable drift-free receiver is best for long-term monitoring. Generally, a transistorized FM receiver should be best. It can be tuned as a band-spread dial to separate crowded FM signals. Signals may not be on constantly, so tune slowly and monitor each frequency for a considerable lengh of time. ■



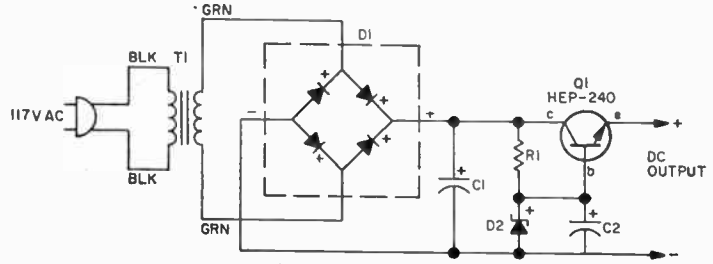
The converter gets its power from a 9-volt plug-in module, which simplifies the construction.

REGULATED 9-VOLT POWER SUPPLY

Providing 9 volts at approximately 250 mA, this lab-type power supply will handle many experimenter projects including the VHF high-band converter above. Actually, T1 can be a 6.3-V imported filament transformer since they usually give approximately 12-V peak at less than 500 mA output. Change the Zener diode to 12 or 6 volts (and possibly the value of R1) and you get a regulated 12- or 6-volt supply. For 12 volts, use a 12-V filament transformer. Filtering is very good since the equivalent capacitor equals the value of C2 times the gain of Q1. It can add up to thousands of uFs. For lab use, put in an aluminum cabinet.

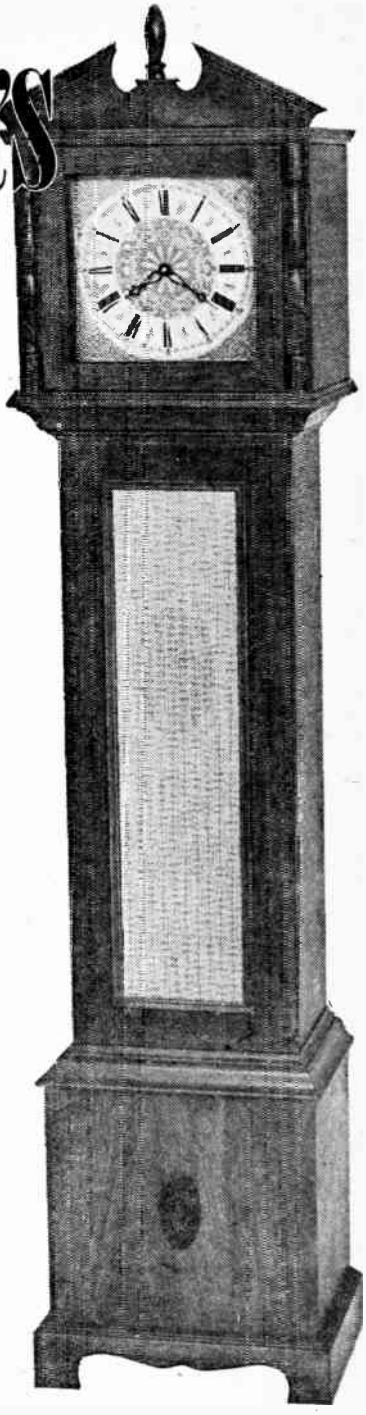
PARTS LIST FOR REGULATED 9-V POWER SUPPLY

C1—500-uF, 25-VDC electrolytic capacitor
C2—100-uF, 15-VDC electrolytic capacitor
D1—Motorola HEP-175 50-PIV diode bridge rectifier
D2—Motorola HEP-104, 9.1-V Zener diode
Q1—Motorola HEP-240, 10-watt npn transistor
R1—560-ohm, ½-watt resistor
T1—12-V filament transformer (see text)
1—Aluminum cabinet, select size to fit components or wire into existing project
Misc.—Wire, hardware, perfboard, line cord, solder, on/off switch optional, etc.



Most of the heat generated by this circuit comes from the iron losses in T1. Be sure to allow for a few vent holes above and below T1. An on/off switch may be added to T1's primary circuit.

AUTHENTIC GRANDFATHER'S CLOCK doubles as hi-fi SPEAKER



by John Capotosto

Old Father Time was never more at home than in this replica of yesteryear gone sonic!

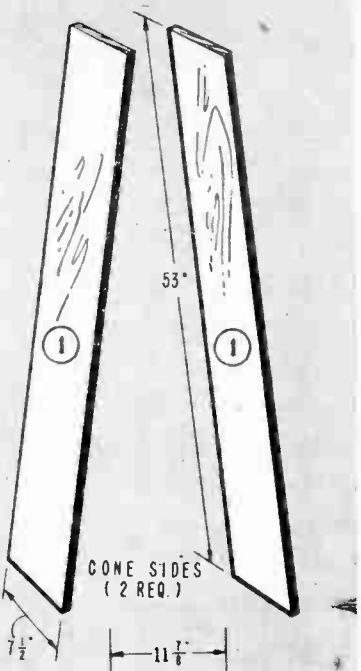
Here's a beautiful grandfather's clock that does more than tell time! Deep down inside it contains a speaker—mounted not just in an ordinary enclosure, but in a modified tapered pipe which offers very bright tone reproduction as well as efficient acoustic output.

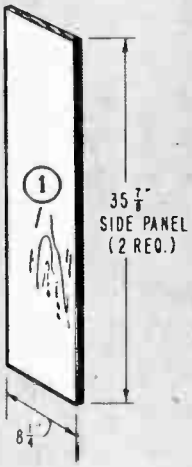
Why a pipe as opposed to the entire mid-section of the clock? Explanation runs this way: a pipe closed at one end produces third and fifth harmonics. But by placing the speaker a third of the way down, the third harmonic is eliminated. All things considered, the tonal results are remarkable. To be sure, a speaker with a larger cone would be even better, but we are limited to the confines of a well-proportioned clock.

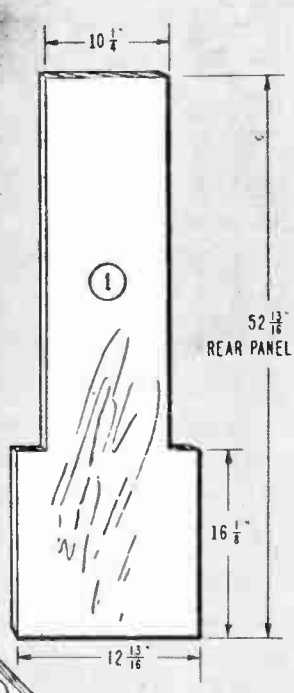
Though the clock looks fairly complicated, it's actually extremely easy to build. Reason is that we deliberately designed it so that even without previous experience anyone can easily build it. If you can build a box, you can make our grandfather's clock. It's that simple!

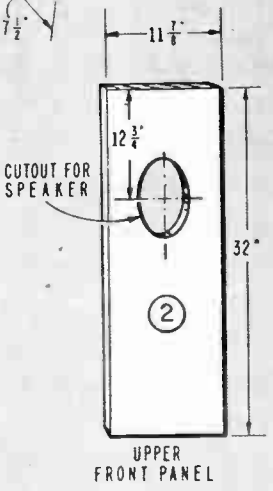
Decorative spin- *(Continued on page 25)*

GRANDFATHER'S CLOCK...

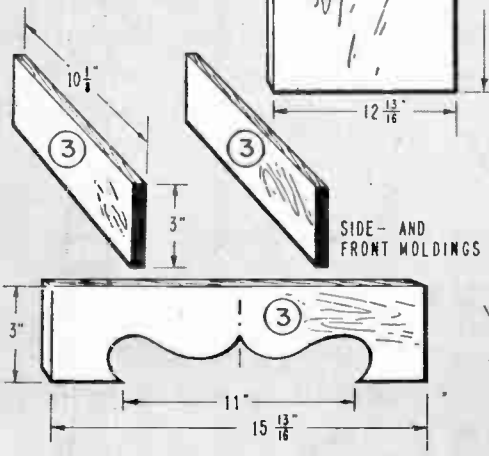


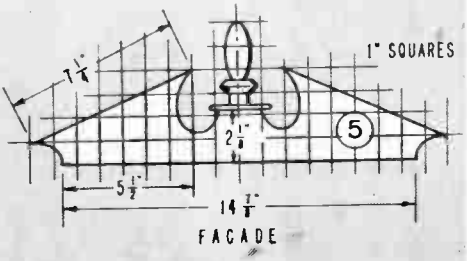


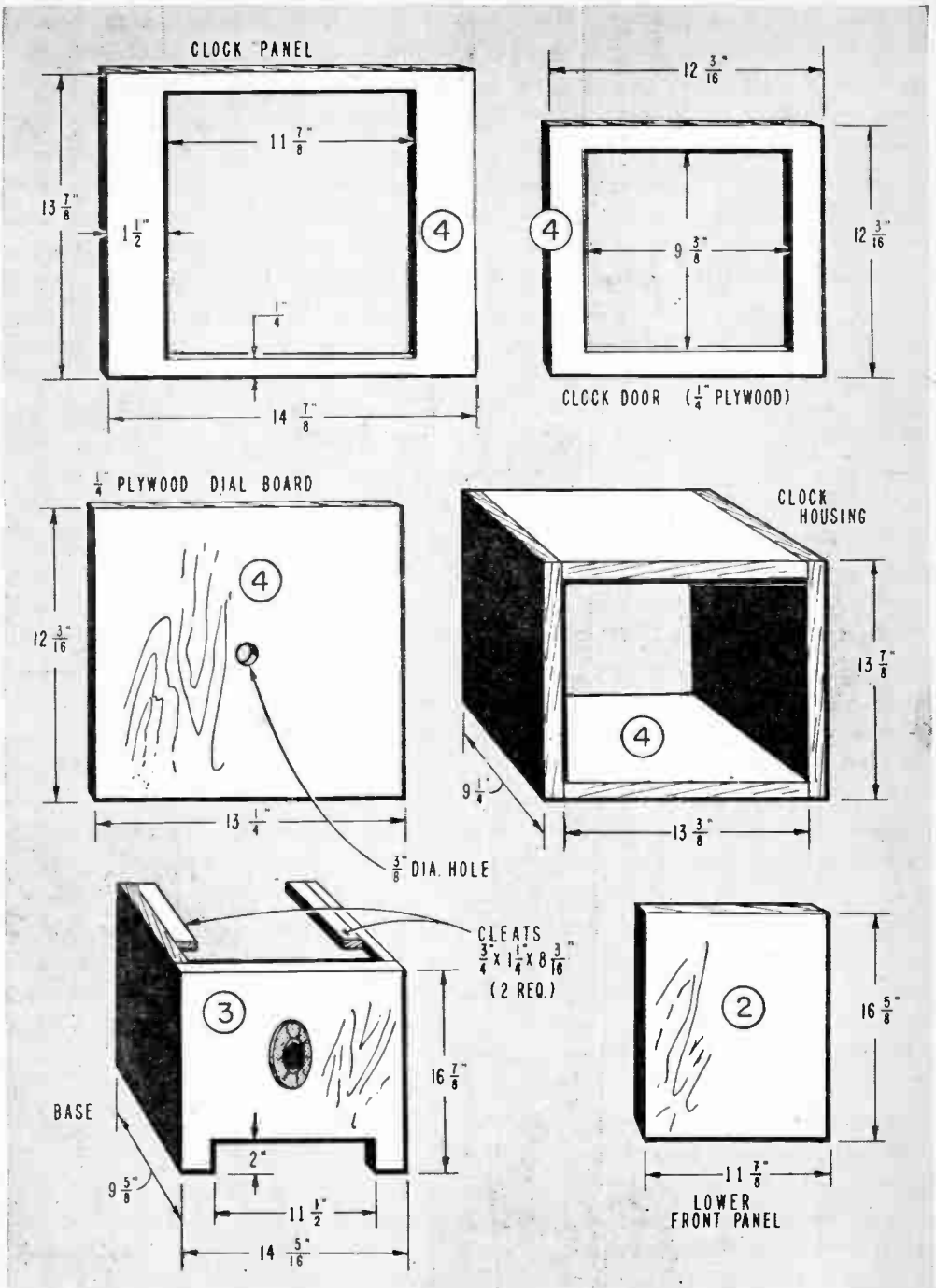




ALL LUMBER 3/4" THICK







dles as well as the movement and dial are available from one source so that you won't have trouble locating the parts. Unlike the kind grandpappy was familiar with, the movement in our clock is battery-powered and transistorized. Winding you don't have to do since like the electric watches now in vogue it'll run a whole year on a single battery.

If you own a table saw you can cut the plywood yourself; otherwise have

GRANDFATHER'S CLOCK...

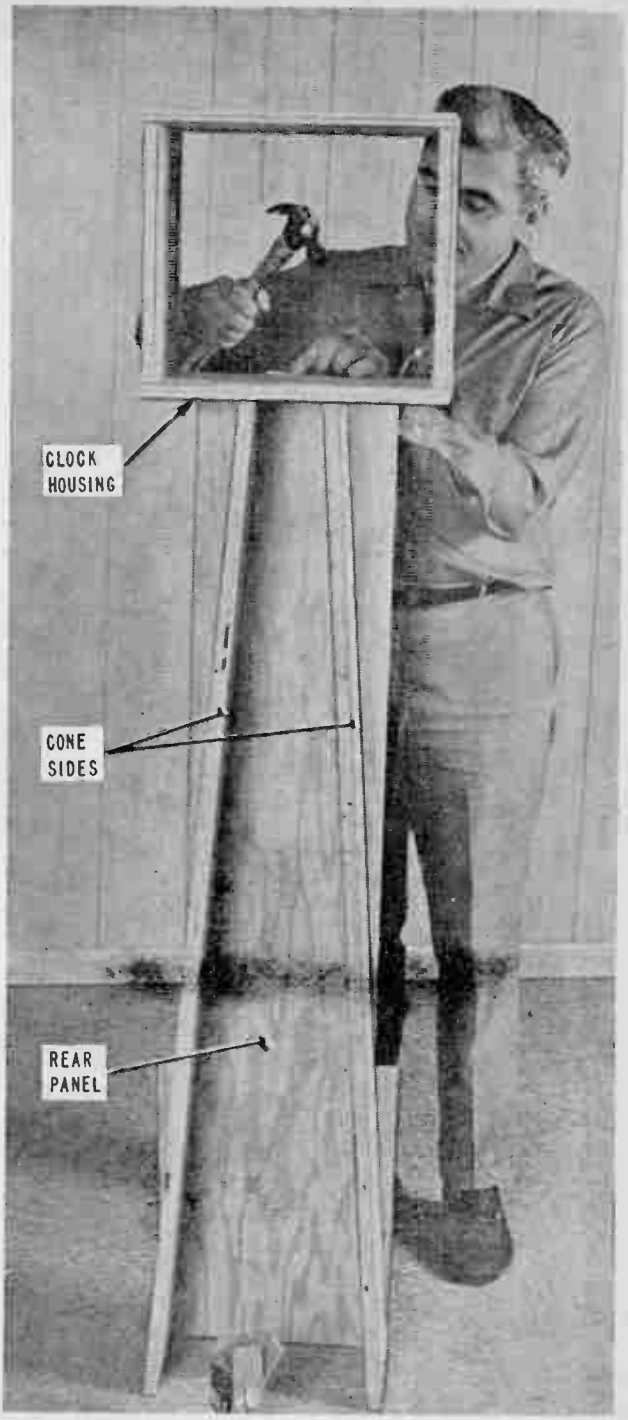
your lumber dealer cut the panels for you. Most lumber yards will cut the panels without cost, though others have a minimal charge.

Butt joints are used throughout, eliminating fancy miters. Nails, white glue, and hot glue combine to further simplify construction.

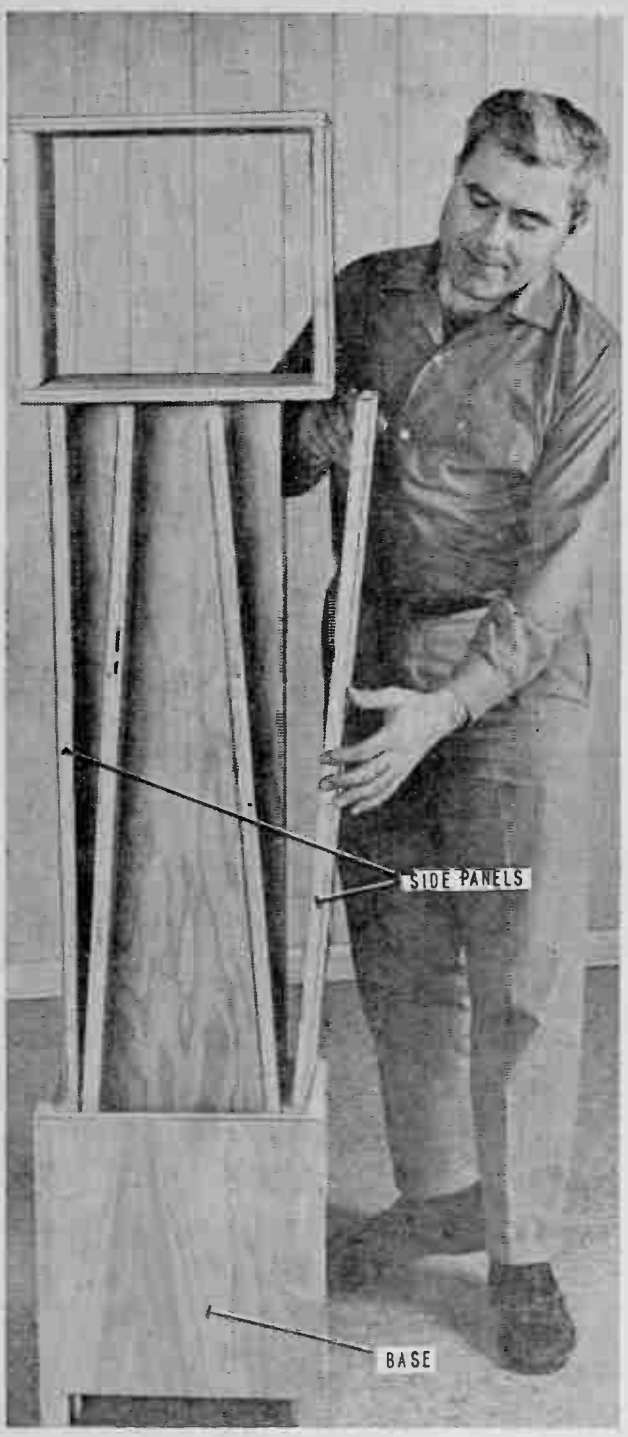
Start by assembling the cone sides to the rear panels as shown. (Note that all parts bear numbers—these relate to the final placement of the parts concerned.) Run a bead of glue along the joint, then nail with 2-in. finishing nails. Most nails will be hidden, but those few that do show should be set below the surface and their holes filled with a putty stick.

The curved shapes at the top and bottom and the speaker opening itself can be made with either a sabre saw or coping saw. Be certain to use a fine blade, and take time to sand the edges after cutting.

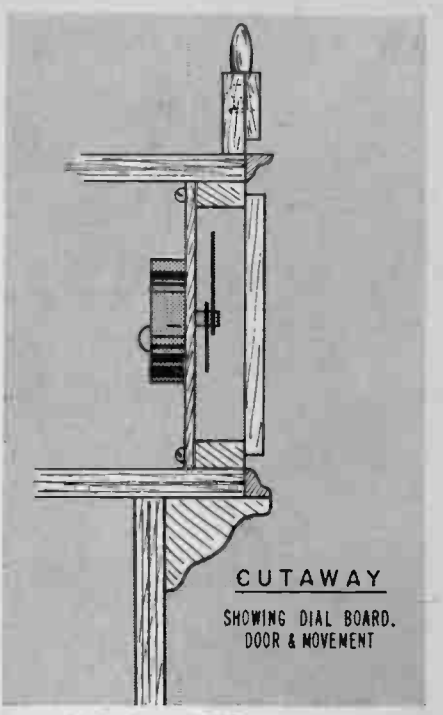
Before installing the front speaker panel, mount the speaker and run the wire leads from it to the rear panel. Solder the wires to a terminal strip mounted behind the rear panel. Be sure the wires are properly soldered, since the only access to the speaker after



Once plywood has been cut to sizes indicated on previous pages, actual assembly can begin. Pre-cut parts fit together like jig-saw puzzle: cone sides (1) are first attached to rear panel (1), then clock housing (4) is placed on top.



Side panels (1) effectively conceal tapered cone which houses speaker. Base (3) is mounted first, then side panels glued and nailed to rear panel. Cutout at bottom of base allows sound to emerge from end of tapered pipe.



BILL OF MATERIALS

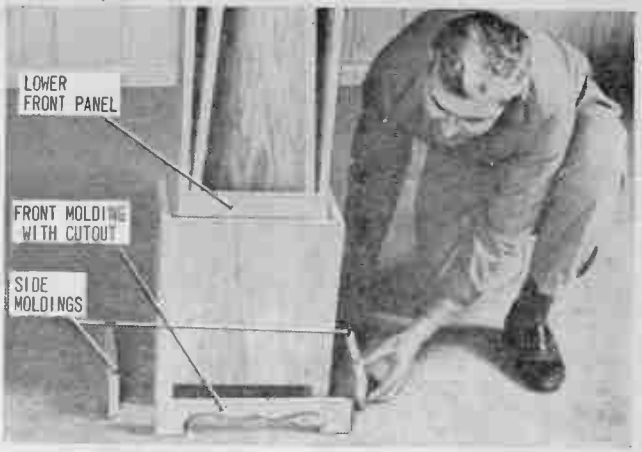
1—4 x 8 ft. sheet of ¾-in. plywood or other wood (see text)
1—4 x 4-ft. sheet of ¼-in. plywood (see text)
1—5 x 7-in. oval speaker (Lafayette 32T0109 or equiv.—see text)
*2—Turned spindles
*1—Battery-driven clock mechanism, dial, finial, decorative applique
1—1½-V battery (Eveready 935 or equiv.)
Misc.—2-in. finishing nails, 3-in. cove molding, glue, solder, grille cloth, terminal strip, stain, shellac, paste wax, etc.

* Parts identified by asterisk are available for $28.00 postpaid from The Armor Co., Box 290, Deer Park, N.Y. 11729 (N.Y. Residents must include sales tax).

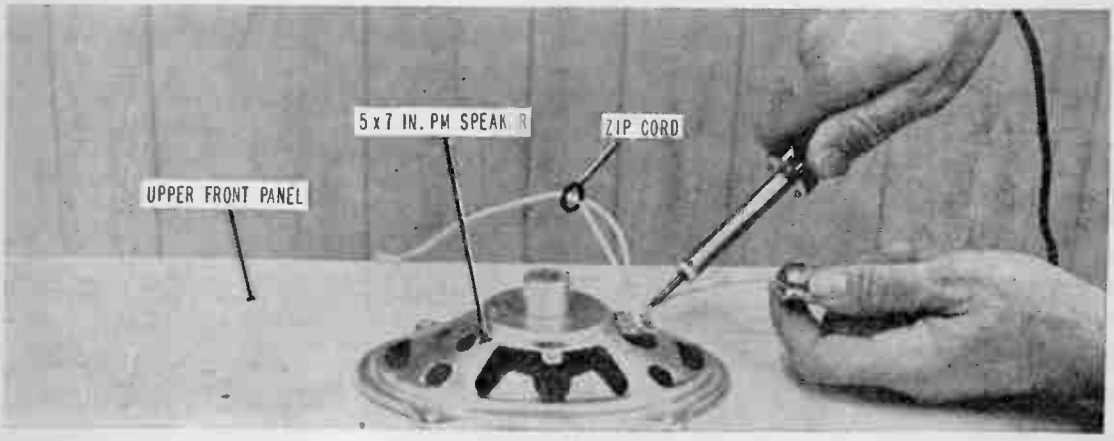
mounting the panel is through the opening at the bottom. And this is a very tight squeeze indeed!

The decorative molding is best cut with a simple miter box and hacksaw, available at hardware stores and lumber yards. Support the molding at the same angle as it will be mounted and cut with slow, steady strokes. To eliminate unsightly nails on the molding, use a glue gun. Since this glue dries in roughly 60 seconds, there's no need for clamps. Run a bead of glue along the joint, then quickly join the parts. The finial, spindles, and decorative appliques at the

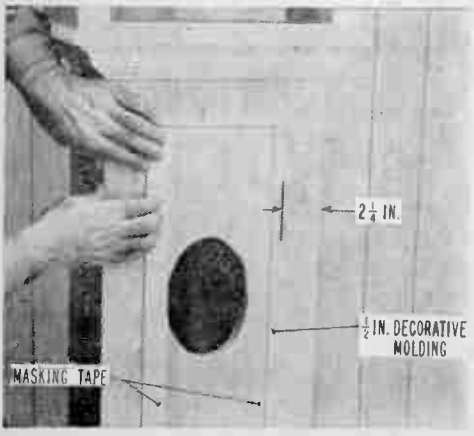
GRANDFATHER'S CLOCK...



With lower front panel (2) in place, side moldings (3) can be attached to bottom of clock body. Front molding has cutout to free sound from pipe.

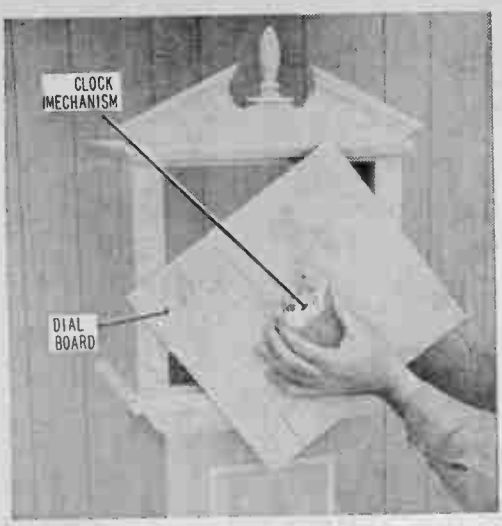


Speaker must be installed on upper front panel (2) before panel is mounted. Zip cord, soldered to speaker terminals, is then routed to terminal strip affixed to rear panel (1).



Outlining area with masking tape aids in applying molding to upper front panel (2).

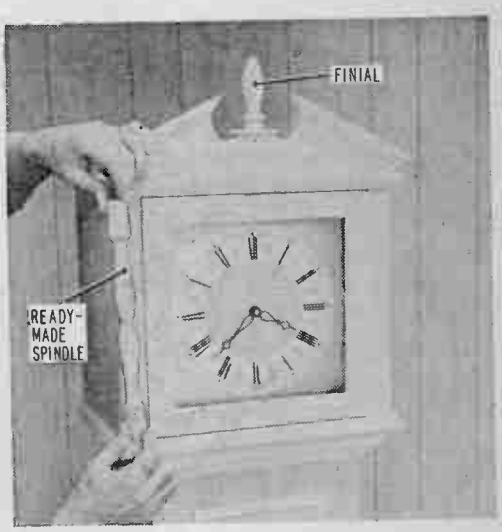
Cove molding and applique are best applied with hot glue: it sets in just 60 seconds.



Heart of clock is transistorized movement which runs for a year on flashlight cell.

Dial and mechanism are mounted on ¼-in. panel, then inserted through rear opening.

Dummy door (4) must be cut to fit opening, since it is glued permanently in place.



Ready-made spindles and finial (from source cited on page 43) dress up face of clock.

base are mounted in the same way.

The grille cloth is cut to size but not mounted until after the clock has been finished. Finishing depends on the wood used. If walnut, birch, or other cabinet woods are used, these can be stained, then given several thin coats of shellac. After the final shellac coat, rub down with fine steel wool, then follow with paste wax.

The grille cloth should be cut to fit within the opening provided. Brush on a coat of white glue that has been thinned down with water, then press the cloth firmly into place. The area of wood covered by the grille cloth shouldn't be stained or otherwise finished or the glue won't adhere properly.

And that's it! You've just completed a highly functional, highly decorative addition to your home that you can be justly proud of! We suggest placing it where an extension speaker will prove most useful—in the rec room, say—but that's up to you. In any case, we'll bet even grandpa himself couldn't have scored better, though we'll have to concede that he didn't have an electrical mechanism to work with. ■

Build a Better Fish Finder

Thermocliner's the name, and sport fishin's the game!

by Charles E. Bryson

The dream of any fisherman is to know where the fish are. Astute angling and fly-tying abilities cast aside, the project discussed here will not always tell where the fish are. Rather, it will tell the fisherman where the fish are *not!* The *Thermocliner,* our fish finder's name, is a rugged electronic thermometer. Slipping into your tackle box, *Thermocliner* is capable of measuring temperatures of the briny deep, thanks to a small thermistor probe located at the end of a 60-foot-long cable. The name *Thermocliner* comes from the instrument's ability to locate the thermocline of a body of water. Essentially, this particular depth of water, sometimes quite deep beneath the surface, is the layer where the water's temperature drops markedly in only a few feet of depth. Generally, almost all of the game fish in a lake will be caught at this depth.

Bridge over Salty Waters. Our *Thermocliner* is a combination of an AC Wheatstone bridge with a thermistor (or *thermal*sensitive re*sistor*) placed into one of the bridge's legs, and an audio amplifier. Bridge power is provided by transistors Q4 and Q5, connected as an astable multivibrator. The mv's output frequency is determined by resistor R11 and capacitor C3.

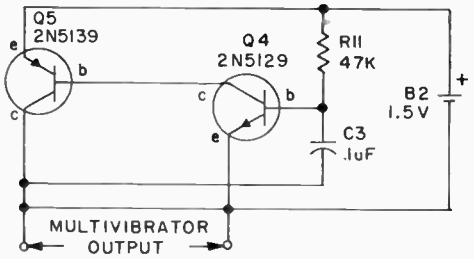
The bridge proper consists of the thermistor RT, resistor R8 in one leg, and potentiometer R10 completing the other leg. When the bridge is out of balance, a signal will develop between the wiper of R10 and the junction of R8 and thermistor. This "error" signal is coupled through capacitor C1 to the audio amplifier made up of transistors Q1, Q2, Q3, and associated components.

When the wiper of R10 is adjusted to bridge balance, no signal is developed. The position of the wiper is really a measure of the thermistor's resistance, and is therefore, directly reading the temperature of the thermistor itself.

Filet of Sole-der. *Thermocliner's* circuit was originally assembled on a printed-circuit board by the author. Alternately, a similarly-sized perf board can be used for mounting the components; parts placement is non-critical. A plastic case houses all of *Thermocliner's* internals. If the speaker is to be mounted using the printed-circuit board as a clamp, be sure to place the foil side of the pc board downwards with ½-in. spacers. Place a piece of insulating material —waxed kitchen paper, or household mylar sandwich wrap—over any part of the circuit board to prevent it from being shorted by the speaker.

Mount batteries and phone jack with suitable hardware to one side of the box. Next, mount potentiometer R10 and switch S1 to the cover panel. While wiring all pc board-mounted components to R10 and S1, be sure to make your wire leads between these components and the pc board long enough.

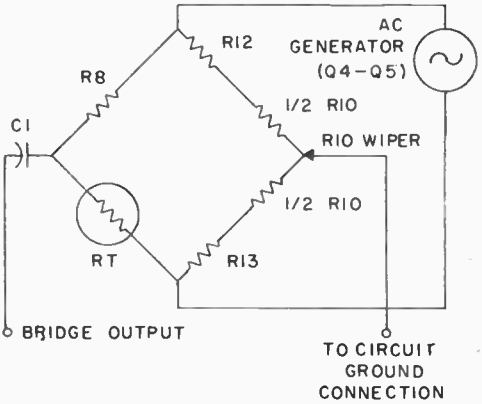
The Prototypic Probe. Generally, it will only be necessary to protect the thermistor from mechanical damage and to provide insulation for the leads. Especially if the probe is to be used in water. Since the author's prototype *Thermocliner* was specifically built for locating fish, the thermistor was first attached to a 10-fathom (or, in landlubber lingo, 60-foot) length of speaker hook-up wire. The cheaper type with thin



This astable multivibrator, based on transistors Q4 and Q5, provides power for the Wheatstone bridge in the Thermocliner.

insulation is better; it tends to float less. Then the thermistor was epoxied into a length of scrap tubing. Care was taken to keep the thermistor's glass bead free of epoxy, and not touching the tubing. In this way, good thermal contact with the water was insured. For convenience, the author felt it was desirable to connect the cable end to the circuit box through a miniature audio-type jack.

Calibrating Thermocliner. Once all parts are mounted, and the probe cable assembly is finished, calibrate your *Thermocliner.* You'll need the following items for calibration: a liquid-type thermometer, a glass of hot water, and some ice cubes. It is desirable that the calibrating thermometer be accurate to 1.0 degree Farenheit and better if possible. *Thermocliner's* accuracy will be determined by the quality of the thermometer used, and to some extent, the patience of the person doing the calibration. Start by connecting the proble cable assembly to the control box, turn power on/off switch S1 to its "on" position, and dunk the probe



In the Thermocliner's bridge, R12 and R13 are trimming resistors, and thus do not enter into the text discussion of the bridge operation.

FISH FINDER

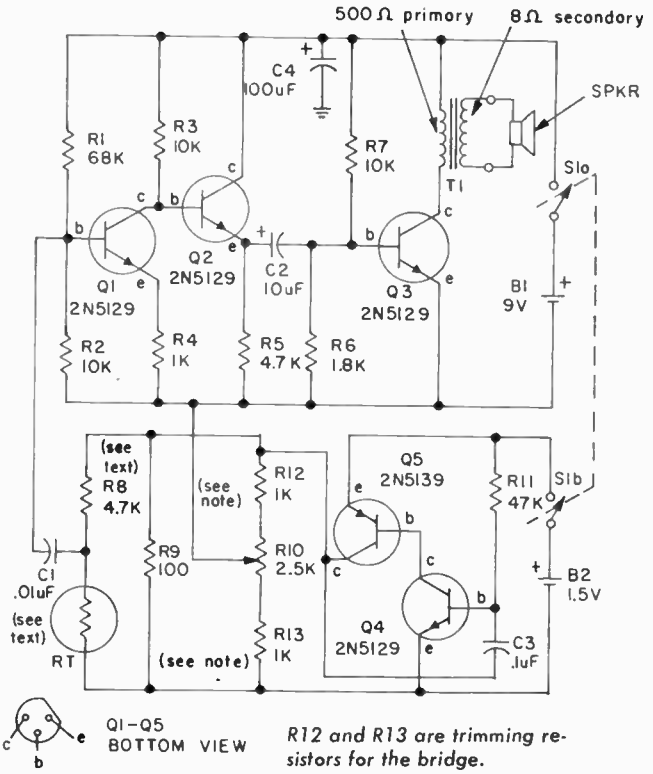
into water which is as hot as to be encountered. For fishing, 100 degree F is plenty!

Water temperature is adjusted by placing small amounts of ice into hot water, and then stirring gently until the ice melts. Periodically, take a new temperature reading, adding more ice as necessary. Overall calibration of our *Thermocliner's* temperature scale is in 10 degree F intervals, from 120 to 40.

Adjust *Thermocliner's* temperature knob for lowest speaker volume, making sure you mark the pointer's position accurately. Proceed to the next lower temperature. When your *Thermocliner* is only going to help you catch one particular fish species, mark the calibrating scale in increments of 1 degree F or better at the expected thermocline level.

If the desired temperature range occupies too small a range of potentiometer rotation, this range can easily be extended with trimming resistors. Note in *Thermocliner's* schematic that the author inserted two trimming resistors (R12 and R13) in series with R10, one at each end of the pot. Make

(Continued on page 111)



R12 and R13 are trimming resistors for the bridge.

trimming resistors. Note in *Thermocliner's* schematic that the author inserted two trimming resistors (R12 and R13) in series with R10, one at each end of the pot. Make

PARTS LIST FOR THERMOCLINER

B1—9-volt battery (Eveready type 216 or equiv.)
B2—1½-volt battery (Mallory MN-1500 or equiv.)
C1—.01 uF @ 1,000 volts disc ceramic capacitor (Lafayette 32F01969 or equiv.)
C2—10 uF @ 25 volts electrolytic capacitor Lafayette 34F85620 or equiv.)
C3—.1 uF @ 600 volts capacitor (Lafayette 34F 82700 or equiv.)
C4—100 uF @ 25 volts electrolytic capacitor (Lafayette 34F85687 or equiv.)
Q1-Q4—2N5129 transistor (see note below)
Q5—2N5139 transistor (see note below)
R1—68,000-ohm, ½-watt resistor
R2—10,000-ohm, ½-watt resistor
R3—10,000-ohm, ½-watt resistor
R4—1,000-ohm, ½-watt resistor
R5—4,700-ohm, ½-watt resistor
R6—1,800-ohm, ½-watt resistor
R7—10,000-ohm, ½-watt resistor
R8—4,700-ohms, ½-watt resistor (see text)
R9—100-ohm, ½-watt resistor
R10—2.500-ohm linear taper potentiometer (Centralab type HMS or equiv.)
R11—47,000-ohm, ½-watt resistor
R12—1,000-ohm, ½-watt resistor
R13—1,000-ohm, ½-watt resistor
RT—2,000-ohm @ 25 degrees Celsius thermistor (Fenwal type GB 32P8) see text
S1—double-pole double-throw type switch Calectro E2-118 or equiv.)
SPK1—10-ohm replacement miniature speaker Lafayette 99F60352 or equiv.)
T1—Audio transformer: primary, 500-ohms; secondary, 8-ohms (Lafayette 99F61293 or equiv.)
1—plastic case 3¾ x 6¼ x 2-in.) Allied Radio Shack 270B627 or equiv.
1—miniature bakelite plug and matching jack (Allied Radio Shack assortment 274B335 or equiv.)

Misc.—miniature speaker cable (Allied Radio Shack 278B1509 or equiv.), battery connectors, hardware, hookup wire, solder, perf board, push-in clips, knob, clear lacquer spray, decals, etc.

Note: Q1-Q5 may be purchased from Southwest Technical Products, 219 W. Rhapsody, San Antonio, Texas 78216

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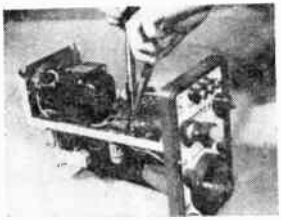
Construction of Oscilloscope.



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Shadow-free snaps shot with your strobe can be yours with the . . .

Photog's Third Eye

by Steve Daniels, WB2GIF

At a recent party I attended, a photographer was taking shots of the guests. He had an assistant with him (it was a large party), who held a second strobe light over the scene. I noticed—before my glass of fortified grape juice took effect—that this second strobe light was not connected to the camera. Yet, it fired at the same time as the master strobe mounted to the camera. "Why two flash sources?" I thought. "I've always gotten along with one." A few weeks later I saw the photog's results. Still stuck to the ferrotyper were prints of the party —all shadowless pictures. Unlike snapshots I've taken lately, nobody looked as if they were wearing pasty masks to a masquerade ball. Was this the result of "filling in" with a strobe slave? Photog's answer was: Yes!

My reflections resulted in a gizmo I've dubbed *Photog's Third Eye*. It will convert any strobe flash into a fast-acting slave, actuated as far as 30 feet away from the master strobe light's source. *Photog's Third Eye* needs no external power source; the strobe it plugs into provides power. It has a sensitivity adjust pot to help you compensate for ambient lighting conditions, and mounts right on the accessory shoe of all low-cost strobe units typically available. Using *Photog's Third Eye* with a Honeywell-type mount, for instance? Just adapt the mounting strap to your needs!

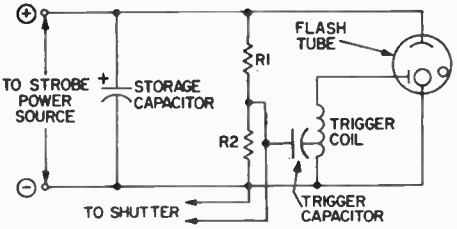
Strobe Theory Recycled. Before I describe *PTE's* theory and design, let's take a look at its reason for being: the typical electronic speed light, or strobe. Look at the simplified schematic of a unit. A power supply charges the storage capacitor to (about) 300 volts and the trigger capacitor to about half that value through voltage divider R1-R2. When the shutter contacts are closed, the trigger capacitor discharges through the trigger coil. A very large current flows for an instant through the trigger coil, producing a high voltage at the topmost end of the transformer due to autotransformer action. The developed high voltage produces a discharge either inside or around the body of the flash tube. Either way, the gas inside ionizes, and the tube fires.

Note that in our *Photog's Third Eye*, SCR1 is directly in series with the shutter contacts. When phototube V1 is energized by a flash of light from the main strobe, its gaseous atmosphere momentarily breaks

down. Result is a positive pulse applied to the gate of SCR1. The SCR, in turn, fires. triggering off the slave strobe by serving as a pair of closed contacts.

The tube specified for V1 was in my spare parts box. No doubt, other phototubes will also work with proper values of R1-R2 plugged in. The silicon controlled rectifier used is rated at 200 volts. Measure the voltage at the shutter cord of your strobe and make sure it is within this limit with the unit fully charged. If the voltage present is over 200 volts, buy type C106C1 SCR; it has a 300-volt rating. In no case use an SCR of a different series unless it matches the gate sensitivity of these units.

Eyes toward Construction. Scrounge around your workshop and find the smallest minibox that will hold the photocell comfortable. I made a cutout measuring ¾ x 1 7/16-in. for the phototube's sensitive surface with a nibbling tool. Cover both minibox face and cutout with black electrical tape; bring enough tape back inward so that the tube



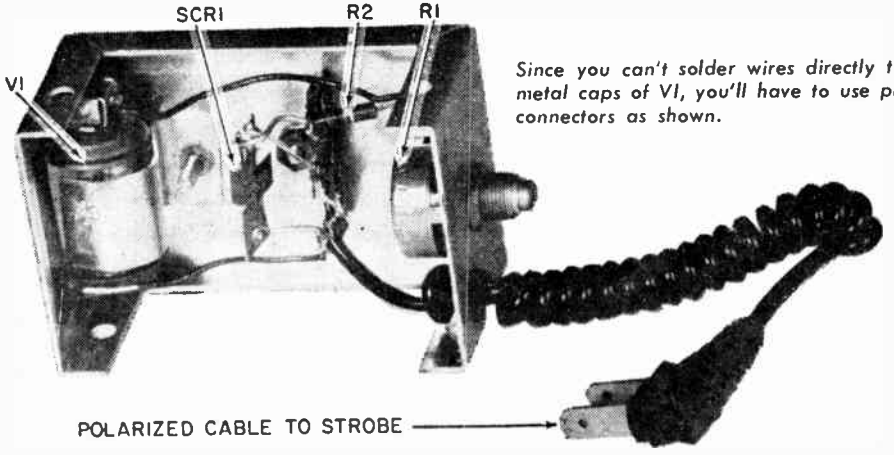
In this simplified strobe, the trigger capacitor is charged by the power supply and discharged by closing the trigger contacts.

will be insulated from the case.

You'll have to make your own contacts for V1. Find a pair of ⅜-in. snap-in button-hole plugs. *Allied Radio Shack's* hole plug assortment (64B3024) will do the job. Solder a wire to each button, and insulate the soldered button with a patch of electrical tape. Form the tube's holding bracket with a piece of sheet aluminum.

Drill holes for the terminal strip, potentiometer, and cable. Mount these components before bolting down the phototube

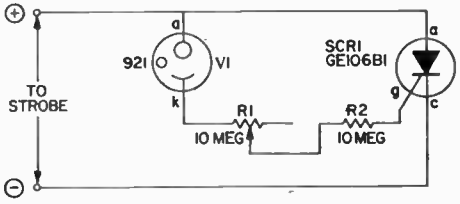
(Continued on page 111)



Since you can't solder wires directly to the metal caps of V1, you'll have to use plug-in connectors as shown.

PARTS LIST FOR PHOTOG'S THIRD EYE

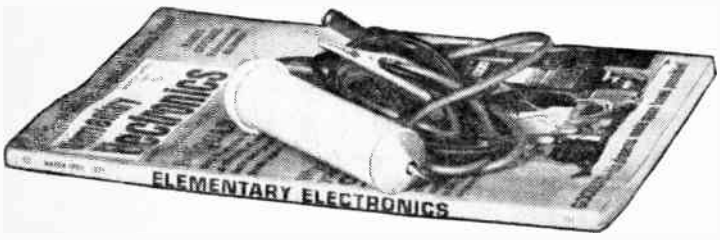
R1—10,000,000-ohm, ½-watt linear taper potentiometer (Allied Radio Shack 961B1813 or equiv.)
R2—10,000,000-ohm, ½-watt carbon resistor
SCR1—Silicon controlled rectifier (GE C106B1 or equiv.)
V1—gas photodiode (RCA type 921)
1—aluminum minibox (see text)
1—polarized camera strobe cable
Misc.—electrical tape, snap-in button-hole plug (Allied Radio Shack (64B3024 or equiv.) terminal strip, paint, solder, etc.



In the Photog's Third Eye, the SCR is in series with the shutter contacts, and is fired with the phototube V1 is energized.

Hounded by tough dogs? Troubleshoot with

MINI-TRACE SIGNAL SNIFFER



by Gary McClellan

Like Man's proverbial "best friend", a good signal tracer can track down all bones of electronic discontent in your various pieces of gear. Problem is, many commercial signal tracers are complicated and rather expensive. While these two disadvantages have limited the widespread use of signal tracing techniques in the shop, our *Mini-Trace Signal Sniffer* forever dognaps both tracing tousles.

To begin with, it's an uncomplicated instrument—the inclusion of a volume control on the amplifier means the *Mini-Trace Signal Sniffer's* easy to use. Secondly, it's an inexpensive instrument—ten bucks buys you the joys of signal tracing with our *M-TSS*. And, *Mini-Trace Signal Sniffer's* battery operated and portable; two plumes no commercial sig tracer's hat can sport!

How M-TSS Works. This signal tracer is built around a prefab amplifier module. By building around one of these modules, a lot of wiring time and trouble has been eliminated. There's a hitch with using this type of ready-built amp, though. Seems the input impedance is too low for the job of signal tracing. Remedy: add a FET amplifier stage. That way the author increased *M-TSS'* input impedance, and ultimately decreased the loading of the circuit under test.

In operation, signals picked up by either probe pass through components C1 and R1, Input voltages then pass through coupling capacitor C2 to the gate lead of the field-effect transistor, Q1. Resistor R3 serves as the FET's drain load. In this circuit, the input impedance is (nominally) the value of the input resistance—about 1 megohm.

Module AM1 contains a preamp, driver, and push-pull output stage. This module has more than enough oomph to bring signals up to speaker level. The module specified in the Parts List, or any other ready-to-run amplifier module you can lay your mitts on, will do an adequate job.

The power supply consists of 9-volt battery supply B1, and decoupling components R4 and C4. Both components prevent undesired audio feedback through the power circuits. Power for the tracer is supplied by any 9-volt source; a battery was considered most convenient.

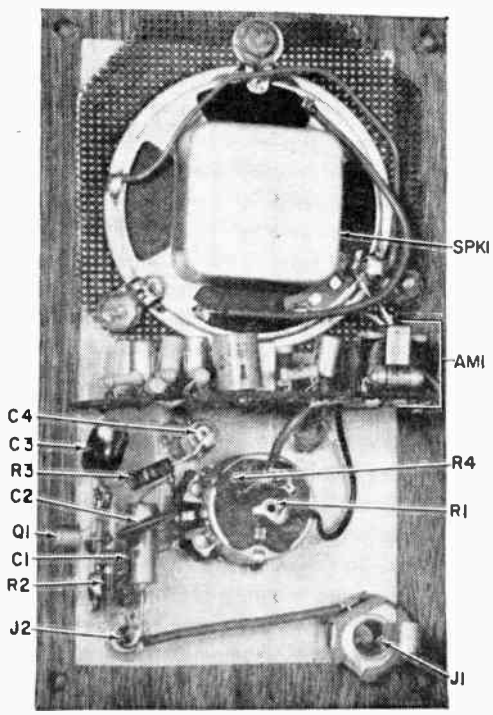
Solder Signals. The tracer's wiring layout is relatively noncritical. All leads should be kept as short as possible. This must be done to minimize hum pickup and possible instability. Re-

member that you are working with a very high gain amplifier, so do your wiring accordingly.

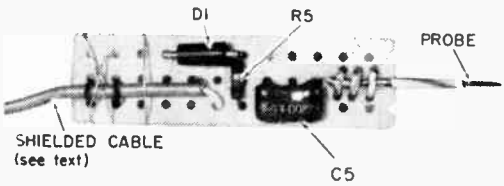
The author built his prototype unit into an Allied Radio Shack mini utility case. This was done for appearance sake only; it was desired that the tracer would match some other test equipment he already had. While this technique can be followed, the author strongly suggests that you build your unit in an all-metal box.

Start construction by working on the box, itself. Note from our photo that all parts are mounted in the cover of the box. You might want to build your unit the same way. Install the speaker, volume control. and input jacks as shown. Amplifier module AM1 is mounted sideways between the speaker and volume control. The author soldered two long solder lugs to the positive foil on the amplifier circuit board. Then he bent them outward and bolted the entire assembly in place.

The FET circuitry goes in place next. Mount a three-lug terminal strip; then start the wiring of all associated components. Be sure to keep all leads *short* in this section. Finish the amplifier wiring by installing the battery connector. Now check over your wiring, and, if all's well, button up *M-TSS'* case.



This prototype of the amplifier unit looks good in a plastic case, but would be better in a metal box, to minimize hum and noise.



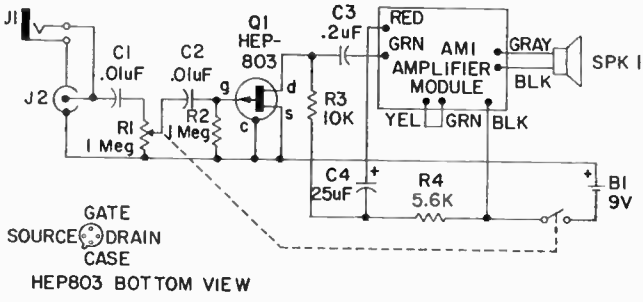
The RF test-probe components are mounted on a small piece of perf board, with a nail as the probe tip, all inserted in a cigar tube.

Testing the Probe. Chances are you won't be able to exactly reproduce the author's prototype probes—especially his RF test probe. The author homebrewed his RF probe from an aluminum cylinder (the kind expensive cigars are packaged in), a nail (it served as the probe, itself), the cap came from a plastic pill container, and topped off with a strip of perf board. A length of shielded audio cable terminated by a ¼-in. phone plug completed his RF probe, as shown on page 73.

For your own test probe construction. start out by thumbing through GC Electronics's catalog FR71-72. It lists all sizes and styles of test proddery. Another source of test probe kits is EICO; choose the type you want to start with from their catalog. Then build your own accordingly. Your last source could even be the local five-and-dime store. Seems you can always turn up some kind of tin box there. In any case. follow *Mini-Trace Signal Sniffer's* schematic for proper test probe components selection and circuit placement.

Hounding an All-American 5. Note our schematic of a typical transistorized superheterodyne BCB receiver. Most of the transistor rigs that will eventually wind up on your bench utilize a design similar to the schematic of the one we've shown; it's a case of you've-seen-one-you've-seen-'em-all! The differences are minor.

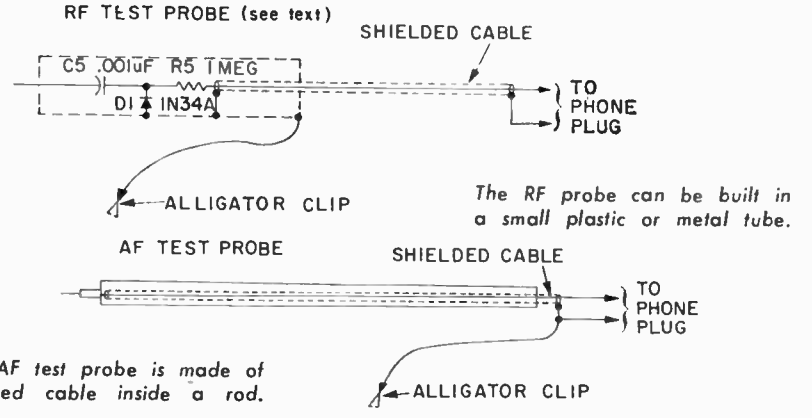
Supposing the complaint is that the radio doesn't play at all. After checking the line cord and power supply components to make sure that the rig's being energized, look at the printed-circuit board for any possible cracks in the foil. Flex the pc board, foil



PARTS LIST FOR MINI-TRACE SIGNAL SNIFFER

AM1—amplifier module, .1-watt minimum output rating (Lafayette 99F90425 or equiv.)
B1—9-Volt battery (Eveready type 216 or equiv.)
C1,C2—.01 uF, 1,000-Volt disc ceramic capacitor (Lafayette 32F01969 or equiv.)
C3—.2 uF, 75-volt capacitor (Lafayette 33F 69097 or equiv.)
C4—25 uF, 16-volt capacitor (Lafayette 34F 85497 or equiv.)
C5—.001 uF, 1,000-volt disc ceramic capacitor (Lafayette 32F01829 or equiv.)
D1—general purpose small signal diode, 1N34A or equiv.
J1—¼-in. phone jack (Lafayette 99F62135 or equiv.)
J2—single-hole mounted RCA-type phono jack (Lafayette 99F62341 or equiv.)
Q1—P-channel field effect transistor, Motorola HEP-803 or equiv.
R1—1,000,000-ohm audio taper potentiometer with switch (Lafayette 99F63521 or equiv.)
R2,R5—1,000,000-ohm, ½-watt resistor
R3—10,000-ohm, ½-watt resistor
R4—5,600-ohm, ½-watt resistor
SPK1—2½-in. replacement speaker (Lafayette 99F60972 or equiv.)
1—3¾ x 6¼ x 2-in. bakelite utility case (Allied Radio Shack 270B627 or equiv.)

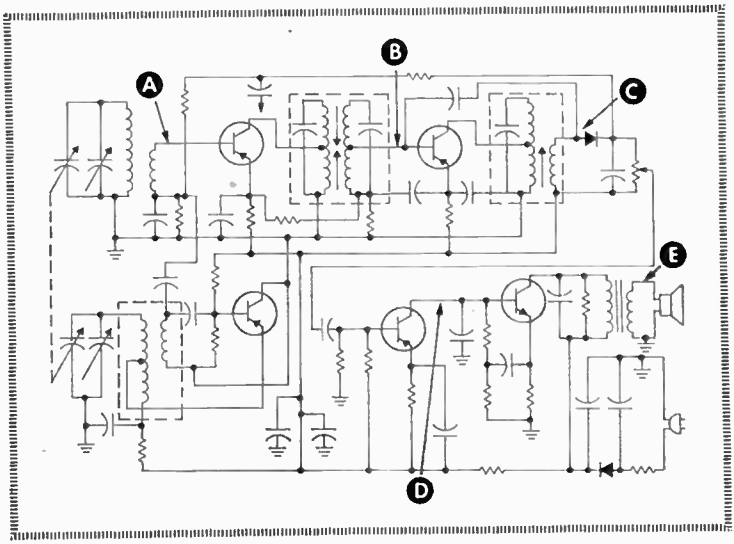
Misc.—Battery connector, phone plugs, 3-lug terminal strip, solder, wire, etc.



side facing you, with a high-intensity study lamp shining through toward you on the other side of the pc board. You'll detect any cracks in the pc board or board foil almost immediately. If this eyeballing doesn't work, whip out your *M-TSS*.

Signal tracing a rig—any radio, for that matter—can proceed from the speaker to the antenna, or the other way around. The key to servicing with a sig tracer is that you work through the receiver methodically; that is, in one direction *only*. For illustration's sake, we've lettered the All-American 5's schematic sequentially, starting at the antenna (A), and working toward the speaker (E).

You'll be working with the RF probe from points A-C; the AF probe comes in handy from points D and E. Attach the RF probe to your *Mini-Trace Signal Sniffer*, crank up the volume control and find point A (or its substitute in your rig). You should hear a received signal, but only very faintly. Tune the radio to a known station on the dial—preferably one knocking out the strongest signal on the BCB dial in



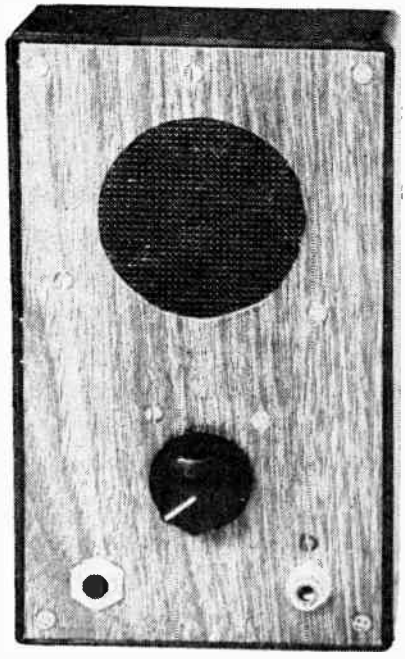
your vicinity. Proceed to point B; listen for a signal. Ditto procedure for point C.

At point D, we stop, look and listen for a signal. None to be had! Starting at the detector diode, you can trace the signal's path until it disappears at point D proper. If the diode junction is open, the signal stops dead in its tracks. If the coupling capacitor located between the junction of the volume control and the audio driver stage opens, or the capacitor located at the junction of the audio driver collector and the output transistor's base shorts to ground, the signal is, again, diverted away from the speaker.

Of course, another prime suspect in our hunt for the missing signal is the audio driver stage transistor, itself. Open base-emitter junctions in particular play blooey with all AC or DC signals!

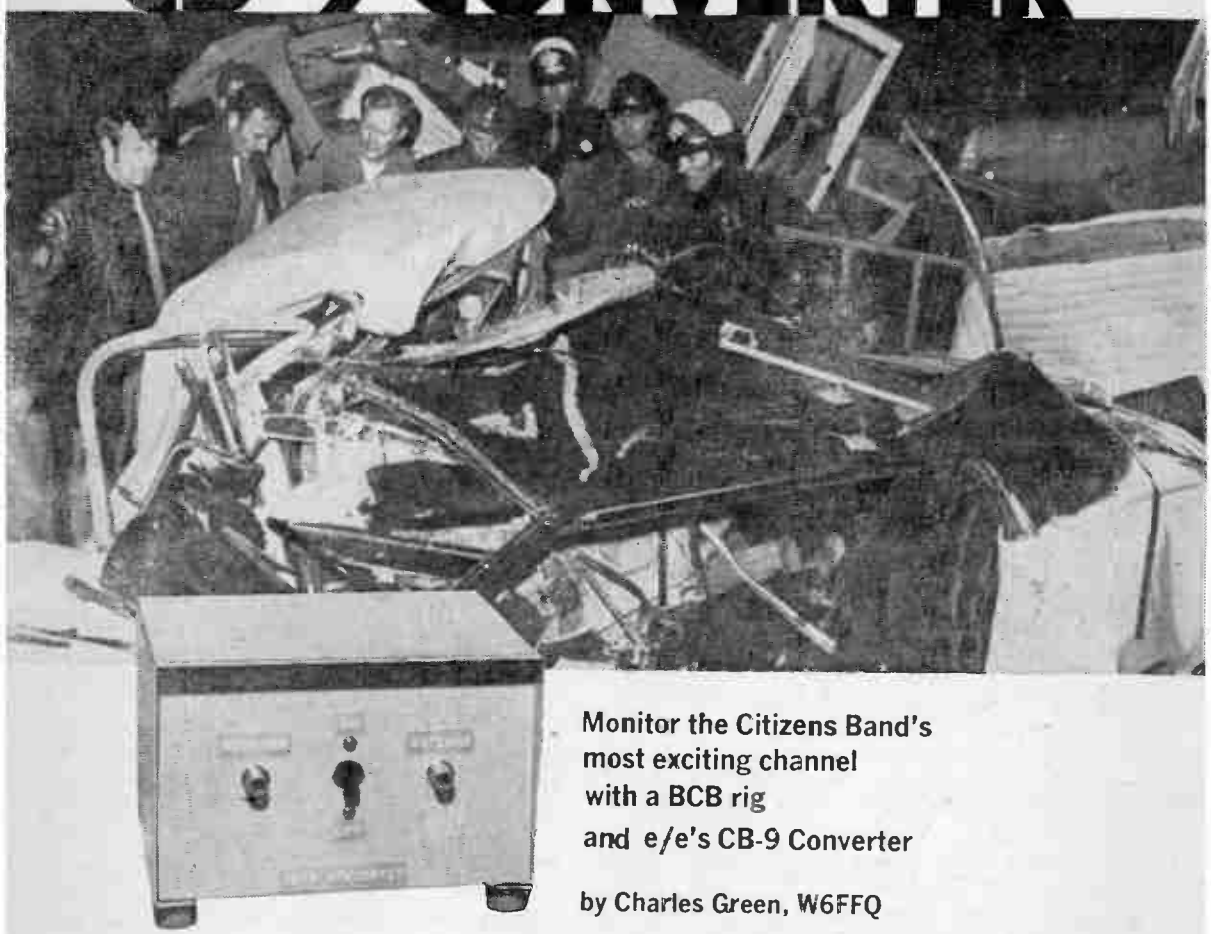
Lastly, check point E—carefully. The speaker voice coil often "opens up." To complete this check, unsolder the voice coil leads from the audio output transformer secondary winding, and look for DC continuity with a VOM. Reason is, you could hear signals bursting forth from your *M-TSS*, yet none emerge from the speaker because the output transformer is working.

Decide to work from the speaker back to the antenna terminal? You'll also need a modulated signal generator. Connect your gen to the speaker leads, and set its controls to deliver an audio signal. Proceed from points E through A, while leaving the audio test probe of your *M-TSS* clipped across the speaker leads. Switch the generator to tone-modulated RF at point C; work with appropriate RF frequencies as you work toward the antenna terminals. ■



The letters on the transistor-radio schematic diagram indicate points to be tested with the M-TSS, which looks like this from the front.

CB-9 CONVERTER



Monitor the Citizens Band's most exciting channel with a BCB rig and e/e's CB-9 Converter

by Charles Green, W6FFQ

He's a jack of all life-saving trades, and he's got to be masterful at them all. If anyone deserves a medal for outstanding citizenship, it surely must be today's dedicated Citizens Band enthusiast. He, or she, is at one and the same time an ambulance driver or tire changing mechanic. And, even a dispenser when the need arises, of coffee and doughnuts—and first aid—at local disaster scenes. The active CBer leads a hectic life, and a few months ago, by Federal decree, his pace quickened.

For obvious reasons, some of the most important documents kept by the CBer are those sundry notices and bulletins mailed by his club that keep him tuned to recent changes at the Federal Communications Commission. One of those biggest changes to affect the 11-Meter enthusiast in recent months is the FCC's redesignation of Channel Nine as the "National CB

CB-9 CONVERTER

Calling Channel." Now, all that the Citizens Bander has to do is to twist his rig's tuning dial to "9", and sit back and wait for the highway action to begin.

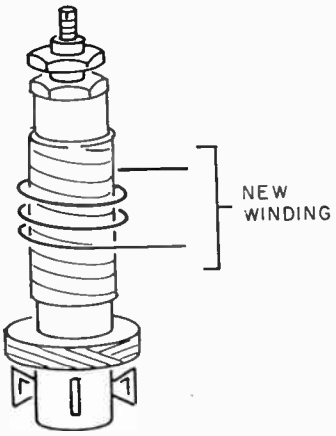
And begin it did. Channel 9 is at present one of the busiest segments of the Band. Fact is, as the number of highway emergencies daily edge higher on the police blotter, we can expect to hear of even more CBers tuning to Nine—and then hurrying to the next twisted wreck down the pike.

But, as the Citizens Band enthusiast is finding out, it's not that simple trying to listen for calls for assistance on 9, and working his assigned channels, too. On one hand, he has to rely upon his rig for normal communication chores, and invest in a second rig just so that channel 9 can be monitored. There are the "normal" complications associated with this lash-up that every CBer is aware of. Problems like frying the front end of the channel 9 monitor with the main transceiver's transmitter activated.

Lately, some Citizens Band equipment manufacturers have started to build special monitor receivers into their rigs. While this is an obvious answer to the problem, many CBers cannot afford the luxury of a second rig of this type, just so that their lives are made a little easier at the listening post. Perhaps the answer to this problem lies on the unused equipment shelf in the shack.

Diversionary Conversions. Don't look now, but one of your unused Broadcast Band radios is the answer to your channel 9 monitor question! Everybody's got at least one of these pocket-sized sports-weather-and-light-music makers gathering dust on the shelf. Why not build a converter especially tuned to receive channel 9, and feed the output of this little "black box" into the BCB receiver? You can listen to your heart's content to the action on 9, and never "lose your place" while trying to work your normal rig.

The components for e/e's *CB-9 Converter* aren't hard to scrounge up, and performance-wise, *CB-9 Converter* plugged into your BCB rig's front end neatly fits the bill for a sensitive—and inexpensive— monitor receiver. The converter uses two mosfets, with a crystal-controlled oscillator circuit assuring maximum stability. Note, too, that the crystal specified has a .005% tolerance —that means *very* little drift once you've got *CB-9 Converter* working!



Note position of added output winding on coil L3's primary winding. New winding is permanently affixed to L3 with dab of coil dope.

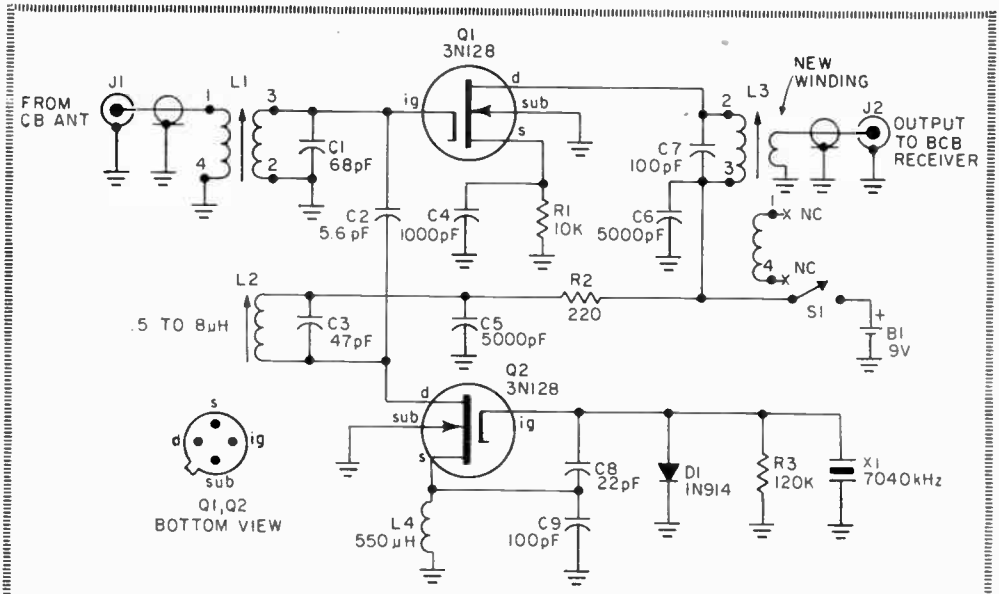
Also note that "NPO-type" ceramic capacitors are used in this project. Reason for this more expensive type of capacitor is, all capacitors normally change value, or drift, as their temperature varies. This would effectively detune the converter. You'd never understand why, after properly tuning for channel 9, the channel seems to slide away into the QRM.

An NPO capacitor, on the other hand, *inversely* changes its capacity with temperature. Results: once you've aligned *CB-9 Converter* to tune in channel 9, you'll never have to play with the frequency-determining components of the converter again!

Look at the schematic to see how *CB-9 Converter* works. Signals from the antenna are connected via jack J1 to the primary winding of RF transformer L1. The signals are tuned by components C1/L1 to channel 9's frequency—27.065 MHz. This signal is fed to the insulated gate of transistor Q1.

This transistor is connected into the circuit as a mixer: a frequency "F1" enters the device, and frequency "F2" leaves it. Also the gate terminal of Q1 is capacitively coupled to the drain terminal of transistor Q2, a special, low-drift oscillator.

Components C8, C9, and L4 and, of course, Q2, comprise the makings of a colpitts-type oscillator. The frequency of this oscillator is partially determined by components L4 and C9; capacitor C8 simply provides enough positive feedback in order to sustain oscillations. But the real frequency-determining element in *CB-9 Converter's* oscillator is crystal X1. It's an



PARTS LIST FOR CB-9 CONVERTER

B1—9-Volt battery (Eveready 216 or equiv.)
C1—68 pF, 1000 WVDC type NPO disc ceramic capacitor (Sprague 10TCC-Q68)
C2—5 pF, 1000 WVDC type N750 disc ceramic capacitor (Sprague 10TCU-V50)
C3—47 pF, 1000 WVDC type NPO disc ceramic capacitor (Sprague 10TCC-Q47)
C4—1000 pF, 1000 WVDC disc ceramic capacitor (Lafayette 32F 01829 or equiv.)
C5,C6—5000 pF, 1000 WVDC disc ceramic capacitor (Lafayette 32F 01944 or equiv.)
C7,C9—100 pF, 1000 WVDC type NPO disc ceramic (Sprague 10TCC-T10)
C8—22 pF, 1000 WVDC type NPO disc ceramic capacitor (Sprague 10TCC-Q22)
D1—silicon diode (1N914 or equiv.)
J1,J2—phono jacks, single hole mounting type (Electrocraft 33-804 or equiv.)
L1—antenna coil (J.W. Miller type D-5495-A)
L2—adjustable inductance—.508-.816 uH (J.W. Miller 20A687RB1)
L3—RF coil—540-1700kHz (J.W. Miller type A-5495-RF)
L4—RF choke—550uH (J.W. Miller type 4649)
Q1,Q2—field effect transistor type 3N128 (RCA)
R1—10,000-ohms, ½-watt resistor
R2—220-ohms, ½-watt resistor
R3—120,000-ohms, ½-watt resistor
S1—spst slide switch (Calectro E2-110 or equiv.)
X1—crystal: 7040 kHz, fundamental mode, type FT-243. See note below.
1—crystal holder (Cinch type 2KM or equiv.)
1—length RG-58A/U coaxial cable (see text)
1—battery connector (Calectro F3-052 or equiv.)
4—rubber feet (GC type 1075B or equiv.)

Misc.—aluminum cabinet 5-in. D x 6-in. L x 4-in. H (LMB 564-N or equiv.), perf board 5¼-in. x 4¼-in., push-in clips, hardware #6-32, brass cadmium-plated spacers, solder, wire, paint, decals, etc.

Note—order X1 from Crystek, 1000 Crystal Drive, Ft. Myers, FL 33901
Be sure to specify .005% tolerance, type FT-243 crystal

FT-243-type "rock", resonating on its fundamental frequency, or, 7040 kHz. Components L2 and C3 tune the output of the oscillator to X1's fourth harmonic.

This signal—28.160 MHz—is fed via capacitor C2 into Q1 where it's "mixed" with the incoming signal to produce a *third* frequency—the frequency your Broadcast Band receiver picks up. Our third frequency is tuned by components L3 and C7, and it, in turn, is coupled to your BCB rig via the three-turn winding added to RF transformer L3.

Circuit power is supplied by battery B1. With normal use, B1 should last quite a while before replacement; total current drawn by the *CB-9 Converter* under no-signal conditions is a scant 1.6 milliamperes.

Doing the Workshop Walk. After moseying into your Electric Haven and sitting down in front of the solder-splashed work bench, don't perform any workshop acrobatics until you've read the rest of *CB-9 Converter's* story! You can't build this project in any slap-dash fashion. Both transistors require special handling until you're ready to fire them up. And furthermore, the perfboard layout, as seen in our photos,

CB-9 CONVERTER

must be scrupulously followed in order to get maximum performance from our *CB-9 Converter*.

Note that the author's prototype model was built into a 5-in. x 6-in. x 4-in. aluminum cabinet. It doesn't matter what size cabinet you whip up for your own converter —only make sure that it, too, is of all metal construction. Forget bakelite cabinets with metal front panels, too.

Most of the components for *CB-9 Converter* are mounted on a 5¼-in. x 4¼-in. perfboard with push-in clips. Also. point-to-point wiring is an absolute must. The reason for all these seeming limitations to your creative genius is that we're working with relatively high frequencies. high-gain, high-impedance transistors, and oscillator circuits. This triple-dynamite combination —if not treated with r.e.s.p.e.c.t—will invariably lead to an it-doesn't-work trauma. So, follow directions.

Begin construction by cutting the perf board to size. Then make the mounting bracket for L1/L3. This L-shaped bracket is formed from sheet aluminum, approximately 2 ⅜-in. long by ⅝-in. high. with a ⅝-in. mounting lip. Drill two mounting holes in the mounting lip to accept #6 hardware. Then mount RF transformers L1 and L3 on the bracket, approximately 1½-in. apart (center to center). Mount the bracket on the perfboard with 6-32 hardware, about ½-in. from the board edge.

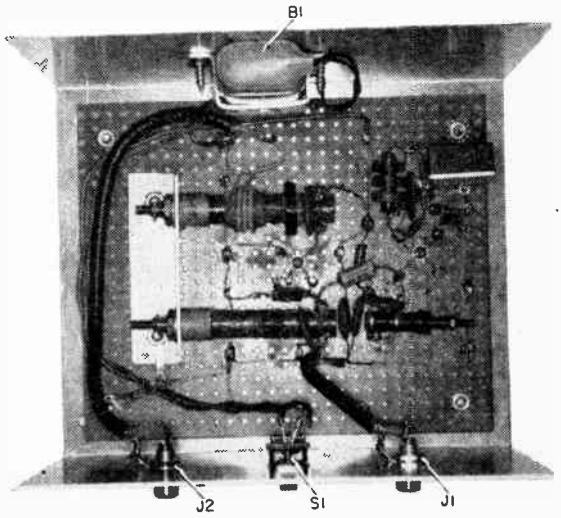
Carefully noting component placement on the perfboard, you mount the remaining parts in place. The author used #24 tinned bus wire to form the ground path. We suggest that you solder nothing home until you've checked all connections; solder each connection with care after your wiring appears correct.

Transistors Q1 and Q2 are mounted upside-down. and are supported by their leads. If the prospect of soldering directly to Q1's and Q2's leads doesn't appeal to you, use mounting sockets (of the low-loss variety). Just remember to make sure that you *do not* remove the shorting wire rings from the transistors until the wiring is complete. Static electricity charges from handling, or stray fields generated from a soldering gun, can easily destroy these units, even before power is connected!

Note from the schematic that L3 has a new winding added to it. Wind three turns of number 22 hookup wire over the secondary of L3. Twist the ends to keep the winding in place. After this new winding is in place on the coil, fix it in position with coil winding dope, *not* a general-purpose cement. Coil L2 may be mounted to the perfboard by soldering its lugs to push-in terminals. Position as shown in the photo. Crystal X1 was mounted by the author by plugging it into contacts removed from an old octal tube socket which, in turn, are soldered to push-in clips. You can substitute a conventional crystal mounting socket, instead.

Install components J1. J2, and S1 onto the cabinet's front panel. Battery B1 is mounted onto the cabinet's rear panel with a U-shaped section of aluminum bracket bent into the form of the battery.

Next, cut off the portion of the push-in clips protruding through perf board bottom, and mount the component-laden cabinet bottom with either machine screw hardware or metal standoffs. Whatever method you choose, make sure that no push-in clip bottoms short against the cabinet bottom. The



CB-9 Converter, before cabinet's other half is buttoned down. Output lead is kept away from input lead; that's why Jacks J1, J2 are so widely separated.

perf board, after mounting, is spaced about ½-in. away from the cabinet's bottom in the author's prototype. Be sure to install a couple of ground lugs; these connect the RF transformer mounting plate to the cabinet via mounting hardware. See our photos.

Last phases of construction merely consist of tying the mounted components to both jacks, battery and on/off switch. Connect jacks J1 and J2 to their respective components with short sections of RG-58A/U coaxial cable. Keep both cable lengths as short as possible, and physically separated from each other.

Twist a pair of hookup wires, and solder one end of them to the on/off switch. Solder one lead of the other end to the battery connector's positive terminal; solder the remaining lead to the junction of components C6 and R2. Set S1 to its "off" position, and connect B1 to the connector. Lastly, remove the shorting rigs from both transistors, and install X1 into its holder.

Selecting the Rock. The crystal frequency of X1 in our *CB-9 Converter* is 7040 kHz. This particular choice of crystal yields a resultant frequency of 1095 kHz in the broadcast band. If either adjacent broadcast frequency (1090 or 1100 kHz) is occupied by a local broadcast station, locate a clear frequency on the BC band, and use a different crystal frequency. Calculate this new crystal frequency by adding the channel 9 frequency (27,065 kHz) and the BC band frequency in kiloHertz and then dividing the resultant by 4 to obtain the crystal frequency in kHz.

For example, if a clear BCB frequency in your locale is, say, 935 (this means no BC station on either 930 or 940 kHz), you'd add: 27065 kHz + 935 kHz=28000 kHz. Dividing 28000 kHz by 4, the new crystal frequency is 7000 kHz. No matter what crystal frequency you choose, the particular rock you order *must* resonate in its fundamental mode. Also, for maximum frequency stability, it would be wise to order the crystal with a .005% tolerance. See our parts list for a suitable source.

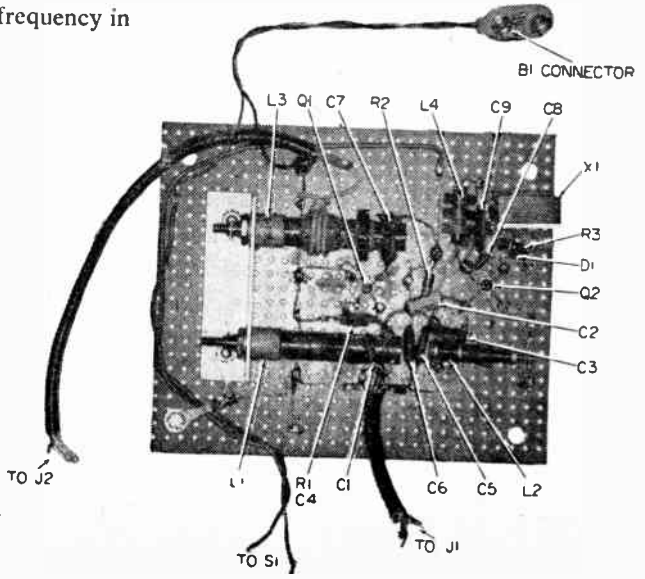
CB-9's Alignment Procedure. After you've checked your soldering, screwed down the cabinet cover, connected the antennal terminals, and hit the on/off switch, tune your BC Band receiver to the selected clear frequency. Run a length of RG-58A/U cable to the external antenna and ground connections between your rig and *CB-9 Converter.* If the receiver does not have external antenna and ground terminals, wind three turns of hookup wire around the antenna loopstick, and connect these leads to the coaxial cable emerging out of jack J2. Be sure there's no connection between the chassis of an AC/DC radio (if that's what you're using), and the chassis of our *CB-9 Converter.*

Connect a signal generator to jack J1. Set the generator controls for a 27.065 mHz tone-modulated output.

First, adjust L2 for maximum tone output from your radio speaker. At this point, you may only hear the tone very faintly. It will be necessary to simultaneously adjust L3 and L2 for maximum tone volume. This is not a tricky procedure; it merely takes patience.

If you own a Volt Ohm Meter, the alignment process may be made a little easier if you connect the vom's leads across the radio's speaker terminals, and adjust coils L2 and L3 for maximum deflection of the vom's meter needle. After you've satisfied that both L2 and L3 are properly adjusted, peak coil L1. Again, either listen for maxi-

(Continued on page 110)



Converter's high gain makes short lead length absolute must. Follow parts placement exactly as shown.

ROLL YOUR OWN CAPACITORS

Using ordinary kitchen-type waxpaper and aluminum foil, you can make capacitors!

by Thomas R. Sear, WA6HOR

Early electrical experimenters and radio operators made many of their components. Not because they thought it was great fun, but because that was the only way they could get many of the parts they needed to proceed with their work. Many of the early breakthroughs in electricity were aided by this make-it-yourself spirit, because those early experimenters really had to understand the fundamentals of electricity in order to build electrical components completely by hand.

Nowadays only those who work in state-of-the-art electronics have to build anything by hand, and then it's usually a new type of transistor or multi-component integrated-circuit chip. The rest of us are content to use ready-made resistors, tubes, capacitors, transistors, etc., to build projects of all types, but how many **really** understand just how those basic parts work? Or even care what's going on inside of them?

This project is designed to help you learn most of what there is to know about capacitors by **rolling your own** out of common kitchen aluminum foil and waxpaper. And what's more, the finished product will actually work in circuits that you can build using the RYO.

The oldest form of capacitor is the Leyden Jar, first built by Muschenbroeck at the University of Leyden in about 1745. Leyden jars

ROLL YOUR OWN

were the first electrical devices that permitted experimenters to "imprison" or store electricity for long periods of time, and they are still used by scientists when heavy electric charges are needed. Whoever invented the modern form of metal foil and dielectric capacitor covered his tracks too well to be uncovered by reasonable research, but it appears that such components were in common usage as early as the 1890's.

What a Capacitor Is. A capacitor is an electrical device for storing quantities of electricity in much the same way that a reservoir is a container for storing water, or a steel tank is a container for storing gas. Two plates or sheets of metal that are separated by air, glass, mica, or some other *dielectric* form a capacitor.

The principles of a capacitor are illustrated in the drawing on this page. One plate of the capacitor in each diagram is grounded and the other is insulated. Initially both plates are neutral, and neither has a charge. Referring to A, if the insulated plate is given a positive charge as shown, electrons from ground are attracted up into the other plate by the positive charge. If the insulated plate is given a negative charge as shown in B, electrons are repelled from the other plate into ground.

It is because of the physical laws that opposite charges attract each other, and like charges repel each other, that a capacitor works. When, through the "capacitor action" described above, a capacitor becomes charged, then a difference of potential exists between its plates—it has stored electricity. If the two plates of the capacitor are suddenly connected together by a wire, the excess electrons on the negatively charged plate will move through the conductor to the positively charged plate until both plates are again neutral. The capacitor is then said to be discharged.

The capacitance of a capacitor, or the amount of electricity it can store, can be increased by several methods:

- The area of the plates can be increased.
- The plates can be positioned closer together.
- A more suitable dielectric can be placed between the plates.

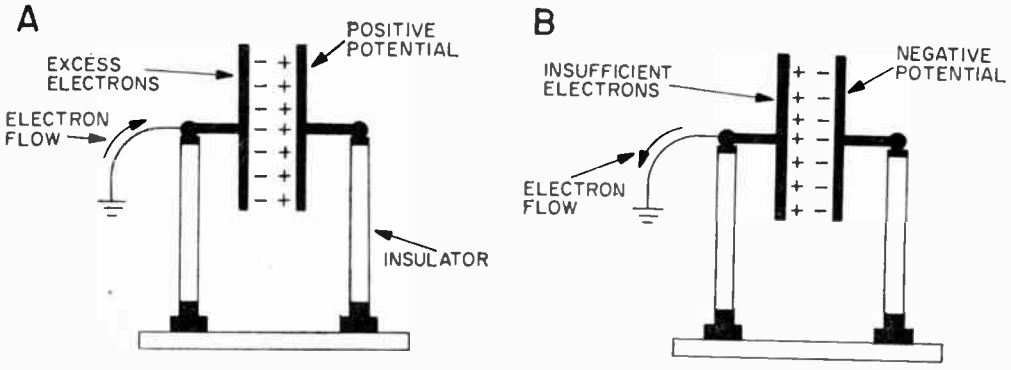
If the area of the plates is increased, there is more room for more electrons or electricity. If the plates are placed closer together, or a more suitable dielectric is used, the electrostatic forces of attraction between the plates are stronger, and the positive plate will be able to attract more electrons to the other plate.

Calculating Capacitance. The general formula for calculating the capacitance of a parallel plate capacitor is

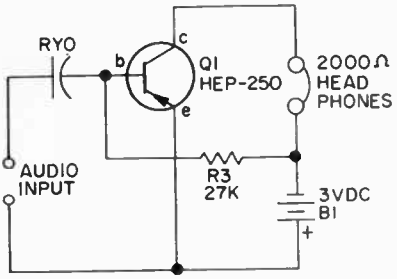
$$C = K\frac{A}{d}$$

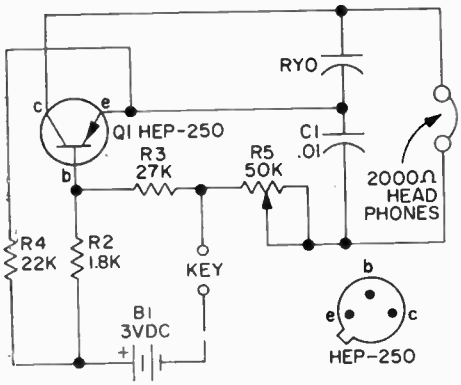
where A is the area of one of the plates, d is the distance between the plates, C is the capacitance of the capacitor in farads, and K is a constant that depends on the medium between the plates.

As a capacitor is being charged, the plates develop a greater and greater difference of potential. The amount of charge that a given capacitor can store is limited only by the breakdown of the dielectric



Capacitor Principles. *The insulated plate is given a positive charge in A and a negative charge in B. The grounded plate (left) will have the opposite charge of the insulated plate (right).*

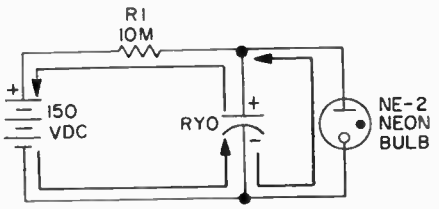




This audio amplifier (above) and code-practice oscillator (right) can be built with the RYO capacitor. In these circuits the polarity of the RYO doesn't matter, but for RF circuits the outer lead should be grounded.

PARTS LIST FOR ROLL-YOUR-OWN CAPACITOR

C1—.01-μF, 200 VDC capacitor
Q1—Germanium medium-gain pnp transistor (Motorola HEP-250 or HEP-253)
R1—10,000,000-ohm, ½-watt resistor
R2—1,800-ohm, ½-watt resistor
R3—27,000-ohm, ½-watt resistor
R4—22,000-ohm, ½-watt resistor
R5—50,000-ohm potentiometer (any taper)
B1—3-volt battery, 2 D cells or equiv.
Misc.—Two pieces of #16 wire 12 inches long, kitchen-type waxpaper and aluminum foil, candlewax, 2000-ohm headset, NE-2 neon bulb.



To test the roll-your own capacitor, you can use an ohmmeter, or build this relaxation oscillator around it. If you don't have a 150-volt battery, the power supply below will furnish the required voltage.

between the plates. When the charge exceeds the breakdown-voltage of the dielectric, a spark will jump between the plates and discharge the capacitor just as if a wire had been connected between them.

The capacitance of a capacitor is defined as the amount of charge, Q, required to raise the potential of one of the plates one volt above the other. In mathematical form the formula is

$$\text{Capacitance} = \frac{\text{Charge}}{\text{Volts}}$$

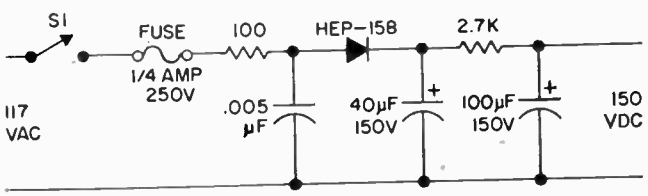
$$C = \frac{Q}{V}$$

This explains why capacitors with the same value can vary so greatly in physical size. By changing the dielectric, we can make a capacitor that will require either more or less charge to establish a difference of potential of one volt between the plates.

The major unit for measuring capacitance is the *Farad*, named in honor of Michael Faraday. One farad is defined as the capacitance of a capacitor that will have a 1-volt difference of potential between its plates when it has stored a charge of 1 coulomb. One coulomb is equal to the charge of 6.28×10^{18} electrons.

$$1 \text{ Farad} = \frac{1 \text{ Coulomb}}{1 \text{ Volt}}$$

How to Make Your Own Tubular Capacitor. Making your own RYO capacitor out of aluminum foil and wax paper is easy, fun, inexpensive, educational, and will set you

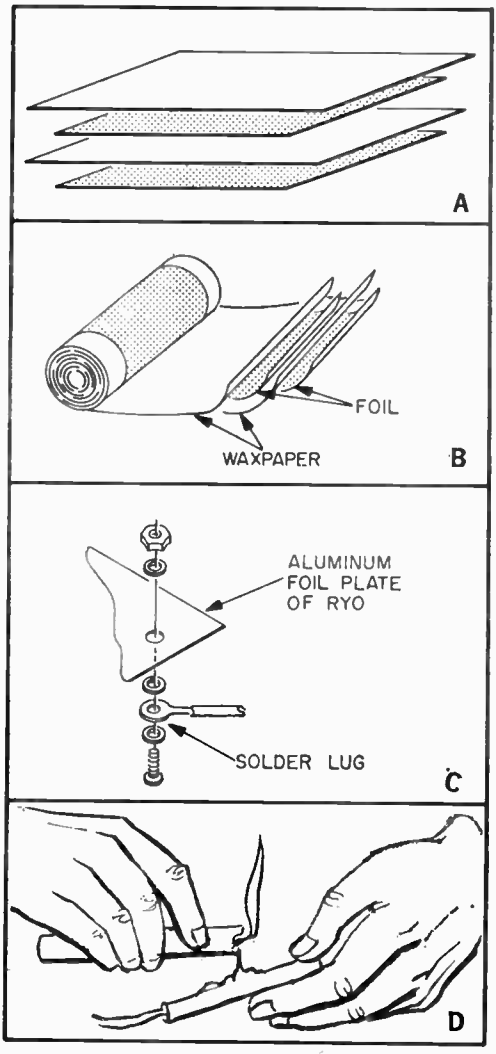


This power supply will operate the relaxation oscillator, if you don't have a 150-volt battery handy. CAUTION: This supply is not isolated from ground—if you have a line-isolation transformer, use it.

ROLL YOUR OWN

apart as one who does his own thing. Most of the required materials can be found right in your own kitchen.

The first step is to cut out two sheets of aluminum foil 3 inches wide and 12 inches long, and two sheets of waxpaper 3½ inches wide and 13 inches long. Place one of the aluminum sheets on a flat surface such as the top of your kitchen table. Then center the second sheet of aluminum foil between the two sheets of waxpaper, and lay this combination on top of the sheet of aluminum foil that is laying on the table. Be certain that the two sheets of aluminum foil are centered in relation to the edges of the waxpaper so they can not touch.



Carefully roll the four sheets into a tight cylinder, being certain that the sheets of aluminum foil do not touch at any point. The bottom foil layer should be on the outside. Tie a string around the assembly to keep it tightly rolled together during the rest of the operation. Connecting the leads to the capacitor requires a little time and patience because the aluminum foil tends to tear if it is bent too often, but the actual process is simple. At either the same or opposite ends of the cylinder, punch a small hole in one corner of each sheet of aluminum foil, about half an inch from each edge. Connect a 12-inch wire lead to each sheet of foil using ¼-inch long, small diameter screws with bolts and three washers, as shown in the figure. These connections should be as tight as possible to ensure a permanent contact, and to be certain that no wax can seep into the joint when the capacitor is sealed. It is important that these connections be made carefully. If you slip and jerk the connection it will most likely tear the corner off the aluminum sheet.

After each lead is connected to the aluminum plate of the capacitor, tie the wire against the body of the assembly, using string to prevent further movement. When both leads are connected, connect an ohmmeter between them to verify that the two plates of the capacitor are not shorted together. Fold the excess waxpaper at each end of the capacitor down as you would the end of a roll of coins. Then light a candle and slowly drip wax all over the outside surface and ends of the RYO. Repeat the process every 10 or 15 minutes until the wax coating is at least 1/16th of an inch thick at all points. Be very generous with wax around the capacitor leads—this will add strength to the connections. Also, a good coating of wax will protect the RYO from physical damage that might short the plates together, will hold the unit together much better than string, and will keep moist-

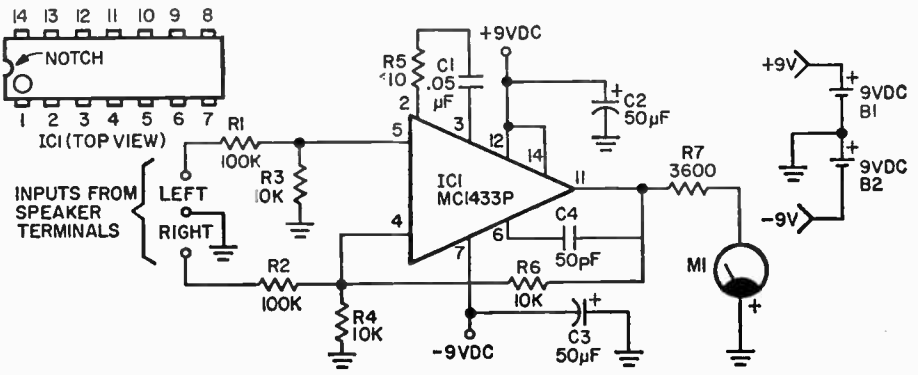
(Continued on page 110)

How to Roll Your Own. *Stack and center the waxpaper and foil sheets (A). Roll the alternating layers into a tight cylinder (B), with a foil layer on the outside. Trim the ends. Connect wires to the foil plates of the RYO capacitor (C)—be careful not to tear the foil. Tuck in the ends. If you don't have a pan of melted wax, use a candle (D) to drip wax onto the RYO to form a protective coating.*

EIGHT GREAT IC PROJECTS FOR WEEKEND EXPERIMENTERS

Integrated circuits, or ICs, are finding their way onto more and more hobbyists workbenches. ICs are inexpensive, have overall uniform electrical quality — and contain considerably more electronics stuffed into them than any other semiconductor of equivalent price. All the projects presented on the following pages are built around inexpensive and readily obtained ICs. Follow the instructions given for each project, and observe IC base diagrams carefully. Note circuit voltage polarity, and use a 40-watt maximum soldering iron.

PROJECT 1 – Stereo Channel-Balancing Amp



8 GREAT IC PROJECTS

☐ Many an audiophile has found that after setting the "Balance" control on his stereo amp to its mechanical dead-center position, more sound still seems to come from one channel. It's truly the audiophile's twist-of-fate working again—try as he may, he can't properly set his amp for electrical balance.

While, perhaps, the only way to find the electrically-flat position of a tone control is by laboriously plotting its effect on frequency response, it's easy to calibrate a not-too-accurate balance control with a stereo differential amplifier. All you do is compare the difference between left and right channel outputs while feeding a monophonic signal into your stereo amp. Then read the difference in channel output on our differential amp's meter!

Wiring is not critical. The amplifier can easily be battery powered by a couple of 9 Volt transistor batteries connected in a bi-polar arrangement.

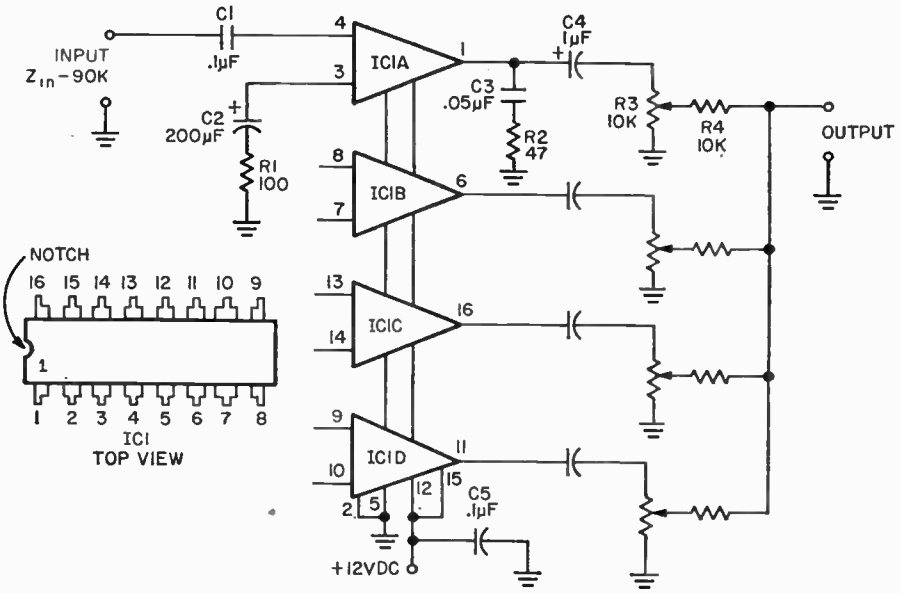
It's very easy to use this differential amplifier. First, set your stereo amplifiers mode switch to "Mono". Then, adjust your amp's balance control until meter M1 indicates a null, or minimum reading. If you can't reach a null, this means that there is phase reversal—which must be corrected—between the signal input and the speaker terminals.

When the stereo amp is in perfect balance, there is no difference in mono output voltage between channels. Therefore, our differential amplifier indicates zero difference on its meter.

PARTS LIST FOR STEREO CHANNEL BALANCE METER

B1, B2—Battery, 9V, type 2U6
C1—0.05 uF, 10 VDC
C2, C3—50 uF, 10 VDC
C4—50 pF, 10 VDC
IC1—Motorola MC1433P
M1—VU meter
R1, R2—100,000-ohms, ½-watt, 10%
R3, R4, R6—10,000-ohms, ½-watt, 10%
R5—10-ohms, ½-watt, 10%
R7—3,600 ohms (usually with VU meter)

PROJECT 2 – Mike Mixer



☐ The hallmarks of a high quality microphone mixer are high signal-to-noise ratio, and the ability to "mix" each mike channel after amplification takes place. These qualities are combined in a four-channel microphone mixer built around an integrated circuit containing four separate amplifiers.

The mixer achieves its good signal-to-

PARTS LIST FOR AUDIO MIXER

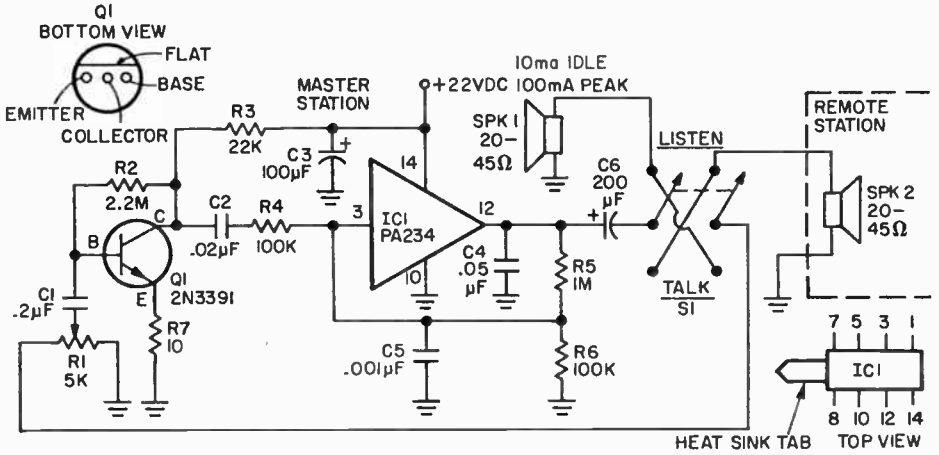
C1—0.1 uF, 3 VDC
C2—200 uF, 3 VDC
C3—0.05 uF, 75 VDC disc
C4—1 uF, 15 VDC
C5—0.1 uF, 15 VDC
IC1—RCA CA3052
R1—100-ohms, ½-watt, 10%
R2—47-ohms, ½-watt, 10%
R3—Potentiometer, 10,000-ohms audio taper
R4—10,000-ohms, ½-watt, 10%

noise performance by placing the mixing potentiometers at the tail end of each amplifier channel. Isolating resistors placed in the circuit after the mixing pots further enhance the mixing action between channels.

Two R/C networks, one in the output of each amplifier, and the other strapped between an internal IC connection and ground, serve to limit the overall bandwidth of each amplifier section. These bandwidth limits—50 Hz and 400 kHz—are set by these R/C networks. True, no microphone's upper frequency can reach a stratospherically-high 400 kHz! The R/C network yielding this high-frequency cutoff point is inserted into the amplifier's output network to prevent unwanted oscillations taking place. For overall schematic simplification, we've shown only the connections for one of the amplifiers. All other channels are identical in parts value to those values shown for the first, or "A", channel.

Note that the power supply is single-ended 12 Volt, negative ground. It must be well filtered. For best results, use a battery lashup—since total current capacity is only 30 milliamperes. That's a load easily handled by wiring 8 D-size batteries in series. The power supply is connected to all four amplifier sections via substrate wiring in the integrated circuit.

PROJECT 3 – Home Intercom



PARTS LIST FOR HOME INTERCOM

C1—0.2 uF, 3 VDC
C2—0.02 uF, 3 VDC
C3—100 uF, 25 VDC
C4—0.05 uF, 75 VDC
C5—0.001 uF, 10 VDC
C6—200 uF, 25 VDC, see text
IC1—General Electric PA-234
Q1—NPN transistor, G.E. 2N3391
R1—Potentiometer, 5,000-ohms, audio taper
R2—2.2 megohms, ½-watt, 10%
R3—22,000-ohms, ½-watt, 10%
R4, R6—100,000-ohms, ½-watt, 10%
R5—1 megohm, ½-watt, 10%
R7—10-ohms, ½-watt, 10%
SPK1, SPK2—Speaker, 20 to 45 ohms, see text
S1—Switch, DPDT, see text

☐ It's fun living in the lap of luxury, especially when the lap is solid state. Here's a miniature intercom system you could probably fit behind an ordinary electrical wall plate! Utilizing a 1-watt IC power amplifier, our intercom provides high sensitivity, and a loud, clean output. Wiring and layout are not critical just so long that capacitors C4 and C5 are installed directly to IC1's terminals.

Capacitor C6's value depends upon how much luxurious sound quality you want. This capacitors value can be as low as 100 *u*F, if you are trying to cut costs and don't

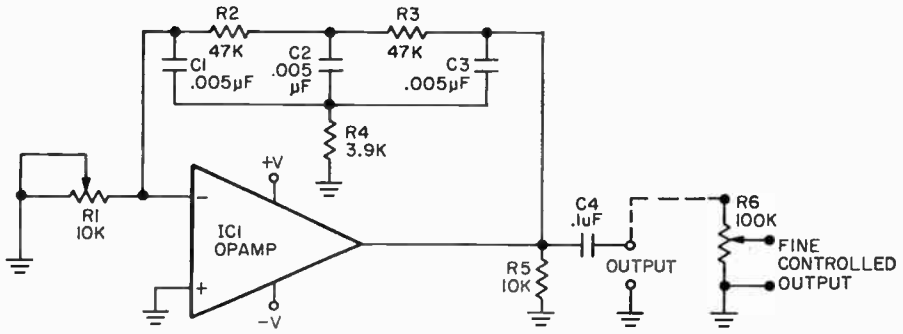
mind giving up a little bass response.

While switch S1 can be standard DPST variety, a spring-return type will keep the Master station always monitoring the Remote. The speakers can be any "intercom type", rated from 20 up to 45 ohms. Though miniature 16 ohm speakers can be used, they do not have the power handling capacity of the "intercom type" speaker.

Should you experience high-frequency instability, run a shielded wire between talk switch S1 and potentiometer R1. Make a single-shield ground at R1.

An AC power supply is a natural for this project. It must, however, be rated for at least 100 mA drain. If a battery supply is used, figure the 100 mA drain current when specifying battery type.

PROJECT 4 – 1 Kilohertz Audio Oscillator



☐ Every experimenter can find a use for an oscillator that delivers a high-purity sinusoidal waveform. Our 1 kHz audio oscillator does just that—and with a minimum of components. This oscillator's useful for testing audio equipment, signal tracing, and even making tape recorder bias adjustments.

We've left the exact details of the integrated circuit up to you. Practically any IC will oscillate in this circuit. Most electronics surplus dealers have supplies of integrated circuits in stock that are either production over-runs, or were rejected by the manufacturer for minute mechanical flaws or electrical discrepancies, tolerance-wise. This is the kind of IC that you can buy very cheaply—and since the frequency we're working at is not high, any IC you can lay your hands on will work!

The 1 kHz notch network from the amplifier output to the inverting, or negative, input determines the output frequency. The oscillator's non-inverting, or positive, input is grounded.

The power supply required is bi-polar. Use any voltage up to the maximum rating of the IC you buy. Resistor R5 may not be necessary in many instances; its inclusion merely insures that any IC you plug in will start pumping out 1 kHz signals.

Potentiometer R1 sets the output voltage level: its maximum value approaches the total power supply voltage. If fine output control is needed, add potentiometer R6. When connecting the oscillator to a "hot" DC point, connect a blocking capacitor in series with R6's arm.

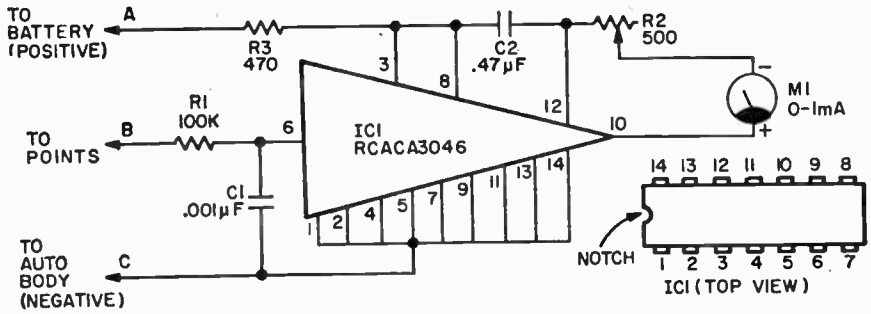
If the oscillator is to drive circuits of less than 10K ohms impedance, substitute a 1 *u*F non-polarized capacitor in place of C4, rated at the power supply's voltage.

PARTS LIST FOR
1 KILOHERTZ OSCILLATOR

C1, C2, C3—0.005 uF, 75 VDC
C4—0.1 uF, see text
IC1—"surplus" operational amplifier
R1—Potentiometer, 10,000 ohms
R2, R3—47,000-ohms, ½-watt, 5 or 10%
R4—3,900-ohms, ½-watt, 5 or 10%
R5—10,000-ohms, ½-watt, 10%, see text
R6—Potentiometer, 100,000 ohms, audio taper, see text

PROJECT 5 – Heavy Duty Tachometer

☐ Whether you drive a hunk of Detroit iron or a handcrafted Italian racing machine, sooner or later you're going to need a portable and shockproof tachometer. Here's



a bolt-on goody that allows you to tune up the engine, set the carburetor, and adjust any slush box's shift points with ease. Furthermore, once you've crawled out from under your car, you're going to need a tachometer—tach, as they're called by the boys at the garage—if you're going to shift the car's transmission at its best engine speed.

The tach described here is the high-range type; its meter's full-scale reading is in the neighborhood of 6000 RPMs. Unless you're in the business of throwing gassers around dirt ovals, this rpm limit should be quite sufficient for any auto legally licensed to use public highways.

Integrated circuit IC1 should be mounted in a cool location—under the dash, or in front of the air-stream under the hood. Follow the component values given in the parts list—combine resistors in series or parallel in order to obtain the correct resistance value if you're spare parts collection is meager.

The tach should be calibrated against another of known accuracy. It is only necessary to adjust potentiometer R2 for the correct full-scale reading. Meter M1's scale is linear.

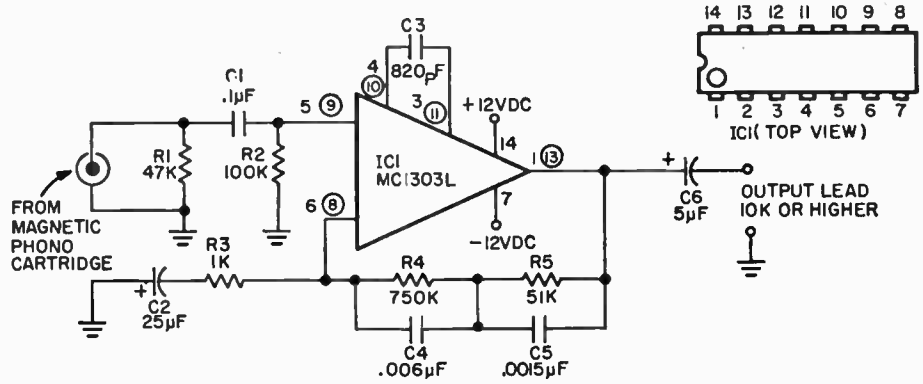
PARTS LIST FOR TACHOMETER

C1—0.001 uF, 1000 VDC disc.
C2—0.47 uF, 25 VDC or higher, see text
IC1—RCA CA3046
R1—100,000-ohms, ½-watt, 10%
R2—Potentiometer, 500 ohms linear taper
R3—470-ohms, ½-watt, 10%
M1—Meter, 0-1 mADC

To use the tach, connect lead A to the car battery's positive terminal. Run lead C to the battery negative terminal; lead B to the distributor points. The distributor lead connection is easily made at the ignition coil. Note that one lead running to the coil goes to the battery, and the other to the distributor points.

If lower rpm full-scale readings are required, reduce capacitor C2's value accordingly. Again, calibrate the tach against a unit of known accuracy.

PROJECT 6 – Stereo Phono Preamplifier



☐ Need an additional phono preamp for your stereo system? More than one audiphile's gone out and bought a spanking brand new turntable, brought it home to plug in and play—and found out that his amplifier didn't have the required additional "phono" position needed for a second turntable.

Our phono preamp/equalizer neatly bypasses the problem. Plug the cables coming

8 GREAT IC PROJECTS

from your phono cartridge into our preamp, and plug the preamp output leads into the "Auxiliary" input of your stereo amplifier. Simple, isn't it!

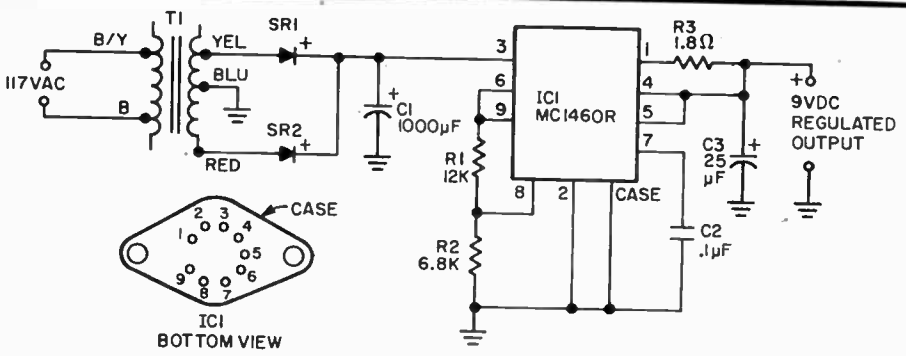
The integrated circuit specified was specifically manufactured for low-signal level work. Combined with the associated circuit components, the IC provides a fully equalized 1 Volt rms output from any standard magnetic pickup. The terminal numbers circled on the schematic are the connections for one of the two independent amplifiers in the single IC Case. The uncircled numbers are the terminals for the second IC.

Power supply terminals are common for both amplifiers. Note that the power supply must be able to supply ±12 volts to ground. Two 6-Volt batteries wired in series can be used for each side of the power supply. If batteries are used, a 25 *u*F electrolytic capacitor, rated at least 25 Volts must be connected from pins 7 and 14 to ground. Make sure you observe the capacitor's correct polarity, too.

PARTS LIST FOR PHONO PREAMP

C1—0.1 uF, 3 VDC
C2—25 uF, 3 VDC
C3—820 pF, 500V disc
C4—0.006 uF, 100V disc.
C5—0.0015 uF, 100V disc
C6—5 uF, 25 VDC
IC1—Motorola MC1303L
R1—47,000-ohms, ½-watt, 10%
R2—100,000-ohms, ½-watt, 10%
R3—1,000-ohms, ½-watt, 10%
R4—750,000-ohms, ½-watt, 10%
R5—51,000-ohms, ½-watt, 10%

PROJECT 7 – Regulated Power Supply



☐ A regulated power supply is one of the handiest projects any experimenter could own. Especially if the supply's output voltage is rated at the universally-useful level of 9 Volts. Many projects utilizing transistors require a 9 Volt power pack—why not build this one, and save yourself the cost and trouble of always having to buy spare batteries.

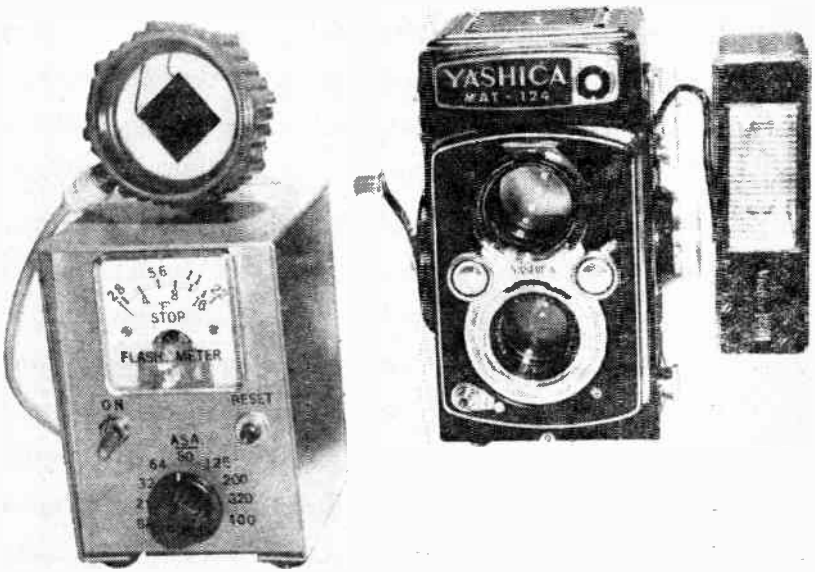
Our regulated power supply will deliver up to 300 milliamperes at 9 volts; more than enough for the majority of the projects you're likely to conjure up on your workbench. Also, the supply has an over-current protection feature built into it—thanks to the design of the integrated circuit. Whenever more than 300 mills tries to squeeze itself through IC1, the voltage regulator section of the IC automatically removes the applied voltage from it. The 300 milliampere current rating is not that of the IC; depending upon the power transformer's secondary rating, up to 600 milliamperes can safely be handled by IC1. If this higher current capability is desired, substitute a 0.5 ohm resistor in place of the 1.8 ohm resistance rating of R3.

PARTS LIST FOR REGULATED POWER SUPPLY

C1—1000 uF, 15 VDC
C2—0.1 uF, 15 VDC
C3—25μF, 15 VDC
IC1—Motorola MC 1460R
R1—12,000-ohms, ½-watt, 5%
R2—6,800-ohms, ½-watt, 5%
R3—1.8-ohms, ½-watt, 5%
T1—Low voltage rectifier transformer, Allied Radio series 54 A 4731 (1970 catalog)
SR1, SR2—Silicon rectifier, 750 mA, 50 PIV

(Continued on page 109)

FLASH MASTER



Our meter stops strobe photography's F-stop fumble

by Charles Green, W6FFQ

Electronic flash units, or strobes, as they are called, are blinking their way into the equipment carry-alls of amateur and pro shutterbug, alike. And, for pretty good reason, too. Low in cost, these compact strobes bring the advantages of professional electronic flash gear to John Q. Hypo. Having made obsolete the conventional you-have-to-slobber-the-end-first flash bulb, an electronic flash's light quality is so close to daylight that it's the perfect Jill for all the Jacks whose cameras are always loaded with daylight rated color film.

But, you can't go strobing yourself into a silver halide eternity, though. Problem with modern electronic flash doojobbies is that you still need to revert back to old fashioned methods to determine your camera F-stop lens setting. Many a pro develops calloused shoulders hefting his assortment of tape measures, guide estimates, and a whole host of literature give-aways needed each time he goes on a shooting spree with his electronic flash. Worse yet, pity our poor photog busily poring over his not so easily understood tables and guides, all the while missing that one-in-a-lifetime shot he so arduously prepared himself for!

Slaying The F-Stop Dragon. Saint George made short shrift of the mythical Dragon the same way our *Flash Master* takes the fumble out of F-stop calculation. Our electronic meter will give you F-stop readings faster than any published table can. All without the problem of measuring the distance between film plane and subject. And *Flash Master* "remembers" the F-stop needed in the particular scene you want to

Flash Master

capture, too! Just trigger the electronic flash before you take your picture with *Flash Master* at the subject. Our *FM* will indicate the required F-stop you have to set your camera's lens opening to. Exposure bracketing is now a thing of your past!

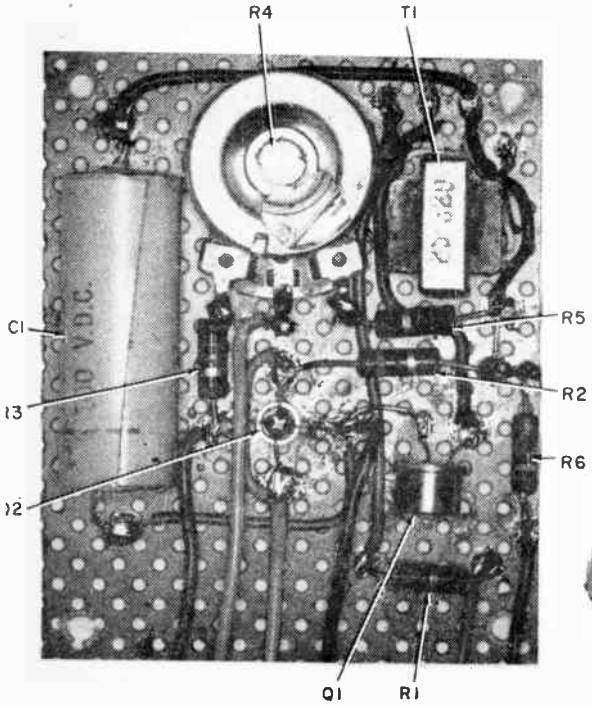
Take a peek at *Flash Master's* schematic; you'll see our electronic flash meter uses a silicon photo cell and an IGFET (Insulated Gate Field Effect Transistor) in a novel and easily-duplicated circuit. *Flash Master's* ASA ranges are switch selected for performance repeatability. And, the DC power requirements are supplied by a C-size flashlight battery.

Our *FM* is housed in a compact aluminum cabinet with the silicon photo cell in a probe housing. One of *Flash Master's* advantages over conventional photo light reading devices is that it doesn't respond to incident light. Not only can it be left on for long periods without constant re-zeroing before actual use, but our *Flash Master* only responds to *electronic* strobe light, making its readings accurate either indoors or out of the studio. And the flash meter's circuit draws less than 1 mA from the self-contained battery, assuring the photographer long battery life.

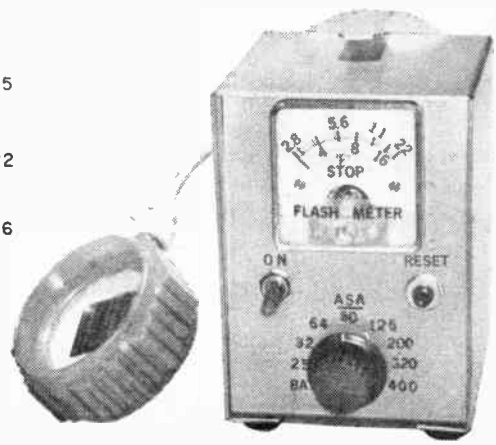
Flashing Performance. When a brief burst from an electronic flash unit is sensed by the photocell Z1, a pulse is generated and fed via resistor R1 to the 3.2-ohm winding of transformer T1 (an ordinary audio output transformer connected "backwards"). The pulse voltage is stepped up to a higher value in T1's 500-ohm secondary winding. This stepped-up pulse is rectified by transistor Q1, rigged a la diode. The "diode" is really formed by the collector to base junction of Q1. Referring to our schematic, you'll see that no connection is made to Q1's emitter; snip off this lead close to Q1's case.

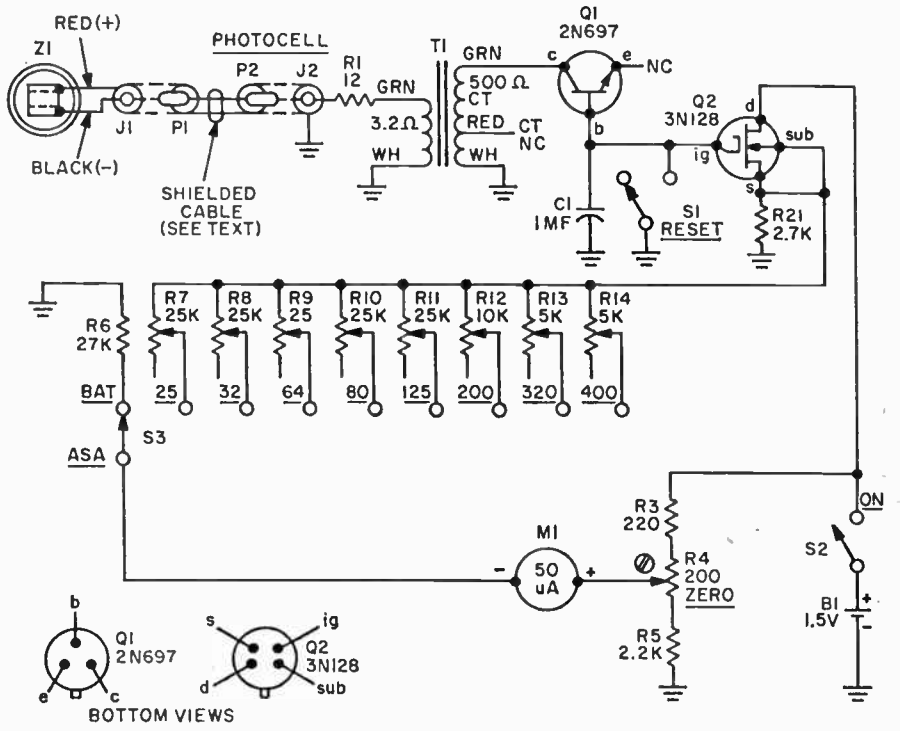
The voltage output of Q1 charges capacitor C1 to a value dependent upon the amplitude of the electrical pulse (which is determined by the light flash intensity). Capacitor C1's voltage charge controls direct current flowing through the insulated gate of field effect transistor Q2 which is wired into a basic super-high-input-impedance voltmeter circuit. Finally, voltage across C1 is read on milliammeter M1, calibrated in F-stops to read directly.

The electrical charge of C1 will be held until the very high internal resistances of Q1 ad Q2—measured in terms of thousands of megohms—and the dielectric re-



Perf board, with all of Flash Master's components except pots R7-R14 (mounted on separate perf board), is housed in pro-style cabinet, below.





PARTS LIST FOR FLASH MASTER

B1—1.5 volt C-size battery (Eveready 1035 or equiv.)
C1—1 uF, 100 volt min. rating, Mylar capacitor (see text)
J1, J2—Phone jacks (single hole mounting type)
M1—50 uA panel meter (Lafayette 99F50494 or equiv.)
P1, P2—Phono plugs (part of 6-inch shielded cable—see text)
Q1—2N697 silicon NPN transistor (RCA)
Q2—3N128 Insulated gate field effect transistor (RCA)
R1—12-ohms, ½-watt, fixed resistor
R2—2,700-ohms, ½-watt, fixed resistor
R3—220-ohms, ½-watt, fixed resistor
R4—200-ohms, linear potentiometer (with slotted shaft)
R5—2,200-ohms, ½-watt, fixed resistor
R6—27,000-ohms, ½-watt, fixed resistor
R7, R8, R9, R10, R11—25,000-ohms, miniature trim pot (from Radio Shack 271-201 Trim Pot Assortment)
R12—10,000-ohms, miniature trim pot
R13, R14—5,000-ohms, miniature trim pot
S1—SPDT, miniature pushbutton switch (Calectro E2-141 or equiv.)
S2—SPDT, miniature toggle switch (Rodio Shack 275-326 or equiv.)
T1—Output transformer: 500-ohm center-tapped primary; 3.2-ohm secondary. Turns ratio 12.5 to 1 (Midland 25-620 or equiv.)
Z1—Silicon photo cell, approximate output .5 Volt @ 25 mA (Calectro J4-800 or equiv.)
1—Aluminum cabinet 4-inches high x 2¾-inches wide x 2¾-inches deep (LMB 2754-N or equiv.)
1—plastic flashlight lamp housing (see text)

Misc.—perf board and push-in clips, battery holder for B1, sheet aluminum for photo cell housing, 3/16-in. spacers, hookup wire, sheet foam rubber, decals, solder, etc.

sistance of C1 itself, drains the charge off the capacitor. C1's electrical charge will normally last long enough for you to take your reading on M1 minutes after your strobe light has flashed. After you take the reading, depress switch S1, discharging C1 and resetting M1 for the next light flash.

Potentiometers R7 to R14 are adjusted for specific sensitivities of M1 and are selected by switch S3 for the eight most popular ASA ranges. Resistor R6 is connected in series with M1 with S3 thrown into the *Bat* position to form a simple voltage divider. Purpose is to provide the photog with some means of checking B1's health. Lastly, switch S2 controls the DC power from B1 to *Flash Master's* circuit.

Flash Master's Bright Boardwork. Most of

Flash Master

our *FM*'s components are mounted on a 2½ x 3-inch perf board installed on the rear of the 2¾ x 2¾ x 4-inches high aluminum cabinet. Component placement is not critical; any size perf board and cabinet can be used. Trim pots R7 to R14 are mounted on another perf board measuring 2½ x 2-inches. It's installed on the rear terminals of M1. *Flash Master's* remaining components are mounted on the box front panel and bottom section.

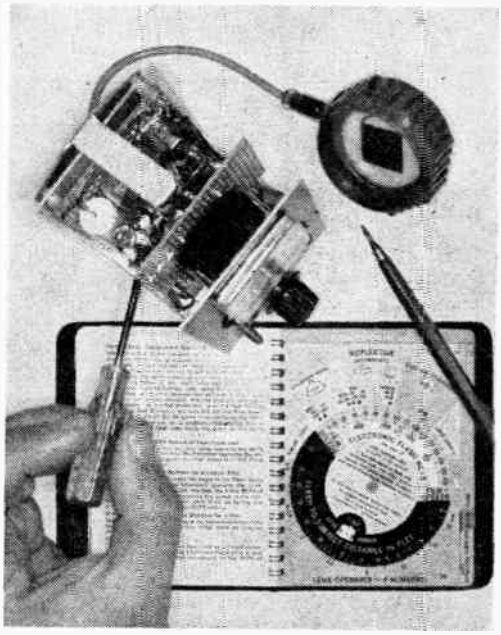
Begin construction by cutting the 2½ x 3-inch perf board to size, and mounting the components with flea clips as shown in our photos and schematic. Use caution when mounting the insulated gate field effect transistor Q2. To prevent damage to Q2, do not remove the shorting wire that the manufacturer has wrapped around the transistor leads (at the body base) until you've wired all of *Flash Master's* circuits.

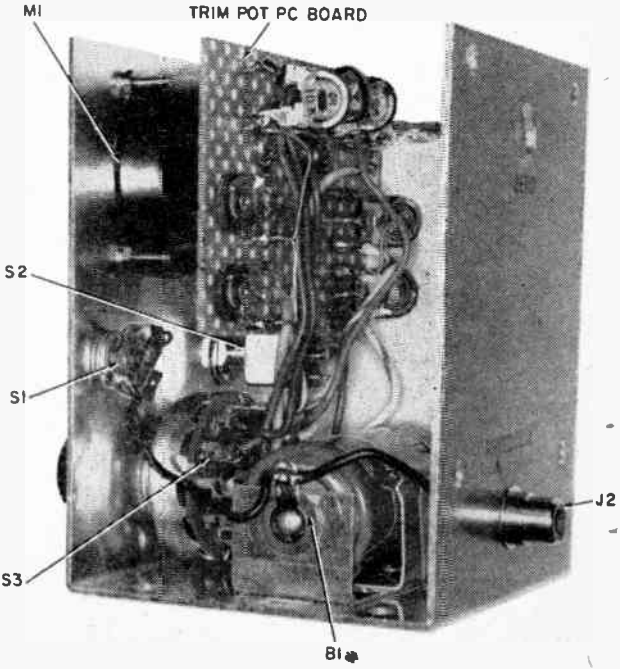
Transformer T1 is mounted by bending its mounting lugs through holes in the perf board. Then drill a hole in for potentiometer R4 (zero adjust) near the top of the perf board holding *FM*'s circuit. Mount and wire the remaining perf board components as in our schematic.

Lay out and mount meter M1 and the remaining front panel components as shown in our photos. Temporarily position the 2½ x 3-inch component board on the rear panel and locate the hole for adjusting R4 zero-adjust potentiometer. Also locate the mounting holes for RCA-type phono jack J2, and B1's battery holder on the bottom of the box. After you've mounted the circuit perf board on the rear panel with 3/16-inch spacers, slap J2, the battery holder, M1, and the remaining controls onto the front panel.

Cut a 2½ x 2-inch perf board section for all trim pots. The author attached this perf board to M1's meter terminals. But it can

(Continued on page 108)





Trim pot perf board is mounted on rear of meter via M1's lead hardware. Prewire trim pot perfboard first, wire it to S3 next; then mount both units in place. Calibrating Flash Master only requires strobe with known BCPS rating plus Kodak's Master Photoguide AR-21, available at most photo shops. Calibrate Flash Master for incident light.

Super Booster

Add this devilishly simple RF booster to any Broadcast Band rig, and watch the once dead BC Band come alive.

by
Lars Jorgensen

Imagine your receiver's broadcast band dial jammed from end to end with a solid wall of signals! Pip-squeek stations that normally can't be heard with headphones *can* come booming into your shack at S9. A dream? Nope! That's just the kind of performance you'll get with COMMUNICATION WORLD'S Super Booster.

Here's a preamplifier specifically designed for BC DX'ers. Whether you live in a concrete and steel tower, or ont in the boondocks with plenty of space for a long-wire antenna, the Super Booster will dig out signals you've never heard before. The average gain of Super Booster is almost 42 dB—that's 7 S-units "extra" sensitivity!

As shown in our figure, the booster can function either as an "electronic antenna", with signals received only by loopstick antenna coil L1, or as a preamplifier, with long-wire antenna signals coupled to L1 through L2. Coil L2 is supplied as part of the specified antenna loopstick; you have no coil winding problems.

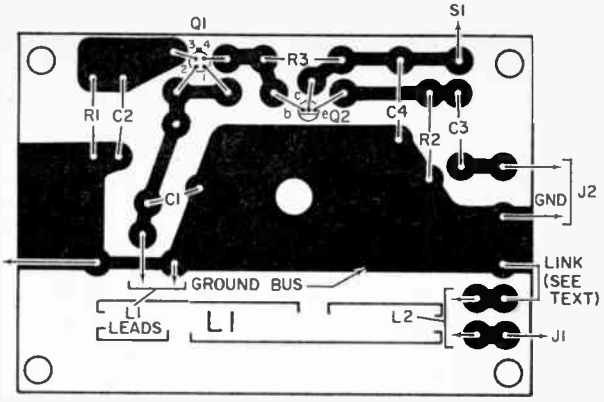
Signal voltage appearing across L1 and C1 is coupled to Field Effect Transistor Q1 which provides approximately 20 dB gain on top of the L1/C1 resonant gain. The output of Q1 feeds transistor Q2, connected as an emitter-follower. This transistor stage provides an additional 10 to 15 dB power gain, and also provides a low-impedance output for connection to the relatively low impedance receiver input.

Though intended for direct connection to a receiver's antenna input terminals, CW's super Booster can also be used with "loop antenna radios" by connecting the booster's output to a loopstick antenna (a duplicate of L1), and then positioning this loopstick near the radio. We'll show how both connections are used.

The total current drain of Super Booster is less than 2 mA. Power is provided by a standard 9V transistor radio battery. The 2U6 type will last at least 3 months, even under heavy service. An "activator" type battery can last a year or more. With such low power consumption, there is no reason to build an external AC power supply for Super Booster.

—Construction. Though the circuit appears very simple, extreme care must be taken in the circuit board preparation. Reason is. the very high gain can cause total instability if a single component, or printed foil-circuit is out of position. We suggest that no attempt be made to

SUPER BOOSTER



Placement diagram for SB's parts. If the output is fed to an AC/DC-type rig, disconnect the link and ground J2's cold end separately.

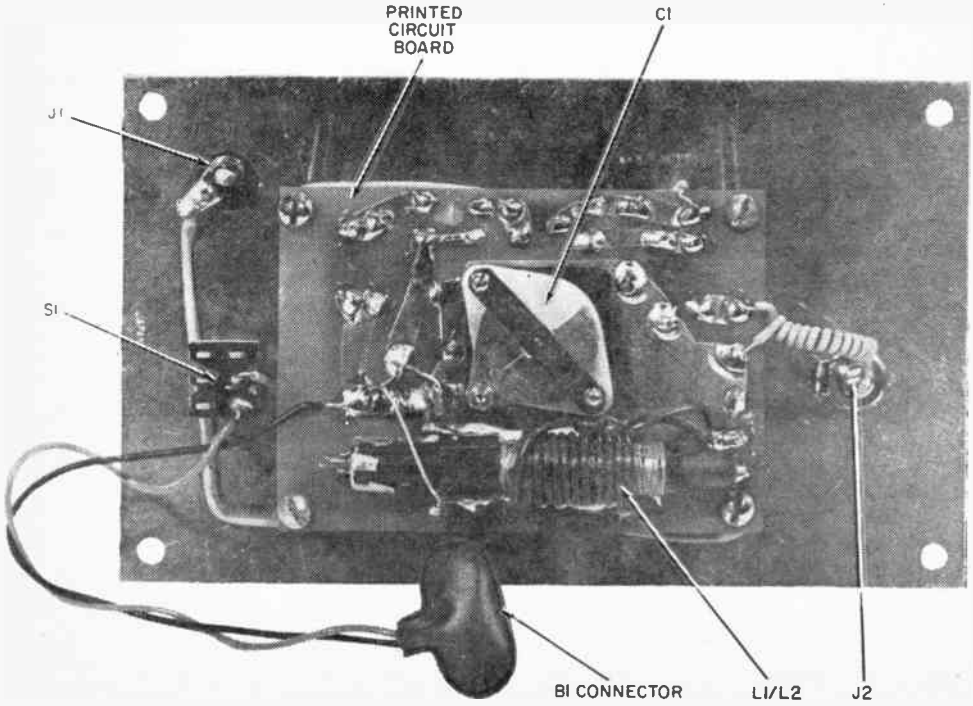
use point-to-point wiring; use a PC board which is an exact copy of the supplied template. The board can be of type XXXP; there is no need for a more expensive board.

Make *no* component substitutions; Q1 and Q2 should be the specified types. Through the circuit might work with some "general purpose replacement transistors," it probably won't work with other dime-a-cheapies. Worse yet, it might work only on very weak signals while distorting on strong signals.

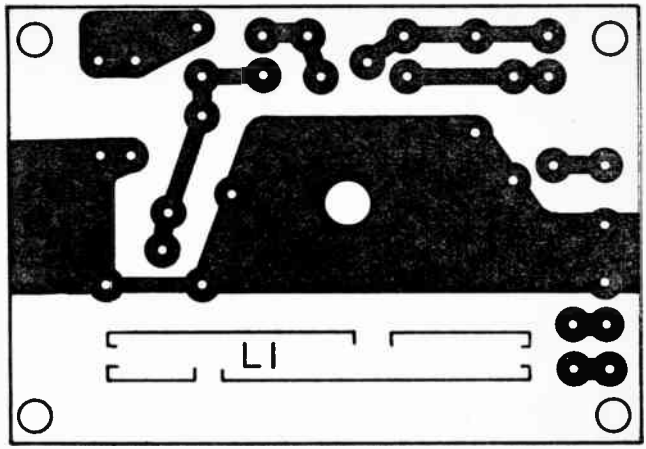
The specified components will provide distortion-free performance on signals as high as 80,000 *u*V. You can expect Super Booster to provide its great performance until the battery voltage falls below 6 volts.

The circuit board and a *very short* connection to output jack J2 are the only critical assemblies. You may make mechanical modifications to Super Booster as long as the general layout approximates the unit shown in the photographs. Any cabinet can be used; the PC board has a built-in hand-capacitance shield. For maximum stability, though, a metal front panel will reduce the possibility of RF instability caused by the signal being fed into the receiver radiating back into the booster's input.

—Making the PC Board. Cut a piece of cop-



This is Super Booster's printed circuit board drawn full-size. If you make your own PC board, follow this pattern exactly; RF instability, or regeneration, could result if you don't. Our diagram on page 18 shows where the various components are mounted on this PC board. Follow the layout carefully.



per-clad board to the size of the template and scrub the copper surface clean with a strong household cleanser such as Ajax. Or, use steel wool and a liquid detergent. Place a piece of carbon paper (carbon side towards the copper) over the board and tape the board under the template. Next, find a sharp pointed instrument, such as an ice-pick or scriber, and indent the copper foil at each component mounting hole by forcing the point of the tool through the template and into the copper. Use only hand pressure, not a hammer. Then, using a ball point pen, trace the outline of each foil area.

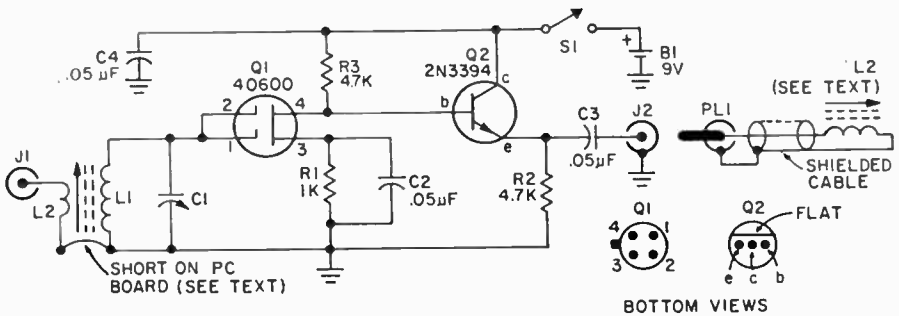
Remove the board, discard the carbon paper, and fill in the outlines with a resist pen such as supplied in the Allied Radio Shack printed circuit board kits. Allow about 15 minutes for the resist to dry and then immerse the board under at least ¼" of etchant.

When all the excess copper is dis-

PARTS LIST FOR SUPER BOOSTER

B1—9 volt transistor radio battery (Burgess type 2U6 or equiv.)
C1—365 pF subminiature poly-type variable capacitor
C2,C3,C4—0.5 µF, 50 VDC disc ceramic capacitor
J1—5-way universal binding post
J2—RCA-type phono jack
L1—loopstick antenna
L2—loopstick antenno (optinal for radios without antenna terminals—see text)
PL1—RCA-type phono plug—see text
Q1—dual gate mosfet n-chonnel transistor (RCA 40600)
Q2—bipolar npn transistor (G.E. 2N 3394)
R1,R3—4,700-ohms, ½-watt composition resistor, 10% tolerance
R2—1,000-ohms, ½-watt composition resistor, 10% tolerance
S1—single pole, single throw switch

A complete set of components, including J1,J2, S1,B1, and an undrilled printed circuit board is available for $12.95 (includes postage) from the Electronic Hobby Shop, Box 587, Brooklyn, N.Y. 11202. Add $1 for antenna loopstick L2 if needed. Canadian citizens add $1 extra. New York state residents must add sales tax. No foreign orders, please.



SUPER BOOSTER

solved—about 45 minutes later—rinse the board thoroughly and remove the resist with a cloth moistened in rubber cement thinner or by scrubbing with steel wool.

All of Super Booster's component mounting holes, except the one for tuning capacitor C1, are drilled with a number 58, 59 or 60 bit. Capacitor C1 requires a 5/16" mounting hole. The holes in the corner of the PC board, used for mounting the completed PC assembly, should clear #4 or #6 screws—whichever you prefer.

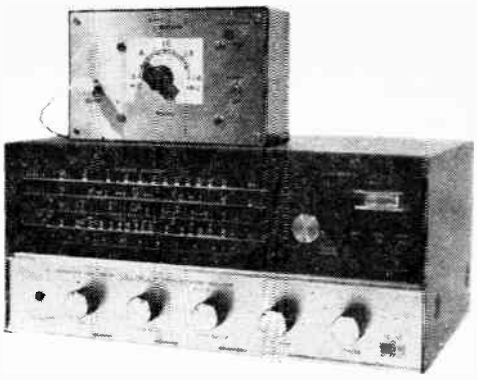
The PC board is best assembled in the following manner: install capacitor C1 first, then all other components except Q1. Then push Q1's leads through the holes in the PC board and solder them home. Finally, solder the two power leads to their respective points if you intend to check out the booster before installation in the cabinet.

Note that Q1 is supplied with a shorting clip around all the leads. *This clip must be left in position until the booster is completed and ready for operation.* If the clip is removed, a high static voltage from the tip of the soldering iron, or a voltage generated through normal handling, might destroy Q1.

Position transistor Q1 so that the tab sticking out from the case faces the nearest edge of the PC board. Position transistor Q2 so that the round side of the case faces the nearest edge of the PC board; the flat side faces the far edge of the PC board.

Note that there are no crossed leads for Q1 and Q2. When they are oriented so the tab and round end are properly aligned, the transistor leads will plug straight into the board.

Note that L2's leads have individual printed foil connections. Normally, one foil is connected to the boosters' ground through a shorting wire. The remaining foil connects to antenna jack J1. If, for some reason, you prefer a separate antenna ground, open the shorting wire and install a "ground" jack on the panel. Connect the proper foil to the ground jack.



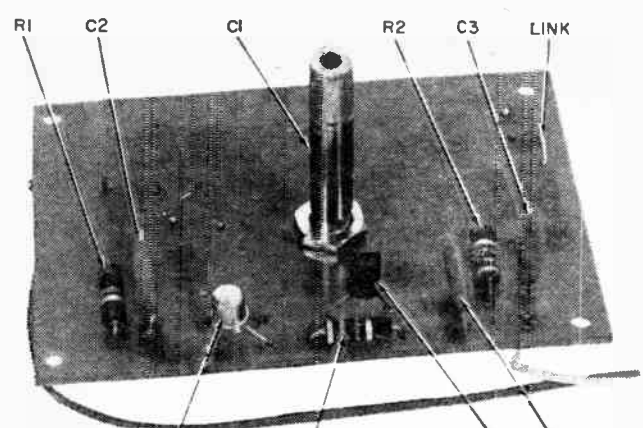
Super Booster helps this Realistic DX-120 to run after flea power BCB DX.

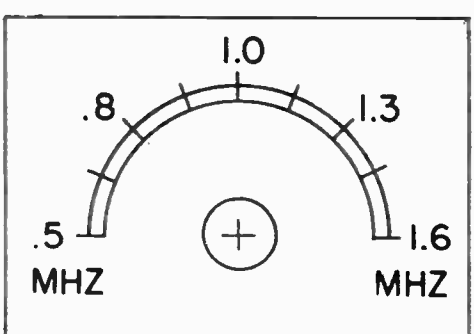
Because the components are mounted on the side of the pc board facing the cabinet panel, stand-offs must space the board away from the panel. You'll find, however, that C1's tuning shaft will be too short to pass through the panel for application of a tuning knob. But the cure's simple enough; simply cut off a section of shaft from an old potentiometer and epoxy-cement the section to C1's shaft. Or, use a plastic extension sleeve (such as the type supplied for "insulated shaft" potentiometers); the sleeve is sufficiently rigid to support a knob.

The loopstick coil is cemented to the board with General Electric's RTV Silicon Rubber adhesive. Use no other brand or type of adhesive. Other brands, such as Dow-Corning's Silastic, are conductive at RF frequencies, and will ruin the electrical properties of the coil.

Check that the foil area outlined on the board has the indicated "breaks". You don't want a closed loop. If you forgot and made a closed loop, cut four breaks as indicated with a knife or hand grinder. Apply a thin layer of Silicon Rubber adhesive inside the marked coil area and press L1-L2 into the adhesive. Make certain L1's connection terminals are parallel to the board, with L2's leads away from the board. Then allow sufficient time for the adhesive to dry.

We suggest you check out the PC assembly before it is installed in a cabinet. Remember to remove Q1's shorting clip! Simply pull on the end of the





Here's what finished PC board looks like before it's mounted to front panel with standoffs. Tuning dial faceplate can be used as is; just paste it down!

clip with long nose pliers and the clip will unwind from around Q1's leads.

Connect a DC milliammeter rated at 5 mA or higher between the battery's positive terminal and the board's positive foil. Connect the battery's negative terminal to the board's negative foil. The meter should indicate slightly less than 2 mA. If the meter indicates 1 mA or less, or more than 2.5 mA, check for a component mixup or incorrect installation of Q1 and Q2. If the meter reading is correct, disconnect power and install the board in a cabinet.

We recommend a plastic cabinet with aluminum panel such as shown in the photographs. The plastic cabinet allows direct signal pickup by the loopstick, which will be more than adequate for most DX'ing. Keep antenna jack J1 as far as possible from coil L1. Keep output jack J2 as close as possible to the board's output terminals. The power and antenna input leads should be flat against the panel.

Make up a short, shielded output lead by wrapping a solid-conductor, insulated wire around another wire. Keep the wrap turns against each other. Using the shortest possible length of this shielded wire, connect J2 to the board's output terminals. Make certain the "ground" wire goes from J2's ground lug to the ground foil.

Adjust L1's slug clockwise with a small screwdriver until only $\frac{1}{4}$" of the slug's adjusting screw sticks out of the coil form. The other end of this screw, the slug itself, will protrude about $\frac{1}{4}$" out the end of the form. The slug is generally secured with wax, so the first turn or two might require a little extra force; don't be afraid to adjust the slug if it "feels" tight.

Make up a connecting lead to go from output jack J2 to the receiver's antenna terminals. Any shielded wire or coaxial cable can be used. Install a phono plug on one end. For least signal attenuation, the lead should not exceed 15 inches.

If the Super Booster will be used with a transistor radio having a built-in loop antenna and no external antenna terminals, connect the free end of the output lead to a loopstick antenna—merely an exact duplicate of L1! If the loopstick has an antenna winding, such as found on the specified loopstick, simply unwind the few turns and connect the output lead to the coil's solder terminals. Position this coil on the radio's case opposite its built-in antenna and tape the coil in position.

—**Using Super Booster.** Turn on both the receiver and booster and tune in the desired station. Adjust tuning capacitor C1 for maximum signal strength or highest S-meter reading. As a general rule, the direct signal pickup by L1 will be more than adequate. If greater sensitivity is needed, connect 6 to 15 feet of wire to antenna jack J1. If you have the space needed for an outdoor longwire antenna, take note that the signal level into the receiver can be so high as to overload the receiver.

If there is a strong local station in

(Continued on page 107)

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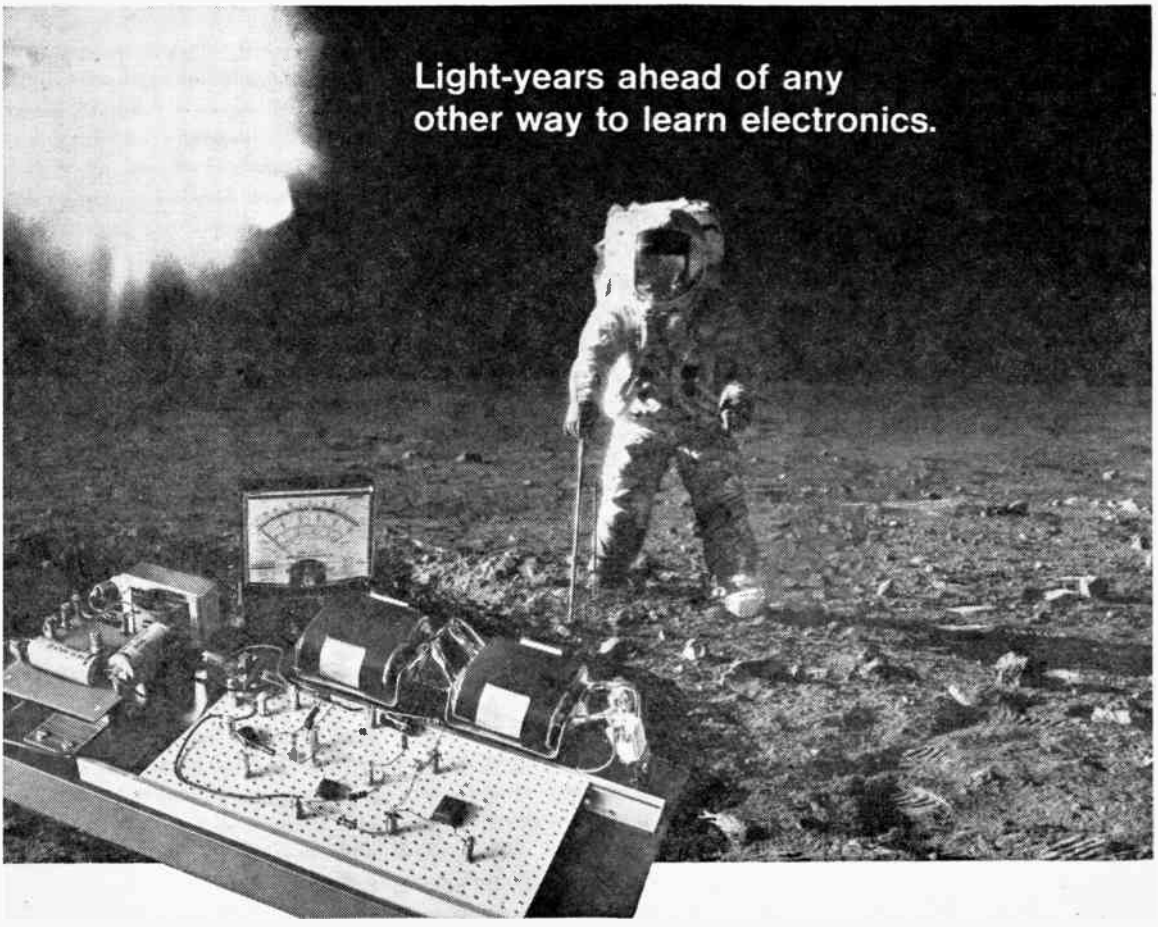

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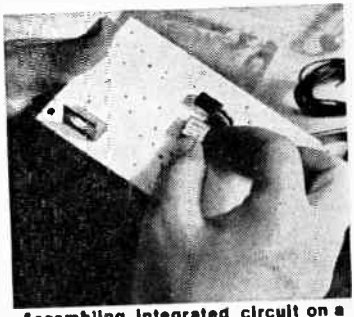
Working with basic single transistor circuit — Student learns best installation and troubleshooting techniques. He has constructed a basic single transistor circuit, first step toward understanding more complex solid-state circuitry.

Observing transistor operating as shunt-fed amplifier — Student has installed an oscillator and shunt-fed amplifier. He takes various measurements and observes the transistor operating as an amplifier. This is a typical solid-state circuit.



Assembling integrated circuit on a printed circuit board — Circuit is identical to one used in latest IBM System 360 computers. Student is constructing an oscillator combined with a Darlington pair output amplifier.

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EB-08

by Francois Markette

THE BEEPER

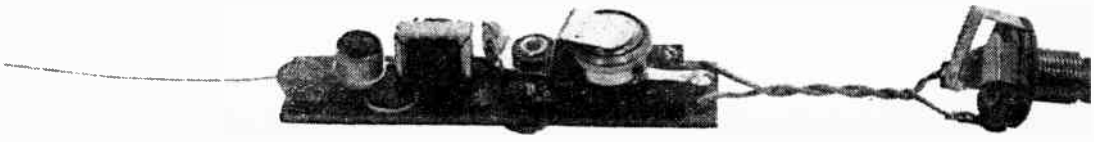
One of the easiest ways to troubleshoot a defective amplifier or radio is with a signal injector. Here's a device that generates, simultaneously, AF and RF signals. You feed the injected signal into the stage closest to the speaker, and then work back towards the input or antenna. At the point where you can no longer ram a signal through the equipment, you've found the defective stage. Then you proceed with standard volt-ohm measurements to determine which component is disabling the stage.

A simple, easy-to-use signal injector, dubbed *Beeper*, costs about $6, exclusive of the battery and power switch. *Beeper* is a simple blocking oscillator, like the garden variety found in early TV receiver vertical oscillators. The fundamental frequency of this oscillator type is in the audio range, but since the output waveform is so distorted, it's output voltage contains harmonics well up into the RF spectrum.

Fact is, *Beeper's* output extends from approximately 1kHz to the top of the standard AM Broadcast Band. Our little tube shaped injector's ideal for servicing tube or transistorized radios.

In the model shown, a mercury cell sup-

Check out Beeper for shorts, other wiring errors, before slipping unit into its case.



plies power rather than a flashlight-size battery. Seems the small batteries, such as the AA and N size, which would fit into the probe, are highly prone to leakage which would destroy the components. A mercury cell will last several years without leaking, so it's the author's choice and is, therefore, suggested. In the model shown, a standard mercury cell holder is used. Reason is, you want to avoid soldering leads directly to the mercury cell, which could destroy the cell.

Except for battery B1 and push-button switch PB1, all component values are critical and *no* substitutions should be made. Push-button switch PB1 can be any normally open (NO) type you have lying around. The probe handle is supplied predrilled with a 13/32-in. hole for a standard ⅜"PB switch. But, by using a ⅜-in. grommet to fill the hole, a miniature type ⅜-in. PB switch can be used. If you prefer, an on-off miniature switch can be substituted to avoid having to hold the switch down when using our *Beeper*.

Construction. The *Beeper* is assembled on a ⅝-in. x 3-in. printed circuit board for which a template is supplied. To make the PC board, cut a piece of copper-clad board (any type) to the specified dimensions and clean the copper surface thoroughly with a coarse household cleanser: then rinse the board and dry.

Place a piece of carbon paper, carbon side towards the copper foil, on the board and tape the board under the supplied template, or a copy of the template. Using a sharp instrument, indent the copper at the indicated component mounting holes by forcing the point of the instrument through the template into the copper. Then, using a ball-point pen, trace the foil outlines.

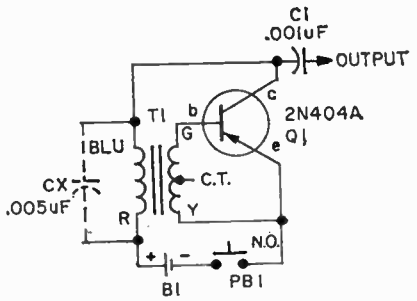
Remove the PC board, and using a resist pen, or a brush dipped in resist, fill in the outlined areas of foil to be protected. Let the resist dry for a few minutes and then immerse the board under at least ¼-in. of etchant.

Etch for about 45 minutes, agitating the board frequently. Then check to see if all undesired copper is removed. If it isn't, reimmerse the board for 5 minute intervals until every trace of the undesired copper has been etched away.

Rinse the board thoroughly under running water and then drill the component mounting holes, which are indicated in the copper foil by the indents.

The holes for the mercury cell holder requires a #39 bit for #2 or #3 screws. The holes for transformer T1's mounting tabs use a #27 bit. The remaining component holes are made with a #57, #58 or #59 bit.

Install transformer T1 first. Note that the secondary is center-tapped. The center-tapped lead is not used; cut it off at the transformer. Though we have given the color codes for T1's leads in the schematic, note that manufacturers do change their color codes, so double-check the particular transformer you use before installation. Regardless of the color codes, the secondary is center-tapped, and the leads on both sides of the center-tap are the secondary leads.



If Beeper doesn't oscillate, reverse T1's secondary leads. Or, add Cx (see text).

PARTS LIST FOR THE BEEPER

B1—Mercury cell, Mallory type RM625 or PX-13
C1—.001 uF, 500 VDC disc capacitor
Cx—.005 uF, 25 VDC capacitor, see text
PB1—Push-button switch, see text
Q1—Transistor, 2N404A
T1—10000 ohm primary, 2000 ohm C.T. secondary sub-miniature transistor transformer. (Custom Electronics 442-3390).
1—Keystone type 117 mercury cell holder
1—Keystone test probe kit
A kit contoining oll the above components except B1 ond PB1 is ovailable for $5.85 plus 75¢ postage and handling from the Electronic Hobby Shop, Box 587, Brooklyn, N. Y. 11202. Outside U. S. shipments add $1 extra.

THE BEEPER

Orient the PC board horizontally so that you face the top of the board (copper foil is underneath) with the holes for the mercury cell holder to the right. The extreme right side of the board has three component holes—one for the holder connection and two for the switch.) Hold T1 so you face the top of the transformer with the center-tap lead on top. Then push T1's mounting tabs into their respective holes.

Using a screwdriver or long nose pliers, fold the tabs over so that T1 is secured to the board. Then install T1's leads, C1, Q1 and the battery holder in that order. If the holder is supplied with the "solder lug" off to one side, carefully bend it in so the lug cuts through the center of the holder's insulating block.

Note carefully the construction of the holder. When the cell is installed, the positive terminal seats into the holder. The solder lug is the positive terminal. The heavy spring clamp that secures the cell is the negative terminal. Make certain the holder is installed so that the heavy spring clamp faces T1 while the solder lug faces the end of the PC board.

Capacitor Cx, a 0.005 uF disc ceramic unit, is not used or installed at this time. It is needed to compensate for possible variations in the transistor or transformer, and its use, depending on the checkout, might not be required.

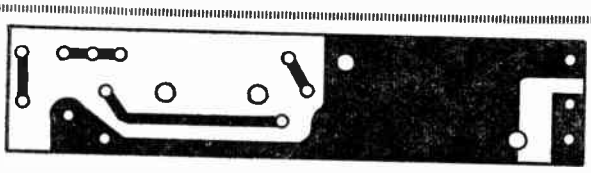
Solder a 1½-in. stranded twist pair to switch PB1; then connect the free ends to the appropriate PC board terminals. Solder a 1½-in. bare solid wire to the output PC terminal.

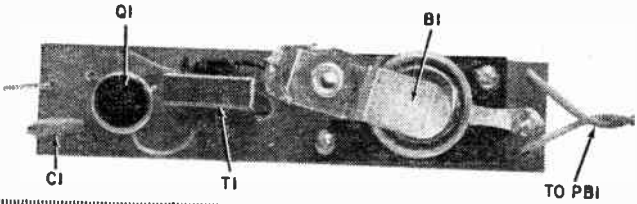
Checkout. Using an amplifier, tape recorder, or any other audio device, check out the *Beeper* by touching the output wire to the amplifier input. You should hear a tone of approximately 1 kHz. If you get a deep *growl*, connect capacitor Cx across T1's *primary* terminals on the *under-side* of the board—the foil side. (Tack solder Cx's leads to the foil.)

Using the BEEPER. Since the peak output of the *Beeper* is 2V—a voltage that can damage some transistors—always try to inject the signal without directly touching a transistor lead. Bring the probe tip *near* the appropriate transistor lead until the signal is heard in the speaker. If this "capacity" coupling does not inject the signal, you can then bring the probe tip in contact with the transistor lead. Tubed circuits aren't critical in this respect and the tube pins can be touched directly with the probe tip.

In RF circuits, such as a superhet radio's IF amplifier, *Beeper's* signal can often be injected by simply placing the probe tip near an IF can or connecting wire.

If you work primarily with tube circuits, or any high-impedance-type circuit, and find that touching the probe tip to a low-level amplifier grid causes excess hum in the amplifier, install a ground lead for the *Beeper* by soldering a short flexible wire to Q1's emitter PC tab. Drill a small hole in the probe body, bring the wire through the hole and install an alligator clip to the free end. The ground lead has not been made part of the basic *Beeper* since accidental contact of the ground lead when working on solid-state gear will disable the *Beeper*. ■

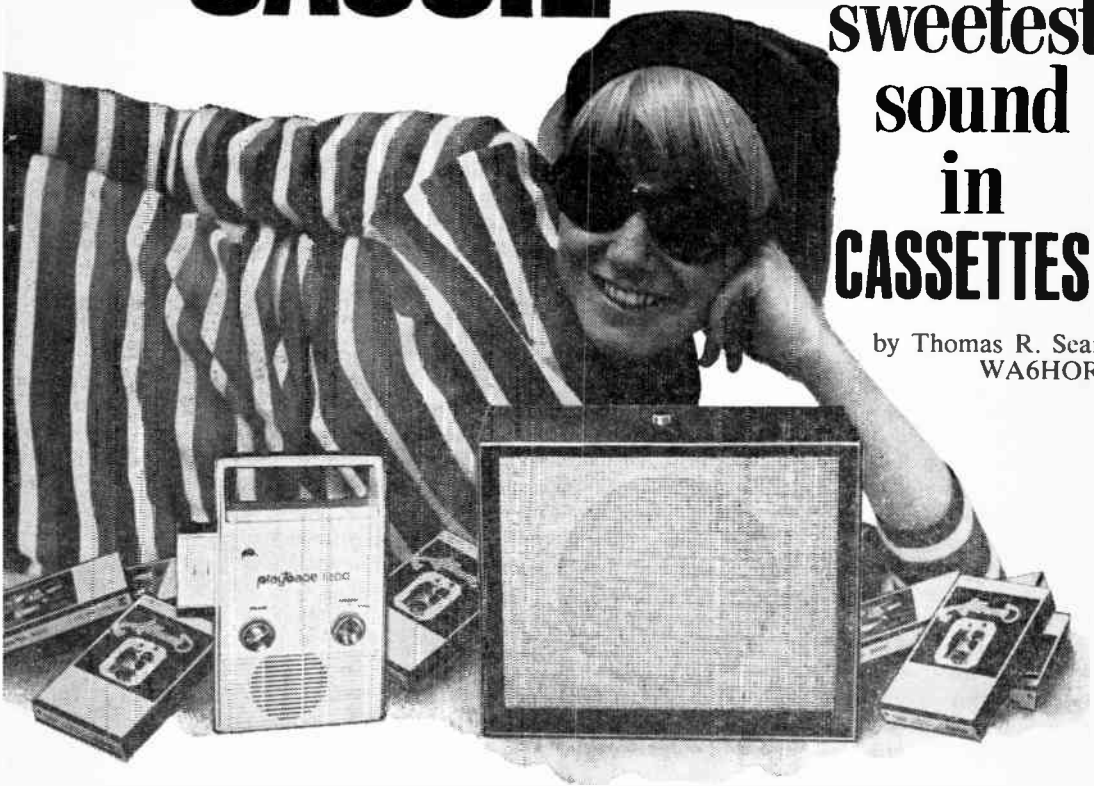




Top Right—Full-size foil outline for Beeper's printed circuit board. Right—Topside view of printed circuit board showing location of components. Hold board with foil pattern as shown; flip over for correct parts placement.

let CASSIE give you the sweetest sound in CASSETTES

by Thomas R. Scar
WA6HOR



SIX years ago no self-respecting audiophile seriously considered slipping the Beatles into his hip pocket. And no stereophile envisioned cramming all those Monkees into, say, a tote bag. But all you Beautiful People know how time eventually changes fiction into fact. Today it's easy to hold the Boston Symphony in your hand. Spouting off at the tonsils aside, you've got a lot to like with a new-as-tomorrow tape cassette.

Since its introduction in the mid-1960s, the tape cassette has achieved immense popularity among novice and experienced audiophiles. The ease of loading this ½-in. wide, self-contained marvel into its record/playback unit consistently earns hurrahs from anyone who has ever fumbled with a conventional, reel-to-reel tape recorder. But it turns out all's not perfect in cassette country.

Like a small battery-operated transistor radio, a cheapie cassette player's playback sound oftentimes leaves a little something to be desired. Seems the commemorative-stamp sized speaker found in the majority of cassette players stumble and fall way down in the bass-reproduction department. One solution might have us tack on a larger speaker having better frequency response. But did you ever try driving that hi-fi speaker of yours with a cassette player? It's all show and no go as the flea-powered player struggles against your mighty inefficient speaker.

Room-filling sound for little expense is surely the password for our

gives you the sweetest sound...

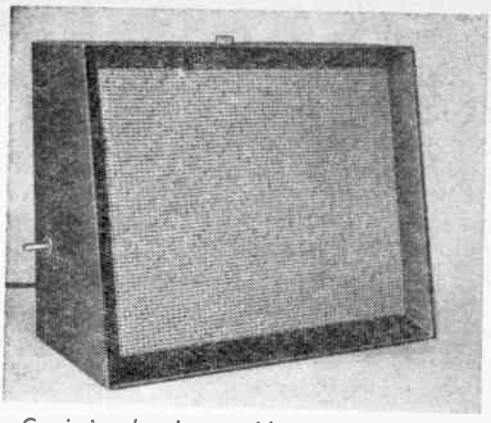
Cassie. She gives you the sweetest sound you've ever coaxed out of your cassettes! You won't have to sell your kazoo to build *Cassie*, either. Handily lifting Bacharach or Bach from soupy to silvery, *Cassie* tootles to a 20-buck tune. We think you'll be glad you found a couple of constructive hours and a finger for your solder gun trigger, after you've heard *Cassie* perform.

Our photos show *Cassie* in all its glory. You can easily see how speaker and internal amplifier fit into the cabinet, with neither cramped for breathing room. We did a bit of catalog page twisting and found a full-range 8-in. speaker tucked within a deluxe baffle for an unheard-of $6.95. And another six dollars and 95c later, we fished up an amplifier whose internals can easily drive the speaker.

Cassie can find happiness indoors with its own internal power supply, or outdoors by connecting a 12-volt battery to the terminals provided for this purpose. Making our *Cassie* even more electrically attractive are two inputs: one for high-level signals ordinarily cranked out by cassette players, another for low-level signals such as you'll find from phono cartridge, guitar pickup, or even a microphone.

These features make *Cassie* ideal for all those indoor or outdoor gatherings where you want your vocal cords or rock vibrations to carry a lot more zonk.

Prancing Through Cassie. The electrical body of *Cassie* consists of two major organs.



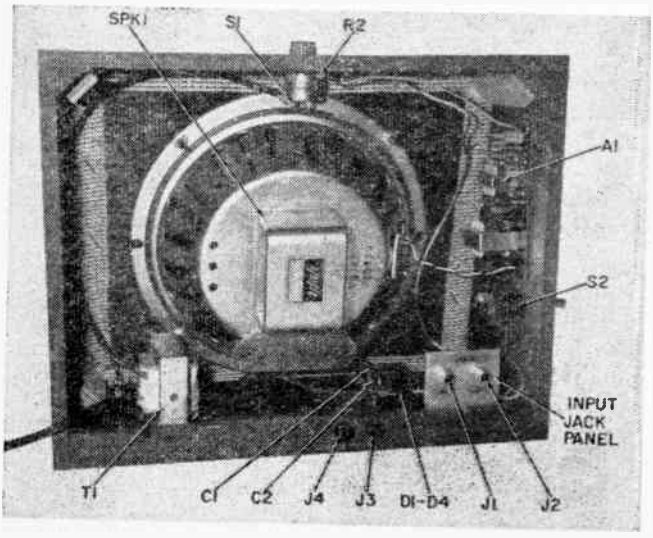
Cassie is a handsome addition to any system. Not only does it add tone quality to your cassette player, it's good to look at too.

One's a solid-state, store-bought, 1-watt power amplifier: the other's a home-brew 12-VDC power supply.

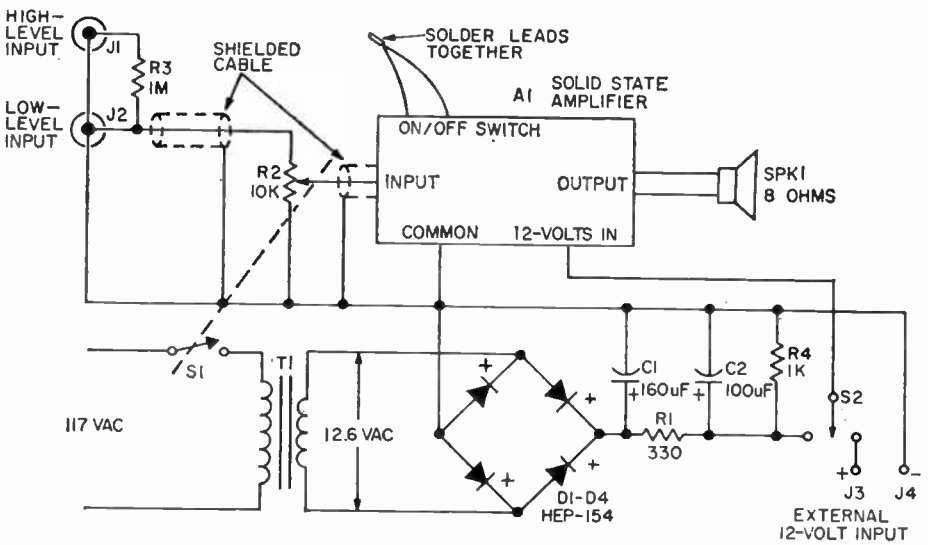
The power amplifier has a frequency response running out to 15 kHz. What's more, when presented with 4.5 millivolts at the head end, it'll zap its output into an 8-ohm speaker without busting a gut. And all this razzmatazz is yours with only 150 mils squeezed out of the power supply!

The 8-ohm speaker and enclosure were found hiding together in McGee Radio Co.'s catalog. You'll find it lurking as no. SLDC8S. The speaker's a no-nonsense coaxial job with a frequency-response curve considerably wider and flatter than the squawker found in most cassette players.

From Full Wave to No Wave. Taking a peek at *Cassie*'s schematic, you'll see that



Guts of Cassie layed bare here for all good constructors to see how easy it is to place all the units for easy accessibility without affecting speaker. Circuit board construction of amplifier and power supply lends itself to placement that fits spaces available. Controls are placed within easy reach from exterior.



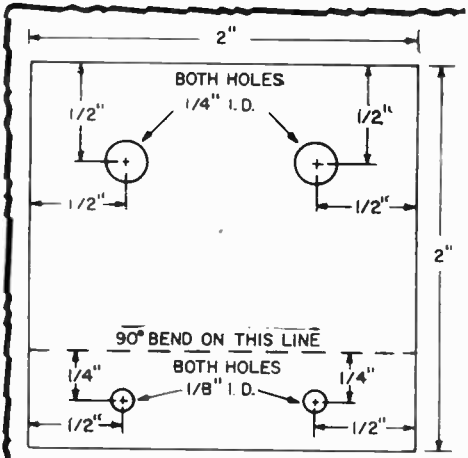
PARTS LIST FOR CASSIE

A1—1-watt, solid-state amplifier (Lafayette 99E90383 or equiv.)
C1—160-μF, 25 VDC electrolytic capacitor (Lafayette 34E85687 or equiv.)
C2—100-μF, 16 VDC electrolytic capacitor (Lafayette 34E85547 or equiv.)
D1-D4—50-IV, 1-A silicon rectifier (Motorola HEP-154 or equiv.)
J1, J2—RCA phono jacks (Lafayette 99E62341 or equiv.)
J3, J4—Insulated banana jacks; red (Lafayette 32E64942 or equiv.), black (Lafayette 32E64959 or equiv.)
R1—330-ohm, ½-watt carbon resistor
R2—10,000-ohm, ½-watt carbon potentiometer (Lafayette 32E22528 or equiv.)
R3—1,000,000-ohm, ½-watt carbon resistor
R4—1,000-ohm, ½-watt carbon resistor
S1—Spst on/off switch (part of R2)
S2—Spdt toggle switch, center off (Lafayette 99E61558 or equiv.)
*SPK1—8-in., 8-ohm coaxial speaker with wall baffle
T1—Power transformer: primary, 117 V 50-60 Hz; secondary, 12.6 V @ 2 A (Stancor P-8130 or equiv.)
1—2-ft. length shielded wire (Belden 8431 or equiv.)
Misc.—knob, 6-ft. line cord with plug, wood screws, solder, wire, etc.

*SPK1 available from McGee Radio Co., 1901 McGee St., Kansas City, Mo. 64108 for $6.95 plus postage. Specify stock no. SLDC8S.

switch S1 is the power *on/off* switch socking 117 volts to transformer T1's primary winding. Transformer T1's secondary is connected to the power supply, which is four silicon diodes, two capacitors, and two resistors. Diodes D1 through D4 are connected as a bridge rectifier; the output from this bridge is smoothed by capacitor C1 to provide a relatively hum-free DC output of approximately 20 volts. Resistor R1 drops the DC output voltage down to the 12 volts required to breathe life into our power amp. Capacitor C2 provides additional filtering.

There's nothing spectacular about switch S2. A prune-juice-regular, three-position toggle switch, it selects either the output from the internal power supply, or an external 12-volt supply connected 'twixt jacks J3 and J4. The *center-off* position of S2 also provides you with a means of turning *Cas-*



Don't say we haven't told you all—here's how to make input jack panel.

gives you the sweetest sound...

sie on or *off* when an external source springs it to life.

Longnose Looping. Okay, it's time to dig out your dikes. But before you'll read more of our sage construction advice to the shop-worn, you'll need to perform a minor surgical operation on the power amplifier.

Solder the power *on/off* wires (coming out of the amp) together. and wrap them in a piece of electrical tape. These wires normally run to an external switch which performs the *on/off* function. In *Cassie's* case, however, we halt those jolts with our volume control-mounted switch. If you're still in the dark over which two wires to solder together, consult the directions accompanying your amp; it'll call out two leads marked "to on/off switch." After you've taped up the patient, place it aside.

Don't let that bright 'n' shiny speaker talk you into mounting it into the baffle while you're still in the early construction phases. Few speakers improve their tone when they're subjected to holey indignities like screwdriver blades, drill bits, and solder gun tips.

Prior to mounting the electronics within the speaker cabinet, drill a 7/16-in. hole on the left-hand side of it. This hole is for switch S2, and it's positioned about 3¼-in. up from the bottom and 1½-in. from the back of the speaker baffle. Also drill two ¼-in. holes spaced ¾-in. apart on the side of the speaker cabinet. That's where you'll mount jacks J3 and J4.

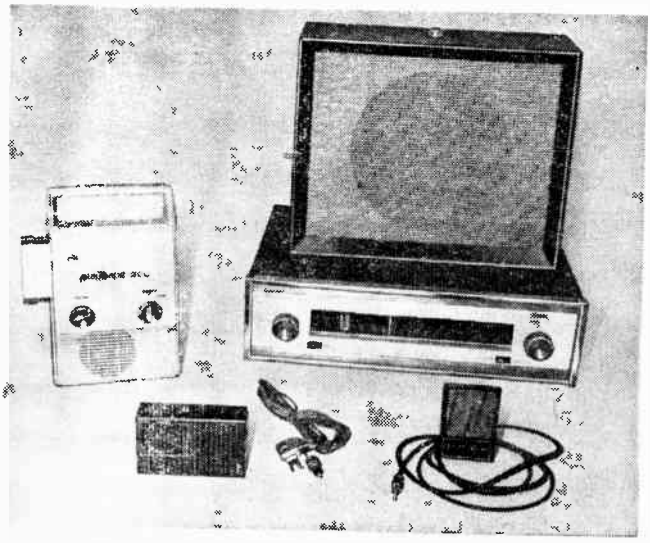
Cutting, bending, and drilling the input jack panel is the toughest job on *Cassie*. Take a 2 x 2-in. piece of aluminum stock, and drill two ¼-n. holes about an inch apart, as our diagram shows. Then drill two ⅛-in. holes about an inch apart at the opposite end of the aluminum plate. Scribe a line ½-in. in from this side and bend the metal so it forms a 90° angle along the line. This aluminum mashery becomes the mounting plate for your high- and low-level input phono connectors. Finally, attach this assembly with round-head screws to the cabinet base.

Screw both RCA phono jacks onto the mounting plate. After you solder a 1-megohm resistor between both center conductor pins, drill a hole for the volume control *on/off* switch assembly on top of the baffle and mount it in the newly-created hole. Be sure you orient the potentiometer terminals so they face the amplifier.

The power supply assembly can be tackled by any soldering iron wielder. The author built his volt smoother on a small piece of Bakelite, but we suggest you delve into your spare parts collection for a 3 x 2-in. hunk of perfboard. Before you loose your wonder-watter upon the components, remember that diodes and electrolytic capacitors are like polar bears. They lose their cool if jabbed too often with a hot iron.

Once you've wired the power supply, mount it to the speaker baffle's bottom with spacers between perfboard and mounting screws. Only four connections are made to one power supply—transformer T1's second-

(Continued on page 107)



Cassie's with it for other than cassette players. You can use it to sweeten up your tuner or build two of 'em for stereo. Too, it makes an OK phono amplifier when you feed it from a record changer. Need a small PA? That's right, just add a mic and you've got one rarin' to boost that weak voiced politico. In fact it fills the bill for just about any audio application where there's need to faithfully raise the signal level with low distortion and good frequency response.

NO-TICKET RIG

Here's 4 bucks worth of transmitter that says you can get on the air, now!

By Steve Daniels, WB2GIF

□ Are you just itching to key that rig? Most Novices are. Trouble is, most people who are dying to get on the air need a little bit more code practice before they can take the exam and grab their ticket.

The No-Ticket Rig is designed with precisely this in mind. And while you won't DX (legally) any further than your front porch, you will have an AM transmitter that can pop the *dihs* and *dahs* into your portable radio with no trouble at all. In fact, you will be amazed at how loud and clear the signals are. A more pleasant way to bone up on theory simply ain't to be found.

Circuit Operation. Transistor Q1, resistor R1, and audio transformer T1 comprise an oscillator circuit that produces a constant audio tone. The base of Q1 is forward biased through R1, while the emitter is forward biased through the secondary of T1; as a result, the transistor conducts heavily.

When the transformer's core is saturated, current flow stops, and the transistor is cut off when the magnetic field in the core reverses. This cycle repeats itself at a rate determined by T1, Q1, and R1.

The audio signal from T1 is injected into the RF stage through the emitter of Q2, and resistor R2 which also supplies the base bias for Q2. This RF oscillator is similar to the audio stage except that an autotransformer is used rather than a coil having two separate windings. The lower half of L1 augments the forward bias to Q2.

The modulated RF carrier appears at the collector of Q2 where it is coupled to a long-wire antenna. The signal can be picked up by any nearby AM radio.

Construction. A 1¾-in. square chip of perf board should provide enough space for

all components. The adjustable antenna coil (loopstick) is mounted on one side of the case. You can use a larger board should things be too cramped, but all leads must be kept as *short* as possible.

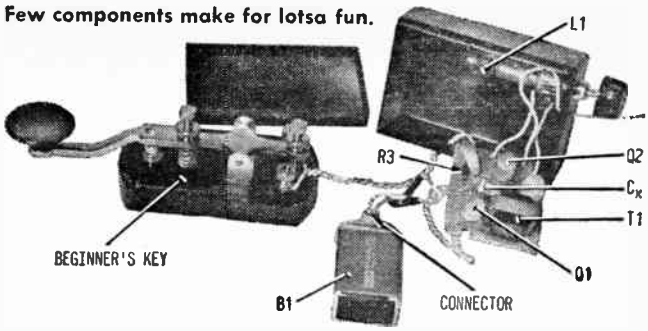
Wire the RF stage (Q2) first and bring out three leads for the loopstick. You will have to trim these to size later on. Then wire the audio oscillator, leaving an inch or so between L1's windings and T1. The core of the driver transformer may become over-saturated if these components are too close together.

Note that transistors Q1 and Q2 are not critical and that substitutes are available (see Parts List). Remember that the value of R2 (and perhaps R1) may require adjusting when a substitution is made.

When all the parts are mounted and wired, your key should be connected in series with the battery connector; it operates as a switch to bring power into the circuit. That nice twisted pair of leads in the author's model was obtained by securing two hookup wires in a vise and attaching the remaining leads to an electric drill. Turn on the drill for a few seconds and you have a cable.

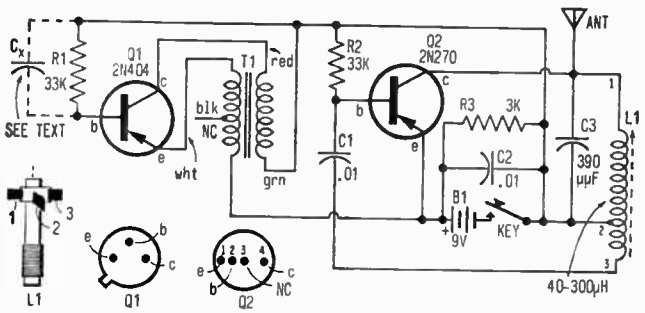
To mount the antenna coil, start by drilling a ¼-in. hole and then ream it out until the metal collar snaps snugly in place when the coil is pushed in. Make sure that the perf board, loopstick, and battery fit easily into the case. Connections should be as rugged as possible.

Few components make for lotsa fun.



Adjustment. With the battery connected (for better voltage regulation and longer life, a mercury battery can be used), attach a long-wire antenna (between 3 to 6 ft) to terminal 1 of the loopstick and close the case. Screw your key shut (for a constant tone) and tune across the BC band until you pick up your rig's signal. Adjust the slug of L1 to get the tone on a quiet part of the band. There's no point in trying to copy through QRM.

If the audio tone is too low, add C_x to the circuit as shown. Any value between .01 to .02 μF should do the trick. ■



PARTS LIST FOR NO-TICKET RIG

B1—9-V battery (Burgess 2U6 or equiv.)—see text
C1, C2—.01-uF disc capacitor
C3—390-pF disc capacitor
Cx—See text
L1—40-300 uH, miniature BCB antenna coil (Lafayette 34T8749 or equiv.)
Q1—Pnp germanium transistor (RCA, GE 2N-404; HEP-739 or equiv.)
Q2—Pnp germanium transistor (RCA 2N270; HEP-632 or equiv.)
R1, R2—33,000-ohm, ½-watt 5% resistor
R3—3000-ohm, ¼-watt 5% resistor
T1—10,000-ohm pri., 2000-ohm (CT) sec., miniature audio transformer (Lafayette 99-T6126 or equiv.)
1—3¼ x 2⅛ x 1⅛-in. utility box (Lafayette 99T8077 or equiv.)

Misc.—Telegraph key (Lafayette 99T2554 or equiv.), battery connector (Cinch-Jones 5D, Allied 18C5184; Lafayette 99T6287 or equiv.), perf board, push-in terminals, knob, wire, hardware, solder, etc.

TennaBoost

Wipe out the dead spots on your BCB dial with our easy-to-build signal booster

by George Hattlett

WOULD YOU BELIEVE IT? There really isn't a dead channel on the BC band. What's more, neither rain nor sleet nor much of anything else (our apologies to the Post Office) will stay the broadcast signals in the 540- to 1600-kHz range. Transmitted daily by more than 7600 stations in the Western Hemisphere alone, these signals can be yours—if you have a suitable antenna.

To log real BCB DX (the flea-power locals in the band), you'll need a long-wire antenna supported as high as possible above buildings and tree tops and free of obstructions. Catch is, what city dweller can find such a spot? Fortunately, you don't have to. For by connecting our *TennaBoost* in place of whatever makeshift antenna you've been putting up with to date, you should be able to snag plenty of these distant weaklings. What may have appeared to be dead spots on your dial before *TennaBoost*

TennaBoost

will now come alive with stations you never knew existed. And signals that were once puny to the point of being unreadable will now blast in like a herd of buffalo heading for Injun country.

What Is It? *TennaBoost* is an inexpensive, easy-to-build, indoor antenna/signal booster amplifier. Basically, it consists of a tuned loopstick (same as supplied in the majority of transistor radios) that feeds signals to a two-stage, transitorized, wide-band amplifier. As noted in our Parts List, the amplifier is available in kit form direct from the International Crystal Manufacturing Co. Included in the kit is a well-laid-out printed-circuit board, ready to accept the components making up the amplifier, with easy-to-read identifications of the locations for the various parts printed on the board.

Building TennaBoost. Because the overall gain of the combined amplifier and loopstick is extremely high—30 dB for the amplifier and 10 to 20 dB for the loopstick—the layout of the amplifier and the overall wiring are critical. Therefore, we suggest you buy the kit and follow the construction details furnished with it as well as our construction tips and layout, to lessen the likelihood of your amp being plagued with instability. The amplifier kit sells for less than $4.00, so you'll be ahead of the game to buy it, considering the cost of the parts plus the dividend of getting a properly laid out, finished printed-circuit board.

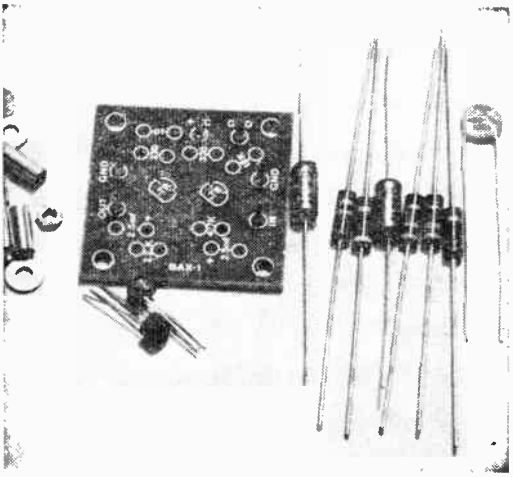
We made one change in the kit. Since it's intended to cover the 50 Hz to 150 kHz range, it comes with two 2.5-μF electrolytics. For optimum performance in the BC band we substituted two 0.001-μF subminiature ceramics. The two 2.5 μFs are the only electrolytics furnished in the kit, so you should have no trouble identifying them. Put them aside, as you'll no doubt find use for them in some future project.

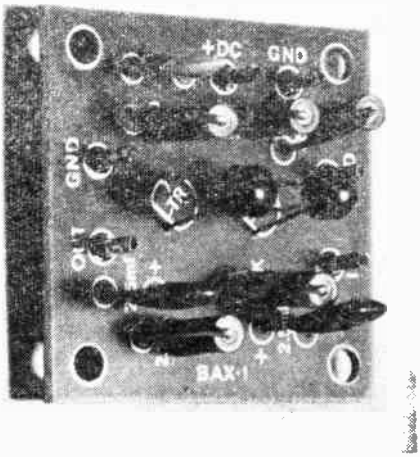
We recommend that you first assemble the kit and solder all components in place. Be very careful not to use excess heat on the transistors and other miniature components. In fact, you should use a small alligator clip as a heatsink while soldering them. A small pencil-type soldering iron rated at about 25 watts should work very nicely.

Just as the amplifier itself is critical as to layout, so is the completely assembled *TennaBoost*. Therefore, exercise the greatest care with your parts layout. Follow our construction details as closely as possible.

We mounted *TennaBoost*'s components in a 5¼ x 3 x 2⅛-in. minibox. All of the components are mounted in half the minibox; the other half closes up and shields the assembly. First step is to drill and deburr all mounting holes. Be sure to follow the dimensions for locating the holes, placing them exactly as shown in our drawing. This is necessary to reduce the possibility of instability for the complete assembly. Position the amplifier as shown, using two ¼-in. spacers to lift it from the metal of the cabinet so that there will be no possibility of shorts.

Place the amplifier so its input terminals





Pic on left is how you get 'em, pic on right is what you do with 'em to make a BAX-1.

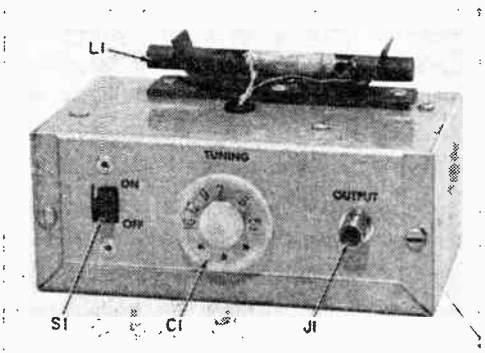
race the battery holder and its output terminals face the edge of the minibox. Mount switch S1, tuning capacitor C1, and output jack J1 on the front panel as dimensioned in our drawing. Jack J1 should line up with the center line of the amplifier board and S1 should be in line with one of the battery terminals of the battery holder. Both S1 and J1 are equidistant from the center of the box; capacitor C1 is centered to give the front panel a balanced look.

TennaBoost's Loop. Loopstick L1 is mounted outside on the top rear of the minibox. When mounted, the loop's tap, which is just a few turns from one end, should be in line with the grommet that is exactly centered in the top of the minibox. Since you will have to remove the loopstick from its fiber mounting bracket in order to mark the mounting holes, it's good to remember where the tap should be when reinstalling the loop in its mount.

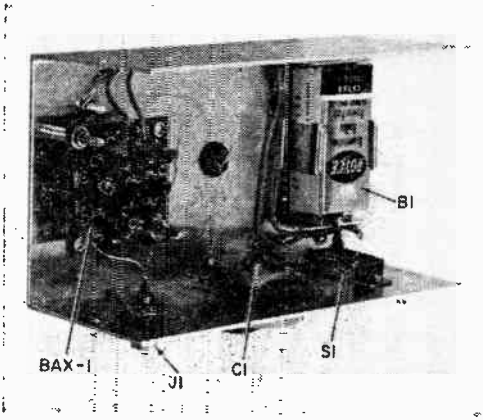
Be careful not to break the delicate leads of very fine wire from the loop. Also, install a ¼-in. rubber grommet in the hole for the leads to ensure that the loop leads will not be cut by the rough edge of the hole drilled in the minibox. Use the full length of the leads when connecting it to tuning capacitor and the amplifier.

The rotor plates of tuning capacitor C1 are grounded through the mounting of the capacitor; the stator plates are connected to L1 by the lead from the loop.

Amplifier output is connected directly to J1 with a short piece of unshielded hookup wire. Make this lead as short and direct as possible. Even though the input and output



TennaBoost's good looks are attributed to its balanced front control panel. However there's more than meets the eye here. Layout is important to ensure short, direct wiring for minimum coupling that can cause unwanted oscillation.



Here's how we put TennaBoost together. You'll be wise to follow this layout for a minimum of trouble with instability. TennaBoost's high gain requires careful parts placement.

connections of the amplifier are made to push-on clips, solder connections directly to them.

To avoid unstable operation care must be taken in proper dress of interconnecting leads. The leads from the loop should run through the rubber grommet directly to the amplifier, with the excess pulled towards the battery holder. Power leads from the battery should be run along the side of the battery to the rear of the cabinet and thence across to the power terminals on the amplifier.

The output cable to connect *TennaBoost* to the BC receiver should be a short piece of low-loss coaxial cable (it should be no longer than 40 in. maximum). We used RG-174/U. You can also use RG-62/U with equal success; if these are not readily available RG-58/U or RG-59/U can be used if the length is limited to a maximum of 24 in.

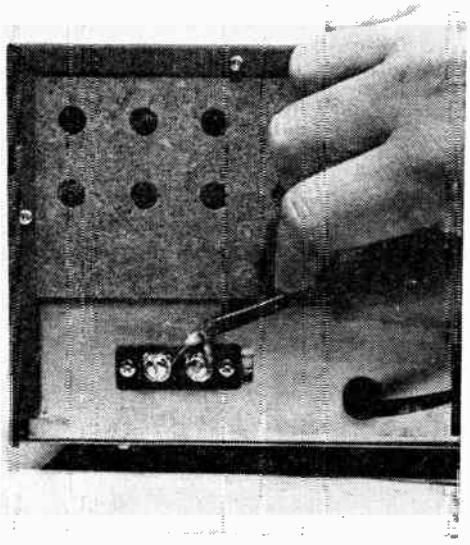
Since there is no check-out or alignment needed before putting *TennaBoost* into service, close up the minibox, being sure to use all of the screws furnished. If the box you use should be one of those having a snap fit to keep it closed, you'll have to drill it and install sheet metal screws to be sure that the two halves are electrically connected to provide complete shielding. You can't check out *TennaBoost* with the cover off since it will break into oscillation from feedback between the amplifier output and loopstick L1. Use press-on lettering (Datak or equiv.) for a very professional look in identifying the controls on the front panel.

TennaBoost

Using TennaBoost. Connect the free end of the coax from *TennaBoost* to the antenna and ground terminals of your BC receiver. Be sure the shield of the coax cable is connected to the ground of the BC receiver. Turn *on* switch S1 of *TennaBoost* and the power switch of your BC receiver. If the set is a tube model, allow time for the tubes to warm up (because it's transistorized, no warm-up is required for home-constructed *TennaBoost*).

If your receiver uses a loopstick for a BCB antenna instead of having terminals for external antenna and ground, don't despair. Pare back about 2-in. of shield on coax cable to let you twist a turn or two of the center conductor around the set's loop. Best way to handle the shield is push it back, loosening the mesh. Gently make an enlarged opening in the mesh and draw the center conductor through the hole, leaving a pigtail of shield for grounding to the set's chassis. If, in this process, insulation on the center conductor is damaged, insulate the conductor with tape or sleeving. Once the twist has been tested in its initial position, move it back and forth over the set's loop for best signal.

Now tune the BC receiver to the approximate frequency of a station and adjust the dial of *TennaBoost* for maximum noise output. Once that has been done, tune in the station with the receiver's dial and peak the sensitivity of *TennaBoost* by adjusting its dial for maximum signal level. The dial furnished with capacitor C1 is calibrated in standard BCB frequencies so you can use these calibrations as an initial setting for

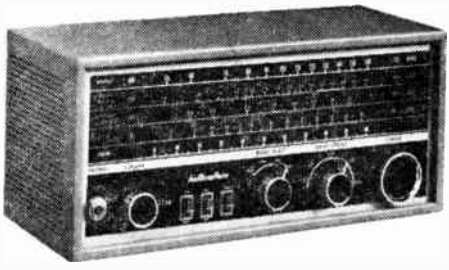


If your BCB set has terminals for external antenna and ground connections, here's how TennaBoost is connected.

THE RECEIVER WE USED

Hallicrafters' new Star Quest broadcast and shortwave receiver shown on page 25 incorporates many features normally found only in more complex and expensive general-purpose communications receivers.

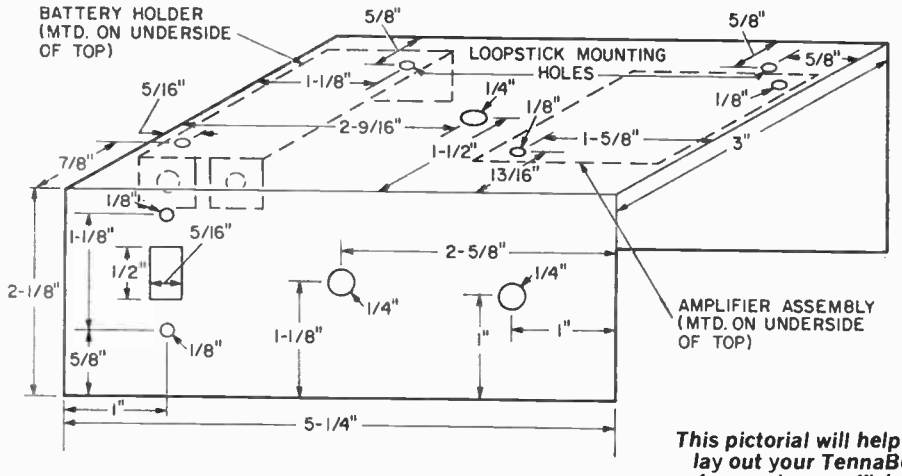
It's a transistorized version of Hallicrafters' original most famous Model S-120 vacuum tube SW (shortwave) receiver. Many a freshman ham started his career by using the S-120 for his SWL activities. Model S-120A covers the AM-BCB and 76 shortwave services in four tuning ranges. Because of its special solid-state circuitry and BFO (beat frequency oscillator), standard SW as well as CW (code) and SSB (single sideband) reception is boosted considerably over conventional vacuum-tube sets.



Hallicrafter's Model S-120A Receiver

The model S-120A is a transistorized receiver housed in a steel, communications-type cabinet. It has a large, illuminated slide-rule dial. This receiver covers the AM broadcast band as well as providing complete SW coverage from 2 to 30 MHz. Special features include electrical bandspread, a logging scale, and automatic gain control, in addition to the aforementioned BFO for SSB/CW reception. Its low-distortion audio power output of over 1000 mW drives a built-in, rugged, 4-in., communications type speaker. An universal impedance output jack for connecting various communications type headphones is mounted on the front panel.

Basically, the S-120A is a real winner that more than adequately fills the bill for the budding SWL-DXer, rather than being considered a commercial communications receiver.



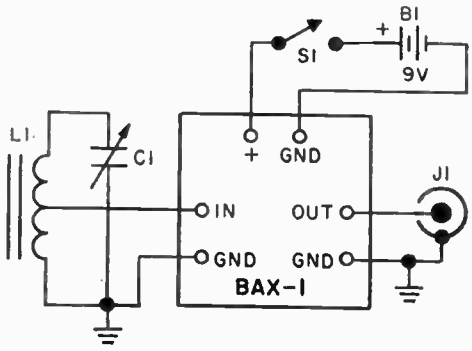
This pictorial will help you lay out your TennaBoost for maximum efficiency.

PARTS LIST FOR TENNABOOST

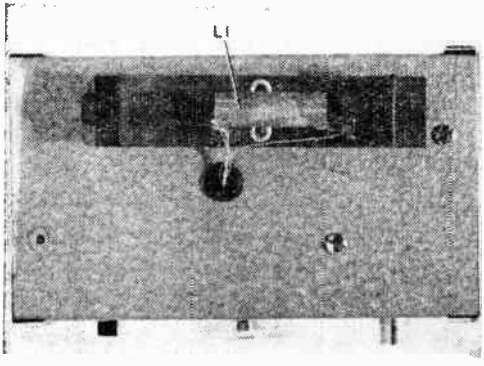
BAX-1—Broadband amplifier, International Crystal Mfg. Co. type BAX-1
B1—9-V transistor radio battery (Eveready 216 or equiv.)
C1—385-pF tiny tuning capacitor with dial (Lafayette 99E62176 or equiv.)
J1—RCA type phone jack, single-hole mount (Lafayette 99E62341 or equiv.)
L1—Miller type 2001 miniature loop antenna (Lafayette 34E87485 or equiv.)
S1—Miniature slide switch, spst (Lafayette 34E37035 or equiv.)
2—0.001-uF, 75-VDC subminiature ceramic capacitor (Lafayette 33E69022 or equiv.)
1—5¼ x 3 x 2⅛-in. minibox (Lafayette 12E83738 or equiv.)
1—Keystone type 203P battery holder for 9-V transistor batteries

Misc.—Wire, solder, coaxial cable and connector to fit J1, screws, nuts, press-on letters (Datak or equiv.), spray paint in colors of your choice, etc.

Note: BAX-1 broadband amplifier kit is available from International Crystal Manufacturing Co., Inc., 10 N. Lee, Oklahoma City, Okla. 73102. Kit costs $3.75 F.O.B. factory, add 25¢ for parcel post. International Crystal can ship from stock upon receipt of order accompanied by money order or check in the amount of $4.00.



Schematic shows how easy it is to hook up.



Bird's eye view giving correct L1 location.

TennaBoost. Since the loopstick on *TennaBoost* acts just the same as any loop antenna, try rotating *TennaBoost* for a possible improvement in signal strength.

If you find that adjusting capacitor C1 of *TennaBoost* tunes stations on the receiver, or the receiver blocks, chances are you have a feedback loop between the receiver and *TennaBoost* because of their proximity to one another. Should this occur, move *TennaBoost* further away from the receiver to bring back A OK condition. ■

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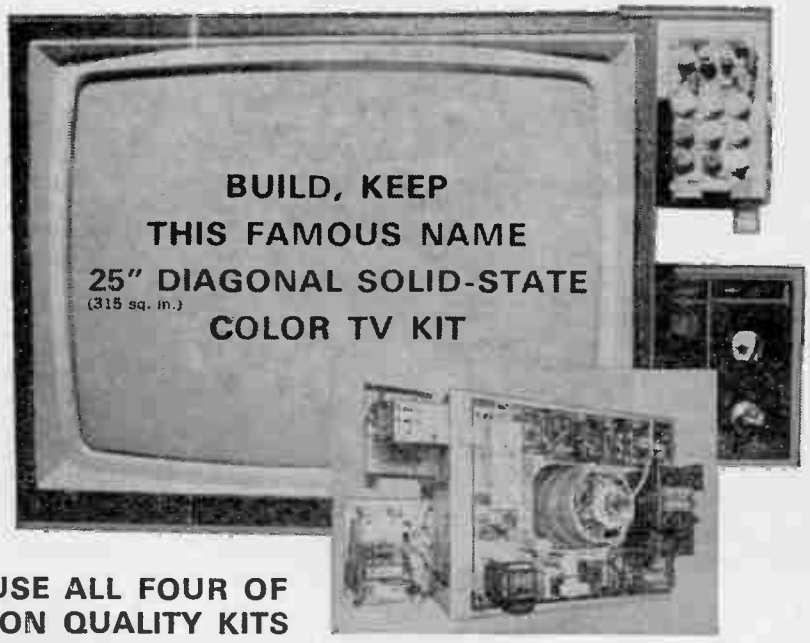

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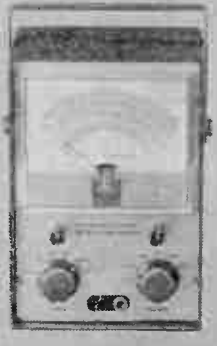

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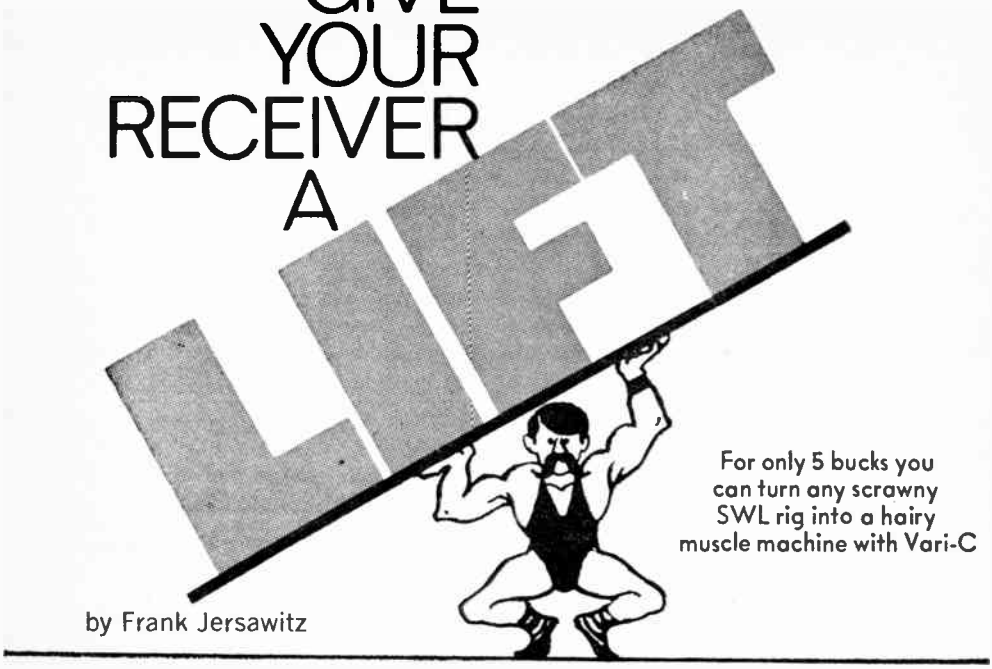


For only 5 bucks you can turn any scrawny SWL rig into a hairy muscle machine with Vari-C

by Frank Jersawitz

THERE are many transistorized SW receivers available today in the price range from less than $15 to several hundred dollars. The author owns one of these low priced versions that, after a little diddling turned in a pretty good record in receiving DX.

One reason for this success with a low priced receiver is the fact that the listening point is located in a rural community away from big city areas that are congested with electrical interference from machinery, appliances and an overabundance of radio stations in the immediate vicinity. Also, the house is atop a hill at least 100-ft. high, with the antenna somewhat higher than this since its installed on the roof. All are conditions known to be ideal for SWLing.

Of course, knowing a thing or two about what it takes to wring the most out of a set helps too. Following are a few tips that have helped tremendously and are in easy reach of the average experimenter.

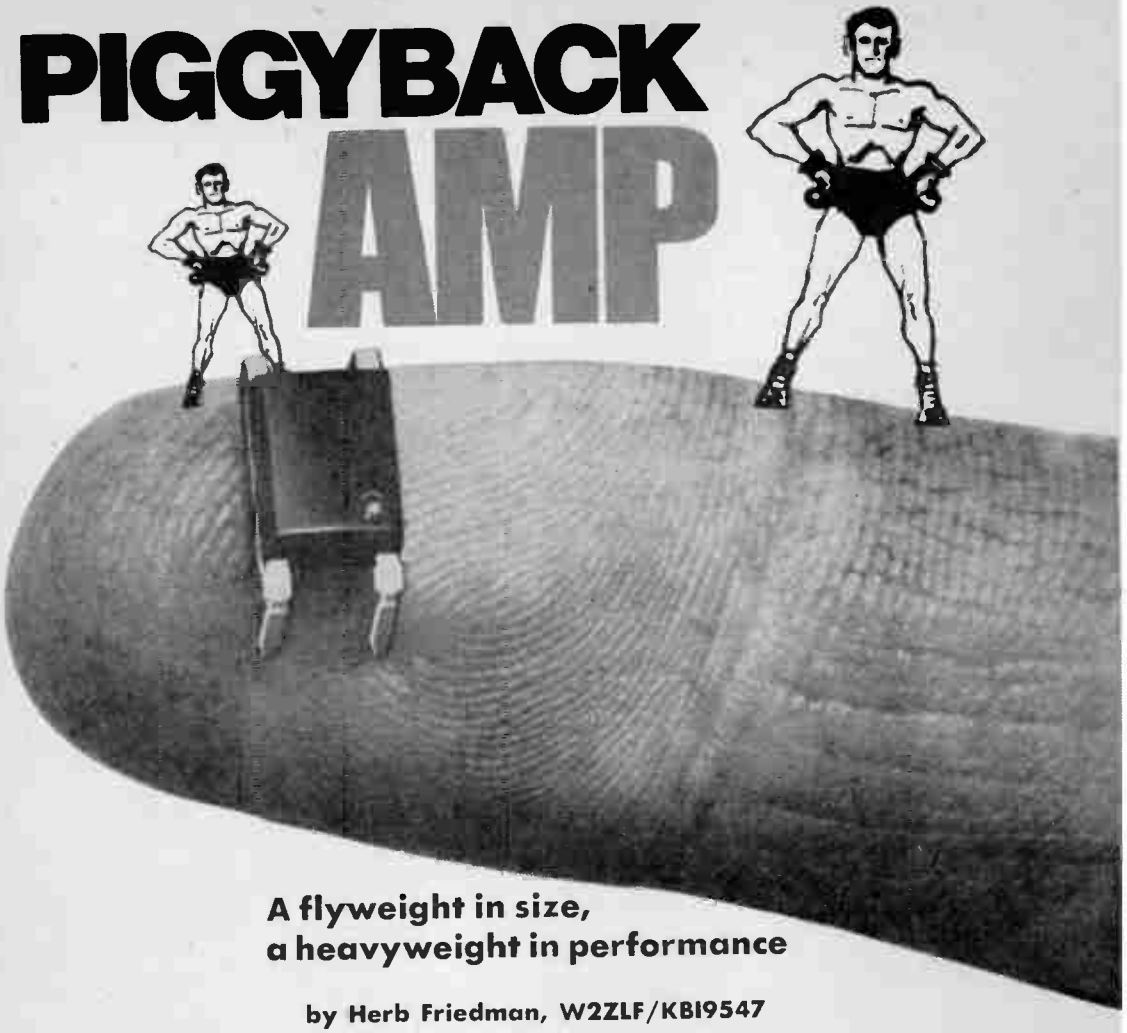
Grounding. One major aid to improve reception is to use a good earth ground. If your set doesn't have a ground terminal, check out the circuit for the common ground bus and connect a lead to this bus and thence to a cold water pipe. Or, run a ground wire to a rod sunk at least 4-ft. into the earth. To be effective the ground wire must make a good contact with the water pipe or ground rod. You can buy a ground clamp designed to dig past the dirt and oxidation on the pipe or rod, thus ensuring a good ground connection.

Using An Outside Antenna. Certainly a properly erected antenna, the higher the better will bring stronger signals to the set's input. In the event your set doesn't have a terminal to connect an external antenna, you can connect the lead-in to the whip antenna built into the set, with an aligator clip. This will make it easy to disconnect so you can take the set with you on an outing.

Boosting Sensitivity. Next, let's consider a way to improve the sensitivity of the receiver. In all probability, because the set is an economy model and was rushed through the production line to keep down the cost of manufacture, the IF transformers may not be peaked for maximum tuning to track with the output of the set's mixer oscillator. A simple aligning tool, similar to GC type 5000, long enough to reach the tuning screws and small enough to fit into the openings for them, will help to overcome this deficiency. Initially, just tune the set to a weak BCB signal (if the set tunes the BCB) and then slowly rotate the adjusting screws,

(Continued on page 105)

PIGGYBACK AMP



A flyweight in size, a heavyweight in performance

by Herb Friedman, W2ZLF/KBI9547

CAN you imagine a power amplifier no larger than a fly? It's easy—just mount a fly-sized integrated circuit (IC) on a 1⅛ x 1½-in. PC board, and along with it add a single transistor preamplifier. The whole bit adds up to a *complete* amplifier small enough to cement right on the back of the magnet of a small speaker. Depending on the input circuit used, our *Piggyback Amp* can be an intercom, a utility amp. a signal tracer, or even a monitor amplifier small enough to be built into a tape deck.

The possibilities for using Piggyback Amp are endless because its power requirement is only 9 V at a minimum of 3.5 mA idling current, which is easily obtained from a small power supply or 9-V battery for a transistor radio. Our photo shows a typical application, the Piggyback Intercom. The schematic details the input circuit modification for the basic Piggyback Amp when used as a signal tracer, tape monitor, etc.

Secret of such a wide latitude in application is the power amplifier, a Motorola integrated circuit (MFC4000). As shown in our photo, the IC takes up no more room on the tip of your finger than a fly, measuring just 0.26 x 0.21 x 0.14-in. (HWD). Yet small as it is, this IC develops an output signal up to 250 mW into 16 ohms—that's about equal to a fairly loud transistor radio. The MFC4000 IC consists of an output stage with drivers and an input amplifier stage for a total of six transistors. Five resistors and three diodes are also packed into its fly-sized case.

Unfortunately. you can't get everything for nothing. The MFC4000 requires 150 mV

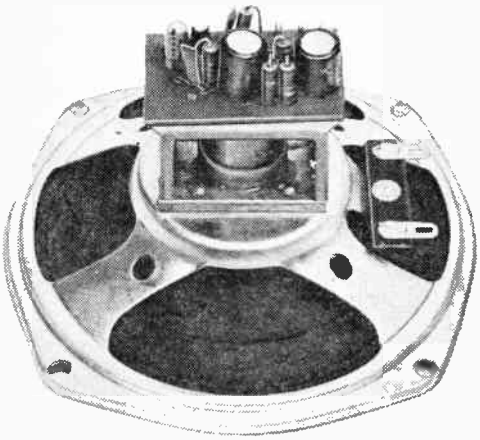
PIGGYBACK AMP

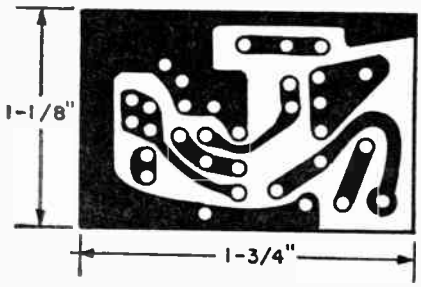
(rms) input drive for full power output. The IC's input impedance appears as 1000 ohms. A preamplifier is needed to increase its sensitivity for universal applications. Our schematic includes the preamplifier stage. Transistor Q1 is biased by R1 and R2 to act as a variable resistor. Bias for IC1's input transistor is derived from its output through the R3/R4/R5 network and Q1.

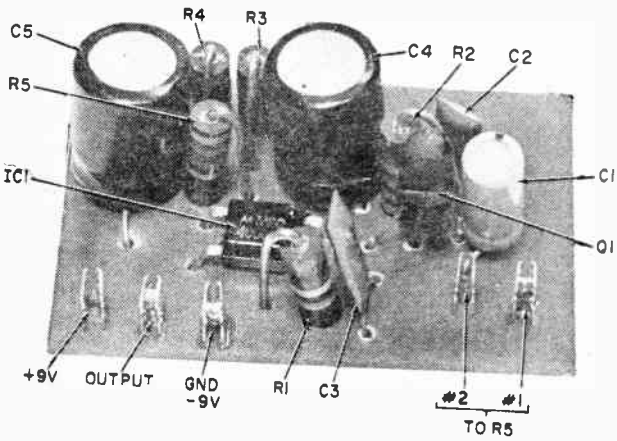
Since the bias voltage is derived from the amplifier output, the circuit is automatically temperature stabilized. Reason for this is that heating effects on the IC, which result in a change in DC, raise the amplifier's output. Thus the output signal, in turn, controls the amplifier's gain by being fed back to its input. If the DC output voltage attempts to rise because of temperature rise, the feedback to the input biases the amplifier to reduce the drive and thus keeps the DC output voltage constant.

Because transistor Q1 is in the feedback loop, you can use just about any pnp *silicon* transistor having gain in the 100 to 300 range (we used a 2N5355). The amplifier will continue to operate even if the power source falls to about 4 volts. Naturally, its output will be lower.

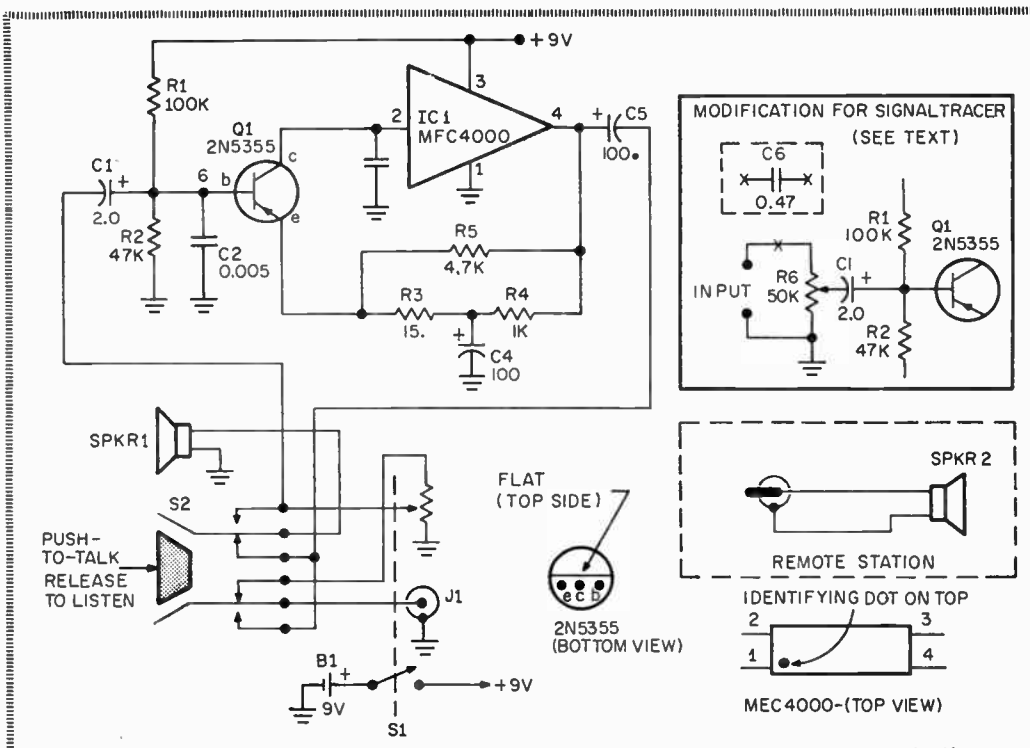
The overall frequency response is established by the capacitance of C5. Response will be essentially flat from 100 to 20,000 kHz when C5 is 500μF. Response will be down about 6 dB at 100 Hz when C5 is 100μF. However, since Piggyback Amp was intended for use with small speakers which can't reproduce lows, anyway, there's really no need for an oversize and expensive capacitor. Further, if C5's capacity will be greater than 100 μF, much more will have to be provided on the PC board. Of course, you can use perfboard construction which easily accommodates any size components.







Above—full size pattern for making Piggyback's circuit board. But why bother when factory-made board as well as complete kit of parts for Piggyback universal amplifier can be purchased just by filling out coupon on page 44, thus saving walking and working time. Upper left—see how easy Piggyback Amp fits on back of speaker. Lower left—parts layout for basic amplifier.



Circuit above covers application of Piggyback Amp to a two-way intercommunication system. We've also included a modification when unit is used as signal tracer.

Construction. First step is to order or make the PC board. Easy way out is to order one using our coupon, but those who are venturesome may choose to *roll their own*. To help we've included a full-scale pattern for etching, and we refer you to page 32 of the September/October 1969 ELEMENTARY ELECTRONICS for detailed instructions in the art of etching printed circuit boards.

Drill the holes for the components to be mounted on the board. The IC's leads require a hole made by a #55 drill; the rest of the components need holes drilled by a #58 drill. Type T-28 terminals or flea clips are used for terminating external connections and you'll need a #50 drill for mounting them.

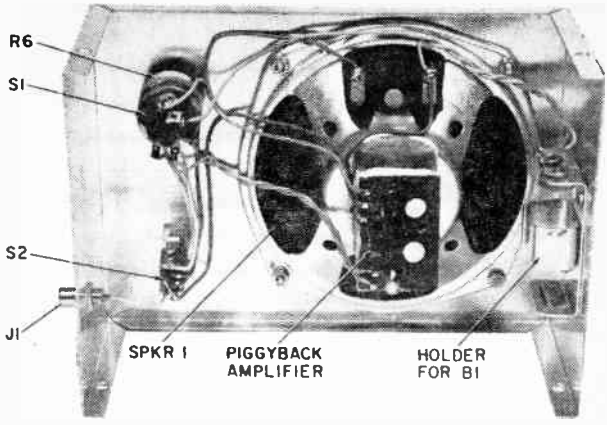
Mount all components, saving the IC for the last. All resistors are end mounted in a position perpendicular to the board; the capacitors are the printed circuit type with both leads on one end. Transistor Q1 is mounted using the full length of its leads. After the T-28 terminals or flea clips are soldered, the excess lead wire protruding through the foil side of the board is cut off. Final step is to mount the IC.

After doublechecking for correct polarity of capacitors, the orientation of Q1 and IC1, and making sure there are no cold solder joints, you can now cement the PC assembly to the back of a speaker. Use a silicon rubber adhesive such as GE's RTV or Silastic Bathtub Calk. To prevent the leads that stick out from the foil side of the board from shorting to the speaker frame, insulate the bottom of the board with a single layer of plastic electrical tape. Place a small blob of RTV adhesive on the foil side of the board, cover the board with tape, and then apply it against the speaker magnet. Pack the RTV around the edges of the board, using a screwdriver to tamp it down. Allow the adhesive to dry for at least 24 hours.

Piggyback as an Intercom. The speaker can be mounted in any convenient enclosure. *Talk listen* switch S2 is a spring-loaded pushbutton type; the N.C. (normally closed) contacts are the *listen* connection, connecting remote speaker SPKR2 as the microphone. The sound originating at SPKR2 is amplified by the Piggyback Amp and monitored through SPKR1. When S2 is pushed, SPKR1

PIGGYBACK AMP

With Piggyback Amp cemented to back of speaker, about all you'll need to house this combo plus the few controls and battery is a small Mini-box. We used one 7 x 5 x 3-in. for our intercom.



is transferred from the output of the amplifier to its input. Result is that SPKR1 now serves as a microphone and the amplifier output is transferred to the line feeding SPKR2 at the remote station.

Note that volume control R6 is connected so that it is in the circuit when receiving signals from the remote station to control received volume. When transmitting to the

(Continued on page 106)

PIGGYBACK AMPLIFIER PARTS KIT & PRINTED CIRCUIT BOARD ORDER BLANK

ELECTRONICS HOBBY SHACK
PO BOX 587
Brooklyn NY 11202

☐ Please rush Printed Circuit Board for Piggyback Amp at once. I am enclosing $2.95 to cover costs for the board, handling, and postage.

☐ Please rush Amplifier Kit (parts that mount on the PC board) at once. I am enclosing $6.95 to cover costs for the parts, handling, and postage.

☐ Please rush Printed Circuit Board and Amplifier Kit (parts that mount on PC board) for the Piggyback Amp at once. I am enclosing $8.95 to cover costs of board, parts, handling, and postage.

Name_____
Address_____
City_____ **State**_____ **Zip**_____

PARTS LIST FOR PIGGYBACK AMP

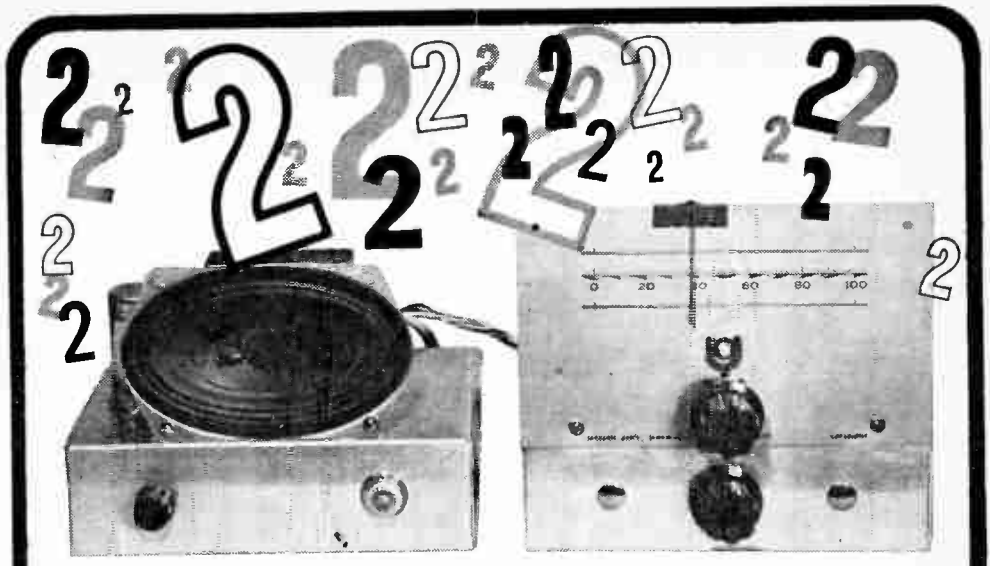
Amplifier Parts Kit (parts mounted on PC Board)

C1—2-μF, 3 to 50-VDC electrolytic capacitor for PC board (Aerovox BCD-5002 or equiv.)
C2, C3—0.005-μF, 75-VDC subminiature square ceramic capacitor (Lafayette 33E69048 or equiv.)
C4, C5—100-μF, 12 to 15-VDC electrolytic capacitor for PC board (Aerovox BCD-15100 or equiv.)
C6—0.47-μF, 100-VDC dipped mylar capacitor—see text (Lafayette 34E67248 or equiv.)
IC1—Silicon monolithic integrated circuit (Motorola MFC4000)
Q1—Pnp silicon transistor (GE 2N5355)
R1—100,000-ohm, ½-watt resistor
R2—47,000-ohm, ½-watt resistor
R3—15-ohm, ½-watt resistor
R4—1000-ohm, ½-watt resistor
R5—4700-ohm, ½-watt resistor
R6—50,000-ohm, audio taper potentiometer with spst switch (Mallory U-33 control with US-26 switch or equiv.)

Intercom Parts

B1—9-V transistor radio battery (Eveready 216 or equiv.)
J1—RCA type phono jack (Lafayette 99E62341 or equiv.)
P1—Single-contact jack for J1 (Lafayette 32E64579 or equiv.)
S2—Dpdt momentary pushbutton switch (Lafayette 30E41167 or equiv.)
SPKR1, SPKR2—16-ohm, 5-in. diameter PM speaker

Misc.—Wire, hardware, perfboard or other grille screening, solder, interconnecting cable, etc.



Build TWOFER-FLEX

Here's a two-for-one BCB project! In addition to trying your hand with a reflex circuit, you wind up with a universal B-plus power supply.

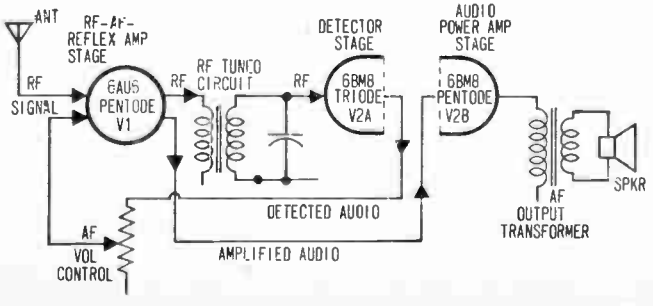
by Charles Green, W6FFQ

☐ Everyone is interested in getting something for nothing. How would you, as an experimenter, like to work with a circuit that gives the performance of four tubes but uses only two? It's easy if you use a reflex circuit, which was popular in the early days of radio when vacuum tubes and components were much more costly than they are now. Experimenting with reflex circuits is still interesting. By constructing our *Twofer-Flex* you can determine first hand how to achieve efficient circuits with fewer components.

Two for One. A tube can simultaneously amplify two different frequencies, such as RF and AF, if proper filtering is used. In this way we make one tube do the work of two.

The *Twofer-Flex* uses the reflex principle in a two-tube broadcast band receiver.

(Continued overleaf)



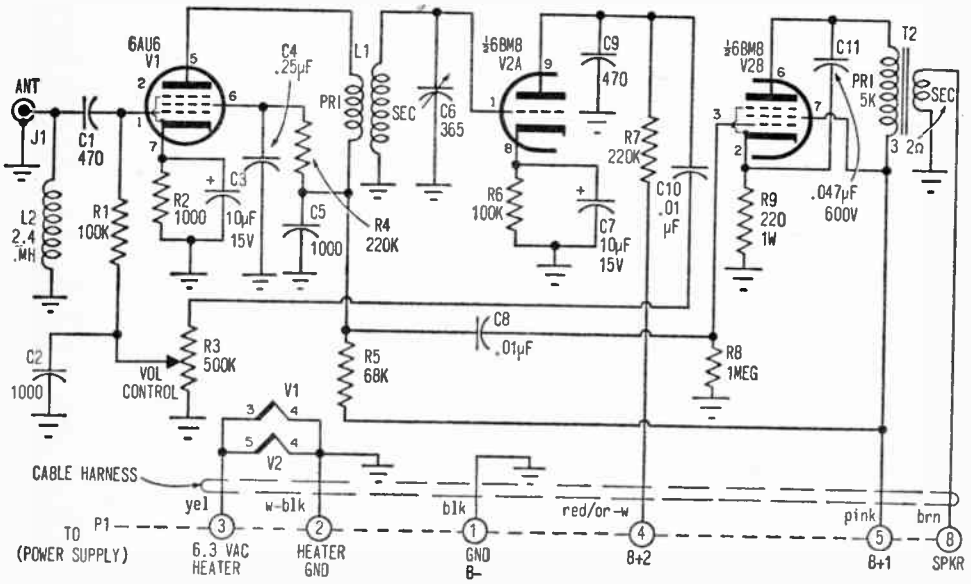
Block diagram showing signal flow and multiple function of tubes in reflex circuit. First tube serves both as an RF and then as an AF amplifier. Second tube serves as detector and output.

TWOFER-FLEX

By referring to the block diagram, you can see that a pentode (V1) acts both as an untuned RF amplifier and as an AF amplifier. The triode half (V2A) of the 6BM8 tube serves as a plate detector and the pentode half (V2B) of this tube is the AF power amplifier, which delivers sufficient power to drive the speaker.

Construction. We built the *Twofer-Flex* on two identical chassis, one containing the power supply and the other containing the RF breadboard. The power supply employs a conventional half-wave circuit, using a silicon diode and RC filtering. In addition to supplying high DC plate voltages, it also furnishes the 6.3 VAC for the tube heaters. Note that the speaker is mounted on the power-supply chassis.

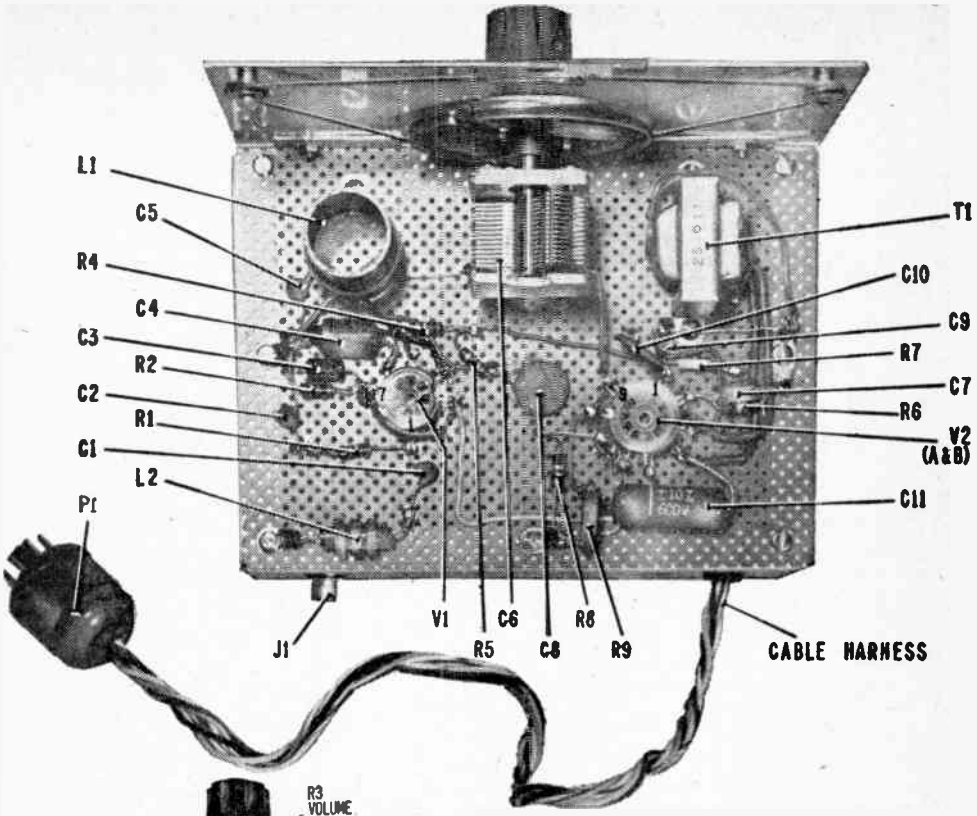
The RF breadboard is constructed on a standard perforated board employing push-in terminals to mount the components to the

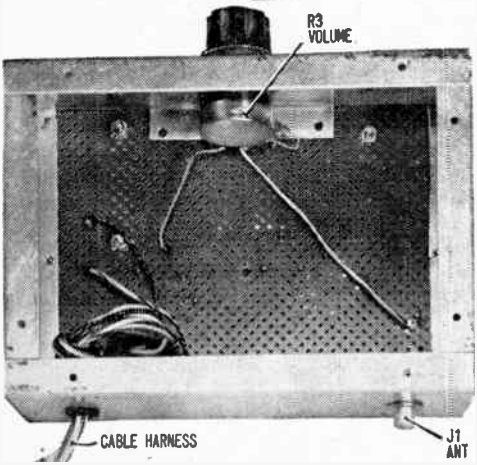


PARTS LIST FOR TWOFER-FLEX RF BREADBOARD

C1, C9—470-pF, 1000-V ceramic disc capacitor
C2, C5—1000-pF, 100-V ceramic disc capacitor
C3, C7—10-uF, 15-V electrolytic capacitor
C4—.25-uF, 200-V paper capacitor
C6—365-pF variable capacitor (J.W. Miller 2111 or equiv.)
C8, C10—.01-uF, 1000-V ceramic disc capacitor
C11—.47-uF, 600-V paper capacitor
J1—Phono jack (Switchcraft 3501F jack or equiv.)
P1—Octal plug with cable connector shell (Amphenol 78R58 or equiv.)
L2—2.4-mH RF choke (J.W. Miller 4666 or equiv.)
R1, R6—100,000-ohm, ½-watt resistor
R2—1000-ohm, ½-watt resistor
R3—500,000-ohm audio taper potentiometer (Mallory U-48-1 or equiv.)
R4, R7—220,000-ohm, ½-watt resistor
R5—68,000-ohm, ½-watt resistor
R8—1-megohm ½-watt resistor
R9—220-ohm, 1-watt resistor
L1—Broadcast band RF coil (J.W. Miller 20RF or equiv.)
T2—Output transformer, 5000-ohm pri. to 3.2-ohm sec. (Allied 54C2064 or equiv.)
V1—6AU6 tube
V2—6BM8 tube
1—7 x 4¼-in. slide rule dial (J.W. Miller SL-16 or equiv.)
1—7-pin miniature printed circuit socket (Lafayette 33T8712 or equiv.)
1—9-pin miniature printed circuit socket (Lafayette 33T8713 or equiv.)
2—Aluminum chassis, 5 x 7 x 2-in. (Bud AC-402 or equiv.)
1—5 x 7-in. bottom plate for power supply chassis (Bud BPA1589 or equiv.)

Misc.—Push-in terminals, knobs, hook-up wire, hardware, solder, etc.





Top and bottom views of RF chassis showing components and layout of chassis for efficient wiring. If your finished unit looks like the author's, it should work fine.

board and to make the circuit connections to them. The full chassis width slide-rule dial, which is mounted on the front of the aluminum chassis base, serves both as a front panel and as an RF shield. Power for the RF breadboard as well as the AF from the output stage of the receiver is conveyed between the two chassis by a cable harness that is permanently wired to the RF board and plugged into the power-supply chassis.

Let's get the hard work done first. Then the balance of the construction project will be easy and will add to the pleasure of building a receiver, learning about new circuits, and achieving a job well done.

RF Chassis. The top surface of the RF aluminum chassis is cut out to provide a clear mounting space for the perforated board containing the components for the RF portion. Cut out the top of the 5 x 7 x 2-in. aluminum chassis, leaving a ½-in. flange all around. Slit the flange on the front edge of the chassis 1½-in. from each end and bend up two tabs, which are used to mount the slide-rule dial, as shown in our photo. Our chassis has two extra ⅜-in. holes in the front of the chassis 1½-in. from each end for future experimentation. These are not required for the *Twofer-Flex* receiver; therefore, it is not necessary to drill them.

Cut a 5 x 7-in. section of perforated board and mount it to the top flange of the chassis,

TWOFER-FLEX

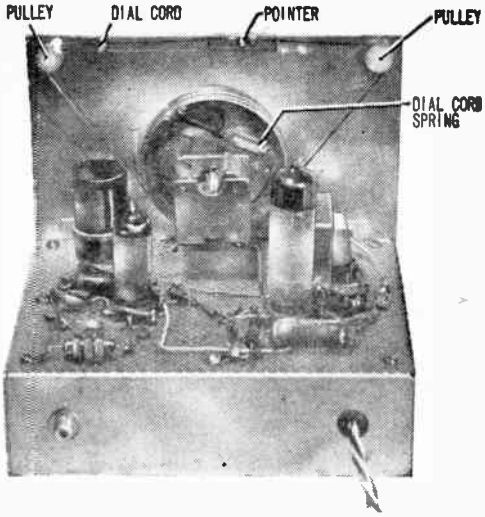
using sheet metal screws. Drill holes, if needed, to mount the receiver components to the perforated board.

Wiring and layout are critical even though the receiver operates in the broadcast band. For best results, follow the photos for the most convenient component layout.

A 2 x 1¼-in. aluminum strip is fastened to the front of the frame of tuning capacitor C6. This assembly is then fastened to a ½ x ½ x 1¼-in. aluminum angle section that has been mounted on the top of the front flange of the chassis. Mounting holes in the angle section to which this assembly is fastened are slotted in order to adjust the position of C6 for proper alignment with the slide rule dial hub.

The tube sockets are mounted on the perforated board with push-in terminals which are then soldered to the socket contact lugs. Position the sockets as shown in photo. If printed-circuit type sockets are not available, standard chassis mounting sockets can be used by cutting off the mounting flange or shell.

Cable Harness. Make up the cable harness by twisting and taping together 18-in. lengths of stranded hook-up wire, using colors shown in the schematic diagrams. Feed one end of the harness through a hole in the rear of the chassis base, knot it so that it will not slip out of the hole, and connect the various colored leads to the components. The free end of the cable harness is soldered to an 8-prong plug following the color code and pin arrangement of the schematic. A word of warning—be sure to slip the protective cover for the plug over the harness before soldering the wire leads to the plug pins.

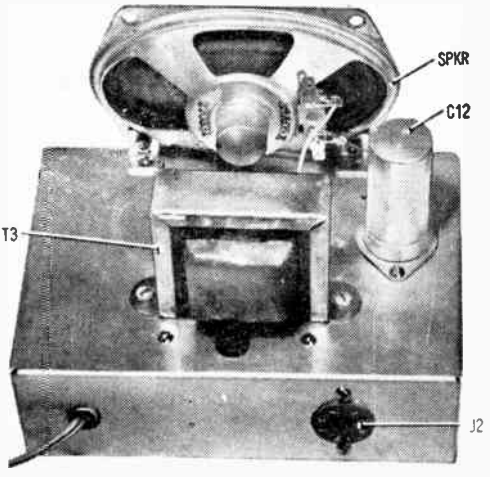


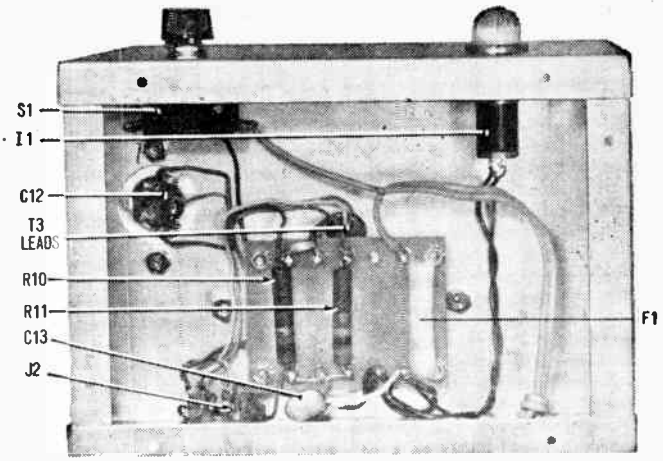
Rear view of RF chassis pointing out the various parts of the dial assembly and detailing the stringing of the dial cord.

Power Supply. The power supply, which is constructed on a 5 x 7 x 2-in. chassis identical to the RF chassis, is protected from accidental shorts by a 5 x 7-in. aluminum bottom plate. Small components are mounted on a terminal board and then to the chas-

PARTS LIST FOR TWOFER-FLEX POWER SUPPLY

C12A, B, C—Triple-section 40-30-20uF, 150-VDC electrolytic capacitor (Sprague TVL-3438 or equiv.)
C13—5000-pF, 1000-V ceramic disc capacitor
D1—1N2070 silicon diode
F1—1-amp pigtail fuse
I1—Neon lamp assembly (Dialco 52-0463 and NE-51H lamp, panel mounting or equiv.)
J2—Octal socket (Amphenol 78R58 or equiv.)
R10—1000-ohm, 2-watt, 10% resistor
R11—10,000-ohm, 2-watt, 10% resistor
SPKR—3 x 5-in. oval PM speaker, 3.2-ohm voice coil
S1—Spst power switch, rotary or toggle
T3—125-V, 50 mA with 6.3-V, 2-amp sec. power transformer (Allied 54C2064 or equiv.)
1—5 x 7 x 2 in. chassis
Misc.—Speaker grille, AC cord, bottom plate, grommets, etc.





Bottom view of power supply with protective cover removed showing location of mounting board containing components.

sis, using ½-in. spacers to raise it from the chassis metal. Locate the heavier components, drill their mounting holes, and fasten them to the chassis using rubber grommets to protect the T3 leads and the AC power cord. The speaker is mounted to the chassis with two ½-in. angle brackets fastened to the front top of the chassis. A piece of perforated board can be used to protect the speaker cone. Wire the components in accord with the power-supply schematic.

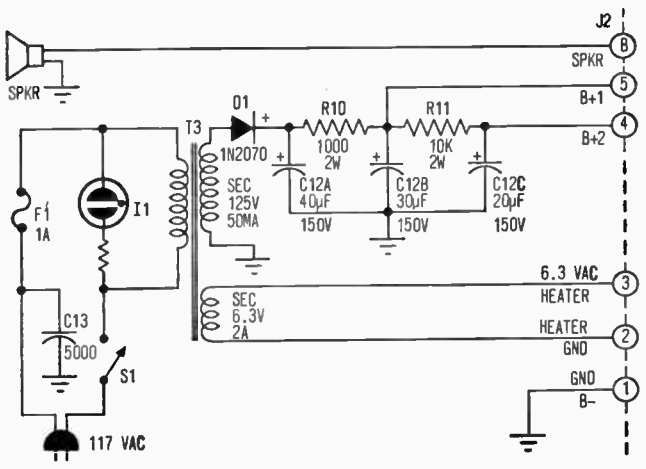
Operation. Now that the hard work has been completed, you're ready to check-out and enjoy the receiver. You will, of course need an antenna, which can be just a 6-ft. length of hook-up wire if you are located near stations producing strong signals. If you are in a fringe area, a good outside antenna and ground will be required.

With the tubes in their sockets, the antenna connected, the harness plugged into the power supply chassis, and the AC cord plugged into an outlet, you are all set to operate the receiver. When the power switch is turned on, pilot lamp I1 indicates AC power is flowing into the power supply. Allow the tubes time to warm up and then check AC and DC voltages with a VOM.

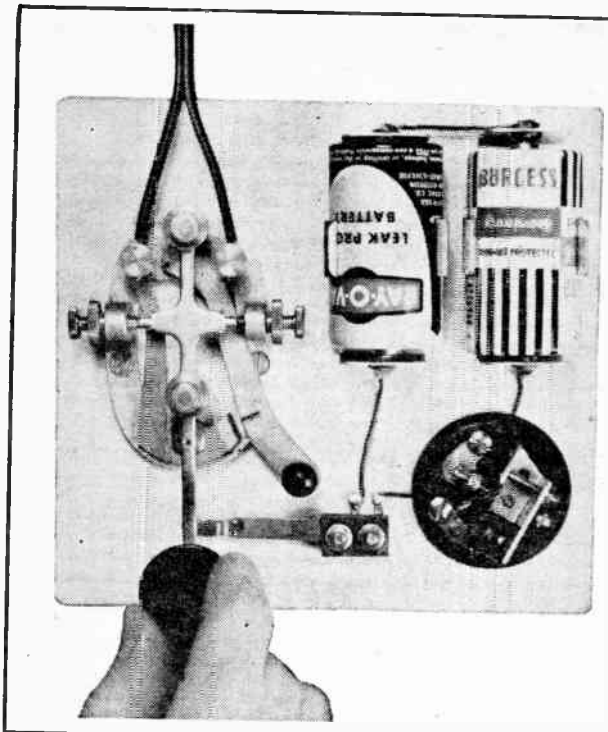
Tune the receiver to a local station and adjust the volume to a suitable level. Since there is only one tuned circuit in the *Twofer-Flex*, selectivity will not be as sharp as in receivers having multiple tuned circuits. The broad tuning and the use of a plate detector, which does not load a tuned circuit as do other types of detectors, accounts for the excellent tone of the *Twofer-Flex*.

The L1 primary winding should be positioned down over the coil lugs for maximum selectivity and minimum coupling. For higher selectivity, regeneration can be achieved by bringing the antenna lead near the top of T2. If there is too much coupling, oscillation will occur, which can be stopped by raising the antenna lead further from the top of the coil. ■

Power supply chassis layout. Parts location is not critical. However, power transformer should be located for free air circulation around it. Twofer-Flex is fitted with cable to be plugged into rear socket.



Power supply schematic. The circled numbers refer to output socket pin numbers. Before plugging in cable harness from RF chassis, make certain that cable wires are connected properly to match connections on this socket.



SIMPLE CODE MONITOR

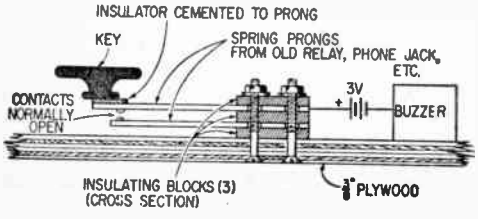
By Art Trauffer

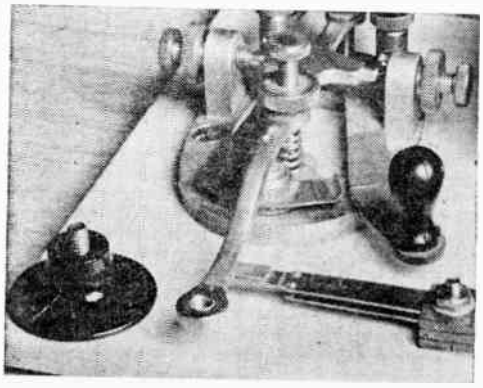
■ Most of us send better code when we can hear what we're sending. This code monitor, which is entirely independent of your receiver or transmitter and has no electrical connections to any of your equipment, is quickly rigged up using only three main components: first, a pair of prongs or reeds from an old phone jack, switch, or relay; secondly, a 3-volt supply (two D batteries); and, finally, a buzzer.

As shown in the photos and cross-section below, the monitor is actuated by the lever of your regular transmitter key. While the regular key operates your transmitter, it also closes the spring prongs of the old relay, activating the buzzer.

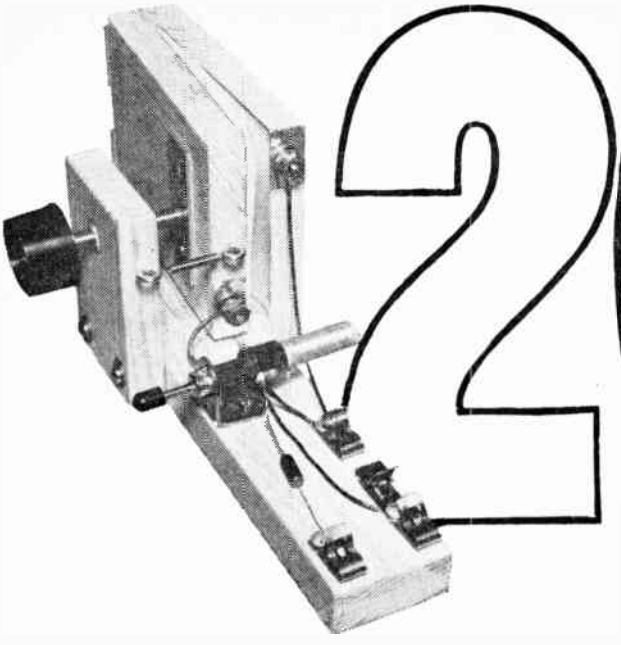
Monitor Mounting. Your transmitter key, monitor spring contacts, buzzer and battery are all mounted on a convenient surface; as shown here, they were mounted on a 6-inch square piece of ⅜-inch plywood. Prongs are mounted under the lever of your key close to the knob. A small piece of insulating material is cemented to the top spring prong to insulate it from the key. Adjust the monitor prongs so that they make contact just before the transmitter key contacts; then wire monitor in series and start sending! ■

The knob of the telegraph key at the right is removed to show how the key actuates the insulated top spring prong to make contact with the bottom prong, thereby completing buzzer circuit. Size of insulating blocks, below, is determined by height of the key.





RADIO FROM THE ROARING 20's



by Art Trauffer

Build an authentic Book Condenser Crystal Set

HERE'S a radio construction project that's just the reverse of what you'd expect. In this one, instead of making the coil and buying the variable tuning capacitor, we'll show you how to make a variable capacitor for use with a commercially made coil. You've got to admit that this is a project with a twist!

The variable capacitor we're going to show you how to build is called a book condenser. Its plates are hinged like the pages in a book, and capacitance is varied by increasing or decreasing pressure on the supports of the plates, which, in turn, increase or decrease spacing between the insulated plates—thus varying the capacity. Though this is a unique approach to varying capacity of a tuning capacitor, unfortunately we can't claim to be its innovator. Way back in the early 1920s, Crosley Radio Corporation (now a division of AVCO Corp. and renamed AVCO Electronics Div.) patented a design for and manufactured book condensers. These were used in the then famous Crosley Model 50, better known as the *Crosley Pup,* a one-tube broadcast band radio receiver.

Our *Book Condenser* is quite similar in basic design to the Crosley condenser. It's also easy to build, since it uses hardwood blocks, aluminum foil, tissue paper, etc., all materials normally found around the house.

The coil, a major component of the radio you'll wind up building upon completion of the condenser, is a standard ferrite cored variable loopstick used in many commercial radio sets, and therefore easily procured as a replacement part.

The How of It. Either the coil or the tuning capacitor shunted across it must be capable of having its parameters varied in order to tune across the band for which the combination has been designed. In this project the capacitance of the tuning condenser is varied by moving the plates closer together without shorting them, for maximum and moving them further apart for minimum capacitance. As the plates are brought closer together capacitance increases; as they are separated it decreases. That's all there is to it. The mechanical construction we've adopted is quite simple and therefore it's easy to make our variable book capacitor.

Making the Book Condenser. Two plates, one fixed in position and the other hinged so that it can be moved closer or farther

away from the fixed one, is how we achieve variation in capacity. The plates for the condenser are made by carefully cementing aluminum foil to one side of each of two wooden blocks. The two blocks are mounted so that the foil sides face one another. A piece of unused airmail stationery, placed between the foil, insulates them.

The thickness of the paper determines maximum capacity—the thinner the paper the higher the capacity. That's why we've specified airmail stationery. This is just about the correct thickness for the plate sizes used to give our *Book Condenser* the capacity required to tune the loopstick coil over the broadcast band. The sizes of the blocks and mechanical details are shown in our photo and in the materials list.

Plate Connections. Be sure to leave a tab of aluminum that can be folded over the edge of the wooden block to make connections to the plates. After the cement has dried, fasten a soldering lug to the tab with a wood screw, making certain that the eyelet of the solder lug is held tightly against the foil by the head of the screw.

The foil must be as flat as possible, so be sure all air bubbles are pressed out before the cement dries and be careful not to tear the foil. A good cement to use is Pliobond. Since wood is more porous than the metal foil, spread the cement on the foil first and then on the wood. Press the foil to the wood immediately after spreading the cement on the wood.

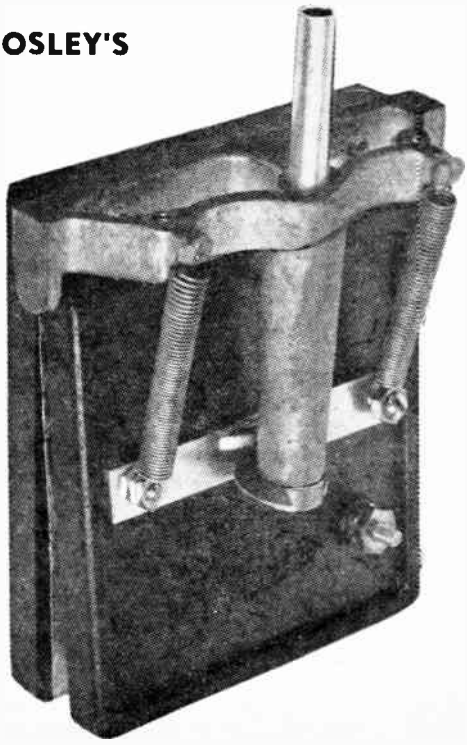
A good way to ensure that the foil will be cemented smoothly is to first place the foil on a table top or other hard, smooth surface, facing *up* the side on which the cement has been spread, and then pressing down the cemented side of the wood block to the cemented side of the foil. After the cement has dried, trim excess foil to the size of the wood blocks. Cement the paper insulator, which has been cut slightly larger than the foil, to the hinged end of the large wooden block that is fixed in position.

When mounting the hinges hold the two wooden blocks together in a vise, or clamp, to ensure correct movement of the small wooden block.

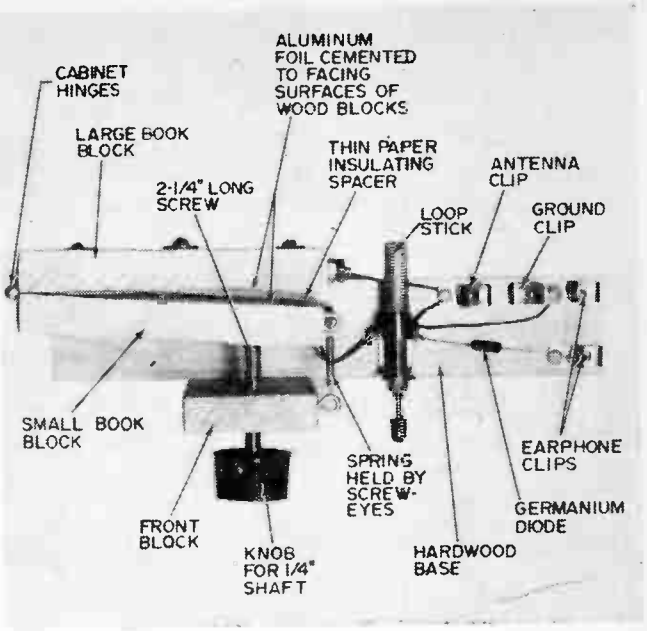
IN THE BEGINNING WAS CROSLEY'S BOOK CONDENSER

The Crosley book-type variable condenser consists of two molded insulating plates coated with metallic foil and hinged together at one edge so that they can be swung toward or away from each other like the leaves of a book. A cam, mounted on a shaft passing through a bearing in the condenser frame, and provided with a knob and dial, offers the mechanical means of adjusting this condenser. A thin sheet of mica is mounted between the plates in order that the capacity may be sufficiently high without making the plates excessively large, and so there will be no danger of short-circuiting no matter how close together the plates are pressed.

—Crosley Radio Corp., 1923



In this case innovation is the mother of invention. On the previous page we showed how one manufacturer, Crosley, made their commercial Book Condenser from metal and molded insulation. We've duplicated it with wood and aluminum foil. This top view of a complete radio shows its construction as well as location of all major components.



A screw or threaded rod, approximately 2¼ in. long and having fairly heavy threads, is threaded through the Front Block to exert pressure on the metal strip fastened to the small wooden block. Turning the knob clockwise causes the screw to change the length of the screw that projects beyond this Front Block. This in turn moves the Small Book Block closer to the Large Book Block.

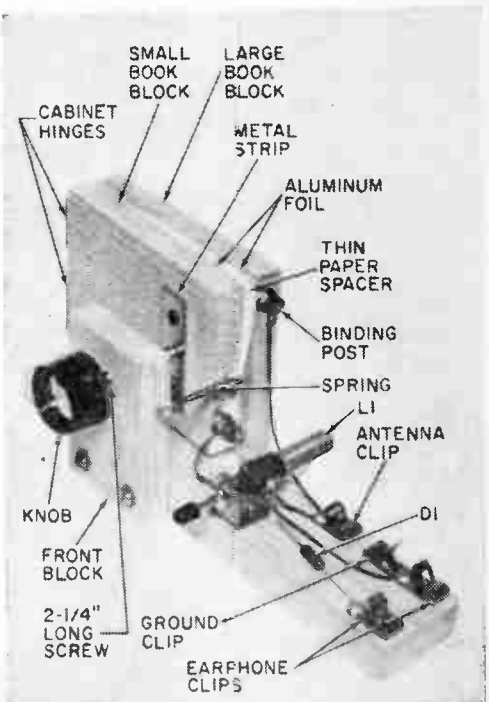
When the screw is turned counterclockwise, the part of the screw that moves the Small Book Block is shortened. The Small Book Block is pulled away from the Large Book Block by the spring stretched between the Front Block and the Small Book Block. Small screw eyes, one in the free end of the Small Book Block and one in the end of the Front Block that is adjacent to the free end of the Small Book Block, hold this spring in position.

Now the Coil. Remove all but 80 turns of wire from the loopstick coil to adjust its inductance to permit tuning the broadcast band with the capacitance of our Book Condenser. Mount this coil assembly on a 1 x 1 x ½-in. metal bracket with the ferrite core adjusting screw facing the front of the radio and fasten a small knob on the adjusting screw. You may find slight changes in the position of the core will improve the performance of the receiver.

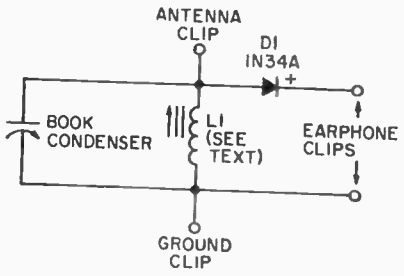
Connect the Book Condenser, coil, and crystal diode as shown in the schematic.

Enjoying Book Condenser Radio. Since there are no amplifier stages in this radio,

Just in case top view may not reveal all intimate details of construction of our Book Condenser we've included this oblique view. It's really a very crude approach by comparison with commercially produced ones even though they were made way back when radio was in its infancy.



RADIO FROM THE ROARING 20's



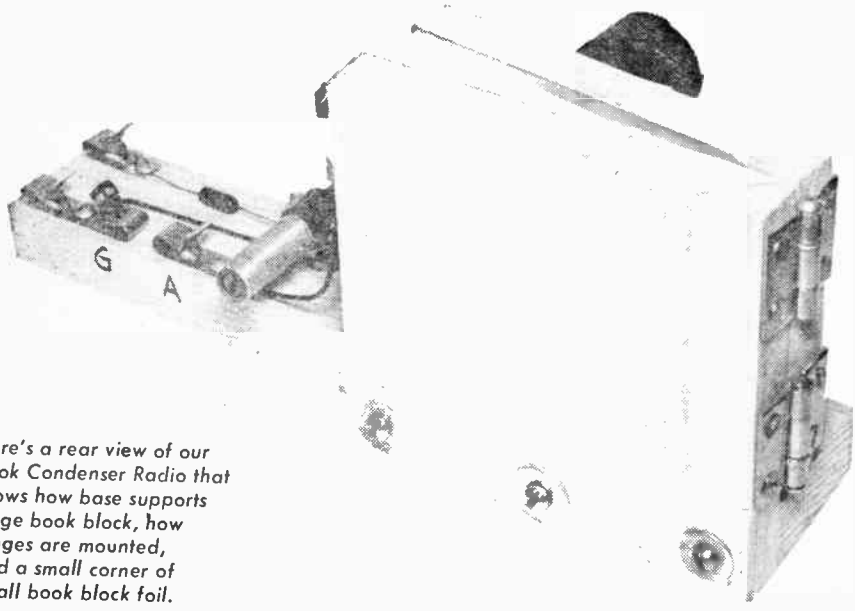
Back in the beginning we had solid-state radios but then they were called crystal sets. Note simplicity of circuitry.

BILL OF MATERIALS FOR BOOK CONDENSER RADIO

D1—Germanium diode, type IN34AS, IN60, IN82A, or IN295
L1—Variable loopstick (Lafayette 32E41064 or equiv.)
4—Fahnestock clips, medium size (Lafayette 32E71028 or equiv.)
1—Base, hardwood, 8½ x 1½ x ¾ in.
1—Block, hardwood, 3 x 2 x ½ in.
1—Small book block, plywood or hardwood, 4 x 3 x ½ in.
1—Large book block, plywood or hardwood, 4 x 3¾ x ½ in.
2—Brass cabinet hinges, 1 x 1 in. (usually available with required brass flathead screws)
1—Long screw, ¼-28NF x 2¼ or equiv.
1—Brass or polished steel metal strip, 2 x ½ in.
1—Spring, 1 in. long x 3/16 in. diameter
1—Knob for ¼-in. shaft
2—Screw eyes, ½-in.
Misc.—Aluminum foil, paper spacer, ½-in. round head brass wood screws, 1¼-in. round head brass wood screws, washers, wire, glue, solder etc.

it's important to use a long antenna and good water-pipe ground in order to collect as much signal as possible for the set. Since the output is high impedance, you must use either high-impedance magnetic or crystal headphones on the output.

Because the Book Condenser Radio has a simple single tuned circuit, it will not tune sharply, and therefore will receive only those stations whose signal strength is high and that are widely separated from other nearby stations. Strong local signals will be received best. If you are located near several powerful stations, this simple, broad-tuning receiver will make an ideal AM tuner for your hi-fi system. ■



Here's a rear view of our Book Condenser Radio that shows how base supports large book block, how hinges are mounted, and a small corner of small book block foil.

Confessions of a solid-state circuit sleuth

or—how beautiful life can be when you build our continuity tester

by John McNarney

MOST recently designed VOMs need to have built-in electronic movement protection. It's meant to guard the fragile, taut-band meter movement from the aftermath of accidentally trying to measure volts when the meter's selector knob tells you to read current. But what about those day-to-day thumps, thuds, and jars accumulated while your VOM tries living in a tool box? Or, how 'bout your VOM taking an occasional pendulum-like swing from the ends of your test leads. Followed, of course, by a fast trip to the floor when both leads jerk from their sockets.

Meter fatalities may not always be so spectacular, but it's another matter to an ever-famished wallet. And when a VOM finds itself hung across everything, from the switching circuit of the attic fan to the field coil on the sump pump, accidents are sure to occur a lot more frequently. For those around-the-house jobs where you've only got to check the circuit's continuity, we introduce you to *CON-TEST*, our faceless, scaleless continuity tester.

Our *CON-TEST* won't give you a voltage, current, or resistance *reading*. But it can surely check vacuum-tube filaments, auto fuses, power supply transformers and chokes, and heating elements from electric broilers or hotplates. Fact is, it's sensitive enough to handle most point-to-point testing where element continuity, rather than an exact resistance reading, is your unknown variable.

Since *CON-TEST* has no meter movement to damage, it's rugged enough to survive in a handyman's tool box. And with this beeper in your pocket, you avoid the need to juggle a delicate meter and two probes on your knee while crouching behind the kitchen range or balanced on a stepladder.

Budding radio amateurs also take to our tester, and for good reason. By connecting a key in place of the test leads, our ham has a very realistic practice oscillator for learning code! Between wrist-twister sessions, and after he's earned his ticket, our novice happily finds that his tester leads a double life as it earns its keep on a variety of household maintainence chores.

Total cost is less than $4.00, and it can be assembled in an evening with no danger of missing the late show.

Cheapy Beepy. *CON-TEST* (for Continuity Tester, see?) keeps costs to a minimum by having its panel serve as a chassis. Starting with the speaker, all parts except both transistors, and the capacitor, can be assembled directly on the front panel. The speaker opening was cut for a 2-in. speaker; it's about 1-in. high by 1½-in. wide. Size of opening is not critical.

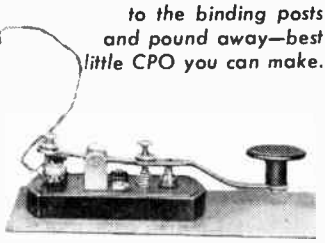
The author home-brewed his battery holder from light aluminum stock and shaped to enclose a Burgess 2U6, or equivalent, 9-V transistor battery. No attempt was made to search the spare parts collection for subminiature parts. An alternate subminiature potentiometer with *on/off* switch is in-

Confessions

cluded in the Parts List. This pot eliminates cutting 'n' filing chores for the slide switch.

Both transistors and the 0.02-μF capacitor are mounted on a board approximately 1¾ x 1¼ in. cut from ⅛-in. masonite or hardboard stock. This assembly is supported on two speaker bolts. If you don't have masonite or hardboard in your workshop, old reliable perfboard makes our construction scene just as well.

Your choice of transistors is not critical. For transistor Q1, the author found a bargain-basement 2N170 to his liking. And after thumbing through an electronics parts catalog, he tried several universal npn replacements jobs from those 20-for-a-buck assortment bags, with equally good results. Transistor Q2 can be any pnp power pusher, so long as it's happy with a 9- or 12-volt supply. In spite of the awkward size of Q2's TO-36 case, we found the 2N173 equivalent shown worked AOK in this circuit. The alternates given in the Parts List for Q2 would be just as satisfactory; any transistor enclosed in a TO-3 package would be smaller and easier to fit.

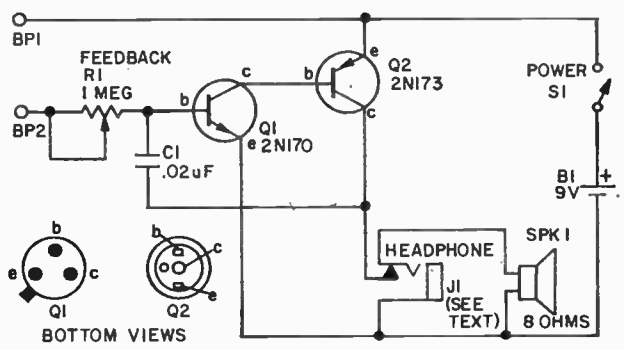


CON-TEST will earn its keep in your ham shack. Just connect a key to the binding posts and pound away—best little CPO you can make.

Log Taper Turn On. Resistor R1's a you-seen-'em-once-you've-seen-them-all ½-watt carbon potentiometer. Controlling circuit feedback, this 1-megger helps produce a low audio tone from the speaker, with minimum drain on the battery. Obviously you'll need less resistance as the battery ages, or if you're testing a high-resistance circuit. While your family's ham cures his code by using our *CON-TEST* as a practice oscillator, potentiometer R1 serves as pitch control. Don't be too surprised if his speed sweetens considerably, for a very realistic effect can be produced by our baby beeper!

It was found that small binding posts work better in place of the usual jacks, as they lock solidly on the test leads. They're also more convenient for inserting connecting wires from a Morse Code key.

(Continued on page 103)



PARTS LIST FOR CON-TEST

B1—9-V Battery (Burgess 2U6 or equiv.)
BP1, 2—Binding posts, one red, one black (Lafayette 99E62333 or equiv.)
C1—.02 µF, 50 VDC disc capacitor (Lafayette 32E09491 or equiv.)
J1—Phone jack, closed-circuit (Lafayette 34E60668 or equiv.)
Q1—Transistor, npn replacement type (Lafayette 19E27029 or equiv.)
Q2—Transistor, pnp power replacement type (Lafayette 19E15032 or equiv.)
R1—1,000,000-ohm, corbon potentiometer (Lafayette 99E63521 or equiv.)
S1—Slide switch, spst (Lafayette 34E37035 or equiv.)
SPK1—8-ohm, 2-in. speaker (Lafayette 99E60630 or equiv.)
1—Case, 5⅛ x 2⅝ x 1⅝-in. (Lafayette 99E80756 or equiv.)

Misc.—Hardware, solder, wire grille, solder lugs, wire, etc.

build the . . .

STOP LIGHT STROBOSCOPE

by Steve Daniels, WB2GIF

It didn't take you very long to discover that a little NE-2 neon lamp strobe may be OK for checking the speed of your turntable, if you don't mind working with it in a darkened area and then squinting. But it just isn't satisfactory for checking motors, such as those used in appliances, or those running at odd speeds.

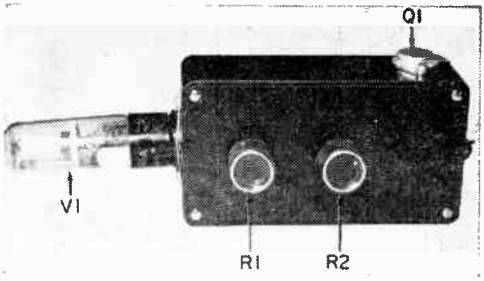
Our StopLight Stroboscope, which combines a single transistor and a Strobotron flashing tube, will meet most of your speed-determining needs. True, its output is not as

Here's a compact stroboscope that takes only one evening to build and many more to enjoy!

STOP LIGHT STROBOSCOPE

brilliant as the expensive units using Xenon lamps. However, its simplicity of design and moderate cost will more than offset this major difference and certainly make this a worthwhile project to build.

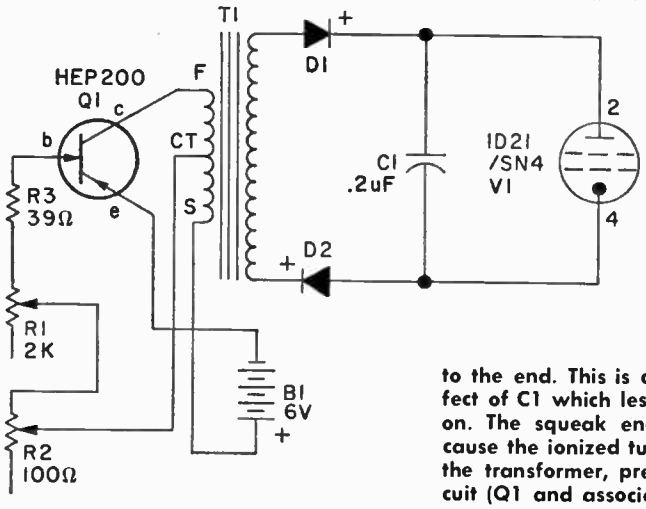
How It Works. Transistor Q1, acting as an audio oscillator, generates AC voltage in the primary of transformer T1. The secondary steps up the voltage which is rectified by diodes D1 and D2 to supply DC current to capacitor C1. When the voltage builds up high enough V1 fires, discharging C1 and the whole process is repeated. The frequency and output voltage of the oscillator is controlled by varying the base bias of transistor Q1 through R1, R2, and R3. This varies the DC pulsing, which, in turn, determines the charging of C1 and the rate of flashing of the Strobotron tube, V1.



All wired up and ready to go, the StopLight Stroboscope looks simple enough to wire in one evening. Motorola transistor can be mounted inside box—but looks exotic outside.

Note that transformer T1, designed to step down the 117 VAC (normally applied to its primary) to 6.3 V in its CT secondary, is connected in just the reverse manner. In our StopLight Stroboscope the 6.3V CT primary is the tank coil of the oscillator, and the normally 117V primary becomes the secondary, in our circuit, providing a step-up ratio of better than 18.5 to 1.

How to Make It. We used a 6¼ x 3¾ x 1⅞-in. molded black bakelite case with



Hearing is believing! You can verify the "How It Works" notes on this page by placing your ear next to the plastic box of the unit. You'll hear an audio tone that will stop with each flashing. With the stroboscope set for a slow flashing rate, you can detect a slight tone increase from the beginning of each squeak to the end. This is caused by the loading effect of C1 which lessens as a charge is taken on. The squeak ends when V1 flashes, because the ionized tube is a short circuit across the transformer, preventing the oscillator circuit (Q1 and associated parts) from working.

PARTS LIST FOR STOPLIGHT STROBOSCOPE

B1—6-V battery (Eveready #731 or equiv.)
C1—0.2-uF. 600-V capacitor
D1, D2—1.0 Amp, 1000 PIV silicon diode rectifier (International Rectifier 5A10 or equiv.)
Q1—HEP-200 Motorola transistor
R1—2000-ohm, linear taper potentiometer (Allied 46E3785 or equiv.)
R2—100-ohm, linear taper potentiometer (Allied 46E1102 or equiv.)
R3—39-ohm, ½-watt resistor
T1—6.3-V @ 1.5 amp CT filament transformer (Allied 54E1419 or equiv.)
V1—1D21/SN4 Sylvania Strobotron tube ($7.30 from Allied Radio)
1—6¼ x 3¾ x 1⅞-in. molded plastic box and panel (Allied 42E7885 or equiv.)
1—4-prong tube socket (Allied 47E0024 or equiv.)

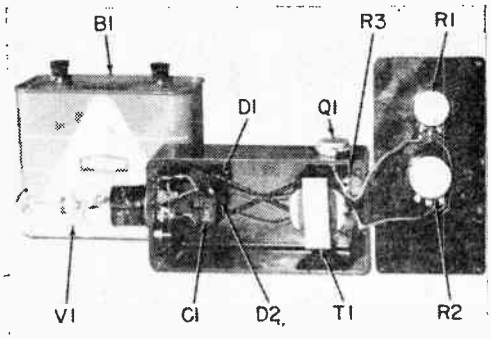
Misc.—Tie strips, knobs, hardware, hookup wire, solder, etc.

matching panel to house our StopLight. Drill a 1 3/16-in. hole in one 3¾ x 1⅞-in. end to mount the 4-prong socket for the Strobotron. Use a circle cutter in a slow-speed drill to cut this hole. Drill holes to mount the transistor in the right-hand 6¼ x 1⅞-in. side of the case near the end opposite the one in which the Strobotron socket is mounted.

Transformer T1 is mounted in the bottom of the box near the transistor terminals. A three-terminal tie strip is also mounted on the bottom but near the Strobotron socket. Resistor R3 is mounted to a tie strip fastened to the end of the box opposite the one in which the socket is mounted.

Potentiometers R1 and R2 are mounted centered on the panel of the box in the clear space between the 4-prong socket and transformer T1. Battery leads are brought out through a small hole in the end opposite the socket. The battery lead is fabricated by twisting together two pieces of different colored hook-up wire. Solder alligator clips to the leads on the ends outside the box.

Be sure to wire the potentiometers so that speed increases with clockwise rotation of R1 (course adjustment) and with counter-



With the front cover removed, the StopLight Stroboscope reveals all of its electronics. If you care to, mount the parts in a larger case and include battery holders for four D cells. Sure as shootin', the D cells will not last as long as the Eveready #731 job listed in the Parts List, but they will do the job just the same—and in one small portable box, too!

clockwise rotation of R2 (fine adjustment). If either control operates just the opposite, reverse the leads to it.

Testing StopLight. After mounting and wiring all of the parts in accord with the schematic, double-check the wiring, making sure of the polarity of diodes D1 and D2. Plug the Strobotron in its socket.

Before connecting the battery, set the controls at the midpoint of rotation. Prolonged operation at highest speed could damage the Strobotron. As soon as the battery is connected the Strobotron should start to flash off and on. Rotate R1 full counter-clockwise and the flashes should slow down.

It may be difficult to notice any change created by the fine adjustment control unless you are actually observing a rotating device; then it will appear to stop the motion if the coarse control has been adjusted to the point where the motion appears to slow down almost to stopping. The flashing lamp should be brought as close as possible to the rotating object in order to shine as much light from the lamp onto the rotating object. However, remember that the Strobotron tube, V1, is made of glass. Don't jam it into a moving fan blade or gear drive.

Another operation note: do not run the StopLight so that the Strobotron tube burns continuously.

Calibration. There are several ways that can be used to calibrate the controls. One method would be to connect a frequency meter across the Strobotron and read the frequency directly which would be the same as the speed of rotation. If a frequency meter is not available, you may use an oscilloscope that has a calibrated time base. Connect the oscilloscope the same as the frequency meter was connected and count the number of pulses displayed on the oscilloscope screen. This will give an indication of the frequency.

If these lab instruments are not available to you, it's possible to shine the flashing lamp on a turntable or other rotating device whose speed is known and then adjusting the controls until the device appears to stop. This will then be your major calibration point.

Another way to calibrate your StopLight Stroboscope is to use an audio oscillator, amplifier, and speaker. Set the oscillator to a low audio frequency and shine the flashing lamp on the cone of the speaker. When the speaker seems to stop its motion, the flashing rate will be the same as the frequency of the audio oscillator.

Of course you can always borrow a General Radio Strobotoc, if you are fortunate enough to know some one who owns one and will be agreeable to your borrowing it.

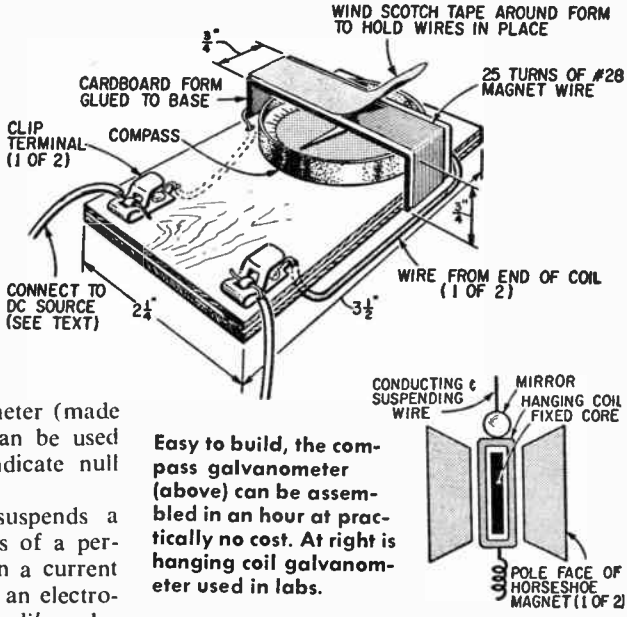
A word of caution: remember when you have apparently stopped the motion of a rotating device by shining your StopLight stroboscope on it, the device is still running full speed, so keep your fingers away. ■

COMPASS GALVANOMETER

by T. A. BLANCHARD

Many electrical measuring instruments today are based on the design of the d'Arsonval *String Galvanometer*, but substitute a needle-suspended coil riding on jeweled bearings for the hanging coil employed in the original precise lab instrument.

The galvanometer is not often used to measure quantity of current flowing in a circuit, but rather to indicate the polarity and presence of small currents by comparison to null methods. The compass galvanometer (made from the illustration at right) can be used with a Wheatstone bridge to indicate null points.



Easy to build, the compass galvanometer (above) can be assembled in an hour at practically no cost. At right is hanging coil galvanometer used in labs.

The d'Arsonval instrument suspends a small coil between the pole faces of a permanent *horseshoe* magnet. When a current flows through the coil it becomes an electromagnet and its *like* poles repel the *like* poles of the horseshoe magnet, thus causing the coil to turn on the connecting wire. The strength of the current through the coil determines the extent of the coil's rotation.

A small pointer attached to the moving coil registers on a curved dial, or a tiny mirror is attached to the galvanometer string. A beam of light is aimed at the mirror, bouncing the beam off to a wall screen or chart to give great magnification of tiny current changes in a darkened room.

Making A Simple Galvanometer. A small amount of insulated magnet wire, any Boy Scout pocket compass and a 2¼ x 3½-in. scrap of plywood is what you need to make the compass galvanometer. Cut a strip of cardboard ¾-in. wide and 3¾-in. long. Score the cardboard ¾ in. from each end, with a dull knife blade and crease so the cardboard form resembles a C or bridge shape. Now glue the cardboard to the edges of the wood base. Do not use tacks!

Bind the cardboard with a rubber band until glue or cement dries. Wind 25 turns of #28 magnet wire around the cardboard. Heavier wire and fewer turns will work, too, with a slight drop-off in sensitivity.

Scotch tape is wound around the finished coil to keep the wire turns in place. Connect the ends of the coil to screw terminals or clips. Slip the compass under the coil in a position where its needle comes under the coil and parallel to the coil turns.

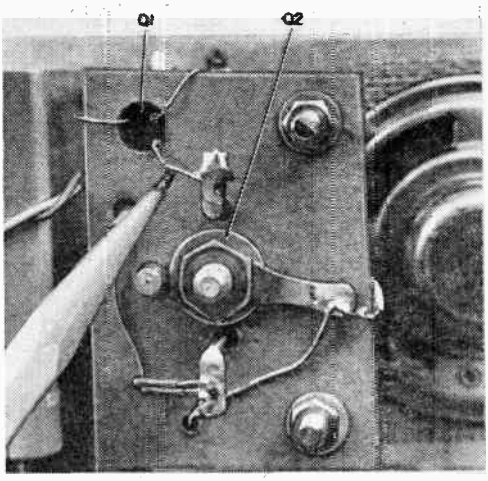
Connect the galvanometer in series with a flashlight battery and bulb, a buzzer or a toy motor, etc. When the circuit is closed, the compass needle will be drawn so that it is at right angles to the coil. A slow swing of the needle indicates the circuit is drawing little current. A rapid swing denotes an increase in current flow.

To show how sensitive this simple galvanometer is, connect what appears to be a dead flashlight cell across the terminals, immediately breaking the circuit. The compass needle will spin at a merry clip, indicating there is still some life in the "dead" cell. ■

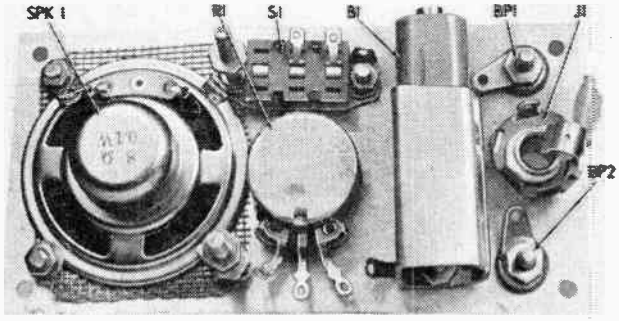
Confessions

Continued from page 97

Wire Rapping. Needless to say, the wiring is straightforward. You can get a detailed picture from our schematic. The battery's negative side, a speaker terminal, one side of the optional jack, and the emitter of Q1 are all connected to the front panel. If your ear lobes don't take kindly to headphones, the phone jack can be omitted.



With careful lead placement, transistor Q1 can be mounted to masonite panel with single ¼-in. hole. Pencil's pointing to Q1's collector lead; it is soldered directly to base pin of transistor Q2. Transistor Q2 is bolted to board. Solder lug underneath bolt is Q2's collector lead.



Almost all parts are mounted to front panel. Only transistors Q1-2, capacitor C1 sit on masonite board. Board's attached to front panel with 1½-in. screws which also hold speaker, grille to front panel. Exercise caution when mounting binding posts BP1-2 to panel; take care not to crack plastic insulators as you tighten down mounting nuts with hex wrench.

The remaining speaker terminal's connected directly to Q2's collector terminal. Power transistor Q2, and the capacitor, can be wedded to your choice of board before uniting this assembly with the panel. Metal-to-metal contact between Q2's case and the panel or potentiometer should be avoided.

As you can see from our photo, all connections excepting one capacitor lead are easily accessible, and can be soldered with the circuit board in place. Transistor Q1 and the battery snap were installed last because their leads are the most fragile.

The current you induce through a component being tested will run between .02 mA and .06 mA. You should be able to wring at least 30 hours of life from the battery as drain will average about 7 mA throughout its life. If you can bear to lose a little audio, your *CON-TEST* will operate with as little as 5 volts from Battery B1. ■

Ask Hank, He knows

Continued from page 16

Uncle Sam's Good Book

How can I buy government-published books about electronics? I understand they're very good and also cheap.

—T.S.E., Baltimore, Md.

Write to Sup't. of Documents, Government Printing Office, Washington, D.C. 20402. Ask for catalog PL-82. Also ask to have your name placed on the mailing list to receive announcements of Uncle Sam's latest publications.

Floatable Mobile

Can I use a CB walkie-talkie on board a ship when on a cruise?

—G.E.S., Miami, Fla.

Of course, provided you have the radio officer's permission. But, when you're within three miles of the U.S. shore be sure you have a CB license. Beyond the three-mile limit, you're in no-man's-land. But, any licensed CB station communicating with you will undoubtedly be

ELECTRONICS HOBBYIST

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violating CB international regulations. And if you louse up the ship's navigation or radio system, the captain might move you from your stateroom to the brig. Leave your rig at home and enjoy!

TV Scope

I have an old television set. All the tubes are OK, and all but the tuning circuit is in good condition. Is it possible to convert the set into an oscilloscope? I have heard it can be done, but no one seems able to supply any information.

—F. E. K., Carroll, Iowa

While it could be done, the cost would probably be more than that of a scope kit complete with wiring and assembly instructions. Furthermore, why build a complicated piece of equipment with used parts? We suggest you pick up a Heath catalog and try a kit. It's more fun.

Penguin DX

I was told by a friend that there is a radio transmitting station at the Antartica. He thought it was part of the Scientific Research Base. I said I never heard of such a thing. What is the word? He said that it could be received with a good SW set.

—S.F.T., Someplace, U.S.A.

Undoubtedly there is. They have no land line telephone service to the U.S. down there. And smoke signals don't carry very far. ■

TVI Times Three

I live in an apartment complex. Three hams live in the same building as I do. The complex has a master antenna with a very poor filtering system. I know for a fact that all of these hams are legal but my TV reception is still very poor on almost all stations, high and low. Could you please give me information on either building or buying a filter for my TV set and FM radio?

—R.A.M., Norwalk, Conn.

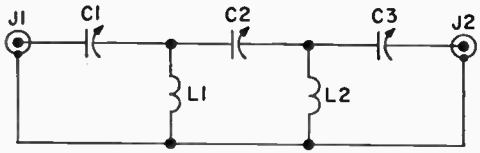
If spurious emissions of the ham transmitters are actually very low, TVI (TV interference) is the fault of your TV set. The strong transmitter signals overwhelm the front end of your TV set. You can add a degree of protection by installing a high-pass filter (available at parts stores and most TV dealers) at your TV and FM sets' antenna terminals. Such a filter is cheap. If it doesn't do the job, you can use an expensive CATV type filter (your parts store can order one for you), or buy a better TV set.

Front End Frazzle

What filter can I use between my 146-175 MHz VHF monitor receiver and my VHF antenna to get rid of FM BC stations?

—H.G., Detroit, Mich.

You've got a can of worms. Your problem is a lack of front-end sensitivity. Try building a high-pass filter using the circuit shown in the diagram. J1 and J2 are SO-239 coaxial recep-



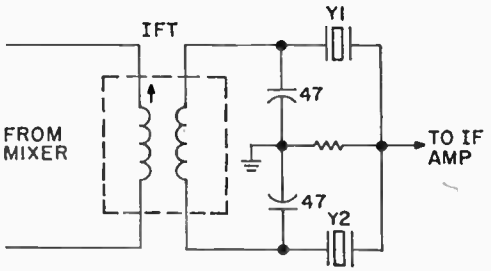
tacles or phono jacks. Coax to the antenna is connected to J1 through a matching plug. The receiver A-G terminals are connected to J2 through a short length of coax and a plug that fits J2. Capacitors C1, C2 and C3 may be 8-50 pf ceramic trimmers. L1 and L2 are 1- to 2-turn coils made of #12 solid copper wire wound on a pencil form. Put all of the parts in a small metal box. To tune the filter, get your hands on a VHF signal generator. If you don't have one, adjust C1, C2 and C3, and the spacing of the coil turns until you eliminate the FM BC stations and still get good reception in the 146-175 MHz band.

Crystal Filter

I would like to know if a Heathkit Q multiplier, Model GD-125, could be converted to an IF of 1681 kHz. If it can be done, tell me what modifications are necessary.

—D.T., Lykens, Pa.

Unfortunately, Q multipliers are more effective at lower frequencies and work well at 455 kHz.



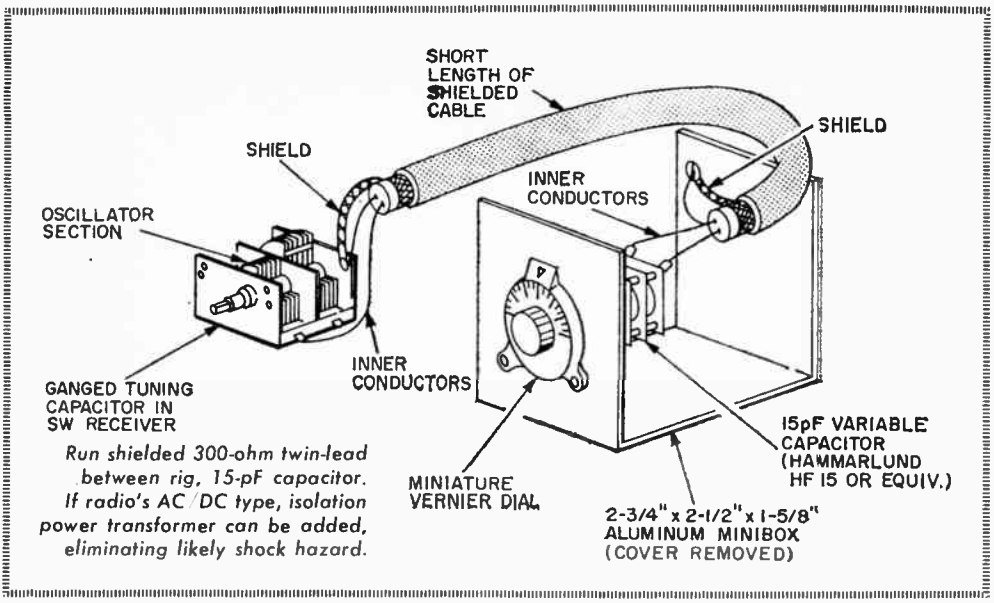
You might try modifying your receiver by adding a crystal filter, as shown in the diagram. Crystals Y1 and Y2 should be ground for approximately 1-1.5 kHz above and below 1681 kHz. You'll probably have to order them direct from a crystal manufacturer. ■

Give Receiver a Lift

continued from page 82

back and forth from their original position, for maximum signal level. Then tune in a weak SW signal, such as the weakest WWV transmission, and recheck these adjustments. If your set boasts an S meter, all the better; make your adjustments for maximum S reading on the meter.

Adding Bandspread. One other disadvantage of the lower priced SW receivers is a



lack of bandspread tuning, a most useful assist in separating closely spaced stations at the higher frequencies. With a little patience, and a few parts and tools you can also add this feature to most economy model SW receivers. All you need in the way of parts is a 15-pF variable capacitor, an inexpensive vernier dial, a small aluminum box and a short length of low capacity, shielded two conductor cable. Once you've mounted the capacitor and dial in the aluminum box as shown in our drawing, you're ready to hook it up. Locate the oscillator section of the tuning condenser gang in your SW receiver and connect this externally mounted variable capacitor in parallel with this section of the set's tuning gang. Ground one end of the shield from the interconnecting cable to the common ground bus in your SW receiver and the other end of the cable shield to the box used to house the external 15-pF capacitor. Connect one end of the two conductors of this shielded cable to the two connections of the oscillator section of the ganged tuning capacitor in your receiver, and to the two connections of the 15-pF variable capacitor in the aluminum box. Keep this piece of cable as short as possible.

To use the bandspreading feature you've just added to your set start off by setting the new capacitor's dial to zero and tune the receiver in the normal way. Once you tune in a station (in all probability you'll get several stations interfering with one another in a congested portion of the band), you then use the bandspread dial to improve the signal by separating these stations near the same frequency. With a little practice you'll soon learn how best to use the band spread to your advantage.

Now that we have given you tips on how to get into the swing of things better with your economy model SW receiver—go to it, have more fun out of SWL. ■

Piggyback AMP

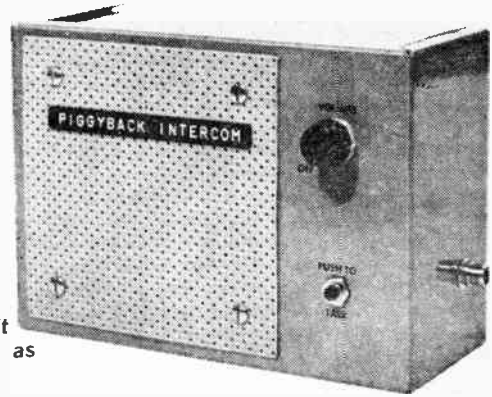
Continued from page 86

printed circuit board is used as is; however, the input connections are modified as shown in the schematic. Actually, all that's done is to connect the volume control ahead of the amplifier at its input. Volume control R6 can be a potentiometer from 25,000 to 50,000 ohms. If the Piggyback Amp is to be used as a signal tracer, it will probably be connected into DC circuits and therefore a DC blocking capacitor should be used ahead of R6 as shown by the dotted lines as C6 in the schematic; in 0.47-μF capacitor rated at 200 or 400 VDC is adequate.

With no signal the amplifier idles at approximately 3.5 mA, peaking up to almost 100 mA at full power ouput. An ordinary transistor radio 9-volt battery such as type 2U6 can be used, though larger batteries naturally give longer life. For permanent

installations a small 117-VAC power supply such as a 9-V battery elminator for transistor radios, can be used. Under no conditions should the voltage applied to terminal 3 of the IC exceed 9 volts.

Unlike many IC power amplifiers, Piggyback Amp is rock-stable—provided the unit is built as shown in our photos using the layout as designed into the printed circuit board. ■



In case cut-out for speaker opening isn't perfectly round use a piece of perfboard as we did to make unit look professional.

. . . Gives the Sweetest Sound

Continued from page 72

ary leads and the leads running to switch S2. Don't forget to run a ground lead from amp to supply.

After you've soldered and screwed the amp and power supply in place, fasten the power transformer to the baffle's bottom with a couple of wood screws. A 3-lug terminal strip should be placed under a convenient transformer mounting foot to make your chores easier.

Having consulted our astrologer-in-residence, we decided to buy a handful of ¼-in. round-head screws for those remaining mounting jobs. While you're hanging around the hardware store, buy four #6 fiber washers. They'll reside at each corner of the amp between the printed circuit board and the speaker cabinet. It wouldn't be especially smart if you crack your amp's PC backbone as the mounting screws are tightened. And as a final cutting remark, our astrologer told us to dress the amplifier output wires to a reasonable length for future connection to the speaker.

You've now reached the last step in decorating our tonal tortoni. Handle your Coaxial Caruso with TLC as you mount it in place. Finally, garnish the speaker lugs with amp output leads. Mamma mia, bel canto! ■

Super Booster

Continued from page 63

your area, it is possible that its signal strength will be so greatly boosted that it might swamp the receiver when listening to a weak signal on the other end of the dial. If this occurs, simply detune the booster away from the strong local until its interference is gone. While this might sacrifice some gain on the desired station, the actual loss will be slight.

It is possible that the booster's output might radiate back into the input (particularly when using a loopstick coupling coil). You'll know when this happens—the booster breaks into self-oscillation—as evidenced by receiver blocking, or signals being tuned in and then "lost" when C1 is adjusted. If this happens, position the booster as far away from the receiver as possible. And, keep an external antenna, if used, well away from the receiver and the booster's output. Do this, and under normal conditions, there should be no instability.

Under certain conditions Super Booster will provide an additional benefit which should not be construed as improper operation. Some inexpensive rigs are highly prone to marine band "image" interference when signals at the high end of the BC band are received. The booster, by providing tuned preselection, will eliminate or supress these images while providing signal amplification. Do not assume the loss of image interference means reduced sensitivity; actually, the desired signal will be getting full boost while the image signals are squashed. ■

Flash Master

Continued from page 58

also be mounted with small bracket or long screws attached to the front panel on either side of M1. Mount and wire *FM*'s ASA trim pots R14 to the perf board, before installing it into the flash meter. Incidentally, you can mount your trim pots on both sides of the pc board for easier wiring, instead of on the rear side as in our unit. Last step's installing a C-size 1½ volt battery into its holder.

Flash Master's Big Red Eye. We mounted the photo cell made from a red plastic lamp housing cannibalized from an inexpensive flashlight. Jack J1 fits into a hole in the lamp housing's side. Photo cell Z1 is held against the ex-flashlight's glass or plastic faceplate by a section of foam rubber. Finally, after you've soldered Z1's leads to J1 cut a section of sheet aluminum and press-fit it into the lamp bottom.

A plastic strap was also mounted on the aluminum section to fit an aluminum bracket. Install it on the *Flash Master's* case as shown in the photos. If you don't need this feature, it can be left out of your model. Only problem is that the photo cell housing would have to be hand-held while you're working with *Flash Master.*

Normally, a short shielded lead (approximately 6-inches long) connects the probe assembly to J2. But longer pickup probe lead lengths can be used as well. After you've made sure that your wiring chores are completed—and correct—set S2 to its off position. Then depress the reset button (that's S1), and remove Q2's shorting strap while keeping S1 depressed.

BCPS and Tape Measure, too. To calibrate *Flash Master,* you need an electronic strobe unit with a known guide number BCPS rating (Beam-Candlepower-Seconds). Also, scout up a tape measure and a flash exposure distance guide (similar to the one in Eastman Kodak's Master Photoguide AR-21 Manual). You'll find the Photoguide available in most photo stores.

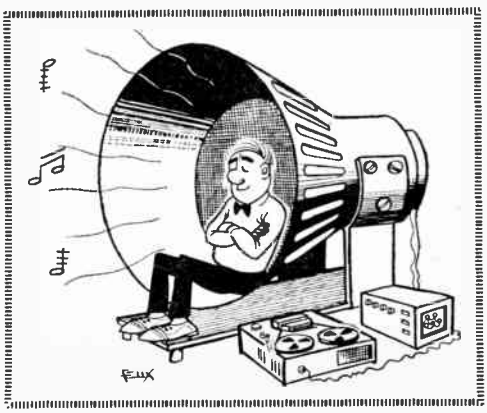
Make sure that M1's pointer is at zero; if not, adjust the meter's mechanical zero until the pointer sits on the goose egg. Set the ASA switch (S3) to bat, turn S2 on, and observe that the pointer of M1 swings nearly full scale. Mark the M1 scale at this point to indicate a fresh battery's voltage reading. Next, set the ASA switch to the position that is connected to R14 (full clockwise position), depress S1, and electrically "zero" M1 by adjusting R4. If M1 cannot be adjusted to zero, change the resistance value of R3 or R5. Set S2 to its off position.

We calibrated our flash meter for the eight most popular ASA film ratings. If you desire, the meter can be calibrated for other ASA values to fit your special needs (up to ASA 400). All you need is a large room, or long hallway, to properly calibrate the flash meter. Set your *Flash Master* on a window ledge or table at one end of the room or hallway and position the photo cell toward you. Attach one end of the tape measure near the photocell and extend the other end outward.

Turn your strobe power switch on, and let its capacitor charge for the proper time up to full charge. If you are not sure how much time is necessary for a full charge, allow at least one minute after each flash, during the meter calibration.

Adjust the dial of the flash exposure chart in the Master Photoguide Manual to either the electronic flash BCPS or flash guide number at the ASA 125 setting. Position your electronic flash at the designated distance (from the photocell) for f/22. (Our unit was set at four feet.) Aim the flash directly at the photo cell.

Set the flash meter ASA switch (S3) to the position connected to R11, and adjust R11 for maximum resistance. Turn S2 on, then press the reset switch (S1). Ensure that M1 indicates exactly zero. If not, adjust R4. Press the open flash switch on your electronic flash unit and observe that M1 indicates upscale. Adjust R11 until M1 indicates exactly at the 50 microampere meter marking (full-scale meter indication).



Then press the reset switch (S1) to discharge C1 and return M1 to zero indication.

Position your flash unit back from the photo cell at the designated distance given in the manual flash exposure dial for f/16, and press the open flash switch. Note M1's indication, and then press the reset switch (S1). Operate your electronic flash at each distance indicated by the manual flash exposure dial for F11, F8, F5.6, F4, and F2.8 (depressing the reset switch after each operation). At each one, note the M1 indication. You can now remove the M1 meter face and use rub-on numbers to calibrate the dial at the F-stop indications noted previously, or you can just make a chart of the meter indications for each F-stop instead of marking the M1 dial.

Set the ASA switch (S3) to the position connected to R7 and depress the reset switch (S1). Set the manual flash exposure dial to the ASA 25 setting, and select an F-stop at a convenient distance. Ours was at five feet. Operate your electonic flash at the selected distance, and then adjust R7 for the selected F-stop indication of M1 (at the noted or marked M1 F-stop previously calibrated for the ASA 125 range). Calibrate the other ASA positions of S3 at a selected F-stop indication of M1 by adjusting R8 for ASA 32, R9 for ASA 64, R10 for ASA 80, R12 for ASA 200, R13 for ASA 20, and R14 for ASA 400.

Watch the Birdie. The *Flash Master* is designed to work only with very short light pulses—like electronic flash or strobe light bursts. The unit will not operate with the longer light pulses generated by conventional flash bulbs. Normally, the reset switch (S1) should be depressed after each operation to discharge C1 and return M1 to zero indication, ready for your next picture.

If desired you can measure successive light flashes, as if you were "painting with light." Do not depress the reset switch (S1); now C1 builds up a cumulative voltage charge and M1 will indicate the total amount of light pulse energy for the series of light flashes.

Usually, a short length of shielded cable connects the photo cell housing to the main unit, with the photo cell mounted on the flash meter cabinet. But, it may be more convenient to hang the main unit on the camera tripod, and temporarily hold the photo cell on the subject being photographed, with a long shielded cable connecting the photo cell to the flash meter. As always, make sure that the photo cell is aimed directly at your electronic flash; and that the ASA switch is set to the corresponding value of the film you're working with. ■

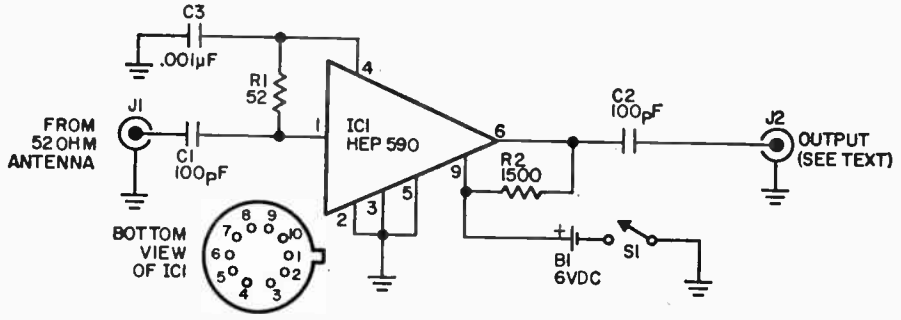
Eight Great IC Projects

Continued from page 54

When building this regulated power supply, shortest point-to-point wiring techniques are desirable. Solder capacitor C2 directly to terminal 7 of the IC; make the ground connection for this capacitor also as short as possible.

The transformer specified in the parts list supplies 20 Volts rms, centertapped across the Yellow and Red secondary leads.

PROJECT 8 – Shortwave Booster



☐ This inexpensive shortwave booster could make the difference between bagging rare DX and aimlessly searching around the bands. Our little SW booster also gives CB signals that extra kick where it helps the most—before the signal enters your CB

receiver. Using no tuned circuits, you can use this signal pepper-upper on almost any band. The shortwave booster delivers about 15 dB overall gain—that's about 3 S-units!

There's one restriction, though. Our SW booster is best suited to work with a communications-type receiver—one that has an antenna trimmer on the front panel. The output of the booster is of high impedance: low-impedance-type receivers and transceivers will load down the output of the booster, and whatever gain benefits won for you by IC1 would be all for naught.

Just like any RF booster project you're likely to build, this one demands short, point-to-point connections. In particular, solder bypass capacitor C3 directly to pin 4 of the IC. Socketing the integrated circuit saves many a 14-pin Wonder Can for the experimenter not familiar with soldering procedures. But, if you feel you're no longer in the novice experimenter class, go right ahead and solder IC1 directly home.

Battery power is furnished by a 6-Volt type Z4 battery in the prototype model. Should you have a 6-Volt battery on hand having greater capacity, use it instead. ■

PARTS LIST FOR SHORTWAVE BOOSTER

B1—6V battery
C1, C2—100 pF, 15 VDC
C3—0.001 uF, 15VDC
IC1—HEP 590
R1—52-ohms, ½-watt, 10%
R2—1,500-ohms, ½-watt, 10%
J1, J2—Phono or coaxial jack
S1—SPST switch
B1—6V battery

CB-9 Converter

Continued from page 44

mum volume from your rig's speaker, or look for maximum meter needle deflection on your vom. While adjusting L1, reduce the signal generator's output level; otherwise, you'll be swamping Q1 with too much signal and invalidating your alignment procedure.

Becoming a CB Samaritan. For best operation, a high-mounted, outside CB antenna is required. Use either a ground plane or beam antenna with coax cable connecting the antenna to your *CB-9 Converter*. If you're only concerned with local signals, a whip antenna will suffice. Sensitivity of reception is largely dependent upon the broadcast receiver you're working with. Also, for long-term monitoring of channel 9, a stable, drift-free rig is your best choice. In fact, a sensitive—and inexpensive—transistor portable radio would be your best bet to use with *CB-9 Converter*. ■

RYO Capacitor

Continued from page 48

ure out that could change the characteristics of the RYO. And it makes the finished product look better, especially if you can dip the final product into a pan of melted wax.

How to Test and Use the RYO. After the RYO capacitor has been sealed in wax, it must be tested to ensure that no short-circuits have developed during the sealing process. The easiest way to do this is, of course, with an ohmmeter. But if you don't have an ohmmeter, or are the impatient type, you can test the RYO and use it at the same time by building a simple circuit. Probably the simplest circuit that can be assembled using the RYO is the relaxation oscillator shown on page 61. When voltage is applied to this type of circuit, the RYO begins to store electricity by absorbing all of the current that flows into the circuit as shown by the solid lines. The potential difference across the RYO increases until it reaches a voltage value that will ignite the gas in the neon bulb—about 85 volts. At that time the electrons stored in the RYO will quickly flow from the negatively charged plate of the capacitor, through the ionized gas of the neon bulb, to the positive terminal of the voltage source, as shown by the dotted line. This process will continue until the voltage across the RYO decreases to a value that will not sustain current flow through the neon bulb. Then the neon bulb will stop conducting current, and the capacitor will begin to charge again. The speed at which this cycle will occur depends upon the value of the RYO, the value of the series resistor, and the voltage applied to the circuit.

The RYO described here has a value of 0.0235 *u*F, as measured on a quality labora-

tory capacitance bridge. With the 10-megohm series resistor shown in the schematic, the neon bulb should blink about two times a second. Increasing the voltage applied to the circuit will increase the number of flashes per second, because more current will flow in the circuit. Increasing the value of either the series resistor or the RYO will decrease the number of flashes per second. This is because less current will flow in the circuit with a larger value of resistor, and with a larger value of RYO more current will have to enter the capacitor before the ignition voltage of the neon bulb is reached.

When you are satisfied that the RYO is not shorted, you can proceed to use it in any circuit that requires a capacitor with a value of approximately 0.025 *u*F. The two circuits shown are common types that will give you a chance to use the RYO and build a useful circuit. Of course, any circuit you need that requires an 0.025 *u*F capacitor, can be built using the RYO described above. If you need a different value of RYO, a good rule of thumb is to change the area of the plates accordingly. For example, if you need an 0.05 *u*F capacitor make the plate area of your next RYO twice as large, or connect two RYO's such as we have described in parallel.

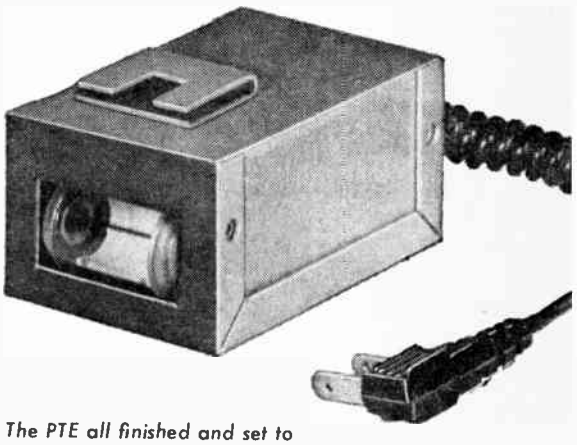
The only true limitation in using RYO capacitors is your own imagination. If you have access to a capacitance bridge, and are industrious enough, there is no reason why you can't build fairly complex circuits using only RYO capacitors. ■

Photog's Third Eye

Continued from page 35

bracket. Push the button plugs into the recesses in V1; solder the other end of V1's cathode lead to the center terminal on potentiometer R1. The 10-megohm is soldered from the pot's end to one lug of the terminal strip. Solder the shutter cable to the appropriate terminal strip; the last component soldered into the circuit is the SCR. Lastly, fashion a bracket or strap from sheetmetal to hold *PTE* to your slave strobe.

Testing PTE. Plug your completed *Photog's Third Eye* into the socket on your slave strobe. Set R1 to its maximum resistance setting. Turn on the strobe, and wait until it charges. Back R1 off slowly; the strobe will fire at some point. Adjust the control back a trifle further. *PTE* is now adjusted so that ambient light does not affect it. Your *PTE* will now respond each and every time to its master's bidding. And, it'll reward you with shadow-free snaps at your next bash. ■



The PTE all finished and set to slave away. Aluminum clip at top mounts unit.

Fish Finder

Continued from page 32

sure that both resistors are *not* different values. Otherwise, the temperature corresponding to the center of rotation of the pot will shift in the direction of the ohmically larger of the two resistors. For a fishing thermometer where a range of from 32F to 100F is desired, make each trimming resistor equal to 1,000-ohms. For his own *Thermocliner*, the author chose a thermistor with a resistance of 3,500-ohms at 25 degrees Celsius (Fenwal type GB 34P8) and a 4,700-ohm resistor for R8.

Should you run into trouble locating a similar thermistor, substitute a 2,000-ohm unit. See the Parts List for an alternate thermistor. You'll also have to fiddle with R8's value, in order to maintain the same thermistor resistance versus potentiometer mid-scale position. Start out with a 3,900-ohm resistor, and adjust its value up or downwards as needed. In any case, get the 80 degree F mark to coincide with pot R10's mid-scale rotation point. ■

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

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

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

THE "EDU-KIT" IS COMPLETE

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

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

Progressive "Edu-Kits" Inc., 1189 Broadway, Dept. 510EN, Hewlett, N.Y. 11557

UNCONDITIONAL MONEY-BACK GUARANTEE

Please rush my expanded "Edu-Kit" to me, as indicated below:

Check one box to indicate choice of model

- ☐ Deluxe Model $31.95
- ☐ New Expanded Model $34.95 (Same as Deluxe Model Plus Television Servicing Course).

Check one box to indicate manner of payment

- ☐ I enclose full payment. Ship "Edu-Kit" post paid.
- ☐ I enclose $5 deposit. Ship "Edu-Kit" C.O.D. for balance plus postage.
- ☐ Send me FREE additional information describing "Edu-Kit."

Name .....

Address .....

City & State ..... Zip .....

PROGRESSIVE "EDU-KITS" INC.
1189 Broadway, Dept. 510EN, Hewlett, N. Y. 11557

FREE EXTRAS
• SET OF TOOLS

- SOLDERING IRON
- ELECTRONICS TESTER
- PLIERS-CUTTERS
- VALUABLE DISCOUNT CARD
- CERTIFICATE OF MERIT
- TESTER INSTRUCTION MANUAL
- HIGH FIDELITY GUIDE & QUIZZES
- TELEVISION BOOK & RADIO TROUBLE-SHOOTING BOOK
- MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE • FCC AMATEUR LICENSE TRAINING
- PRINTED CIRCUITRY

SERVICING LESSONS

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

FROM OUR MAIL BAG

Stata Iris, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends and made money. The Edu-Kit paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

PRINTED CIRCUITRY

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

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

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

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