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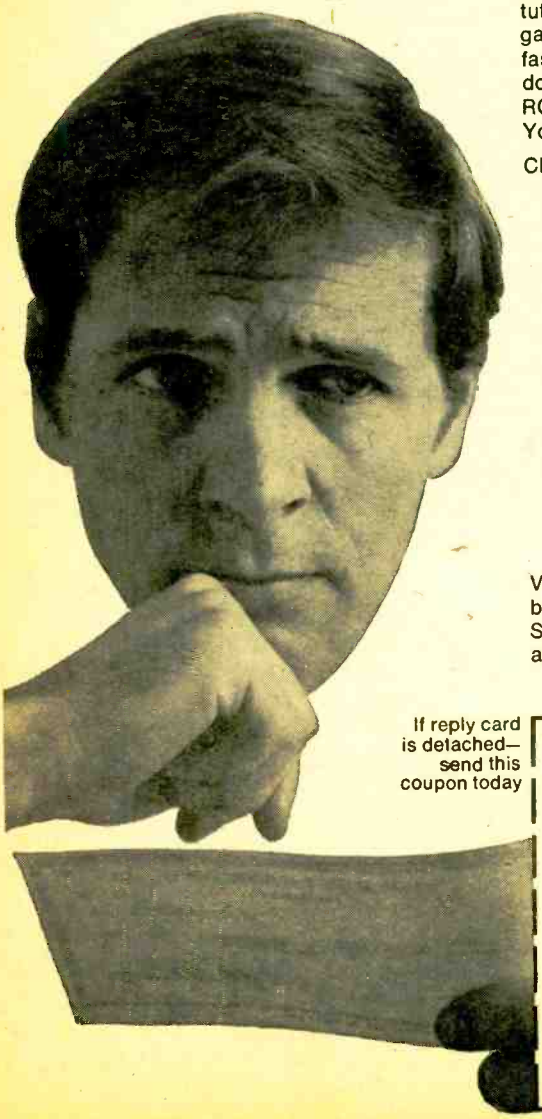

It tells you more than how much you make. It tells you how far you've come. And if your paycheck looks very much the same as it did last year, or the year before, it simply means that *you* look very much the same as *you* did last year and the year before.

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CIRCLE NO. 1 ON PAGE 17

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elementary Electronics

Dedicated to America's Electronics Hobbyists

☆ Cover Highlights

Cover Photo by Leonard Heicklen

AUTHORS IN THIS ISSUE

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CIRCLE NO. 2 ON PAGE 17

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INCLUDING SCIENCE AND ELECTRONICS

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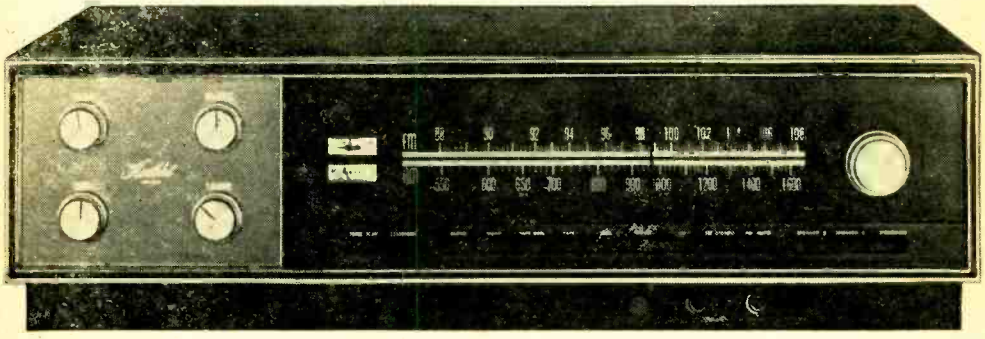
Announcing 16 exciting new Heathkit projects for wintertime kitbuilding fun!

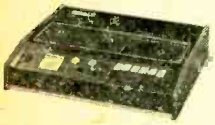


Meet the second generation AR-15 ...new Heathkit AR-1500!

From the AR-15, hailed at the time of its introduction in 1967 as the most advanced receiver of its kind, comes the AR-1500... with impressive improvements in every critical area! *180 Watts Dynamic Music Power,* 90 watts per channel (8 ohm load); 120 watts dynamic music power per channel under 4 ohm load, with less than 0.1% intermod distortion, less than .25% harmonic distortion. A 14-lb. power transformer and massive output transistor heat sink are mute testimony to the power at your command. Direct coupled output and drive transistors are protected by limiting circuitry that electronically monitors voltage and current. *FM selectivity greater than 90 dB,* better phase linearity, separation, and less distortion are the result of two computer-designed 5-pole LC Filters. An improved 4-gang 6-tuned circuit front end offers better stability, 1.8 uV sensitivity, 1.5 dB capture ratio, and 100 dB image and IF rejection. Four ICs are used, three in the IF and one in the Multiplex. Patented automatic FM squelch is both noise and deviation activated, fully adjustable for sensitivity. *Vastly Superior AM,* an "also ran" with many receivers, has two dual-gate MOSFETS in the RF and Mixer stages, one J-FET in the oscillator, 12-pole LC Filter in the IF, and broad-band detector. Result: better overload characteristics, better AGC action, and no IF alignment. *Greatly simplified kit construction.* Ten plug-in circuit boards, two wiring harnesses and extensive use of pre-cut wiring with installed clip connections make the AR-1500 a kit builder's dream. Built-in test circuitry uses signal meter to make resistance and voltage checks before operation. *Other advanced features* include Black Magic panel lighting that hides dial markings when set is not in use; flywheel tuning; pushbutton function controls; outputs for two separate speaker systems, bi-amplification, oscilloscope monitoring of FM multipath; inputs for phono, tape, tape monitor and aux. sources — all with individual level controls. *Versatile installation* in optional new low-profile walnut cabinet, in a wall, or black-finish dust cover included. Join the "NOW" Generation in audio technology...order your Heathkit AR-1500 today!

Kit AR-1500, less cabinet, 42 lbs. **349.95***
ARA-1500-1, walnut cabinet, 6 lbs. **24.95***

New Heathkit Stereo Cassette Recorder



119.95*

Frequency response of ±3 dB, 30-12 kHz, brings your stereo system into the cassette age. Features built-in bias adjustment to accommodate the new chromium dioxide tape; counter; automatic motor shutoff; preassembled and aligned transport mechanism. The AD-110 offers fidelity recording and playback of stereo or mono when used with your stereo system.

Kit AD-110, 10 lbs. **119.95***

New Heathkit Stereo-4 Decoder

29.95*

Compatible with your present stereo system and FM receiver, lets you hear all Stereo-4 material currently being broadcast by a number of stations across the country. Additionally, imparts a 4-channel effect to your existing stereo library. Requires second amplifier and 2 speaker systems for installation with conventional stereo system.

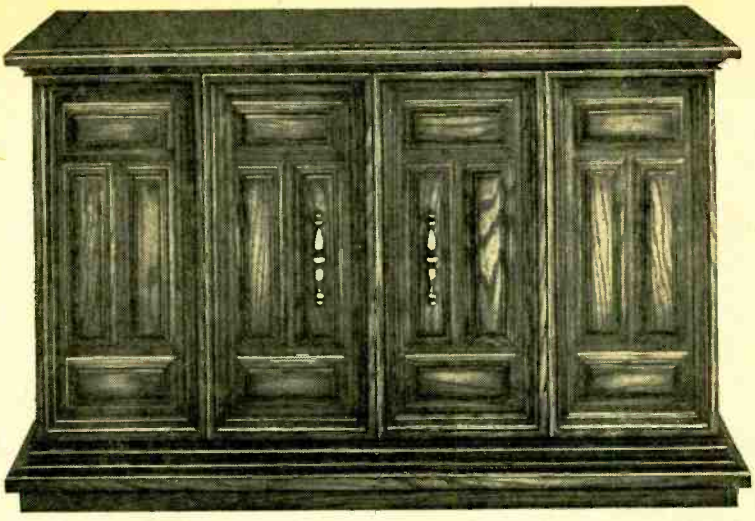
Kit AD-2002, 5 lbs. **29.95***

New Heathkit Stereo Phonograph with AM Radio

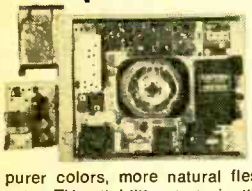
109.95*

Gets it together in a portable package with a purple plum snakey skin that's as far out as today's sounds. Solid-state 18-watt amplifier, fold-down 4-speed automatic changer and swing-out high compliance speakers. Speakers can be separated up to 5'. A flip of the mode switch and you're into AM radio! 45 spindle adapter included.

Kit GD-111, 50 lbs. **109.95***



Now Heath's finest color TV package comes wrapped in a handsome new optional cabinet!



Here's the inside story:...the Heathkit 25" solid-state color TV with exclusive MTX-5 ultra-rectangular tube to bring you the largest color picture in the industry! The etched, bonded tube face cuts glare, increases contrast for sharper picture, purer colors, more natural flesh tones. But the true story of color TV reliability starts in the solid-state modular circuitry ... 45 transistors, 55 diodes, 2 silicon-controlled rectifiers, 4 ICs containing another 46 transistors, 21 diodes, and just two tubes (picture and high-voltage rectifier). Major circuit functions are contained on individual plug-in glass epoxy boards (see chassis inset above) to simplify assembly, service and adjustment. And, of course, only Heathkit color TV offers you the money-saving advantages of home-serviceability...with the built-in dot generator and tilt-out convergence panel to let you perform the periodic adjustments required of all color receivers.

Other advanced design features include solid-state VHF tuner with MOSFET for greater sensitivity, lower noise and cross modulation; solid-state UHF tuner with hot-carrier diode design for greater sensitivity; 3-stage solid-state IF for higher gain and superior picture quality; Automatic Chroma Control for constant color quality under different signal conditions; adjustable video peaking; adjustable noise limiting and gated AGC; "Instant-On"; VHF power tuning on 13 channels plus one preselected UHF channel; Automatic Fine Tuning; Tone-Control; and an output to your stereo/hi-fi system for the ultimate in sound reproduction.

And to wrap it all up ... your Heathkit GR-371MX is available in a magnificent new Mediterranean cabinet with doors that transform your home television theater back into an attractive center of decor. This finest cabinet in the Heathkit line features deep-grained pecan veneers on hand rubbed furniture grade hardwood solids. Two beautifully scalloped double-hinged bi-fold doors hide the TV screen when it's not in use, fold neatly to the cabinet sides when opened. Ornate brass "Canterbury Antique" handles add the perfect finishing touch. Measures 29⅝" H x 56¼" W x 22⅜" D.

Kit GR-371MX, TV less cabinet, 125 lbs. **579.95***

GRA-404-25, assembled cabinet, 87 lbs. **139.95***

New Heathkit Solid-State Wireless Intercom

29.95*

Plug two of them into standard 105-130 VAC outlets for 2-way communications. Three channels let you carry on 3 conversations in a 6-unit system, call one unit without disturbing the others in a 3-unit network. Intercoms have channel selectors, spring loaded "talk" button, slide-action volume control, and "dictate" for extended one-way communication.

Kit GD-113, 5 lbs. ..... **each 29.95***

New Heathkit Solid-State Shortwave Receiver

59.95*

Four over-lapping bands provide continuous coverage from 550 kHz to 30 MHz, giving you local AM plus international, amateur, marine & weather and citizens band broadcasts. Features band-spread tuning for close station separation; BFO control for receiving code; signal meter; front-panel headphone jack; noise limiter; built-in AM antenna.

Kit SW-717, 10 lbs. **59.95***

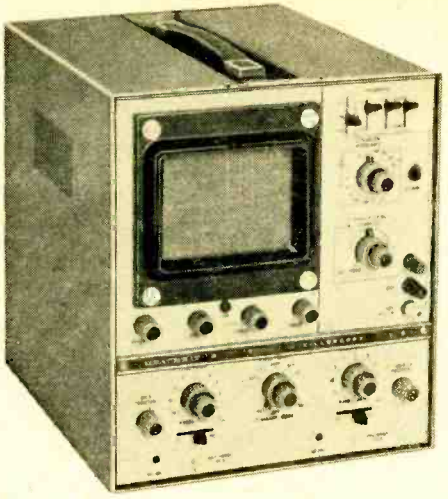
New Heathkit Automatic Battery Charger...

Charges 12-volt batteries automatically. 10 amp max. charge rate. Impossible to hook up wrong. No charge setting to make ... can be left hooked up indefinitely. Meter monitor charge. **Kit GP-21,** 13 lbs. **29.95***

New Heathkit Automotive Timing Light...

Completely self-contained. Bright flash lets you work in sunshine. Adapter for connecting to distributor. Hi-impact plastic case.

Kit CI-1020, 2 lbs. **19.95***



399.95*

New Heathkit DC-15 MHz Dual Trace Solid-State Oscilloscope...

The new Heathkit IO-105 is a high-performance scope designed to give you a wide range of measurements for use in instrumentation courses, engineering, R&D and electronics...at a fraction of the cost of comparable scopes! The IO-105 brings you complete dual trace and X-Y capability, allowing comparison of input/output for such parameters as loss, gain, phase shift and distortion. You can display two separate input signals in Channel 1 or Channel 2 modes of operation. Direct comparison of both signals is possible in alternate and chopped modes. In the alternate mode, both signals are alternately displayed on successive sweeps...at faster sweep speeds they are retained on the screen for time relationship comparison. In the chop mode, both signals are sampled at 100 kHz and appear as a function of the same time base. In X-Y, both channels are displayed as a function of each other...channel 1 controlling the vertical (Y) axis and channel 2 controlling the horizontal (X) axis. Both input channels are precision balanced for 5% or less phase shift to 50 kHz. Switch selected AC or DC coupling lets you trigger the time base at a given point on the signal or at a preselected DC level. Flipping a switch gives you automatic triggering at the crossover (O) point. You can also switch select positive or negative slope triggering. Internal, External and Line trigger inputs are provided. The convenient 18-position time base switch in a 1, 2, 5 sequence provides sweep rates from 100 msec/cm to 0.2 usec/cm. The separate vernier control with a calibrated position gives you continuous control between settings, while a 5-times magnifier switch allows detailed trace viewing. The DC-15 MHz bandwidth capability and 24 nsec rise time make possible analysis of high frequency signals and transient waveforms. Full bandwidth is featured from 20 V/cm to 50 mV/cm in 1, 2, 5 sequence. For special applications, a rear panel Sweep Gate output delivers a 3.5V pulse in sync with the sweep. A TTL-compatible external blanking input is also provided. Other features include a CRT bezel incorporating standard camera mount dimensions...flush mounted handle for easy stacking... easily-removable side panels for quick accessibility...compact, 15" depth for bench installation instead of cart. If you want to expand your analysis capability while holding the budget line, order your new Heathkit IO-105 now! Or send for more information and complete specification sheet.

Kit IO-105, 35 lbs. **399.95***

New Heathkit Vector Monitor...

49.95*

Designed for use with the Heathkit IG-28 Pattern Generator or similar units which display either "rainbow" (offset carrier) or NTSC patterns, the IO-1128 vector display helps you perform fine tuning, static and dynamic convergence, purity, 3.58 oscillator, reactance coil, phase detector transformer, demodulator angle check, and chroma bandpass adjustments. Represents exactly the color signals fed to CRT guns.

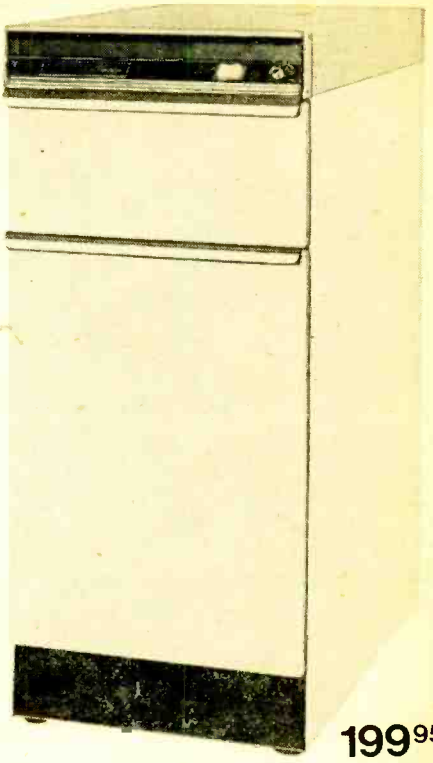
Kit IO-1128, 10 lbs. **49.95***

New Heathkit Electronic Switch... 39.95*

Provides simultaneous visual display of 2 input signals on a single trace oscilloscope. Has DC coupling and DC-5 MHz ±3 dB frequency response. Conventional binding posts permit fast hook-up. Can be left connected to scope. Ideally suited for digital circuit work; amplifier input and output for gain and distribution checks; simultaneous monitoring of 2 stereo channels.

Kit ID-101, 6 lbs. **39.95***

New Heathkit "Minimizer" kitchen waste compactor...



Today's most modern refuse handling method in easy-to assemble kit form! Now you can own the most exciting kitchen appliance on the market for less than you'd pay for any other comparable compactor. The Heathkit Minimizer lets Mom throw out the unsightly waste baskets and garbage cans for the latest in clean, convenient, odor-free disposal. The Minimizer handles all normal household trash — food wastes, glass and plastic containers, tin cans, wrappings, boxes, floor sweepings, light bulbs, etc. The packing ram descends with 2,000-lb. force to reduce refuse to almost ¼ of its original size, packaging the material in a strong disposable bag — one bag holds an entire week's trash for a family of four! When the bag's full, Mom simply folds over the top and removes a neat, dry package for normal rubbish pickup. And the Minimizer deodorizes the contents each time the drawer is opened and closed. The sanitation man will love Minimizer, too!

Simple, safe operation! To use, Mom merely inserts a Minimizer plastic-lined bag in the drawer and starts the compacting cycle. In less than a minute the ram forces down the trash, returns to its normal position, and the Minimizer shuts itself off. For maximum safety, the Minimizer uses a key lock switch and an interlock which automatically turns unit off if drawer is not fully closed or is accidentally opened during cycling. Your Heathkit Minimizer can be built-in under the kitchen counter or left free-standing. Its bright white enamel finish with marble-tone vinyl-clad top complements any decor. And you can build it yourself in 6 to 10 hours. Has long-life ⅓ hp motor, plugs into 110-120 VAC conventional household outlet. Kit includes 5 plastic-lined bags, one 9 oz. aerosol can of deodorant. Minimizer measures 34⅜" H x 15" W x 25½" D.

Kit GU-1800, 203 lbs. **199.95***

GUA-1800-1, 25 plastic-lined bags, 2 aerosol cans, 6 lbs. **10.95***

199.95*

New Heathkit Thermo Spotter

24.95*

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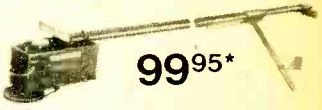

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CIRCLE NO. 5 ON PAGE 17

DX central reporting

A world of SWL info!

By Don Jensen

The last major holdout to the Strasbourg Treaty reportedly is about to sign on the dotted line. By the time you read this, the Netherlands already may have added its name to the list of signatories.

So what's the Strasbourg Treaty? A new economic common market scheme? A nuclear non-aggression pact? Nope, it's an agreement hammered out several years ago by the main European powers to deep six the private broadcasting stations that operate shipboard from International Waters.

Plagued by a rush of illicit offshore stations operating during the '60's and egged on by their state radio monopolies, the European nations agreed to crack down on owners, suppliers, advertisers, and even in some cases, on listeners to these illegal broadcasters. And, for the most part, the lid stayed on.

The one real exception was Holland, which never ratified the treaty. And Holland became the haven for the two or three remaining pirate stations, the most important of which were Radio Veronica, a medium wave outlet, and Radio Nordsee International, which operated on medium and short waves and on FM.

But now the Netherlands will—or perhaps has already—decided to join the rest of Europe by signing the pact.

What brought about this seeming change of heart was a nasty bit of internecine warfare between Radios Veronica and Nordsee International that culminated in the firebombing of RNI's radioship in mid-May.

Among radio pirates, Radio Veronica was unique. While others came and went, Veronica enjoyed 11 years of illegal, but highly profitable broadcasting from a ship anchored outside Holland's three-mile limit. Though regularly supplied from a Dutch shore base, the authorities made no move to interfere with the popular station.

Then, a couple years ago, Radio Nordsee International moved in. After a few false starts, it began successfully luring away both listeners and advertisers. Allegedly, Veronica tried to buy off the competition. Negotiations between

(Continued on page 14)

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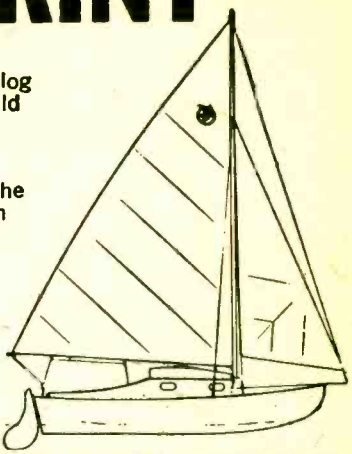

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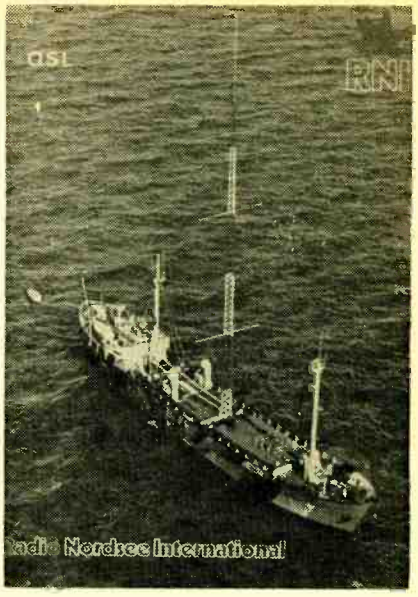
DX Central Reporting



It's dull work for station personnel to address QSL cards to interested listeners except on the RNI ship where anything can happen!

the pirate broadcasters led to court action, in which the Veronica owners apparently felt they came out on the short end.

That brings us to the night of Saturday, May 15, when three men, dressed in black "wet suits," launched a rubber raft near the Dutch harbor of Scheveningen and paddled toward the psychedelic-hued hull of the radioship, MEBO II, seagoing home of RNI. Aboard, the crew and off-duty disc jockeys were watching a soccer game on TV and never saw the approaching raft.

Shortly before 9 p.m., the trio slipped aboard the MEBO II, entered the engine room unnoticed and taped an ounce of dynamite to the pipe leading from a 250 gallon diesel fuel tank to the station's generators. The unexpectedly powerful blast touched off a raging blaze and blew the three men, unharmed, into the water. They managed to make it back to shore, where they buried th raft and their rubber suits in the sand dunes.

Aboard MEBO II there was instant chaos. The radiomen and the ship's crew vainly tried to fight the fire. At 2158 GMT, the station broke its rock music programming and began calling, "Mayday! Mayday!"

Luckily, no one was killed or injured and a nearby supply tender moved in to take off the crew. Then, with only the captain and two assistants aboard, the station went silent.

A Dutch naval craft and the fireboat Volans from Scheveningen came alongside to fight

the blaze. By 1 A.M., the fire was under control. Though the flames had caused nearly $50,000 worth of damage, the broadcasting facilities were untouched and Radio Nordsee International resumed broadcasting at its normal 0500 GMT sign-on time.

Later that day, Dutch police arrested three frogmen and their statements led to charges against 48-year-old Norbert Jurgens, an employe of the firm that owned Radio Veronica, who allegedly hired them.

The biggest surprise of all came on Tuesday, two days later, when Hendrik "Bull" Verwey, the tough, bearded director of Radio Veronica, admitted on Dutch TV that he had given his support and financial backing to the firebombing scheme. On Wednesday, Verwey, too, was arrested. All are now awaiting trial.

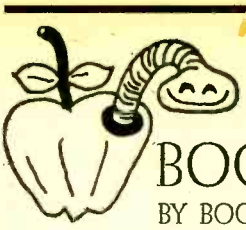
The bombing shook the Dutch parliament and newspapers began predicting that by fall it would act to shut off the pirates' last haven.

As of this writing, both pirate stations were still on the air, with RNI's shortwave signal on 6,205 kHz offering U.S. DXers their best—and perhaps last—opportunity to tune an honest-to-goodness shipboard pirate. Best time to try is around 0500 to 0600 GMT.

If legal action does end the offshore broadcasting, what then? One of RNI's co-owners has hinted he might move the refurbished MEBO II to the Mediterranean for one last try. There also are rumors afoot that the Dutch government may legalize limited commercial broadcasting and give one or both of the pirate stations licenses to operate ashore, under proper supervision, of course, to guarantee that nothing like the incident in May occurs again.

Bandsweep. Frequencies in kHz, all times GMT: **3,300**—The English-speaking station you're hearing on this ferquency around 0045 is the *Windward Islands Broadcasting Service* at St. George's, Grenada, not British Honduras. According to recent word from the Central American, it no longer broadcasts on shortwave. . . . **3,220**—Want a real toughie to shoot for? Try the brand new *Radio Morobe*, a two kilowatter located at Lae, Papua Territory, New Guinea around 1100 to 1200 sign off. . . . **4,923**—"*Radio para usted, Radio Quito.*" Translated that means *radio for you*, and this station in Ecuador's capital is one of your best bets among the Latin American broadcasters. Listen for its Spanish language programing and easy-to-understand indentification around 0400. . . . **6,130**—If you prefer your programs in English, try for CHNX, one of Canada's private shortwave broadcasters, in Halifax, Nova Scotia about 2300. It's an easy one for east coasters; tougher for those living farther west. . . . **8,630**—Libya is a hard country to log, even for DXers with a few

(Continued on page 97)



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Circle No. 42 on Reader Service Page

Long Title. Here's a book whose title is the longest we've reported on in many years—*How to Use Vectorscopes, Oscilloscopes, Sweep-Marker Generators.* Written by Stan Prentiss, this volume has a combination of

Hard cover
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instructions not equalled anywhere. Guesswork and frequent substitution techniques are grossly outmoded and inefficient in today's electronic work. The technician must know

(Continued on page 98)

ELEMENTARY ELECTRONICS

READER SERVICE PAGE

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stamp shack

Philatronics Today!

BY ERNEST A. KEHR

●● On last May 22, when the International Stamp Exhibition opened in Capetown, the Republic of South Africa released a pair of special commemoratives. One of them, the five-cent denomination, features the J. G. Strijdom Tower and a portrait of the prime minister who served from 1954 to 1958, and after which this fantastic building was named.

● Such towers and stamps honoring them are not exactly new to collectors. It all began in April, 1961, when the United Arab Republic issued is 10-millieme, greenish-blue commemorative for the opening of the Cairo Tower on Gezireh Island—first of its kind in the world and precursor of all the others that now are sprouting from the earth's scattered nations.

● The Strijdom's main purpose—like those of Cairo and London—is to provide improved electronic communications facilities. It becomes

the heart of South Africa's ultra-modern and sophisticated microwave network which links all the major cities of the land.

● Careful investigation and study revealed that the microwave technique offers superior communications quality and also is cheaper than expanding existing underground trunk routes.

● The network comprises a number of high-frequency radio relay stations over which microwaves are transmitted in direct visual lines from one station to the next with saucer-shaped antennas. Because of their high frequency, microwaves have the same characteristics as light beams: they travel in straight lines, so it becomes essential that no obstacles lie within their paths. To maintain adequate transmission performance, stations are situated about 30 or 40 miles apart, in direct line of sight with each other.

● One such route can provide up to 32,000 channels for simultaneous telecommunications since the microwaves are electronically processed into individual telephone calls at the terminal stations through automatic switching equipment to subscribers.

● Including a 115-foot mast for Post Office VHF radiotelephone communications, the Strijdom Tower rises 870 feet above Johannesburg to make it the tallest structure man ever built in Africa. (Until it was finished last March, the Cairo Tower, at nearly 700 feet, held this record.)

● In silhouette, it looks a bit like some strange giant flower atop a slender stem. The topmost cluster of extensions house elevator motors, a VIP room, and battery storage chambers for radios and associated apparatus. These are recessed to accommodate the antennas not only to preserve the architectural beauty of the whole, but to make them more easily accessible for maintenance and repairs.

● Built at a cost of $5 million, it has a mass of some 19,050 metric tons of concrete and reinforcing steel. Its walls which are sunk 140 feet below street level are more than two yards thick at the bottom and a yard thick at the top. It took 38 months in the building and installation, after the foundation was begun in January, 1968.

● Because it is so high above the streets of Jo'burg's Hillbrow, there never need be any worry that it ever will be surpassed by other structures that are continuing to rise in this great African metropolis.

● But its communications facilities are not the only Strijdom Tower attractions. Just below the technical installations is a seven story complex designed to make it a popular, utilitarian landmark. There is, for example, a swank revolving restaurant where 108 guests may be accommodated in its luxurious salon decorated with murals depicting exotic native birds. Just below is a grill room to handle another 113 diners. Its murals have stylized pictures that record the postal history of South Africa from the time when native couriers brought letters to pioneers in forked sticks.

● Still lower are bars and lounges offering refreshments and snacks for those who have less time and funds. Also, an observation level from whose 24 large windows one gets an unobstructed, clear view of the surrounding countryside to a distance of about 60 miles.

● Two high-speed elevators (they call them "lifts") carry visitors up through the interior of the tower at 20 feet per second. One is intended for tourists to the observation deck, the other, to the dining rooms and VIP room.

●● To commemorate the centenary of telegraph service in what today is Yugoslavia, this nation issued, on June 20, a half-dinar brown,

(Continued on page 99)

e/e etymology

How about a word with us?

Boron

▲ Names of many elements are rooted in ancient discoveries and hence can't be dated within several centuries. Many found in recent times can be precisely pinpointed.

That's the case with *boron*.

Sir Humphry Davy, English chemist whose curiosity was insatiable, was fascinated by the fact that electrolysis often breaks down compounds.

With no special purpose in mind, one day in October, 1807, he tried his hand at electrical decomposition of boracic acid. One product of the experiment was a dark brown powder. Davy immediately recognized it as a new element.

The discoverer took the first three letters of the *bor*ax with which he had started. Because his end product looked a bit like powdered carb*on* he borrowed the last two letters from the name of that familiar element.

Named in this helter-skelter fashion, boron attracted little interest until German chemist Alfred Stock found that it can form unusual compounds. Later it was discovered that though boron is a poor conductor of electricity at normal room temperatures, conductivity increases remarkably as temperature rises.

Development of nuclear technology led to a spurt of new research, for the stable isotope boron 10 proved to be an excellent absorber of thermal, or slow, neutrons.

Today the element found almost casually in an English laboratory is basic to manufacture of compounds used in semiconductors designed to operate at high temperatures, thermoelectric generators, and many other highly sophisticated pieces of Space Age hardware.

Lithium

▲ Swedish chemist Johann August Arfvedson isolated a most perplexing element precisely a decade after Davy found and named boron.

Though it was only half as heavy as water, the Swede was sure he had discovered a new metallic element. Because of its mineral origin he modified Greek *lithos* (Stone) and called the odd stuff *lithium*.

Since it frees hydrogen when placed in water, lithium was a vital commodity during World War II. Antenna balloons used with emergency radio sets were almost always filled with hydrogen that had been secured from water by means of lithium.

Pound for pound, it can be used to generate 240 times as much electricity as lead. Hence it is a prime candidate for a role in the battery-powered car of the future.

In spite of its strange properties and potential role in 21st-century transportation, millions had never even heard of the rare element until Apollo 13 ran into trouble. Carbon dioxide in the spacecraft could have taken the lives of John Swigert, Fred Haise and James Lovell had it not been for lithium. It was this versatile element that astronauts used to scrub the spacecraft's air and make it breathable.

Titanium

▲ English scientist William Gregor is so obscure that few reference works even include his name. The only thing of importance he ever did was to probe into the nature of the rare mineral menachinite. About 1789 he discovered that the substance is an oxide.

Gregor was sure it couldn't be anything but a metallic oxide, so used "menachin" to name the substance he never succeeded in isolating from the oxide.

Working without knowledge of Gregor's findings, Martin Klaproth of Germany delved into the properties of the mineral called rutile. It, too, proved to be an oxide. Klaproth failed in attempts to prepare a pure sample from the oxide. His experiments of 1793 convinced him that rutile was compounded of oxygen plus a highly unusual metalic element.

For so powerful an element no ordinary name would do.

Klaproth remembered that in Greek mythology the sun-god Titan was regarded as ancestor of all persons of colossal size and strength. It was fitting, he felt, to borrow the name of the sun-god and frame *titanium* as a label for the "colossal metal" whose tracks he found but which he never came close to isolating in pure form.

Even the oxide of titanium wasn't fully refined until 1821. Minute quantities of the pure metal were isolated at intervals during the 19th century, but there was no commercial production until a huge DuPont plant went into operation in 1948.

Though it is estimated to be the world's ninth most plentiful element, titanium clings too firmly to oxygen and other substances to be isolated by primitive methods.

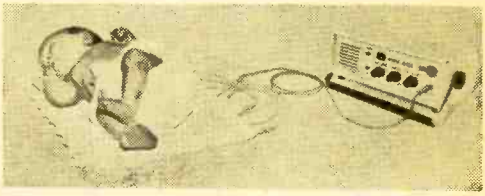
Now available in quantity to those willing to pay the price, titanium remains strong at high temperatures. This quality makes it vital in manufacture of high-speed aircraft and of rockets. Lacking the strength of the element named for the sun-god, man never would have made it to the moon! ■

newscan

Electronics in the News!

LIFE SAVER

A "lifeguard" that protects premature babies has been developed by British engineers of International Telephone and Telegraph Corporation. The device protects the infants from an ailent known as apnoea, a condition in which the baby suddenly stops breathing for no apparent reason. Engineers developed a special mattress to detect this condition. The baby merely lies on this special mattress; this has the advantage that nothing is connected to the child.



The mattress monitors the slight motions of the child's body as it breathes. It flashes a signal if the baby's breathing ceases due to the ailment called apnoea.

The mattress has a number of tubular sections filled with air. When the baby breathes, the small motions of its body cause the air to circulate around a pinhead-sized electrical device (a "thermistor"), which is cooled by the moving air. Should the baby stop breathing, the air stops circulating, the device immediately warms up, and an alarm sounds. The concept is advantageous especially in these times of hospital help shortage.

IT'S DONE WITH LOOPS

A new radio direction finder that "rolls its eyes instead of turning its head" has been introduced by Raytheon Company. The new navigation aid for pleasure boats and small commercial craft electronically seeks out the strongest signal on any frequency, locks on it, and then continuously points out the direction of the distant radio beacon, commercial radio broadcasting station, or the transmitter aboard another vessel.

The new automatic radio direction finder, called the *Navimatic*, uses phase-shifting techniques to point out the bearing of the distant signal. Ordinary radio direction finders must rotate their antennas in order to find the bear-

Radio Direction Finder attracts Jan Cody of Raytheon Company, Lexington, Mass. The antenna loops of the new "Navimatic" automatic radio direction finder for mariners remain stationary. The Raytheon electronic navigation aid is priced at $1200.

ing on which the distant radio station lies. The new *Navimatic* ADF uses two 13-inch loops that remain fixed.

Three bands are covered by the automatic direction finder: the 190 to 420 kilohertz beacon band including marine and aviation beacons and consolan signals; the 500 to 1400 kilohertz standard broadcast band for U. S. and Canadian commercial broadcasting stations; and ship-to-ship and ship-to-shore channels found between 1400 and 3500 kilohertz.

In operation, the boatman tunes to the frequency of the stations selected and then switches on the automatic feature. A bearing arrow on a dummy compass continuously points out the relative bearing of the signal. For even quicker operation, five crystal-tuned channels can be used to automatically tune-in stations frequently homed on or used for navigation.

LESS THAN SKIN DEEP

A photoelectron spectrometer is like a near-sighted X-ray machine—it can't see very deeply. But what it does see, it sees exceedingly well. It's a new development in spectroscopy—the most significant advance in more than 20 years—that has scientists excited by its promise to quickly and nondestructively analyze the first few layers of the surface of any number of materials for any number of reasons. The photoelectron spectrometer permits nondestructive analysis of only the first two to ten atomic layers of a specimen, by bombarding the material

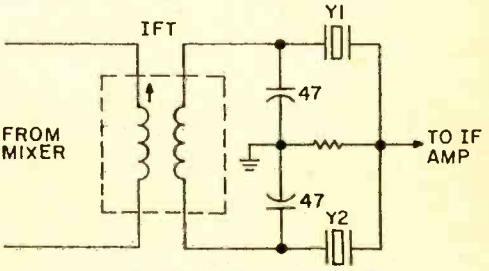
(Continued on page 102)

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.

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

(Continued on page 99)

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:

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Showcase of New Products

Mike Talk

A modern-style microphone, with a slide-action control plus a new compression amplifier circuit to prevent over-modulation, has been made for CB applications by Turner Division of Conrac Corporation. The Turner Model M+3 allows the user to set the volume for up to 20 db gain over

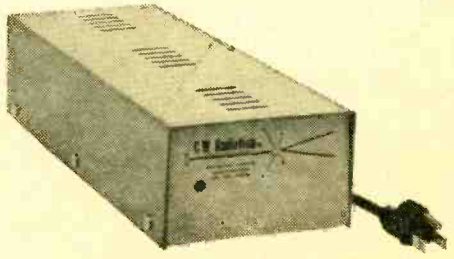
Turner Model M+3 Microphone

conventional microphones with a new slide-action control that is easier to see and use than previous knob designs. The added feature of a compression amplifier circuit then allows the user to talk close to, or far from the microphone without varying the output signal or transmitter modulation. Model M+3 is designed for relay switching, JM+3 for electronic switching. List price of each model is $55.00.

Circle No. 35 on Reader Service Page

Laser Bargain

The model S101 self-contained laser made by the C. W. Radiation, Inc., has a series of inter-



C. W. Radiation, Inc. Laser

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(Continued on page 100)

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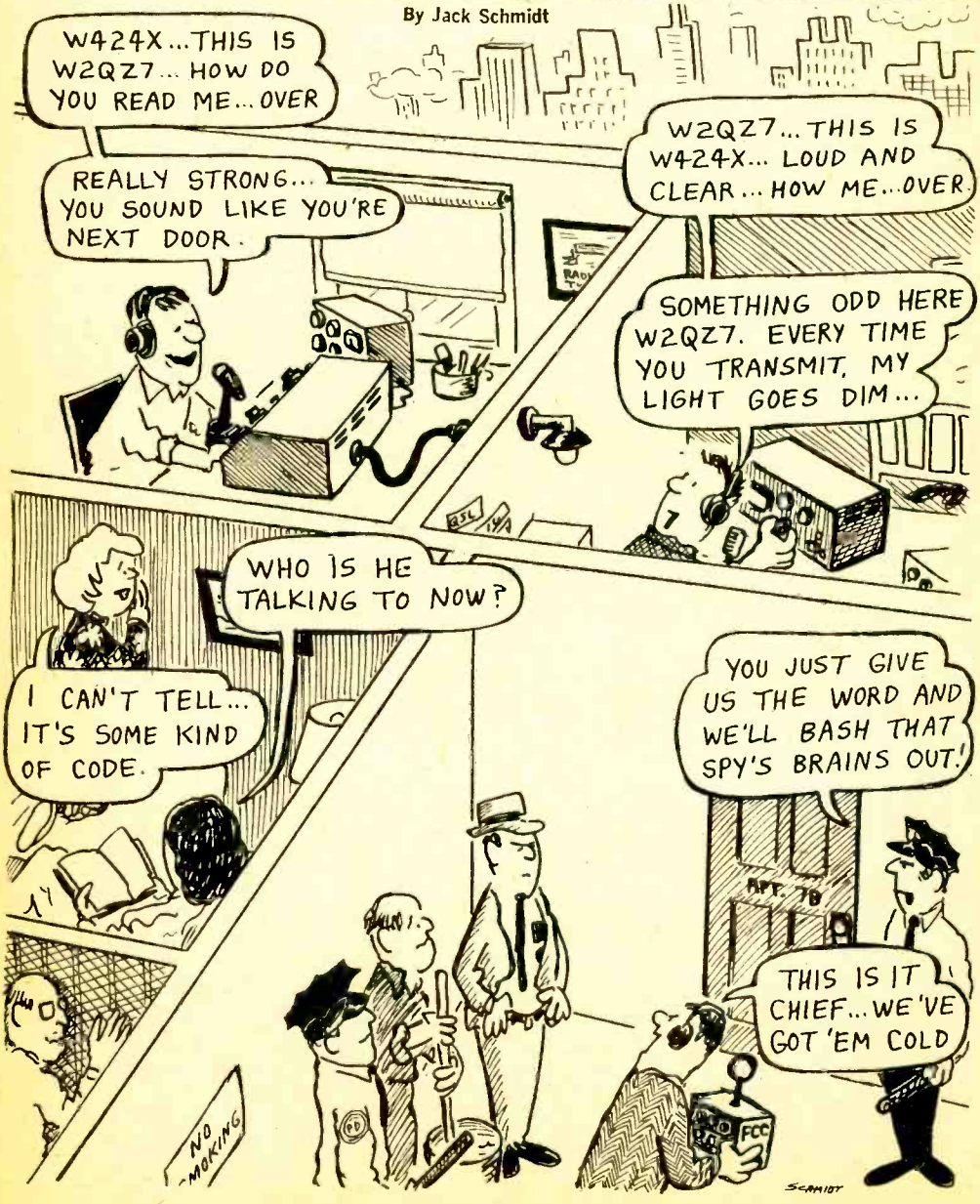
THE HAM IN THE BIG CITY

By Jack Schmidt



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Discover the World of Shortwave Listening

by Jackson Kaye

Becoming an SWL (Shortwave Listener) means more than tossing a coil of wire on the back of a kitchen-type AC-DC receiver and listening to the distant stations roll in. This is not to say that this describes the listening posts of many beginners, but after awhile every beginner wants really to get into this fascinating hobby more seriously. This article will give beginners and old-timers, alike, the combined experiences of several leading SWL's who have dragged some of radio's rarest stations from out of the static—and *without* necessarily spending fantastic sums of money in the process.

THE HOBBY ITSELF. Before delving into the trade secrets of SWLing, let's briefly scan the hobby itself to see what it has to offer. SWLing is actually a peculiar name for the hobby—a name which has ruffled more than one set of feathers in the ranks of listeners.

You don't have to be an expert to roam the dial and tune in Chad, Botswana, Sarawak, Fiji, Upper Volta, Yemen and Nepal. Get started now!

e/e SHORTWAVE LISTENING

Why limit listening to shortwave stations? That's a good question, and a sufficient number of listeners have asked themselves these words to form an entirely separate segment of the hobby. So, while the hobby has become to be generally known as "shortwave listening," it actually means listening for distant stations on *all* frequency bands—usually encompassing the long waves (starting as low as 15 kHz) and running all the way up through the VHF (very high frequency) portions of the radio spectrum where the hobby of watching for far-off TV stations has become popular in the past few years. The hobby is actually getting into the UHF (ultra high frequency) band.

Between these frequency extremes there are literally millions of stations to be chased down, and most SWLs eventually gravitate to a certain group of stations to concentrate upon—well, isn't this an age of specialization? Some of the most popular stations for the specialists are: Hams, SWBC (Short Wave International Broadcasting), Utility (police, aeronautical, maritime, military, point-to-point communications, etc.), Citizens Band, and all of the various broadcasting services, which includes AM, TV, and FM stations.

We will concentrate upon setting up a station which will receive international transmissions—so that naturally excludes TV and FM stations—also VHF transmissions on the ham and utility bands.

The Receiver. A popular misconception among beginners is that just about any piece of electronic equipment which can be scrounged up will be suitable for a receiver. This is *not* so.

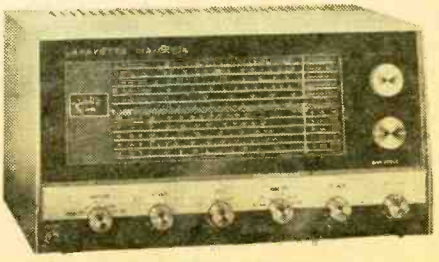
Best results are always obtained from a "communications receiver," that is, a radio receiver specifically designed for reception of frequencies approximately between 535 kHz to at least 30 MHz. These sets have features which include noise limiting circuits, bandspread (fine tuning), a BFO (beat frequency oscillator) for the reception of code and SSB (single sideband) transmissions, an antenna trimmer to match the antenna for maximum performance at the frequency to which the receiver happens to be tuned, and optional features such as an RF gain control to cut down the sensitivity of the set when desirable, and a switch to elim-

Knight Star Roamer II, $69.95

Realistic DX-120, $69.95

Heathkit SW-717, $59.95

Hallicrafters S-214, $89.95



Lafayette HA-600A, $99.95

inate the automatic volume control from the receiver circuit when necessary. This then is the communications receiver and no serious chaser of DX would dare be caught without one.

We do not suggest that you attempt to seriously DX on even the high priced imported radios which have all the foreign cities marked on their dial plates. It's one thing to mark "Tahiti, Minsk, Pago Pago, and Little America" on a receiver, but another to actually hear such exotic DX on the gear (all receiving equipment is affectionately known as "gear" to the SWL). While these sets are very tempting, what with their sleek lines and sophisticated prices, they are generally to be avoided for real listening.

Communications receivers can be purchased for as little as $29.95 brand new in kit form, or you can pick up a second hand receiver for a fraction of its original purchase price. Of course, you can run on up the price scale and start pushing into the high hundreds, but this is hardly necessary unless you have heard all the stations on this planet and want to start pulling them out of the universe. The low-cost receivers are relatively basic and do not contain some of the real aids to listening, but somewhere between $29.95 and $130.00 you should certainly be able to find yourself the set of your dreams. Manufacturers of the most popular receivers are Heath, Lafayette, Hallicrafters, Allied, Knight, EICO, and Realistic. See our table of currently available receivers listing features, price and other data. Be wary of off-band electronic equipment, regardless of price.

SHORTWAVE RECEIVERS FOR THE BEGINNER

Price	Model	FET Front End	Freq. (MHz)	Tuning Bands	Signal Strength Meter	Antenna Trim	Internal Speaker	Band Spread	Kit or Wired	Power (P)
$ 39.95	Knight Star Roamer	A	.200-.400 .550-30.0	4	yes	yes	yes	yes	K	AC
54.95	Lafayette Explor-Air Mark V	A	.550-1.60 5.9-6.25 9.45-9.8 11.45-12.0 15.05-15.5	5	no	no	yes	no	W	AC
59.95	Hallicrafters S-125 Star Quest II	*	.550-30.0	5	no	no	yes	yes (E)	W	AC/12VDC
59.95	Heathkit SW-717	yes	.550-30.0	4	yes	no	yes	yes	K	AC
69.95	EICO 718 Space Ranger	yes	.535-30.0	4	yes	no	yes	yes	W	AC/12VDC
69.95	Knight Star Roamer II	yes	.220-.400 .550-30.0	5	yes	yes	yes	yes	K	AC/12VDC
69.95	Realistic DX-120	yes	.535-30.0	4	yes	no	yes	yes	W	AC/12VDC
75.95	Allied A-2509	yes	.550-1.60 5.9-6.25 9.45-9.85 11.45-12.0 15.05-15.55	5	yes	no	yes	no	W	AC/12VDC
89.95	Hallicrafters S-214		.550-160 5.90-6.25 9.45-9.9 11.65-12.00 15.05-15.6 88-108 FM	6	no	no	yes	no	W	AC
99.95	Allied A-2515	yes	.150-.400 .550-30.0	5	yes	yes	no	yes	W	AC/12VDC
99.95	Hallicrafters S-240		.550-30.0 88-108 FM	5	yes	no	yes	no (T)	W	AC
99.95	Knight R-195	*	.200-.400 .550-30.0	5	yes	yes	yes	yes	K	AC/12VDC
99.95	Lafayette HA-600A	yes	.150-.400 .550-30.0	5	yes	yes	no	yes	W	AC/12VDC
119.95	Realistic DX-150A	yes	.535-30.0	4	yes	yes	no	yes	W	AC/12VDC
129.95	Heathkit GR-78	yes	.190-.410 .550-30.0	6	yes	no	yes	yes	K	9.6VDC (B)

A—uses tubes, K—kit, W—factory wired, *—not announced, E—electronic bandspread, T—fine-tune vernier, P—12 VDC power supply usually external, B—built-in recharger

e/e SHORTWAVE LISTENING

The Sky Hook. Don't ask why, but everyone in SWL circles calls an antenna a "sky hook." Regardless of the comical name bestowed upon antennas, they are, nevertheless, an extremely important part of your receiving setup.

The most common antenna for all band receiving is simply 100 feet of wire strung on insulators out of your window to a point on a telephone pole or other building. See Fig. 1. Glass or porcelain insulators should be used at each end of the antenna and the wire should be kept in the clear of all objects (especially metal) along its length. You will find that this antenna will receive best in the direction broadside to the length of the wire.

A possible aid to this type of antenna would be to attach as short an insulated wire as possible from the chassis of the receiver to a *cold* water pipe. This often helps reception, but sometimes makes absolutely no difference. Most receivers have a terminal on the rear deck marked "G" for the ground connection.

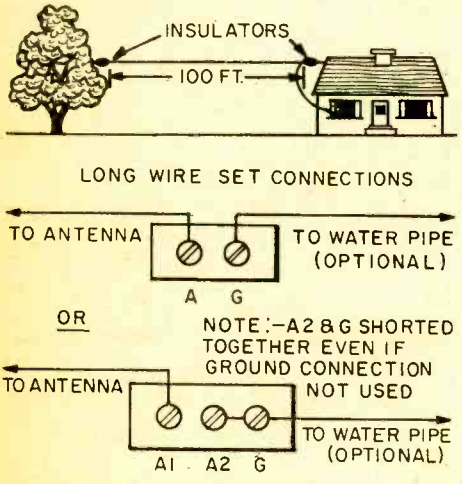
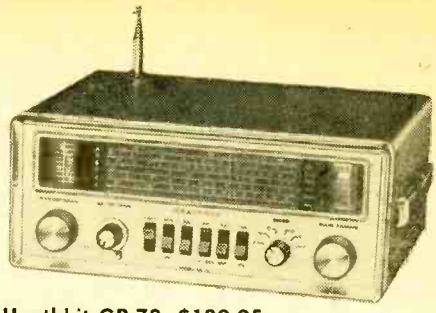


Fig. 1—This simple 100-foot antenna should be connected to the shortwave receiver as shown. The pipe-ground connection may not be needed.

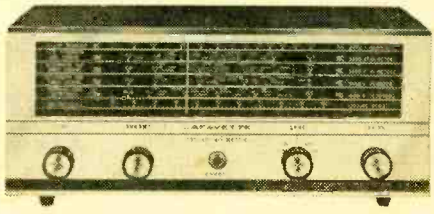
Doublet. Another popular antenna for listening is the "doublet," which will also receive broadside signals, with best reception offered on specific bands to which the doublet is tuned. The doublet is tuned for only one specific band, and this is determined by the length of the antenna as given in the



Heathkit GR-78, $129.95

Knight R-195, $99.95

Hallicrafters S-240, $99.95



Lafayette Explor-Air Mark V, $54.95

Realistic DX-150A, $119.95

Doublet Measurements Table. The antenna is to be constructed with No. 12 or 14 wire, and fed with 75-ohm twin lead or RG-59U coaxial cable. See Fig. 2. At the receiver end of the antenna, one side of the twin lead is attached to the "A" or"A1" terminal on the rear deck of the receiver. The other wire on the twin lead connects to the "A2" or "G" terminal. If coaxial cable is used, the center conductor of the cable connects to the "A" or "A1" terminal, and the outer shield of braided copper connects to "A2" or "G."

Doublets cut for various bands are inexpensively available from Mosley and Hy-Gain. These are to be found at many dealers and are listed in mailorder electronics catalogs.

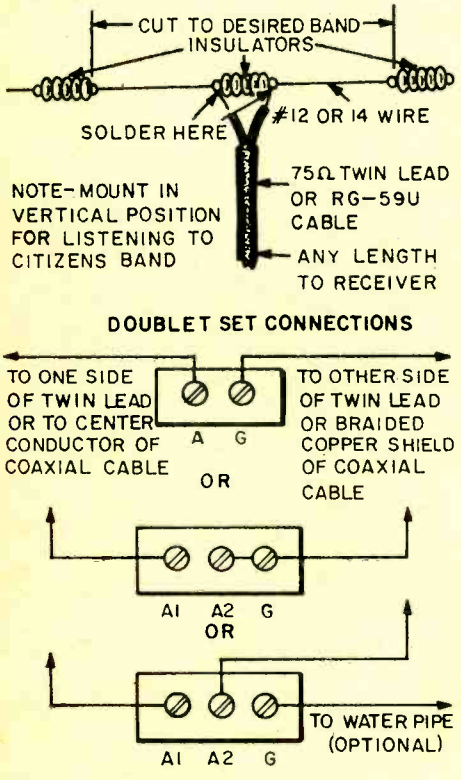


Fig. 2—How to construct a doublet antenna and connect it ot your receiver, using measurements from the table below. Note the mounting position for CB listening.

Double Measurements

Band (Meters)	Overall Length (Feet)	Band (Meters)	Overall Length (Feet)
10/11	16	31	48
13	21	40/41	66
15/66	22	49	76
19/20	33	60	95
25	39	75/80	120

Accessories. Now that you've got the receiver warmed up and the sky hook all hooked, you will find that certain accessories will make your listening more convenient and efficient.

For instance, what about a headset (also known as earphones, headphones, or "cans") You will find that stations which might just be barely audible ("readable") in the noise ("QRM" or "QRN") will pop out into the clear when you are wearing *cans*. When purchasing a headset, make certain as to whether or not your receiver offers a high or low impedance. If your receiver does not offer provisions for your using a headset, one may be easily attached in parallel with the loudspeaker from the audio transformer. Low impedance phones of about 10 ohms would be used in this instance. It will be necessary for a switch to be inserted in this circuitry so that you can switch back and forth from speaker to cans as required by conditions. Hi-fi stereo headphones are great for the job.

Now that you're listening to that distant station it would be a shame if the fellow in the next apartment, or in the house down the road decided to use his electric razor, or some other devilish instrument of torture to the constitution of every ardent SWL. What do I mean? Well, if you've ever tried to nurse a station out of the great beyond only to have the identification obliterated by a burst of man-made static then you can't

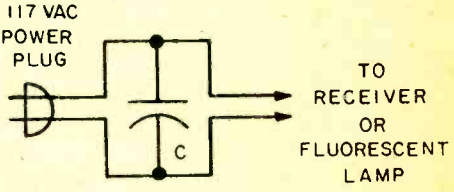


Fig. 3—One cure for man-made static is to put this .05-uF capacitor across the power line.

count yourself among the "in" crowd of SWLs. In most instances, this interference can be eliminated by the insertion of a line noise filter (see Fig. 3) consisting of only a single .05-uF 600-volt capacitor in the power line cable of your receiver. Be sure to solder all connections and it would be a good safety measure to enclose the whole thing, capacitor, connections and all, in one

of those medicine capsule plastic containers which are given out by drug stores.

If you have the common problem of an annoying buzzing from a fluorescent desk lamp, the problem is easily conquered by the simple addition of a .01-uF 600-volt disc ceramic bypass capacitor across the power line. Best place for this connection is inside the base of the lamp where it will be unobtrusive. By the way, don't forget to unplug the lamp and receiver.

Squelch. A further refinement in your receiving station can be had by adding a squelch circuit, something not normally found in inexpensive communications receiver, but mighty handy if you intend monitoring a single utility frequency over an extended period of time. Eventually the back-hiss and static will have you on the way to the funny farm but our little squelch device will silence the receiver altogether—

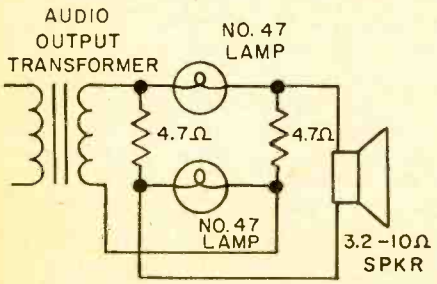
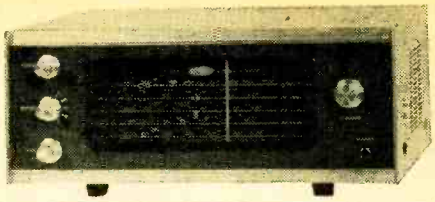


Fig. 4—A squelch circuit is handy for long-term monitoring of a single utility frequency.

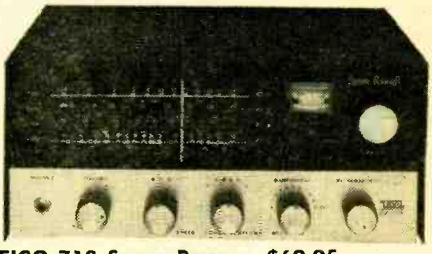
that is until a signal pops onto the frequency. There is a slight loss in audio when you use this gadget, but this is easily compensated for by adjusting the volume control.

The squelch circuit (see Fig. 4) consists of two No. 47 lamps wired into the speaker leads together with two 4.7 ohm resistors, details are simple and are shown in the schematic diagram. This device is well worth the slight effort and few cents expense to silence the receiver during periods of no-signal.

SWL Antenna Tuner. Should you find yourself with a receiver not having an antenna trimmer for peaking the set and antenna on your monitoring frequency, you might try tinkering with a tuning device of your own. See Fig. 5. About as basic as you can get, it consists solely of a 150 uuF mini-



Allied A-2509, $75.95



EICO 718 Space Ranger, $69.95

Allied A-2515, $99.95

Hallicrafters S-125 Star-Quest II, $59.95

Knight Star Roamer, $39.95

Bob Zilmer of Milwaukee, Wisconsin, is a member of the American Short Wave Listeners Club. He does his tuning with Drake 2-C and SPRA4 receivers. The photo also shows a cassette recorder Bob uses to help remember details when he sends in reports to shortwave stations. The clock is a 24-hour type.

This dyed-in-the-wool SWL is John Zaharek. Though industrial arts is the vocation of this resident of Torrington, Conn., he enjoys tuning this Realistic DX150A rig. Note the neat array of framed DX certificates on his shack wall.

Martin Martelle of Sarnia, Ontario, Canada, calls himself "The Happy Listener." His listening gear includes a Hallicrafters S-38D receiver, a Heathkit Trio Jr.-200 receiver, a Lafayette VHF monitor, and various types of CB equipment. Considering the number of QSL cards displayed on Martin's wall, The Happy Listener must also be known as The Avid Listener.

ature variable capacitor and a sub-miniature antenna rod (Miller type 2002, or equivalent). When a station is heard, both the capacitor and the coil slug are tuned for maximum signal loudness or maximum reading on the receiver's S-meter.

Other Gadgets. Other electronic attachments to your station would come into the "elite" class and might include such things as a tape recorder, remote speaker, digital clocks, etc. These are useful devices but are certainly not a necessity for basic listening. If you can build or buy a small 100 kHz crystal calibrator you will probably find it handy, but far from a necessity. Some of the more expensive receivers have these calibrators built in.

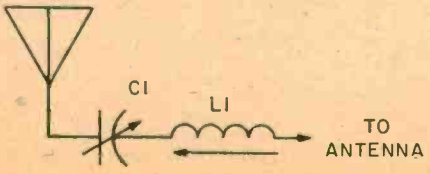


Fig. 5—If your set has no antenna trimmer, you can easily make up this tuning device.

Non-electronic aids for the listening post include a *good* world atlas or map, a log book and an up to date listing of the stations you expect to monitor. Ham stations are listed in the Radio Amateur Callbook (published 4 times a year with separate U.S. and foreign listing editions, and sold through most ham radio stores or mail order hous-

(Continued on page 97)

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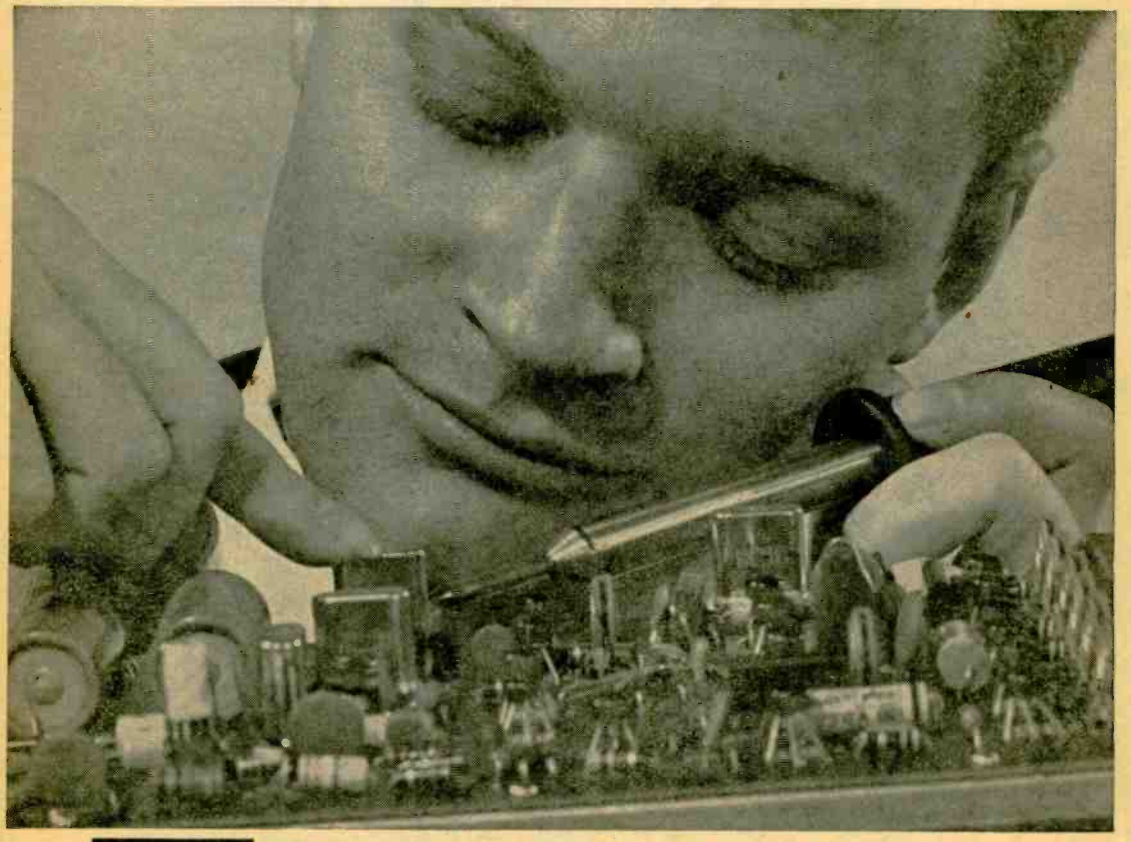

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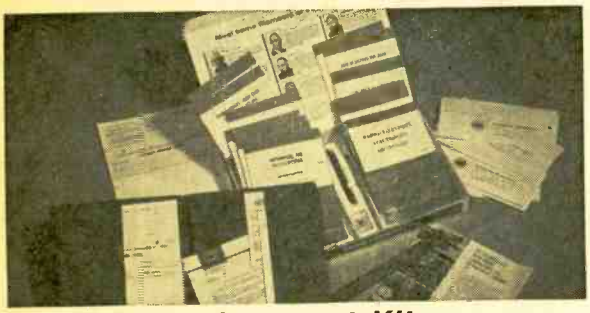

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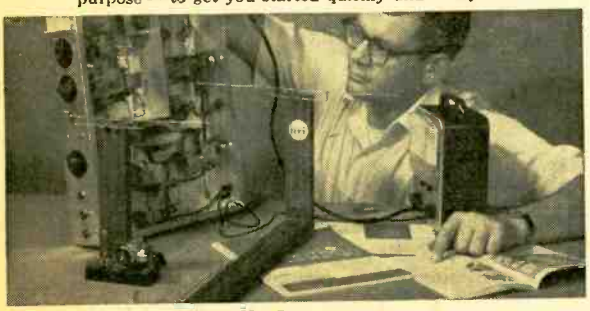

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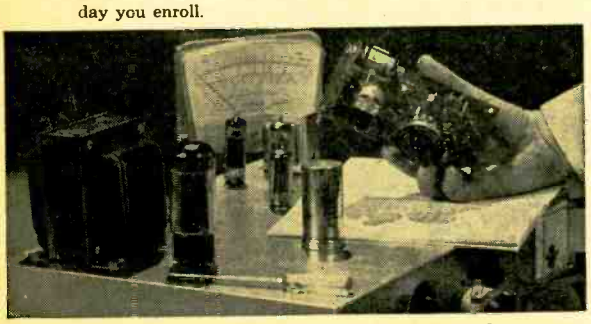

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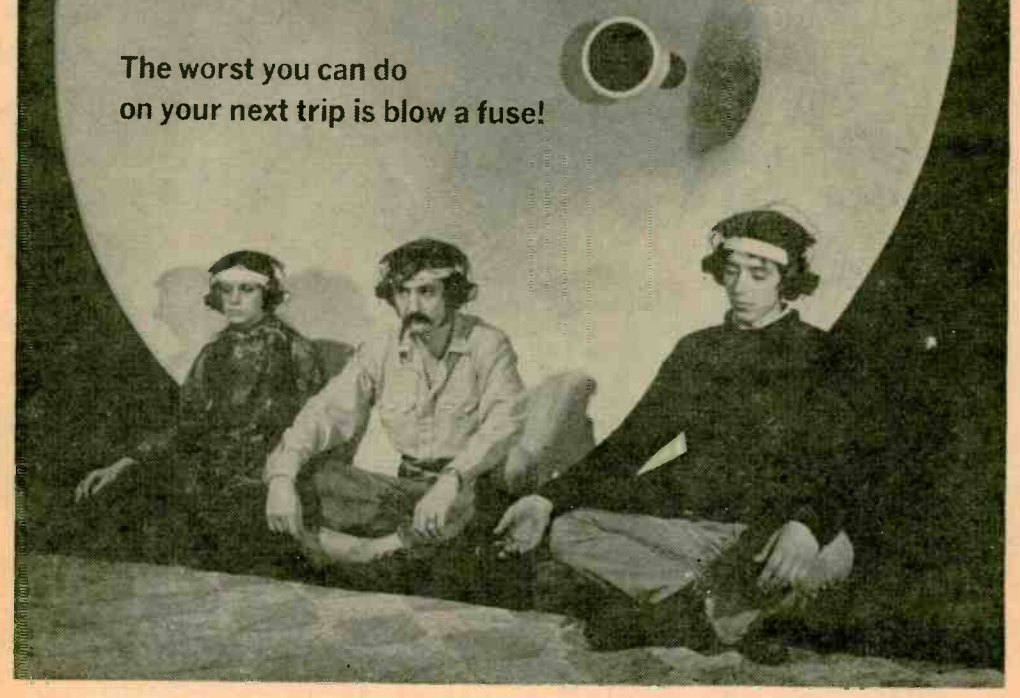
ACCREDITED MEMBER NATIONAL HOME STUDY COUNCIL

RIDING HIGH ON YOUR ALPHA WAVES

The worst you can do on your next trip is blow a fuse!



Put down that pipe and pick up these Alpha-phones—just turn on to your own brainwaves and get high (legally, of course). All it takes is a little control and training and your head can fill you with tranquility and peace. Sound like a good trip? Well, it is and we all possess the ability to turn on this way. The secret lies in your own brainwaves, or should we say Alpha waves. This discovery is the result of research being done by both Japanese and American scientists on the electrical activity that constantly goes on within one's own head. The brain is continually producing small electrical currents on different wave lengths. During the research it was discovered that certain mental states were associated with the prominence of certain wave lengths (such as the state of consciousness of a Zen master). When large amounts of Alpha waves are produced, people appear extremely relaxed, yet quite open and sensitive to outside stimuli.

Alpha waves are produced by everyone and they may be characterized by a high fluttery sound. However, the waves are generally random and almost totally dominated and even drowned out by Beta waves, also produced by the brain. Dr. Joe Kamiya, at the Langley-Porter Neuropsychiatric Institute in San Franciso, decided that there was no reason why the average person couldn't learn to turn on his Alpha waves at will, even though they had no training in the meditative arts. He attached electrodes to the skulls of volunteers, and connected them to an electroencephalogram (EEG) to record the changing voltages of brainwaves. When the test person was in the Alpha-state, a bell or bleep would go on, turning off when his Alpha wave was drowned in Beta. Soon the subject learned how to turn on his Alpha—no encouragement was necessary since most of those

Gene Estribou (left) adjusts a tape in his sound room. He uses both music and tapes of Alpha waves to create the total environment with the aid of a huge speaker.

With the aid of Alphaphones, these two women (right) are learning how to turn on their Alpha waves at will. After a little training, they will be able to achieve tranquility and peace of mind through proper thinking.

Battery-operated Alphaphones can even be worn while in water without any worry. Gene relaxes with some friends in his Japanese bath (above) as they turn on their Alpha.

tested found the experience rather pleasant and tended to describe the sensations in terms usually associated with drug highs.

As a result of his work with Dr. Kamiya, Ken Keefe, a psychologist, began working with Gene Estribou, a micro-biologist, to try training themselves to turn on large amounts of Alpha. They did this by wiring themselves up to laboratory EEGs. "We thought, wouldn't it be great if we could get more people, whole communities for that matter to turn on Alpha. It would have such a fantastic effect on their peace of mind and general level of sanity. But an EEG machine costs anywhere between $6,000 and $40,000. So we set about trying to compress that vast laboratory equipment into something relatively cheap and portable for people to use to turn on at home." Their research continued for over six months, and the result of their labors was the Aquarian Alphaphone, or just Alphaphone for short.

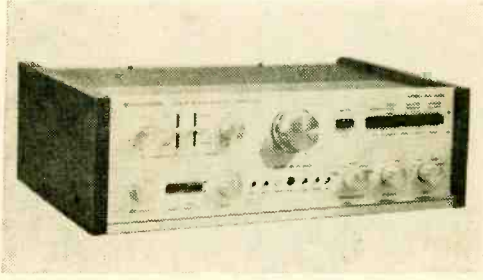
With the aid of the Alphaphone, a person is able to listen to his own brainwaves—the headset amplifies the sounds of these waves. In this way, the individual can determine when he is in an Alpha-state. These headphones are merely designed to teach the person how to achieve an Alpha-state by practicing the calm thinking that produces the Alpha waves. Through the use of the Alphaphones, one eventually learns what types of thoughts and moods produce Alpha waves. The headphones operate on batteries, so you can even wear them in water without any worry.

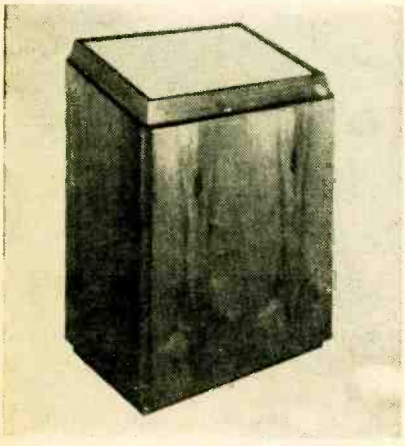
During an Alpha "trip," a high fluttery sound fills the person's ears. A warm, glowing feeling flows through the limbs, and peace of mind is achieved. People have continually searched for such relaxed states but generally these sensations were only externally induced. Due to the work of these men, people can now turn to their own brainwaves as a means to reach peace with themselves. And, there is no worry of addiction or withdrawal! —*Joe Gronk*

E/E looks at new...

For the music lover who wants a quality AM/FM stereo receiver, but doesn't need high-power output, Sansui has the 100-watt 1000X, at $269.95. Circle No. 45 on Reader Service Page.

At the top of Kenwood's line of stereo amplifiers is the 196-watt (IHF) KA-7002, featuring direct coupling and a complementary-symmetry driver stage to deliver clear, pure, undistorted stereo sound, for $299.95. Circle No. 46 on Reader Service Page.





Harman-Kardon's new approach to omnidirectional sound is the Citation Thirteen speaker system, at $295. The 14-degree tilt of the mounting board, to which all drivers are attached, produces a natural blend of direct and reflected sound. Circle No. 47 on the Reader Service Page.

A versatile high-impedance, cardioid, dynamic microphone ($29.95), floor stand ($17.95) and adjustable boom ($11.95) from GC Electronics. Circle No. 48 on the Reader Service Page.

HI-FI COMPONENTS

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.

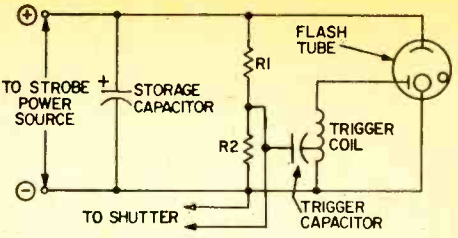
Note that in our *Photog's Third Eye*, SCR1 is directly in series with the shutter contacts. When phototube V1 is energized by a flash of light from the main strobe, its gaseous atmosphere momentarily breaks down. Result is a positive pulse applied to the gate of SCR1. The SCR, in turn, fires,

PHOTOG'S THIRD EYE

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 will be insulated from the case.

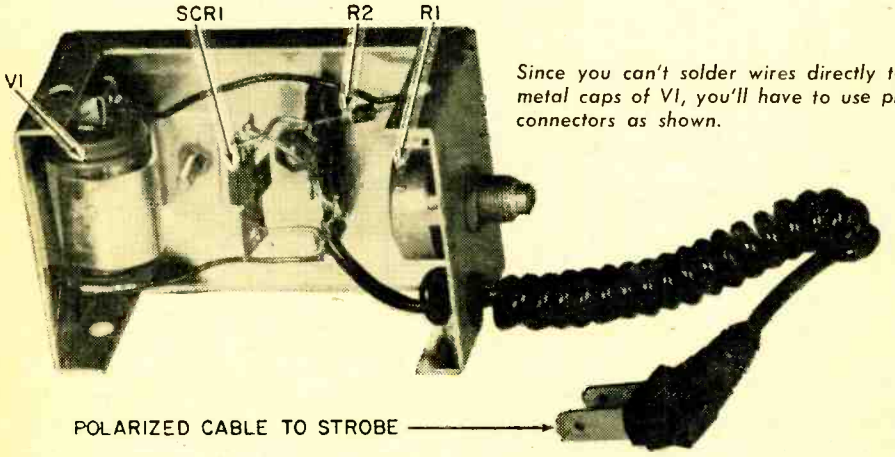


In this simplified strobe, the trigger capacitor is charged by the power supply and discharged by closing the trigger contacts.

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

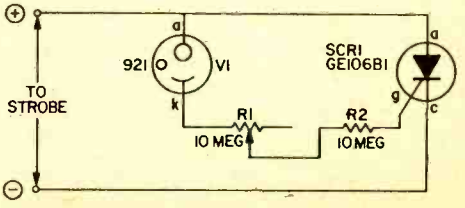
(Continued on page 96)



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.

KATHI'S CB CAROUSEL

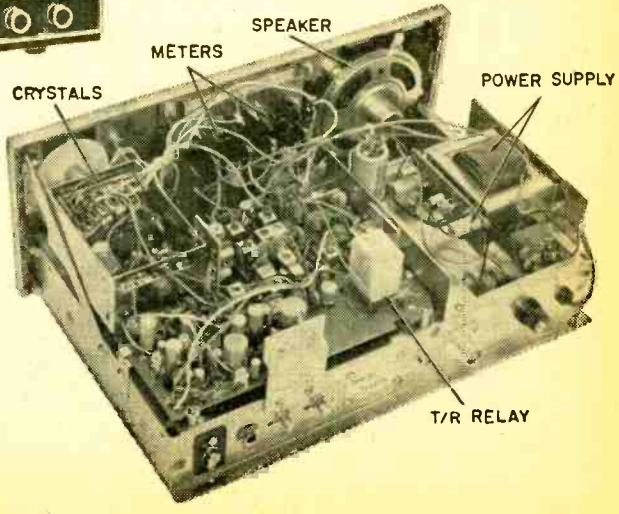
By Kathi Martin, KAI0614

I don't know about you, but the spirit of egg nog, holly berries, and a little pink-cheeked man squirming down the chimney is already upon this YL's shack. Although Thanksgiving is still a few weeks away, I've started my yuletime gift list. Seems to me that my local electronics mail order outlet is as busy with wide-eyed CBers carting home goodies as is the downtown department store trying to cope with the crush of women returning armloads of duplicate gifts the day after Christmas.

Gift swapping for CBers isn't much different than trying to satisfy any other group of electronics devotees. First, know your recipient's base station setup; that'll save you from the embarrassment of buying a piece of gear the CB enthusiast can't make use of. On the other hand, if you can't exactly afford to let your cup of goodies runneth over, useful accessories like a logbook, or supply of new QSLs, would bring a smile to any CBer's face. And some Band buffs, lucky bunch for sure, are going to tear open a carton holding the Ultimate Gift: a new rig!

If you're thinking of giving the U.G. to the type of CBer that tailors his modulation for maximum "talk power," or if he's the kind of CBer who delights in tuning his antenna system as fine as a gnat's eyelash in hopes of mustering up every smidgen of soup out of the sky hook, *B&K's Cobra 25 Base Station Transceiver* might well be the answer to his dreams. Obviously intended for the professional and experimental CBer, the *Cobra 25* features a built-in double duty SWR/modulation meter, and a second combination power output/S-meter setup. It also sports a do-it-yourself mike connector, and a microphone gain control. All this built into a 23-channel base-station-only transceiver.

Snake Charmin' Straight Talk. Let's talk about the *Cobra's* first things, first. The *Cobra 25* is supplied with all crystals, but as I said before, comes less the microphone.



B&K's Cobra 25 Communications Transceiver features two meters that monitor several functions. The unit comes with all crystals, but without a microphone, allowing the CBer to choose his favorite type. The total transceiver consists of several sections mounted on a rigid chassis assembly. To make tests and service a little bit easier than usual, the power-supply components are completely independent of the main printed-circuit board. Both the power-supply output and the modulation limiting can be adjusted by the Cobra 25's owner.

Reason for this seeming omission becomes clear once you think about it. The pro, or advanced CBer, would almost certainly want to provide his favorite type of microphone! There's no need to worry about what type of mike he tries to plug into the *Cobra 25*—standard dynamic type, built-in amplifier, mike-with-compressor—all work well because cranking up the mike gain control while watching the modulation meter draws optimum modulation from any mike. The only restriction is that the microphone (or mike with built-in compressor/amplifier) has a low-impedance output.

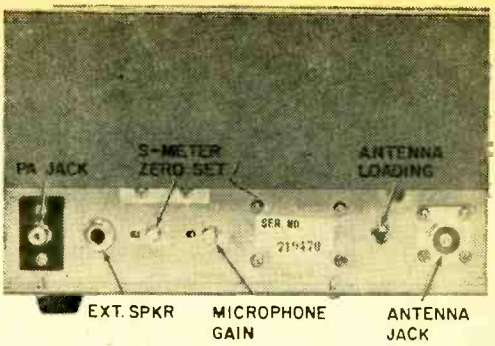
Two meters allow full-time monitoring of just about, well . . . everything! One meter triples as an S, RF output, and SWR forward power meter. The other meter doubles as a percent modulation/reflected power meter. With the front panel Mod/SWR switch set to SWR, the meters indicate the forward power and the reflected power (SWR). Set the switch to Mod, and one meter indicates the percent modulation, while the other meter indicates the forward power. In the receive mode, one meter is inoperative, while the other functions as an S-meter.

The SWR metering equipment, by the way, is actually a section of transmission line with both forward and reflected power pick-off loops and detector diodes. Everything's built into the transceiver—there are no external cables or connections.

Cuddled around the front panel are the microphone connector and what appears to be a vast array of six controls: channel selection, SWR calibrate/power output trimmer, squelch, volume, PA/CB selector, and a three-position Delta tune. In addition to the Mod/SWR panel switch on the *Cobra 25*, there is a Noise Limiter on-off switch.

Turning the rig on its ear, the CBer finds that the *Cobra 25's* rear apron has the an-

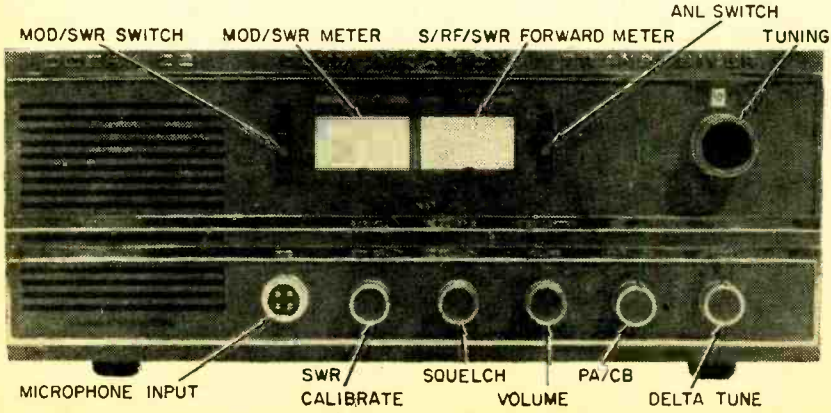
(Continued on page 95)



A mike gain control is provided on the rear apron of the Cobra 25. Just about any mike and voice level results in 100% modulation.

B&K Cobra 25 Box Score

Power supply—117 VAC
Sensitivity—1.1 uV
Selectivity—60 dB
Image rejection—86 dB
AGC action—3 dB
Input level for S9—20 uV
RF output—3.8 watts
Modulation to 85%—Yes (adjustable)
Relative microphone sensitivity for 85% mod.—Adjustable
Modulation limited to 100%—Yes



The front end of the B&K Cobra 25 is all business, with dual meters providing full-time monitoring of SWR, power outout, percent modulation and received signal strength.

e/e checks out a...

Sophisticated Electronic Oven kit

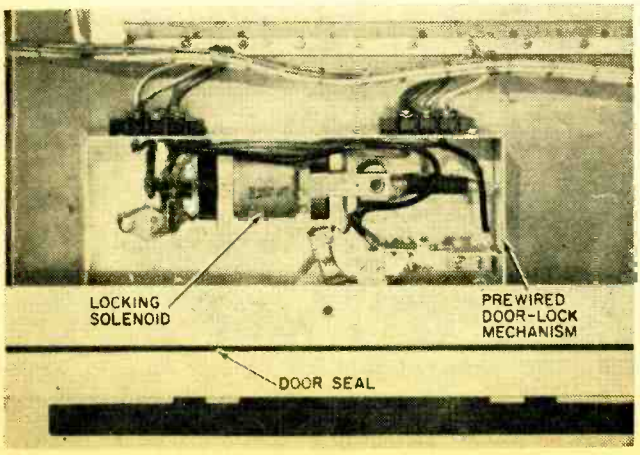
Bake potatoes in 4 minutes, cook hamburgers in about the same time—with electronic cooking! The Heath microwave oven, with safety interlocks, takes only a couple of evenings to build.

In the time it takes for you to say Galloping Gourmet, you, or your wife, can start rummaging through the refrig for a snack and get a fully-cooked, piping hot meal on the table! Drool no longer. With electronic cooking, you can prepare a full-course gourmet meal in less time than it takes to think about *Heathkit's GD-29 Electronic Oven.*

Just a few examples illustrate the speed of electronic cooking. Baked potatoes usually take at least an hour in a conventional oven—not even allowing for the time needed to heat the oven. *Heath* electronic cooking takes but 4 *minutes.*

A grilled cheese sandwich takes about 1 minute, while burgers or ground steak takes several minutes. It all depends on whether you like your meat rare or like shoe leather. Roast beef takes but 5 minutes per pound, while a turkey needs 10 minutes per pound. And, just in case you've pulled the dinner out of the freezer rock-hard, add 30 seconds per pound to allow for thawing.

Even cooking. An interesting—and never before attainable with any other cooking medium—feature of *Heath* electronic cooking is *uniformity.* If you want rare roast



The Heathkit GD-29 Electronic Oven is designed so that anybody can operate it, and almost anybody can build it. The prewired door-lock mechanism turns off the Magnetron whenever the oven door is opened, and there's a backup interlock just in case that doesn't work. Other safety devices make the oven foolproof.

beef, it is rare from inside to outside, and from end to end. Want well-done steak-burger? It is uniformly well-done from core to shell. But bear in mind that electronic cooking means *roasting* or *heating;* you cannot prepare a char-broiled steak in an electronic oven because there is no *sear heat* as there is in a conventional oven.

The Molecules Move. Electronic cooking bears no relationship to normal high temperature cooking. Fact is, there is really no external heat in electronic cooking! The actual "cooking" is accomplished through molecular movement caused by microwave radiation.

The *Heath Electronic Oven* is basically a metal cabinet surrounding a Magnetron oscillator. It's essentially the same type of oscillator used in radar equipment. The 650-750 watt Magnetron oscillates at 2450 Mhz; a waveguide (just like in radar) spews RF output to the main oven compartment.

When food is placed in the oven compartment, it is subjected to "bombardment" by the microwave radiation, which causes the food molecules to vibrate. The vibration of the molecules generates heat, and it is this molecular-movement heat which cooks the food. Since the radiation more or less penetrates the food evenly, all the molecules vibrate with equal intensity. Result: the heat, and therefore cooking, is uniform throughout the food.

As you would expect, the greater the food density, the greater—and more close—the individual molecules. Dense food such as roast beef "cooks" faster than a low-density food such as fowl (turkey, chicken, etc.)

Water content is the key to molecular density. Ordinary paper plates and even glass can be used as cookware because they will not heat—there is no water density, hence, no heating through molecular movement. Fact is, paper plates don't even get warm! Metal cookware *cannot* be used because it reflects the microwaves. Food placed in a covered metal pot would come out "ice cold" because the metal reflects all the microwave energy away from the food.

Inside Heath's Electronic Oven. The *Heath Electronic Oven* consists of a decorative cabinet containing a shielded Magnetron compartment. Also, there's a waveguide that transmits the microwave radiation to an interior cooking compartment (the oven), a *stirrer* that distributes the microwave energy equally throughout the oven, a timer—and a heck of a lot of safety interlocks.

The oven compartment contains a glass shelf that allows the microwave radiation to enter the food from the bottom as well as from top and sides. The oven door has both a capacitive plate shield and a vinyl door seal to prevent excessive exterior radiation. In addition, the door has an interlocked handle that turns off the Magnetron as soon as the lock is released. A back-up interlock disables the Magnetron if the door is opened; the Magnetron is therefore disabled even if one or the other of the door interlocks fail.

Because metal cookware reflects microwaves, this pie was baked in a glass pie-plate, and could have even been baked in a paper plate!

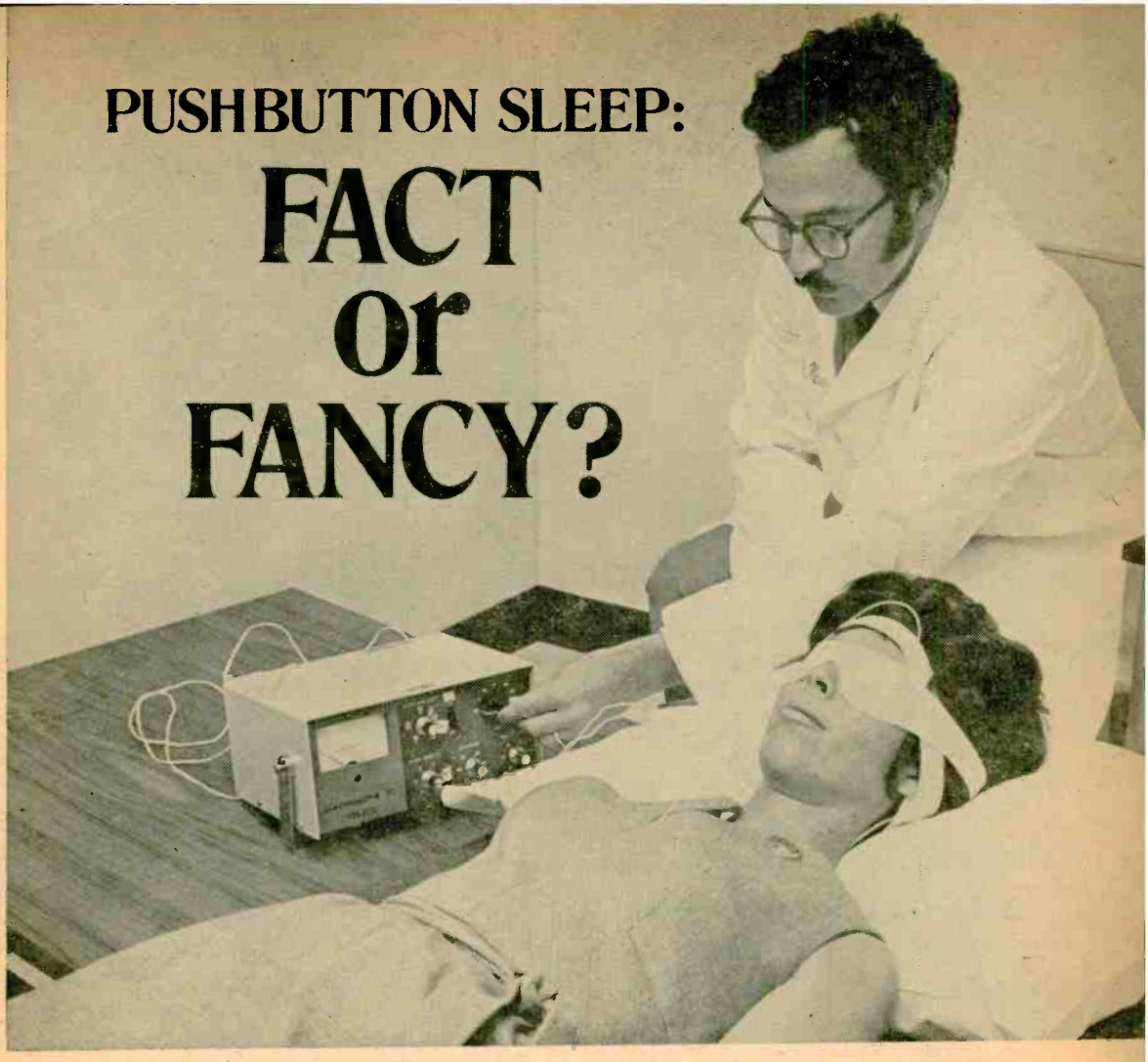
The timer also receives its power from the door interlock so that it stops when the door is opened, allowing foods which require shorter cooking times to be added to the oven without affecting the cooking of items previously placed in the oven.

Other features include a *fluorescent oven light,* an *external circuit breaker,* a *power on lamp,* a *cook lamp* that indicates the Magnetron is on, a *door open* lamp that warns if the door is not closed and a *high temperature lamp* that indicates the Magnetron heat is excessive—that the filter needs a cleaning. (The Magnetron is air-cooled by forced air).

Mostly Metalwork. Unlike most other kits which you might have assembled, the *Heath GD-29 Electronic Oven* requires little electronic assembly. Most of your work goes into assembling the metal components comprising cabinet, oven, door, waveguide, etc. The electrical assembly consists pri-

(Continued on page 104)

PUSHBUTTON SLEEP: FACT or FANCY?



Does an electrosleep machine actually put you to sleep, or does it work simply because you believe it does?

/By Webb Garrison

Ten years ago no U. S. research worker who valued his reputation would have admitted interest in using electrical devices to induce sleep.

Today this special application of a still-mysterious force is one of the hottest areas of medical research. Ranks of Americans who were considered to be hopelessly addicted to bedtime pill-popping have already been thinned a little. Some of the nation's leading clinics are eagerly testing, or planning to test, solid-state electrosleep machines.

Sophisticated new variants of methods long linked with quackery are yielding positive results that can't be ignored. Debate still flourishes, though, on the unresolved question of whether results stem from pulsating current entering the brains of patients—or from subjective reactions to techniques and gadgets.

A Willing Guinea Pig. Take the case of Harold Y. A successful junior executive whose performance during the next two or three years will determine whether or not he makes it to the top, Harold has always been rated as exceptionally competent.

He sometimes suffers from periods of depression, though. Since 1959 he has been plagued with insomnia that didn't respond to any conventional treatment. Harold's physician prescribed Elavil and later Librium.

e/e PUSHBUTTON SLEEP

Neither drug helped him. Valium, another standard pharmaceutical weapon against sleepless nights, was totally ineffective. So was chloral hydrate.

Though he showed some symptoms of anxiety, nothing in his personality profile indicated that intensive psychiatric treatment was needed. There was nothing left—or so it seemed.

As a desperate last resort, Harold's family doctor referred him to an electrosleep clinic where he registered as an outpatient. Neither he nor his physician had any real hope of positive results, but every other alternative had been tried.

He took a battery of tests. Finally the day came for his first treatment.

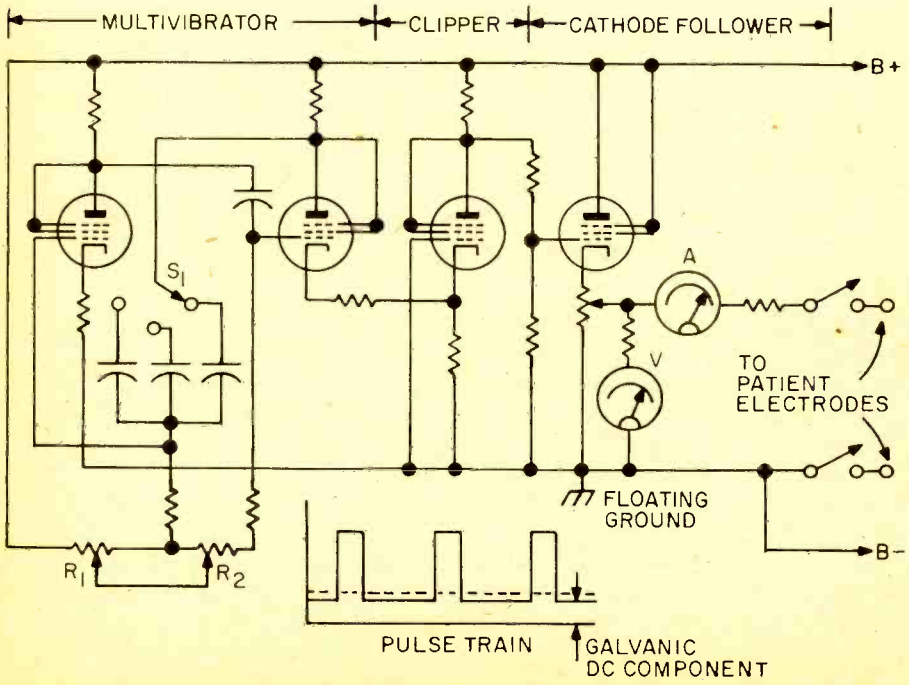
At the clinic, the specialist working with him had already explained that he would be treated with the Electrosone 50. This machine is based on the circuitry of the Electrosom "sleep machine" widely used in Russia, but differs from the Iron Curtain device in several important respects.

Electrosone. Manufactured and sold by Tri-Tronics Laboratory, Inc., near Dallas' Love Field in Euless, Texas, the Electrosone 50 is the only electrosleep machine that has won F.D.A. approval. Currently, such approval isn't absolutely necessary. Unless electronic medical devices can be considered "drugs" under recent court interpretations, they don't have to prove either efficiency or safety.

This situation may change any time, however. Once such devices are promoted for sale to the public, the F.D.A. is likely to initiate regulatory action. Two major brand-name electrosleep machines, made in Russia and Germany, are readily available in Europe and other parts of the world. So are half a dozen competing products.

Even without specific laws governing manufacture and sale in the U. S., F.D.A. pressure is strong enough to limit distribution to "qualified scientific investigators" wishing to use electrosleep machines for research purposes. This meant that in subjecting himself to treatment by means of the Electrosone 50, Harold Y. was a willing

What's Inside a Sleep Machine?



Schematic of Russian-developed sleep inducer (above). The machine's output resembles the brain's alpha rhythm. The sleep inducer on the opposite page will modulate dreams.

guinea pig. The result of his experience could affect the future of the electronic device as well as his own health and career.

From his doctor's instructions, Harold already knew that he didn't have to strip and don a hospital gown to receive his first treatment. So he walked into the clinic wearing an ordinary business suit. He elected to lie down—not because this is considered necessary, but because it is more comfortable than sitting.

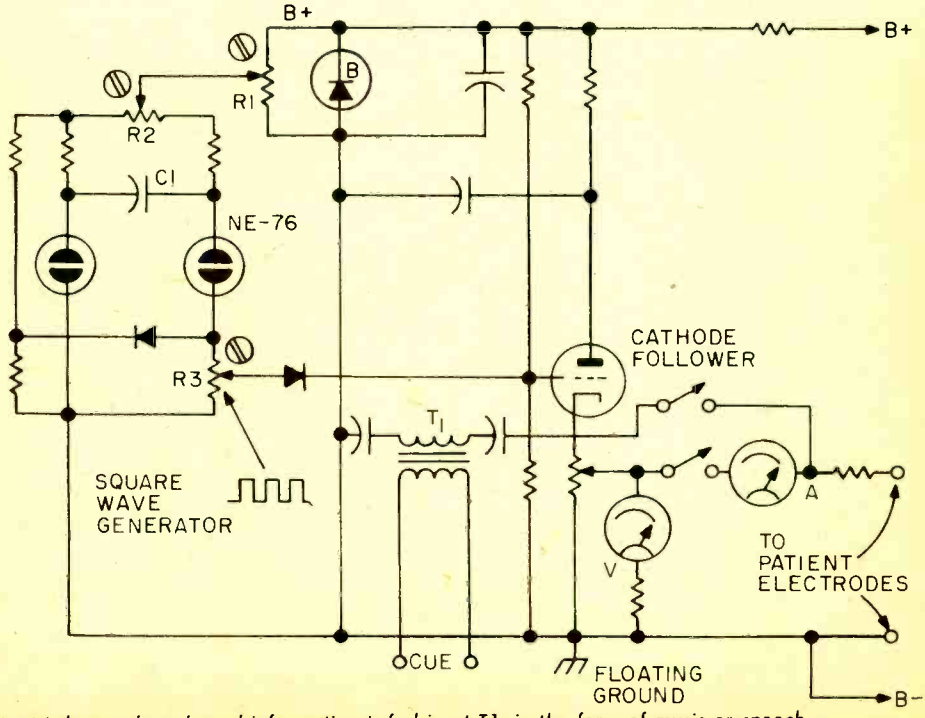
Sleep Treatment. A sleep mask was placed over his eyes in such away that the built-in negative electrode was positioned over his eyelids and the positive over his mastoid areas. It took only seconds for connection of the positive wire to the mastoid electrode and the negative wire to the eyelid electrode.

Electrical contact, Harold already knew, would be made by means of throw-away plastic pads moistened in a saline solution to improve electrical conductivity. Manipulating dials of the Electrosone 50, his physician set the machine for a frequency of 100 positive pulses per second and a pulse duration of 1 millisecond. By turning a third dial, the timer control was set for a thirty-minute treatment with automatic cutoff.

Harold felt a slight "prickling" or "flashing" sensation over the eyes. Then the same sensation was felt in the mastoid area. He was in no way uncomfortable—simply aware of the reaction he had been told most patients experience. He knew enough about electronics to realize that the squarewave pulse yielded by the Electrosone 50 closely approximates the brain's alpha wave.

Tense for a few minutes but never actually apprehensive, the patient soon relaxed. Though he didn't fall asleep, he found himself in that never-never land where there are no conscious thoughts or dreams. His pulse rate and breathing assumed such patterns that though fully conscious, he was, for clinical purposes, asleep.

At the outset, Harold had agreed to a course of ten half-hour treatments. Largely as a courtesy to his physician he completed the entire series. After the third treatment he found himself drifting off to sleep more easily and sleeping more restfully than in years. He voluntarily gave up all medication.



The output is lowered, and cued information is fed in at T1, in the form of music or speech. Frequency is determined by R1 and C1, pulse width by R2, and output amplitude by R3.

e/e PUSHBUTTON SLEEP

Still waiting to see whether or not he'll get the promotion that will determine the course of his career, Harold Y. threw away his bottles of pills after his seventh electrosleep treatment. In the nearly eighteen months that have elapsed since he received treatment #10, he has had only a few sleepless nights.

Though the name is fictitious and details have been changed to prevent identification, the story of Harold Y. is no fairy tale. It represents one fruit of very recent American willingness to give European electrosleep techniques a genuine clinical try.

Pioneer. One of the pioneers in this country is Saul H. Rosenthal, M.D. Associate professor in the department of psychiatry, University of Texas Medical School at San Antonio, Rosenthal himself was highly skeptical of electrosleep. But he felt that low-intensity electrostimulation of the brain as a psychiatric treatment was too important to be ignored. Pioneer work began in Europe more than fifty years ago. The *Foreign Science Bulletin*, published by the Library of Congress, lists hundreds of technical papers reporting results of tests and treatments involving tens of thousands of persons.

European Activity. Practically all European nations have encouraged experimentation. In Russia, electrosleep machines are in daily use in more than three hundred "sleep centers." Scientists from all over the world converged on Graz, Austria, in 1965 and again in 1969 for international conferences on electrosleep and electroanesthesia. The international society whose headquarters are located there (Chirurgische Universitaetsklinik, 8036 Graz, Austria) has a big and growing library, and publishes extensive literature on current work.

During the past decade, Moscow has been host for four symposia on electrosleep and electroanesthesia, involving participants from the Union of Soviet Socialist Republics.

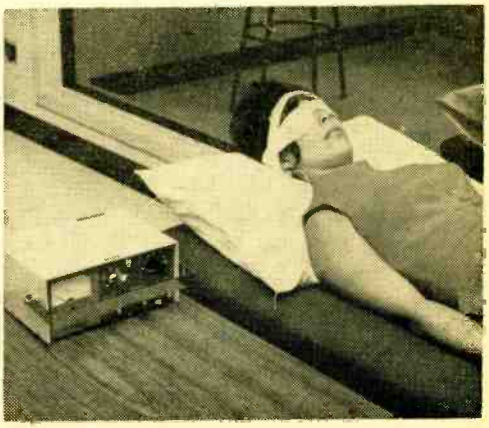
Russia's "All Union" symposia have concentrated entirely upon electrosleep and electroanesthesia. In the U. S., a much broader approach has been followed. Milwaukee was host to the nation's first "neuroelectric conference" in 1968; others followed in San Francisco the following year and in Las Vegas in 1970.

"One would think that with all this activity," Dr. Rosenthal said at the American Psychiatric Association annual meeting in May, 1970, "electrosleep would be a flourishing area of investigation in the U. S. Amazingly, this is not so. There is a very small amount of clinical work published on electrosleep in the U.S. and almost nothing at all in the psychiatric literature."

Rosenthal himself got into the field quite by accident and was at first skeptical about positive results reported by European research workers. He now confesses that he "had the university trained psychiatrist's traditional distrust of anything electrical in the treatment of patients as being at least vaguely disreputable."

Some Tests. With Normal L. Wulfsohn, M.D., associate professor in the department of anesthesiology in the medical school where he teaches, Rosenthal set out to make some tests of the way precisely-regulated electrical pulses affect the brain and behavior patterns. Results of their clinical studies were communicated to the American Psychiatric Association and summarized in the *Journal of the American Medical Association.*

Rosenthal's personal skepticism notwithstanding, nine of the twelve patients in his first series of tests gained "relatively total remission of symptoms" through electrosleep. Partial improvement was noted in one, while two showed no improvement at all.



Controls for the battery-operated portable Electrosone 50 were adjusted so that the patient felt no sensation except a slight tingling. Relaxed but not actually asleep, the patient will virtually "float" until electrosleep is ended by a preset timer.

On a 7-point scale where 1 represents no symptoms, the average rating for sleep disturbances fell from 5.9 to 2.7. On a similar scale, the average anxiety rating dropped from 5.9 to 2.7, while the depression rating declined from 5.2 to 2.3. Still, the most remarkable effect was total disappearance of insomnia—usually by the third treatment.

Not yet convinced that extra attention and suggestion might not account for the remission of symptoms, Rosenthal made "blind" tests. He treated a group of patients with simulated current. None showed the dramatic "total remission of symptoms that were seen in the active treatment group." It was a different story when four of these patients who had undergone simulated treatment got the real thing. This time, two had complete remissions and two showed partial improvement.

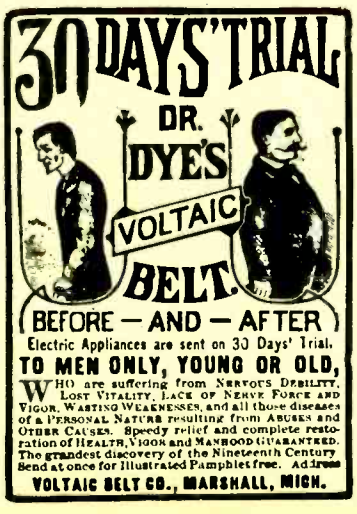
A later and more complicated "double-blind" study (in which neither patient nor physician knew who actually received electrical treatment and who had gear attached without current being turned on) gave "startling confirmation" of European findings about electrosleep.

Quackery. This doesn't mean that the U. S. medical-scientific community is anywhere near being convinced—or even open-minded to experimentation. Nowhere in the world is the prevailing mood of medicine more conservative than in this country. This general conservativism is particularly prominent in relation to any form of "electrical treatment"—because quackery ran rampant during the nineteenth century.

Electric belts made and sold by the Pulvermacher Galvanic Company as "a common-sense treatment for weak men" offered quick relief from "sexual debility, impotency, drains, losses," and related conditions by means of current that was supposed to pass "through the Sexual centre and kidneys at the back to the Liver and Sexual organs in front." The "Improved Graduated Magnetic Machine" was guaranteed to cure anything from arthritis to cancer. As late as 1899, the Electropoise Co. of New York marketed a machine designed to cure "Catarrh, Neuralgia, Asthma, Hay Fever, Insomnia, Inflammatory Rheumatism," and a host of other ailments.

Present-day findings suggest that makers

(Continued on page 96)



A Common-Sense Treatment for Weak Men

[Part of insulating case is removed, showing position of batteries.]

The above shows how extremely rational my treatment is for men suffering from Sexual Debility, Impotency, Drains, Losses, Varicocele, Atrophy, etc., as the current fully envelopes EVERY PART AFFECTED, in passing through the Sexual centre and Kidneys at the back to the Liver and Sexual organs in front. Any man who can move about and eat and sleep is in line for a cure by my system of electrical treatment, as I have demonstrated in thousands of cases, and any one who suffers as above is simply throwing health and happiness away who does not avail himself of it. The belt is also used same as above in Rheumatism, Kidney, Bladder, Liver and Stomach complaints, Nervousness, General Ill-Health, etc., either with or without the Spiral Suspensory. When the latter is detached all the negative current goes to the Liver or Stomach Disc.

Grandiose claims for electric and magnetic devices made physicians and scientists skeptical of all machines dispensing power. Electric belts widely sold after the Civil War era varied in their construction, but were alike in extravagant claims for curing a great variety of complaints.

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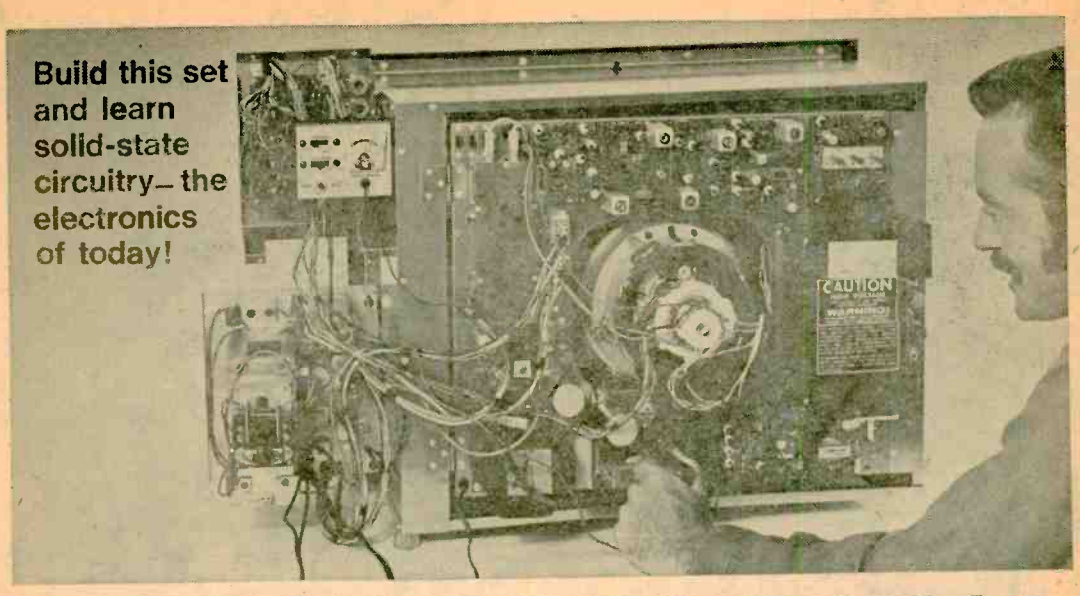

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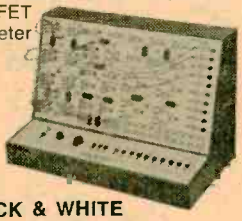

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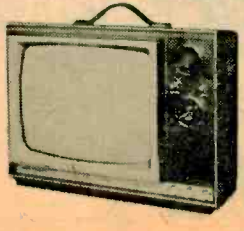

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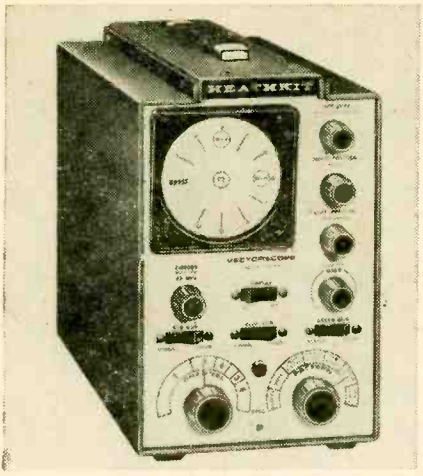
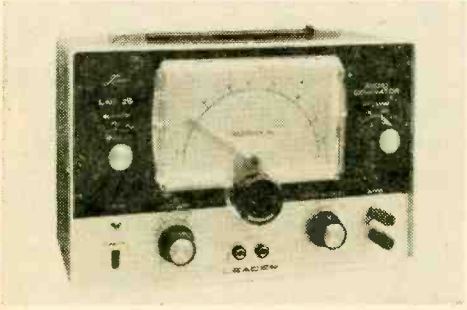


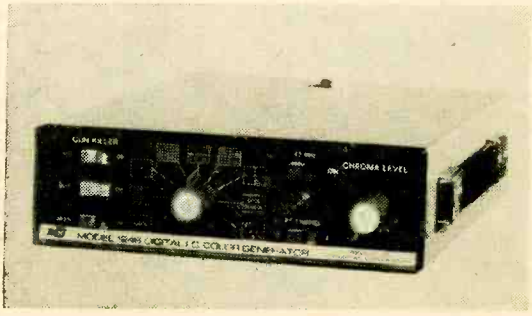
If you service color TV, you know how useful a vectorscope can be. Heath combines this with a color generator in the $129.95 IO-101 kit, which also produces test patterns such as dots and cross-hatch. Circle No. 50 on Reader Service Page.

The easy-to-read display is only one of the many advanced features of the Triplett 6028 DVOM, or digital VOM. It operates on line voltage or from an optional battery pack, costs $275. Circle No. 51 on Reader Service Page.

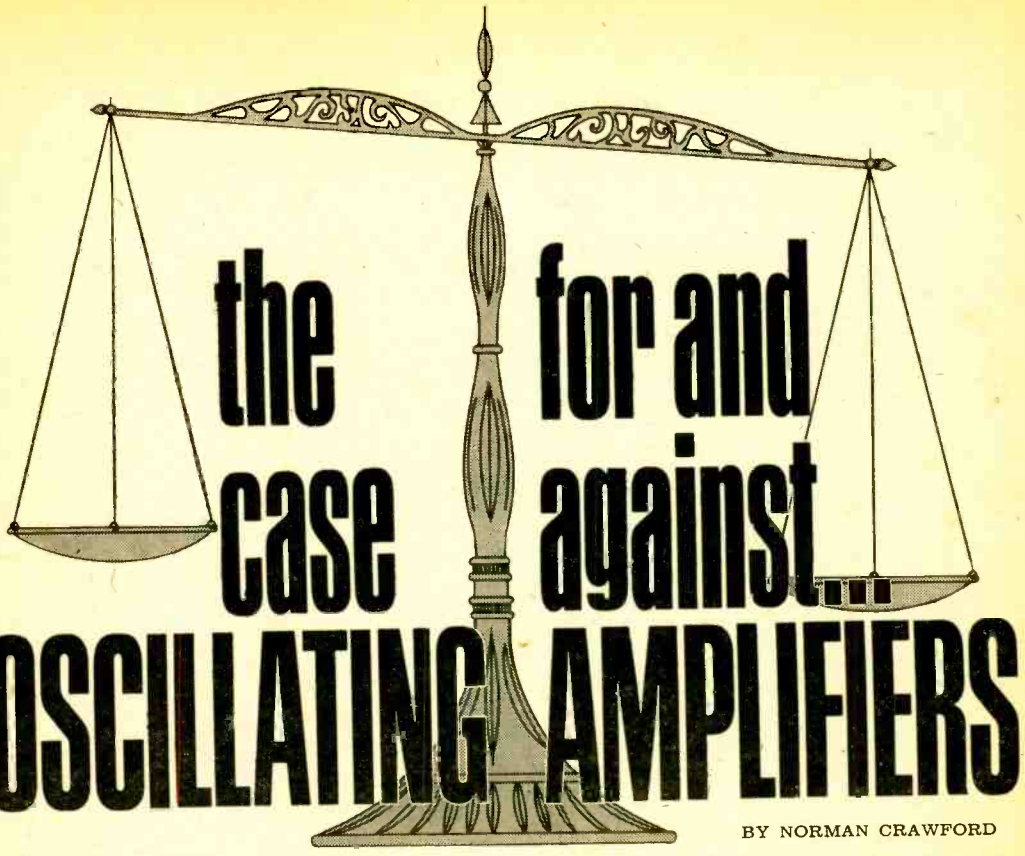


For testing the most sensitive audio equipment, the solid-state LAG-25, by Leader Instruments, generates a complex wave for IM distortion checks, plus sine and square waves. Featuring a range of 20 Hz to 200kHz, the LAG-25 is priced at $99.50. Circle No. 52 on the Reader Service Page.

Built with digital integrated circuits, the 1246 color generator, by B&K-Dynascan, checks convergence, color, linearity, size and focus. The 1126 provides nine test patterns, costs $149.95. Circle No. 53 on the Reader Service Page.



TEST GEAR



the case for and against OSCILLATING AMPLIFIERS

BY NORMAN CRAWFORD

As ANY slightly cynical experimenter can tell you, if you want an oscillator, build an amplifier—it's sure to oscillate. Conversely, if you want an amplifier, (this same cynic will tell you), build an oscillator—it's sure to fail to oscillate, and you can then use it as an amplifier![1]

Our informed cynic must have had long and unhappy experience with negative-feedback amplifiers, which are known to have at least two outstanding characteristics:

1. They function beautifully if carefully designed and built.
2. Otherwise, they oscillate!

Why do they oscillate? Or, more basically, how does a feedback amplifier differ from an oscillator?

The fundamental block diagrams of an oscillator and an amplifier with feedback bear a strong resemblance to each other, as you can see from Fig. 1. From a block diagram viewpoint, both diagrams are *very* similar. Both contain some type of amplifying device, and both have part of their output signal fed back to their input. There are only two major differences between them:

1. The amplifier with feedback contains an *inverting* amplifier; the oscillator contains a *non*-inverting amplifier.
2. The oscillator doesn't have an input.

The circuit action obtained from these two circuits is entirely different. In the amplifier with feedback, the output waveform is upside down with respect to the input, so when it is fed back to the amplifier input, it cancels a portion of the input waveform. The output is therefore less than it would be without feedback. See Fig. 2.

The feedback signals from inventing amplifiers are not "in phase" with the input signal and subtract (or reduce) the input signal level to the amplifier. When a feedback signal does this, it is called *negative feedback*.

So Why Negative Feedback? Of course, if you merely want the biggest possible gain for your money, negative feedback's not

[1] This is well known as a corollary to Murphy's famous Law, "If anything *can* go wrong—it *will!*"

OSCILLATING AMPLIFIERS

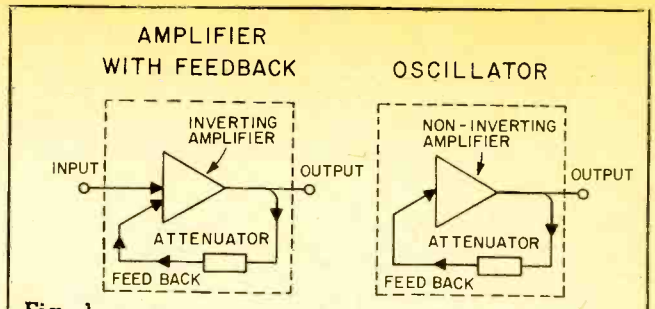


Fig. 1

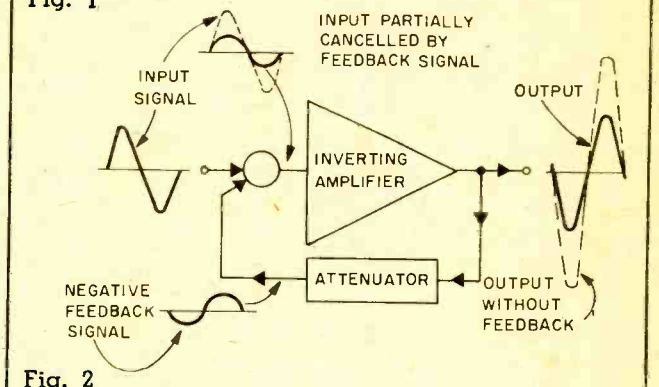


Fig. 2

your game. However, negative feedback offers other advantages, which can be summed up by saying that the amplifier's output, though smaller, is always nearly constant for the same input signal. For example, if the amplifier weakens with age, and the output tries to drop, there is less signal to be fed back; hence there is less cancellation, and the output is restored almost to its former level. Similarly, if you feed a high-frequency signal through the amplifier—so high in frequency that the amplifier can barely amplify it—the resultant drop in output reduces the fed-back voltage, produces almost no canceling feedback signal, and keeps the output nearly the same as it was at lower frequencies. Moreover, any clipping or other distortion of the waveform inside the amplifier produces an output waveform which does not match the input; hence the non-matching part is not cancelled, and the distortion is removed, or at least greatly reduced. Without this action, hi-fi amplifiers would not exist.

So the loss in output you obtain from negative feedback repays you by providing less distortion, better long-term stability, and better frequency response—that is, the best and most uniform output in response to *all* input frequencies.

On the Flip Side. The oscillator, on the other hand, is not supposed to give the best output from all input frequencies, but is instead made to give an output at a *single* frequency—with no input at all. It's not surprising that the opposite type of internal amplifier (non-inverting) is used to obtain this opposite result. See Fig. 3.

In the oscillator, any output at all (probably the result of some random noise in the internal amplifying device) is fed back, non-inverted, to the input, where it does not cancel but instead serves as the signal at the input. This feedback signal causes an even larger output, which results in an even larger signal fed back, further reinforcing the input signal, and so on.

You guessed it—this type of feedback signal is commonly referred to as *postive feedback*. In theory, the output waveform should continue to get larger forever. In practice, the amplifier is limited in the maximum size of the signal it can deliver, so the output waveform stops growing at this amplitude. As it stops to grow, so does the postive feedback signal. Now the signal reduces rapidly and the positive feedback signal lends a hand until the signal can get no lower. This is the beginning of the first cycle of many to follow.

All well and good, you say, but if the major difference between feedback amplifiers and oscillators is the inverting or non-inverting nature of their internal amplifiers, why does an amplifier sometimes oscillate? What turns an inverting amplifier into a non-inverting one?

To answer this question, first observe that an inverting amplifier, in passing a sine-wave signal, *effectively* shifts the signal's phase by 180° as shown in Fig. 4. We says *effectively*, because it doesn't really shift the timing by delaying the signal (which is what a real phase-shifter does) but, by turning the signal upside down, the amplifier makes it look like a signal which has been delayed (phase-shifted) by 180°.

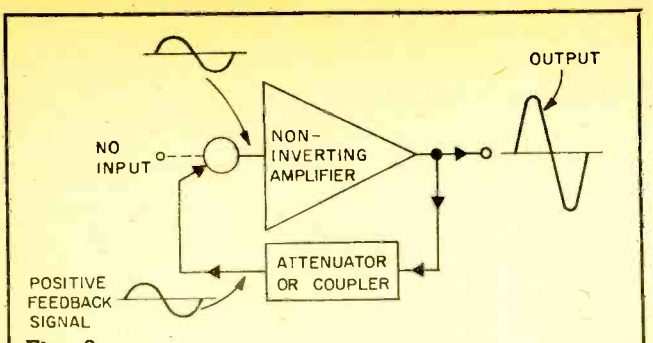


Fig. 3

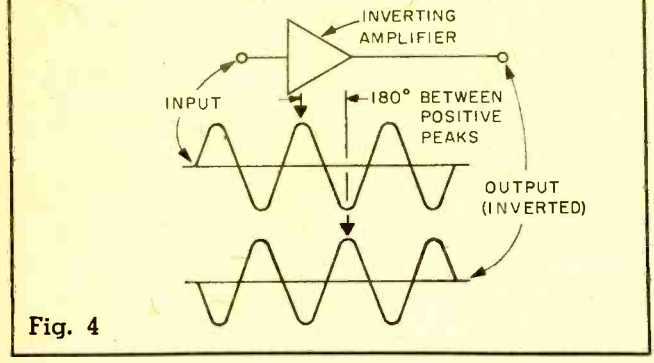


Fig. 4

A real phase-shifter, on the other hand, is normally nothing but a fistful of judiciously connected resistors and capacitors (and sometimes inductors) which can be designed to give a 180° phase shift *at a single frequency*, such as 1,000 Hz, for example. In contrast to an inverting amplifier, it provides this phase shift by actually delaying the signal. See Fig. 5.

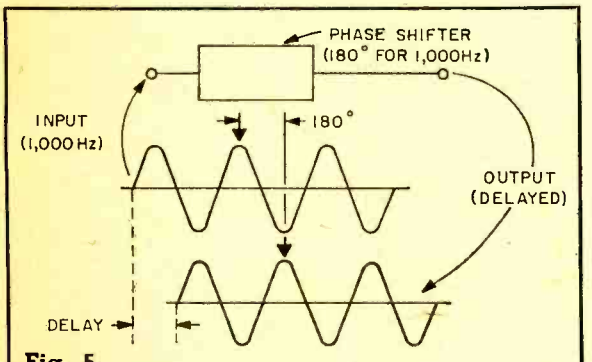


Fig. 5

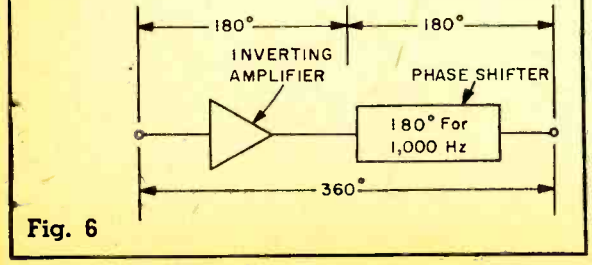


Fig. 6

What happens if we combine an inverting amplifier and a 180° phase-shifter? Take a look at Fig. 6.

This combination will shift the phase of a given frequency by a total of 360° (an entire cycle) so the output is identical to the input. In effect, this combination (at 1,000 Hz) *will behave the same as a non-inverting amplifier*. See Fig. 6.

Therefore, if we build a feedback amplifier which contains the normal inverting amplifier but also (inadvertently) contains a 180° phase-shift network, the resultant circuit will oscillate at the particular frequency, (1,000 Hz in the figure) for which the phase-shifter provides 180° phase shift. See Fig. 7.

How can one "inadvertently" make a phase-shifter? It's easier than you might think. The circuit shown in Fig. 8A will provide 60° phase shift at 1,000 Hz. Three such networks connected in a "ladder" (see Fig. 8B) will proved 3 X 60° = 180° of phase shift.[2] This network, if dropped into a normal feedback ampliflier circuit, will convert it to an oscillator. *(turn page)*

[2] But not at 1,000 Hz. Because of the way the networks load each other, the 180° shift occurs at 707 Hz. However, if an amplifier were located between each network, then the amplifier will oscillate at 1,000 Hz.

e/e OSCILLATING AMPLIFIERS

This circuit (Fig. 9) is known as a *phase-shift oscillator* and is widely used in electronics.

Of course, when you set out to build a phase-shift oscillator, you *deliberately* insert a phase-shifter to make the circuit oscillate. How could one ever *inadvertently* place such a circuit in a feedback amplifier, thereby producing unwanted oscillations?

Phase-shift circuits can "hide" within an amplifier, posing as other circuits. For example, vacuum-tube amplifiers often have grid circuits arranged as shown in Fig. 10A. Does that resistor/capacitor circuit look familiar? In form, it's just like the phase-shift circuit above. And transistor amplifier circuits often take the form shown in Fig. 10B.

Again, the coupling/biasing network looks just like the basic phase-shifter network. At some frequency, this network will provide 60° of phase shift. If we use three such identical networks in a three-stage amplifier we have a 180° phase-shift network "buried" inside the amplifier, masquerading as three normal coupling networks. If this three-stage amplifier is used as part of a feedback amplifier arrangement, the amplifier will oscillate at some frequency, and be quite useless for the purpose for which it was intended.

This is not the only way an amplifier can get into trouble. There are other types of phase-shifters than can creep into amplifiers, unrecognized, and drive the unwary experimenter up the nearest wall. This circuit (shown in Fig. 11A) can also produce a phase-shift of 60° at 1,000 Hz. Three of them, can produce the 180° phase-shift required for oscillation. See Fig. 11B. This particular network can invade amplifiers in an even more insidious fashion. The "masquerading" part of the circuit is shown heavy in Fig. 11C. The dotted capacitor doesn't appear physically in the circuit, because it is the so-called "stray" capacity associated with wires, sockets, terminals, etc. Three of these circuits hiding in an amplifier, can produce an unwanted oscillation. See Fig. 12. Since the stray capacities are so small, this "osc-plifier" will oscillate at a very high frequency; often so high that it is undetected as an oscillation. However, such oscillation can make an amplifier behave erratically; sometimes distorting, sometimes not; sometimes overheating, sometimes not. Fig. 7 and Fig. 12 have a lot in common.

Are feedback amplifiers the only culprits in this oscillating-amplifier business? Absolutely not! Often, so-called "straight" amplifiers—with no *intentional* feedback—will gaily oscillate away. But watch that word *intentional*. Close inspection of these misbehaving circuits usually uncovers an *unintentional* feedback path hiding within the amplifier. Consider the innocent-looking circuit in Fig. 13. This is an ordinary two-stage amplifier, obviously assigned the task of

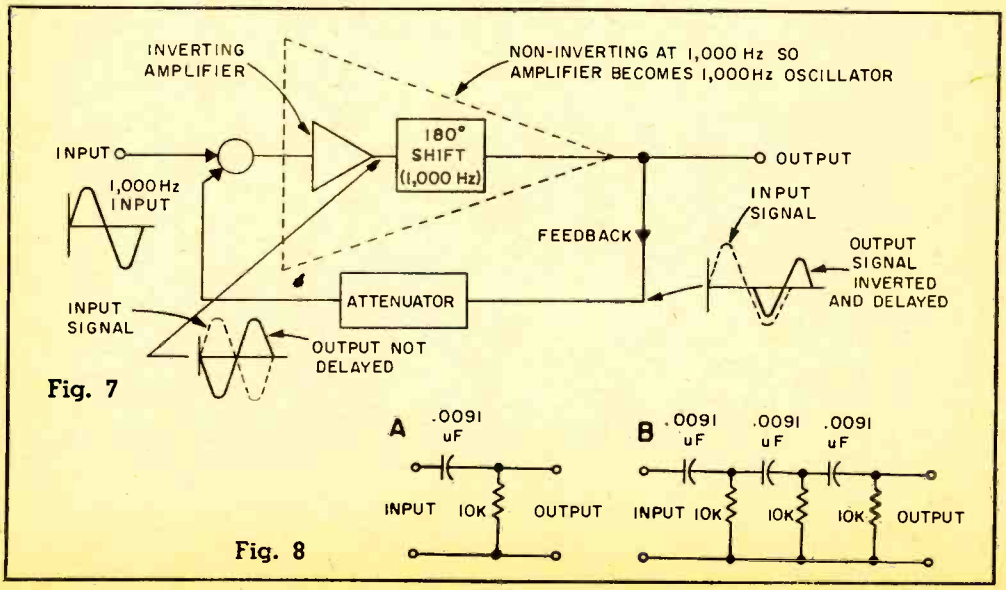


Fig. 7

Fig. 8

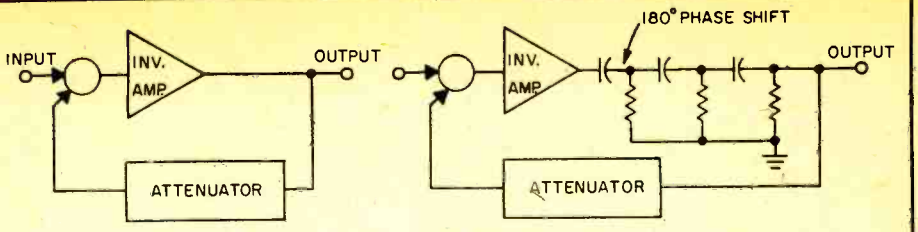


Fig. 9 AMPLIFIER PHASE-SHIFT OSCILLATOR

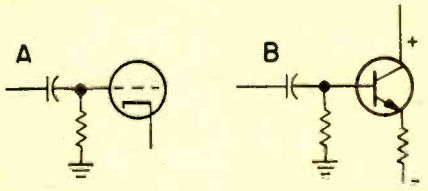


Fig. 10

converting a small, positive-going signal into a large, positive-going signal. To help it along, the designer has even provided a de-coupling network, R1 and C1. At high frequencies, C1 acts like a short circuit, effectively isolating (de-coupling) the amplifier's power bus, Ecc+, from the main power bus, Ecc++. But, at low frequencies, the capacitor acts like an open circuit—it just isn't there! A small part of the ouput voltage now appears across R1, and is coupled through the ampilfier's power bus back to the input, arriving there with the same polarity as the normal input. True, the signal unintentionally fed back isn't very large, because the unintentional feedback path provides substantial losses for this stray signal. For example, the signal may arrive back at the input 100 times smaller than it was at the output. However, if the amplifier has a gain of 101, it makes an even larger output signal out of the fed-back signal, which then is fed back as an even larger voltage, and we're off and running . . . and oscillating!

Careless construction can get you into

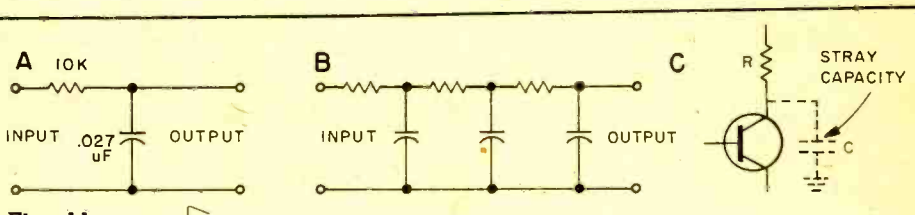


Fig. 11

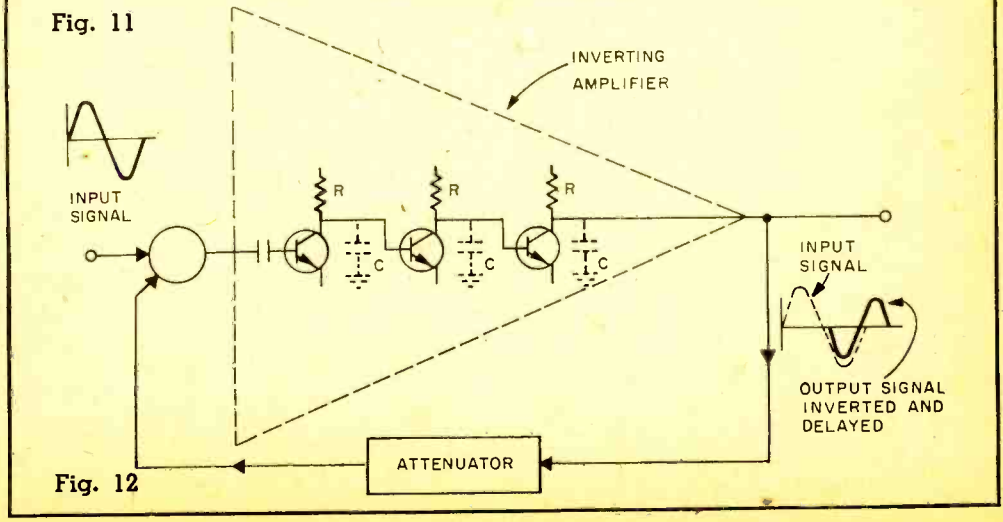


Fig. 12

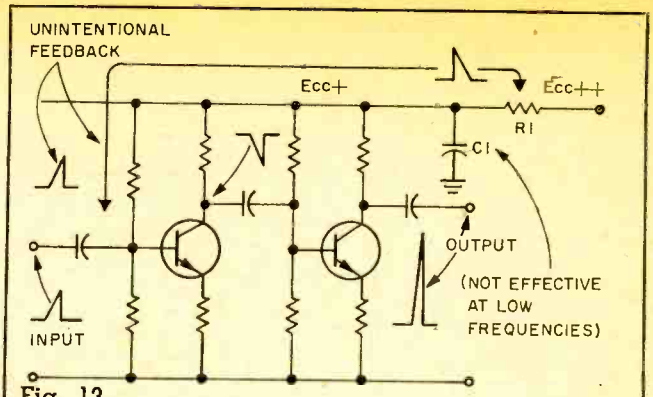


Fig. 13

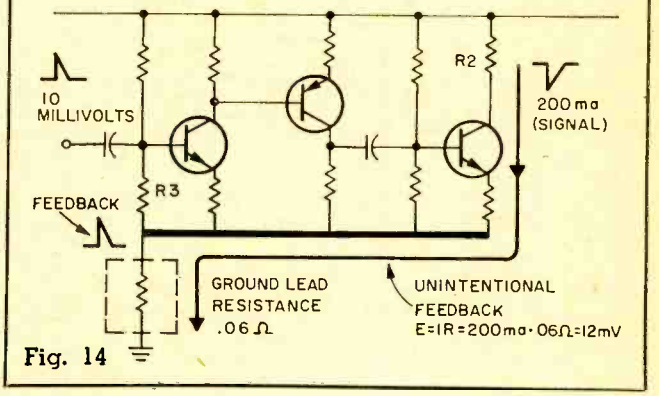


Fig. 14

trouble, too. The amplifier show in Fig. 14 is trying to convert a 10-millivolt input into a 200-ma signal needed by the load, R2. The builder has tied all ground returns to a heavy ground bus, and returned this bus to ground at only one point. Unfortunately, that single ground wire has to carry both the tiny input signal and the large output current. And, since every wire has *some* resistance, the actual circuit includes an 0.06-ohm resistor that does not appear in the original construction schematic diagram, but must be considered and is shown in Fig. 14.

Again, an uninvited, unintended feedback path has appeared, coupling the output back to the input. In the sketch, the large output current, flowing through the tiny ground-lead resistance, produces a voltage which is even larger than the original input voltage. And, since this voltage is also connected to the input (through the bias resistor R3), the fed-back voltage appears uninverted (and uninvited!) at the input, and will cause the amplifier to oscillate.

All this presents a pretty bleak picture, with amplifiers oscillating at the drop of a hat. What is to be done to convert these oscillators back into well-behaved amplifiers?

The general rule is *divide* and *conquer*. In the example just above, we can conquer the oscillation by dividing the ground returns, making sure that the high-current output circuits and the sensitive input circuits have their own private and individual paths to the power supply. See Fig. 15.

Short leads to the input connector are also helpful in squashing oscillations.

The misbehaving decoupling network, R1 and C2 in Fig. 13, can also be brought under control by dividing the network into *two* decoupling networks, as shown in Fig. 16.

The stray capacities causing the unwelcome phase shifter to hide in the amplifier are harder to exorcise. Your best divide-

(Continued on page 104)

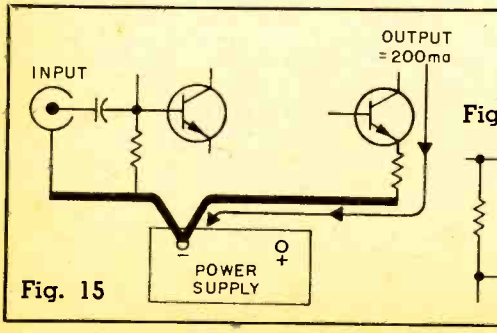


Fig. 15

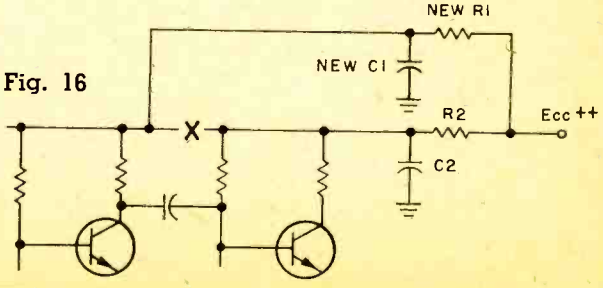


Fig. 16

THIS TEDDY HAS A HEART

This is no ordinary teddy bear —he has a heart, which is kept in a small tin containing capacitors, resistors and other assorted electronics. They all help make Teddy tick.

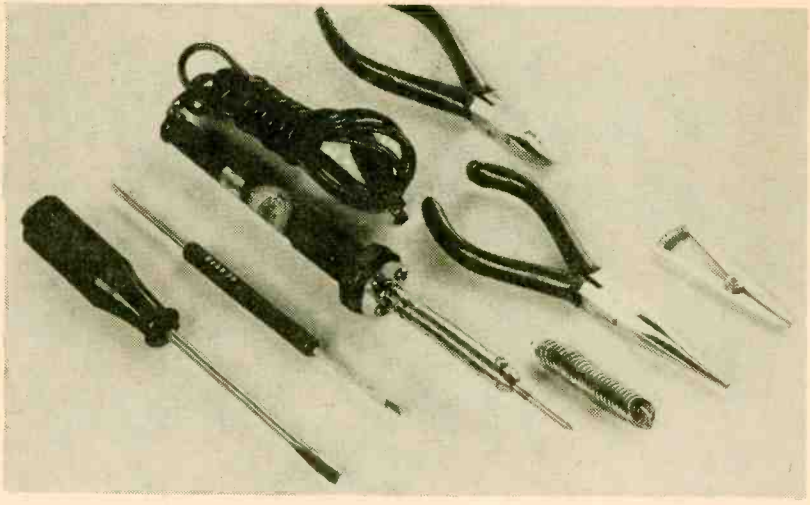
Everyone sleeps better with a teddy bear, especially one that ticks you to sleep! That's right, Mr. Bear will help your child gently fall off to sleep just as if she were rocking in her mother's arms.

This surrogate mother was developed because little Janine Masters had difficulty falling asleep. Her parents recognized the soporific effect of being rocked near the mother's heart, and decided to apply this principle in a practical way. First, they tried tape recordings of a heartbeat, but this lacked the comfort and security necessary. Then they tried "Teddy"—and it worked!

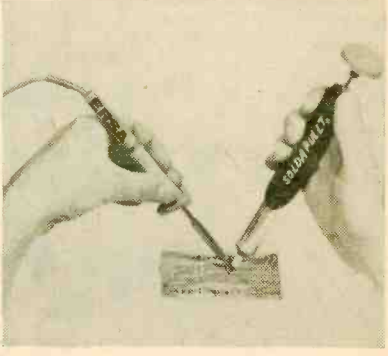
Although it may look like an average toy on the outside, Teddy houses a mechanism that creates a dull thud, perfectly imitative of the mother's heartbeat. Contained within a 2-oz. tobacco tin, the small battery-operated circuit releases a solenoid regularly to hit the side of the tin. The resultant tapping sound is dulled by the soft composition of the bear. To activate the circuit, simply press the head of the bear into its body. The beat is regulated by balancing the capacitor against the resistor.

Surgical repairs on Teddy's heart are no problem. Mr. Masters simply inserts new batteries through the seam in the back of the animal, and then resews it. Teddy's now good as new and ready to tick—he doesn't need much time to recuperate. ■

E/E looks



No need for the beginning hobbyist to buy tools one by one—now GC Electronics has a kit of just what you need to start. You get pliers, cutters, soldering iron, screwdriver, soldering aid, heat sink and solder—all for only $7.95. Circle No. 54 on Reader Service Page.



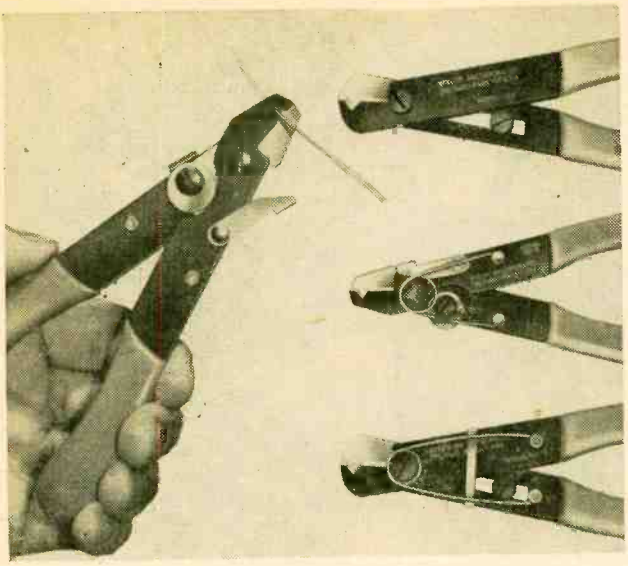
Soldering parts together is easy, but how about removing the solder? A tough job, unless you use Ersa's new Soldapullt tool, at $5.95. Just thumb the release and the solder is sucked up and away. Circle No. 55 on Reader Service Page.

When you're on a service or repair call, how long does it take you to find a tool? If it's more than a few seconds, do what the pros do, and get Xcelite's tool case that looks just like one of those neat attache jobs. Straps and pockets hold up to 59 hand tools. Model TC-100 sells for $50, and Xcelite also sells the tools. Circle No. 56 on the Reader Service Page.

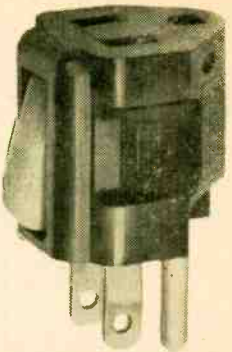
Reader Service Page is on 17

TOOLS AND

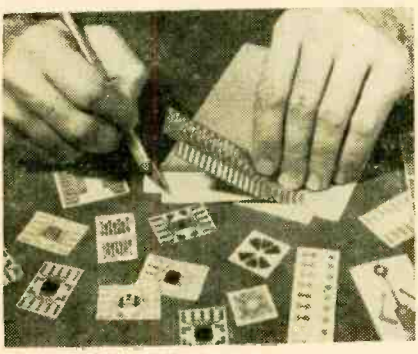
at new...



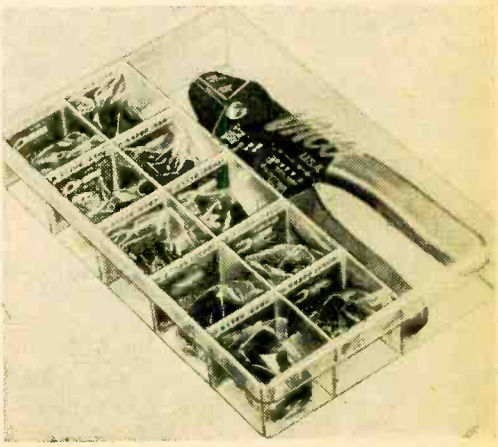
Three wire-strippers from Xcelite, with screw stop or cam for setting to wire size, spring for self-opening. Prices are, top to bottom, $1.88, $3.08, $2.55. Circle No. 58 on Reader Service Page.



No more problems when you need to put a three-prong plug into a two-hole receptable. Just press the button on the Delfex plug adapter, and the grounding blade swings aside. Only $1.00. Circle No. 57 on the Reader Service Page.



Assemble a PC board in minutes with these "Quik-Circuit" copper patterns from Circuit-Stik. No drilling, no terminals. Just press these conductive stick-ons on P-pattern Vector board—the .100-inch grid matches exactly. Dozens of patterns available, from TO-5 to 16-pin IC. Circle No. 59 on Reader Service Page.



Solderless terminals save time for the serviceman or active hobbyist. Vaco now has a convenient package containing the ten most popular insulated terminals including the ring-tongue, spade and flanged-spade types, plus a crimping tool. Circle No. 60 on the Reader Service Page.

GADGETS

The Pollution Fighters' Electric Motorcycle

If you think this cycle looks pregnant, well it is—electrically. All that bloat is really fiberglass fairing to reduce drag from wind resistance. This non-polluting model has a low center of gravity and aerodynamic shape. The result? She handles like a dream! But cleaner air may no longer be a dream with developments like this.

Pollution-minded? Well, you can still get the power and thrill of a motorcycle, without the poluting fumes! Scientists have finally developed an electric motorcycle. And this cycle can go over 65 MPH—it's the fastest electric motorcycle in the world. Eight feet long and weighing 650 lbs., this bike was constructed from a scrambler frame, specially modified to accomodate the batteries and motor. The vehicle is powered by four 12-volt lead-acid cobalt batteries, designed for electric vehicle use. A golf-cart motor was rewound to obtain better efficiency and higher speeds. This type of winding made regenerative braking possible, which conserves energy in hilly regions. Velocity is regulated by varying the voltage to the series and shunt fields of the motor. Through the use of a twist-grip selector, any one of four voltage levels can be delivered to the series field. Current to the shunt field is controlled by a small variable resistor. A fiberglass fairing cuts down wind resistance. And it accelerates from 0-45 MPH in 9 seconds—not bad for a "modified golf cart"! ■

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

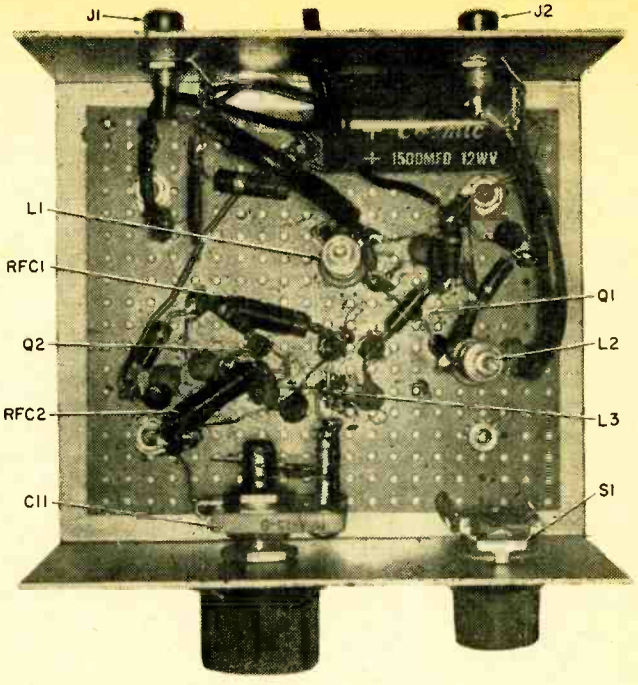
Cliff-hanging emergencies, weather forecasts, ham QSO's, law enforcement patrols in action, mobile radio telephones—two-way broadcasts make listening to the VHF High Band an ever-changing adventure. Our VHF High Band Converter covers from 135 to 175 MHz, and it pulls in public safety, industrial, marine, 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 tuned circuit, and fed to gate 1 (g1) of the dual-gate 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

e/e 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

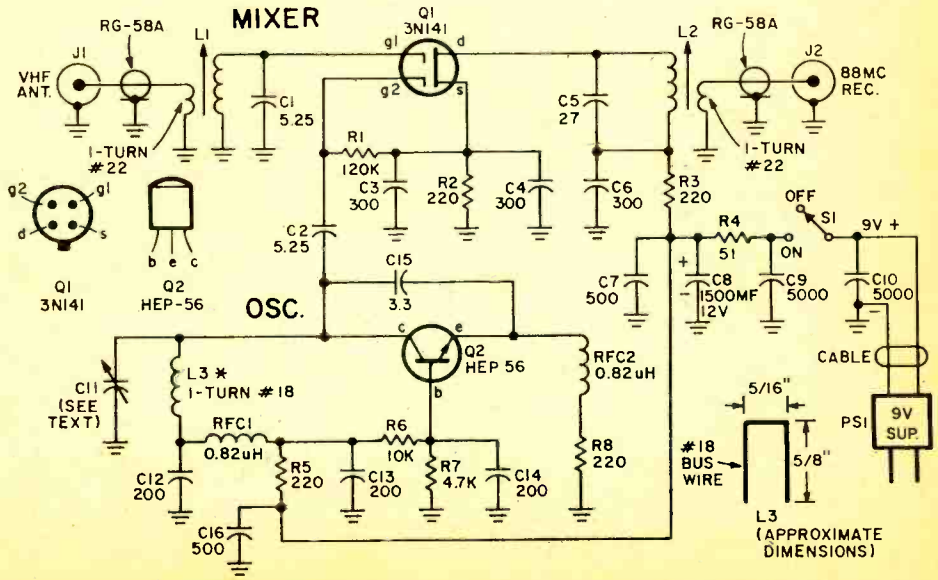
ing of coil L1 to J1, and the secondary winding of coil L2 to J2. These primary and secondary windings are made of one turn of No. 22 hookup wire, and are wound around the center of each of the L1 and L2 coils. Make all wiring as short and direct as possible, except the leads to S1. Position the S1 leads 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 2⅜-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.



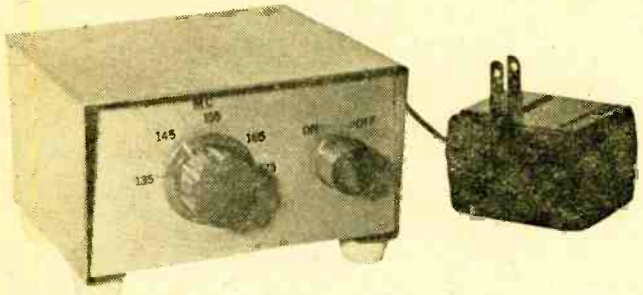
VHF HIGH-BAND CONVERTER

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. ■



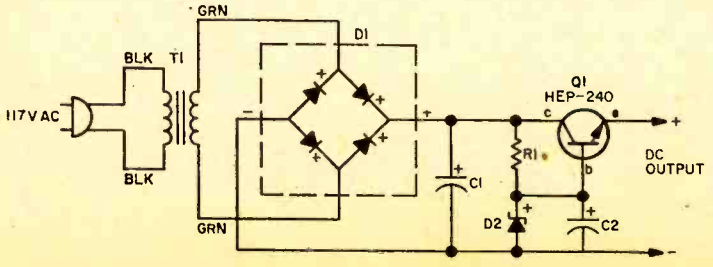
The converter gets its power from a 9-volt plug-in module, which simplifies the construction.

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.

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.

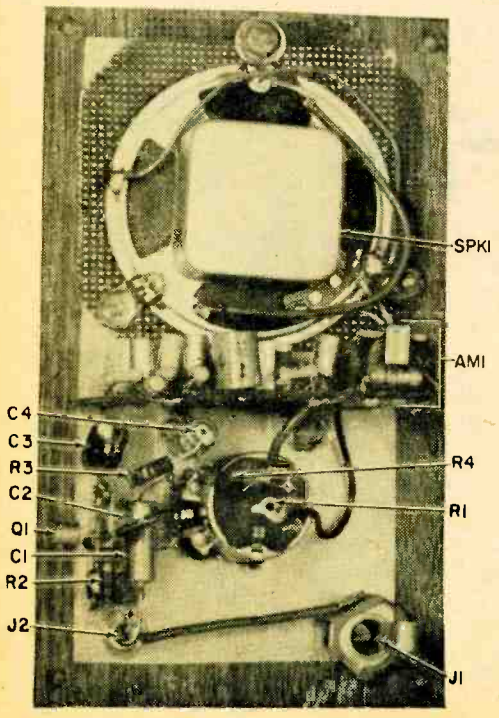
The power supply consists of 9-volt battery supply B1, and decoupling components R4 and C4. Both components prevent undesired audio feedback through the power circuits. Power for the tracer is supplied by any 9-volt source; a battery was considered most convenient.

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.

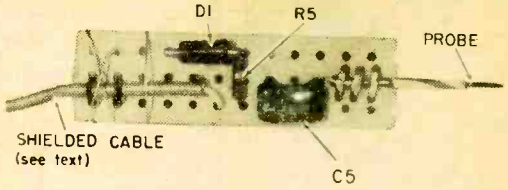
The author built his prototype unit into an Allied Radio Shack mini utility case. This was done for appearance sake only; it was desired that the tracer would match some other test equipment he already had. While this technique can be followed, the author strongly suggests that you build your unit in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



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 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.



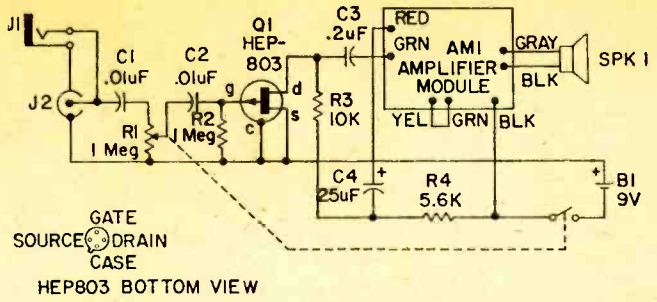
The RF test-probe components are mounted on a small piece of perf board, with a nail as the probe tip, all inserted in a cigar tube.

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.

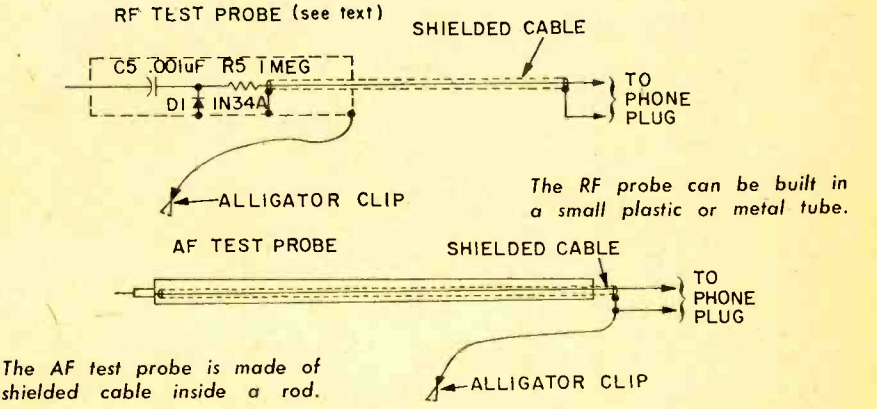
Supposing the complaint is that the radio doesn't play at all. After checking the line cord and power supply components to make sure that the rig's being energized, look at the printed-circuit board for any possible cracks in the foil. Flex the pc board, foil



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.)

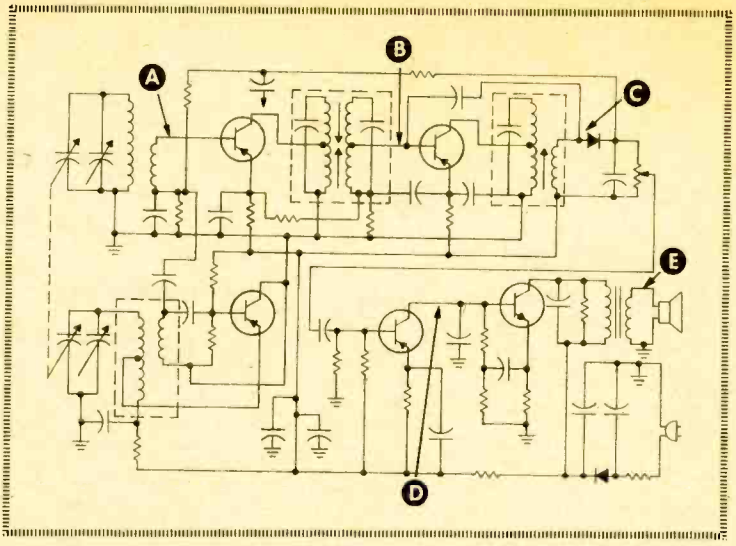
Misc.—Battery connector, phone plugs, 3-lug terminal strip, solder, wire, etc.



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



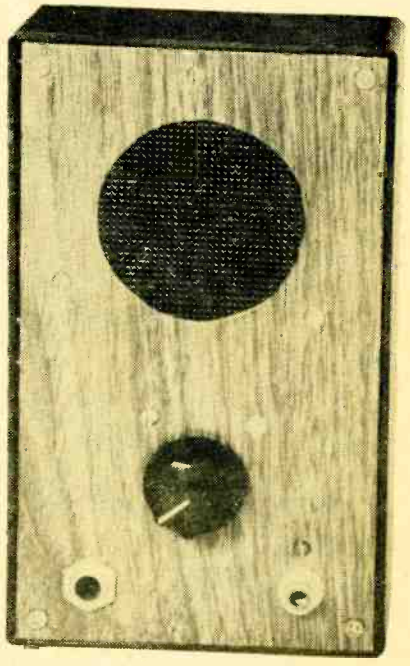
your vicinity. Proceed to point B; listen for a signal. Ditto procedure for point C.

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.

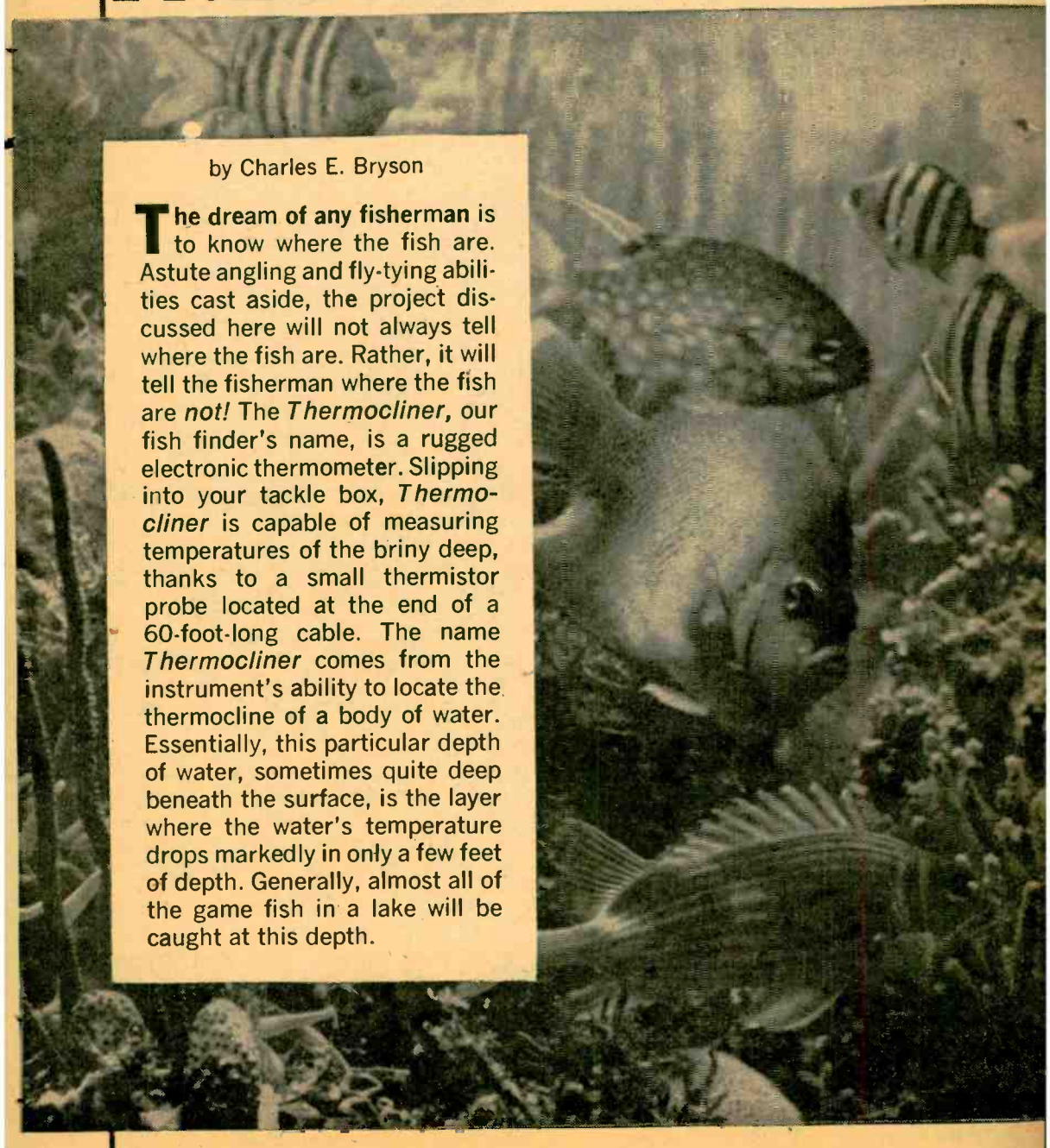
Decide to work from the speaker back to the antenna terminal? You'll also need a modulated signal generator. Connect your gen to the speaker leads, and set its controls to deliver an audio signal. Proceed from points E through A, while leaving the audio test probe of your *M-TSS* clipped across the speaker 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.

Build a Better Fish Finder

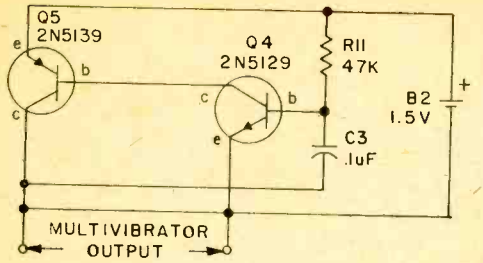
Thermocliner's the name, and sport fishin's the game!



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.

e/e FISH FINDER

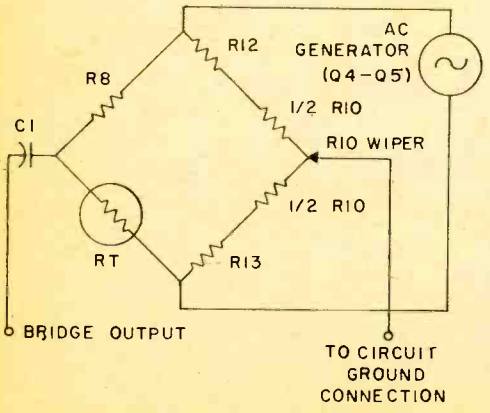


This astable multivibrator, based on transistors Q4 and Q5, provides power for the Wheatstone bridge in the Thermocliner.

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.



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

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 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

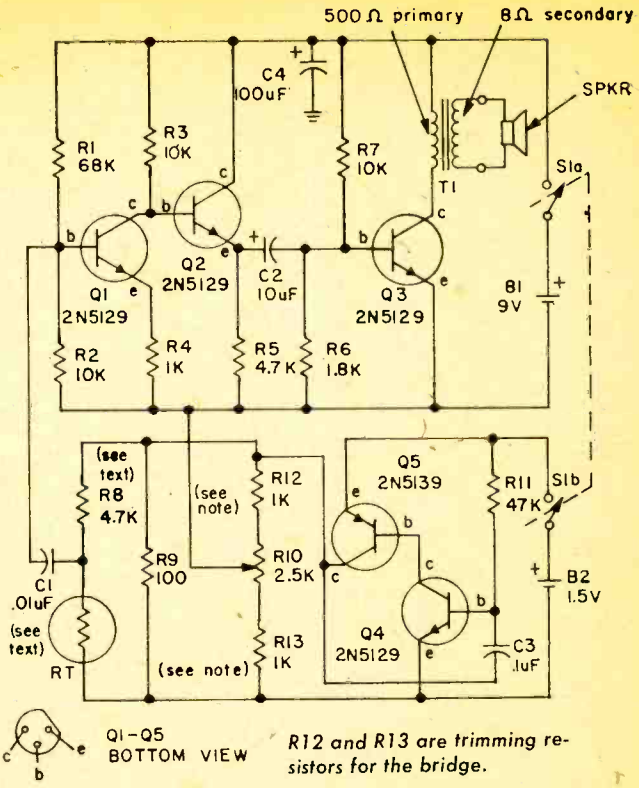
of the person doing the calibration. Start by connecting the proble cable assembly to the control box, turn power on/off switch S1 to its "on" position, and dunk the probe into water which is as hot as to be encountered. For fishing, 100 degree F is plenty!

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 97)



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

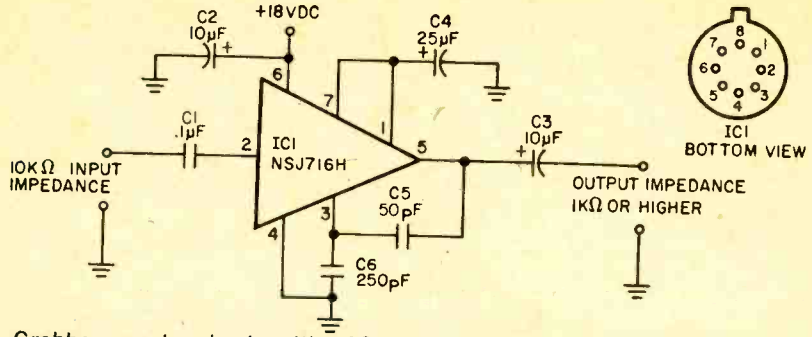
B1—9-volt battery (Eveready type 216 or equiv.)
B2—1½-volt battery (Mallory MN-1500 or equiv.)
C1—.01 uF @ 1,000 volts disc ceramic capacitor (Lafayette 32F01969 or equiv.)
C2—10 uF @ 25 volts electrolytic capacitor Lafayette 34F85620 or equiv.)
C3—.1 uF @ 600 volts capacitor (Lafayette 34F 82700 or 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

Clip Book Circuits

GABBER GRABBER

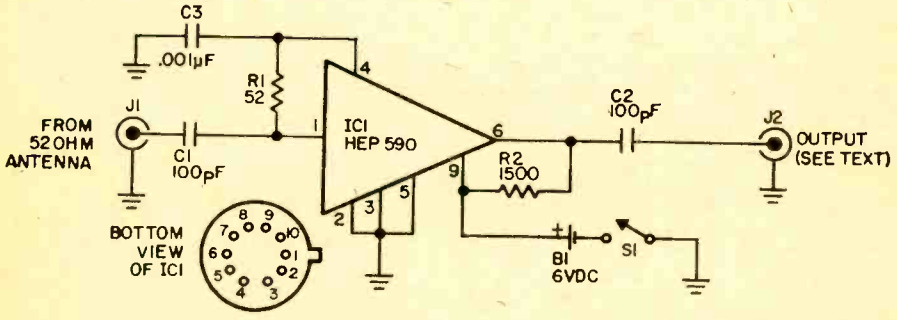


Gabber Grabber works best with 10K mikes and telephone pickup coils. It provides 20 dB gain, and is ideal when a single microphone is used for conference recording or when remote telephone monitoring through a pickup coil is desired. The 18V power supply can be two-series connected 9V transistor radio batteries. IC leads should be kept short.

PARTS LIST FOR GABBER GRABBER

C1—0.1 uF, 25 VDC
C2, C3—10 uF, 25 VD C
C4—25 uF, 25 VDC
C5—50 pF
C6—250 pF
1C1—Fairchild NSJ716H

CB BOOSTER



Connect CB Booster ahead of a low cost receiver, and you'll hear CB signals as if they were coming from your back yard. Using no tuned circuits, the CB Booster delivers approximately 15dB overall gain—that's about 3 S-units! Only restriction is that this little rf amplifier be used with a communications-type receiver having an antenna trimmer. It cannot be used in front of a low-impedance-input type CB transceiver. Seems the low impedance antenna input common to CB transceivers will sharply reduce the booster's gain.

Typical of all RF amplifiers, the booster requires very short connecting leads. In particular, solder capacitor C3 right at pin 4. Integrated circuit IC1 can be soldered directly into the circuit or an IC socket can be used. ■

PARTS LIST FOR RCB BOOSTER

B1—6V battery, Z4 type or larger
C1, C2—100 pF, 15VD C
C3—0.001 uF, 15VDC
1C1—HEP-590
R1—52-ohms, ½-watts, 10%
R2—1,500-ohms, ½-watt, 10%
J1, J2—Phono or coaxial jack
S1—SPST switch
B1—6V battery

E/E's all NEW BASIC COURSE in ELECTRICITY & ELECTRONICS *

PART 1
UNDERSTANDING POWER SUPPLIES

What You Will Learn. In this part you will learn about the purpose behind the power supply, and the components found in a typical AC-to-DC power supply. You will also learn what the rectification principle is, and why filters are found in power supplies. Finally, you will learn about the two types of electronic rectifiers found in most kinds of power supplies, and the similarities and differences between each type of rectifier. In part 2 "Understanding Power Supplies", you will learn about the various configurations that filters take, and how power supply output variations are smoothed out, or regulated.

* This series is based on Basic Electricity/Electronics, Vol. 2, published by Howard W. Sams & Co., Inc.

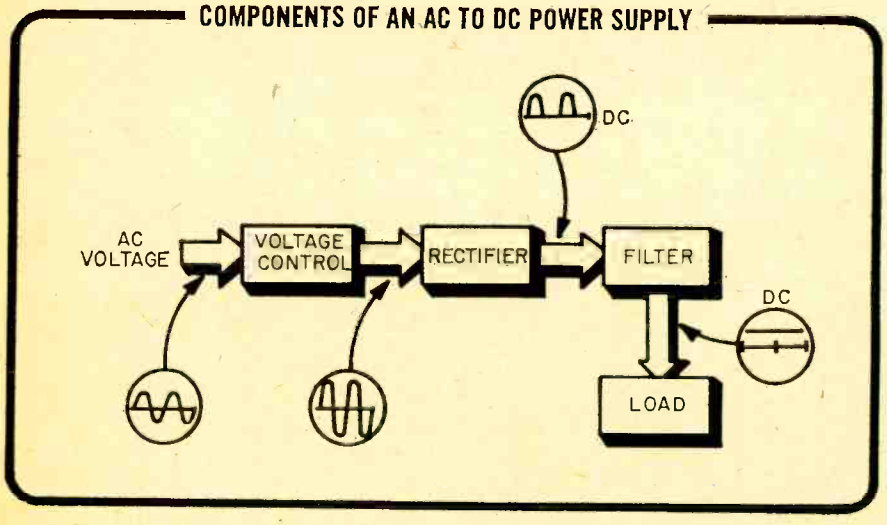
PURPOSE OF A POWER SUPPLY

Some source of electrical power is required for the operation of all electronic equipment. This can be a **prime power source** such as a battery or a generator. Most electronic equipment, however, cannot make direct use of prime power sources. For such equipment, it is necessary to convert the output of a prime power source into an electrical form suitable for the particular piece of equipment. The devices used to do this are known as **power supplies.**

COMPONENTS OF A DC POWER SUPPLY

The three major components of a typical AC-to-DC power supply are the **voltage control,** the **rectifier,** and the **filter.** The voltage control serves to adjust the output of the power supply so that the delivered voltage is correct for the circuits that the power supply feeds. The rectifier serves to change the incoming AC voltage into a pulsating DC voltage. (A rectifier may be a vacuum-tube diode, a semiconductor diode, or a metallic-oxide rectifier.) The filter changes the pulsating DC from the rectifier into a smooth or, ripple free, DC.

COMPONENTS OF AN AC TO DC POWER SUPPLY



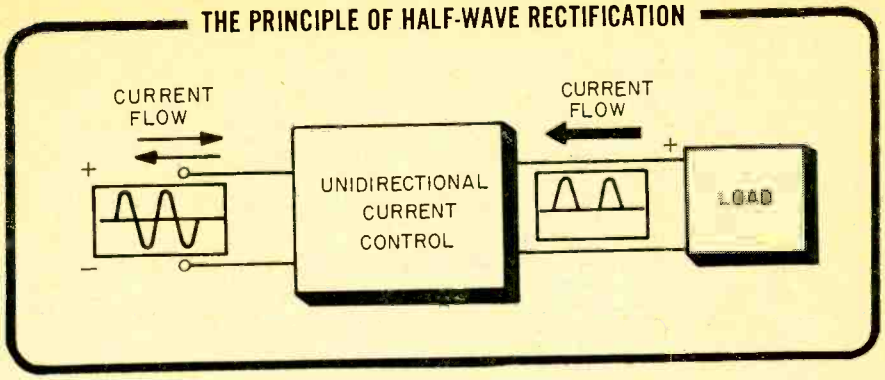
The basic functions of a power supply are to **rectify** and **filter.** The voltage-control function is actually incidental to the operation of the power supply. Once you learn to separate the rectifier and filter circuits from the power supply, you will see that the leftover components are in the voltage-control portion.

THE RECTIFICATION PRINCIPLE

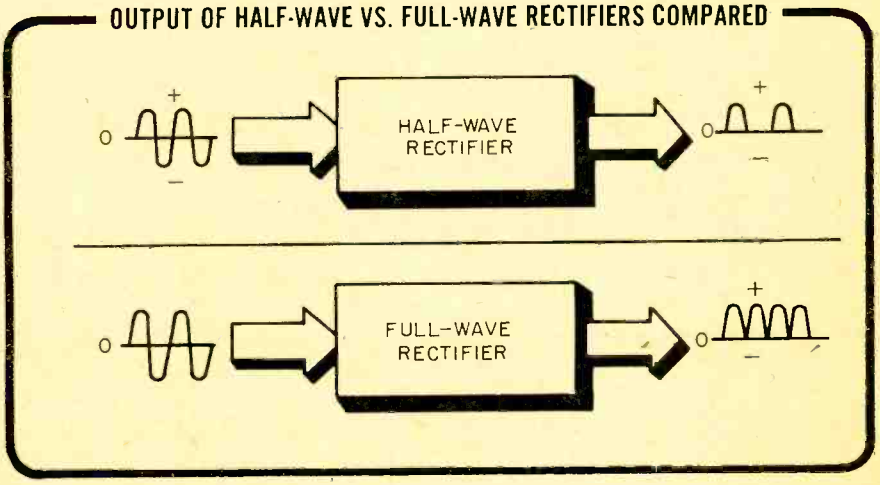
The rectification principle is very simple to understand. If it is desired to change an AC voltage to a pulsating DC voltage, a unidirectional current-control device must be used. Any device that accomplishes this result is called a **rectifier.** The diode is such a device.

The principle of rectification is shown on the next page. An AC voltage is applied to a unidirectional current-control device. In the illustration, the rectifier is connected to the load so that the current flows only during the positive portions

of the input signal. The output voltage is therefore composed of only the positive portions of the input. This positive polarity output is called **pulsating DC.**



The two most common rectifier configurations in use are the **full-wave** and **half-wave.** The differences between the two are obvious from the figure. When an AC voltage is applied to a half-wave rectifier, only half of each cycle is made available to the load. You will see later that not only is this type of rectification inefficient, but it also makes it more difficult to obtain the non-pulsating DC voltages required by some electronic circuits.



When AC voltage is applied to a full-wave rectifier, the load receives current during both half cycles. Notice that the negative half cycles have been inverted so that all the half cycles are positive at the output of the rectifier. This type of pulsating DC is much easier to filter than the output of the half-wave rectifier. Thus, smaller and less expensive components can be used in the filter section.

Q1. An AC voltage is converted into a DC voltage by a ----------.
Q2. The two major functions of a power supply are to ------- and -------.
Q3. The component of a power supply that changes AC voltage to a pulsating DC voltage is the ----------.
Q4. The component of a power supply that smooths out pulsating DC into almost pure DC is the -------.

Your Answers Should Be:

A1. An AC voltage is converted into a DC voltage by a **rectifier.**

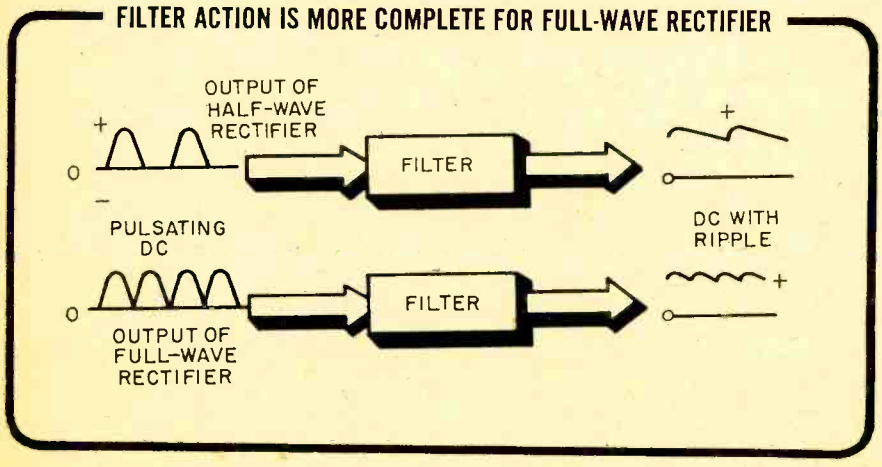
A2. The two major functions of a power supply are to **rectify** and **filter.**

A3. The component of a power supply that changes AC voltage to pulsating DC is the **rectifier.**

A4. The component of a power supply that smooths out pulsating DC to become almost pure DC is the **filter.**

FILTERING ACTION

The function of the filter is to smooth out the pulsating DC and provide an almost pure DC. You can see in the figure that the actual output is not quite pure DC. The amplitude of the ripple is the factor that determines how close the



output is to DC. The higher the amplitude of the ripple voltage, the farther the output is from DC.

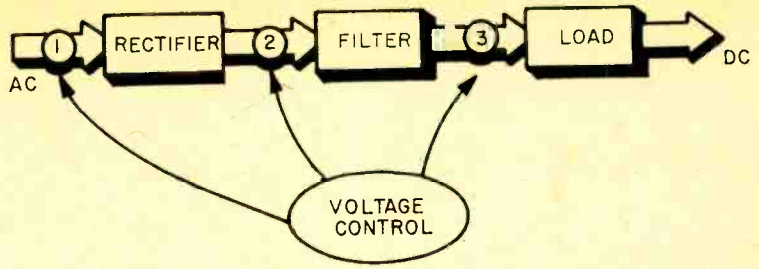
VOLTAGE CONTROLS

Several types of voltage controls are used in power supplies. The figure on the next page shows the locations they may have in a power supply. The types of voltage control can be roughly divided into two classes—**automatic** and **manual.** Either type serves the same function, to supply the correct voltage to the load.

The voltage control used at point 1 in the illustration is the power transformer. It may be some sort of transformer equipped to deliver a variable output, that can be manually controlled to provide the desired output voltage. Or it may be a power transformer with several windings, each of which provides a different voltage.

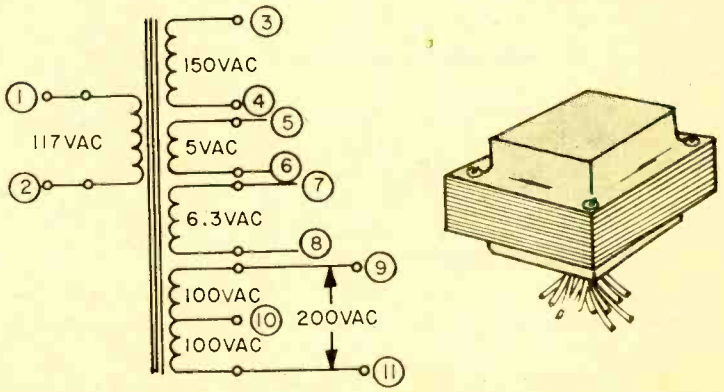
The power transformer in the figure has an input winding (1 and 2), a 5-volt filament winding (5 and 6) for the rectifier, a 6.3-volt filament winding (7 and 8) for the vacuum tubes in the equipment, and two step-up voltage windings to supply voltage to the rest of the load. One of these windings (3 and 4) provides

VOLTAGE CONTROL CIRCUIT LOCATIONS IN A POWER SUPPLY



150 volts AC, and the other (9, 10, and 11) provides 200 volts AC with a center tap. The use of this center tap will be explained later.

A MULTI-WINDING POWER TRANSFORMER AND SCHEMATIC



Q5. The function of a filter is to ------ pulsating DC.
Q6. Voltage controls can be either --------- or ------.

Your Answers Should Be:
A5. The function of a filter is to smooth pulsating DC.
A6. Voltage controls can be either automatic or manual.

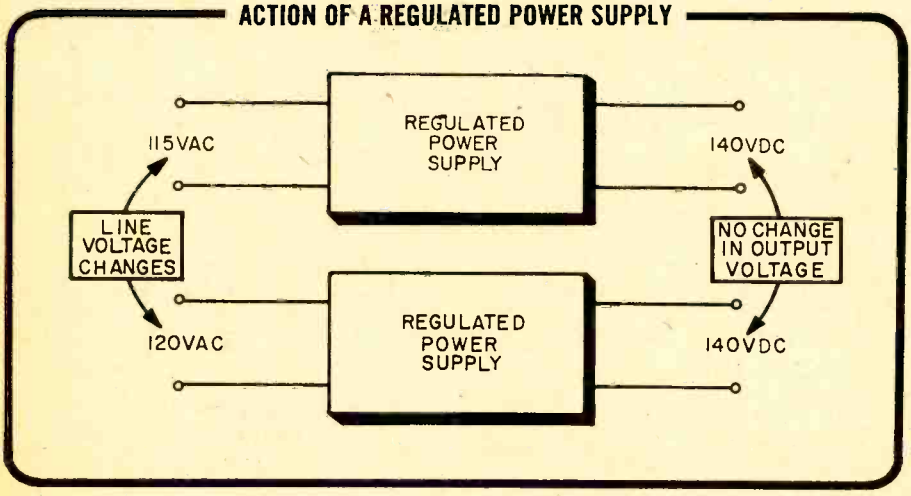
The type of voltage control used at point 2 (see the figure at the top of the page) is capable of making automatic voltage changes. This is accomplished by using various types of rectifier circuits that may double, triple, or even quadruple the input voltage.

The type of voltage control used at point 3 can vary the output voltage either automatically or manually, and is called a **regulator circuit.** Its main function is to maintain a steady output voltage from the power supply. A power supply using a regulator is called a **regulated power supply.**

For example, an unregulated power supply is fed by a line voltage of 115 volts AC. It provides an output voltage of 140 volts DC to its load. Now suppose the line voltage changes to 120 volts AC.

When there is an increase in the line voltage, there is a corresponding increase in the output voltage. In the example given, it happens to be an increase of 10 volts DC. Many electronic circuits are not affected by this much change. Others are affected only slightly. However, many circuits are disturbed considerably by this type of change, and a voltage regulator must be used to correct it.

The power supply shown below has a voltage regulator. When the line voltage increases 5 volts, the output voltage remains at 140 volts DC. Changes in the load current will also change the output of a power supply. Voltage regulators



are designed to prevent changes under these conditions as well. Notice that many voltage regulators can be manually controlled, incorporating an adjustment used for selecting a particular voltage output.

VACUUM-TUBE AND SEMICONDUCTOR RECTIFIERS

A diode, whether it is a vacuum tube or semiconductor type, is sensitive to the polarity of an applied voltage. A positive voltage applied to the plate, or anode, causes a diode to conduct readily, while a negative voltage applied to the same point results in no conduction (in the case of the vacuum diode) or very slight conduction (in the case of a semiconductor). It is this unidirectional property that makes a diode useful as a rectifier.

Q7. In an unregulated power supply, the output voltage ------- when the input voltage changes.

Q8. The output voltage of an unregulated power supply (changes, does not change) when the load current changes.

Q9. A ---------- is used to keep the output voltage of a power supply constant.

Q10. A diode conducts only when its plate, or anode is ---------.

Your Answers Should Be:

A7. In an unregulated power supply, the output voltage **changes** when the input voltage changes.

A8. The output voltage of an unregulated power supply **changes** when the load current changes.

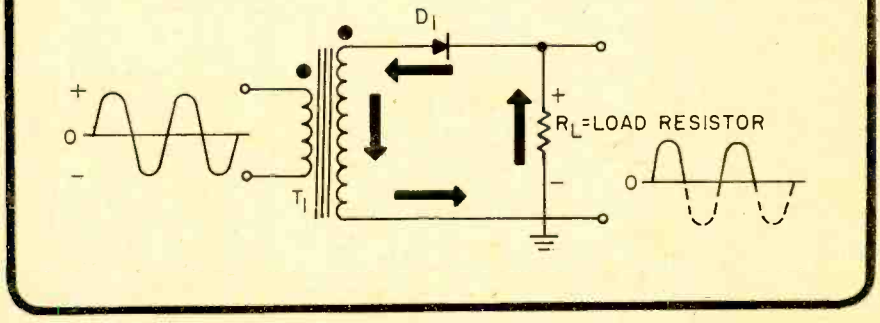
A9. A **voltage regulator** is used to keep the output voltage of a power supply constant.

A10. A diode conducts only when its plate, or anode is **positive.**

Half-Wave Rectifier Circuits

A half-wave rectifier converts an AC voltage into a pulsating DC voltage. It does this by removing either the positive or negative half cycles from the input voltage. In other words, only half of each sine-wave cycle is used to provide power to the load. It can readily be seen that this type of supply is relatively inefficient.

HALF-WAVE RECTIFIER USING SEMICONDUCTOR DIODE

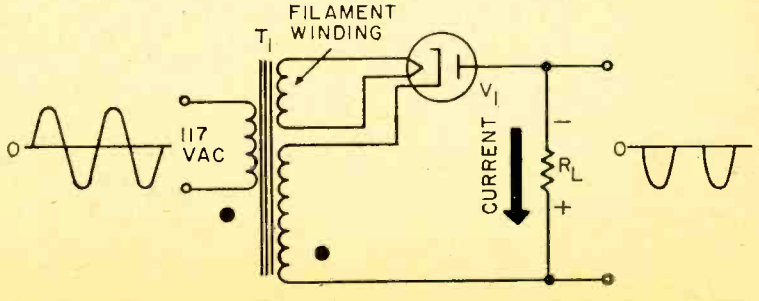


Above is a typical half-wave rectifier with a power transformer in the input. Notice the dots at the top of each winding of T_1. These dots indicate that the transformer is wound in such a fashion that the voltages at the ends of the windings marked with the dots are in phase with each other. Therefore, when the top of the primary is positive, the top of the secondary is also positive.

When the positive half cycle of the input voltage is applied to the primary winding of T_1, there is a positive voltage applied to the anode of semiconductor D_1, causing it to be forward biased Diode D_1, then conducts, causing a current flow and a voltage drop across the load resistor R_L. During the negative half cycle, D_1 is reverse-biased and very little current flows. There is very little voltage dropped across R_L during this half cycle.

A half-wave rectifier can also utilize a vacuum-tube diode. Such a circuit is shown in the figure below. The small secondary winding is a filament winding to

HALF-WAVE RECTIFIER USING VACUUM TUBE DIODE



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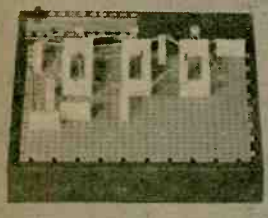

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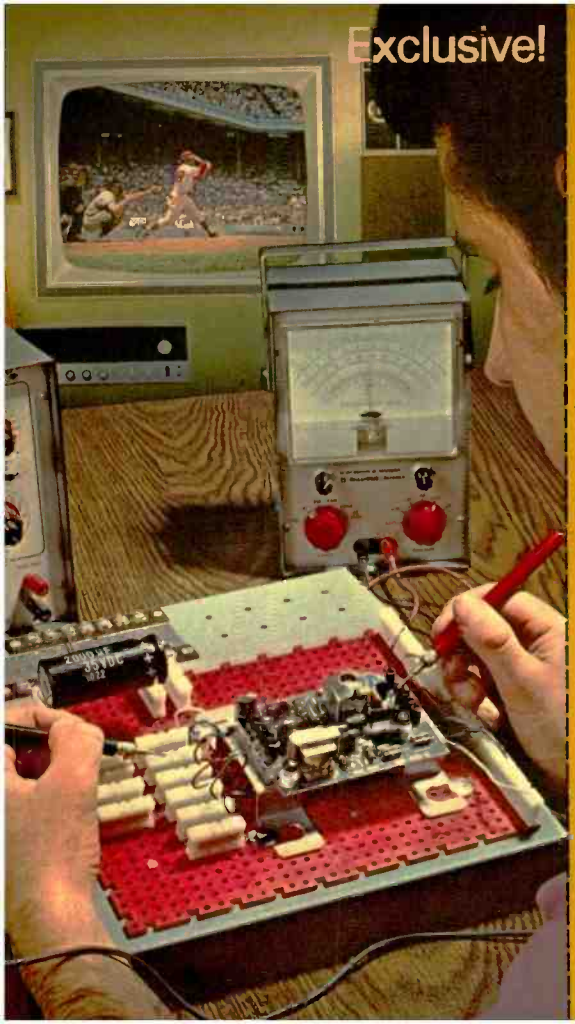

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Note: TV picture is simulated.

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supply heating current to the filament of V_1. (Notice that this winding was not needed for the semiconductor diode.) Observe the negative voltage output shown in the figure. This is obtained by connecting the diode so that it permits current to flow down through the load resistor (R_L). Therefore, the diode plate is connected to the top of R_L. The bottom of R_L is connected to the bottom of T_1, and the cathode of V_1 is connected to the top of T_1. The diode could just as easily be connected in the reverse direction to give the opposite polarity.

In its operation, this circuit is very similar to the semiconductor half-wave rectifier. On the positive half cycles, a positive voltage is applied to the cathode of the diode, and the diode will not conduct. On the negative half cycles a negative voltage is applied to the cathode, and the diode does conduct. Current flows down through R_L, producing an output of the polarity shown. Thus, only negative half cycles appear at the output.

Q11. A half-wave rectifier passes current to the load during (one half, both halves) of each cycle of applied voltage.

Q12. A half-wave rectifier can be made using a ---------- or ---------- diode.

Q13. Output-voltage polarity depends on the connections to the ------.

Your Answers Should Be:

A11. A half-wave rectifier passes current to the load during **one half** of each cycle of applied voltage.

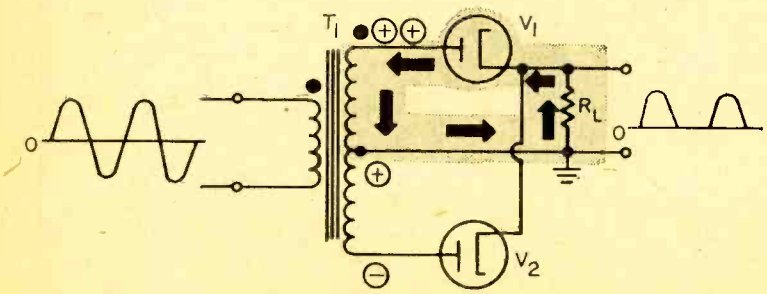
A12. A half-wave rectifier can be made using a **semiconductor** or **vacuum-tube** diode.

A13. Output-voltage polarity depends on the connections to the **diode.**

Full-Wave Rectifier Circuits

A full-wave rectifier differs from a half-wave rectifier in that it utilizes both halves of the input-voltage cycles for its pulsating DC output voltage. Such a rectifier is shown in the figure below.

ELECTRON FLOW DURING POSITIVE HALF CYCLE IN FULL-WAVE RECTIFIER

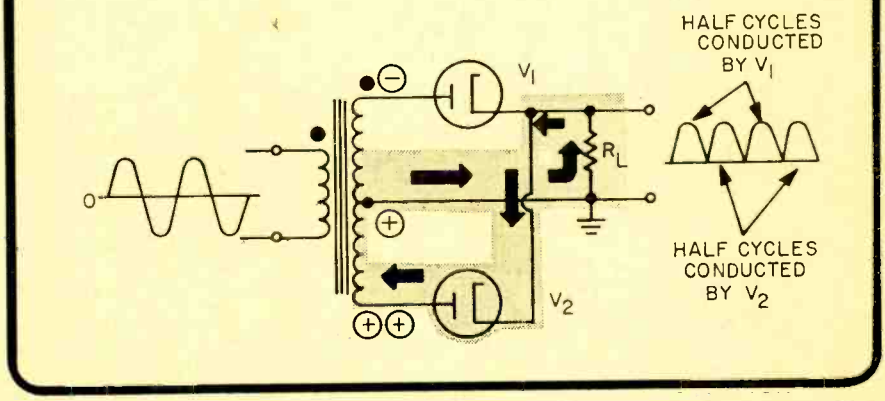


Two diodes are employed in this circuit. A transformer with center-tapped secondary winding is used; its center tap is connected to one side of R_L and

ground. When the dot side of T_1 is positive with respect to the center tap, V_1 will conduct. The plate of V_2 is connected to the other end of T_1, which is negative with respect to the center tap. Thus V_2 will not conduct. The output of the circuit is as shown in the figure. Compare this output with that of the half-wave rectifier.

On the negative half cycle, the top of T_1 is negative with respect to the center tap, so V_1 will not conduct. The bottom of T_1 is positive with respect to the center tap, and V_2 will now conduct. Notice the direction of current flow—through V_2, to the bottom of T_1, out of the center tap, **up through R_L,** and back to the cathode of V_2. Current flows through R_L in the same direction as it did for the positive half cycle. This results in the output half cycles all being positive. The effect is just like passing the positive half cycles and inverting the negative half cycles.

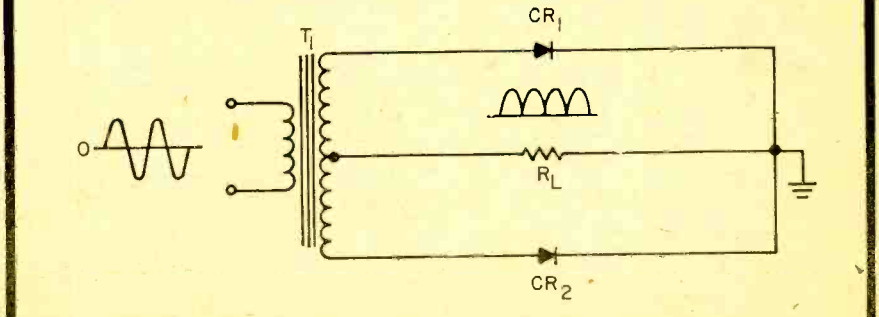
NEGATIVE HALF CYCLE ELECTRON FLOW IN FULL-WAVE RECTIFIER



Notice the difference between the pulsating DC from a half-wave rectifier and from a full-wave rectifier. The variation in the output from the half-wave rectifier has half the frequency of the variation from the full-wave rectifier.

A full-wave rectifier can, of course, be made using semiconductor diodes. The circuit below shows this. Although the position of R_L on the diagram has been changed, the circuit is still the same.

SCHEMATIC OF FULL-WAVE SEMICONDUCTOR RECTIFIER



Q14. A full-wave rectifier uses a transformer with a ---------- secondary.

Q15. A full-wave rectifier conducts during (one half, both halves) of the applied-voltage cycle.

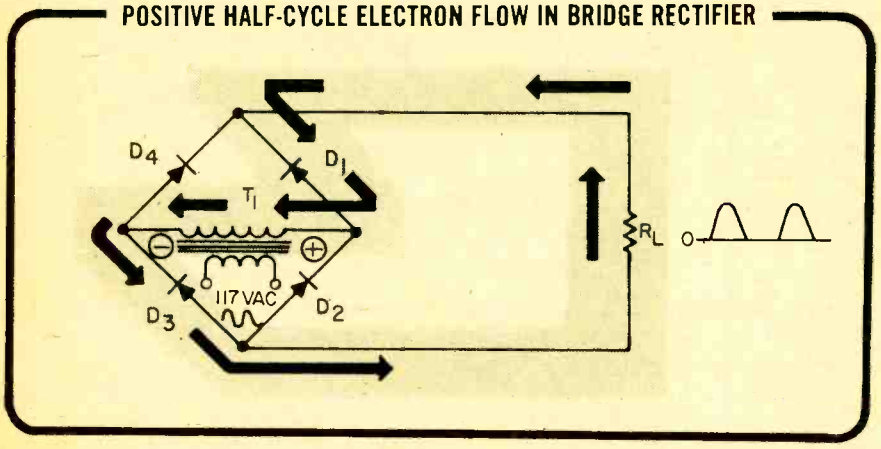
Your Answers Should Be:

A14. A full-wave rectifier uses a transformer with a **center-tapped** secondary.

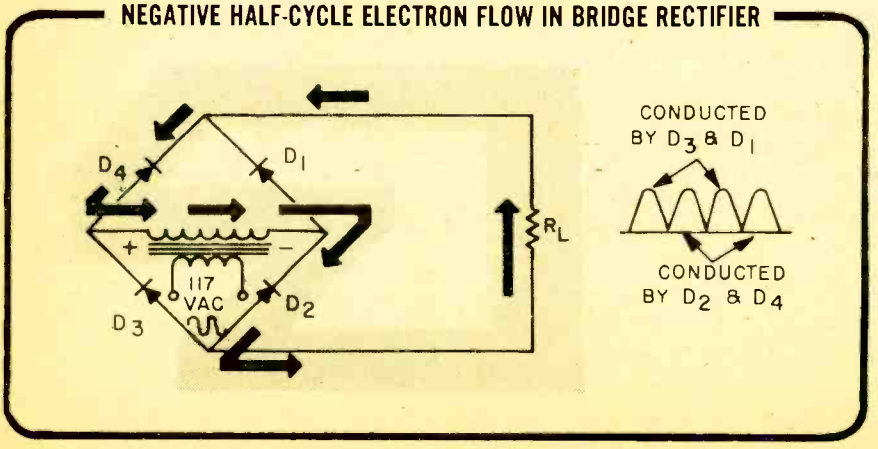
A15. A full-wave rectifier conducts during **both halves** of the applied-voltage cycle.

Bridge Rectifier Circuit

There is a type of full-wave rectifier circuit that does not require a transformer with a center tap. Instead, it uses four diodes. This circuit is called a **bridge rectifier circuit.**



On the positive half cycle, current flows through D_3, up through the load resistor, and back through D_1. Diode D_2 and D_4 are reverse-biased and act like open switches.



The figure above shows the current direction for the negative half cycle. The bridge rectifier is found in power supplies that must deliver a large

amount of current. Since some semiconductor diodes are not adequate to carry large currents, special selenium or copper-oxide metallic rectifiers are employed.

WHAT YOU HAVE LEARNED

1. Power supplies convert AC input voltages into DC output voltages.
2. The components of a DC power supply are: voltage control, rectifier, and filter.
3. A power transformer provides AC at desired voltage values to the input power supply.
4. A diode (or combination of diodes) converts AC into pulsating DC.
5. There are basically two types of rectifiers—half-wave and full-wave.
6. A bridge rectifier is one particular type of full-wave rectifier.

NEXT ISSUE: Part 2—Understanding Power Supplies

This series is based on material appearing in Vol. 3 of the 5-volume set, BASIC ELECTRICITY/ELECTRONICS, published by Howard W. Sams & Co., Inc. @ $19.95. For information on the complete set, write the publisher at 4300 West 62nd St., Indianapolis, Ind. 46268.

Kathi's CB Carousel

Continued from page 46

tenna jack, PA and external speaker jacks, antenna loading control, S-meter zero set, and the microphone gain control.

B&K's Cobra 25 receive-half is double conversion with three tuned circuits and a ceramic filter contributing to this rig's selectivity. The conventional transmitter, the lab crew informs me, uses a form of modulation limiting for both overmodulation protection and compression. Both transmitter and receiver sections are fed by a regulated power supply.

Figuring that some CBers like to doodle with their rig's innards, *B & K* made both modulation limiting and power supply output adjustable by the owner.

Snake Charmer's Performance. The *Cobra 25's* input sensitivity measured 1.1 uV for a nifty dB S+N/N ratio. Selectivity measured 60 dB adjacent channel rejection. Actually, the selectivity is greater than 60 dB; a signal 60 dB above 1 uV—and that's equivalent to a very weak but usable signal—desensitizes the input. If you were receiving a moderate-to-strong signal, the desensitization would be insignificant since realized selectivity would be greater than 60 dB.

Image rejection was an unbelievably high 86 dB. The AGC action was a superb 3 dB for a 2 to 10,000 uV input signal range. Because of front-end desensitization, signal levels higher than 10,000 uV wind up being compressed into the 3 dB AGC range. I'd bet my last false eyelash that your ears won't shatter because a local CBer's signal pounced on top of an adjacent weak signal!

It takes 20 uV for the S-meter to slide upscale into S9 country. All other readings, however, are relative; there is no fixed value for each S-unit.

The transmitter half of the *Cobra 25* delivered 3.8 watts into a 50-ohm load. Heaps of reserve microphone gain—and any mike we tried—combine to bring the *B & K Cobra 25* up to essentially 100% modulation. Even with my whisper voice level, modulation reaches, and is limited to, 100%.

The modulation meter is darn accurate when monitoring speech. It did not give accurate results with test tone modulation, but then, this characteristic is common to all CB modulation meters. Fact is, for all CB rigs, modulation tests and measurements should be made with mike and voice only.

Overall performance of *B & K's Cobra 25* is very good. Which is the reason why this rig slips so easily into the Ultimate Gift slot on my Christmas list. Want to know more about the *B & K Cobra 25*? Circle number 49 on the Reader Service Page. *B & K* will be happy to oblige.

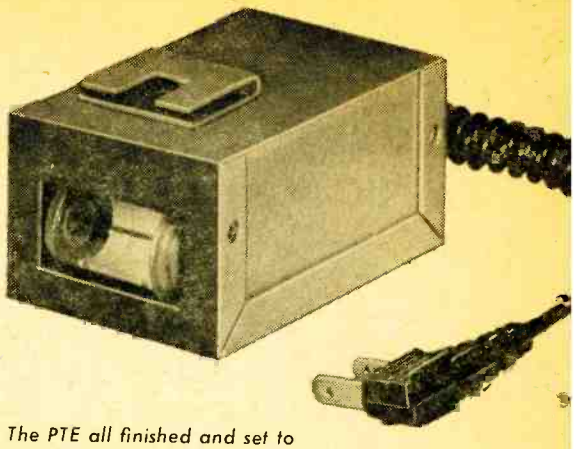
Our readers will be happy to know that other B&K products plus *mucho* more CB gadgets will be discussed in our upcoming 1972 CB YEARBOOK. Watch for it! ■

Photog's Third Eye

Continued from page 44

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.

Electrosleep

Continued from page 53

of these pioneer electric devices were on the right track, but lacked knowledge of natural electrical processes of the human body as well as ability absolutely to control the input of power impulses.

Alpha Waves. Electrosone 50 yields a squarewave pulse of very brief duration and very low voltage. Because such a wave closely approximates the all-important natural alpha wave of the brain, it can be regarded as an electronic equivalent of synthetic chemicals that are patterned after naturally occurring ones.

Whether "synthetic electrical impulses for the body" will ever have an impact equal to that of synthetic chemical compounds remains to be seen.

Also debatable until much more clinical experience has been assessed is the question of direct influence of electricity versus influence of suggestion plus confidence in a radical new type of treatment.

The F.D.A. Joseph B. Davis, M.D., director of the F.D.A.'s division of clinical and medical devices, remains in the cautious corner. Until 1938, the agency had no control whatever over mechanical and electrical devices. Today the reins are getting tighter, and restrictive legislation is being urged by many persons who fear exploitation of the public by quacks. Dr. Davis' agency can presently move against medical devices only through sections of the Food, Drug, and Cosmetic Act—permitting court action only if the equipment is being marketed through false or misleading advertising, has been adulterated, or proves dangerous to health.

Davis himself notes that use of electrosleep machines sometimes leads to "adverse eye effects" that may last half an hour. "What is being done to the enzymatic and humoral systems, and whether the nervous system's chemical-electro impulses are being overriden" needs to be known.

Paul Williamson, M.D., is making medical news from the unlikely spot of McComb, Mississippi. Interviewed by telephone recently, Dr. Williamson predicted "astonishing progress" in electrosleep therapy within the seventies. Himself an American pioneer in the field, he now spends much of his time lecturing to professional groups whose members wouldn't have given him the time of day a decade ago.

Other important work is being done by Dr. William Dement, director of the Stanford University Sleep Research Laboratories. Along with Drs. Rosenthal and Wulfsohn, plus others who are beginning to experiment but haven't yet put their findings into print, these men are going to make certain that Space Age man finds out whether push-button sleep is a fact or a fancy. ■

Fish Finder

Continued from page 79

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. ■

Shortwave Listening

Continued from page 35

es). Broadcasting stations are listed in White's Radio Log, published semiannually in COMMUNICATIONS WORLD—this includes AM, FM, TV and Short Wave Broadcast station listings.

Like the old fisherman told the freckle faced youngster, "I can only bait the hook, you'll have to catch them yourself," I can tell you that the foregoing information should get you well on the way to serious SWLing; but how far you go in the hobby depends solely on your own ingenuity and tenacity. Patience may be a virtue, but it is the by-word of SWLing, it may actually take *years* for you to hear one particularly elusive station that you seek—but that's half the fun! Good fishing! ■

DX Central Reporting

Continued from page 15

years of listening under their belts. Here's an inside tip. Listen for Libya's Arabic language home service on this off-beat channel during the afternoons until 2300 sign off. . . . **10,010**—*South Vietnam Liberation Radio*, actually the clandestine voice of the Viet Cong, now has a daily English language newscast at 10:30. Lately they've been answering reports, even from "Imperialist Warmongers," if they're addressed to 39 Avenue Georges Mandel, F-75 Paris 16, France. . . . **11,920**—France doesn't exactly go overboard when it comes to English language programs, but you can catch the news to Africa from *Ofice de Radiodiffusion-Television Francaise* at 0515. . . . **15,410**—When not in Rome, do as Stateside DXers do, listen to the North American service of *Radiotelevisione Italiana* at 0045.

(Credits: Dan Ferguson, West Virginia; Carroll Patterson. Georgia; William J. Penn, New Jersey; Alvin Sizer, Connecticut; Gregg Calkin, Mexico; Gladys Martin, New York; Larry Magne, Pennsylvania; David Williams, Oregon; North American SW Association, Box 989, Altoona, Pennsylvania; SPEE-DX, Box 321, Santa Ana, California)

Backtalk. Antarctica, the seventh continent, seems to hold a special attraction for DXers. Steve Martin of Upper Marlboro, Maryland, passes along three frequencies used by Antarctic military utility stations. They are 7,370, 13,975.5 and 21,277 kHz. Steve says the latter one is used by the Palmer Station station at 2015 GMT.

Candian reader, Frank Eimer of Calgary, Alberta, asks about shortwave broadcasting from Iceland, frequencies and times to tune.

Sorry, Frank, but the SWBC station at Reykjavik, Iceland, is no longer on the air. If some of you readers managed to bag this one a few years ago, congratulations. Your QSL is a "rarie!"

Speaking of stations leaving the shortwave broadcast band, word is out that the Fiji Broadcasting Corporation also is soon to abandon the higher frequencies. So now's the time to try for this one on 3,284 kHz during the wee hours of the morning.

"I regularly receive Radio Nacional de Brasilia on 15,445 kHz." writes Joseph Straub of Pittsford, New York. "But I can't get a QSL because I haven't been able to decipher the address. Can you help?"

Sure can, Joe. Send your reception report to Radio Nacional de Brasilia, Caixa Postal 1472, Brasilia, Brazil. Program producer Luthero Toledo is a good guy when it comes to QSLing listener's reports.

This month we focus the DX Central spotlight on another fine shortwave clubs, the up and coming Midwest DX Club. (turn page)

Though MWDXC's emphasis is on the shortwave frequencies, the broadcasters, the utility communications stations and the ham bands, medium wave listeners are not neglected. Its monthly bulletin, MWDXC Journal also includes plenty of interesting feature articles and a useful propagation column, telling you when and where to tune for optimum reception.

Like the other DX clubs spotlighted in this column, MWDXC is affiliated with the Association of North American Radio Clubs. If you'd like information on other DXers organizations, write to ANARC, 2110 West 74th Street, Prairie Village, Kansas, 66208.

If the Midwest DX Club sounds like your cup of tea, or if you'd like more information about the organization, use the handy form on this page. Please send it directly to MWDXC, not to DX CENTRAL REPORTING. ■

MIDWEST DX CLUB
6636 Davis Street
Morton Grove, Ill. 60053

I read about MWDXC in ELEMENTARY ELECTRONICS "DX Central Reporting." (Please check one:)

☐ I want to join. I am enclosing $3.00 (third class mail) or $5.00 (first class mail) for one year's membership.

☐ Please send me more information about MWDXC.

Name: _____

Address: _____

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Bookmark by Bookworm

Continued from page 16

how to isolate troubles to a specific unit with extreme accuracy, based on his keen observation of waveforms and precise voltage measurements possible only with an oscilloscope and a vectorscope. It is these 'scopes that are really the "eyes" of a modern troubleshooter. Published by Tab Books.

Circle No. 43 on Reader Service Page

Brain Book. Consisting of an integrated description on intelligent machines, a new book —*Artificial Intelligence* by James R. Slagle—shows that computers can mimic the behavior

Hard cover
196 pages
$8.95

or performance normally associated with human intelligence. This book is primarily intended for students of computer science. Published by McGraw-Hill Book Company.

Circle No. 44 on Reader Service Page

Mini Reviews—

● *101 TV Troubles from Symptom to Repair* by Art Margolis—an invaluable *cause and cure* guide to the solution of most TV troubles —both color and B&W. Published by Tab Books: hard cover, 224 pages, $7.95.

● *Semiconductors—Physics, Devices, and Circuits* by Michael M. Cirovic—contains fundamentals needed to understand the devices that revolutionize electronics, from the physics of semiconductors to basic amplifier circuits using semi-conductor devices (a college-level text). Published by Prentice-Hall, Inc.: hard cover, 420 pages, $13.50-student's edition.

● *How to Read Electronic Circuit Diagrams* by Robert M. Brown and Paul Lawrence—a modern guide of practical value to hobbyists experimenters, students and others who want to upgrade their knowledge the easy way. Published by Tab Books: soft cover, 256 pages, $3.95.

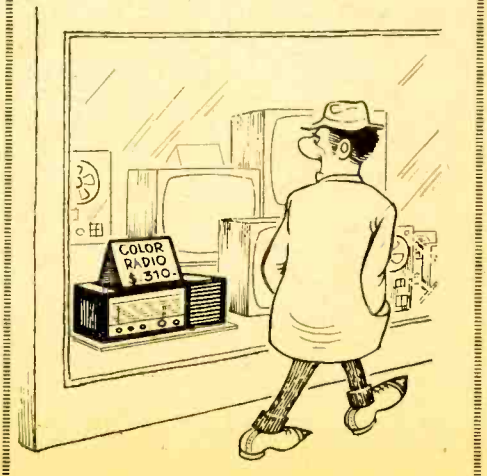
Book Publishers' Addresses

Hayden Book Co., Inc.—116 West 14th Street, New York, NY 10011

McGraw-Hill Book Company—Public Information Dept., 330 West 42nd Street, New York, NY 10036

Prentice-Hall, Inc., Englewood Cliffs, NJ 07632

Tab Books—Blue Ridge Summit, Pa. 17214.



Stamp Shack

Continued from page 18

gold and black stamp showing just a telegrapher's key, surrounded by concentric lines symbolizing its communications service.

● The first telegraph was part of Prince Nicola of Montenegro's first social reforms and began when he and Austria signed a treaty on Feb. 18, 1860. The latter provided the technical know-how and equipment to enable service to begin a couple of years later.

● Begun as a purely national communications facility, the telegraph system eventually was linked with Austria and later through Vienna, with other European nations.

● **What's New?** The H. E. Harris Co., Boston, Mass. 02117, has just published a "Starter Outfit," intended to enable one to begin stamp collecting. Priced at only $1.98, it contains an album for 7,000 different stamps of the world, especially those related to Space exploration, a packet of stamps and a variety of necessary accessories.

Readers who chance to live in or visit the Boston area will find a visit to the Cardinal Spellman Philatelic Museum well worth while. Established by the late prelate, this magnificent building on the campus of Regis College, in Weston, contains displays of stamp collections and a library of books and magazines related to stamp collecting as well as other comfortable facilities. Admission is free. ■

Ask Hank, He knows

Continued from page 24

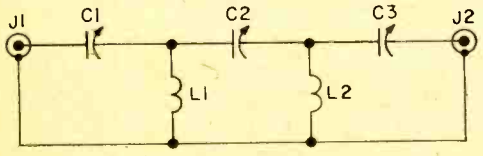
are actually very low, TVI (TV interference) is the fault of your TV set. The strong transmitter signals overwhelm the front end of your TV set. You can add a degree of protection by installing a high-pass filter (available at parts stores and most TV dealers) at your TV and FM sets' antenna terminals. 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.

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.

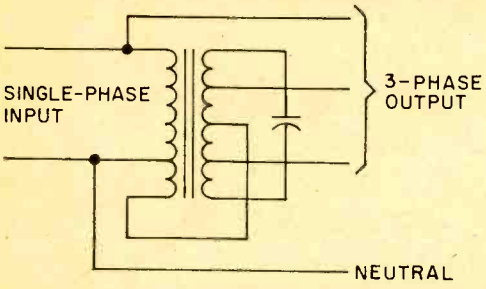
One-to-Three Phase

I need 3-phase AC power at low wattage, but only have single-phase power at my home. Is

there any way I can get 3-phase power without having the power company install a new line?

—F.A., Bronx, N.Y.

The hard way is to rig up a motor-generator set consisting of a single-phase AC motor and a 3-phase alternator. You could even use a



3-phase auto alternator, and step up the voltage with a transformer. An easier way is to use a Paraformer (parametric transformer) made by Wanlass Electric Co., 2175 S. Grand Avenue, Santa Ana, Calif., connected as shown in the diagram. It provides 4-terminal output (3 phases plus neutral).

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 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. ■

Hey, Look Me Over

Continued from page 26

Numbers CWS102, S103 and S104 specify the increased power models. Input power requirements are 115 or 230 VAC. Prices start at $129.95 to $249.95.

Circle No. 36 on Reader Service Page

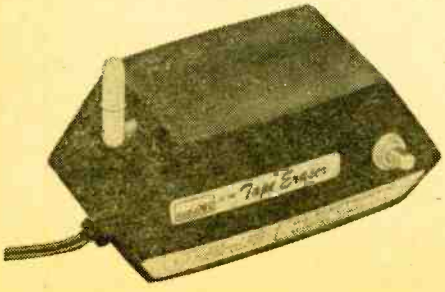
Reel Racer

An unusual, double-duty bulk Audiotex tape eraser, Model 30-140, is included in the GC Electronics' new general catalog. Priced at $18.31, the new eraser can be used both separately on a *table-top* and a *hand-held* unit. It will magnetically wipe clean audio tape reels, cassettes, cartridges and video tape. The eraser is powered by standard house current (117 volts AC) and draws four amperes in operation. The unit is turned on with an integral pushbutton switch. A single pass over the unit by a magnetic tape completely erases all program material and background noise—restoring the tape to "virgin" condition.

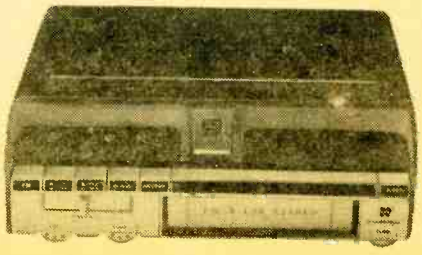
Circle No. 37 on Reader Service Page

Auto Stereo Center

Five completely new stereo 8-track tape players have been introduced by Panasonic Auto Products. At the top of the line is the Model CQ-909,



GC-Audiotex Tape Eraser



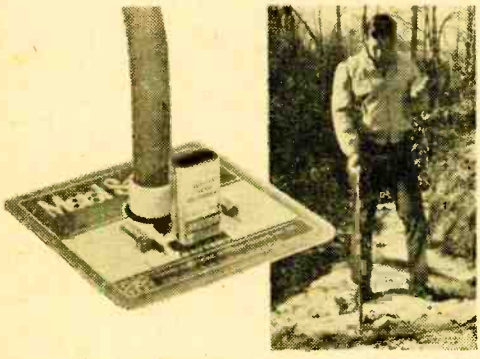
Panasonic CQ-909 Tape Player/FM Receiver

The Riverside, a combination stereo-8 player/FM-stereo receiver for automobiles, featuring a slide-rule balance control, repeat button which provides for playing back any channel, automatic or manual program selection, eject button for releasing the cartridge from the player, bass/treble tone control, and flush cartridge fit for added safety and enhanced appearance. The FM-stereo receiver section of the CQ-909 features a mono/stereo switch, distant/local switch for greater selectivity, built-in AFC. Suggested retail $119.99.

Circle No. 38 on Reader Service Page

Hidden Asset

A very sophisticated, yet surprisingly low cost, metal detector is available by mail through Edmund Scientific Co. With it, you can find hidden coins, jewelry and precious minerals at the beach, at a campground, or in your own backyard. You can operate this durable detector (weight: 10



Edmund Scientific Metal Detector

ounces) for hours without fatigue, feeling only the excitement of discovering hidden treasure. It works in conjunction with any portable AM transistor radio (not included), thus eliminating costly extra circuitry and dangling wires which make other metal detectors so expensive and heavy, and operates on a 9 volt transistor battery. It costs just $14.95 (Stock No. 71,395).

Circle No. 39 on Reader Service Page

CB Toting

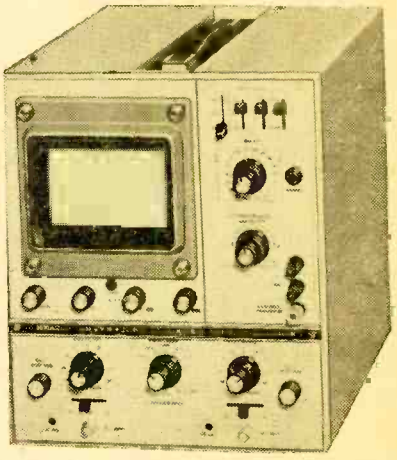
The compact Messenger 125 Citizens Band two-way radio can be used as a battery-operated portable unit, thanks to the new "Porta-Pack" carrying case introduced by the E. F. Johnson Company. The Porta-Pack case allows the radio to be removed from a vehicle and converted into a portable unit within seconds. The Messenger 125 slips easily into the leather Porta-Pack case, which contains its own collapsible whip antenna. Built-in high capacity nickel-cadmium batteries will power the Messenger 125 for six hours of normal use, and over eight hours if transmit time is held to a minimum. External jacks on the case are provided for recharging the batteries and connecting an external antenna. Suggested retail price: $69.00.

E. F. Johnson Messenger 125

Circle No. 40 on Reader Service Page

Super Scope

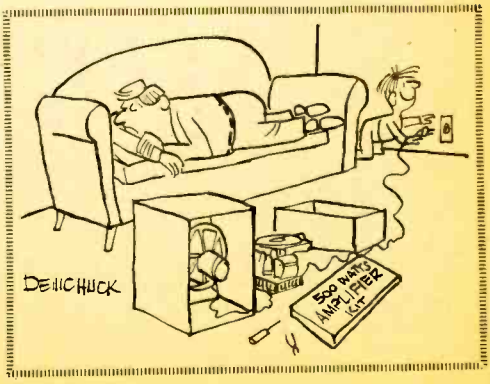
A brand new Heath EU-70A scope features complete dual trace and X-Y capability. Two separate



Heath Model EU-70A Oscilloscope

inputs can be individually displayed in Ch. 1 or Ch. 2 modes. Alternate and chopped modes allow both signals to be displayed at once for direct comparison. Alternate mode displays on alternate sweeps; in chop, both signals are sampled at a 100 kHz rate and appear as a function of the same time base. X-Y capability permits each input to be displayed as a function of the other, with Channel 1 controlling the Y axis and Channel 2 controlling the X axis. Both input channels are precisely balanced for less than 1% phase shift to over 100 kHz. The Heath EU-70A is sold factory assembled & tested, and is priced at $565.00. ■

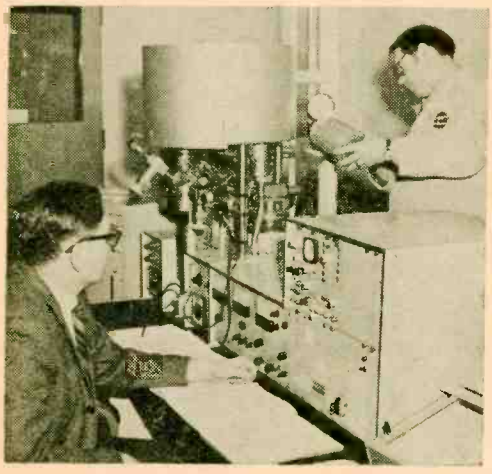
Circle No. 41 on Reader Service Page



Newscan

Continued from page 23

with X-rays, causing electrons to be ejected for identification and analysis of chemical elements. With the photoelectron spectrometer, scientists can test only to a depth of four to 30 angstroms (about 0.000000076-of-an-inch). If you touch the specimen before it goes into the machine, the only analysis you will get is of the sweat on your finger. Applied to organic structural chemistry, the spectrometer can help scientists quickly classify offensive or poten-



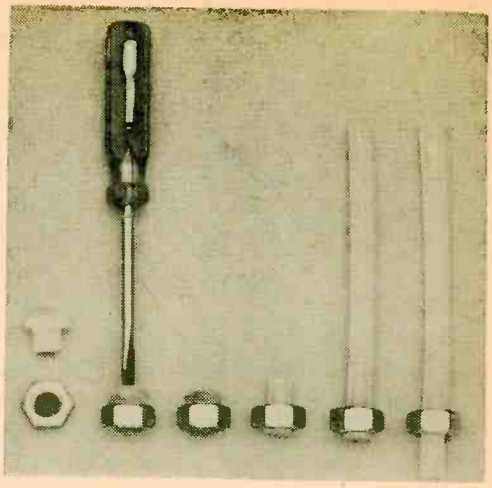
Liquid Nitrogen is added to the cooling system of Gulf Research & Development Company's photoelectron spectrometer by technician James B. Adamson while Dr. Richard R. Slater, supervisor, Chemical Physics Section, keeps a check on the instrument's control panel. This is the second unit of it kind in the world.

tially polluting elements in crude oil, such as sulfur, and assist in working out new refining methods to remove them. It also will test only the scaling in metal corrosion to better identify the cause and indicate how to stop it—helping, for instance, to develop improvements in motor fuels and oils to retard deterioration of vital engine parts.

The Bureau of Mines has shown an interest in the photoelectron spectrometer to help trace causes of *black lung*. By analyzing dust in the filters of miners' masks, they believe they can *fingerprint* coal, then determine from what part of the mine hazardous dusts originated.

PLASTIC RIVET

Radiation Technology, Inc. has developed the first plastic rivet for the hobbies market. The new noncorroding, thermoplastic fastener product known as *Radfast* will replace many ordinary uses for metal rivets, screws, bolts and nuts. With *Radfast*, no machining or injection



Through heating the non-corroding, thermoplastic Radfast rod, it can expand under heat to predetermined size and shape, thereby creating tough rivets, plugs and all-purpose fastening devices.

molding is necessary to make a fastener. Threads are formed to exact dimensions during the fastening process. You no longer have to hunt for the right size rivet or screw. No tool except a common heat source such as a match, cigarette lighter, soldering iron or hot air gun is needed in the radfastening process. Threaded inserts or screws can be formed by heat ex-

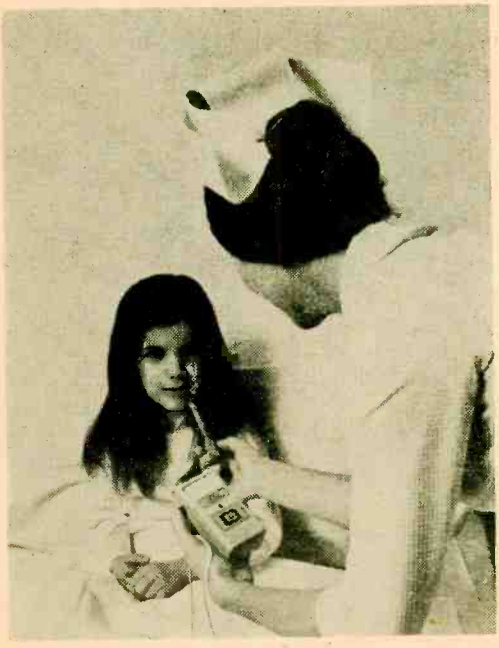
"Hey, Fred, remember that space probe back in the 60's when they ran out of monkeys and someone at NASA suggested using rabbits . . ."

panding the *Radfast* into tapped holes. Slotted, phillips or allen heads can then be formed while the material is hot. Spacer fasteners can also be formed, which is a totally new technique for plastic fasteners.

Radfast comes in flexible rods that can easily be cut to any desired insert length. Three rod diameters are presently available: 1/8"; 3/16"; and 1/4". Sample *Radfast* kits are available at $1.50 each by writing to Radiation Technology, Inc., Department J, Box 41, Hibernia, New Jersey 07842.

NO GLASS TO BREAK

Here's a better mousetrap—an electronic thermometer that will reduce hospital and nursing home costs sharply, eliminate the danger of cross infection and speed patient service. It's a fact that electronic thermometry is the first basic change in temperature-taking since Gabriel Fahrenheit invented the mercury thermometer in 1714.



A young patient is about to have her temperature taken with a new electronic thermometer. The thermometer accurately records temperatures in approximately twenty seconds and has a sterile diposable cover.

Each time a hospital patient's temperature is taken by a mercury thermometer, the cost per patient ranges from 4 cents to 8 cents depending on such factors as the cost of washing, packaging, cleaning equipment, breakage and the initial investment in thermometers. The LaBarge Electronic Thermometer reduces that cost to less than 1½ cents per patient, including the cost and operation of the instrument and the disposable cover.

The LaBarge thermometer utilizes a sterile, disposable cover which eliminates cross infection and re-infection. The standard mercury thermometer is a very real source of contamination in hospitals today. Scrubbing procedures are, at best, an effort to reduce the amount and types of bacteria. However, a disposable sensor cover can be absolutely sterile.

The operation of the LaBarge Electronic Thermometer is very simple. Hospital personnel were trained to use the thermometer in about fifteen minutes. During the hospital evaluation there was ready acceptance by the nursing staff, and there were no complaints from patients.

TO STOP A THIEF

United Air Lines has installed a special purpose computer system to check for stolen and counterfeit airline tickets at Los Angeles International Airport. The system utilizes 23 keyboard terminals, 17 located at boarding gates and six at the ticket counters of United's two airport satellite buildings. As passengers check in, the ticket number is put into the computer through a keyboard by a passenger agent. An instantaneous reply with a green light indicates the ticket is valid. A red light indicates the ticket may be stolen.

Because the computer gives an immediate response when a ticket number is entered, United officials said use of the system will not affect or delay service to passengers as they arrive for check in. Numbers of tickets stolen anywhere in the country can be checked. ■

Checking for stolen airline tickets at Los Angeles International Airport, United Air Lines passenger agent Lynne Overton keys in ticket number to a new computer. An instantaneous respose by red or green light indicates whether ticket is good or stolen.

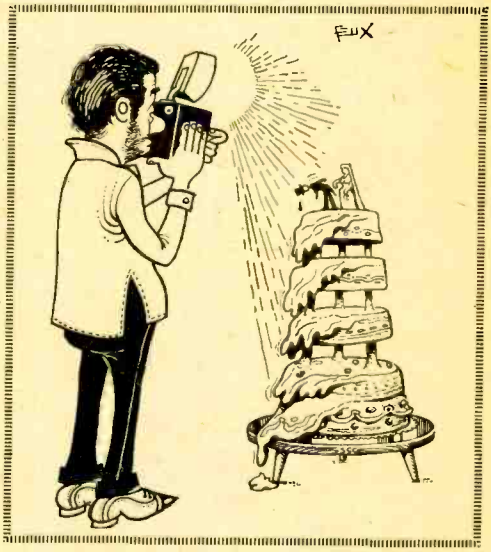
Oscillating Amps

Continued from page 64

and-conquer approach to this amplifier is to put feedback around only a pair of stages instead of three or more. This way, there are only two pairs of stray R's and C's lurking in the amplifier, and it takes at least three such pairs to make an oscillator.

The coupling capacitors, which combined to make a phase shifter in the very first example, can be prevented from ganging up on the amplifier and making it oscillate by making the product of each capacitor times its associated resistor (called the "RC Product") 5 or 10 times larger or smaller than the other RC products. For example, in a three-stage feedback amplifier which has all its base resistors the same values, you could make the three coupling capacitors 2μF, and 10μF, and 50μF, respectively. Again, you have divided the coupling capacitors into three widely-separated values, and conquered the oscillation.

All these problems and solutions are by no means a comprehensive list of all the ways an amplifier can get into trouble, nor of all the tricks of the trade that can be used to bail them out. For that matter, we've said nothing at all about the opposite problem—how to persuade a balky oscillator to "take off" and do its thing. But we've said enough to indicate that the cynic mouthing Murphy's Law would be well-advised to look to his basic theory and construction, because both amplifiers and oscillators answer to certain basic circuit laws, and will behave themselves impeccably if those laws are not violated. ■



Heath Electronic Oven

Continued from page 48

marily of mounting electrical hardware such as the power transformer, switches and lights. Total construction time runs about 10 hours. Then the unit is ready for a final checkout.

During the final check the power transformer is made inoperative so the Magnetron cannot be accidentally placed in operation. All switches, lights and interlocks are checked out. Finally, there is the operational check. Very simply, it consists of verifying how long it takes to get 8 oz. of water to boil. If it boils in 3 minutes, you're ready to cook!

During operation, considerable heat is blown through the door. This heat, and the humidity built up during cooking, is vented by the Magnetron's cooling blower. No maintenance is required other than the periodic cleaning of the blower motor's filter. Naturally, the frequency of cleaning will depend on how often the oven is used. If the filter becomes clogged, thereby reducing the blower's cooling efficiency, a front panel lamp will indicate excessive Magnetron heat. Periodically, the door seals should be checked and cleaned if necessary; the same as you would do with a standard oven.

Summing up. We found the *Heath Electronic Oven* to be an excellent performer. In fact, it was better than some commercial models which did not have an interior glass shelf to provide microwave radiation from under the food. *Heath's* supplied chart of recommended cooking times proved reasonably accurate. Should you want to modify cooking time to obtain a more rare or well-done cooked quality, *Heath's* recommendations will put you well inside the ballpark.

The *Heath GD-29 Electronic Oven* kit is priced at $379.95. For additional information, circle No. 34 on the Reader Service Page located on page 17. It's guaranteed to make you hungry for one! ■

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DOUBLE Money Back if you can't beat horseraces using my system! Strauss-AJW, Brooklyn, New York 11219.

HAVE your own Television Business. Even if you are not an expert. $2.00. Redmond, P. O. Box 593, Daly City, Calif. 94017.

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PRACTICAL tips for home, garden and workshop are in "1001 How-To Ideas." Send $1.00 for your copy includes Postage. to 1001 How-To Ideas, 229 Park Avenue South, New York, N.Y. 10003.

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UNIVERSITY Degrees by mail. Via Thesis. Experience. Home study, Norman, Dept. 63, Box 3199, Pasadena, Calif. 91103.

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MICHIGAN 10 to 160 ACRE TRACTS Lake Superior - Marquette area from $99.00 Acre. Cabins, trailers, camping welcome. (Acreage Anywhere in Michigan). FREE PICTURES. Any Terms A-OK with BLOCH BROTHERS, write 3650 Dixie, Drayton Plains, 44 Michigan 48020.

HI-FI EQUIPMENT

"CB Tranceivers, linear amplifiers Free Catalog. Echotronics, Box 1215, West Babylon, N.Y. 11704"

HOME WORKSHOP SUPPLIES

NEW Revolutionary Screwdriver with built in light complete with 4 blades, regular driver, Phillips types, drill and-awl. Batteries available locally $1.65. Jose Pacheco, Box 1724, NYC 10027.

INVENTIONS WANTED

WE either sell your invention or pay cash bonus. Write for details. Universal Inventions, 298-3, Marion, Ohio 43302.

MISCELLANEOUS

BEAT the horses — blackjack — bingo. Free details. Cappie, Box 5986-EE, Lighthouse Point, Florida 33064.

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MAKE THOUSANDS OF DOLLARS, raising rabbits, cavies, Chinchillas for us. Complete information $1.00. Keeney Brothers, New Freedom, Penna 17349.

MEN—WOMEN! Start money-making Plastic Lamination business at home in spare time. Material costing 11¢ brings back $2.58. No canvassing or selling but mail orders bring in $20.00 a day. Write for full particulars free. Rush name on postcard to: Warner, Room LC-107-AL, 1512 Jarvis, Chicago, Ill. 60626.

MAKE YOUR CLASSIFIED AD PAY. Get "How To Write a Classified Ad That Pulls." Includes certificate worth $2.00 toward a classified ad in S & M. Send $1.25 (includes postage) to R. S. Wayner, Science & Mechanics, 229 Park Avenue South, New York, New York 10003.

MAKE $1.00 PER SALE selling engraved metal Social Security plates. FREE SALES KIT. Engravaplates, Box 10460-7503, Jacksonville, Fla. 32207.

$$$ UNLIMITED Addressing, mailing circulars! Details, send 8¢ stamp. Happy, Box 1161-DV, Battle Creek, Mich. 49016.

OF INTEREST TO WOMEN

NEW Improved Electric Toothbrush, includes 4 extra fine Nyon bristles, plus Travel Case. Vertical brushing action.—uses standard batteries $7.90 Jose Pacheco, Box 1724, NYC 10022.

$$$ UNLIMITED Mailing circulars! Details, send self-addressed envelope. Fay's, 182 N. Wood St.—(DDL), Battle Creek, Michigan 49017.

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RADIO & TV tubes 35¢. Free Catalog. Cornell, 4217 West University, San Diego, California 92105.

FREE electronics catalog. Tremendous bargains. Edu-Kits, Dept. C-548-DJ. Hewlett, New York 11557.

EXCITING Listening! Police—Fire—Emergency calls on your broadcast radio. $19.95 up. Also receivers, scanners, dual-band high/low, crystals. Salch Company, Woodsboro 1, Texas 78393.

"DISTANCE Crystal Set Construction" Handbook—50¢, "20 Crystal Plans"—50¢. Catalog. Laboratories, 754-G Cordone, Reno, Nevada 89502.

SWAP QSL's, KRN-8291 $1.00. 1971 Knob Ct. Cincinnati, Ohio U. S. A. 45225

MOTOROLA-RCA-HEP transistors and integrated circuits for Elementary Electronics projects. Write stating devices needed for prices—or send for free price sheet. Also instant printed circuit materials. Circuit Specialists, Box 3047, Scottsdale, Ariz. 85257.

OLD RADIO PROGRAMS on tape. Catalog 25¢. Radio Days Forever, R. D. 2, Box 123 McVeytown, Pa. 17051.

REMAILING SERVICE

SAVANNAH Remails 20¢, monthly $3.00. Dewilco, Box 13063, Savannah, Ga. 31406.

NEW YORK REMAILS 25¢ each-$3.00 Monthly. Foreign Accounts Welcome. M. Cassidy, 2845 University, New York, N.Y. 10468.

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TREASURE FINDERS—PROSPECTING EQUIPMENT

"BOUNTY HUNTER" Metal detectors. Free details. Wilkinson, Box 1385-B, Gray, Pennsylvania 15544.

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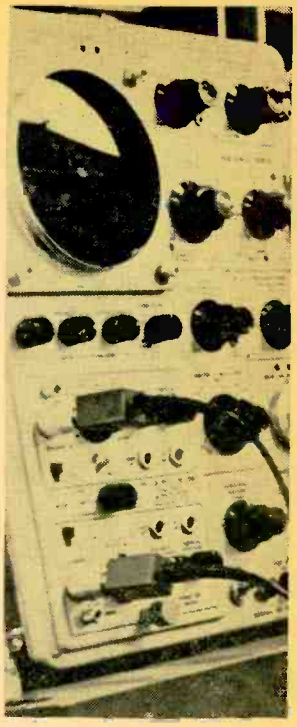
How to become a "Non-Degree Engineer"



Exciting careers in the new industries of the Seventies are waiting for men with up-to-date electronics training. Thousands of real engineering jobs are being filled by men without engineering degrees—provided they are thoroughly trained in basic electronic theory and modern application. The pay is good, the future is bright...and the training can now be acquired at home—on your own time.

ELECTRONICS, the Science of the Seventies, has created a new breed of professional man—the non-degree engineer. Depending on the branch of electronics he's in, he may "ride herd" over a sophisticated computer installation, run a powerful TV transmitter, supervise a law enforcement communications control center or work side by side with distinguished scientists fighting pollution or doctors seeking a medical break-through.

But you do need to know more than soldering connections, testing circuits and replacing components. You need to really know the fundamentals of electronics.

How can you pick up this necessary knowledge? Many of today's non-degree engineers learned their electronics at home. In fact, some authorities feel that a home-study course is the *best* way. *Popular Electronics* said:

"By its very nature, home study develops your ability to analyze and extract information as well as to strengthen your sense of responsibility and initiative."

CIE Method Makes It Easy

If you do decide to advance your career through home study, it's best to pick a school that *specializes* in the home-study method. Electronics is complicated enough without trying to learn it from texts and lessons that were designed for the classroom instead of the home.

Cleveland Institute of Electronics concentrates on home study exclusively. Over

the last 35 years we have developed techniques that make learning at home easy, even if you once had trouble studying. Your instructor gives the lessons and questions you send in his undivided personal attention—it's like being the only student in his "class." He not only grades your work, he analyzes it. And he mails back his corrections and comments the same day he gets your lessons, so you read his notations while everything is still fresh in your mind.

Students who have taken other courses often comment on how much more they learn from CIE. Says Mark E. Newland of Santa Maria, California:

"Of 11 different correspondence courses I've taken, CIE's was the best prepared, most interesting and easiest to understand. I passed my 1st Class FCC exam after completing my course, and have increased my earnings by $120 a month."

Always Up-To-Date

Because of rapid developments in electronics, CIE courses are constantly being revised. This year's courses include up-to-the-minute lessons in Microminiaturization, Laser Theory and Application, Suppressed Carrier Modulation, Single Sideband Techniques, Logical Trouble-shooting, Boolean Algebra, Pulse Theory, Solid-State Devices . . . and many more.

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

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

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

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

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 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 Gulde 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.

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- 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

J. Stataltis, 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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