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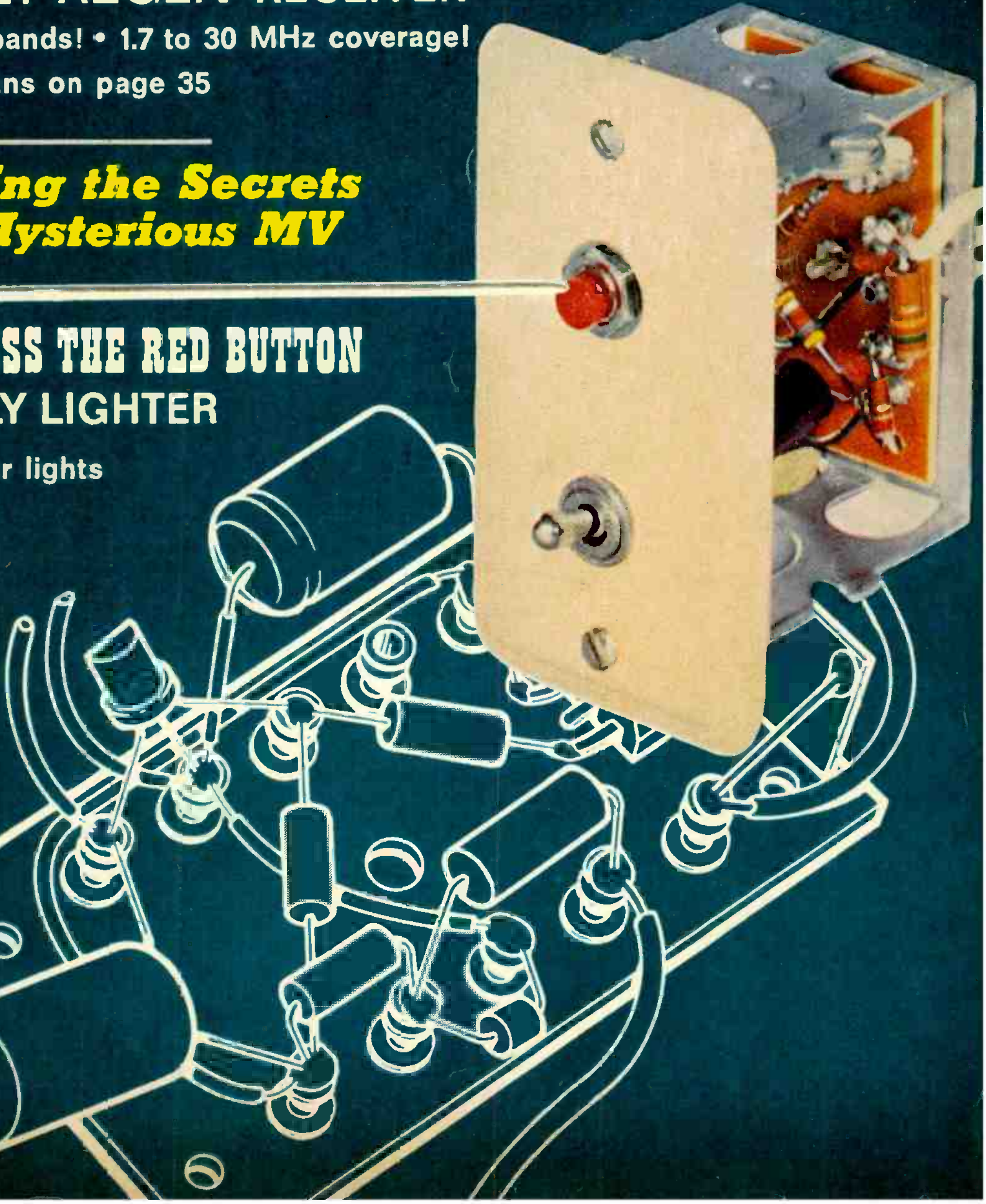

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• May/June 1969 • Vol. 8 No. 2

e/e elementary Electronics

Dedicated to America's Electronics Hobbyists

Cover photo by Leonard Heicklen

☆ Cover Highlights

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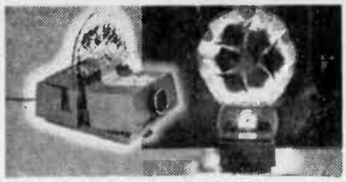

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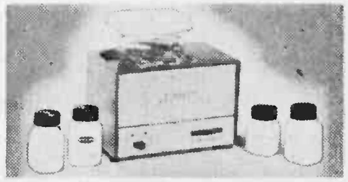

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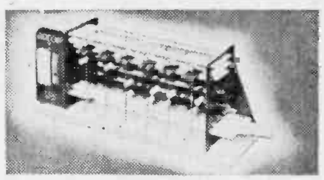

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May/June 1969 Vol. 8/No. 2

Dedicated to America's Electronics Hobbyists

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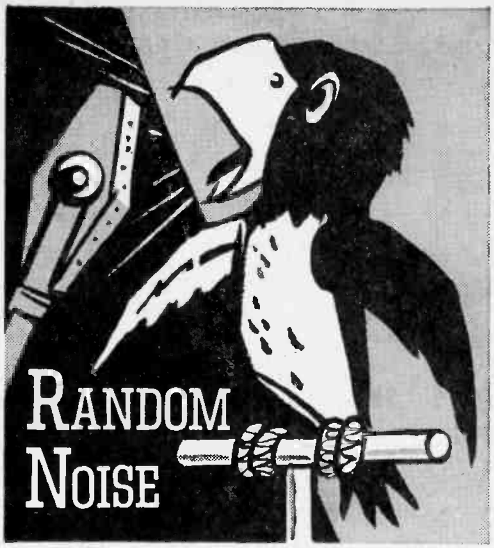

BY JULIAN M. SIENKIEWICZ, Editor

There's some big news in the magazine world lately. Our sister publication is going through a name change. RADIO-TV EXPERIMENTER, the oldest small-sized electronics magazine on the stands today, will soon become SCIENCE AND ELECTRONICS. One could almost have prophesied the change because of the growing world of electronics and its application as a research tool for the sciences. Who today can investigate a new area of scientific exploration, whether it be in space or the ghettoes, without the aid of electronics? Electronic computers are used almost universally. Communications—two-way radio, video tape recorders, cable TV, electronic copying machines, etc.—have grown in step with electronics invading every field of business except possibly the post office. Even our leisure moments, vacations and hobbies have benefited by the marriage of science and electronics. So why not reflect this growth of two combined fields in a magazine title—SCIENCE AND ELECTRONICS? Watch for it on your newsstand.

Science and Electronics

This is what the new "logo" for Science and Electronics will look like on the newsstand. For the time being it'll share billing with the Radio-TV Experimenter logo with which everyone is familiar. Before 1969 comes to an end, Science and Electronics will get top billing.

Hey, Mailman! When this Editor opens his

(Continued on page 8)

You can pay $600 and still not get professionally approved TV training.

Get it now for $99.

Before you put out money for a home study course in TV Servicing and Repair, take a look at what's new.

National Electronic Associations did. They checked out the new TV training package being offered by ICS. Inspected the six self-teaching texts. Followed the step-by-step diagrams and instructions. Evaluated the material's practicality, its fitness for learning modern troubleshooting (including UHF and Color).

Then they approved the new course for use in their own national apprenticeship program.

They went even further and endorsed this new training as an important step for anyone working toward recognition as a Certified Electronic Technician (CET).

This is the first time a self-taught training program has been approved by NEA.

The surprising thing is that this is not a course that costs hundreds of dollars and takes several years to complete. It includes no kits or gimmicks. Requires no experience, no elaborate shop setup.

All you need is normal intelligence and a willingness to learn. Plus an old TV set to work on and some tools and equipment (you'll find helpful what-to-buy and where-to-buy-it information in the texts).

Learning by doing, you should be able to complete your basic training in six months. You then take a final examination to win your ICS diploma and membership in the ICS TV Servicing Academy.

Actually, when you complete the first two texts, you'll be able to locate and repair 70% of common TV troubles. You can begin taking servicing jobs for money or start working in any of a number of electronic service businesses as a sought-after apprentice technician.

Which leads to the fact that this new course is far below the cost you would expect to pay for a complete training course. Comparable courses with their Color TV kits cost as much as six times more than the $99 you'll pay for this one.

But don't stop here. Compare its up-to-dateness and thoroughness. Find out about the bonus features—a dictionary of TV terms and a portfolio of 24 late-model schematics.

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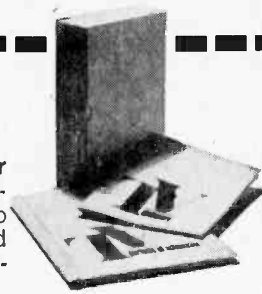

Yes, I'd like all the details about your new TV Servicing/Repair basic training package. I understand there's no obligation. (Canadian residents, send coupon to Scranton, Pa. Further service handled by ICS Canadian, Ltd.)

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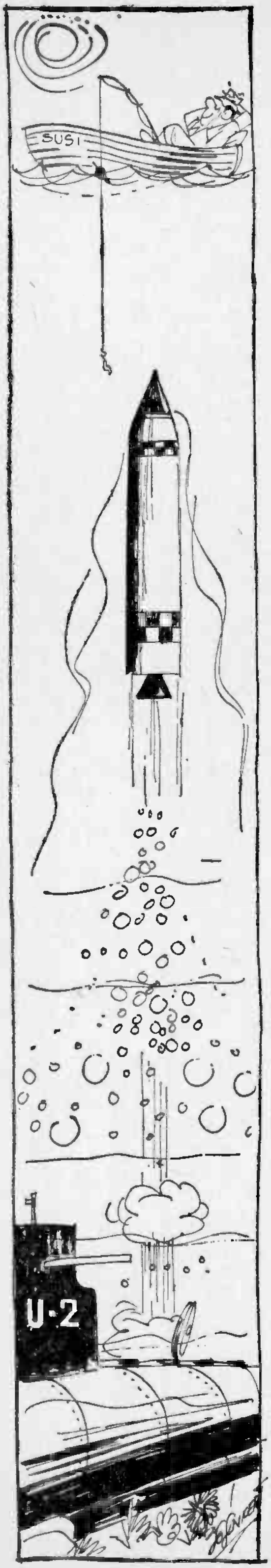


mail, he never knows what to expect. To give my readers a good example, I've decided to publish a few hot news flashes sent in by George Caisse of Levittown, Pa. I hope you'll chuckle as hard as I did.

● Chicago—Mayor Haley of this city moved quickly to day to suppress a suspected threat to the Loop. All leaders of the D'Arsonval movement were quietly arrested and held incommunicado. No other data is available.

● Washington, D. C. —The Supreme cord warned several states of appliance with fair housing and education laws, and stated that a compatible color system leading to integrated circuits was essential.

● New York—A grand jury panel which probed sensor ship made its findings public today. It held that the department distorted its function when its lightning arrestor, Patrolman Audio Rourke, arrested Miss Crystal Pickup at Coney Island for wearing an arc-back bikini. When informed of this statement the policeman said, "What the helix is going on in this country?"

● Rome—The Ecumenical Council meets here to continue a dialogue on cross-modulation. A Vatican pronouncement on RC coupling is also expected momentarily. Said an observer, "They cannot be expected to sel-syn."

● Portland, Argon—Noted psychiatrist C. B. Dipole, author of the famous best-selling volume, *The Fluorescent the Place to Make Love,* attacked marriage as a dense pattern of twisted pairs reflecting a spurious response to the demands of modern-day life. He recommends the old-fashioned hayride as a tension reliever. Says Dipole, "If you're seeking an outlet chuck your hangups and tumble into the hay."

Complaint Dept. I've received a letter of protest from a reader, Ken Greenberg of Chicago, which should not go unnoticed. I would like to put Ken's complaint to you in his own words. They are: "Those little earphones that come with transistor radios are undoubtedly the most uncomfortable, ill-fitting, unsanitary, low-quality, always tangled, listening devices ever made. Surely we consumers deserver better."

Well Ken, you can bet your sweet bippy we consumers do deserve an improved product. Those uncomfortable little "plugs" that sometimes have to be hammered into our ears to stay put, are the byproduct of inexpensive transistor radio imports. Prior to World War II and immediately after, all American portable radios were designed to offer good listening pleasure for a reasonably large loudspeaker with good volume and fair fidelity. Then came the transistor radio, and the low price, and the awful earphones.

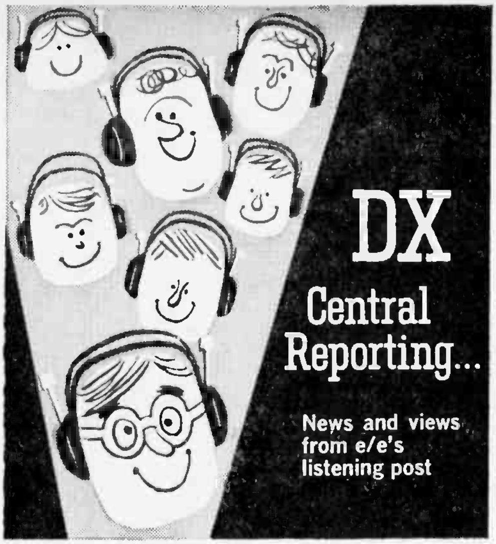
Why there was a demand for an earpiece for private listening on these cheap transistor radio products may never be truly understood. In all honesty, the best thing to do with these earphones is to toss them away when you have obtained the mini-radio and just listen to that 2¼-in. loudspeaker screech away.

Back to School. A three-week summer course in Research Instrumentation will be conducted at Polytechnic Institute of Brooklyn for educators, engineers and scientists from all technical fields who need a working knowledge of electronic instrumentation as applied to problems in research. The course will be held from July 19 to August 9, 1969, on the Brooklyn campus.

The course is open to industrial and academic scientists and engineers from all disciplines. Medical research workers will find the course valuable and are also invited to apply. There are no specific prerequisites beyond a basic understanding of college physics.

The text for the course is "Electronics for Scientists" by Malmstadt, Enke and Toren. This unique volume presents both reference material and detailed experiments for laboratory work.

Applicants should secure a place in the course at the earliest possible date. Industrial participants must file their applications by June 1. Inquiries may be directed to: Prof. Kenneth Jolls, Office of Special Programs, Polytechnic Institute of Brooklyn, 333 Jay St., Brooklyn, N.Y. 11201 (telephone: 212-643-4442 or 643-2266). ■



BY DON JENSEN

● CRUCIAL TRUCIAL

With the Middle East a political tinderbox, the ears of the DX world increasingly are tuned to the shortwave voices off this turbulent region. Drawing particular attention is the sandy collection of sheikdoms known formerly as Trucial Oman.

These seven mini-states, plus neighboring Qatar and offshore Bahrein, early in 1968, joined to form the Persian Gulf Federation. Under British protection for a century and a half, the area could be up for grabs when Her Majesty's forces withdraw in 1971, unless the new federation can fill the political vacuum.

To counteract the heavy Pan-Arab propaganda barrage of Cairo Radio, Great Britain has been working hard to put the Trucial sheikdoms on the shortwave map. Since last June 25, the 100 kilowatt Qatar Broadcasting Service has been active on 9,570 kHz. *(See DX Central, Mar.-Apr. 1969 issue.)*

Its BBC-trained announcers are on the air daily from 1400 to 1730, and 0330 to 0500 GMT (Fridays until 0700). And, station director Taher Shahibi confirms that QBS sometimes extends this schedule. SWLs, who can fight their way through the interfering Chilean, Radio Portales on 9,572 kHz., have heard it around 0400 GMT.

And, last year, United Kingdom Crown Agents advertised in the London papers for a senior broadcasting engineer to supervise the installation and operation of other high-power medium and shortwave transmitters further down the Trucial Coast at Abu Dhabi. Little more is known of this project.

For the past four years, DXers have been waiting for another Persian Gulf SWer. In 1965, the Bahrein Broadcasting Service announced plans for a 10 kilowatt transmitter at the capital,

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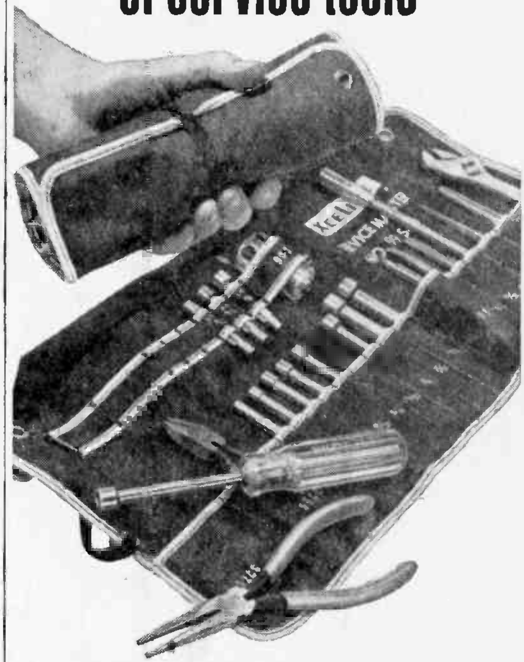

23 essential tools at your fingertips in this lightweight (only 2¾ lbs.), compact, easy-to-carry, roll-up kit. Contains long nose plier, diagonal plier, adjustable wrench, regular and stubby plastic handles with these interchangeable blades: 9 regular and 3 stubby nutdriver, 2 slotted and 1 Phillips screwdriver, 2 reamer, 1 extension. Eyelets in plastic-coated canvas case permit wall hanging. New elastic loop secures roll, eliminates need for tying.

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Manama. So far, no shortwave broadcasts have been reported from this island, 20 miles off Qatar's shores.

The usually reliable Foreign Broadcast Information Service, the shortwave monitoring arm of the U.S. Central Intelligence Agency, in its published logbooks, claims another station in Trucial Oman, The Voice of the Coast. Supposedly, it operates a one-kilowatt transmitter at Sharjah on 6,040 kHz.

Several months ago, an overseas shortwave bulletin stated The Voice of the Coast broadcasts daily from 1300 to 1900 GMT, with Arabic

newscasts at 1600, 1700, 1800 and 1845. And, though no American listeners have claimed reception, not long ago a well-known New Zealander reported logging it.

But, and here's a real grabber for you, DX Central, just at presstime, learned that MP4TCE, a Persian Gulf ham—and he should know—told a midwest DXer flatly, "There is no shortwave broadcast station at Sharjah on 6,040 kHz., or any other shortwave frequency!"

Until more is known of the supposed Voice of the Coast, we'll let you ponder these contradictions.

For SWLs who want to get their feet wet in Persian Gulf broadcasting, there's the new 250-kilowatt transmitter of the Kuwait Broadcasting Station, widely heard in English between 1600 and 1730 GMT, on 11,920 kHz. Though not a member of the Trucial group, prosperous, oil-rich Kuwait obviously is Britain's model for broadcasting in the fledgling federation.

• TIP TOPPER

Back in '45, with a thousand bucks and a dream, three men founded the Far East Broadcasting Co. Over the years, FEBC has established a series of missionary stations stretching nearly half-way around the globe.

Now, an FEBC affiliate, the Far East Broadcasting Associates of Britain, has put a rare country back on the DX map with the opening of a shortwave service from the island of Mahe in the Seychelles group.

Tropical Seychelles, nearly 90 dots in the Indian Ocean, a thousand miles east of Africa, have been without shortwave since the Seychelles Broadcasting Service closed down its 40-watt transmitter three years ago.

Studio and transmitter buildings are up on Mahe and since the first of this year, tests supposedly have been conducted with a one-kilowatt transmitter on loan from the FEBC Okinawa station. A pair of powerful Marconi shortwave units were shipped from England in December and technical director John Wheatley has been shopping around for second-hand antenna towers and miscellaneous hardware.

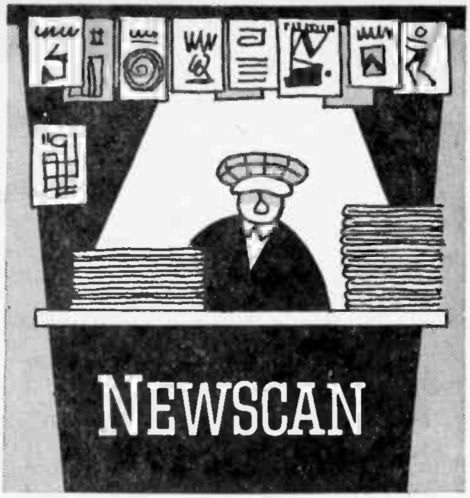
From studios in Victoria, the Seychelles capital, programs are relayed by VHF link to the transmitter site on Mahe's coast. The first of these high-power stations should replace the test transmitter about the time you read this. The second, supposedly, is to be completed by year's end.

Though India, Pakistan and Ceylon are prime targets, U.S. listeners should have a good chance to hear FEBA-Seychelles. No frequencies have been announced, but DX Central will keep you posted.

• BANDSWEEP

660 kHz.—Medium wavers may find XERPM, Mexico City, around 0400 GMT, with mostly Spanish programming. There are occasional English announcements, though. . . . 3,225 kHz.—Brand new Latin American outlets usually are good bets for QSLs. Try the Venezuelan newcomer, Radio Occidente before 0200 GMT sign off. . . . 4,865 kHz.—Signing off with "A Portuguesa," Portugal's national anthem, at 2305 GMT, is Emisora Regional dos Acores, Ponta Delgada, on one of the mid-Atlantic Azores Islands. . . . 5,000 kHz.—The Italian standard time and frequency station, IBF, Turin, has been heard through WWV interference. This time-ticker is audible from 0645 to 0700 GMT, with code identification every five minutes and voice announcement in Italian on the hour. . . . 9,009 kHz.—Israel's Kol Yisrael has daily English language programs at 2115 GMT. It's off-beat frequency makes it easy to find. . . . 11,783 kHz.—For just plain enjoyable listening, Lorenco Marques Radio, in Mozambique, has been a DXers' favorite for years. Try 'em at 0300 GMT sign on. . . . 15,060 kHz.—The clandestine Basque station, Radio Euzkadi heard here now until 2300. They pre-

(Continued on page 103)



Sunshine They Have

A ship-board radar designed to sweep over the water to detect distant land is cast in a reverse role at San Jose, Calif. The landlocked radar sweeps the Santa Clara Valley and the sky above it looking for water in clouds approaching the valley. The radar is part of a sophisticated water control system operated by the Santa Clara County Flood Control and Water District.

Located some 50 miles south of San Francisco, the fertile valley is bounded on three sides by mountains ranging up to 4200 feet high. Population growth in the valley has placed

Radar detects moisture laden clouds which, when seeded with silver iodide crystals, will cause rain to fall in the Santa Clara Valley. Unseeded clouds seldom reach the height necessary for rain to form until they have passed over the valley and are many miles down wind.

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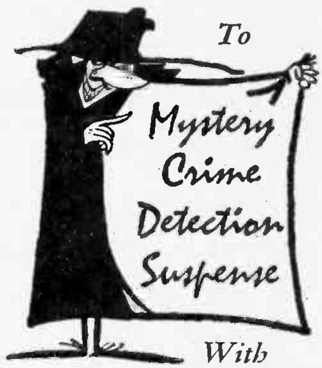

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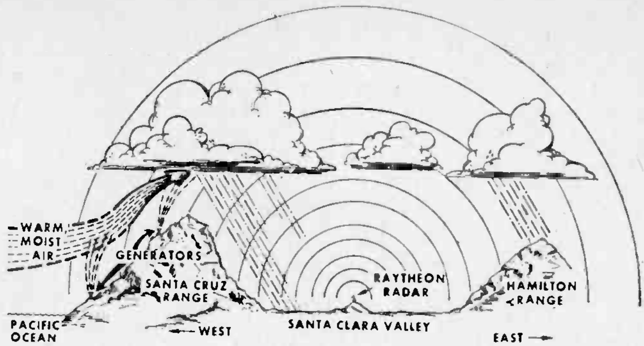


Raytheon Radar pinpoints approaching clouds so that weather watchers at San Jose, Calif. can track their approach and start cloud seeding generators located in the path of the clouds at the most effective time! Radar is a type designed for shipboard use.

added emphasis on capturing rain water to sustain reservoir levels.

The source of rain in Santa Clara Valley is warm moisture-laden air that blows in from over the Pacific Ocean. As the winds reach shore the steep slopes of the Santa Cruz mountains, lying between the valley and the sea, force the air masses to rise abruptly. Swept upward rapidly, the water droplets in the clouds are supercooled but will not freeze until they reach an altitude where the temperature is 40 degrees *below* zero. If there are minute particles of natural impurities in the air such as molecules of salt, dust or hydrocarbons, the water droplets will freeze at −4° Fahrenheit.

Upon freezing, their weight will help them overcome the updrafts and they'll fall, gathering other droplets as ice until they descend into warmer air, melt and become full-fledged rain drops.

But typically the air does not contain the *rallying agents* or *nucleii* for the cloud droplets and the updrafts do not carry them high enough to encounter −40° temperatures.

Daniel F. Kriege, senior hydrographic engineer for the District system, reports that their program of water control has been scientifically evaluated by statisticians who attest to the production of increased rainfall at selected target locations in the valley. By the most conservative index, the rainfall in the valley over the last 12 years totalled 218.71 inches. This was 24.61 inches, or 12.7 per cent, more than that in the adjacent control area.

To keep the reservoirs full, the county rain increasers have installed 21 generators that look and act like oversize vaporizers used in a sickroom. The generators burn a 2.75 per cent solution of silver iodide. Operating at full capacity, each can vaporize 25 grams of the chemical each hour.

Located at key points on the ocean side of the coastal mountains and along the ridge of the Santa Cruz mountains, the generators release their fine mist of microscopic silver iodide crystals into the air. The strong updraft carries them high into the sky to mix with the moisture laden clouds.

Silver iodide acts as a nucleating agent. It forms a rallying point for the moisture in the clouds. It's more efficient than natural nucleii, for the ice crystals start to form at 23° Fahrenheit and reach their peak at −5° Fahrenheit. By injecting the crystals into the right type of clouds one can raise the temperature and lower altitude at which freezing, and hence rain, can be expected.

The silver iodide crystals swept up into the sky attract cloud droplets that measure only one one-thousandth of an inch in diameter. A gram of silver iodide can produce more than a quadrillion nucleii or rallying points for cloud droplets. To become a raindrop each droplet must attract one million others before it grows to a diameter of one tenth of an inch and is heavy enough to overcome the updraft and fall as rain.

The District has installed silver iodide generators at ranches and other locations as near the strategically-correct upwind positions as possible. Generator tenders are somewhat like lighthouse keepers. When certain generators must be started, a telephone call goes out to start them on cue, tend them, and log the time of their operation. Knowing which generators to operate and when to start them depends upon the radar plot.

The District staff watches the long range advisories received by facsimile from the Weather Bureau and monitors the hourly radio forecasts. When meteorological conditions are conducive, they man a converted house trailer on top of 440-foot-high Canoas Hill in the center of the valley.

A special antenna fitted to their Raytheon Model 2505 marine radar enables them to tilt it skyward and capture the electronic "watermarks" of the still-distant clouds. The radar they can see which parts of the cloud formation contain the highest concentration of moisture. This information, coupled with a plot of the advancing front permits the District staff to evaluate whether cloud seeding will be effective and to determine which generator stations are in the best location to have a chance to pull more rain out of the sky.

The radar makes it possible to pinpoint silver

☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆

iodide injection to more effectively increase the rainfall near specific reservoirs or sections of the valley where it is wanted. It also plays an important role as a cost-lowering tool. The silver iodide is expensive and generator tenders are paid for the time they are on call.

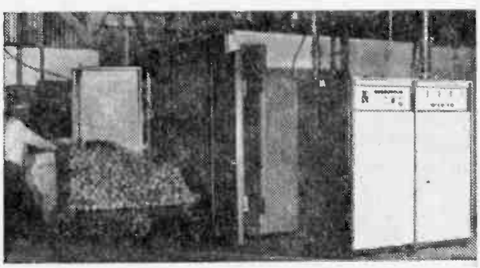
What do valley residents think of "shower power"? Naturally, there are always some people who would prefer it with no rain, a situation that exists in the valley seven months out of the year, but the general weather pattern is so excellent that no one really begrudges the little extra rainfall. Everyone shares in the welcome bounty of water for drinking, gardening, swimming and the many other things that an ample supply of water makes possible. After all, the Santa Clara District staff can only hope to increase rainfall under certain conditions; they are not rainmakers.

For Four-Bagger Slammers

A new U. S. hardwood resource—one estimated at two billion board feet—has been uncovered by radar. And it's all because radar tubes now are being used to make baseball bats and other hardwood products. The new baseball bats are made from tanoak which is cured in a microwave kiln heated by 30,000-watt klystron radar tubes. Previous attempts at curling tanoak, which is harder than ash, required from 60 days to 18 months and gave results so unpredictable that the tree historically has been categorized as a *weed*.

The new bats, which are made in Oregon by Tanoak Industries, Inc., are cured from green fresh-cut tanoak logs in four hours by microwaves. Called "Oregon Slammers," the bats, which the manufacturer states are harder than customary ash bats yet equally resilient, will enter the market this month.

The process for making the bats was developed by Varian Associates, the electronics organization noted for its invention of klystrons and production of other radar tubes and similar space age scientific hardware. Varian's Industrial Microwave Operation consists of a group of scientists devoted to harnessing the energy of



Workman (at left) at Tanoak Industries' Harbor, Oregon, mill loads the radar kiln with tanoak rough billets which will become "Oregon Slammers" baseball bats.

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radar for down-to-earth purposes ranging from toasting potato chips to building automobile parts. The Industrial Microwave Operation developed an exclusive process for microwave curing of tanoak in conjunction with Tanoak Industries.

Native to Northern California and Oregon, the reserves of tanoak are estimated at an abundant two *billion* board feet. Its extreme hardness is matched in its uncured state by its moistness. In fact, fresh cut tanoak logs often contain more water by weight than dry wood; 130% water content is not uncommon.

Conventional kiln drying of tanoak can take 60 days or more and give uncertain results regarding splitting, etc. Combination air and kiln drying takes as long as 18 months requiring uneconomical inventories and still gives spotty results.

Using microwaves for industrial heating offers distinct advantages over conventional power and drying tanoak bats provides a good example. An electric field agitates the wood's molecules producing friction (and heat) which vaporizes the moisture. Since the microwaves penetrate the substance, the inside dries at the same rate as the surface; in the use of traditional heat sources, heat must be conducted inward from the surface. The result with microwaves is faster, more uniform drying.

According to Tanoak's president, James Richmond, sample bats from the production line have been tested by a spring-loaded device which swings the bat to hit a baseball from a tee into a net. The test program indicates that with the same force tanoak bats will drive a ball up to 156 feet versus 150 feet for an ash bat. The new bats resist checking, splitting, and flaking for a longer life.

The bats will be sold nationally at competitive prices in little league, prep, collegiate and professional sizes and configurations under Tanoak Industries' "Oregon Slammer" trademark. The Detroit Tigers better start stocking up on "Oregon Slammers."

Fricatively Speaking

"Hi There, Big Boy!", said in a sexy toned voice may mean nothing more to an IBM engineer than the punch card that programmed it. It's all because some IBM engineers developed an experimental device that helps improve the naturalness of synthesized human speech.

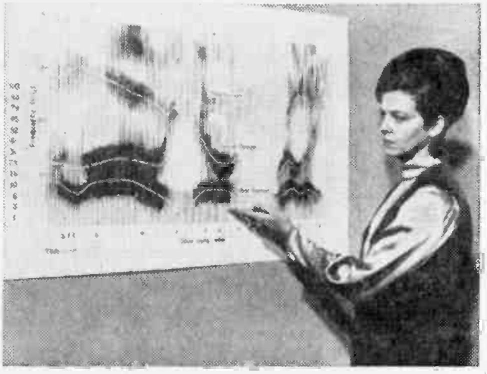
The new device—called a formant generator—has application in machine-to-man voice communication devices. Computer-based systems using formant generators could be used to provide stock market quotations, telephone information assistance and satellite commands.

The formant generator is a digitally tunable filter which simulates resonances in the human vocal tracts (formants) during speech. Three of the formant generators, each covering a specific frequency range, are used to simulate the three lowest resonances of the human vocal tract. These devices are also modified and used in the same speech synthesizer to simulate nasal (such as "m" and "n") and fricative (such as "f", "v" and "sh") sounds. (Fricative—that's a word you don't fool with!)

Information on the components of speech is used to design the controls for the formant generators. These are initially fluctuating waveforms—subsequently converted to digital data—which determine the frequencies and amplitude of the sounds produced. One source of such information is sound spectrograms.

This information, after digitizing, is stored by a computer. It is then used to vary the frequencies of the three formant generators in complex combinations to simulate the rapidly shifting formants of human voice. These formants are combined with the output of other speech sound generators and filters—fricative, nasal, hiss and "buzz"—to produce recognizable, "spoken" sounds.

The formant generators filter the complex waveforms obtained from a broadband source. Each consists of an attenuator between two amplifier-type integrators, plus a feedback circuit. Attenuation, determined by the digital address from a computer, is obtained by turning on different transistors which modify amplifier gain. All frequencies, however, are not attenuated equally, and the frequencies selected vary with the amount of attenuation. The least-attenuated frequencies, returned to the input by the feedback circuit, determine the frequency range of the generated formant.



A member of the IBM Speech Synthesis Laboratory showing a sound spectrogram of the phrase "allow young Willie." The spectrogram illustrates the three lowest formants of speech, indicated by the dark, horizontal bars. The addresses for the three formants are stored by a computer and used to vary the three formant generators required for speech synthesis.

It'll be a long time before the female operator's voice at the other end of a telephone line is computerized. So dream on, lads, while our dreams may still be real.

Planning a Touchdown

Microscopic examination of thousands of lunar photographs by Raytheon Company photo-interpretation specialists will help determine the final selection of a landing spot when America's astronauts first touch down on the moon's surface. The goal is to provide a selection of can-

(Continued on page 103)

"Sorry, bud, but I've got to see your ham operator's license!"

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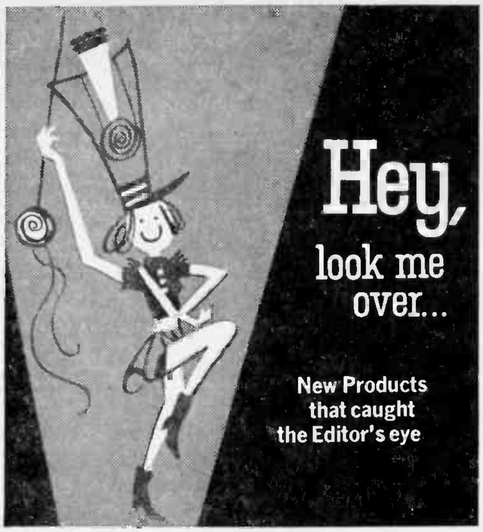
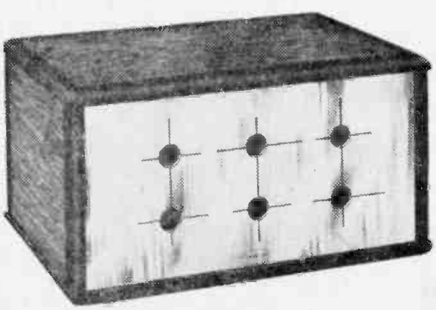


Hey, readers! ELEMENTARY ELECTRONICS *is your magazine, and Hey, Look Me Over is your department. We'd like to know what you think of our new products column. Send your comments to the Editor,* ELEMENTARY ELECTRONICS, *229 Park Ave. So., New York, N.Y. 10003, % Hey, Look Me Over.*

Kustom Kabinets for Kit Konstructors

The Bell Educational Laboratories Div. of Beltronix Systems has developed a new line of custom cabinets, aimed at all you kit builders, experimenters, and hobbyists, to be marketed under the name Flexi-Cab. Flexi-Cab consists of 6 panels and 12 vise-grip slides and can be assembled in minutes by joining the panels with the slides, a departure from conventional cabinets which require adhesives or screws or rivets. The panels are made of vinyl-clad steel and are available in a choice of walnut wood grain or black leather with a front panel of brushed brass or chrome. Flexi-Cab is packaged with a set of printed pressure sensitive labels that can be used to identify controls. For starters, they are available in these sizes: 3 x 4 x 4 in., 3 x 4 x 6 in., 3 x 6 x 9 in., and prices start at $2.98. For further information and the name of your nearest dealer, write Bell Educational Laboratories Div., Beltronix Systems, Inc., Dept. ee, 123 Marcus Blvd., Hauppage, N. Y. 11787.



Bell Educational Labs Flexi-Cab Cabinet

Play To Me Only . . .

The David Clark Co. has a new stereo headset, the Clark/300, which, at $19.00 is much more modestly priced than their previous models. But the specs are impressive: frequency range, 20 to 17,000 Hz; sensitivity, 1 milliwatt input at 1000 cycles produces 105 dB reference .0002 microbar (per earpiece, maximum power input, 1 watt per phone; nominal impedance, 8 ohms. For further information send to David Clark Co., Inc., 360 Franklin St., Worcester, Mass. 01601.

Clark/300 Stereo Headset

Treasure Hunt, Anyone?

Caringella Treasure Locator

With the TRL-1 Treasure Locator you can go looking for buried pipes, lost jewelry, coins, all types of metals, and all other such non-spiritual goodies. The circuit uses 3 FETs and 2 silicon transistors, and kit assembly is simplified with etched circuit board construction and easy-to-follow instructions. A 6-in. etched circuit coil furnished with the kit means there are no coils to wind and no test equipment needed for alignment. Glass epoxy material is used for both etched circuit boards, and construction time is said to take less than three hours. The Treasure Locator weighs only 24 oz., and is powered by any 9-volt battery. Kit comes with all parts, wire, solder, and headphone. Price is $29.95,

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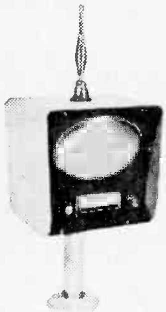
and you can get a data sheet from Caringella Electronics, Inc., Box 327, Upland, Calif. 91786.

Keep 'Em Down on the Farm

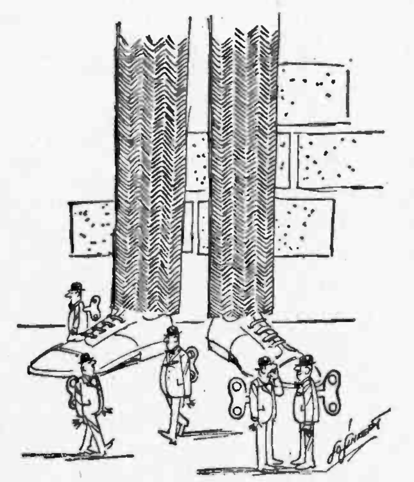


J.C. Whitney Tractor Radio

Now farmers can hear the news, weather, livestock prices, crop prices, and music even when they're down on the lower 40. This powerful tractor radio is solid state with a 6-watt output. The heavy-gauge steel shroud is completely shockproof. There's a 5 x 7-in. speaker and a stainless steel spring base telescoping antenna, developed especially for this tractor radio. The unit can be easily installed on all tractors with 6- or 12-volt system. The price is $51.50, postpaid, from J. C. Whitney & Co., 1917 Archer Ave., Dept. 401, Chicago, Ill. 60616.

Solid Wave for Squares

The Heath Company announces a new solid-state sine-square wave generator, model IG-18, priced at $67.50. Its output range is continuously variable from 1 Hz to 100 kHz, using one multiplier and two selector switches plus a vernier control. The IG-18 has 8 output voltage ranges from .003 to 10 V rms with an external load of 10 K ohms or more, and 6 output ranges from .003 to 1 V rms (−62 to +22 dB) using



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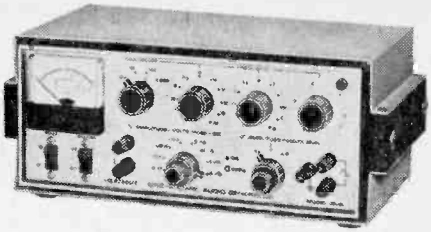
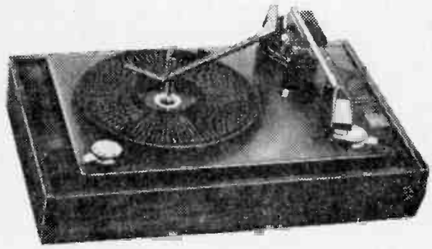


Heathkit IG-18 Sine-Square Wave Generator

the built-in 600-ohm load or an external 600-ohm load. Sine-wave output has less than 0.1% distortion from 10 Hz to 20 kHz. The square wave section has a frequency range from 5 Hz to 100 kHz at 0.1, 1 and 10 V switch-selected outputs. Unit is equipped with a dual-primary transformer for 120/240 VAC operation and a 3-wire line cord for added safety. Styled to match Heathkit's instrument line. For complete specs and how to order, write the Heath Co., Benton Harbor, Mich. 49022.

Changer Goes Mini

Lafayette's new "Mini" changer, stock No. 21-1401, is a 4-speed changer equipped with a ceramic turnover stereo cartridge and diamond stylus. Made in England, it features a low-mass tone arm, dynamically balanced 2-pole motor, and automatic shut-off after last record. You can stack and intermix up to 6 records of 10- and 12-in. size of the same speed, or manual single play. On a walnut base, the Mini measures 14⅜ x 5 x 10 in., weighs 6 lb. For 110-130 VAC 60 Hz, the Mini is priced at $34.95. For more dope, write Lafayette Radio Electronics, 111 Jericho Tkpe., Syosset, N. Y. 11791.



Lafayette 4-Speed Automatic "Mini" Changer

"Now you're getting somewhere, Turner. This display is the exact opposite of what I had in mind!"

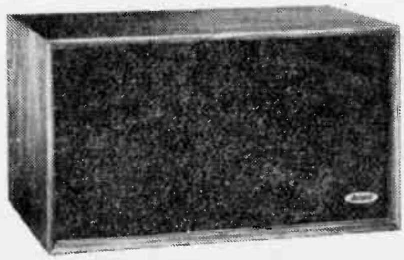
Screwdriver Gets a No-Shock Treatment

The makers of the Quick-Wedge screw-holding screwdriver, the Kedman Co., have added color-coded vinyl covering over the tubing as protection for electrical work. Dielectric strength of vinyl tubing at room temperatures averages 1100-V per mil of thickness. The vinyl cover is 20 mils thick, and will withstand 20,000 volts. There are 16 sizes being offered with color vinyl covering, and for their various prices and information on distributors, write Kedman Co., Box 267, Salt Lake City, Utah 84110.

Kedman Quick-Wedge Screw-Holding Screwdriver

Let's Hear It from the Shelf!

Allied is very proud of their model 2370 speaker system. For one thing, the overall frequency response is 20 Hz to beyond audibility. It has a 12-in. acoustic suspension bass woofer, a compression-type midrange with diffraction horn, and a compression-type wide-dispersion horn tweeter for the treble notes. Crossover frequencies at 1000 and 5000 Hz permit each



Allied 2370 Speaker System

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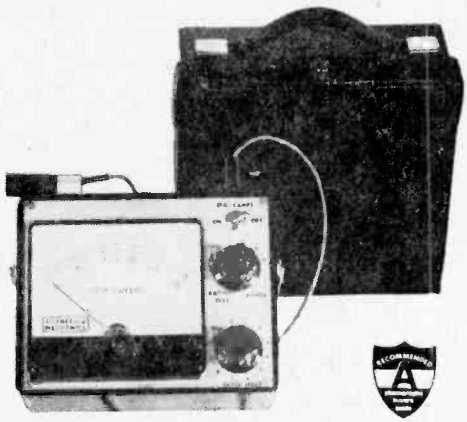

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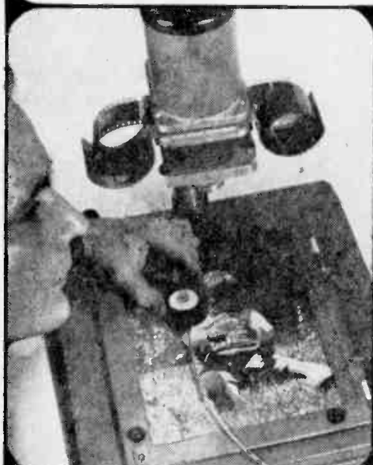

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This Model A-3 Meter is named the "Darkroom Meter" because it has been so widely accepted for reading enlarger easel exposures. It has earned a reputation as a precision instrument in color studio photography, copy work, portraiture, and available light photography. You can use it with movie cameras and with single lens reflex cameras. The A-3s are also used for ground glass exposure readings with microscopes, telescopes and can even be set up for use as a densitometer.

An exclusive feature of this versatile instrument is its standard plug-in probe assembly with three foot flexible cable. This probe utilizes the newest Clairex Corp. CL-505L cadmium sulfide photocell—the best grade available today—balanced for color, and the complete range of exposures from dim available light to full bright sun light. Its field of view is 43 degrees. equal to normal camera lens angles.

The meter is supplied with a 5-inch, easy-to-read computer with four-range selection and EV-EVS-LV settings to give F stops from .7 to 90 and list exposure time from 1/15,000 second to 8 hours.

The 4½-inch dial of the meter is self-illuminated with built-in battery lamps. You read on 4 sensitivity ranges, therefore the meter dial and selector switch give you an equivalent of 18 inches of total dial space for reading accuracy. The paper speed control knob is used to set sensitivity to match the various grades of printing papers. The meter sensitivity is sufficient to detect the light of a match 10 feet away.

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Whether you buy the S&M A-3 Meter as an easy-to-assemble kit, or completely factory-assembled, you can be sure you have the advantage of owning a rugged and dependable instrument. A complete manual tells you step-by-step how to assemble the instrument, how to use it for profitable photography and how to keep it working right for years □

speaker to reproduce only those frequencies for which it is designed. There are two level controls for midrange and tweeter to permit adjustment to the personal taste of the listener. The walnut-veneered enclosure (14 x 25 x 13 in.) is Fiberglas-filled to prevent resonance. The bass speaker is matched to the size and characteristics of the enclosure. In kit form (and they even supply the oil to rub into the cabinet) you ask for the 2370K, and it's $99.95. Factory-assembled and finished, it's $119.95. For more info, write for a catalog from Allied Radio Corp., Dept. 20, 100 N. Western Ave., Chicago, Ill. 60680.

Stereo Over the Waves

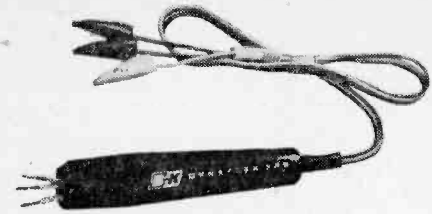
Here is a pint-size stereo system, the Scottie, that the manufacturers suggest is just the thing for boat owners. Operating on AC or a 12-V battery, the Scottie employs FETs, so you can bring in distant stations when you're 'way out

H. H. Scott Scottie Stereo System

at sea. Scott claims their full complementary output stages provide undistorted sound at lowest listening levels. There is an optionable turntable to go with the speakers-receiver system. The Scottie retails for $199.95. The optional turntable is $59.95, with cartridge and diamond stylus. Further information can be had from H. H. Scott, 111 Powder Mill Rd., Maynard, Mass. 01754.

Three-In-One Probe-ity

The new B&K FP-3 test probe provides a way of making three termination touch-to-test contacts simultaneously using only one hand, where before it would have taken three probes and both hands. The three-point probe is called Dyna-Flex and is priced at $12.95. Designed for use with in-circuit transistor testers, VTVMs, VOMs, and TVOMs, Dyna-Flex makes positive,

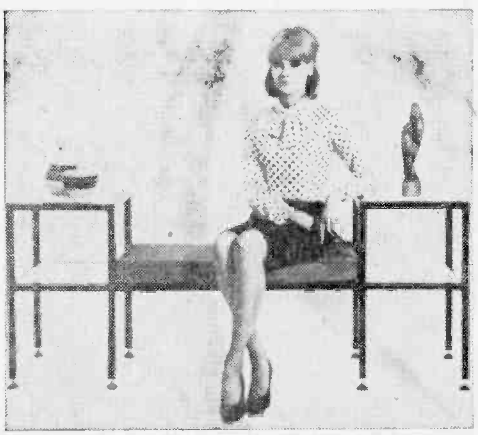


B&K Dyna-Flex FP-3 Test Probe

non-slip direct contacts to printed circuit terminations. The probe has 3 spring-loaded needle-point tips which tilt or swivel on ball joints to permit automatic adjustment to any spacing from 1/32 to 5/8 in. to fit the terminations of a wide variety of components. Three leads, color coded to their respective tips, terminate in insulated alligator clips for easy connection to the test instrument being used. The clips also permit making rapid component test substitutions. If you want to know more, write B&K Div. of Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago, Ill. 60613.

Make With a Mallet

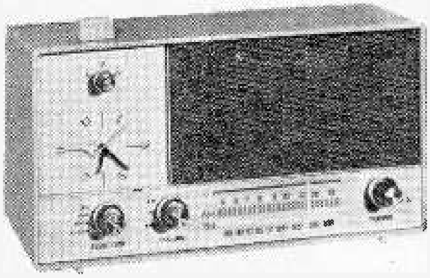
Here's a new construction system—a method of assembling square steel tube furniture and fixtures with the use of just a mallet. The system, called Apton, has three basic components: square steel tube; a tough styrene type collar; and a series of seven different joint formations. The tube can be either ordered in the desired lengths or cut to size with an ordinary hacksaw. You assemble Apton by sliding a collar into the end of a tube, inserting the tapered arm of joint into the collar and tube, then driving the joint solidly home with a soft-faced mallet. The tube is made in 1- and 3/4-in.-square sizes in lengths



Hobbyist designed furniture made from Dexion Square Sheet Tubes up to 8 ft. In black matte finish, the 1-in. size is 37¢ a foot; the ¾-in. goes for 32¢ a foot. For further information write for a brochure, "Planning and Building with Apton," from Dexion, Inc., 39-27 59th St., Woodside, N.Y. 11377.

Wake Up, Musical Sleepyheads!

The GR-58 from Heath is a solid-state AM-FM clock radio kit with a lot of cute features. For instance: a clock-controlled auxiliary AC socket on the rear panel for having hot coffee at bedside in the morning, or for turning on lights; a "snooze" button—ten minutes before the alarm goes on the radio starts, when the alarm goes on you shut it off by depressing the snooze button and the radio remains on. This operation will continuously recycle until the GR-58 is reset to another position. The FM section has AFC, a built-in FM antenna, and 3-stage IF. The AM portion has a 2-stage IF, amplified AGC, and a built-in ½-in. ferrite-rod antenna. The unit comes in a blue plastic cabinet and both the AM and FM front ends are factory built and aligned. You can put together all this for $47.95, and for further description write to the Heath Co., Benton Harbor, Mich. 49022.

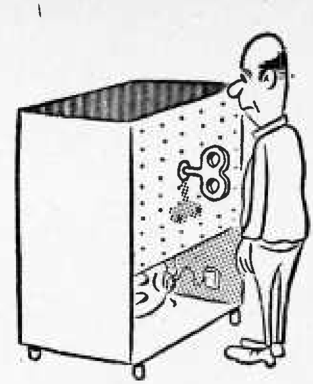


Heathkit GR-58 AM-FM Clock Radio

Patch Makes Dialogue

Hy-Gain has introduced a CB phone patch which will interconnect any base CB with the telephone—thus extending a CB call to any telephone in the nation. The company says having the Phone Patch on your base is equivalent to having a telephone in your car. You can talk to any local or long distance phone via your base while traveling. This could be very handy in emergencies for contacting police or other public safety units. The Hy-Gain Phone Patch (part No. 402) can easily be connected to any CB transceiver and comes with complete instructions. It sells for $7.95; for further information write Hy-Gain Electronics Corp., Hwy 6 & Stevens Creek, Lincoln, Neb. 68501. ■

Can't find the key to electronics?



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★5. *Edmund Scientific's* new catalog contains over 4000 products that embrace many interests and fields. It's a 148-page buyers' guide for Science Fair fans.

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7. Before you build from scratch, check the *Fair Radio Sales* latest catalog for electronic gear that can be modified to your needs. *Fair* way to save cash.

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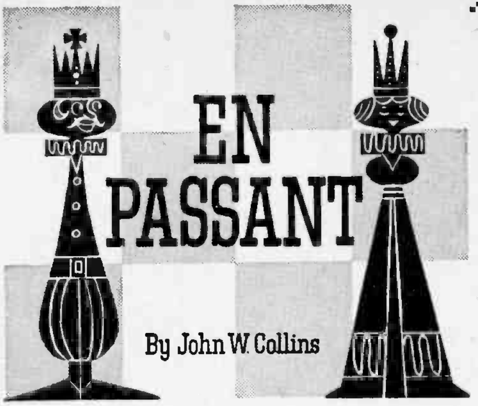

"Well begun is half done" is an old saying that particularly applies to the *opening*—the first ten or fifteen moves of a game. It is during this phase that both sides develop their pieces, get ideas, and prepare for the later phases. And it is essential to understand the concept of each debut, rather than just memorize its characteristic moves. Here are four more standard openings to add to those which have appeared before.

Four Knights' Game. The Four Knights' Game is a sound but too conservative opening. A kind of Ruy Lopez (1 P-K4, P-K4 2 N-KB3, N-QB3 3 B-N5), it counts on the first move, development, and a slight initiative. Old masters, such as Maroczy and Dr. Tarrasch, considered it a sharp weapon, but contemporary ones regard it as merely a drawing device. The Symmetrical Variation is one of its best known forms and proceeds:

1	P-K4	P-K4	8	B-N5	Q-K2
2	N-KB3	N-QB3	9	R-K1	N-Q1!
3	N-B3	N-B3	10	P-Q4	N-K3
4	B-N5	B-N5	11	B-QB1	R-Q1!
5	0-0	0-0	12	N-R4	P-KN3
6	P-Q3	BxN!	13	P-N3	P-Q4!
7	PxB	P-Q3			

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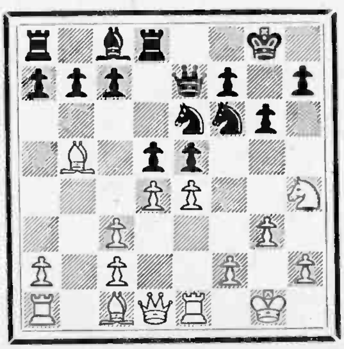


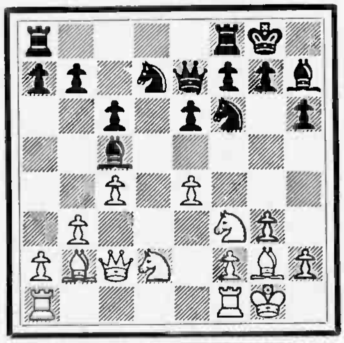
White

The position offers equal chances.

Reti Opening. This one is hyper-modern, subtle, and flexible, and bears the name of Richard Reti, a Czechoslovakian grandmaster who wrote and played during the first two decades of the century. It works on the center from afar and is replete with transpositional possibilities. A good defense to it is the London System, an example of which follows.

1	N-KB3	P-Q4	7	0-0	P-KR3
2	P-B4	P-QB3	8	P-Q3	B-B4!
3	P-QN3	N-B3	9	QN-Q2	0-0
4	P-N3	B-B4!	10	Q-B2	Q-K2
5	B-KN2	P-K3	11	P-K4!	PxKP
6	B-N2	QN-Q2	12	PxP	B-R2

Black

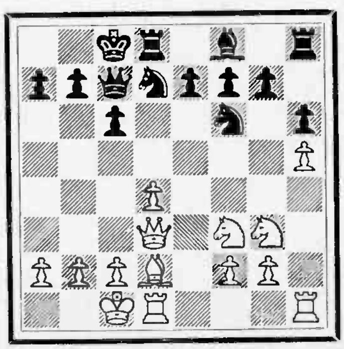


White

Equal chances.

Caro-Kann Defense. Safety against the rigors of 1 P-K4 is sought with the Caro-Kann Defense (1 . . . . P-QB3). Solid, if not overly dynamic, it seeks simplicity and the possibility of an early ending. World Champion Tigran Petrosian is one of its advocates and here is one of the lines he likes (see moves top of next page)—

Black



White

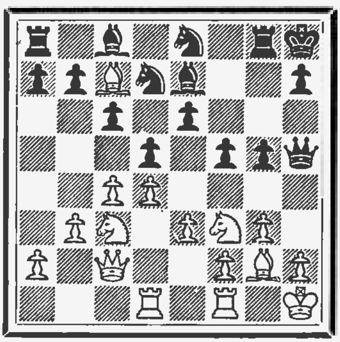
1	P-K4	P-QB3	7	N-B3	N-Q2
2	P-Q4	P-Q4	8	P-R5	B-R2
3	N-QB3	PxP	9	B-Q3	BxB
4	NxP	B-B4	10	QxB	KN-B3
5	N-N3	B-N3	11	B-Q2	Q-B2
6	P-KR4	P-KR3	12	0-0-0	0-0-0

Equal chances.

Dutch Defense. Said to be a Dutch treat by some, this defense has nevertheless been a favorite of World Champions Alekhine, Botvinnik, and Morphy. It creates imbalance, tension, and tactics, seeks control of the K5 square, and utilizes the KB and KN files for an attack. The Stonewall Variation, hereafter given, is one of its crucial lines.

1	P-Q4	P-KB4	8	Q-B2	Q-K1
2	P-KN3	P-K3	9	B-B4	Q-R4
3	B-N2	N-KB3	10	QR-Q1	QN-Q2
4	N-KB3	B-K2	11	P-N3	K-R1
5	0-0	0-0	12	K-R1	R-KN1
6	P-B4	P-Q4	13	P-K3	P-KN4!
7	N-B3	P-B3	14	B-B7	N-K1

Black



White

Equal chances.

Game of the Issue. Grandmaster Samuel Reshevsky, 58, of Spring Valley, N. Y., is still producing great chess. "Sammy" was born in Ozierkov, Poland, learned the game when he was four, toured Europe as a child chess prodigy at eight, and was brought here a year later. He is a five times winner of the United States Championship, winner of numerous International Tournaments, and recently competed in the Candidates' Matches for the World Championship. Reshevsky has authored "Learn Chess Fast" and "Reshevsky's Best Games of Chess" and is a regular contributor to "Chess Life."

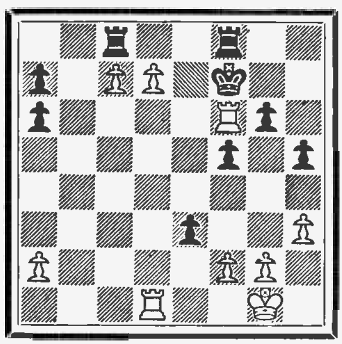
With White in the game below against his fellow countryman Grandmaster Robert Byrne of Indianapolis, in the Interzonal Tournament at Sousse, Tunisia, 1967, Reshevsky essays his beloved 1 P-Q4 and a favorite line against the King's Indian Defense, obtains a clear advantage by move 12, increases the pressure, and then wins by sacrificing a Bishop to secure two connected passed Pawns.

This game was cited as one of the 10 Best in Vol. 4 of the "Chess Informant," an up-to-date compilation of important parties in the world-wide arena, published by the Yugoslav Chess Federation, which contained 867 games!

1	P-Q4	N-KB3	20	R-B1	B-K3
2	P-QB4	P-KN3	21	P-B5	QPxP
3	N-QB3	B-N2	22	N-Q5!	BxN
4	P-K4	P-Q3	23	PxB	Q-K1
5	B-K2	0-0	24	PxP	P-K5
6	N-B3	P-K4!	25	Q-N3	R-N1
7	B-K3!	QN-Q2	26	P-Q6#	K-R2
8	0-0	N-N5	27	KR-Q1	R-KB1
9	B-N5	P-KB3	28	B-N5	Q-K4
10	B-Q2	P-B3	29	P-Q7	P-KR4
11	P-KR3	N-R3	30	R-Q6	P-K6
12	P-QN4!	P-KB4	31	QR-Q1	QR-Q1
13	B-N5	Q-K1	32	Q-K6!	QxQ
14	P-Q5	N-B2	33	RxQ	B-B3
15	B-B1	N-B3	34	B-R6!!	PxB
16	N-KN5!	NxN	35	P-B6	K-N2
17	BxN	P-KR3	36	P-B7	B-B2
18	BxN!	RxB	37	R-B6	R-B1
19	QPxP	QxP	38	RxB#!	Resigns

Position after 38 RxB#!

Black



White

Why did Black resign? Because he must relinquish two Rooks for two Pawns and see White emerge a whole Rook ahead if he plays on. Here is the analysis:

A. If 38 . . . . K-N2 39 RxR, RxR 40 P-Q8=Q, RxQ 41 PxR=Q wins.

B. If 38 . . . . KxR 39 P-Q8=Q# QRxQ (moving the King is worse) 40 PxR=Q# RxQ 41 RxR, P-K7 41 R-K8! followed by 42 RxP wins.

C. If 38 . . . . KxR 39 P-Q8=Q# (not 39

(Continued on page 109)

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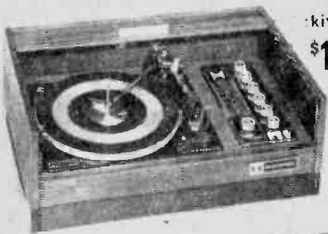

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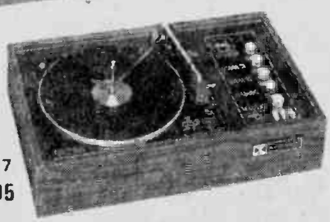

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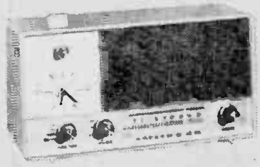

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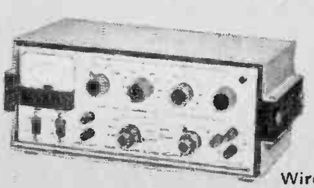

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HEATHKIT AD-27 FM Stereo Compact

The new Heathkit "27" Component Compact was designed to change your mind about stereo compact performance. How? By sounding as if it were made of top quality stereo components . . . which in fact it is. Heath engineers took their highly rated AR-14 solid-state Stereo Receiver, modified it physically to fit the cabinet, and matched it with the precision BSR McDonald 500A Automatic Turntable. Performance? Here's the AD-27 in detail. The amplifier delivers 30 watts music power . . . 15 honest watts per channel — enough to drive any reasonably efficient speaker system. Response is virtually flat from 12 Hz to 60 kHz, and Harmonic & IM distortion are both less than 1% at full output. Tandem Volume, Balance, Bass & Treble controls give you full range command of all the sound. Select the FM stereo mode with a flick of the rocker-type switch and tune smoothly across the dial, thanks to inertia flywheel tuning. You'll hear stations you didn't know existed in your area, and the clarity and separation of the sound will amaze you. The adjustable phasing control insures best stereo separation at all times. And the automatic stereo indicator light tells you if the program is in stereo. AFC puts an end to drift too. The BSR Automatic Turntable has features normally found only in very expensive units, like cueing and pause control, variable anti-skating device, stylus pressure adjustment and automatic system power too. Comes complete with a famous Shure diamond stylus magnetic cartridge. The handsome walnut cabinet with sliding tambour door will look sharp in any surroundings, and the AD-27 performs as well as it looks. For the finest stereo compact you can buy, order your "27" Component Compact now. 41 lbs.

HEATHKIT AD-17 Stereo Compact

Using the component approach of the AD-27, Heath engineers took the solid-state stereo amplifier section of the AD-27, matched it with the high quality BSR-400 Automatic Turntable and put both of these fine components in a handsomely styled walnut finish cabinet. The result is the "17" — featuring 30 watts music power, 12 Hz to 60 kHz response, auxiliary & tuner inputs, less than 1% Harmonic & IM distortion, adjustable stylus pressure & anti-skate control and much more. Order your "17" now. 27 lbs.

HEATHKIT TA-38 Solid-State Bass Amplifier

The new Heathkit TA-38 is the hottest performing bass amp on the market, for quite a few reasons. First, there's all solid-state circuitry for reliability. Then there's the tremendous power — the TA-38 puts out 120 watts of EIA music power, 240 watts peak, or 100 watts continuous. Extremely low harmonic & IM distortion too. Many amps suffer from "blow-out" problems, but not the new TA-38 — *YOU CAN'T BLOW IT* . . . it boasts two 12" heavy duty special design speakers with giant 3 pound 6 ounce magnet assemblies mounted in a completely sealed, heavily damped ¾" pressed wood cabinet — those speakers will take every watt the amp will put out, and still not blow. Sound? The TA-38 is tailored to reproduce the full range of bass frequencies delivered by bass guitars and its sound with combo organs and other instruments is remarkable. Easy 15 hour assembly to the wildest bass amp on the market. Order one now and surprise the guys with the high-priced gear. 130 lbs.

HEATHKIT GR-58 Solid-State AM/FM Clock Radio

The easy way to get up in the morning. Choose the morning news & weather on AM or the bright sound of FM music. AFC makes FM tuning easy. The "Auto" position on the Telechron® clock turns only the radio on, or use the "Alarm" setting for both the radio and the alarm. You can even enjoy fresh coffee when you awake in the morning, thanks to the clock-controlled accessory AC socket on the back of the new GR-58. The handy "snooze" alarm feature lets you wake up gradually for ten minutes to the sound of the radio, then the alarm goes on . . . push the "snooze" button to silence the alarm for ten minutes more of music or news — the alarm sounds automatically every ten minutes and the "snooze" button turns it off, cycling continuously until the selector switch is moved to another position. Fast, easy circuit board construction, smart blue hi-impact plastic cabinet and top reliability make this GR-58 the clock radio for you. 8 lbs.

HEATHKIT IG-18 Solid-State Sine-Square Wave Generator

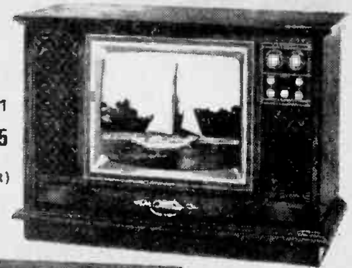
A precision source of sine or square waves at a low kit price . . . that's the new solid-state IG-18 from Heath. Delivers 5% accuracy thru the wide range of 1 Hz to 100 kHz. The sine wave section features less than 0.1% distortion thru the audio range, 8 output voltage ranges from 0.003 to 10V, switch-selected internal 600 ohm load or external load and metered output of both voltage & dB. The square wave section has a 50 nS rise time and three output voltage ranges from 0.1 to 10 V P-P. Both sine & square waves are available simultaneously and the frequency is switch-selected for constant repeatability and fast operation. Circuit board construction makes the new IG-18 easy to build . . . new Heathkit styling and engineering excellence make it easy to use. Put the new IG-18 on your bench now. 10 lbs.

Hobby...From The Leader

HEATHKIT

Now There are 4 Heathkit Color TV's... All With 2-Year Picture Tube Warranty

NEW Deluxe "681" Color TV With Automatic Fine Tuning

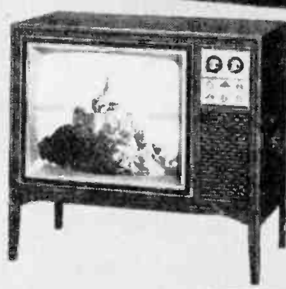


kit GR-681
$499.95
(less cabinet)

The new Heathkit GR-681 is the most advanced color TV on the market. A strong claim, but easy to prove. Compare the "681" against every other TV — there isn't one available for any price that has all these features. Automatic Fine Tuning on all 83 channels . . . just push a button and the factory assembled solid-state circuit takes over to automatically tune the best color picture in the industry. Push another front-panel button and the VHF channel selector rotates until you reach the desired station, automatically. Built-in cable-type remote control that allows you to turn the "681" on and off and change VHF channels without moving from your chair. Or add the optional GRA-681-6 Wireless Remote Control described below. A bridge-type low voltage power supply for superior regulation; high & low AC taps are provided to insure that the picture transmitted exactly fits the "681" screen. Automatic degaussing, 2-speed transistor UHF tuner, hi-fi sound output, two VHF antenna inputs . . . plus the built-in self-servicing aids that are standard on all Heathkit color TV's but can't be bought on any other set for any price . . . plus all the features of the famous "295" below. Compare the "681" against the others . . . and be convinced.

GRA-295-4, Mediterranean cabinet shown.................... **$119.50**
Other cabinets from $62.95

Deluxe "295" Color TV...Model GR-295



kit GR-295
now only
$449.95
(less cabinet)

Big, Bold, Beautiful . . . and packed with features. Top quality American brand color tube with 295 sq. in. viewing area . . . new improved phosphors and low voltage supply with boosted B + for brighter, livelier color . . . automatic degaussing . . . exclusive Heath Magna-Shield . . . Automatic Color Control & Automatic Gain Control for color purity, and flutter-free pictures under all conditions . . . preassembled IF strip with 3 stages instead of the usual two . . . deluxe VHF tuner with "memory" fine tuning . . . three-way installation — wall, custom or any of the beautiful Heath factory assembled cabinets. Add to that the unique Heathkit self-servicing features like the built-in dot generator and full color photos in the comprehensive manual that let you set-up, converge and maintain the best color picture at all times, and can save you up to $200 over the life of your set in service calls. For the best color picture around, order your "295" now.

GRA-295-1, Walnut cabinet shown.......................... **$62.95**
Other cabinets from $99.95

Deluxe "227" Color TV...Model GR-227

kit GR-227
now only
$399.95
(less cabinet)

Has same high performance features and built-in servicing facilities as the GR-295, except for 227 sq. inch viewing area. The vertical swing-out chassis makes for fast, easy servicing and installation. The dynamic convergence control board can be placed so that it is easily accessible anytime you wish to "touch-up" the picture.

GRA-227-1, Walnut cabinet shown.......................... **$59.95**
Mediterranean style also available at $99.50

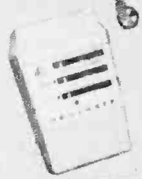
Deluxe "180" Color TV...Model GR-180

kit GR-180
now only
$349.95
(less cabinet)

Same high performance features and exclusive self-servicing facilities as the GR-295 except for 180 sq. inch viewing area. Feature for feature the Heathkit "180" is your best buy in deluxe color TV viewing . . . tubes alone list for over $245. For extra savings, extra beauty and convenience, add the table model cabinet and mobile cart.

GRS-180-5, table model cabinet and cart...................... **$39.95**
Other cabinets from $24.95

Now, Wireless Remote Control For Heathkit Color TV's



New Wireless TV Remote Control
For GR-295, GR-227 & GR-180
$69.95

New Wireless TV Remote Control
For GR-681
$59.95

Control your Heathkit Color TV from your easy chair, turn it on and off, change VHF channels, volume, color and tint, all by sonic remote control. No cables cluttering the room . . . the handheld transmitter is all electronic, powered by a small 9 v. battery, housed in a small, smartly styled beige plastic case. The receiver contains an integrated circuit and a meter for adjustment ease. Installation is easy even in older Heathkit color TV's thanks to circuit board wiring harness construction. For greater TV enjoyment, order yours now.

kit GRA-681-6, 7 lbs., for Heathkit GR-681 Color TV's.......... **$59.95**
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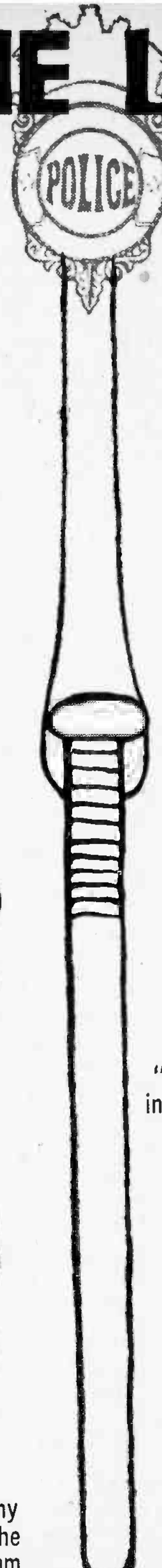
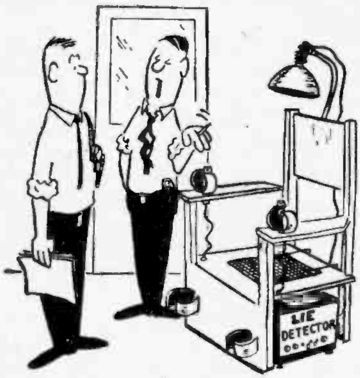
IT'S THE LAW

By Jack Schmidt



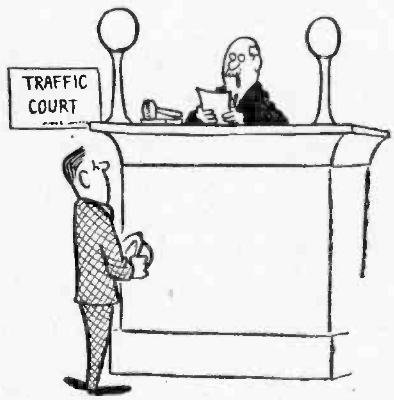


"Don't knock it! Our confession rate is way up since we got this rig!"

"Watch that feedback, Sarge!"

"To my oldest brother, Tom, I leave my AC bench supply. To my sister, Ann, the signal generator. To my nephew, William, the 555 scope. To my aunt, Mil, . . ."

"Your name better be Fred C. Corey or you'll be telling it to the judge."

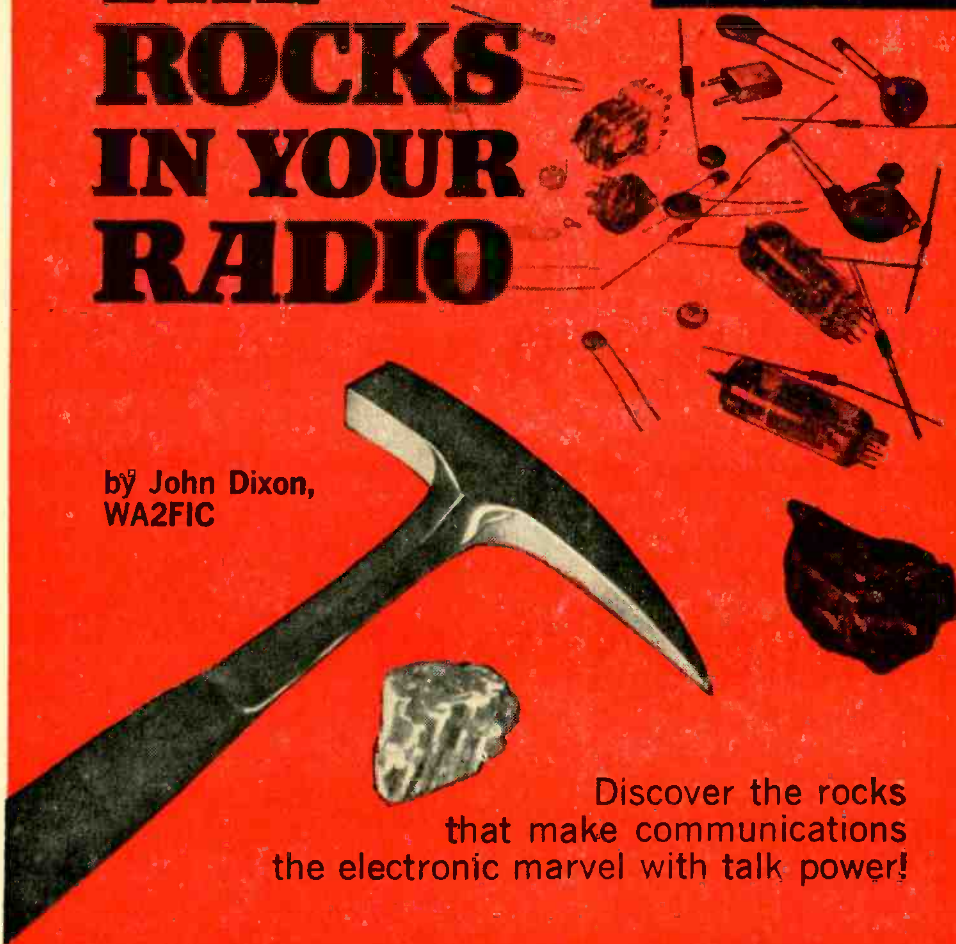


"You're accused of a 73 Hz Doppler shift in a 10,525 MHz zone. How do you plead?"

"To all units—State Police have an undetectable radar on Weed Road. . . ."

elementary Electronics

THE ROCKS IN YOUR RADIO



by John Dixon, WA2FIC

Discover the rocks that make communications the electronic marvel with talk power!

BELIEVE it or not, a rock is a natural enough object in a group of radio components, because almost every radio component you can bring to mind is made from one or another kind of rock. Much of the history of radio and electricity is connected with discoveries of properties of different rocks. The ancient Greeks discovered that amber, when rubbed with fur, produced static electricity. Their name for amber, ēlektron, is the basis for many of our words connected with electricity. Glass, which is made from sand and a rock called sandstone, was the material used for further study of static electricity. And, the early crystal radios used galena as their crystal detector. Galena is a rock, found in the central U.S. and other parts of the world, and is the chief ore of lead.

But, rocks are by no means confined to the history of radio. They are part and parcel of the present state of the art, and they hold the promise of an exciting store of future improvements in all areas connected —*Continued overleaf*

e/e ROCKS IN RADIO

in any way with radio and electronics.

Cu. Look inside a typical radio. The first things you notice is the maze of wire—*copper* wire. The electrical industry used over 850,000 tons of this metal in 1968, and it is found in almost every component used in radio. Fortunately, the rocks from which copper is extracted are widespread.

Although much copper occurs in an almost pure state, there are a few other rocks which contain it compounded with other metals and sulfur. One of these rocks is chalcopyrite, a compound of copper, iron and sulfur, with the chemical formula $CuFeS_2$. Chalcopyrite is one of the rocks known as *fools gold,* because of its appearance. This rock is mined chiefly in Quebec, Canada and much gold is found with deposits of chalcopyrite.

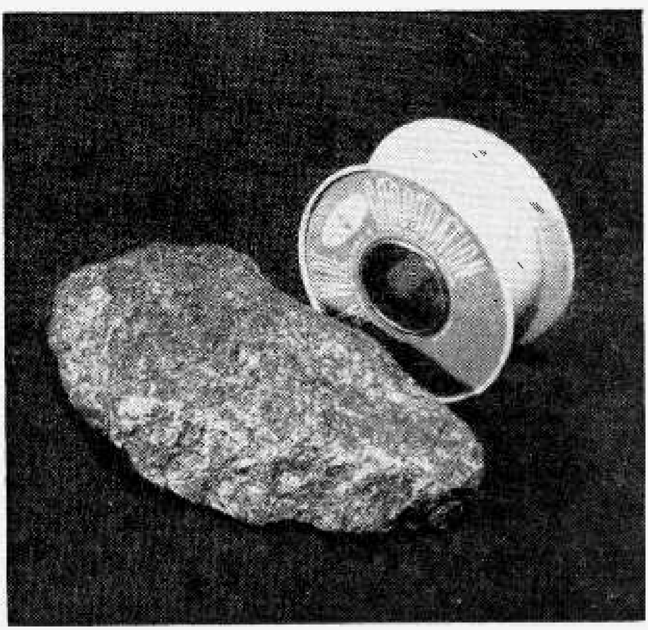
Al. Aluminum is another metal that is widely used in the radio industry. The chassis of the typical radio is now made of aluminum, with countless other radio parts, from washers to heat sinks made partially or totally of aluminum. And, aluminum comes from a rock, one called bauxite. The chief sources of bauxite are Jamaica and Surinam, with other deposits of importance scattered throughout the world. Bauxite is a rock that is usually light brown in color, and, like aluminum, is surprisingly light in weight. It was first noticed near a town in France called Les Beaux, from which the rock received its name. Although it was known to contain aluminum, it was not a commercially valuable source of this metal because there was no practical way to extract the aluminum from it.

In 1886, simultaneous discoveries of a method of extracting aluminum from bauxite were made by Charles Martin Hall and Paul Heroult, and since then aluminum has been produced in quantities that were demanded. During World War II, the metal was produced in fantastic quantities to meet the war demands, and since then the demand has been very high.

Bauxite is still the chief rock which supplies aluminum, but active research to find a way to extract profitable quantities of aluminum from other rocks is now under way. This is a wise course, because the light weight, ease of working, and resistance to corrosion will keep the demand for aluminum as high as it now is.

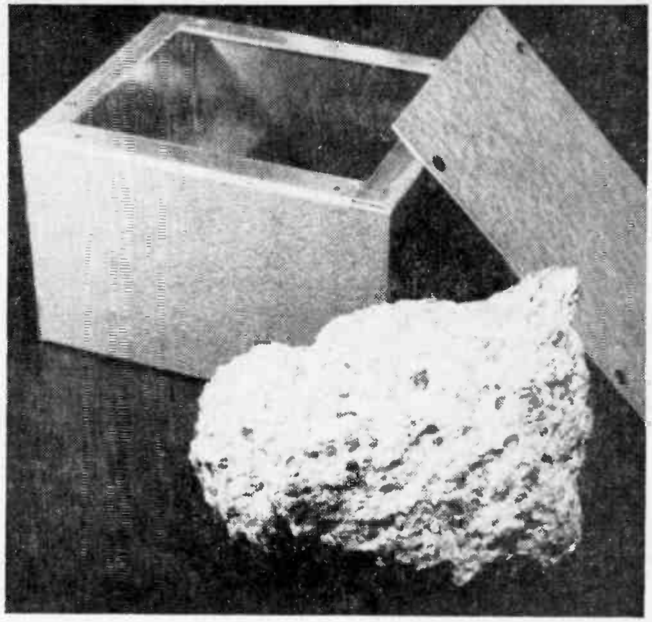
There's More. Besides aluminum and copper, many other metals are used in radio, and each of these metals is extracted from one or more kinds of rock. Silver occurs combined in a few different kinds of rock, and is found with deposits of galena. Mercury, used in batteries and switches, occurs as an ore called cinnabar, a compound of mercury with sulfur. Nickel, cobalt, zinc, osmium are metals that are of some importance in radio. They each have a source which is a rock.

Iron, and steel, are obviously important in radio. But, one of the rocks that contains iron deserves special mention, since it has historical importance in the study of magnetism. This rock is magnetite. It is iron compounded with oxygen, with a chemical formula Fe_3O_4. Also known as lodestone, this rock was



This is a specimen of chalcopyrite, from which copper is made. Copper is used primarily as a conductor, such as copper wire. Chalcopyrite is mined in large quantities near Quebec.

Bauxite is an ore from which aluminum is extracted. The rock can be white to reddish brown in color, and like aluminum is very light.

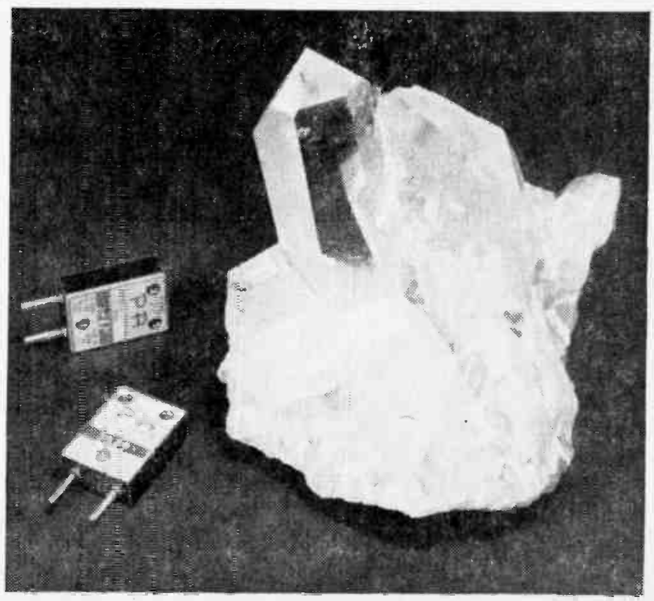


noted in earliest times for its magnetic attraction. Discoveries in magnetism were as important to radio as were those in electricity, and lodestone can be considered the amber of magnetism.

The Brittle Stuff. Not all of the rocks in your radio are there because they are sources of metals; some of the very important components of radio are not metal at all. Glass was mentioned as being historically important, but it is just as important today. Capacitors, tubes and other often unnoticed, but undeniably important components depend on glass for their proper operation.

Glass comes from a rock known as sandstone, and from common sand. Chemically, sandstone and sand are compounds of silicon and oxygen, with a chemical formula of SiO_2. Sandstone is mined, in the United States, in Pennsylvania and West Virginia as Oriskany sandstone, a very pure and large supply to the glass industry in the east. Other sandstones are the St. Peter, found in Illinois, Minnesota and Missouri, and a less pure variety found in New Jersey. Sand, as taken from the beaches may be used if it is of good quality. This means that it contain very little impurity in the form of other metals. These metals will discolor the glass. Though for some applications colored glass is used, most glass used in radio is colorless. The glass in a red panel light might contain some copper, and a blue lamp might contain some cobalt, but an overheated plate element in a vacuum tube will be seen best through clear glass.

Crystals. When you hear an amateur radio operator say he is "rockbound," you find an interesting recognition of the close relationship between rock and radios. This phrase means that the ham is operating on a frequency that is determined by a quartz crystal, as opposed to his being free to move up and down the band with a VFO. The quartz crystal is, in fact, a small slab of a rock, cut to a certain size and mounted in a



These very beautiful quartz rocks are valued as piezoelectric material. The rock here is about four inches high, and can be used to make many plug-in crystals like the ones shown.

holder. This rock is known as "rock" quartz, and looks like large chunks of glass.

Rock quartz is chemically identical to sand and sandstone, being a compound of silicon and oxygen, but the fact that it can occur in a single large crystal makes it valuable as a frequency control.

Mica. If you use a quartz crystal to control the frequency of an oscillator, the other components in this oscillator will be chosen to equal the stability of the crystal. One of the stablest of capacitors is the mica capacitor, and this too depends on a rock. Although mica occurs in "books" that look like thin sheets of plastic stuck together, it is nonetheless a true rock. These widespread books can be quite large, even as large as several feet in each dimension. There are several varieties of mica, but one is used in the mica capacitor. This kind is called Muscovite mica, because it was used by the Russians as windowpanes in their houses and portholes in their ships.

Chemically, Muscovite mica is very complex, containing potassium, aluminum, silicon, oxygen and hydrogen. The dimensional stability and dielectric strength of this type of mica make it valuable. Other micas, used in tubes as spacers, are valuable for their ability to stand high temperatures in addition to their stability.

The Dirty Stuff. Coal is a rock you might not connect with radio. But the carbon used in resistors and the plastics used in many components are based for a large part on this widely occurring rock. Coal is also used in the manufacture of many components in radio, but is not a part of the finished product.

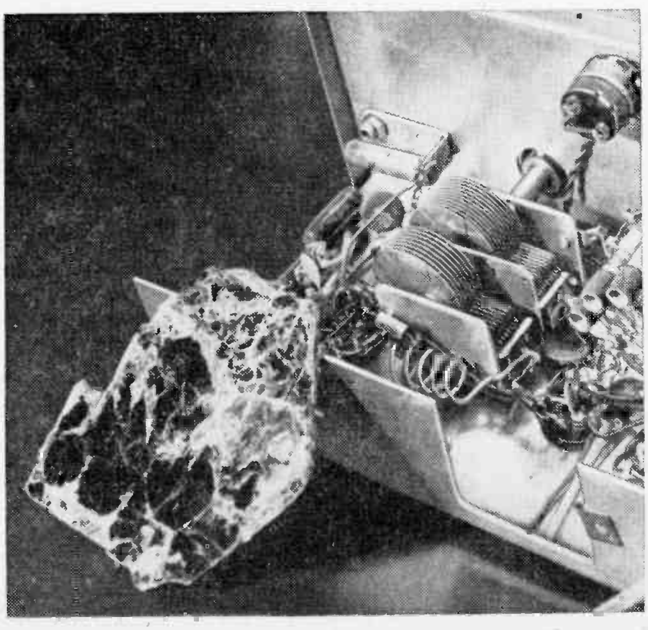
And One More. A class of rocks that are used to make ceramics are important to the radio industry. These ceramics are the insulators on switches, the sockets for tubes, forms for coils and innumerable other parts. The rocks used for these ceramics are the feldspars and kaolinite. Feldspars are a variety of rocks that are very common, and are, in fact, the most abundant kind of rock. They are all aluminum silicates, but are different in that they contain other elements such as potassium, sodium and calcium. Despite the chemical differences, they are extremely difficult to tell apart with the naked eye.

Kaolinite is quite similar to the feldspars, yet it is noticeably different. It is a hydrous aluminum silicate, and is a lustry white. The feldspars and kaolinite, when processed differently yield many types of ceramic. The most valuable ceramic in the radio industry is steatite.

The Last Roundup. This, more or less is the extent of the relationship between radio and the rocks. However, we have purposely left mention of two categories until last, for they represent the future of radio to some degree.

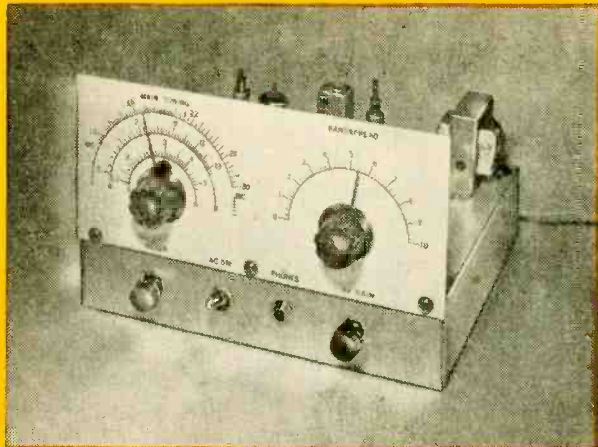
Naturally, we all think of the future of radio in terms of solid state devices rather than in terms of tubes. And, these devices are also related to one or another form of rock. A little earlier, you may have connected the mention of silicon with the diode or transistor. The silicon for these devices comes from the same rocks that glass

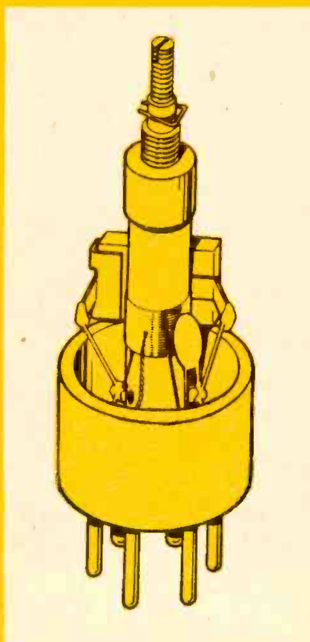
(Continued on page 109)



A book of mica may look like just a rock in the picture, but you can peel it apart with a fingernail. Mica finds uses as a dielectric material and wherever a stable support is needed. Mica spacers in tubes, for example, minimize changes in dimension due to heating of the cathode.

SPECIAL
SWL
CONSTRUCTION
PROJECT





Build the first Electronic Transplant Receiver

by Charles Green, W6FFQ

The sensitivity of the regen couples with the stability of the superhet to make for a receiver that's hotter than hot!

Plenty of electronics hobbyists have experienced the fun of building and firing up their own receiver. But we'll bet a dormouse to a doughnut that you've never tackled a transplant: a superhet/regen combo. By way of explanation, this unusual circuit offers all the stability that has made the superhet the standard of the radio world, *plus* the fantastic sensitivity for which the regenerative detector is famed. This unusual combo uses two tubes in a simplified super-

e/e TRANSPLANT RECEIVER

het circuit, with pre-wound plug-in coils covering 1.7 to 30 MHz. Bandspread tuning makes easy separation of signals in crowded portions of the band; the audio circuit has plenty of gain to drive either a pair of high-impedance phones or an auxiliary amplifier.

About the Circuit. Signals from J1 are tuned by plug-in coils L1A (Band A), L1B (Band B), or L1C (Band C), and the main tuning capacitor C4A or bandspread capacitor C5A. These capacitors (associated with mixer V1A) are ganged with the oscillator circuit (V1B) capacitors C4B and C5B, which tune plug-in coils L2A, L2B, or L2C so the oscillator RF output is always 455 kHz above the incoming signal frequency. This RF output is coupled to the mixer grid via the gimmick capacitor, and the resultant 455-kHz output is fed through tuned IF transformer T1 to regenerative detector V2A. The gain of the mixer circuit is controlled by R4.

The regenerative detector circuit feedback is formed by the C9, C11, and L3, with regenerative action controlled by R7. The detected audio signals are fed via C14 to the amplifier stage (V2B). The resulting amplified signals are connected through C16 to jack J2.

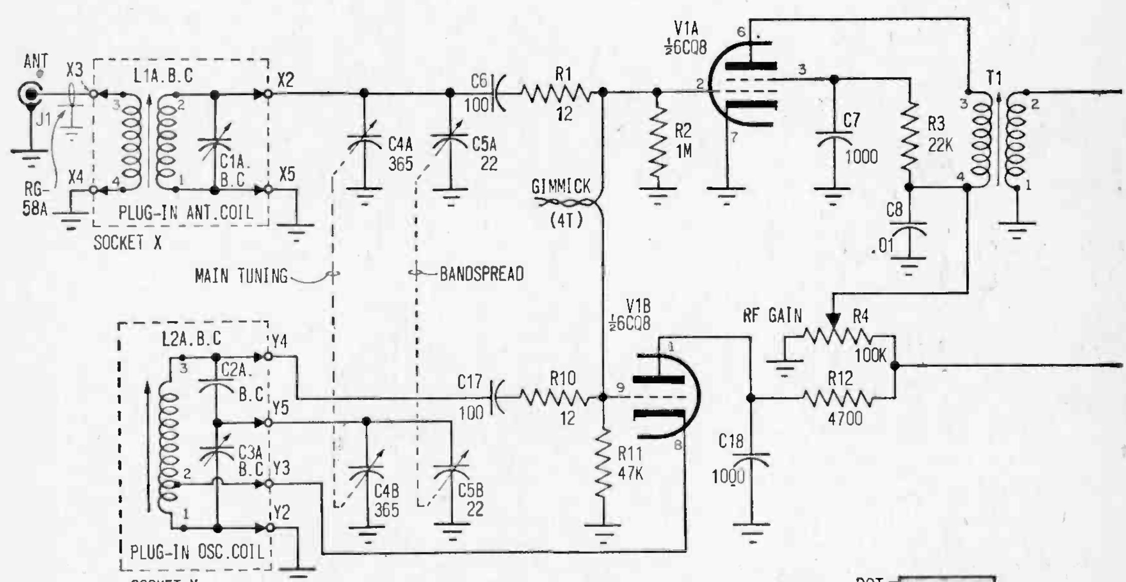
The B+ and tube filament AC supply are powered by T2, D1, and R/C filter circuit of R13-C19.

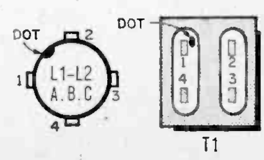
Building It. The receiver is built on a 7 x 9 x 2-in. aluminum chassis, with a 7 x 9-in. bottom plate. Best way to start construction is to tape a section of paper on the chassis and lay out the component locations as shown in our photos (see next page). For best results, follow our layout as closely as possible.

The X and Y sockets in our receiver are 6-pin sockets to fit our coil bases. Since there's nothing much critical here, you can use octal sockets and tube bases, or the 6-pin coil forms specified in the Parts List.

Drill the component mounting holes, and install the parts on the chassis. We cut ⅜-in. holes for the T2 leads and a ½-in. hole for the C4 and C5 leads. Install rubber grommets in these holes.

Wire the receiver as shown in the schematic diagram. Use #18 solid hookup wire or bus wire for the C4 and C5 connections to the X and Y sockets, and dress these wires away from the chassis and components. Connect C6 to R1 and connect C17 to





Two dual-purpose tubes in unusual superhet/regen circuit account for unit's remarkable stability and sensitivity. Pot R4 controls gain of mixer V1A; pot R7 controls regeneration of detector V2A. Main tuning is done with capacitor C4A/B; bandspread tuning with C5A/B. T1 is peaked to 455 kHz.

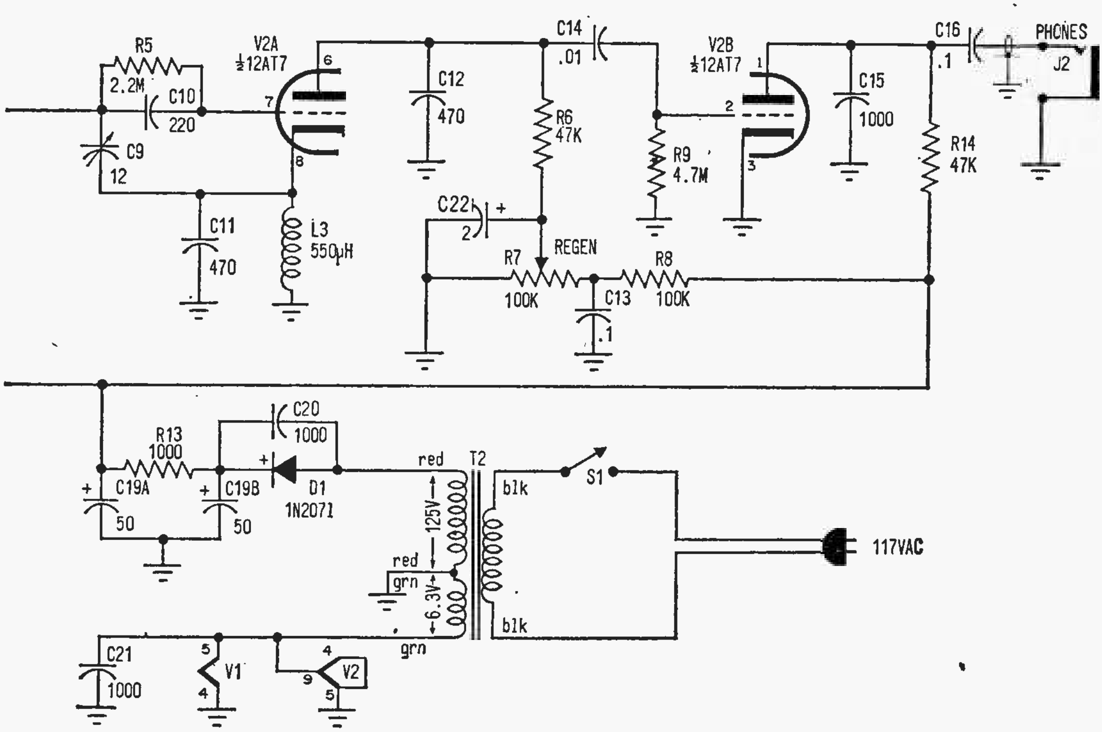
PARTS LIST FOR THE ELECTRONIC TRANSPLANT RECEIVER

NOTE—Capacitors rated 400 VDC minimum ceramic or mica unless otherwise noted.

C1A, C3A—2.7 to 30-pF trimmer capacitor (ARCO 461 or equiv.)
C1B, C3B, C1C, C3C—4 to 40-pF capacitor (ARCO 422 or equiv.)
C2A—2000-pF capacitor
C2B—5000-pF capacitor
C2C, C8, C14—.01-uF capacitor
C4A, C4B—Dual 365-pF per section (2 gang) variable capacitor (Lafayette 32 T 1102 or equiv.)
C5A, C5B—Dual 22-pF per section (2 gang) variable capacitor (J. W. Miller 1461-2)
C6, C17—100-pF capacitor
C7, C15, C18, C20, C21—1000-pF capacitor
C9—1-12-pF capacitor (ARCO 420 or equiv.)
C10—220-pF capacitor
C11, C12—470-pF capacitor
C13, C16—0.1-uF capacitor
C19A, C19B—Dual 50-uF, 150-V electrolytic capacitor
C22—2-uF, 150-V electrolytic capacitor
D1—1N2071 silicon diode or equiv. (100 mA at 200 PIV minimum)
J1—Phono jack, panel mounting type
J2—Phone jack to fit earphone plug
Gimmick capacitor—4 turns of solid #22 hookup wire, plastic covered
L1A—Antenna coil (J. W. Miller B-5495-A)
L1B—Antenna coil (J. W. Miller C-5495-A)
L1C—Antenna coil (J. W. Miller D-5495-A)
L2A—Antenna coil (J. W. Miller B-5496-C)
L2B—Antenna coil (J. W. Miller C-5496-C)
L2C—Antenna coil (J. W. Miller D-5496-C)
L3—550 uH RF choke (J. W. Miller 4649 or equiv.)

NOTE—All resistors ½-watt, 10% unless otherwise noted.

R1, R10—12-ohm-resistor
R2—1-megohm resistor
R3—22,000-ohm resistor
R4, R7—100,000-ohm, linear-taper potentiometer
R5—2.2-megohm resistor
R6, R11, R14—47,000-ohm resistor
R8—100,000-ohm, 1-watt resistor
R9—4.7-meghom resistor
R12—4700-ohm resistor
R13—1000-ohm resistor
S1—Spst toggle or slide switch, 117 VAC, 1A min. rating
T1—455-kHz IF transformer (J. W. Miller 12-C1)
T2—Power transformer; sec: 125V-15 mA, 6.3V-0.6 A (Allied 54C1410 or equiv.)
V1—6CQ8 vacuum tube
V2—12AT7A vacuum tube
X—Socket to fit plug-in antenna coils L1A, B, C (see text)
Y—Socket to fit plug-in oscillator coils L2A, B, C (see text)
Misc.—Tube bases for plug-in coils L1A, B, C and L2A, B, C (6-pin tube bases used) or 6-pin plug-in coil forms (Allied 47C6697—see text), 7 x 9 x 2-in. aluminum chassis and 7 x 9-in. bottom plate, cardboard for panel, AC line cord, knobs, terminal strips, RG-58A/U coax, wire, solder, etc.



R10 with very short connections. Connect these assemblies with short leads between V1 and the X and Y sockets as shown in the schematic. Note that RG-58A/U coax should be used for the J1 and J2 connections.

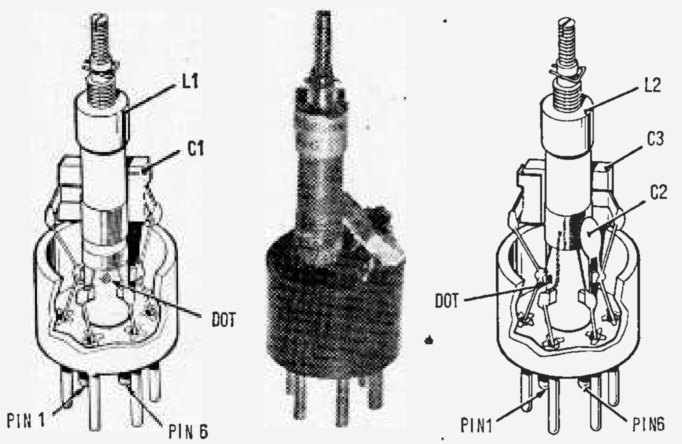
Capacitor C9 is mounted by its lugs between V1 and T1 as shown in our photo. Keep the V1 and V2 circuit components grouped closely around their sockets with short leads. The gimmick capacitor is made by tightly twisting together two short lengths of #22 plastic covered hookup wire for four turns.

Keep the B+ and AC power leads away from the RF circuits of V1 and V2. The plug-in coils are assembled as shown in the photo and the coil table. Use lengths of bus wire to connect the coil and capacitors to their bases, or coil forms. Keep the leads as short and rigid as possible to prevent coil movement.

Either 6-pin tube bases, octal bases or the 6-pin plug-in coil forms specified in the Parts List can be used. Make sure that you clean the base pins and socket contacts of all dirt and solder flux before soldering the coil leads in place.

We used a 4 x 9-in. section of heavy white cardboard for our dial panel. The panel is mounted on front of the chassis with sheet metal screws. Install a bottom plate on the chassis after calibration to protect against component damage or electrical shock. We used lengths of bus wire cemented in the C4 and C5 knobs for dial pointers; the wires are painted black.

Alignment and Calibration. Plug in the tubes and the band A coils (L1A-L2A) and connect the receiver to the AC line. Turn S1 *on* and allow the receiver to warm up for a few minutes. Connect a set of high impedance earphones (2000 ohms or high-



ANTENNA PLUG-IN COIL

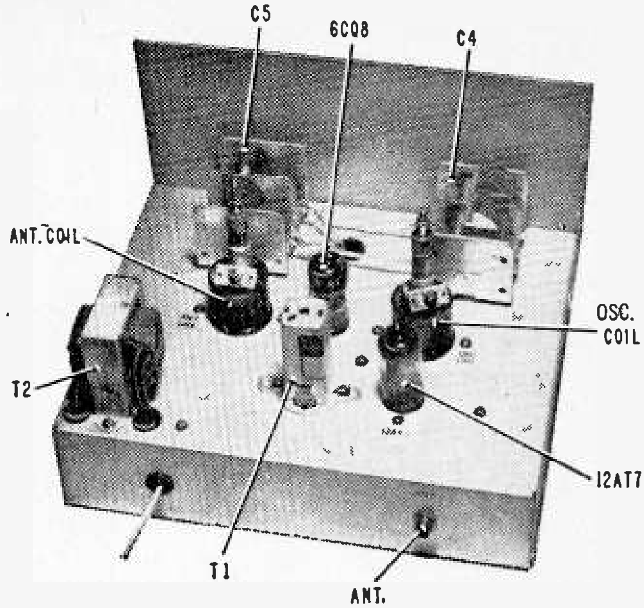
OSCILLATOR PLUG-IN COIL

Receiver's plug-in coils are actually complete coil assemblies, since associated trimmer capacitors are mounted on forms as well. As explained in text, there's nothing sacred about using 6-pin forms (author used them simply because he had some old 6-prong tubes lying around). However, bear in mind that forms you select must match sockets you choose to use for sockets X and Y.

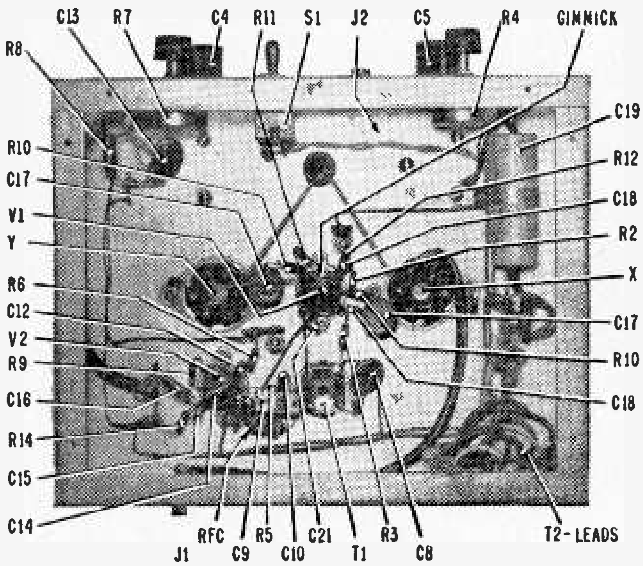
ANTENNA AND OSCILLATOR COIL TABLE

Band	Antenna Coil (X Socket)	Oscillator Coil (Y Socket)
A 1.7 to 5 MHz (Red)	L1A—J. W. Miller B-5495-A C1A—2.7 to 30 pF (ARCO) 461	L2A—J. W. Miller B-5496-C C2A—2000 pF C3A—2.7 to 30 pF (ARCO 461)
B 5 to 13 MHz (Green)	L1B—J. W. Miller C-5495-A C1B—4 to 40 pF (ARCO 422)	L2B—J. W. Miller C-5496-C C2B—5000 pF C3B—4 to 40 pF (ARCO 422)
C 13 to 30 MHz (Blue)	L1C—J. W. Miller D-5495-A C1C—4 to 40 pF (ARCO 422)	L2C—J. W. Miller D-5496-C C2C—.01 uF C3C—4 to 40 pF (ARCO 422)

Some Construction Tips



Best way to undertake construction is to first purchase all parts, then mark position of major components: i.e., capacitors C4 and C5, sockets X and Y, transformers T1 and T2, and sockets for V1 and V2. After drilling holes and mounting these components, you can then proceed to wire circuit.



Removing bottom cover from Transplant Receiver reveals circuit that is relatively wide open and comparatively easy to wire. Circuit is ideally viewed as three distinct circuits on single chassis: i.e., oscillator/mixer (V1 and associated components); detector/amplifier (V2 and associated components); and power supply (T2, D1, et al).

er) to J2 and set C5 to minimum capacity.

Set R4 and R7 to midrange and connect a signal generator between pin 2 of V1 and chassis ground. Set the generator controls for a 455 kHz modulated output and adjust the T1 tuning slugs for maximum signal in the phones. Then adjust C9 so that the detector will oscillate with R7 in midrange position.

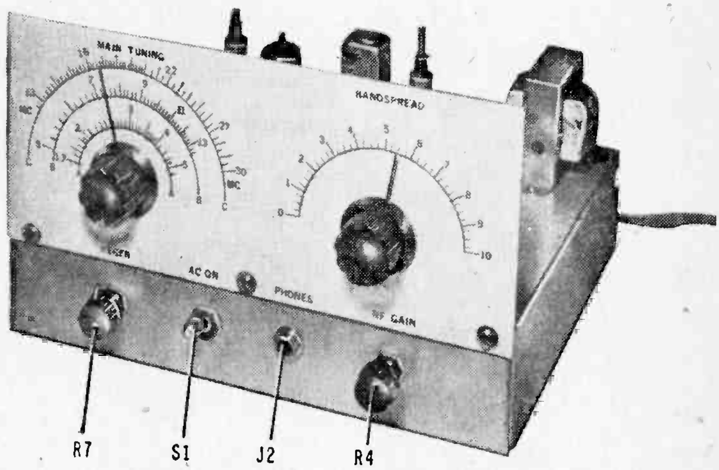
Next, connect the signal generator to J1 and adjust the generator frequency and C4 position as indicated in the alignment table. Make the adjustments as shown for each band, then calibrate the remainder of the band. We used a pencil to mark the dial lightly, then removed the dial panel and used rub-on lettering to identify the frequency points. The bandspread dial was marked from 0 to 10 as shown in the photo.

We used a small drop of model airplane paint to seal the coil and trimmer adjustments, and painted the top of each coil form to identify the bands (not the coils). We painted the band A coils red, band B green, and band C blue.

Operation. Plug in the pair of coils covering the band desired. Make sure that the antenna coil is in the X socket, the oscillator coil in the Y socket. For best results, use a good ground connection and an outside antenna mounted as high as possible. Either a single wire or dipole type will work OK.

Speaking of a ground connection, you'll note that the schematic doesn't indicate one, since the author didn't include provision for one in his prototype. But as we've said, we found that a good ground is required for best results. We ran the ground lead to one of T1's mounting screws, but you might prefer to install a suitable ground terminal on the rear of the chassis.

A transistorized amplifier can be plugged into J2 for speaker operation, or to give additional audio gain to dig out those weaker stations more easily. Use the main tuning capacitor (C4) to tune across the band with the bandspread capacitor (C5) set a minimum capacity. When you desire to tune a particular portion of the band, set the main tuning capacitor to the high frequency end, and tune the band portion with the bandspread capacitor.

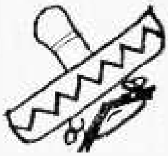


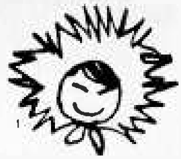
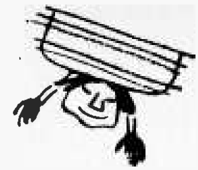
Completed Transplant Receiver has all user-operated controls neatly grouped across front panel. Once antenna and ground are connected, unit is plugged into AC outlet and pair of high-impedance phones plugged into jack J2. Switch S1 is flicked on, and, after unit warms up, R7 is advanced until rushing sound is heard in phones, then backed off slightly. RF gain control R4 acts as volume control and also prevents strong signals from overloading detector stage.

The receiver is most selective with R7 set just below the point of oscillation. When R7 is advanced to cause the detector to oscillate, CW and sideband stations can be received with careful tuning. RF gain control R4 should be adjusted to prevent overloading of the detector circuit. ■

TRANSPLANT RECEIVER ALIGNMENT TABLE

Band	Signal Generator Frequency (MHz)	Setting for C4A, B	Adjust for Maximum Signal
A (Red)	1.7 5	Near maximum capacity. Near minimum capacity.	L2A and L1A. C1A and C3A. Repeat adjustments.
B (Green)	5 13	Near maximum capacity. Near minimum capacity.	L2B and L1B. C1B and C3B. Repeat adjustments.
C (Blue)	13 30	Near maximum capacity. Near minimum capacity.	L2C and L2B. C1C and C3C. Repeat adjustments.



WHAT IS YOUR... VAC-QRP





Now an SWL can rate his DX-Quotient in terms of low-power stations he almost didn't hear!

by Don Jensen

■ How do you rate as a DXer? What's your DX-Quotient? Often these are tough questions to answer since there are few real yardsticks of ability and progress in shortwave listening.

Many listeners tally the number of different countries they've QSLed. Though useful, this popular means of evaluating DXpertise suffers from one basic flaw—it ignores the power factor.

While nearly every DXer has heard the 100,000-watt Deutsche Welle, the international Voice of Germany, how many have pulled in Munich's 10-kilowatt Bayerischer Rundfunk? Country hunters can claim Germany in their totals by verifying either, but the little domestic shortwave outlet is a better test of tuning skill.

What's the answer? "Watts is the answer," echo today's DX in-crowd, "and the *fewer* the *better!*" They measure their DX-Quotient in terms of VAC-QRP. VAC means, simply, *Verified All Continents.* QRP, a term borrowed from the hams' lexicon, signifies low power transmissions.

It's a cinch! Check your QSLs, or the WORLD RADIO TV HANDBOOK, the SWL's "bible," for the transmitter strengths of the low power stations you're verified. Pick the six best—one from each continent, North America (over 1000 miles distant), South America, Europe, Asia, Africa and Oceania—and add their wattage. Divide the sum by a thousand and, *voila,* your VAC-QRP DX-Quotient! Here's a typical example:

	Watts
North America—CFCW, Montreal	500
South America—YVLK, Caracas	10,000
Europe—Deutsche Welle, Cologne	100,000
Asia—R. Ankara, Ankara	100,000
Africa—Sierra Leone R. & TV, Freetown	5,000
Oceania—R. New Zealand, Wellington	7,500
Total	223,000

VAC-QRP = Total ÷ 1000 = 223

As you sharpen your skills and tune more of the weaker stations, substitute them in your calculations. If you should QSL Bayerischer Rundfunk, use it, not Deutsche Welle as your European entry. Your DX-Q drops to 133. Like golf, the lower the score, the better you're doing.

How Long Can It Go? Theoretically at least, a DX-Quotient of about 0.8 is possible, considering the stations now on the air. But let's face it, it'll be a cold day in Calcutta before that ultimate is reached.

There are plenty of lower powered stations to test your abilities. For openers, check the adjoining list. And there many more where they came from. Some are tough enough to curl a veteran DXer's long wire. Others are within the realm of a persevering beginner.

Some rather remarkable records have been racked up by listeners. West coast DXer, Bill Sparks, whose listening career dates back to the 30s, has chalked up a post-war DX-Q of 26.3. Considering only his older QSLs from the days when shortwave was relatively free of interference, Sparks scores 6.0.

Another Californian, Lt. Bruce Churchill, tallies his DX-Q at 7.25, while in the midwest, Gerry Dexter records 6.2. Chicagoan Frank Peters, a veteran SWL, figures his at 3.85! These fellows are real pros when it comes to tuning the weak ones and their DX-Quotients reflect this skill.

How Do You Rate? You'd better peddle your crystal set if you can't break 500. If you're over 250, consider yourself a progressive novice. Hovering around the century mark? Keep up the good work. If your DX-Q is between 50 and 100, you've made the grade and if you score less than 50, you're up there with the pros. Under ten? You're a real expert.

And on that glorious someday when your DX-Quotient drops below one—*Zap! Pow! Boing!* SUPER DXER!!!

WANT TO IMPROVE YOUR DX-QUOTIENT? TRY THESE!

Continent	Station	Country	Freq. (kHz)	Power (Watts)
NORTH AMERICA				
	Radio CKWX	Canada	6,080	10
	Radio CFVP	Canada	6,030	100
	Radio CHNX	Canada	6,130	500
	Radio Zelaya	Nicaragua	5,950	500
	La Voz de Honduras	Honduras	5,875	1,000
SOUTH AMERICA				
	Radio Amazonas	Peru	6,140	25
	Radio Nickerie	Surinam	3,240	50
	Falkland Is. Bc. Sv.	Falkland Islands	3,958	500
	Radio Colosal	Colombia	4,945	1,000
	Ecos de Pasto	Colombia	6,085	1,000
	Radio El Morro	Chile	9,525	1,000
EUROPE				
	Radio Shkodra	Albania	8,215	200
	Pathfinders Station	Poland	7,306	350
	Radio Kozani	Greece	7,215	500
	Radio Renascenca	Portugal	6,155	3,000
	Bayerischer Rundfunk	Germany	6,085	10,000
ASIA				
	Radio Nha Trang	Vietnam	9,720	200
	Thai TV Radio	Thailand	7,105	1,000
	Armed Forces R-TV Sv.	Taiwan	3,990	1,000
	Philippine Bc. Sv.	Philippines	3,286	2,500
	Radio Brunei	Brunei	4,963.5	10,000
AFRICA				
	Tristan Radio	Tristan da Cunha	3,290	40
	Radio ZNF-4V	Lesotho	3,824	100
	Radio Clube Benguela	Angola	5,042	1,000
	Radio Cordac	Burundi	4,897	2,500
	ORTF	Comoro Islands	3,331	4,000
OCEANIA				
	Radio Mt. Hagen	New Guinea Territory	2,450	250
	Radio Villa	New Hebrides	3,905	500
	Radio Tarawa	Gilbert and Ellice Is.	4,912.5	2,000
	VQ02	Br. Solomon Is.	3,995	5,000
	Radio New Zealand	New Zealand	9,540	7,500

SOLDERING IRON + KNOW-HOW = HOT RECEIVER

Here's how I turned an inexpensive set into a real go-getter—*R. E. Schemel*

Newly arrived in the U.S., I went straight to the local ham radio shop with the firm intention of buying a multiband transistor radio. My purpose: to tune in those distant shortwave broadcasts from home. I looked around the shop, but, seeing nothing in the price range that a two-month stay here would justify, I wandered over to the sales section. To my delight, there was the grooviest little communications receiver you ever saw—a Lafayette HA-226. And—wait for it!—it was going for the lower-than-low special sales price of $13.88!

Reckoning it to be a cheap import with little or no performance, I asked for a demonstration. Truth be known, I firmly expected a stern reply that for the price did I really expect a demonstration as well? Instead, a courteous salesman connected a shielded antenna lead and pointed out that the radio was perfect, adequate for SW broadcasts, but not exactly a piece of high-class communications equipment.

I played with it for a few moments. It seemed to pull in SW broadcasts quite well except on the highest frequency range, something I put down to bad conditions. I hurriedly said I would take it before the salesman changed his mind about the price. At the checkout, the girl saw the price and shouted to the salesman with a note of astonishment in her voice, "You shouldn't have, Jack!" I beat it out of that shop so fast that I forgot to ask for the instruction book.

When I got the baby back to the motel, with a reel of wire for an antenna (and that cost me all of a dollar, compared with $13.88 for the radio!), it worked really well on two of the shortwave bands, but not on the 12-30 MHz range. I put this down to the shielding of the motel room, and thought nothing more about it.

Zeroing the S. After a while, I noticed that the S-meter was altering its zero position from range to range, but I resisted an almighty temptation to fiddle inside. However, I did take off the covers, and found a solid type of chassis construction that augered well for future modifications. None of this printed-circuit stuff to inhibit one's enthusiasm in this little radio!

A few days later, we moved into an apartment, and by this time curiosity had got the better of me. I took off the bottom lid and saw what the trouble was. The supply for grids 2 and 4 of the 6BE6 convertor was run from the same dropper resistor as the screen grid of the 6BA6 IF amplifier. As the oscillator section drew differing currents on the different wave-bands, the 6BA6 screen grid varied in voltage, and this caused the cathode current to vary.

Shorting the dropper resistor proved the point. Therefore, purloining a soldering iron and the necessary parts, I made the modification shown in Fig. 1. This cured the problem completely, and now the S-meter stayed firmly at zero on all bands.

In the interim, I had determined that this set was a real goer, definitely better than the average domestic type of radio. It really pulled in stations on the three lower frequency bands, but that 12-30 MHz band remained sullenly silent. I still explained it away with bad conditions. But one fine day it clicked—stations on the 31-Meter band were strong on Range C (4.3-12 MHz), but couldn't even be heard on the bottom end of Range D (12-30 MHz)!

the five-turn tuning coil was of this order. If the phase of the coupling coil was wrong, it would cancel against the ground lead inductance, and there would be no signal pick-up in the main coil.

To prove my idea, I took the antenna to point B instead of point A. I was right! Signal strength increased considerably, maybe as much as 10 dB. So, I ran separate ground leads from the two tags on the Range D coil to the tag located immediately below them on the other side of the chassis; this cured the problem completely. The old ground path

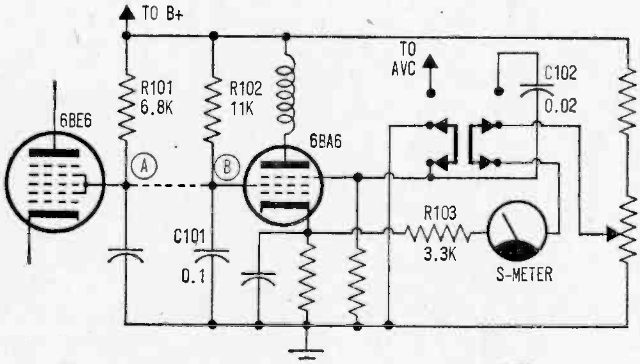
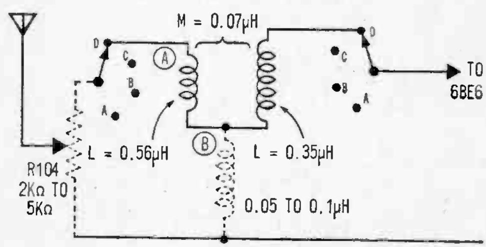


Fig. 1. Common dropper resistor for grids 2 and 4 of 6BE6 convertor and screen of 6BA6 IF was first circuit shortcoming uncovered in Lafayette HA-226. Author removed jumper between points A and B, tossed in R101 and R102 as shown, and sat back to appreciate an S-meter that no longer varied between bands.

Fig. 2. Long (4-in.) ground wire on Band D coil proved second problem with HA-226. Text tells how author handled this one.



Six for a Quarter. I checked the 6BE6 at a local drug store; it wasn't that. Something just had to be wrong with the radio. Surely not on a new one like this? Perhaps it could be a bad antenna system? Lengthening it, shortening it, using the drainpipes, nothing seemed to help. OK, I concluded triumphantly, the receiver input impedance must be wrong for these antennas; so I made a quarter-wave line (this gives a low input impedance when terminated by a high one, and vice versa) by twisting some #22 plastic-covered wire togther. Presto! Here was an improvement of maybe 6 to 9 dB.

Was this it? Not really, for after a couple of days' listening I found stations could still be heard on Range C that just couldn't be found on Range D. Something just had to be wrong with that receiver! So, after studying the receiver layout, the following solution came up.

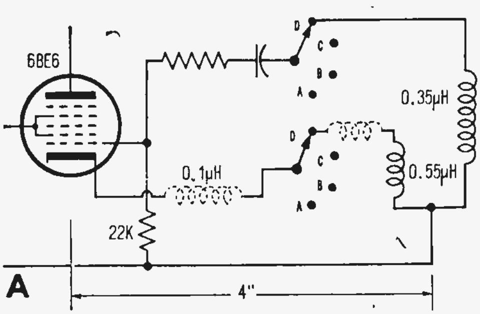
Fig. 2 shows the effective circuit of the antenna tuning on Range D. I found that the ground wire, common to both the coupling and antenna coils on Range D, ran about 4 in. before finally reaching the chassis. I figured its inductance was between 0.05 and 0.1 μH. I also figured that the mutual inductance between the two-turn coupling coil and

was disconnected to leave a connection for the other three antenna coils.

Grounds and Leads. For a few days I was satisfied, but then my fingers became itchy once more. That Range D could still take a lot of improvement. Everyday, the other three ranges seemed to get better, and for a 3-tube radio, we were really pulling those DX stations in. Could a good ground provide the answer? Some chrome-plated bars conveniently doing nothing in the forest near the apartment were brought into use.

Fortunately, the apartment was on terrace level, and the ground was still wet from the winter rain and snow. So with quite a lot of improvization, under cover of darkness with an eye to objecting neighbors, those bars were driven deep. After all that there was just a small improvement, so a good ground obviously wasn't the answer. So on to the next modification!

The 6BE6 is a cathode-coupled oscillator type of frequency changer. To obtain good conversion conductance, the RF cathode-to-ground voltage should be a small fraction of the grid voltage. At low frequencies it's easy to achieve this by tapping well down the coil. However, on Band D this makes for a very small number of turns, and on this receiver the ratio of the main oscillator-to-tickler windings was about 2:5. To make matters a lot worse, the lead from the cathode of the 6BE6 to the four different oscillator coils is about 4-in. long.



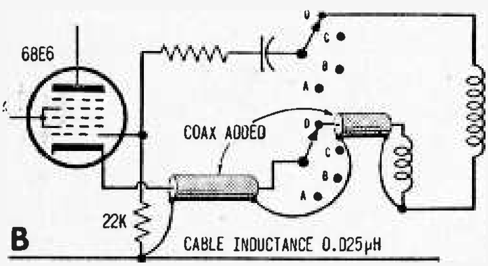


Fig. 3. Though modification detailed in Fig. 2 proved helpful, self-inductance of 6BE6 cathode lead to Band D coil was much too high for good conversion efficiency (schematic labeled A above shows effective circuit—lead, shown dotted, was calculated to have inductance of approximately 0.1 uH). Installing length of coax (schematic B) dropped inductance to 0.025 uH.

The self-inductance of this wire is about 0.1 *u*H, and the effective circuit is shown in Fig. 3a. The effect of the lead inductance is to make the cathode voltage 'way above the expected value, and nearer in potential to the grid. Overall, the conversion conductance falls off rapidly as the cathod-grid potential decreases.

What was done to cure the problem is shown in Fig. 3b. I ran a 50-ohm cable, grounded only at the tube socket on the lug adjacent to pin 1, right up to the range switch and on to the tags on the Range D oscillator coil, grounding the coil only via the outer shield of the coax. The calculated inductance of a 4-in. run of 50-ohm coax is only 0.025 *u*H.

Now things really started working! But, by the latest modification, the oscillator tuning had gone astray. And on realigning it, it was noticed that the receiver worked much better when the local oscillator was tuned lower than signal frequency, rather than higher, as it was originally. I noted that on Range D the designers hadn't bothered to incorporate a padder, and figured that we might as well align with the oscillator set low.

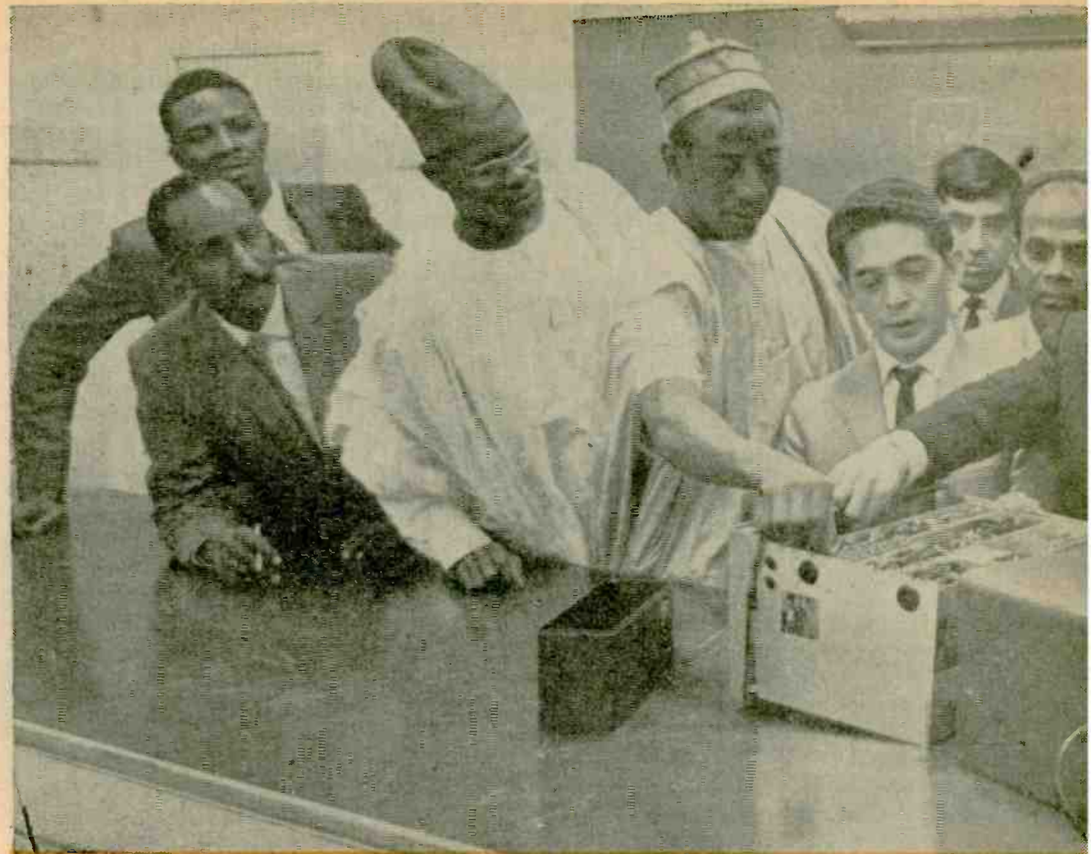
With all these modifications, that high-frequency range was working really well. In fact, there was little difference between the top end of Range C and the bottom end of Range D.

Razor Gen. Realignment presented a small problem with no instruments available, so what I did was to screw in the oscillator coil slug until WWV was heard on 15 and 25 MHz. I checked for WWV at 14.1 and 15.9 MHz; these corresponding to the possible image frequencies. If the oscillator was set correctly, the image of WWV was found at 15.9 MHz on the dial. The process was repeated at 25 and 25.9 MHz, and this time the oscillator trimmer capacitor was altered. If you have another receiver, you could use this same procedure to set oscillator frequencies at 14.55 and 24.55 MHz.

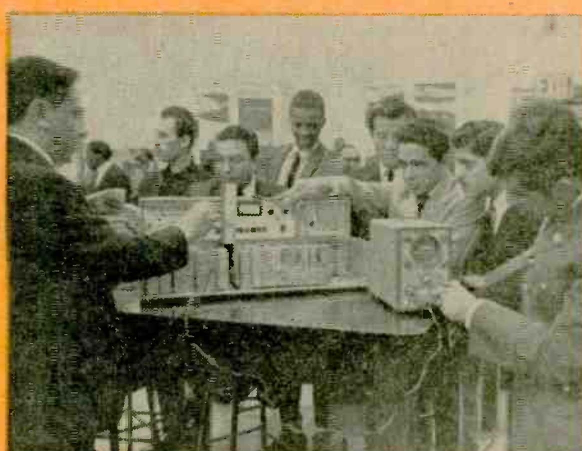
I also checked the antenna circuit alignment, and this really was a problem—moving anything in that front end pulled the local oscillator, so using a local station was no use at all. In the end an electric razor (the AC/DC type with contacts) came to the rescue as a broad-band interference generator. There were two tuning positions for the antenna tuning slug and the trimmer capacitor, and these corresponded to the two possible tuning frequencies above and below the local oscillator. I aligned for maximum noise on the higher of the two frequencies at 13 MHz, using the coil slug (slug in the further out of the two positions) and repeated this at 26 MHz using the trimmer capacitor (set to the minimum capacity of the two positions).

Q And BFO. Well, that wasn't the end of the story. I settled in for SW broadcast listening, and realized that the stability of my little receiver wasn't bad at all—it might even be good for sideband. However, the BFO didn't work properly. In the CW mode, the 6BA6 suppressor grid is not firmly grounded, and the tube works as a dynatron oscillator.

(Continued on page 108)



COPPER'S



Facts and photos by Three Lions

Above, students check out a modern central communications unit. At left, test data is recorded in log book.

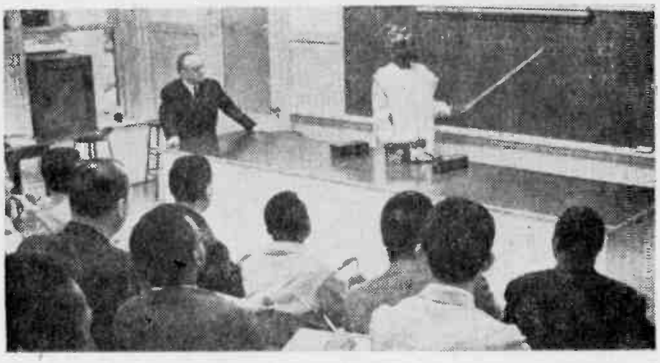
U.N.

Police officers from exotic lands learn to fight crime with scopes and soldering irons in a New York school.

Cops from around the world are catching up on two-way radio at New York's Telecommunications Training School. Sponsored by the U.S. State Department's Agency for International Development, the school attracts police officers from such exotic lands as Jordan, Thailand and the Republic of Chad in Africa.

About 36 foreign police communications officers are receiving specialized training at the school (about a stone's throw from the real U.N.). They represent 14 nations around the globe. Like the metropolitan areas in this country, the *(Continued overleaf)*

Two officers from Jordan, Bani-Hani and Fayyard Bayer, work as a team repairing a transmitter.

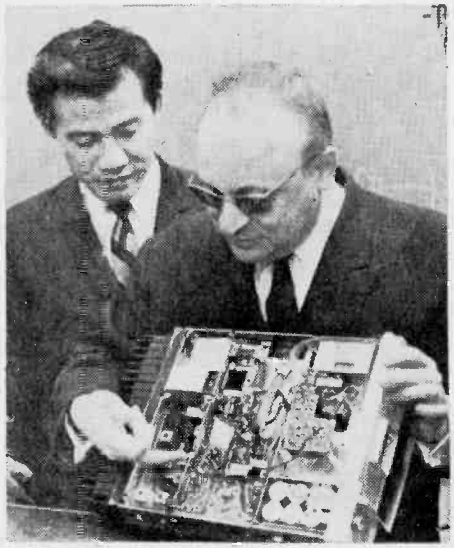


Left, a Republic of Niger police officer, Mr. Sidi, traces through a communications transceiver block diagram, explaining what he has just learned to the rest of the class, while the instructor looks on. Below, Andre Moillard (right), director of the Telecommunications Training School, shows a Thai police officer the location of the components being discussed in theory.

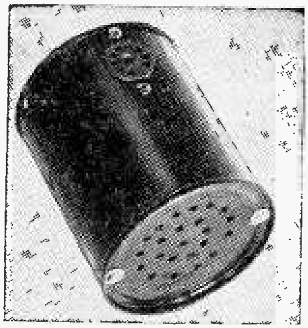
smaller and newly emerging nations are also plagued with criminals of increasing sophistication and derring-do.

These countries want to fight back with one of the policeman's best friends: fast contact by mobile two-way radio.

The officers' training, as our photos show, covers basic electronics, theory of radio transmitters and receivers. They'll receive instruction in practical maintenance of equipment. Then they're given background in how to plan and operate a radio system. Since the group doesn't speak one language, lessons are given in English, French and Spanish under the coordination of the school's director, Andre M. Maillard. After the present 6-months course is over, two more officer groups will arrive, along with executives who will study telecommunications management. ■



Before classes, a group of foreign law officers gather outside the school building and discuss police communications techniques practiced in their countries.



VARI-TONE BUZZER

By James Robert Squires

Here's an easy-to-build electronic signal source that lets your imagination take over where its frequencies leave off

My problems started when I had to make a continuity test in a 20-wire cable. In the tried-and-true fashion, I hooked up one end of the ohmmeter to the connector end of the cable. I then began the one-in-twenty odds search for the other end of the same wire.

As I touched each of the bare wires, I had to look from the wire to the meter and then back to the wire again—I was fast developing a sore neck. Then I remembered that in the electronics industry they use a buzzer, which eliminates the need to look at a meter. Obviously, a buzzer is less expensive, too.

The buzzer I finally purchased was a temperamental gadget and never seemed to stay adjusted. I was never quite sure if it was the buzzer's fault, failing batteries, or me. Convinced that there had to be a better way, I looked around my shack for other uses that might warrant a bit more expense. I found them and the result was a Vari-Tone Buzzer.

Not only does this little device serve as a continuity tester, but it works as a code practice oscillator as well. Since I sometimes grow tired of the same tone, I built in different audio outputs. This multivibrator has four fixed frequencies so that when you're tired of listening to one you can shift to another. Also, each fixed output can be wired through a separate switch to indicate different things. For instance, one tone could signal "full," top speed, etc.; another would be "empty," low speed; and so on.

Multivibrator. The circuitry is designed to make your Vari-Tone signal source as versatile as possible. The multivibrator can be triggered by a number of inputs (connected through jack J1) and different battery voltages.

Frequency range is about 2.5 kHz. A fine-frequency control is also possible by simply adding an external 100,000-ohm pot between

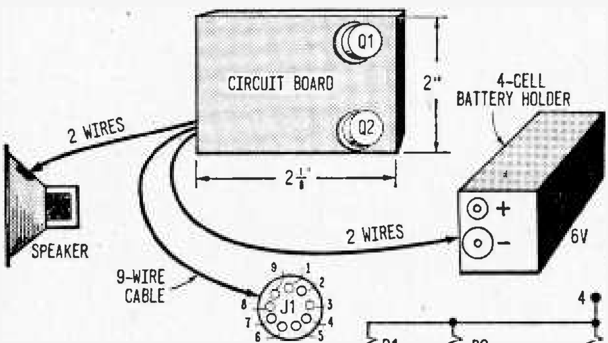
e/e VARI-TONE BUZZER

pin 6 of J1 and the negative terminal of battery B1. Control of tone volume is then possible by varying the pot.

The unit is connected so that an external battery can be used, leaving the internal battery for emergency service. Maximum voltage should not exceed 20 V.

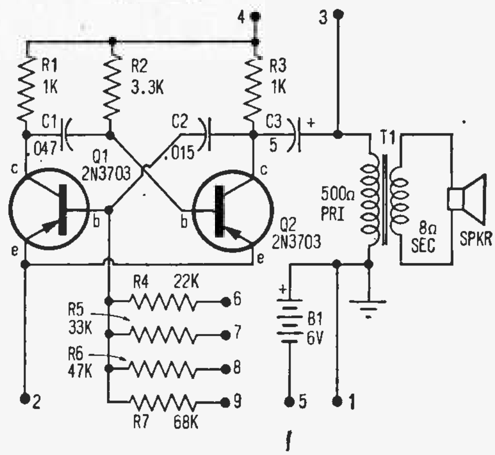
There are three ways to use the buzzer. The first is to connect pins 1 and 2 together and use pins 4 and 5 as test points (a tone will be heard only if there is a short between pins 4 and 5). The second is the converse (i.e., join pins 4 and 5 and use pins 1 and 2 as test points). The third is to connect pins 4 and 5, 1 and 2, then alter the test tone by connecting one of pins 6 through 9 to pin 4.

Construction. A fruit can (2⅝ in. dia x 3¼ in. long) was selected to house the unit because it's inexpensive and small enough to provide a compact, sturdy package. Using the speaker and the 9-pin noval socket as templates, locate them as indicated in the photos. When working with tin, either use slow drill



CONNECTIONS TO J1	
PIN	FUNCTION
1	EXTERNAL BATTERY
2	TO GROUND
3	EXTERNAL AUDIO
4	TO B- (PIN 5)
5	-6V
6-9	FIXED AUDIO OUTPUTS (TO PIN 4)

Bulk of components mount on perf board, with leads running to battery, noval tube socket, and small (2-in.) PM speaker.

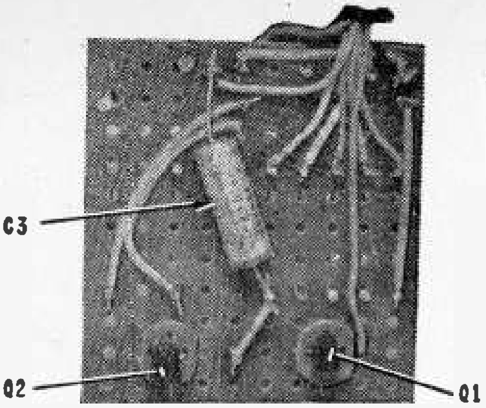


Numbers next to solid dots on schematic correspond to pin numbers on jack J1. Table at upper right shows recommended connections to J1 by pin number.

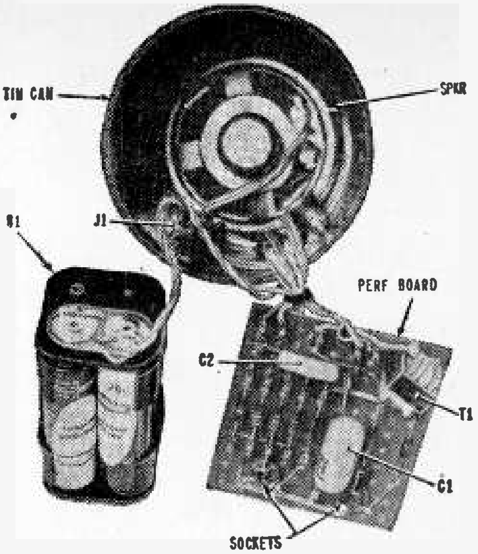
PARTS LIST FOR VARI-TONE BUZZER

B1—Four 1.5-V "AA" flashlight cells
C1—.047-uF, 100-VDC tubular capacitor
C2—.015-uF, 100-VDC tubular capacitor
C3—5-uF, 25-VDC miniature electrolytic capacitor (Sprague TE1202 or equiv.)
J1—9-pin miniature socket
Q1, Q2—2N3703 pnp transistor (Texas Instruments; HEP-57 or equiv.)
R1, R3—1000-ohm, ¼-watt 10% resistor
R2—3300-ohm, ¼-watt 10% resistor
R4—22,000-ohm, ¼-watt 10% resistor
R5—33,000-ohm, ¼-watt 10% resistor
R6—47,000-ohm, ¼-watt 10% resistor
R7—68,000-ohm, ¼-watt 10% resistor
T1—500-ohm (CT) pri., 8-ohm sec., miniature audio transformer (Lafayette 99T6129 or equiv.)
1—Miniature 8-ohm speaker, 2-in. dia (Burstein-Applebee 34A405 or equiv.)
1—Can, approx. 1 cup, liquid (see text)

Misc.—Battery holder for 4 penlight cells (Lafayette 99T6331 or equiv.), transistor sockets (Lafayette 32T4219 or equiv.), perf board, push-in terminals, plugs for J1 (see text), wire, solder, hardware, etc.



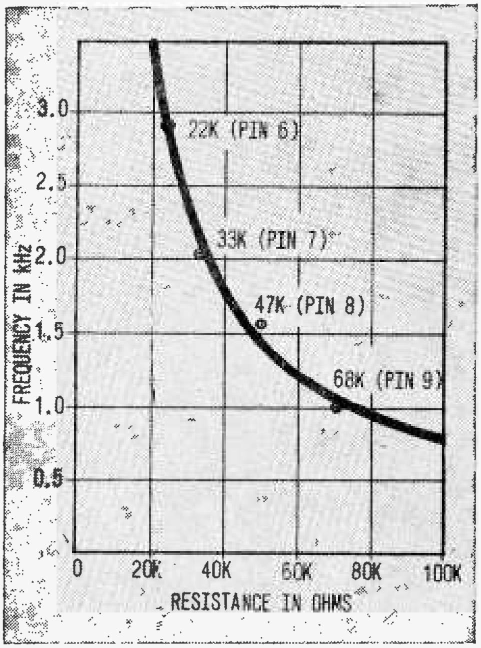
Bottom view of perf board, showing placement of transistors and capacitor C3. Remaining capacitors and transformer T1 mount on other side.



Once speaker and J1 have been mounted in fruit can, assembly is mainly a matter of wiring in battery B1 and perf board. Note position of T1.

speeds or very light pressure (tin has a tendency to tear if you don't follow these precautions). Finally, drill a bunch of holes for the speaker grille at the closed end of the can.

Mount the components on a perf board using push-in terminals. Look at the photos showing both sides of the board. Output transformer T1 fits neatly into the board's pattern when skewed at an angle. The two transistor sockets are mounted by pressing them into the board for a tight fit. I used a reamer to enlarge the holes until a tight fit was possible.



Output frequency of Vari-Tone Buzzer ranges from 1 to 3 kHz, depending on size of feedback resistor selected. Use of small pots rather than fixed resistors would enable frequencies to be trimmed to exact values desired with auxiliary tone source.

Before mounting J1 in its opening, wire all nine pins using 6-in. wires. Solder the wires close to the noval socket and feed them out through the *index slot* in the socket. The socket should be mounted so that the slot points towards the speaker. Bend the wires out the open end of the can and wire them to the circuit board. The extra length allows you to remove the perf board for servicing.

One helpful option is a plastic lid to cover the open end of the buzzer. It acts as a dust cover.

When you program the input plug for J1 the buzzer will do a task. You can use an old tube base that can be broken and wired as needed. I keep these bases around so that when the need arises for a particular function, one is readily available. Whether you require a continuity tester, code practice oscillator, or specific frequencies from a signal source, pre-wired plugs will be a great help. Naturally, you can substitute for the 9-pin arrangement if you wish.

Note that pin 3 on J1 enables the user to feed music into the speaker while at the same time using the buzzer. Also, pin 3 enables the buzzer's output to be used externally for testing or other purposes. ■

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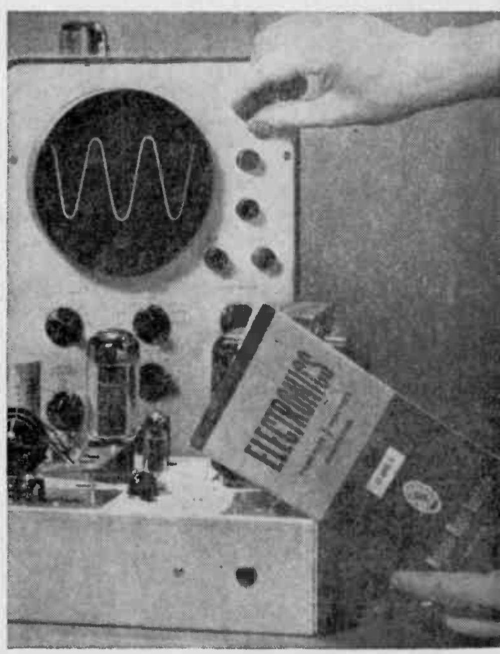


ELEMENTARY ELECTRONICS ETYMOLOGY

By Webb Garrison

Grid

▲ At least as early as the 13th century, Englishmen had developed a taste for the ancestor of the modern pancake. Thin cakes were baked on circular iron plates whose name was formed from Old French *gridil*—based, in turn, on an early Latin label.

A famous document known to scholars as the "South English Legendary" refers both to the *griddle* and the *gridiron*. The latter, also well known in the 13th century, was a frame of parallel metal bars used for broiling. Though the two devices bore only superficial physical resemblance, their names came from the same source. Perhaps the importance of the fact that both were used over the fire outweighed all differences in structure and mode of operation.

Not all gridirons were found in kitchens, though. Big ones were used as instruments of torture. Tradition had it that St. Lawrence was martyred by being broiled alive on a gridiron. Sometimes the devil was represented as bound to a burning gridiron with red-hot chains.

After centuries of use, the name of the metal framework was in popular speech clipped to *grid*. In this form it designated any kind of grating or arrangement of parallel bars with openings. So it was natural that makers of storage batteries should use the term to label a lead plate with heavy ridges that was a component in cells made in the late 19th century.

Inevitably, the term expanded with the electrical industry. Today there are many kinds of grids, including some that control the passage of ions or electrons through vacuum tubes. Many of them bear no resemblance to the gridiron on which St. Lawrence is said to have been roasted—but all are alike in having parallel bars or openings or both.

Live Wire

▲ By the 1890s, ordinary persons in the western world were beginning to have some personal experience with electricity. Generators, motors, and other devices were no longer seen only in experimental laboratories and exhibition halls. Electrical equipment, with wires attached, could be found in many homes and most shops.

Inevitably, some circuits broke down. Frequently the trouble lay in transmission of current from the source of supply. When this state prevailed, it did no good to fasten a wire more securely to a motor or a light socket; the wire itself was "dead."

Because so many dead wires caused so much trouble, *live wires* entered everyday speech as a title of admiration and approval. It named not only a copper wire carrying current, but also a person who showed unusual energy and enthusiasm.

There's evidence that the term born with electricity as its midwife was used orally in its broader sense before 1900. But diligent search has revealed no printed use prior to 1909, when a writer for *The Saturday Evening Post* described a legislator as "an aggressive 'comer' of the live-wire kind."

Mica

▲ Rock-cutters were aware of it centuries earlier, but it wasn't until 1706 that any scientist made specific notes about a special kind of scale of crystal that occurs in marble and other stones. From Latin for "grain or crumb" (influenced perhaps by the verb *micare*, "to shine") the distinctive type of scale compressed in rocks was called *mica*.

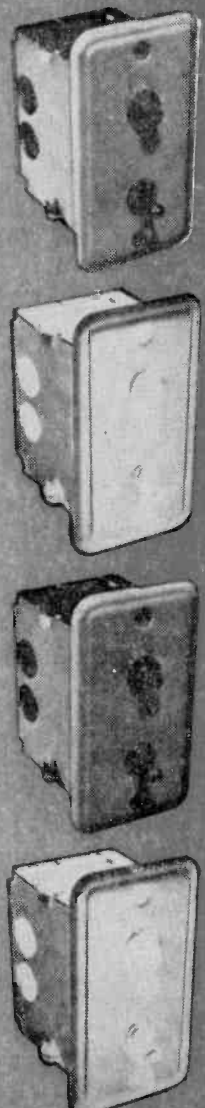
Long after it received this name, the stuff remained a mere curiosity. No one had any idea as to a possible use for it. In popular speech it was often called "Cat-silver," or "glimmer."

By 1778, English chemist Peter Woulfe was telling fellow scientists that "Mica or Glimmer . . . is composed of very thin flexible flakes." He stressed importance of the fact that the substance is a crystal that cleaves very readily in one direction, and correctly concluded that there are several kinds of mica. All of them are alike in having silicate of aluminum as their basic constituent.

Mica has a high melting point, so was first used commercially to make windows in ovens of household stoves. Then it was found to be one of the best insulators known. More than a century ago a special type of "mica battery" was put on the market, but it never won general acceptance.

With the development of capacitors, commutators, and electron tubes mica came into its own. It can withstand high voltages and intense heat. A mica capacitor usually goes through an initial period in which its characteristics "drift" somewhat; then it remains remarkably stable. Even with the development of synthetic dielectric materials there is little likelihood that nature's queer crystalline "glimmer" will be displaced from its special niche in the field of electronics. ■

Outen that light, Harry, with our DALLY LIGHTER...



Here's an AC light switch we're willing to bet is different from any you've ever seen. The reason: it sports not one, but *two* control switches. The first (the toggle switch near the bottom of the switch plate) works like any conventional light switch. Flip it up and you turn the light *on*; flip it down, and you turn the light *off*. The second (the pushbutton on top) . . . well, that's something special.

It initiates a *time delay* that turns the light *on* (just touch the button), then automatically turns it *off* again after a predetermined time. How long? That's up to you. The author's own version of the *Dally Lighter* is set for just under five minutes. But as we'll see shortly, you can select any delay time you wish from 30 seconds to 15 minutes.

In the author's house—and probably yours, too—there are several lighting control situations where the time-delay feature is worth a pound of shoe leather in saved steps. For example:

- In a long corridor not equipped with two-way switches. Thanks to the *Dally Lighter*, the author can now walk from one end to the other at night without the money-wasting need of leaving the light *on* until he walks back through.
- In a garage. Now with the *Dally Lighter*, the author has no need to walk back through the garage to reach the light switch on the rear wall when he pulls his car out at night.
- To control a front (or driveway) floodlight. The *Dally Lighter* gives a person or car plenty of time to find their way through the front yard (or down the driveway). And when they have, it turns the flood *off* automatically.

How It Works. The time delay circuit is built around a silicon controlled rectifier (Q1). This device is connected in parallel with toggle switch S2 (the conventional control switch). Whenever you touch pushbutton switch S1, the simple voltage-divider/rectifier circuit, composed of R1, R2, and D1, charges capacitor C1 to a low DC voltage (about 11 VDC). The capacitor is wired between the base and ground terminals of Q2, a Darlington amplifier connected in an emitter-follower configuration.

This circuit has a very high input impedance (several megohms) and slightly less-than-unity voltage gain. Therefore, a voltage slightly less than the voltage across C1 appears at the emitter terminal of Q2.

(Continued overleaf)

. . . a 1-SCR switch that turns lights off automatically after most any time interval you choose

By Ron Michaels

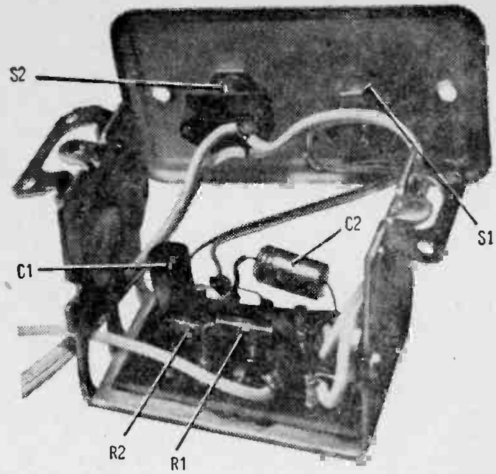
e/e DALLY LIGHTER

In turn, this voltage drives the gate terminal of the SCR (Q1), via current-limiting resistor R4, triggering it into a conductive state. This permits current to flow through the light bulb, causing it to light.

Since the SCR acts like a half-wave rectifier when it's *on*, only the positive-going half of each cycle of AC current can flow through the bulb. This means that the bulb lights to only about 70% of its normal brightness. Nonetheless, the loss of brightness is not important or even noticeable in most lighting situations.

The SCR will remain *on* as long as there is a sufficient driving voltage at the emitter of Q2. This, in turn, depends on the voltage across capacitor C1. The instant you release pushbutton S1, C1 starts to discharge through the base terminal of Q2. Because of the high input impedance, the time constant is very long. Therefore, several minutes will pass before the voltage across C1 drops low enough so that sufficient gate voltage is no longer applied to Q1. When it eventually does, though, the lamp goes out.

Capacitor C2 acts as a filter capacitor for the simple power supply that feeds the amplifier circuit. A glance at the schematic

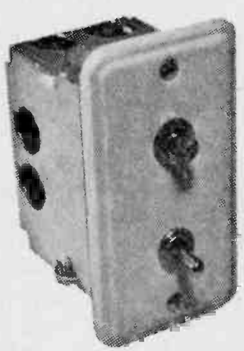


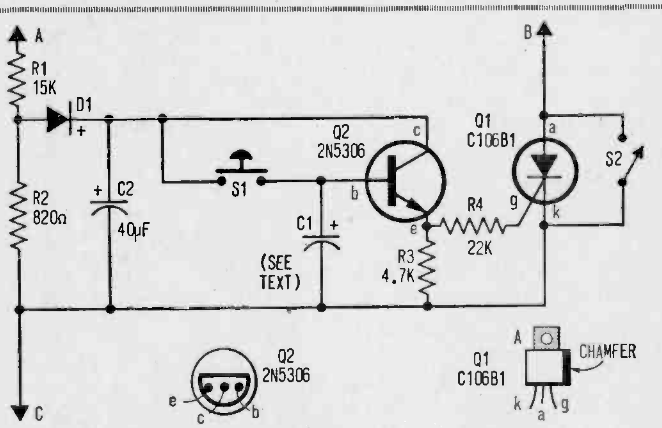
Dally Lighter's circuit (see schematic below) is simple enough that all components can be tucked within standard switch box. That's S1, the one with the red button, at right in photo above.

will reveal that this supply uses the same voltage-divider/rectifier pair used to charge C1.

Switch S2 functions as a normal light switch when the time delay circuit isn't activated. Flipping it *on* causes the lamp to light with normal brilliance.

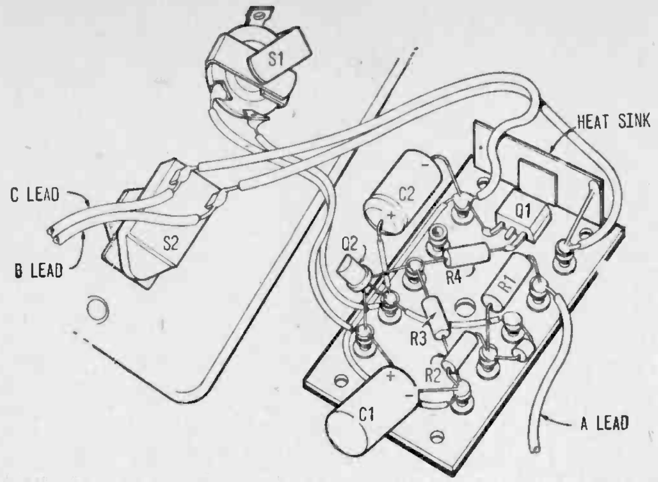
Building It. For convenience and wiring safety, build the entire circuit into a stand-





PARTS LIST FOR DALLY LIGHTER

C1—100uF, 12-VDC electrolytic capacitor (see text and table)
C2—40-uF, 15-VDC electrolytic capacitor
D1—200-V, 50-mA (or better) silicon rectifier
Q1—C106B1 silicon controlled rectifier (General Electric)
Q2—2N5306 Darlington amplifier transistor (General Electric)
R1—15,000-ohm, 1-watt resistor
R2—820-ohm, ½-watt resistor
R3—4,700-ohm, ½-watt resistor
R4—22,000-ohm, ½-watt resistor
S1—Spst, pushbutton switch
S2—Spst toggle switch
Misc.—Electrical switchbox, blank switch plate, 10-post turret terminal board (section of Keystone 15036), hardware, wire, solder, etc.



Ten-post turret terminal board holds all of Dally Lighter's components save switches S1 and S2. Physical size of time-delay capacitor C1 may prove problem if you go after extra-long time delay, though it usually can be squeezed in somehow or other.

ard-depth 2-in. switch box. Mount a single section of phenolic terminal strip (10 pins) in the base of the box as shown in our photos. Before you screw the strip in position, place several thicknesses of plastic electrical tape on the bottom of the strip so that all of the terminal ends are covered. This will prevent short circuits against the metal box.

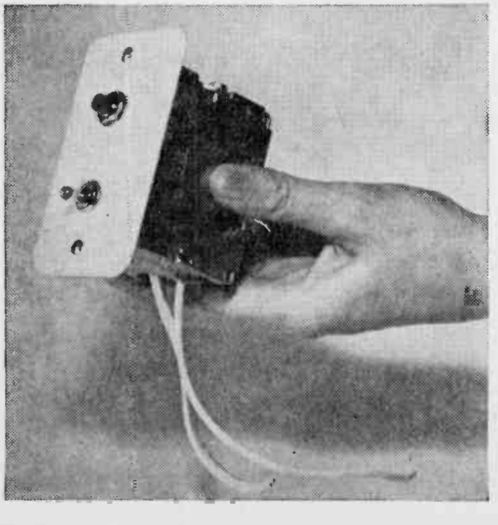
The SCR is an inexpensive plastic-case unit. Mount it on the terminal strip with a dab of cement before you connect components to its leads. Besides being connected to the *anode* terminal, the SCR's metal tab serves as a heat sink. To improve heat dissipation, solder a 1 x 2-in. piece of copper sheet to the tab.

As with all line-voltage-operated devices, short circuits between adjacent leads are a potential hazard. Therefore, play it safe and keep all interconnecting leads as short as possible. Also, double-check the polarities of the two electrolytic capacitors and the diode before you solder them in place (any mistakes here will ruin the components involved).

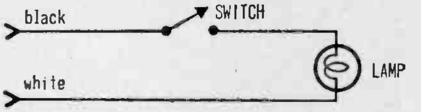
The two switches should be mounted on an undrilled switchplate of the type usually employed to cover unused switchboxes. Since these are almost always sold unpainted, be sure you paint it before you install the switches.

Installation. The complete device mounts within a wall like any other switchbox. The connection diagrams contrast the wiring or a conventional switch and this circuit.

For clarity, our photos show the three device connection leads protruding through the switchbox. Actually, there is sufficient room inside the box to permit you to make all interconnections with house wiring within

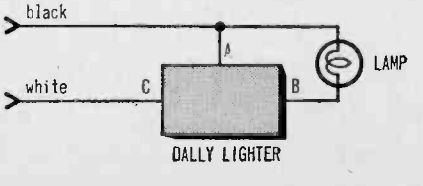


A



Conventional lamp hookup (drawing A, above) has switch in one side of AC line to turn lamp either on or off. Since Dally Lighter contains its own switch, existing switch must be removed and Dally Lighter installed in its place. Three leads from Dally Lighter (labeled A, B, and C) should be connected as indicated in drawing B below.

B



the box proper. However, it's important that you use suitably insulated wire for all connections. Should you experience difficulty in running the BX cable into the box, attach a second box to the side of the one containing the *Dally Lighter* circuit. To do so, remove one side panel from both boxes, join the boxes together, then insert the self-tapping screw.

One thing you should keep in mind: the SCR used in this device is rated for a maximum current flow of 2A DC. This means that the *Dally Lighter* should not be connected to lamps whose current drain exceeds a maximum of 250 watts of resistive load at any time.

And now that you've built it and installed it, there's but one question remaining. Do things go smoother with the *Dally Lighter* on hand? You bet they do! (Doubting Thomases please take note and give the *Dally Lighter* a whirl for themselves!) ■

How to Select Time Delay Control Capacitor C1

With the other circuit values shown in the Parts List, a 100-uF capacitor produces a time delay of approximately 280 seconds (about 20 seconds short of five minutes). The following table lists the capacitance values that will produce other delay times. Note that the time figures are approximate since the actual delay depends upon the gate sensitivity of the SCR. Though these devices are rated to fire when a gate current of 200-uF is supplied, many production line SCRs are far more sensitive, and will fire with gate currents of less than 50-uF. Thus, you should use the table as a jumping off point. If the specified value produces a longer time delay, reduce the capacitance value; to increase the delay, add capacitance.

Time	Value of C1	Time	Value of C1
30-seconds	10-uF	3-minutes	60-uF
1-minute	20-uF	4-minutes	80-uF
90-seconds	30-uF	10-minutes	200-uF
2-minutes	40-uF	15-minutes	300-uF

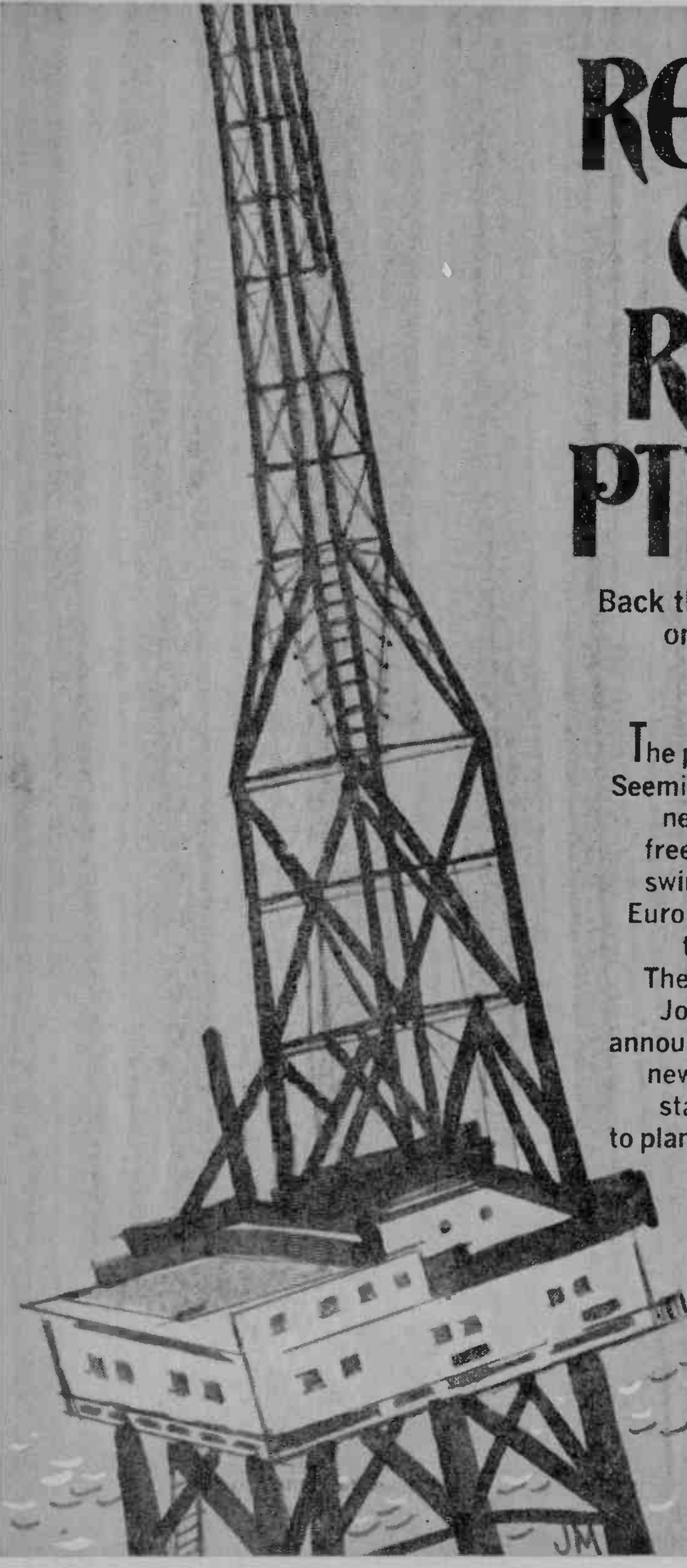
Note: Though larger capacitors will produce longer time delays, their larger physical size may prevent their use in this project.

Make a Right at the Next Computer

□ Ever have that sinking feeling in your stomach when, while driving on a high-speed highway, you miss your exit because you didn't see the directional sign in time? A Head-Up Display System that may eliminate those missed turns is now being tested by the Bureau of Public Roads.

The system causes a directional symbol to appear to be focused at infinity on the windshield and superimposes it on the road scene. As the car approaches an intersection, a coded message from the computer-decoder reaches a loop antenna buried in the roadway and connected to the roadside computer.

That computer receives and decodes the vehicle destination code, then transmits directional instructions back to the vehicle to trigger the windshield display. At the same time, an audible beep warns the driver that instructions are about to be given. ■



RETURN of the RADIO PIRATES

Back they come, big as ever— on land, sea and air!

By Don Jensen

The pirates are coming! Seemingly scuttled by stringent new laws in 1967, these freebooting stations, whose swinging sounds once ruled the European airwaves, are threaten ng a comeback. There's a grin on the face of Jolly Roger again, with the announcing of plans for a whole new series of unlicensed stations. If all goes according to plan 1969 will see an airborne

(Continued overleaf)

television station beaming commercial programs to the British Isles, a seagoing German outlet, and the Beatles' first venture in the field of pirate radio. And, to the dismay of European officialdom, this could be only the beginning.

Eleven Years Ago. Actually, buccaneer broadcasters have bugged the hidebound state radio monopolies since 1958, when an enterprising fellow named Fogh stashed a three-kilowatt FM transmitter aboard an aging coastal vessel, sailed it beyond Danish territorial limits and began broadcasting as *Radio Mercur*.

This was followed in the early 60s by a handful of unlicensed stations off the coasts of Sweden, Belgium and the Netherlands.

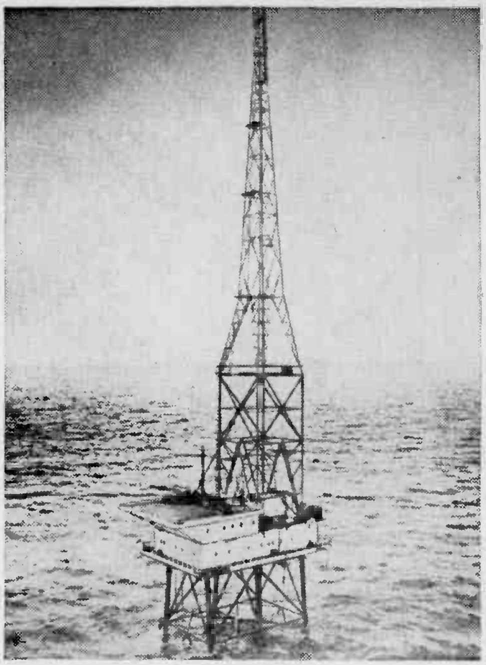
The most audacious was *Radio Atlantis*, a curious dryland pirate that operated openly, thanks to a quirk of Belgian law. For over four years it was heard each Friday evening, transmitting from a TV repair shop in Stropstraat 7, in the East Flanders City of Ghent.

The gendarmes knew it was there but there was nothing they could do. Belgian law prohibits building searches after 10 p.m. At 11 o'clock, *Radio Atlantis* signed on with an hour and a half of commercials and some of the hottest jazz around.

Eight times the cops searched the building during the daylight hours; eight times they came away empty handed. Like its legendary namesake, the station's equipment vanished, only to return to the air the following Friday.

The Lion Makes a Buck. But it took the British to turn pirate radio onto the most lucrative bit of seaborne skullduggery since Sir Francis Drake. The success of the English *Radio Carolines*, which at their peak grossed $1.4 million a year in advertising revenues, prompted a rash of imitators. Broadcasting from refitted vessels and abandoned antiaircraft forts rising from the seabed, these stations bombarded London and other population centers with U.S.-style "Top 40" sounds.

They were an unstable lot, regularly changing their names, frequencies and ownership. Other stations were proposed but never got on the air, or if they did, they died after a few test broadcasts. At the peak of the craze, ten pirates, three of them on old ack-ack gun towers, the rest on vessels, ringed the tight little island.



First pirate TV station, Radio Noordzee, began broadcasts to the Netherlands in 1964. Dutch authorities soon boarded tower, closed station.

Britain's young mod crowd, fed up with stodgy, old "Auntie BBC," loved 'em! Deejays like Spangles Muldoon, Daffy Don Allen and "Screaming" Lord David Sutch, a 22-year-old who claimed to be an honest-to-goodness blueblood, were overnight stars. But British officials were somewhat less than overjoyed by the whole business.

"No one is going to cock a snook at British law," snorted Postmaster General Edward Short, whose office was responsible for enforcing radio regulations.

But the pirate radios, operating from international waters, were beyond the reach of the law. Measures were proposed, but Parliament stalled . . . and stalled. Finally, the M.P.s got off their backbenches.

Cops and Robbers. It was June 1966, when ex-paratrooper Maj. Oliver Smedley touched off an internecine feud with a midnight raid on *Radio City*, a pirate broadcaster perched on a flak tower in the Thames Estuary. Smedley, it seemed, had "lent" a transmitter to the station's operator, Reginald Calvert, who allegedly was about to peddle the major's property to a broadcasting syndicate.

Though not widely heard in U.S. during their heyday, European pirates were picked up by some lucky DXers. These are veries owned by author.

On the theory that "possession is ten-tenths of the law," Smedley led a bloodless invasion of the offshore tower and simply took over *Radio City*.

Outraged, Calvert confronted the ex-officer at his country estate the following day. A shotgun blast ended the angry meeting and 37-year-old Calvert lay dead. Smedley was charged with murder but a jury later acquitted him on his plea of self defense.

The following month, the postmaster general presented Parliament with a draft Marine Offenses Bill, patterned after measures adopted by the Scandinavian countries. By February, the legislators had given the bill tentative approval.

It Looked Like the End. Throughout the Continent, official opposition to the pirates grew. The Council of Europe passed a resolution denouncing the unlicensed stations. Irked because of interference to their domestic radios, Sweden, Czechoslovakia and other nations complained to the International Telecommunications Union. Italy secretly proposed sending warships to shut down the freebooters.

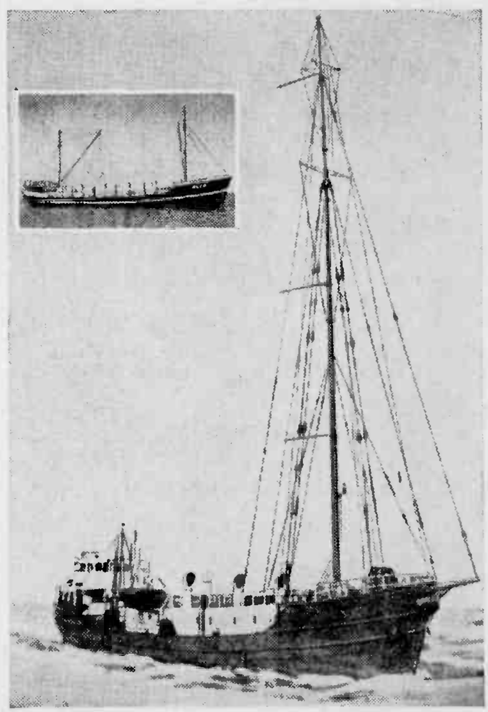
When the British law finally took effect, Aug. 15, 1967, most of the pirates pulled the big switch. Gone were *Radios 227, 270, 355* and *390*. Gone was *Radio London's* "Big L" sound. With a skirl of bagpipes, *Radio Scotland* left the air. And with them, and the others of their ilk, went a collective investment of $8.4 million.

The big moneymakers, *Radios Caroline, North* and *South,* stuck it out until the following February when they, too, gave up and were towed to a Dutch port.

With the exception of Holland's *Radio Veronica* and *Radio Hauraki,* off Auckland, New Zealand, halfway around the world, the pirate radios had disappeared. Only these two remained active. And *Veronica* became at least partially legit. In addition to broadcasting from its old stand off the Dutch coast, it tapes pop music shows, tagged *Radio Veronica International,* which are flown daily to the Mediterranean island of Majorca. There they are broadcast by the legitimate *Radio Popular de Mallorca* for English and Scandinavian tourists visiting the Spanish resort isle.

And *Radio Hauraki,* with the recent passage of a commercial radio law in New Zealand, is waiting hopefully for a government broadcasting license.

We Shall Return. After the mass shutdown there was a lot of brash talk from the



In 1961, lumber-hauling motor ship (inset) was converted to pirate station and became Radio Nord. End came when vessel's registration was cancelled.

beached pirate promoters. The stations would return, they vowed. Fleet Street and the Continental press delighted in playing up these rumors.

The Swedish *Radio Syd*, it was said, would make a comeback as a combination radio station and nightclub off the West African shores of Gambia . . . Others maintained it was the Canary Islands. *Radio Scotland*, *Radio London* and the unsinkable *Carolines*, supposedly, would be back at sea shortly with fabulous new equipment.

But, in fact, the *Radio Syd* vessel, *"Cheeta II,"* lay impounded in Harwich harbor, repainted and rechristened the *"Ca ne va rein." Radio Scotland's* floating base, the "Comet," was being reconverted to a lightship at Flushing. As for *Radio London*, its original owners reportedly were bankrupt and its ship, *"Galaxy,"* was having an unwanted six-inch ballast of barnacles scraped from its hull in Hamburg.

There were other stories too. Tales of a German syndicate about to establish a station aboard a retired American destroyer; of a U.S.-backed radio ship ready to sail from Miami for Europe; and a gaggle of would-be and sometime pirates with such unlikely names as *Albatross*, *Shamus* and *Euro-Weekend*. And, supposedly, there was a *Boss Radio* and a *Wonderful Radio Bumble*, the latter being the creation of a character named "Big Bob" in Staffordshire, England.

Many of these outlets with the wacky names were land-based mini-watters operated by teenagers, the European counterparts of the illicit, homebrew stations that plague the FCC in most of our major cities.

(Continued on page 105)

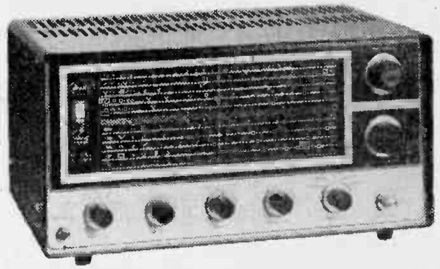
THE PIRATE CREW

Station*		Location	Frequencies**	Target Area
Radio Mercur	(1958)	Aboard "Mercur"	88.0, 89.6 FM	Denmark
Radio Syd	(1958–62)	Aboard "Cheeta II"	88.3 FM, etc.	Sweden
Radio Veronica	(1960–69)	Aboard "Veronica"	1562, 1620	Holland
Radio Nord	(1961–62)	Aboard "Bon Jour"	602	Sweden
Danmarks Comm. Radio	(1961–62)	Aboard "Lucky Star"	94.0 FM	Denmark
Radio Antwerpen Radio Uilenspiegel	(1962) (1962)	Aboard "Uilenspiegel"	1492	Belgium
Radio Atlantis	(1963–67)	Ghent, Belgium (see text)	97.2 FM, 1538	Belgium
Radio Noordzee TV Noordzee	(1964) (1964)	On "REM Tower"	1399 TV Channel I	Holland
Radio Atlanta Radio Caroline South	(1964) (1964–68)	Aboard "Mi Amigo"	1493, 1187, etc.	England
Radio Caroline North	(1964–68)	Aboard "M.V. Caroline"	1169, 1520, etc.	England
Voice of Kent Radio Invicta Radio King Radio 390	(1964) (1964–65) (1965) (1965–67)	On "Red Sands Tower"	980, 1124, etc. 1259 775, etc.	England
Radio Sutch Radio City	(1964) (1964–67)	On "Shivering Sands Tower"	1034, 1529, etc.	England
Radio London	(1965–67)	Aboard "Galaxy"	1137, etc.	England
Radio Essex	(1965–67)	On "Ft. Knock Head Tower"	773, 1353, etc.	England
Tower Radio	(1966)	On "Sunk Head Tower"	1268	England
Radio England Radio Dolfijn Radio 227	(1966) (1966–67) (1967)	Aboard "Laissez Faire"	1322, etc.	England Holland
Britain Radio Radio 355	(1966–67) (1967)	Aboard "Laissez Faire" (Vessel carried two xmtrs)	845, etc.	England
Radio 270	(1966–67)	Aboard "Ocean 270"	1111	England
Radio Scotland	(1966–67)	Aboard "Comet"	1257, etc.	Scotland
Radio Hauraki	(1966–69)	Aboard "Tiri," "Tiri II"	1480	New Zealand

** Frequencies fluctuated greatly.
* Other proposed stations never heard, or only tested briefly.

e/e COMMUNICATIONS

ALLIED MODEL A-2515
5-Band, Solid-State
Communications Receiver



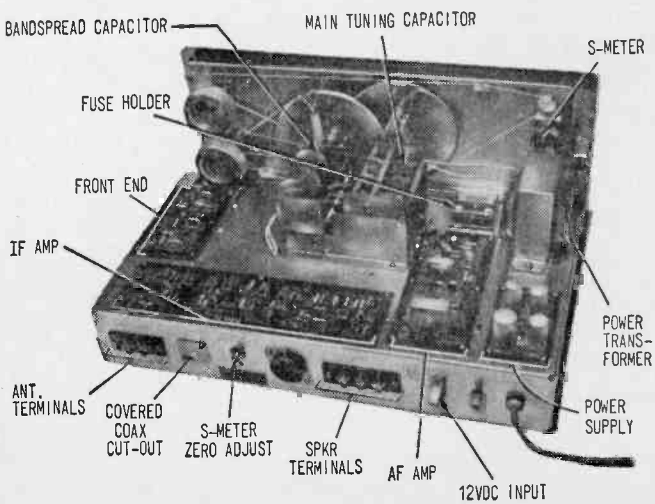
Using the very latest in solid-state technology the Allied Radio Model A-2515 Communications Receiver delivers a level of performance formerly available in tube-equipped receivers priced several hundred dollars higher than the A-2515's reasonably low $99.95 price.

The A-2515 is all solid-state, and can be powered by 115 VAC or a 12 VDC power pack or battery. Frequency coverage in 5 bands is from 150 to 400 kHz and .55 to 30 MHz. AM reception is provided through a standard diode detector, with a product detector used for CW and SSB reception. The BFO is fully adjustable for CW reception, with upper and lower sideband settings indicated on the front panel for SSB reception.

Front panel controls and switches include a *Function* switch which applies power, selects the AM or AM with ANL (automatic noise limiter) modes, provides a standby position for transmitter control of the receiver, and selects the SSB-CW mode. Both *AF* and *RF Gain* controls are provided as an adjustable *BFO* control. The *Band Sel.* and *Ant. Trim* round out the front panel controls, along with the *Main Tuning* and *Bandspread*. A *Phones* jack is located on the front panel along with the S-meter.

The rear apron has terminals for the antenna and a 4 or 8-ohm speaker. A pre-punched hole (supplied covered) is located adjacent to the antenna terminals for those who would like to install a coaxial-type SO-239 jack. The AC/DC switch and the DC power jack are also on the rear apron, as well as the S-meter zero set control and the remote control socket (supplied with matching plug).

Up-to-date Circuits. Even a quick examination of the circuit gives the user a good idea of what to expect in the way of performance. The RF amplifier is a dual gate MOSFET transistor, one gate used for the signal input and one for the AGC. The function switch automatically increases the RF amp AGC voltage in the AM mode (long time constant AGC—slow action). The mixer is similarly a dual gate MOSFET with the signal applied to one gate and the local oscillator to the other. The mixer feeds a three stage IF amplifier having its own AGC system and full mechanical filter coupling-tuning. In place of the usual IF transformers, the IF amplifier has a two section mechanical filter input, with the first two stages having single section mechanical



The receiver is modularized, each section a complete module. Both modules, and main and bandspread capacitor, are rigidly mounted, insuring high mechanical stability for a budget receiver.

e/e ALLIED A-2515 RECEIVER

filters for collector loads. The final IF amplifier is transformer coupled to a diode detector for AM, with the CW/SSB output stripped off before the diode. Looks like the engineers at Allied have been working overtime on this hot shot.

Performance Checkout. As far as lab measurements are concerned, the table tells most of the story. At almost all frequencies the A-2515's sensitivity for 10 dB S+N/N (signal plus noise to noise) ratio is the equal of many—if not most—receivers priced well up to $300. The unusual reduced sensitivity of 4.0 μV. at 11 MHz was due to sloppy alignment (not uncommon in budget receivers). In general, note that the low end sensitivity for each band was somewhat below the high end sensitivity—again, alignment. Image rejection, as shown in the chart, was notably good; even the low 15 dB image rejection on the highest band (28 MHz) compares favorably with the best single conversion receivers—better than most single conversion CB receivers.

Selectivity, the receiver's ability to reject interference from signals on adjacent frequencies, was excellent, particularly so considering the A-2515's $99.95 price tag. At 28 MHz, where the front-end has little or no effect on total receiver selectivity, the selectivity was 77 dB at 10 kHz from the reference frequency—even better than most CB transceivers. The selectivity is rather steep, being only ±1.5 kHz at 6dB down. While this is excellent for SW or Ham reception, when the user is trying to dig a station out from under the QRM, it makes standard "entertainment" BC listening somewhat unpleasant as the high selectivity "cuts" the BC station's sidebands, resulting in a loss of "highs"; but it's great for BCB DXing.

MEASURED PERFORMANCE

Band	Frequency (MHz)	Sensitivity (uV)	Image rejection (dB)
3	2.0	1.1	60
	4.0	1.3	38
4	5.0	1.3	50
	7.0	1.0	37
	14.0	0.9	20
5	11.0	4.0	31
	21.0	1.0	17
	28.0	0.9	15

Selectivity—77 dB at 27 MHz.
AGC Action—12 dB audio output for 90 dB RF input variation with signals over 3.2 μV.

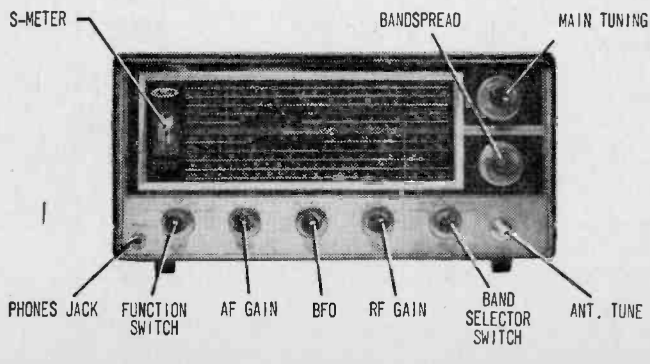
The AGC (automatic gain control) is very effective above a 3.2 μV signal input, translating a 90 dB change in input signal into a 12 dB change in audio output. Below 3.2 μV input there is virtually no AGC action.

Though the S-meter has the usual S-unit and above S-9 calibration, it is more like a *relative signal strength meter* as each S-unit represents a 3 dB rather than 6 dB change in input signal, and the over-S9 calibrations have no fixed signal strength relationship. S9 represents an 80 μV signal input at the antenna terminals.

Operating performance. It is in actual operation that the A-2515's performance grabs the user's attention. The BFO and local oscillator are rock-stable, and to the top of band 4 it is possible to work through a complete 15 minute SSB contact without once correcting the tuning or the BFO. On the high band there was a very slight drift, not serious, certainly better than the average tube receiver.

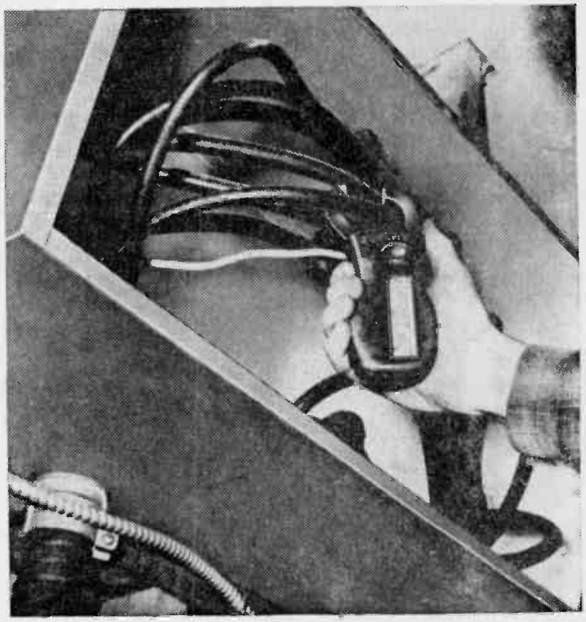
The high selectivity and image rejection was immediately apparent by the lack of

(Continued on page 104)



With all the controls located across the bottom and side of the A-2515, a right-handed operator always get a clear view of the tuning dial and S-meter no matter what knob adjustments are made.

Unnoticed by most, a workhorse for few, the clamp-on ammeter tells you without touching!



Clamp-on to Current

by Sol Wexton

A lot has been written about the current and voltage meters experimenters use every day. There is one useful instrument, however, that seems to go unnoticed—it's the *induction*, *snap-around*, or *clamp-on* meter which operates on the transformer principle. The clamp-on ammeter's big advantage over the usual type is that it does not require point-to-point contact with the circuit being measured. But, before we explore how it functions, let's review some basic meter theory.

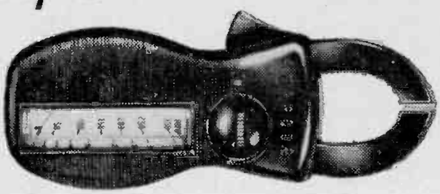
When Grandpa Was a Boy. The first practical, commercially produced meter movement was the Weston type (1888), which was a modified D'Arsonval (1881) movement. It is still one of the most widely used movements for meters of all types. Basically a galvanometer, this movement depends upon the torque exerted on a coil in a magnetic field.

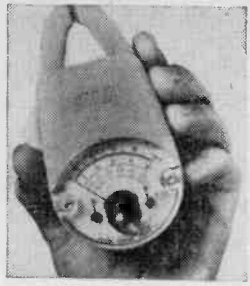
The credit for such galvanometers goes back to Hans Christian Oersted and Arsene D'Arsonval. Oersted in 1819 observed that a pivoted magnet, or compass needle, deflected when placed near a wire carrying a current. In 1881, D'Arsonval applied Oersted's observation to an electromechanical arrangement which was to become known the world over as the D'Arsonval movement—grandfather of meter movements.

Meter Construction. In the moving coil or pivoted coil movement (see drawing on next page), as the modified D'Arsonval movement is commonly referred to today, Oersted's arrangement is reversed: the magnet (Oersted's compass) is stationary and the coil (the wire carrying the current) moves. The magnetic field of the horseshoe magnet, whose poles are designated N and S, is concentrated by the soft iron cylinder core (F). The coil (C) consists of turns of insulated copper wire on a rectangular frame and is connected to helix springs (H) at the top and bottom. These springs provide a restoring or counter torque when the moving coil is deflected from its normal position. The springs also carry current to the moving coil.

When current flows through the moving coil (arrows in drawing), a magnetic field is set up around each side of the coil. Although the field will be in opposite directions on each side of the coil due to current going down one side and up the other (arrows), the interaction of this magnetic field with the magnetic field of the permanent magnet will cause force to be exerted in the same direction of rotation.

This turning moment causes the coil (C) to rotate and as it does, a counter torque is set up by the helix springs (H). The moving coil will continue to turn until it reaches a position where the torque of the springs (H) is equal and opposite to the torque of the moving coil. With no current applied





Two models of the Amprobe clamp-on testers described in this article. Unit left has rotary scale that selects correct range required. Also, meter readings stay locked so they can be taken in dark, read in light. Unit at right measures current only.

to the moving coil, the pointer (P) will automatically fall back to its zero null position.

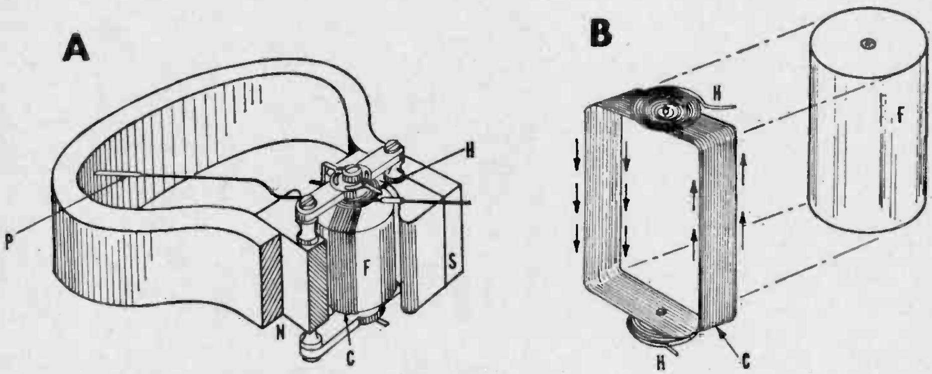
The amount of deflection depends on the strength of the magnetic force created by the current flowing through it—the greater the current the greater the magnetic force and the farther the coil will turn. In a well-designed instrument, the deflection of the coil in angular degrees is directly proportional to the current.

The pointer (P), which is attached to the moving coil and moves with it, indicates on a scale (not shown) the amount of current flowing through the coil. This, fundamentally, is how the majority of meters (ammeters, ohmmeters, voltmeters, etc.) operate. The method of sampling the current and channeling it through the meter movement is also similar in most meters. It requires direct contact—through a connector or some type of test probe—with the circuit to be measured.

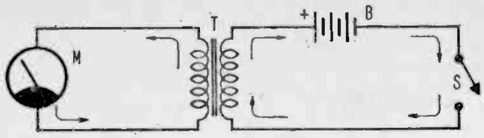
The induction or clamp-on meter, too, has a movement which is identical to the one described. However, its method of sampling is quite different.

Induction Theory. Twelve years after Oersted made his observation, Michael Faraday found that if current in a coil was started and stopped by closing and opening a switch, the increasing and decreasing magnetic field would induce a current in a second coil held next to it. This action is called mutual induction—the principle of a transformer. The iron core of the transformer concentrates magnetic force between the two windings—primary and secondary. Alternating current, because it is constantly reversing polarity, accomplishes the same thing as Faraday's closing and opening the switch in his direct current circuit. (See drawing above.)

It is this principle which makes possible the induction-type ammeters shown in the photos. By encircling a single conductor with the hinged jaws of an induction pickup, it becomes, in effect, the primary winding of a transformer. The AC current flow in the conductor induces a varying magnetic field in the hinged induction pickup. The pickup



Detailed drawing of the moving-coil movement common to DC meters in use today. Cut-away diagram (A) gives complete construction details. Electrical connection to coil C (B) is made thru helix springs (H).



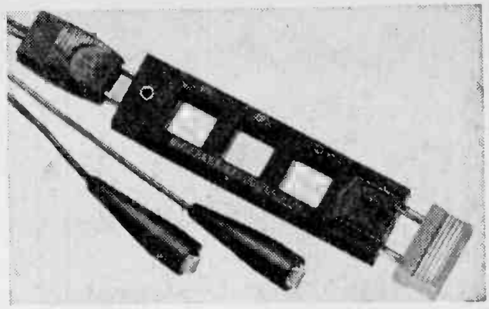
This is simple circuit Michael Faraday first used to demonstrate principles of transformer. When switch is closed current surge in battery circuit causes inductive "kick" in secondary. This kick is a current pulse that causes meter's pointer to move momentarily.

serves as the soft iron core of a transformer which, in turn, induces an AC current in the secondary coil.

The secondary coil inside the instrument is connected to the meter movement through a series of calibrating resistors and a bridge rectifier (see schematic diagram). Rectification is required here since the meter movement is a direct current device and current being sensed by the induction method is alternating. A switch on the instrument selects appropriate circuit resistors capable of reading current in the circuit being measured. Thus we have a multirange AC ammeter using an induction method of sensing current.

Same Extras. This instrument, with only a few additional components, can also function as an AC voltmeter. With test lead inputs and appropriate series resistors through the range selector switch, AC voltages can be measured. The series resistors proportionately reduce voltage to a safe value for the rectifier and meter circuit.

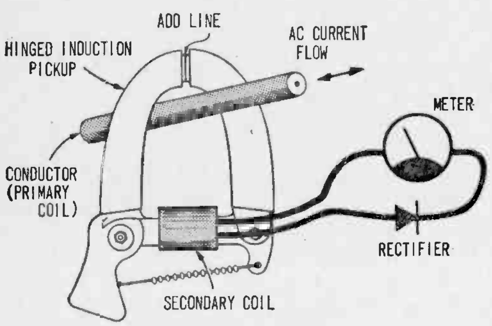
By using the same idea an induction-type meter can also function as a single or multi-range ammeter/voltmeter, ammeter/ohmmeter and ammeter/voltmeter/ohmmeter, all in one instrument.



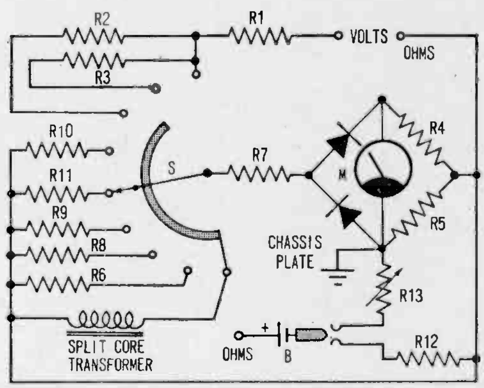
Amprobe A-45L Energizer offers clamp-on meter a measuring point without breaking line cords apart.

Clamp-on meters which incorporate an ohmmeter usually do it through an external adapter (built into one of the test probe lines) which supplies the power and fuse for meter protection required in an ohmmeter (see photo).

The major advantage of the clamp-on ammeter is that it is not necessary to break into the circuit, motor or appliance to be monitored. It is only necessary to clamp the transformer jaws around one of the conductors to obtain a reading. In instances where all conductors are in a common cable or cord and the physical splitting of the cord to enable encircling one conductor is not desirable or possible, an energizer adaptor enables a reading to be made. This accessory also extends the sensitivity of the clamp-on meter 5 to 10 times for low current work. ■



This circuit is very much like that shown at top of page. Conductor is actually one turn of primary winding of transformer. Hinged induction pickup is iron core of transformer. Rectifier permits use of standard D'Arsonval meter movement offering continuous meter indications.

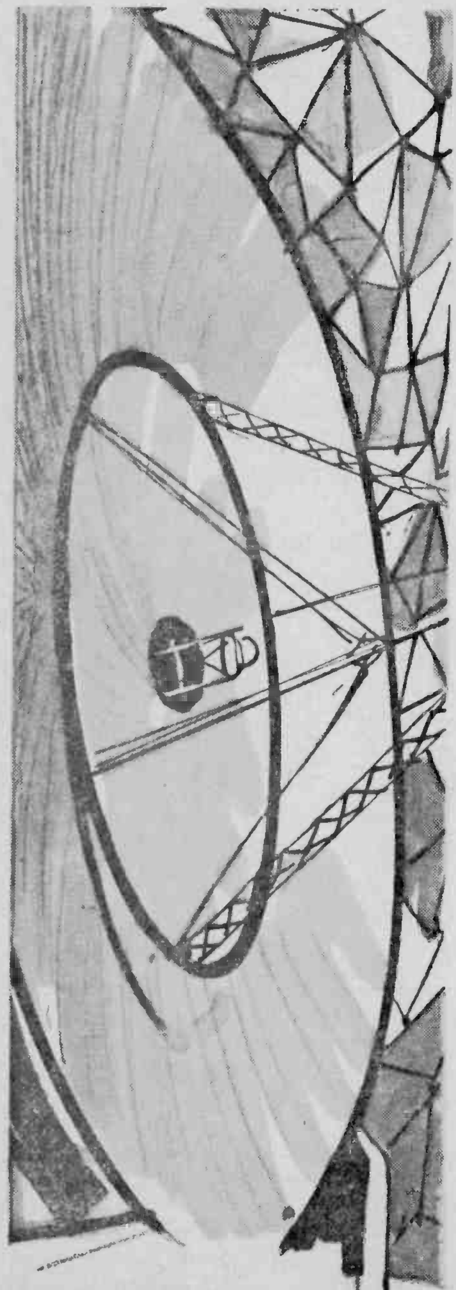


Schematic diagram of the Amprobe RS-3 clamp-on meter that doubles as an ohmmeter (25 ohms mid-scale) and three-range voltmeter (0-150-300-600 V.).

a new start for
HOMER HACKLEBY

Classified ads start many careers—here's one to forget!

by Charles Getts



MEET EXOTIC GIRLS! Intelligent, single man with electronic background wanted as agent at once. Call Nat. Security Association KL 5-1212.

Homer Hackleby read the ad a second time, then put down the paper. Apart from the desire to follow every attractive girl he saw, he had only one minor aberration which he acquired quite recently. It was simply that, every time he looked into a mirror, he saw the image of James Bond, agent 007. As Homer was 52, bald, and rather chubby, this was quite a mental distortion.

So it is understandable that he now reached immediately for the phone and dialed the number given in the ad. After a short conversation he hung up with an excited gleam in his myopic eyes.

"Spencer, there is a possibility that I will not need your services much longer," he told the thin-faced young man puttering at a cluttered work bench in the garage. "I will probably have to close down the Hackleby Electronics Company very soon."

"Then you're not going to go ahead with the Electronic Dictatypewriter you were telling me about yesterday?", asked Spencer.

"No. Anyway, I doubt if it would sell. Most office men would prefer to have the live, flesh-and-blood secretary. Not much fun in holding a

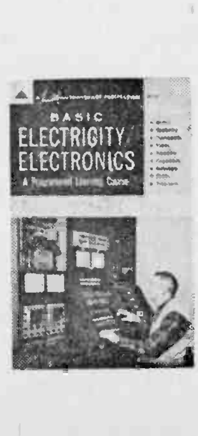
(Continued on page 106)

e/e's BASIC COURSE IN ELECTRICITY & ELECTRONICS*

PART VIII
RADIO TRANSMITTERS AND RECEIVERS

WHAT YOU WILL LEARN. When you have finished this part of the ELEMENTARY ELECTRONICS Basic Course you will have learned what the electromagnetic frequency spectrum is, what a radio transmitter is, how it develops a broadcast signal, and how radio signals are transmitted through the atmosphere. You will also learn how a broadcast signal is received, and how a radio receiver converts it into sound.

In this and the following part in the next issue you will become familiar with the



* This series is based on Basic Electricity/Electronics, Vol. 1, published by Howard W. Sams & Co., Inc.

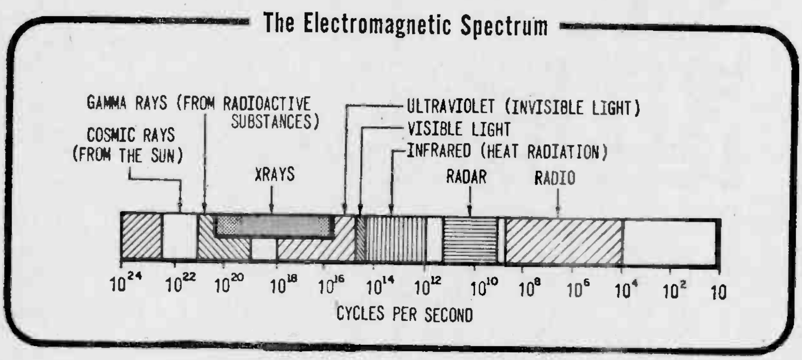
general principles of operation for certain equipment. As pointed out previously, an understanding of how electronic equipment works will help you put descriptions of components and circuits into proper frames of reference so their meaning is not lost.

ELECTROMAGNETIC RADIATIONS

Energy that radiates from a source is said to be an *electromagnetic wave. Gamma rays,* which are given off by radioactive particles such as radium, uranium, or atomic-bomb fragments, are electromagnetic waves. *Cosmic rays* from the sun travel extensive distances to the earth as electromagnetic waves. Electromagnetic waves, which include light, radiated heat, and radio signals, travel through space at the rate of 186,000 miles per second.

Electromagnetic Frequency Spectrum

Electromagnetic radiations differ from each other in terms of their frequencies (cycles per second). The frequency of one of these radiations is the number of times a single cycle repeats itself in 1 second. An *electromagnetic spectrum chart,* showing the relationship of these frequencies, is given below.



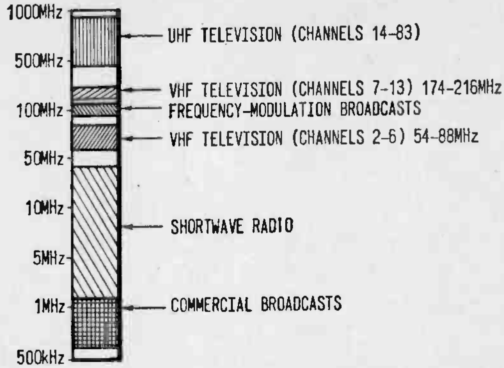
The chart shows that cosmic rays are radiated at a frequency of around 10^{22} cycles per second. (The number 10^{22} is 1 followed by 22 zeroes, or ten-thousand, million, million, million cycles per second.) At the lower end of the radio portion, radiation frequency is under 10^4, or 10,000 cycles per sec.

Assigned Broadcast Frequencies

The Federal Communications Commission (FCC) has assigned specific groups of frequencies to different types of communications transmissions. This is shown in an expansion of the radio-frequency portion of the spectrum.

Commercial transmitters (radio and television, for example) are assigned a transmitting frequency in the appropriate part of the radio-frequency spectrum. Transmitters broadcasting in the home radio band are on 535 kHz to 1605 kHz.

The Radio Frequency Spectrum



Q1. **Cosmic rays and radio waves are examples of ---------------- -----------.**

Q2. **Sound (is, is not) electromagnetic radiation.**

Q3. **Radio waves travel from the broadcast station to a receiving antenna at the rate of ------ miles per second.**

Q4. **--------- is the characteristic which distinguishes one electromagnetic wave from another.**

Q5. **Commercial radio transmissions are at a (higher, lower) number of cycles per second than television.**

Q6. **A frequency of 1000 kilohertz would be assigned to (commercial, short-wave) radio.**

Your Answers Should Be:

A1. Cosmic rays and radio waves are examples of *electromagnetic radiations* (waves).

A2. Sound *is not* electromagnetic radiation. Remember? It is changing air pressure.

A3. Radio waves travel from the broadcast station to a receiving antenna at the rate of *186,000* miles per second.

A4. *Frequency* is the characteristic which distinguishes one electromagnetic wave from another.

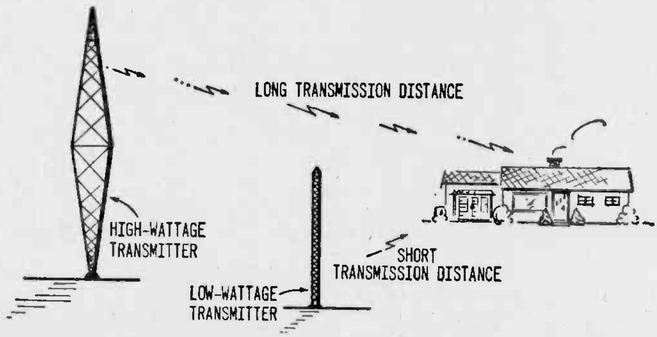
A5. Commercial radio transmissions are at a *lower* number of cycles per second than television.

A6. A frequency of 1000 kilohertz would be assigned to *commercial* radio. (1000 kilohertz is equal to 1 MHz.)

RADIO TRANSMITTERS

The dial on your home receiver is marked off in numbers, probably from 540 to 1,600 kilohertz (or 54 to 160). By rotating the tuning dial, you select the desired station. Since each local station broadcasts at a different frequency, you are able to select the one you desire. The dial setting indicates the broadcast, or *carrier*, frequency of the station.

Transmission of Radio Power



Transmitter Power

You have also noted that some stations come in stronger than others. The stronger stations broadcast at higher power (measured in *watts* or *kilowatts*) than the weaker. Or, if one of two stations broadcasting at equal power is stronger than the other, the stronger station is closer to your home.

The illustration seen above shows two antennas transmitting at different frequencies in the broadcast band. The one farther away is broadcasting at many kilowatts of power and is able to reach the receiver. The low-wattage transmitter, although nearer, does not have enough power to span the distance. This may explain why you cannot pick up some stations that are located in your general area.

Carrier and Audio Frequency

The frequency assigned to a broadcast station is called its *carrier frequency*. The transmitter and its antenna are designed and tuned to that specific frequency. As its name implies, the carrier frequency carries the reproduction of the sound originating in the studio. Actually, there are two frequencies that leave the transmitter, a *radio frequency* (carrier) and an *audio frequency* (sound). Audio frequencies are classified as being between 20 and 20,000 cycles per second. The frequency range of most human ears, however, is usually no higher than 15,000 cps.

Q7. A home radio receiver (can, cannot) be tuned to 1 megacycle.

Q8. 900,000 cycles per second (could, could not) be a carrier frequency of a commercial broadcast station.

Q9. The power of Station A is one megawatt. Station B is broadcasting at 500 kilowatts. Which station will transmit the longer distance?

Q10. Two broadcast stations are equally distant from your home. Assuming your receiver is good, what would be the reason you could not receive one of them?

Q11. A human ear (can, cannot) hear a radio frequency.

Q12. A frequency of 600 kilocycles is classified as a(an) (audio, radio) frequency.

Your Answers Should Be:

A7. A home radio receiver *can* be tuned to 1 megacycle. One megacycle (1,000 kc) is within the broadcast band.

A8. 900,000 cycles per second *could* be a carrier frequency of a commercial broadcast station. It is the same as 900 kc.

A9. *Station A*. It has twice as much power.

A10. *One station* is so *weak in power* it cannot transmit the distance.

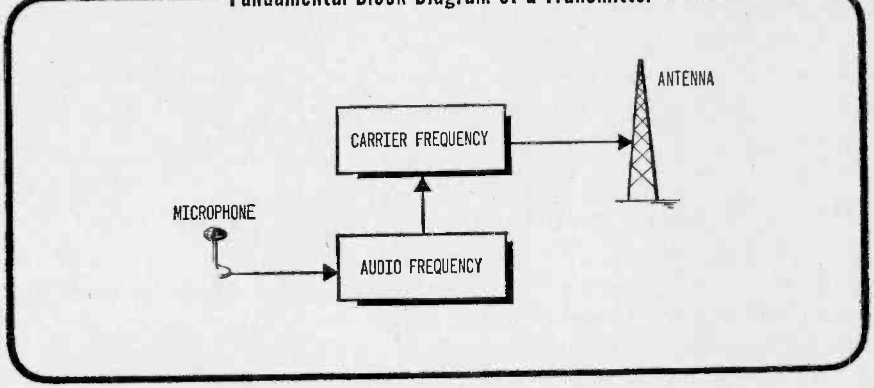
A11. The human ear *cannot* hear a radio frequency.

A12. A frequency of 600 kc is classified as a *radio* frequency.

A Basic Transmitter

The diagram below shows a *functional block diagram* of a typical broadcast transmitter. It is called a functional block diagram because each block is representative of a general electronic function and may include several circuits.

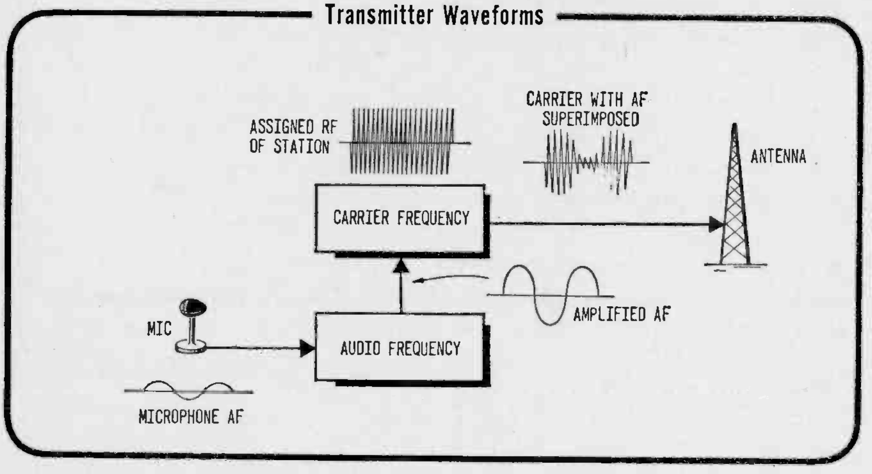
Fundamental Block Diagram of a Transmitter



The arrowheads between blocks show the direction of signal flow. You can probably already read what the diagram reveals.

Sound enters the *microphone* and is fed to the audio-frequency (AF) section. The sound, because it is too weak for transmission purposes, is amplified (signal amplitude is increased) and then passed to the carrier-frequency section.

Carrier Frequency. The specific radio frequency (RF) assigned to the broadcast station is developed in the carrier-frequency block. Passing through several circuits, the RF signal is boosted in power (increased in amplitude) to the rated wattage output of the transmitter. Just before the RF carrier is fed to the antenna, the AF signal is superimposed on it. Waveforms developed in each block are shown below.



Superimposing the Sound. The process of superimposing AF on the carrier, as shown in this particular example, is called *amplitude modulation* (AM). In amplitude modulation the audio frequency (varying at the changing rate of the original sound) is mixed with the carrier (a constant frequency) in a manner that causes that carrier *amplitude* to vary at the same rate as the audio. The carrier *frequency* remains unchanged.

Q13. The drawing on the opposite page is called a(an) ---------- ----- diagram.

Q14. Sound enters the AF section by way of a device called a(an) ----------.

Q15. ---------- on a block diagram show the signal direction between blocks.

Q16. Placing AF on a carrier without changing the carrier frequency is called -------- ---------.

Your Answers Should Be:

A13. The drawing on the opposite page is called a *functional block* diagram.

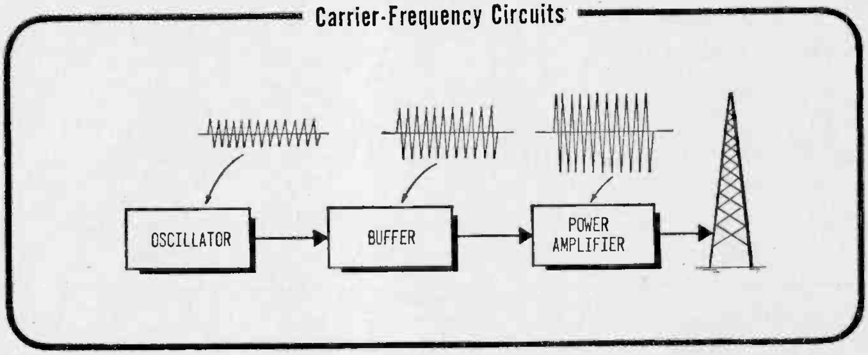
A14. Sound enters the AF section by way of a device called a *microphone.*

A15. *Arrowheads* on a block diagram show the signal direction between blocks.

A16. Placing AF on a carrier without changing the carrier frequency is called *amplitude modulation.*

Carrier-Frequency Circuits

A minimum number of carrier-frequency circuits are shown in the diagram below. An actual broadcast station has many more circuits to attain the frequency stability and power required of its transmitter. The additional circuits are similar to those shown, however.



The Oscillator. The purpose of the *oscillator* is to generate a stable RF signal. The resistance, inductance, and capacitance that make up its input circuit are such that they will not allow the vacuum tube in the oscillator to amplify any other signal but that of the desired frequency. The stable-frequency, low-amplitude output of the oscillator is shown above.

The Buffer. This stage (another name for circuit) is sometimes called an *intermediate power amplifier*, or *frequency multiplier*. In most transmitters it performs three functions. As a *buffer*, the stage isolates the oscillator from the effects of the other circuits. Without this isolation, stray signals may be fed back to the oscillator, causing it to operate at the wrong frequency. As an *amplifier*, the buffer increases the amplitude of the oscillator signal to a level that is between the desired transmitter output and the amplitude of the oscillator signal. In many transmitters the buffer circuit *doubles* (or even *triples*) the frequency of the oscillator output. The oscillator may not be capable of generating the station frequency by itself. In order to produce the assigned frequency, a transmitter may require several multiplier stages.

The Power Amplifier. The purpose of the *power amplifier* is to increase the amplitude of the RF signal to the power (wattage) requirements of the station. Several stages of power amplification may be required to achieve this. Normally, the audio signal from the AF circuitry is fed to the final power amplifier and used to modulate the carrier.

Q17. A transmitter circuit which amplifies a signal and increases its frequency is called a(an) ----------.

Q18. A(an) ----------- generates a signal which has a uniform frequency.

Q19. ----- amplifier output is measured in watts.

Q20. AF and RF are mixed in what stage?

Q21. The carrier arrives at the antenna with its waveform (amplitude, frequency) modulated.

Your Answers Should Be:

A17. A transmitter circuit which amplifies a signal and increases its frequency is called a *multiplier.*

A18. An *oscillator* generates a signal which has a uniform frequency.

A19. *Power* amplifier output is measured in watts.

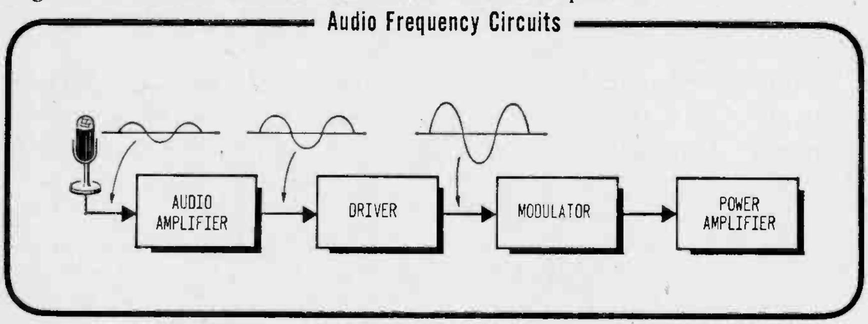
A20. AF and RF are mixed in *the final stage of the power amplifier.*

A21. The carrier arrives at the antenna with its waveform *amplitude* modulated.

Audio-Frequency Circuits

The Microphone. Regardless of the many different types of microphones that are available, even the best develop only a weak signal.

The Audio Amplifier. Although a single stage of audio amplification is sometimes all that is necessary, larger transmitters may have two, three, or more stages to obtain the desired undistorted level of amplitude.



The Driver. Like most circuits, the *driver* obtains its name from its purpose. The driver amplifies the AF to the voltage level required to "drive" the tubes of the modulator. The modulator tubes require large changes in signal amplitude to operate properly.

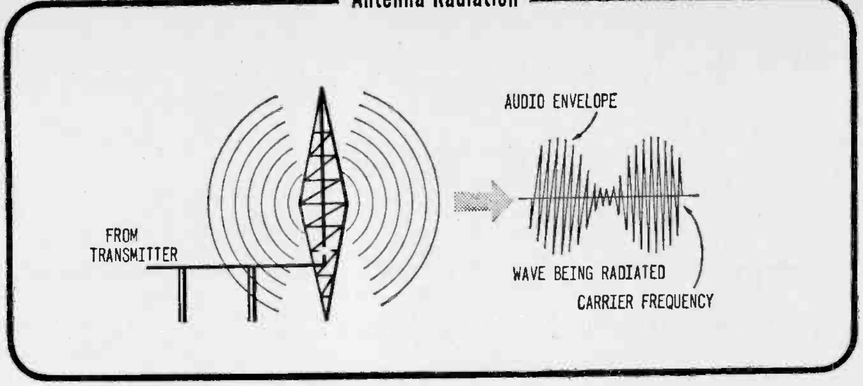
The Modulator. The *modulator* is a power amplifier quite similar to the final circuit of the carrier-frequency block. It amplifies the audio signal to a power level suitable for modulating the carrier power in the final power amplifier. Its power output is roughly half that of the final carrier amplifier.

Antennas

If all circuits are operating properly, an AM (amplitude-modulated) carrier is fed to the antenna and transmitted into the atmosphere.

Power is fed to the antenna in the form of both current and voltage. Voltage sets up an electric field along the length of the antenna. Current, in traveling through the antenna (a conductor), sets up a corresponding magnetic field. Both fields vary at the rate of the carrier frequency and at the amplitude and frequency of its audio envelope.

Antenna Radiation



Both fields expand outward and collapse back to the antenna at the rate of the carrier frequency. The outermost waves continue through space and do not return to the antenna. This action is similar to dropping a pebble in a pool. The energy of the waves moves outward in ever-widening circles; the water, however, remains in place.

Q22. The weak output of a microphone is fed to one or more stages of ----- amplification.

Q23. The output of even the best microphone (can, cannot) be fed directly to the modulator.

Q24. The output of the ---------- is connected to the carrier power amplifier.

Q25. For proper modulation, the output of the modulator stage must be ---- that of the power amplifier.

Q26. Carrier voltage develops a(an) --------- field and carrier current develops a(an) -------- field on the antenna.

Q27. All of the energy in the antenna fields (does, does not) leave the antenna.

Your Answers Should Be:

A22. The weak output of a microphone is fed to one or more stages of *audio* amplification.

A23. The output of even the best microphones *cannot* be fed directly to the modulator. (Even the most powerful microphones develop a signal that is much too weak to drive the modulator.)

A24. The output of the *modulator* is connected to the carrier power amplifier.

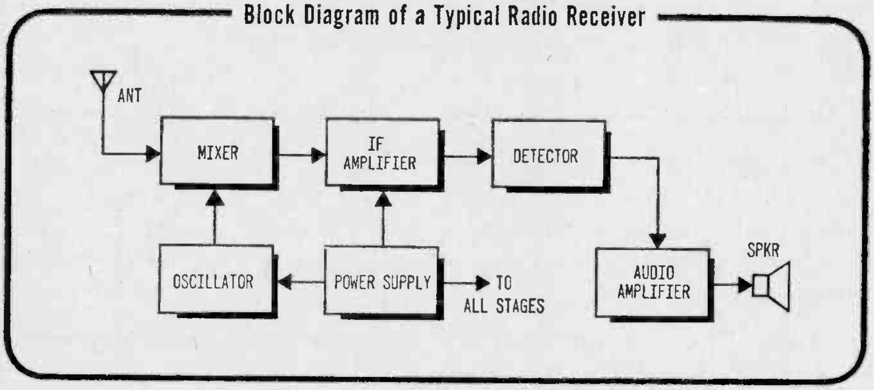
A25. For proper modulation, the output of the modulator stage must be *half* that of the power amplifier.

A26. Carrier voltage develops an *electric* field and carrier current develops a *magnetic* field on the antenna.

A27. All of the energy in the antenna fields *does not* leave the antenna.

A RADIO RECEIVER

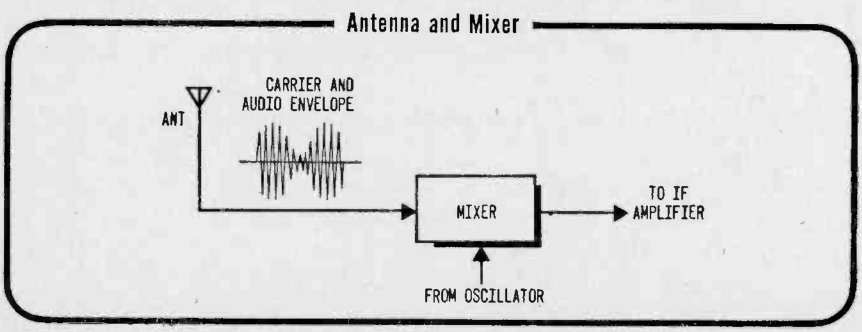
The block diagram for a radio receiver similar to the one in your home is shown below.



The purpose of the radio receiver is to convert the amplitude modulation on the carrier back to its original sound. As the carrier increases in ever-widening circles on leaving the transmitter antenna—like ripples in a pool—its energy decreases in amplitude. The increasing circumference of the circles causes power in the waveform to be distributed over an ever-increasing area. By the time the signal reaches the receiver antenna it is rather weak, usually around a few thousandths or millionths of a volt. The receiver, therefore, must amplify the received signal to a level that will operate the speaker within the hearing range of the human ear. The receiver must also extract the audio component (the *envelope*) from the carrier. The carrier brings the signal to the receiver, but has no value in the reproduction of the audio frequency in the receiver.

RECEIVER CIRCUITS

The Power Supply. Each receiver has a power supply. Its purpose is to convert 115 volts AC from an electrical outlet (or to provide DC if the receiver is battery-operated) to voltages that will operate the receiver properly.



The Antenna and Mixer. Carrier frequencies from all stations within range of a receiver appear on the antenna of the receiver. When you turn the dial of your radio to a specific station, you adjust the electronic components of the *mixer* input so that the receiver will accept a particular carrier frequency and reject all others. The received carrier enters the mixer to be amplified. Some radios have, in addition, an *RF amplifier* between the mixer and antenna.

Q28. What part of the received radio wave does the receiver convert back into original sound?

Q29. A radio wave decreases in power as the circumference of its area increases. What is the approximate amount of voltage that enters the receiver antenna?

Q30. The ----- ------ converts AC to voltages required to operate the receiver circuits.

Q31. A single broadcast frequency appears at the input of the (antenna, mixer).

Your Answers Should Be:

A28. The *amplitude modulation* (or audio envelope).

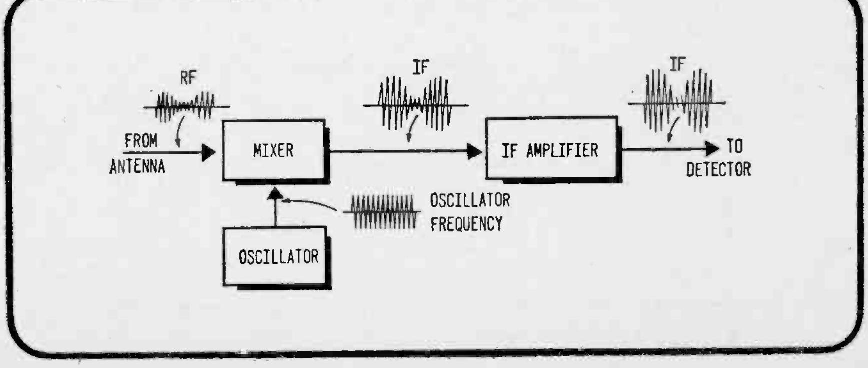
A29. A few *thousandths* or *millionths* of a volt.

A30. The *power supply* converts AC to voltages required to operate the receiver circuits.

A31. A single broadcast frequency appears at the input of the *mixer*.

The Oscillator. The receiver oscillator is similar to its counterpart in the transmitter. Both generate a signal of constant frequency and amplitude. The purpose of the receiver oscillator is slightly different, however. It is designed to generate a frequency that is a constant number of kilocycles above the carrier frequency, regardless of the station to which the receiver is tuned. The tuning dial changes the values of the electronic components in the frequency-generating circuit of the oscillator at the same time it is adjusting the frequency-reception components of the mixer. The arrangement of adjustable components is such that the oscillator will always be tuned 456 kilocycles (or a similar frequency) above the frequency of the carrier being accepted by the mixer. The output of the oscillator is fed to the mixer, as shown in the diagram below.

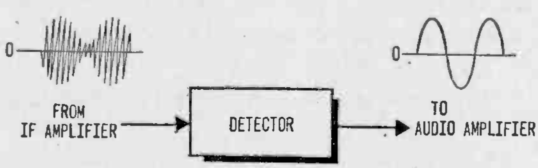
Mixer, Oscillator and IF Amplifier



The Mixer. The carrier and oscillator frequencies combine in the mixer tube and four different frequencies appear at the output. One of these four is the *difference* between the oscillator and the carrier frequencies, and is usually 456 kilocycles. The other three are rejected by the next stage.

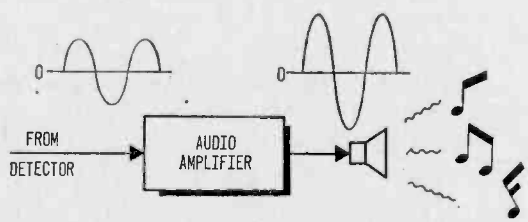
The IF Amplifier. The abbreviation for *intermediate frequency* is IF. In most home receivers the IF is 455 or 456 kc. Amplifying a single frequency in the IF circuit is much easier and causes less distortion than if it were necessary to tune this amplifier to each of the many station frequencies. The only purpose of this stage is to amplify the IF (which still retains the original audio frequency) and pass it on to the detector.

The Detector Function



The Detector. The purpose of the *detector* is to extract the audio component from the IF waveform. The audio envelope is the same (although reversed) at the top of the waveform as it is at the bottom. The detector circuit is so designed that it accepts only the audio frequency at the top and rejects the IF frequency in the waveform.

Audio Amplifier and Loudspeaker Functions



The Audio Amplifier. The final circuit in the receiver amplifies the AF fed to it by the detector. The amount of amplification can be varied by the volume-control knob on the front of the receiver. The output of the audio amplifier is applied to the speaker voice coil, causing the speaker cone to reproduce the sound that originated at the studio.

Q32. The -------- removes the AF from the IF waveform.

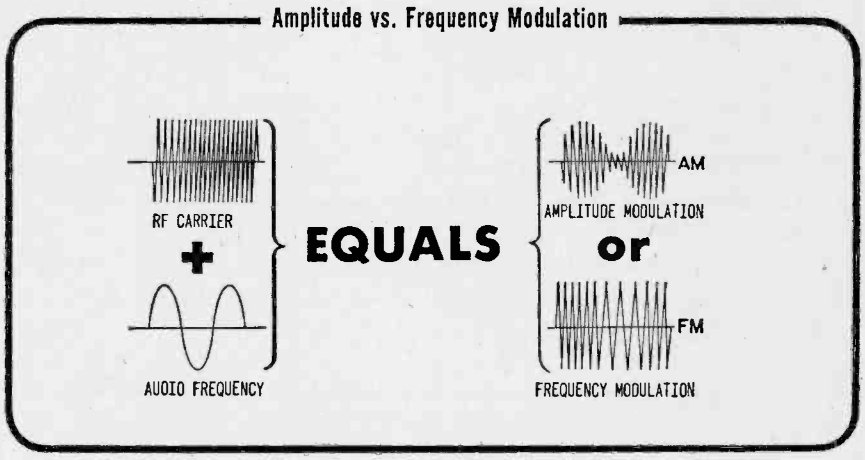
Q33. The oscillator develops a signal at a constant ---------- and ----------.

Q34. The detector extracts the (audio, RF) component from the IF signal.

Your Answers Should Be:
A32. The *detector* removes the AF from the IF waveform.
A33. The oscillator develops a signal at a constant *amplitude* and *frequency*.
A34. A detector extracts the *audio* component from the IF signal.

FREQUENCY MODULATION

The transmitter and receiver with which you have just become familiar employs amplitude modulation (AM) to carry the audio. Another method of superimposing audio on a carrier is called *frequency modulation* (FM). Its process is quite different. The two are compared below.

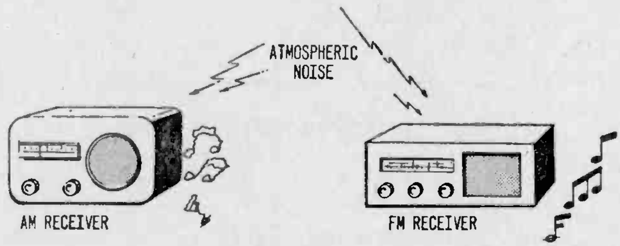


Both AM and FM start out with a carrier frequency and an audio frequency (sound originating in the studio). In amplitude modulation, as you already know, the sound is superimposed on the carrier frequency (which is constant) by varying the carrier *amplitude* in conformance with the voltage and frequency of the audio.

In FM, however, the audio is mixed with the RF in such a way that the carrier *frequency* is varied in accordance with the amplitude of the sound. As the audio cycle goes positive, carrier frequency increases. When the audio cycle goes negative, carrier frequency decreases. The sum of the two changed frequencies in one audio cycle is still equal to the original carrier frequency.

One of the advantages of frequency modulation is its freedom from distortion. Noise and other forms of distorting voltages in the atmosphere or receiver are added to amplitude modulation. Since FM does not depend on a changing amplitude to carry audio, noise has little or no effect on it. This is part of the reason for the clarity of sound that you get from an FM receiver.

Atmospheric Noise and Its Effects—If Any



Q35. In AM, the carrier ---------- changes to match the audio.

Q36. In FM, the carrier ---------- changes to match the audio.

Q37. An FM receiver is (more, less) subject to atmospheric noise than an AM receiver.

Your Answers Should Be:

A35. In AM, the carrier *amplitude* changes to match the audio.

A36. In FM, the carrier *frequency* changes to match the audio.

A37. An FM receiver is *less* subject to atmospheric noise than an AM receiver.

WHAT YOU HAVE LEARNED

1. Radiant energy is given off by electromagnetic waves. The electromagnetic spectrum includes cosmic rays, X rays, visible and invisible light, infrared, radar, as well as radio waves.
2. A radio transmitter is a device that produces electromagnetic waves in the radio portion of the spectrum. Its essential functions are the development and amplification of a carrier frequency and modulating it with an amplified audio frequency. A specific carrier frequency is assigned to each radio station. The distance that the carrier, with its superimposed audio, travels is determined by the power that is developed in the final stage of the transmitter.
3. Energy in the form of voltage and current is fed from the transmitter to an antenna. This sets up electric and magnetic fields around the antenna that expand and collapse at the frequency of the carrier. Part

of the energy is in the form of electromagnetic radiations and is transmitted through the atmosphere. The farther it travels, the weaker the signal becomes.

4. All carrier signals within range are picked up by the receiver antenna. The tuning control on the front of the receiver adjusts the input of the mixer so that only the desired station carrier frequency is received. At the same time, it adjusts an oscillator to generate an IF above the carrier frequency. Carrier and oscillator frequencies are joined in the mixer and the difference between the two, the intermediate frequency, is amplified and fed to the IF amplifier. Here the signal and its audio component are further amplified. The next stage (detector) extracts the audio component and passes it to the final stage (audio amplifier). The audio is amplified and fed to the speaker, causing the cone to reproduce the sound that originated at the studio.
5. Amplitude (AM) and frequency (FM) modulation are two methods of transmitting audio on a carrier. When AM is used the amplitude of the carrier varies according to the loudness (amplitude) and frequency of the audio. In FM, the frequency of the carrier is varied instead of the amplitude. FM transmissions are less bothered by atmospheric and receiver noises.

NEXT ISSUE: PART IX

Understanding Television Transmitters and Receivers

This series is based on material appearing in Vol. 1 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.

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Many readers have written letters requesting information on our Elementary Electronics Basic Course—what has been published and what will be published. The table below lists the parts of the Basic Course and the issues they have appeared or will appear in. If you missed any part and wish to obtain an issue of Elementary Electronics that contains it, send $1.00 for each issue to Back Issue Dept., Elementary Electronics, 229 Park Ave. So., New York, N.Y. 10003. Be sure to tell us exactly which issue(s) you want and include your name and address.

Issue	Part	Title
Mar./Apr. 1968	I	Basic Electrical Circuits
May/June 1968	II	Understanding Resistors
July/Aug. 1968	III	Understanding Capacitors
Sept./Oct. 1968	IV	Understanding Transformers
Nov./Dec. 1968	V	Understanding Vacuum Tubes
Jan./Feb. 1969	VI	Understanding Basic Circuit Actions
Mar./Apr. 1969	VII	Understanding Transistors
May/June 1969	VIII*	Understanding Radio Transmitters & Receivers
July/Aug. 1969	IX**	Understanding TV Transmitters & Receivers

* In this issue. ** Available at newsstands on May 22, 1969.

UNIMETRICS OMNIBAND III VHF/AM/FM Portable AC/DC Radio

Radio entertainment is not limited to just the AM, FM and BCSW frequencies. You'll find two public service VHF bands, the low one at 30 to 50 MHz and the high at 147 to 174 MHz, provide some of the most exciting listening to be found in the radio spectrum. To name just a few: fire, police and emergency services; radio-TV news reporters calling in their stories and the continuous regional weather reports of the U.S. Weather Bureau, which are not only up to the minute but which can be a lifesaver to a boat owner.

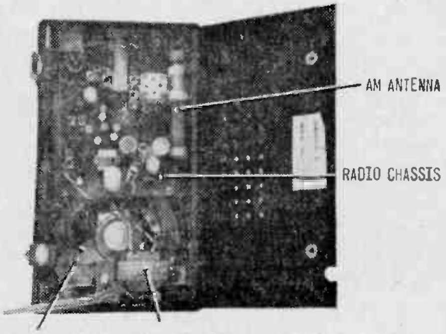
We Took the High Road. The Unimetrics Omniband radios all designed to provide portable or fixed monitoring of the public service bands as well as the standard AM and FM broadcast frequencies. They are available in two models, one tuning AM, FM and the low-band VHF (30-50 MHz), the other tuning AM, FM and the high-band VHF (147-174 MHz). Since high-band listening is more popular, because of the regional weather reports, we chose to test the high-band model.

The Unimetrics Omniband III high-band VHF radio uses twelve transistors and is powered either by four internal C batteries or a built-in 117-VAC power supply. A switch under the battery cover selects the AC or DC mode of operation. A three-stage IF amplifier feeding a standard diode detector is used for AM reception. While the same three IF amplifiers do double duty as the FM/VHF IF amplifiers, the VHF selector switch cuts in a fourth IF amplifier and a ratio detector for the FM and VHF reception. Since the ratio detector is in itself "inter-station noise immune" to a large degree, no squelch is provided. Under normal conditions only a faint background noise is heard between FM and VHF stations. Separate local oscillators are provided for the AM, FM and VHF bands. A built-in ferrite antenna is provided for AM reception, with a telescopic whip for FM and VHF. An antenna jack provides for connection of an external FM or VHF antenna.

The audio amplifier feeds a 3½" speaker. A supplied earphone can be plugged into the unit automatically disconnecting the speaker.

Performance. The Unimetrics Omniband III, compared to other combination VHF receivers in its price range, proved to be a "hot" performer. As an AM radio it is extremely sensitive, pulling in stations just above the noise level which could barely be heard on AM radios priced to $50. FM performance was equally good. Since a sensitivity measurement is really valueless on a portable radio, we again compared the Omniband III's performance against competitive FM radios. The Omniband proved about as sensitive as the best of FM portable

(Continued on page 110)



Good quality sound is delivered by the relatively large 3½" speaker. All critical tuned circuits on the chassis are secured to the chassis by a "blob" of wax. Severe jolts will not detune the set's high frequency circuits.

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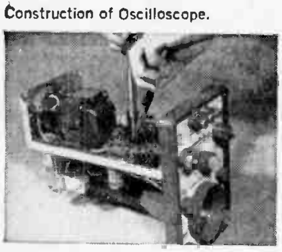

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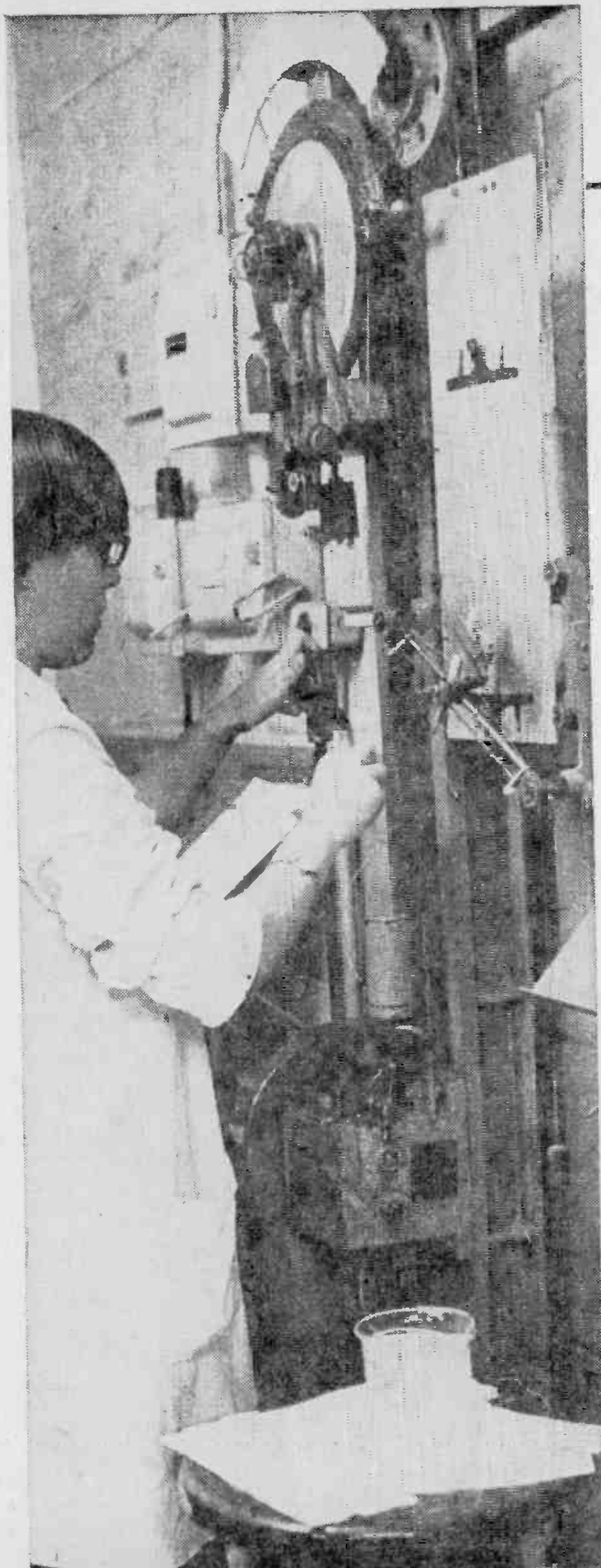


Proof of the Pudding is in the Testing!

There's nothing particularly fishy about testing resiliency of sturdy fishing line at U.S. Testing Co. Girl winds strands around pulley, checks gauge for data.

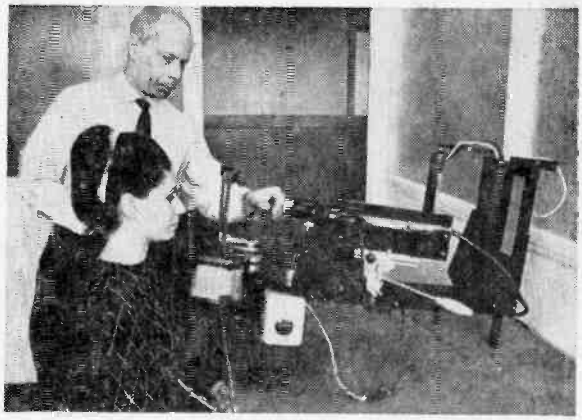
There's a time-honored saying that a little knowledge may be dangerous. But when it comes to consumer products, a little ignorance can be cause for the panic button. If something you buy is chewed by the baby and proves toxic, he's in for trouble. If a raincoat isn't really waterproof, you may end up drenched. And if a food product said to be preserved has actually spoiled, indigestion may be the best (the least?) you can hope for.

For the sake of safeguarding consumers, therefore, the proof of the pudding is in the testing. And at the Hoboken, N.J., headquarters of the U.S. Testing Co., Inc., a team of researchers conducts no end of experiments in hopes of catching flaws in all sorts of products.

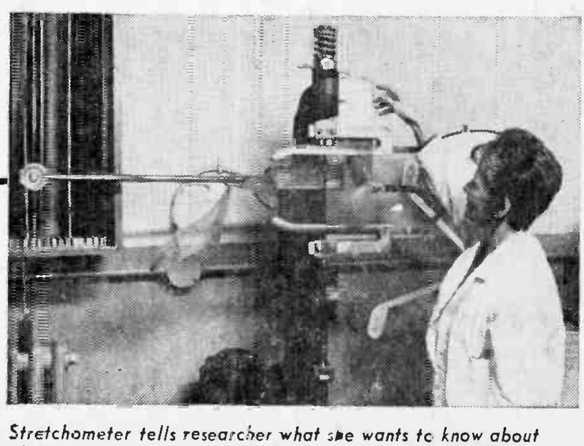
Testing takes many forms, and equipment for the tests varies greatly. One device, for example, called the FadeOmeter, subjects material to simulated sunlight. It consists of a carbon arc burning inside a glass globe that acts as a filter to correct the available spectrum. The materials being exposed are mounted in a rack revolving around the arc. Main function of the apparatus: to determine the material's resistance to color fading on exposure to sunlight.

(Continued overleaf)

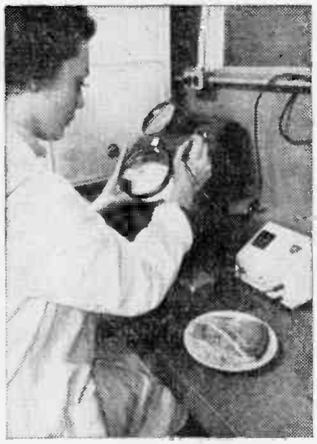
FadeOmeter test at U.S. Testing Co. creates simulated sunlight to test fabrics for fading. Here, draperies reveal sunfastness.



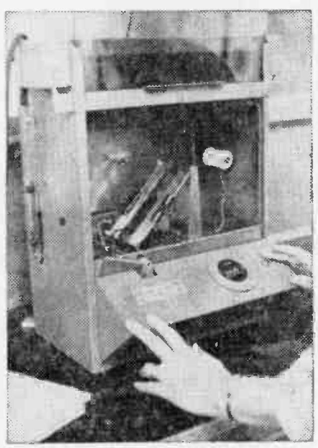
Pupillometer tester records changes in diameter of subject's pupils, is used to improve teaching methods, study eye disorders.



Stretchometer tells researcher what she wants to know about elasticity of sheer nylon stocking before it goes on lady's leg.



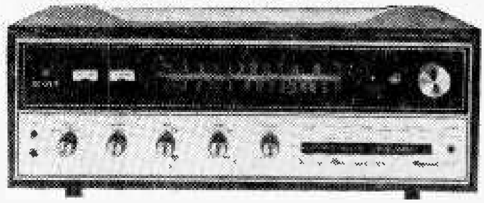
Left, food preservation is important to many a supermarket. This special apparatus reveals rate of apple pie's bacterial growth. Right, lab technician heats test tubes containing variety of cultures, checks them for bacterial growth over 24-hr. period.



Flammability tester (left) subjects wearing apparel for combustibility. Electrical micro-burner, fed by pure butane, caughs up answer within one second. Right, researcher braces to use eye-movement camera. Device discloses what driver, pilots actually look at on job.

From FadeOmeter to pupillometer, the course of consumer product testing goes in one direction—progress. After all, no manufacturer can afford to rest on his old laurels while his competitors continue to improve and perfect a safer, more convenient, and superior product. Quietly working behind the scenes, the scientists at U.S. Testing help make the world a safer place to live in. —*C. Hansen* ■

H.H. SCOTT MODEL LR-88
AM/FM/FM-Stereo
Solid-State Receiver Kit



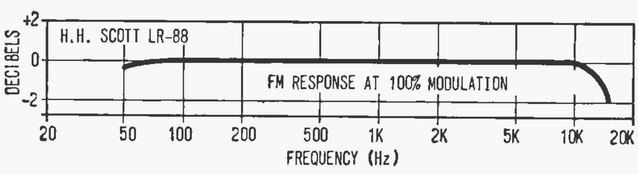
If you've had the itch to build a really top quality stereo receiver kit but have been scared off by thoughts of "acres" of PC boards, and bags and bags of parts, the Scott LR-88 FM Stereo Receiver kit is for *you.* Using Scott's by now familiar preassembled PC boards and color-matched pictorials, the LR-88 comes out as almost a *beginner's* kit.

Featurewise. The LR-88 is loaded! You name it and the LR-88 can do it. On the input side is AM, FM, Phono (with switch-selected *High* and *Low* level sensitivity), Mic. (with *L* and *R* mike inputs on the front panel), Extra (auxiliary), and Tape. More than enough outputs are provided. The main-liners are: front panel stereo phone jack, main stereo speakers, remote stereo speakers, mono remote with stereo main speakers (which can be used as a center channel fill), and tape recorder. As extras there are auxiliary high-level outputs which can be used to drive remote power amplifiers or additional tape recorders if you want the LR-88's tone and compensation controls to affect the tape recorder feed. A switched and an unswitched AC outlet are provided.

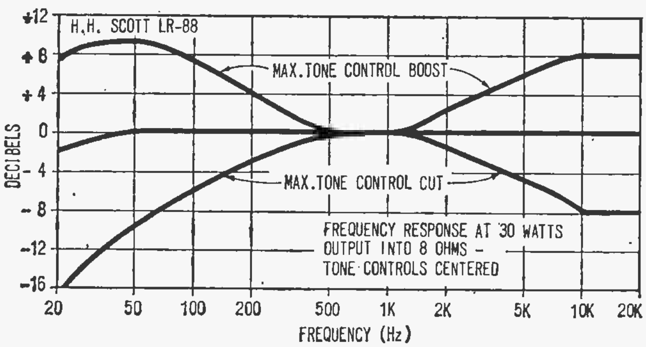
Front panel controls include: *Input, Balance,* dual concentric *Bass,* dual concentric *Treble,* and *Loudness.* Front panel switches include: *Volume Comp.* (ensation) on-off, *Tape* monitor, stereo-mono *Mode* (for complete amplifier), *Noise Filter, FM Muting, Remote Speakers* on-off, and *Main Speakers* on-off. A switch on the back panel provides for remote speakers only and mono/stereo selection.

Extra features include both a Signal Strength and a Center Tuning meter, an FM stereo light and FM control by the amplifier mono-stereo mode switch. When the switch is set to mono both the amplifier and the FM are switched to mono operation. The FM receives stereo (automatically) only when the Mode switch is set to stereo.

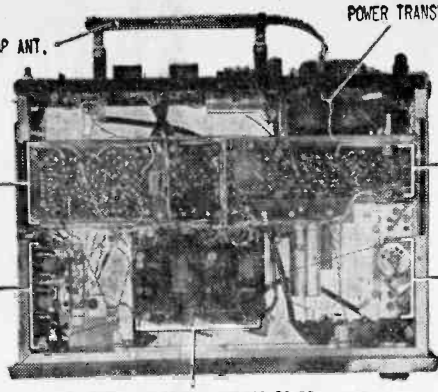
Circuit design is up-to-date and has all the user-desired elements hi-fi buffs want. The front end input is FET (field-effect transistor) for prevention of strong signal overload. The IF strip is all IC (integrated circuits). Four IF stages are used for FM, with two



Flat as a board—that's what can be said for LR-88's response at 100% modulation. ±1 dB performance is considered excellent.



With tone controls centered, amplifier section of LR-88 can knock out solid 30 watts with less than 0.5% THD. That's great when you consider that both channels are driven simultaneously, putting maximum drain on unit's power supply. Tone controls offer modest boost and cut—enough for two equally matched speaker systems.



Open-frame construction of LR-88 provides ultimate in heat dissipation. IF and MX boards are almost fully shielded by cross-bar, and virtually every circuit is separate module. Notice that wiring harness is far from usual "rat's nest" frequently found in kits that are not carefully engineered.

serving double purpose for AM, too! All circuits are modular—each circuit from IF amplifier to AF output to FM muting has its own individual circuit board.

The chassis itself serves as a hollow frame for the critical circuits which also provide extensive inter-circuit shielding. The arrangement also provides more ventilation than will ever be needed by solid-state circuitry. We would guess that the LR-88 will never go out of alignment or drift due to component value changes caused by heat.

Building the Kit. While the LR-88 is jam-packed with parts, most of the boring and critical wiring and assembly was done at the factory. Essentially, the kit builder assembles the frame, power supply and miscellaneous hardware. Wiring involves only the power supply, jacks and switches and PC board interconnections.

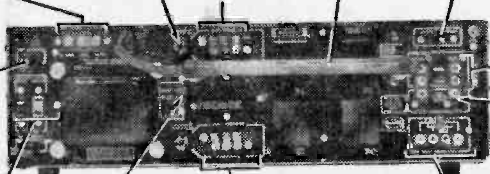
The pictorials are excellent, almost full scale and fragmented so the user always works and "reads" a small independent section at a time. All pictorial wiring is shown in exact matching colors to the actual wires. Another feature is that all wires from a harness are different; no two are alike. When similar circuit wires use identical color coding (for ease of troubleshooting) the two leads will be markedly different physically: one will be thin; the other will be thick.

Finally the kit is supplied with a large selection of cable ties. When the wiring is tied down after completion of the kit, the LR-88 in no way looks home-brewed. In fact, it's more akin to the appearance of laboratory-grade equipment, factory-made.

Performance. As with all Scott high-fidelity equipment, the specifications are limited to the audio or broadcast range. Scott does not go in for measurements meaningful only to dogs and birds. As example, the amplifier response specification is from 20 to 20,000 Hz, and the FM response is from 50 to 15,000 Hz (the limits of the FCC FM proof-of-performance measurements for FM stations). To keep in the same spirit, our measurements were made within the range of Scott's specifications.

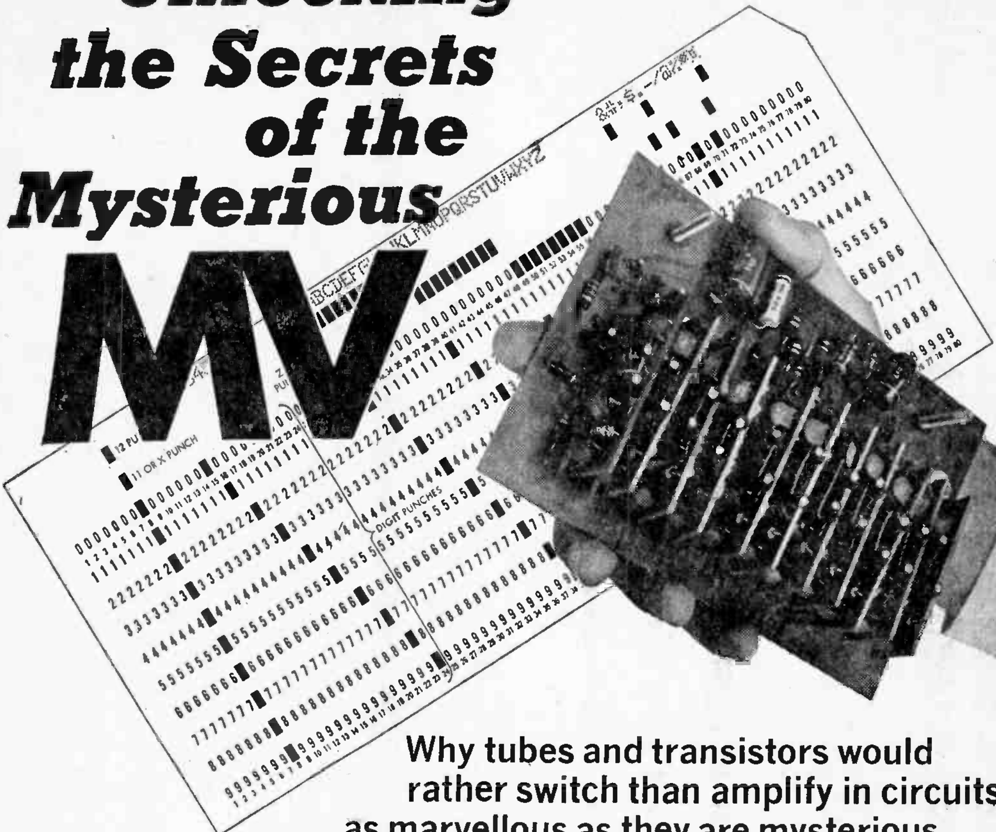
Our LR-88's IHF sensitivity checked out at 1.5 μV, much better than Scott's rating of 2.5 μV. Full noise suppression (optimum signal to noise ratio) of 65 dB was obtained with a 20 μV input *(exactly on specs)*. Mono THD at 100% modulation of the FM carrier was 0.58%, stereo THD measured 0.78% *(both extremely good)*. The FM frequency response was within the ± 2 dB specification from 50 to 15,000 Hz.

(Continued on page 103)



Back of LR-88 is designed to permit easy and unerring connection of (both main and remote) and auxiliary equipment. Unique remote speaker monostereo switch permits simultaneous/mono operation of remote speakers while main speakers are fed stereo programming. This feature permits remote speakers to be used as center channel fill to kill ping-pong effect.

Unlocking the Secrets of the Mysterious MV



Why tubes and transistors would rather switch than amplify in circuits as marvellous as they are mysterious

By Jim Kyle, K5JKX

Television couldn't get along without them. Neither could radar or digital computers. Electronic organs and pianos are packed with them. The mysterious multivibrator, the man-made device that can change its mind faster than a woman, appears in nearly every major electronic device—but few electronics hobbyists really know how it works.

According to one authority, a multivibrator (MV for short) is "a relaxation type of oscillator consisting essentially of a resistance-coupled amplifier in which part of the output is fed back to the input circuit." Even if the double-talk doesn't throw you astray, there's only one thing wrong with that explanation—the MV isn't an amplifier!

In fact, other authorities acknowledge this when they admit that exact analysis of multivibrator action by use of the standard amplifier formulas is well-high impossible.

Sound like a formidable circuit? Relax—it's actually not difficult at all, when you look at it from the right point of view. And once you understand the mysterious MV, you can undoubtedly find dozens of ways to use it in your own circuits and projects, for it's one of the most applied circuits around.

What It Isn't, and What It Is! Granted, the typical multivibrator circuit (see Fig. 1) looks for all the world like a two-stage RC amplifier with the output returned to the input. This resemblance led a whole generation of engineers astray, because when the MV first made its appearance nobody expected a vacuum tube to do anything but amplify.

But the MV isn't an amplifier at all. The tubes, transistors, or other active elements (what others are there? Stick around!)

e/e MYSTERIOUS MV

aren't acting as amplifiers in this circuit. Instead of amplifying, they're acting as electrically-controlled *switches*. Relays, if you will. In fact, relays themselves *can* be used as active elements in a MV and the theory becomes much easier to analyze when this is done.

What makes the difference between "amplifier" and "relay" is simply the "operating point" of the tube or transistor. Fig. 2 shows a typical set of characteristic curves for a triode tube; when this tube is amplifying, the resistance values in the circuit (which control grid bias and plate voltage swing) are chosen so that in the absence of a signal, the tube operates at point "O".

When used as a switch, however, the load resistance, grid bias, and input signal levels are all changed; the tube then operates at one of two points, "P" and "Q". When the input signal is present, the tube operates at "P", and when the input is absent, the tube operates at "Q". Now mind your "P"s and "Q"s.

Other than Tubes. Transistors, incidentally, are superior to tubes in MV circuits provided that they are able to handle the voltages involved. The collector of an "off" transistor (point Q) is usually within a few tenths of a volt of the supply voltage level, and when the transistor turns "on" (point P) this voltage drops to well under 1/10 volt. With a tube, on the other hand, the "off" voltage may be appreciably lower than the supply voltage, while the "on" voltage is seldom lower than 15 to 25 volts.

At slow operating speeds, relays are superior to transistors for the same reasons; they are better switches. Relays, however, can only operate a few times each second. Transistors can operate reliably a million times a second, and tubes can go up to several million times a second if need be.

The Relay MV. If we substitute a pair of s.p.d.t. relays for the two triodes shown in Fig. 1, the circuit looks like Fig. 3—and the action of this MV becomes much easier to analyze.

Until power is applied, both relays are de-energized; this is the condition in which the circuit is drawn. When power is applied, both capacitors begin to charge. C1 charges

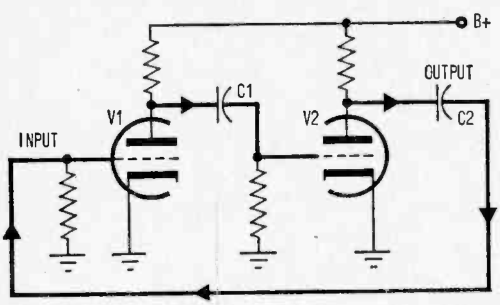


Fig. 1. Typical multivibrator circuit resembles a resistance-coupled amplifier. Circuit actually is a pair of switches which alternate from "on" to "off" and back again, timed by charging current of the two capacitors, C1 and C2. Heavy lines and arrows indicate direction of signal flow.

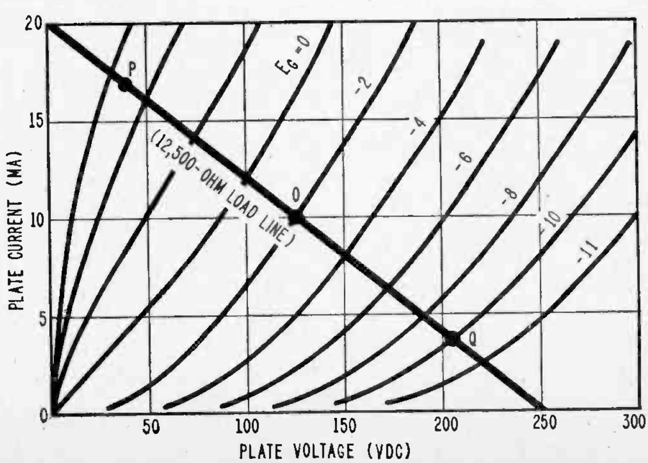


Fig. 2. Typical vacuum-tube triode characteristic curves. Load line connecting 250-volt point on horizontal scale and 20 mA point on vertical scale represents 12,500-ohm load resistor. Triode normally operates at O and swings short distances either side of this point with signal. When switching as in an MV circuit, however, operating points are P (on) and Q (off). Transition from P to Q or back occurs in fractions of a millisecond.

through the upper contact of K1, while C2 charges through the corresponding contact of K2. Current will flow through the coils of K1 and K2.

One of the two relays will operate at least a little bit faster than the other as the charging currents of the capacitors flow through the coils. The first relay to energize (let's assume that K1 pulls in first) interrupts the power to capacitor C1. This disconnects power from K2's coil. So long as C2 is charging, current will flow through K1, holding the relay in the energized state.

When C2 is fully charged, the charging current stops. No more current is flowing through the coil of K1, so this relay drops out or deenergizes. When K1 drops out, it re-connects C1 to the power source. C1 begins charging, which draws current through the coil of K2 and thus energizes K2. When K2 energizes, C2 is disconnected from its power source and begins to discharge through the short circuit connected across it by the bottom contact of relay K2.

When C1 completes its charging, current flow through the coil of K2 stops, which permits K2 to drop out. By this time C2 has discharged, and as soon as K2 drops out C2 begins to recharge. This action draws current through the coil of K1 and starts the cycle all over again. It will continue so long as power is applied; first one relay, then the other, will pull in.

Now Do It with Tubes. In the tube circuit, Fig. 1, the action is almost identical. When power is first applied, both capacitors begin to charge through the plate and grid resistors. This action reduces plate voltage of both tubes, and drives both grids in the negative direction. One of the two tubes, as well, will draw slightly more current than

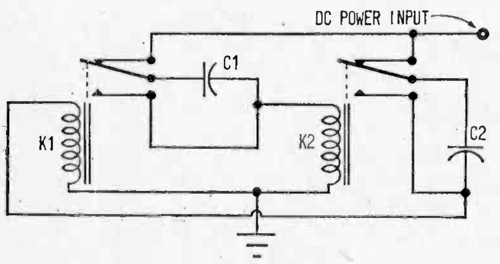


Fig. 3. This circuit is equivalent to that shown in Fig. 1; here vacuum tubes are replaced by relays as the switching devices. Leads connected from the bottom contacts of K1 and K2 to the capacitors permit the capacitors to discharge when power is removed by switching action. See text for details of circuit operation.

the other; plate voltage of this tube will drop more rapidly, which drives the grid of the *other* tube more negative because of charging current through the coupling capacitors. Within a few fractions of a microsecond one tube is fully "on" and the other is fully "off." Current flow continues through the capacitor from "off" plate to "on" grid, but not through the other capacitor. This current flow makes the "off" grid less negative, tending to turn it "on." The resulting decrease in plate voltage at the "off" plate causes a reverse current flow through its capacitor which turns the "on" grid "off." This, in turn, helps the original current flow which is turning the "off" grid "on." The two processes together flip the circuit over so that the tube originally "off" turns "on," and vice versa. As soon as the transition is complete, however, both processes begin again—and continue so long as power is applied.

Thus, whether tubes, transistors, or relays are used as active elements, the MV behaves in the same manner. The secret to its action is the operation of one switch as a result of a second switch's operation, and operation of the second as a result of the first. *Any* circuit which fits this description is a MV, regardless of its active elements or its timing devices.

Types of Multivibrators. Actually, multivibrators can be (and usually are) divided into *three* distinct classes. The only type we've looked at so far is the "astable" multivibrator. It gets that name because it has *no* stable condition. No matter what point of its operating cycle it may be in at any instant, it's merely on its way to some place else. There is no stationary resting place. Other names for the astable MV are "relaxation oscillator" (although not all relaxation oscillators are MVs), "free-running MV," "synchronized divider," and "frequency divider."

The other two classes each have at least one stable state. In fact, that's the distinction between them. One, the "monostable" multivibrator, has only *one* stable state. The other, the "bistable" multivibrator, has *two* stable states.

The monostable MV is frequently called a "one-shot" multivibrator. It normally stays in its stable state. When triggered, it switches to the unstable state, and after a period of time determined by the design, switches itself back to the stable state. It thus produces a single output pulse.

The bistable multivibrator is sometimes

known as an "Eccles-Jordan" multivibrator, for the persons who first developed it. The most common name in the U.S. for this circuit, however, is "flip-flop," and under this name the circuit is widely known in the computer industry.

Before we examine the means by which the three types of MVs operate, and the method for converting one type into another by a simple change of one or two components, let's work out a generalized approach so that the discussions will apply to all kinds of MVs, rather than being limited to relay versions, or vacuum-tube versions, or transistor circuits.

That Sounds Logical. We've already seen how any type of electrically-actuated switch can be used as the active element in a MV. Besides vacuum tubes, transistors, and relays, we can use SCRs or even neon glow lamps for the switches. Since the active element can be any of these devices without affecting basic operating theory (although speed, power, and many operating characteristics *will* be affected), let's choose a single symbol to represent *any* kind of active element, and use it in all discussions.

The triangle symbol shown in Fig. 4A is used in industrial electronics to represent both amplifiers and switching circuits; it is used in the computor industry to indicate "buffer" or "driver" circuits. Adding the small bubble at the point of the triangle makes it an "inverter," with an output signal always the opposite of the input. If input voltage is high, output voltage is low, and vice versa. This is the characteristic needed for our active elements, so let's use this symbol. Figs. 4B, C and D also show some typical vacuum-tube, transistor and relay circuits which may be represented by the symbol in A, and used in any of our circuits.

The MV operates in real time; most study of electronics circuits assume that time is standing still while we look at the circuit, but the whole basis of the MV is the way in which signals change as time passes. For this reason, each of our MV generalized schematics must contain a "timing diagram" which shows how signals change with time. Fig. 5 is a typical timing diagram for the charging of a capacitor.

The Astable Multivibrator. Fig. 6 shows both the generalized circuit and the timing diagram for the astable multivibrator; this is the type of multivibrator which we have examined in Figs. 1 and 3, so this description will be abbreviated.

Let's start our examination at the instant that point 1, the input to the left-hand active device, reaches its "low" point and permits the output of this device to swing high. This is shown as line 2 on the timing diagram. When point 2 swings high, a high charging current flows through the timing capacitor between points 2 and 3, but as the capacitor charges the current flow drops off to zero. This current develops a voltage across the resistor from point 3 to ground, producing the voltage level shown as line 3. So long as this voltage is above its "low" point, the output of the second device (point 4) is held low, but when point 3 reaches its "low" level, the voltage at point 4 swings high.

When point 4 swings high, the same things happen between points 4 and 1 that we have just examined between points 2 and 3. Point 2 is now held low until the voltage at point 1 again reaches its low point. When it does, one full

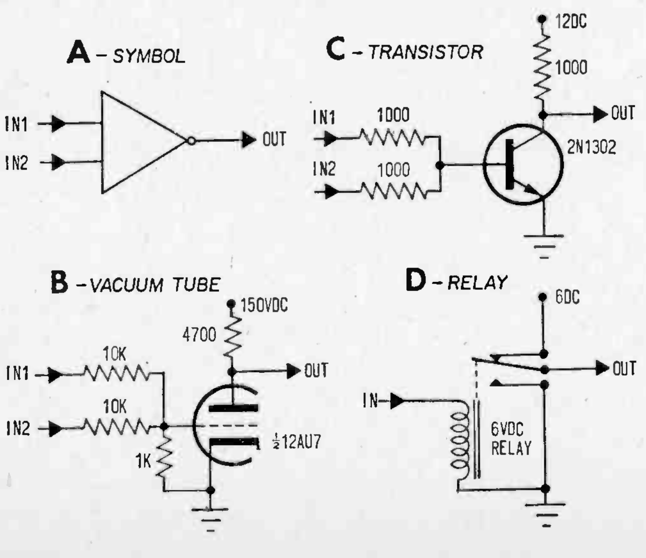


Fig. 4. Any of circuits in B, C, or D can be used to replace the generalized switching-device symbol shown in A. In the following figures only the generalized symbol is used. Be sure you understand what it signifies before you proceed from this point.

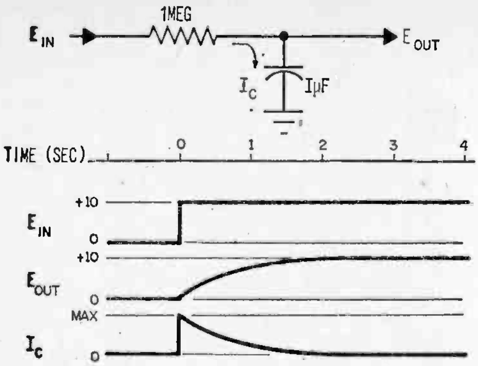


Fig. 5. Here is a typical MV timing diagram which illustrates the voltage and current relationships during the charging of a capacitor from the time voltage is first applied until the capacitor reaches nearly full charge. The timing diagrams in Fig. 6 through 12 all make use of the curves shown here, but for simplicity the true curve is replaced by a straight line.

cycle has been completed and the process begins again. It continues so long as power is applied to the circuit.

If vacuum tubes or transistors are used as the active elements, the resistors shown in the general circuit may be omitted since they already exist in the active-element detail circuit (Fig. 4).

Fig. 6 shows that the length of time during which point 4 is low depends upon the time it takes the capacitor between 2 and 3 to charge, while the length of time that point 2 is low is determined by the charge time of the capacitor between points 1 and 4. Although the timing diagram indicates that the two times are equal, they need not necessarily be the same. If a small capacitor is used at one point and a large one at the other, a "lop-sided" output can easily be obtained from this circuit.

Actual timing depends not only upon capacitor charging time, but upon the voltage levels at which the active devices switch from low to high output. The capacitor charge time itself depends upon three things: the size of the capacitor in microfarads (the larger, the slower), the charging voltage available (the higher, the faster), and the resistance between capacitor and voltage source (the plate or collector load resistance, in series with the base or grid resistor; the less resistance, the faster the charge). Exact times for any specific circuit are normally determined by experimenting; the starting values are determined by RC time constant of total resistance times voltage. The resulting time is in seconds if resistance is in megohms and capacitance in microfarads.

The Monostable Multivibrator. The characteristic which distinguishes the monostable multivibrator is that it has *one* stable, and *one* unstable, state. The astable, on the other hand, has *two* states, both of which are *unstable*. Fig. 7 shows a generalized circuit and a timing diagram for the monostable variety.

Comparing Fig. 7 to Fig. 6 shows that the only difference between the general *a*stable circuit and the general *mono*stable circuit is the removal of the coupling capacitor between points 2 and 3 (Fig. 6) and replacing it by a short circuit.

The engineers describe this difference by saying that the astable circuit has only AC coupling, while the monostable has one AC coupling and one DC coupling.

The timing diagrams show how this one-component change makes a major difference in circuit operation. Let's assume that the circuit has been left alone for an indefinite time, with power applied. The lone coupling capacitor has long since been fully charged and therefore the voltage at point 2 is zero. Since point 1 is also zero, the left-hand active device has no high input. This makes its output, point 3, high. The high level at point 3 holds point 4 low. Point 4 being low has removed all voltage from the capacitor and so any charge it may have had has been drained off.

When we apply a brief pulse to point 1, the picture changes. When the pulse hits point 1, it causes point 3 to go to low level

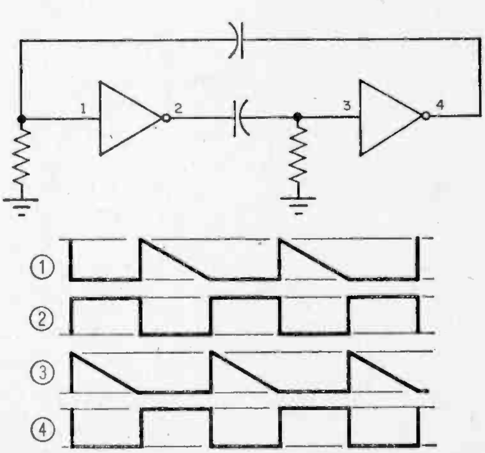


Fig. 6. Generalized schematic and timing diagrams of the astable multivibrator.

—at least for the duration of the pulse. Point 3 going to low level brings point 4 to high level, and starts the capacitor charging current flowing. This charging current flows through the resistor from point 2 to ground, producing a high level at point 2 for the charging time of the capacitor. This high level at point 2 holds point 3 low, even after the original "trigger" pulse is gone, until the capacitor is fully charged.

When the capacitor reaches full charge, current flow through the resistor stops and point 2 is again low. At this time, since the trigger pulse is long gone, point 3 returns to its high level. Point 3 going high forces point 4 low, and the capacitor discharges. The resistor from point 2 to ground is not in the discharge circuit, so the capacitor discharges rapidly. As soon as the capacitor is discharged, the circuit is ready to accept another trigger. Until the next trigger arrives, however, point 4 will remain low and point 3 high.

The major characteristic of the monostable MV, then, is that it produces a single output pulse when it is triggered. The duration of this output pulse is determined by the design of the MV, and is not affected by the nature of the trigger pulse.

The Bistable Multivibrator. The bistable MV is distinguished from its cousins by having *two* stable states, compared to *one* for the monostable and *none* for the astable.

If you expect to find that the other coupling capacitor is taken out to make a bistable out of a monostable, you're ready to go to the head of the class—for that's exactly how it's done. Fig. 8 shows the general circuit and timing diagram.

With no timing capacitors, this circuit does no timing at all. It serves a different function—it is a "memory" circuit which remembers which of its two inputs was last triggered, and will hold that information so long as power is applied. Hence, its name flip-flop.

The timing diagram in Fig. 8 shows how the bistable MV remembers. Let's assume that the right-hand active element is a fraction of a microsecond faster in its operation than is the other. Then when power was applied, this element operated first and brought

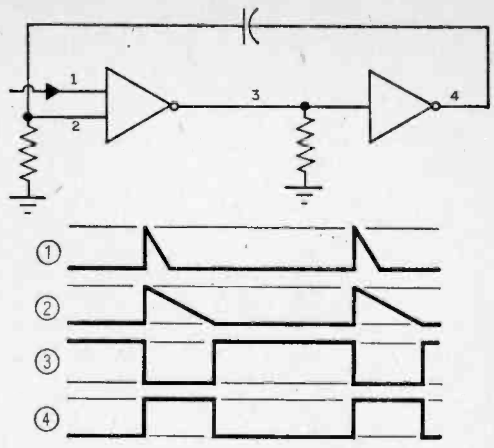


Fig. 7. Generalized schematic and timing diagrams of the monostable multivibrator. Output pulse width is determined by capacitor value.

point 4 to a low level. With points 1 and 4 both low, point 2 had to be high. Point 2 being high kept point 4 low, and this stable state was retained until a value was applied to point 1.

The pulse at point 1 brought point 2 low at least briefly, and when point 2 went low (since point 3 was also low) point 4 went high. The time scale is exaggerated in the timing diagram to emphasize this falling-domino sequence of happenings; it actually happens as fast as the active elements can operate, and with normal transistors is completely accomplished within a few hundredths of a microsecond.

Point 4 being high keeps point 2 low, and point 2 being low holds point 4 high. This

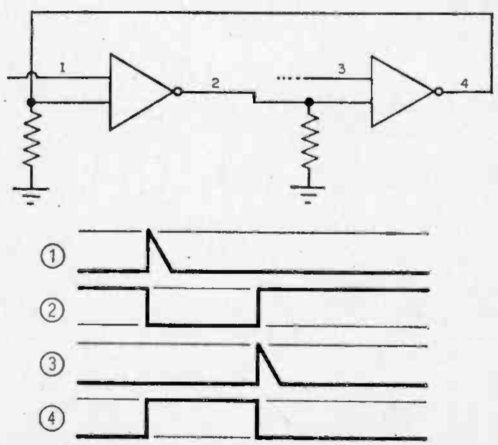


Fig. 8. Generalized schematic and timing diagrams of the bistable multivibrator. This is the basic "flip-flop" so widely used in digital equipment.

state is also stable, and will remain until a pulse comes in at point 3. Additional pulses at point 1 will have no effect.

An incoming pulse at point 3 makes point 4 go low, and by the same sequence point 2 comes high and holds point 4 low.

Points 2 and 4, therefore, "remember" which input received the last pulse. If point 2 is high, the last pulse came in at point 3; if point 4 is high, the last pulse came in at point 1.

Remember that we simply assumed that point 4 was initially low. When such a circuit is actually being used, the designer cannot make such an assumption. He must add some other circuit to send an "initializing" pulse to whichever input he wants; if he does not, he will not know whether the output indication is the result of actual inputs, or whether it is the result of one element switching before the other at the time power was turned on.

Some Multivibrator Applications. As we have seen in our examination of the different types of MVs, the circuits have many potential uses. Here are just a few to stimulate your imagination.

A monostable MV's uniform output pulse can be the heart of an accurate tachometer, by using a signal from the engine ignition to trigger the MV and simply applying the MV pulse output to an indicating meter. The faster the engine goes, the more pulses per second will be generated, and the more the meter will deflect.

The astable MV's rectangular-wave output is rich in harmonics; if the MV operates at audio frequency, its harmonics can be heard throughout the radio spectrum. An astable MV is an excellent signal source for troubleshooting any radio receiver.

The bistable MV's memory characteristic plus a pair of reed switches can provide a "photo-finish" device for slot-car racing. As each car passes above its reed switch it will provide a pulse to the multi; the multi will then show which car crossed the line *last*.

Photo fans and others who need accurate timers can use the astable multi to generate a train of accurately timed pulses at a low frequency, and then use these pulses to charge a capacitor. This permits long time intervals to be measured by relatively small timing capacitors.

Combining the astable, monostable, and bistable multis all into a single unit can provide the enterprising ham with an electronic keyer of the "TO" type; the astable multi provides the basic speed control, two monostables (one producing a pulse three times as long as the other) produce dits and dahs, and the bistable "remembers" whether dits or dahs were last selected by the operator.

From here, you're on your own. Turn your thinking loose, and have fun with multivibrators. ■

Audible Iron Finder

When you hear the high-pitched warning, you're almost on top of your objective. Who's you? Well, you *could* be a police officer checking for weapons among persons entering a courtroom. Or you could be a highway surveyor hoping to uncover stakes buried three years ago. Or you could be a weekend treasure hunter looking for an elusive prize stashed in a steel box. In short, you're looking for an object that, in one form or another, has an iron content. And you're using a new magnetic measuring device that detects objects up to 1 ft. away.

Developed by Schonstedt Instrument Co. of Reston, Va., the GB-1A magnetic locator is a single, self-contained unit that, at 3 lb. weighs less than the search head alone on conventional detectors. Externally, it is nothing more than a headset connected to the 42-in.-long probe. The operator points or waves the probe at a likely target, and the headset tells him whether he's found anything.

The detector sells for just $595.00. Think you can find $596.00 worth of treasure for a cool $1.00 profit?—*Joe Gronk* ■

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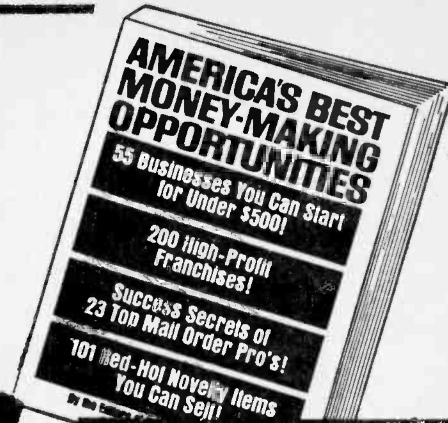

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H. H. Scott LR-88 Receiver

Continued from page 94

AM performance, typical of most AM-FM receivers, is best described as good.

It should be noted that the FM and AM alignment was "as delivered by the factory" and "user trimmed" as per the instruction manual. We could not see how an instrument alignment in our lab could offer any significant improvement. Our hats are off to Scott.

By a novel adaptation to the signal strength meter, and built-in switching circuits, the LR-88 uses the signal strength meter both as a voltmeter for circuit checkout and as an alignment meter. We do not suggest any builder attempt an instrument alignment beyond the minor trimming adjustments specified for the tuning meter.

The Curves. The amplifier performance is illustrated in the charts. The amplifier frequency response is at a full 30 watts RMS sustained output—both channels driven—with the THD well below 0.5% at 20 to 20,000 Hz *(better than specs).* Midband power output for less than 0.5% THD was 30 watts into 8 ohms, 35 watts into 4 ohms, and 25 watts into 16 ohms.

As shown, the tone control range is modest, with a maximum of 9 dB boost at 40 Hz. The *Volume Comp.* switch provides primarily a bass boost (with the volume control ¼ open), which almost exactly matches the normal maximum bass boost characteristic.

The *Noise Filter* is a hi-cut design—being only 6 dB down at 7 kHz provides enough filtering to "clean up" a noisy disc or weak FM signal without destroying the music.

Summing Up. As you have most likely surmised, we are impressed by the LR-88. Though complex, the kit is well thought out and relatively trouble-free in assembly, checkout and adjustment. The instruction/assembly manual is superb. The LR-88's sound quality and conveniences are excellent.

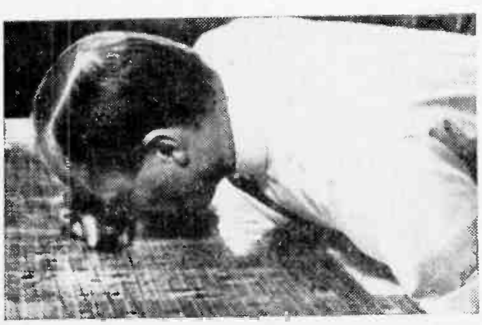
The LR-88, with metal enclosure, is priced at $299.95. An optional wood grain cabinet is available at $26.95. For additional information write to H. H. Scott, Dept. D, 111 Powder Mill Rd., Maynard, Mass. 01754.

Newscan

Continued from page 15

computer-simulated landings of the Apollo Lunar Module. To date, five sites meeting both vehicle and orbital constraints have been selected and forwarded to the Apollo site selection board for final selection.

In selecting candidate landing areas, the emphasis is on making sure there is a clear approach path and terrain is free of sharp slopes and large rocks, craters, and hills that may be misinterpreted by the Lunar Module's landing radar.



Moon craters are counted and measured on a high resolution Orbiter photograph using a 10-power hand magnifier by Raytheon Company specialist in the field of photo-interpretation.

Called "footprints," the elliptically-shaped, three-by-five mile areas having topographic features suitable for a Lunar landing are then used in a series of computer-simulated landings.

Working on high and medium resolution photographs returned by Lunar Orbiters 1 and 2, the Raytheon specialists perform a variety of operations varying from the simple counting of craters to the precise measurement of the distance between points on the moon in the spatial triangulation process. You can be sure Apollo 8 photos will be studied, too! ■

"Yes, my Pet, heat is responsible for 75 per cent of tube failures!"

DX Central

Continued from page 10

tend to have a mobile station hidden in Spain. We'll put our money on a South American location, though. . . . 15,205 kHz.—All India Radio's General Overseas Service is noted in English on this new frequency from 1000 to 1100 GMT. (Credits: A. R. Niblack, Indiana; Frank Peters, Illinois; Del Hirst, Texas; Bill Berghammer, N. Y.; Craig Koukol, Ill.; National Radio Club; North American SW Association.)

• POSTSCRIPT FROM PRAGUE

Lately, SWLs have reported receiving verifications from Radio Prague for reception of Czech clandestine broadcasts during last August's Soviet invasion. These QSLs, understandably, are vague about the operations, usually stating simply that the broadcasts were aired from "various locations" in the country.

Some of the secret stations set up shop in apartments, factory buildings, even in the police headquarters. They used civil defense and government standby facilities, Army equipment, and transmitters belonging to the huge Tesla electronics firm at Prague-Hloubetin. Elsewhere, stations at the Ceska Lodenice shipyard and at the Ceskomoravska-Kilben-Danek machine works were used, too!

Only recently have some of the details filtered out of Prague. One of the most fascinating tales concerns clandestine Radio Czechoslovakia I.

On invasion morning, August 21, Russian infantrymen, carrying "burp" guns, burst into the downtown Radio Prague studios on Vinohradska St., and closed down the station—so they thought.

Though the Red troops guarded the building's lower floors, apparently they were unaware of a separate complex of auxiliary studios on the third floor. From these "blacked out" rooms, just over the heads of the Russians, members of the Czech broadcasting staff worked secretly. A few direct phone lines, which bypassed the monitored switchboard, kept them in contact with the rest of the nation. Messengers slipped in and out of the building through a side door on Balbinova St. For eight hours they fed programs to the still free transmitters at Podebrady, 30 miles east of Prague, and at Velke Kostotal in Slovakia.

By the time the Ruskies got wise, the phantom broadcasters had moved on to a pair of substudios of the Czech broadcasting system in the eastern suburbs of Karlin and Vinohrady. The Karlin studio, used normally for recording concerts and plays, was in a big, private residence. Together with the feature program studio in Vinohrady, it escaped Russian notice.

On August 23, a tank and a jeep pulled up outside the Karlin building. But, tipped off by friendly Czech police agents, the broadcasters had escaped again. Soviet officers checked out the studio, found it empty and drove off toward the city's center.

The new location of Radio Czechoslovakia I was the Czech Army barracks on Prague's western fringe. There, for a half day, they kept going with an Army transmitter.

Then, in one of the neatest tricks of the whole Czech crisis, they doubled back on their pursuers and re-occupied the Karlin and Vinohrady suburban studios, which the Russians carelessly had left unguarded.

And there they operated, undisturbed, until the entire underground network voluntarily shut down nearly a week later. ■

Allied SWL Receiver

Continued from page 66

SW segments. It was particularly noticeable on the Citizens Band where the receiver appeared to "split" a channel in half; if two stations were slightly off-frequency, one on the high side and one on the low side of center-channel, it was possible to tune for only one signal cleanly; the second station came through only on the sideband and at a much reduced level.

Summing up. Though priced at $99.95, the Allied Radio Model A-2515 Communications Receiver offers performance associated with receivers in the $200 to $300 price range. Both for general coverage and as a Ham receiver the A-2515 delivers outstanding performance and value. Allied's A-2515 is that kind of "first receiver" that'll grab stage center in your listening slack for many years.

An optional matching speaker is available as an accessory. For additional information write to Allied Radio, Dept. 20, 100 N. Western Ave., Chicago, Ill. 60680. ■

"Sorry, Higgins, we have to let you go. We need somebody faster around here!"

Radio Pirates

Continued from page 64

The Comeback. Then, late last fall, there were a few solid signs of a pirate comeback. Encouraged by a favorable court ruling that clarified the status of the offshore seabed towers, ex-*Radio Essex* owner Roy Bates proclaimed his old tower the independent nation of Sealand. Prince Roy, as he dubs himself, says he intends to reestablish a commercial station there to cover the London area. To scrape up some cash, Prince Roy has even issued his own Sealand postage stamps.

And a Swiss corporation, The Concorde, announced plans to broadcast tri-lingual variety and pop music programs, complete with commercials, for Britain, France and the Low Countries from a ship moored off Belgium.

A temporary office opened recently somewhere in Brussels, says the Belgian press service, Agency Belga. There seems to be real money behind the plans for 50 kilowatt transmitters on long, short and VHF-FM wavelengths.

Also in the news are reports that Ronan O'Rahilly, the flamboyant Irish mastermind behind the *Caroline* organization, has joined forces with the Beatles' new Apple Corp. This may lend credence to stories that a transmitter purchased recently in the U.S. by Beatle Paul McCartney is to be installed on an uninhabited island, owned by John Lennon, off the west coast of Ireland.

O'Rahilly, himself, has announced plans for a pirate TV outlet, Caroline TV, which in mid-1969 will transmit 9 to 12 hours daily in color and black-and-white. Targeted will be "telly" viewers in Great Britain and Ireland.

The UHF station will broadcast from a pair of Super Constellation aircraft, already purchased, flying a tight pattern above the Irish Sea. Earlier, airborne television proved technically feasible in U.S. educational TV tests.

To get the Caroline TV project off the ground, O'Rahilly will have to skirt the tough Marine Offenses Act, which deep sixed the buccaneer radios by sawing off the plank behind them, making it a criminal offense for Britains to aid or supply the maritime broadcasters, or to advertise over their facilities.

According to the canny Irishman, the law stopped British firms from advertising on pirate radio and foreign companies weren't very interested in doing so.

The American Buck! But, says O'Rahilly, non-British firms are keen to reach a nation-wide *television* audience. He has termed the interest by American advertisers as "fantastic."

Some sources say the semi-autonomous Isle of Man will be used for supplying and refueling the *Caroline* TV aircraft. But O'Rahilly says, "At the moment I do not want to say where our aircraft headquarters are. If the (British) government were to know, it would probably arrange a deal with the country to close us down."

Though pirate ventures are notoriously long on ballyhoo and woefully short on meeting their projected on-the-air dates, there's a fair chance that a new one, *Radio Nordsee*, will be operating by the time you read this.

Owned by Swiss and Lichtenstein businessmen, *Radio Nordsee*, not to be confused with the *Dutch Noordzee*, a tower-based radio and TV combination, circa 1964, was to begin 24-hour-a-day broadcasting in German in 1128 kHz about the first of the year. It was to transmit from the former *Radio Caroline South* vessel, "Mi Amigo," which spent the better part of last year, before the *Nordsee* project was launched, chained to a wharf at Amsterdam's Verschure shipyard. Anchored off Helgoland, its programs were to be beamed at West Germany.

The same business syndicate is trying to swing a commercially-sponsored television station in East Germany to transmit programs over the border to the West. Its prospects for success seem slim.

And so, as the pirate broadcasters prepare to run up the skull and crossbones again, Europe's governments are bracing themselves for another battle. The outcome of this struggle is anybody's guess. ■

Dahdit dahdahdah!

Homer Hackleby—Ace Spy

Continued from page 70

machine on your lap, you know. Besides, my electronic knowledge is needed by National Security. I have an appointment for tomorrow morning and probably in a few days I will be relaxing in the perfumed arms of some shapely, enchanting temptress in Algiers or Nice."

The next morning he sat before the desk of J. J. Watkins, the Chief of Security for the New York office of the Association.

"Could you tell me a little of your electronic background, Mr. Hackleberry?" he asked Homer. "Some of your inventions perhaps?"

"The name is Hackleby, sir. Well, I discovered the use of most quartz crystals to provide damped oscillating circuits. I planned to use them in a vibrating, microelectronic scalp massager to restore the hair on bald-headed men. The device could be fastened inside the hat, you see, and work anywhere—even under water. Swiss engineers stole the idea from me before I could patent it and are using it in waterproof watches."

"A dirty shame," cried Watkins. "Are you working on any electronic projects at present?"

"Yes. I have drawn up blueprints for a color X-ray tube to be used in television cameras," said Homer calmly, as his fertile mind went into high gear. "With my tube, the screen would show all of the internal organs of the performers instead of their faces . . . in full color, of course. A large percent of the viewing audience is getting sick of the same performers each year, only with a few more wrinkles in their faces. Think of the novelty of seeing the digestive juices attacking a delivery of Chop Suey inside the human stomach."

"Well, with such a broad background of electronic experience as that, you're just the man I'm looking for, Hacklebrush," said Watkins as he lit a cigar. "I have a case that is top secret and which may involve the security of our entire nation . . . maybe even of the Milky Way and our entire Galaxy! You are no doubt well informed about the nature of these new *Pulsar* radio waves?"

"Of course. They are the waves coming back from our capsules and sent by the tiny metronic-electronic instruments fastened on the wrists of the Astronauts to record their pulse in Space."

"I'm sorry, Hacklebutt," said Watkins as he shook his head. "You're not running in the money this time. The only word you said which was close was 'Space'." He picked up a paper from his desk. "Pulsars are radio waves coming from Space and discovered in 1967 by Cambridge University astronomers. They are now believed to be coming from beyond the Milky Way and our Galaxy. It is believed by many people that they are being sent by some other civilization."

"Oh, *those* Pulsars," said Homer quickly. "They're spelled with an "a" while the ones I spoke of are spelled with an "e". Yes, I have studied them carefully and my theory is that they are being sent by ham shortwave operators from the Planet Pulsa which, ah, has its orbit on the very edge of Space . . . where it drops off into absolute nothingness, in fact. Really out in the woods, you know."

"I don't know about that but it says in this report that their energy output per square inch equals the entire output of the sun or several thousand hydrogen bombs detonating every second. That means that if some little thing went wrong in some way, they might blow us into Kingdom Come."

Homer felt a slight, cold chill pass quickly down his back.

"Our job is to locate a missing Professor Blotchet, an astronomer at the United States National Radio Observatory in Green Bank, West Virginia. He operates the trainable, dish-type radio telescope there . . . largest in the world. Has a diameter of three hundred feet, fifty feet more than the Jodrell Bank telescope in England.

"We have reason to believe Professor Blotchet had discovered a way of storing up these Pulsar things in some kind of a battery. Then he must have stumbled some new discovery for he wired me that he was coming to New York to see me. He checked into the Park View Hotel on Monday and then disappeared. I lost three of my best men since Monday and I'm down to the bottom of the barrel. That's why I'm going to send you out to find him, Hacklebum," said Watkins.

"Yes, sir! The name is Hackleby, sir," said Homer.

"What? Oh, well, it probably won't make much difference by tomorrow. Now get out and get to work."

"Yes, sir," said Homer as he rose, hat in hand, and walked out of the office.

He went back to his garage-laboratory and dismissed Spencer. Next, he opened a false bottom in a cigar box on his desk and took out several electronic items including a hearing-aid which he inserted in one ear. The other things he put in his coat pocket.

A half-hour later he was walking down a hall in the Park View Hotel toward the Professor's room. He unlocked the door with the pass key the clerk had given him and entered the room. The professor's suit-case was at the foot of the bed and his personal toilet articles in the bath-room. By the telephone, Homer noticed a small notation pad. There was a number scrawled over it.

He picked up the phone, asked for an outside line and then dialed the number. A voice answered, "Hello, Shanghai Bar."

"This is, ah, Professor Hackleby speaking. I am trying to locate a friend of mine by the name of Blotchet, Professor Blotchet. I notice your number here in his hotel room. Is he there now?"

"No, sorry, but I've never heard of any Professor Blotchet."

"Is it most important that I find him. I am a scientist from England . . . the Jordell Bank Radio Telescope. I have discovered vital data that fits in with my friend's research, I must find him."

"Hold the line, please." There was a slight pause. "Hello, yes, your friend is here but very busy and unable to come to the phone. He asks that you come to the Shanghai Bar at once."

"Fine. I'll be there shortly," said Homer as he hung up. He dialed another number and spoke a few words, then hung up and left the room. Outside the hotel he caught a cab for the Shanghai Bar.

The Bar was on Mott street in the Chinese section downtown and after paying his driver Homer walked in and sat on a stool.

"I'm Professor Hackleby," he told the bartender. "I was told over the phone that a friend of mine is waiting here to see me."

"Oh yes," said the bland-faced Chinaman. "Your flend be here in flew minutes. Please to have drink on house. Shanghai Special!"

He mixed a drink in a tall glass and handed it to Homer. It was a slightly bluish color and a wisp of smoke rose from the top.

Homer was busy smiling at an attractive girl on the next stool and he took the drink and tossed it down with a nonchalant air.

He started to ask the girl her name when the lights went out and a block of concrete fell on his head. He went rigid and fell back into the arms of two waiters standing behind him . . . waiting.

He opened his eyes to find himself tied to a heavy chair in a basement. Nearby, bound in another chair, sat an elderly man. There was a circular, metal cone with electrical attachment held by a bracket so that it hung down over the top of his head.

"Professor Blotchet, I presume," said Homer calmly. "I am Professor Hackleby of Jodrell Banks, England. May I inquire, sir, if you are having your hair dried."

"This is an electronic brain-washer," replied Professor Blotchet. "That fiend will be back any minute to turn it on again. It plays a tape of TV commercials in my ears while the picture goes on the opposite wall there. No programs, you understand, only commercials for hours. I don't know how much longer I can hold out. My brain cells are deteriorating faster than butter in a frying pan."

"What did you discover about Pulsars that you wanted to tell National Security? I'm an agent with them. You'd better tell me now before you go mad, Professor, and while we're alone here."

"The Pulsar waves carry a mysterious, creative element that is unknown to mankind. This element causes an immediate cellular growth of any living organism it touches. I discovered it when I accidentally reflected a Pulsar in my laboratory and it fell upon a common fly. The insect began to swell before my eyes until it was four feet high. I managed to turn off the telescope and seize a fire-ax from the wall to cut off the monster's head just as it was preparing to attack me."

"Amazing!" cried Homer. "Think of the possibilities of it."

"Yes. You see, I also discovered a way to store Pulsars in a battery so that they may be transported about and used later."

"Where did you put the formulas for these discoveries, sir?"

"They are on a piece of paper in the Bible in my hotel room," said the Professor. "Can you imagine what would happen if those Pulsars were released over New York. They penetrate walls the same as radio waves. Think of ten million flies and cockroaches ten or fifteen feet high looking around for something to eat."

"Thank you for telling me where you hid the formulas, Professor Blotchet," said a

Continued from previous page

soft, sinister voice as a tall, thin Chinaman entered the basement and walked up to the prisoners. "After the insects have eaten the population of your country, we will breed huge birds in China to eat the insects. Then we will come over and enjoy your fine cars, swimming pools and luxurious apartments."

"But Red China does not have a radio telescope," said Homer.

"We will complete ours next week. Ten miles in diameter and built in the cone of an extinct volcano in the Kunlun Mountains. This will give us enough Pulsars to rule the world. And now, since neither of you are of further use to me, I am going to eliminate you. Have you any last request to make before leaving this life?"

"Yes," said Homer quickly. "I would like to make a will leaving my Electronic Company to my assistant. If you would release my right hand, I have a pen and paper in my pocket."

"Very well," said the man as he removed the leather strap holding Homer's wrist to the arm of the chair. "Write it quickly."

Homer drew a pen from his coat and pointed it at the man.

"I hope you are wearing a five-inch vest under that silk kimono, Fu Manchu. Do not move! This is a micro-electronic *Laser ray* gun that will go right through your heart and across New Jersey."

The yellow face of the arch-criminal turned white in fear.

"Release Professor Blotchet," ordered Homer. "And now, Professor, if you will come and free me, I will send for assistance immediately."

When he stood up, Homer snapped on a small switch in his hearing aid. "This will give our exact location to the police who are waiting on the corner," he said with a smile to the Professor. "I gave them the wavelength just before leaving the Park View Hotel."

Within a few minutes, the police rushed into the basement and quickly rounded up the rest of the gang. Homer walked up to the tall, evil-faced leader and slipped the pen into his kimono pocket.

"Here, Fu," he said, "You might want to write a letter from where you're going. That's a pretty good ballpoint."

The man gave a snakelike hiss of rage as the police led him out. Professor Blotchet walked over to Homer and shook his hand.

"A wonderful job, sir. Then you were bluffing with that pen all of the time and it wasn't a micro Laser ray gun at all?"

"Of course not," said Homer with a smile. "I just took a chance that he had seen the same spy picture that I had, shall we go?" ■

Hot Receiver

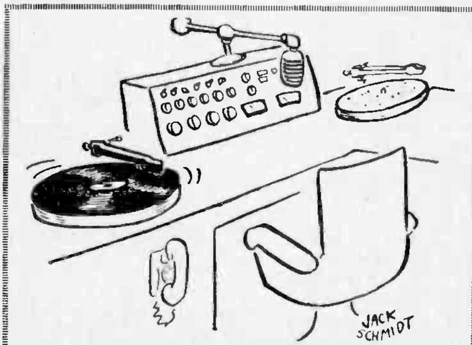
Continued from page 45

I changed the 220-ohm suppressor-to-ground resistor to one of about 3000 ohms, and bridged the fone/CW switch by a 0.02 uF or larger capacitor as shown in Fig. 1. This switches the S-meter zeroing potentiometer from suppressor to ground when the receiver is in the CW mode.

By rotating the potentiometer, really fine control of oscillation can be obtained, and the final IF stage can be used as either a Q multiplier or BFO. The modification doesn't interfere with normal S-meter operation when the receiver is switched back to fone. I could now receive 28 MHz hams on SSB. Not bad for such a simple receiver.

One more suggestion which could be useful: on such a simple receiver, it isn't possible to have both automatic gain control and a BFO at the same time, so strong stations can cause blasting. Connecting the antenna to a 2000- to 5000-ohm potentiometer, as shown in Fig. 2, gives a simple gain control that doesn't alter anything in the receiver.

Having made these modifications—without any more equipment than a soldering iron—I am now the proud possessor of a rather more grown-up HA-226. ■



". . . broadcasting live 24 hours a day, bump a day, bump a day, bump a day."

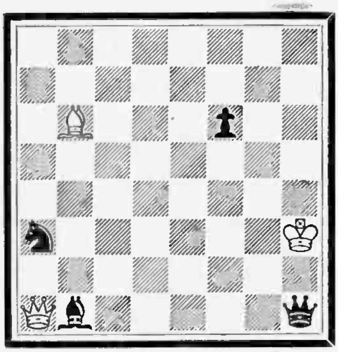
En Passant

Continued from page 25

PxR=Q?? RxQ 40 R-QB1, P-K7! and Black gets the better of it!) KRxQ 40 PxR=Q# RxQ 41 RxR, K-K2 42 R-Q1! PxP# (42 . . . . P-K7 43 R-K1 wins) 43 KxP and the win is child's play.

Problem 18
By Guidelli

Black



White

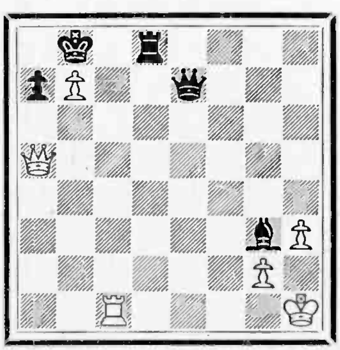
White to move and mate in two.
Solution in next issue.

Sometimes a mate can be far away—even in a two mover!

Solution to Problem 17: 1 P-N6.

Combination #1

Black



White

White to Play and Win.
Solution in next issue.

The basis of this clever combination is a Knight fork. But there are no Knights on the board! Exactly. And that is the clue to the three move solution.

News and Views. Chess Olympiad (International Team Championship), Lugano, 1968: I. Soviet Union, 39½-12½, II. Yugoslavia, 31-21, III. Bulgaria, 30-22, IV. United States, 29½-22½. When will we ever win this prestigeous event? When our government and people support chess as it is supported in most other countries!

Amsterdam Tournament, 1968 (sponsored by IBM Corporation!): L. Kavalek of Yugoslavia won it (10½ points) and David Bronstein, USSR, 10, was runner-up.

U. S. Junior Open, Cleveland, 1968: The joint winners with 7½-1½ were John Anderson of Milwaukee and Steve Stoyko of Newark. ■

Rocks in Radio

Continued from page 34

or quartz crystals come from. The rocks are processed, giving the metal, and the metal is used in the devices. And, in reality, these devices are the future of radio.

Rock centered research is active not only in the semiconductor field, but in the area of *rare earths*. These hard-to-find elements are used in the phosphor coating on the color picture tube. Right now, research is aimed at finding ways of supplying the rare earths, but applications are not being neglected. These too, are in the future of radio.

In fact, if you want a crystal ball to gaze into the future, or past, of radio, pick up any rock. That tells it all. ■

ADVERTISING INDEX

Unimetrics Receiver

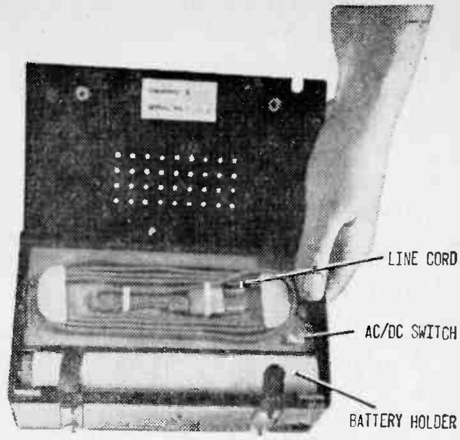
Continued from page 86

radios in the $50 price class. In fact, just the short length of internal wiring from the whip to receiver is all that's needed for average reception; whip extension was only required for the weak FM stations or very distant stations.

The VHF performance proved clearly superior to most of the so-called "hand-held" VHF receivers. Because of the vernier tuning (used for all three bands) it was very easy to tune in the VHF stations *cleanly* dead on channel center. Sensitivity, while not quite up to that of a "communications receiver" in the $70 to $100 price range, was substantially better than the average low cost hand-held models. Selectivity was notably good, and the Omniband III was easily able to separate the fire, police and marine frequencies grouped around the 152 to 157 MHz portion of the dial.

Because of the filter network in the front end, image interference from services outside the VHF band is sharply reduced to a non-objectionable level.

Sound quality. Unlike most transistor portable radios the Omniband III's sound quality is not *shrill*—there are no overbalanced highs. This is due, in part, to the fact that there is no speaker grille. The front panel, though it appears to be an open grille, is really solid, thereby muting the highs and producing a total sound quality best described as *mellow* (at least it doesn't grate

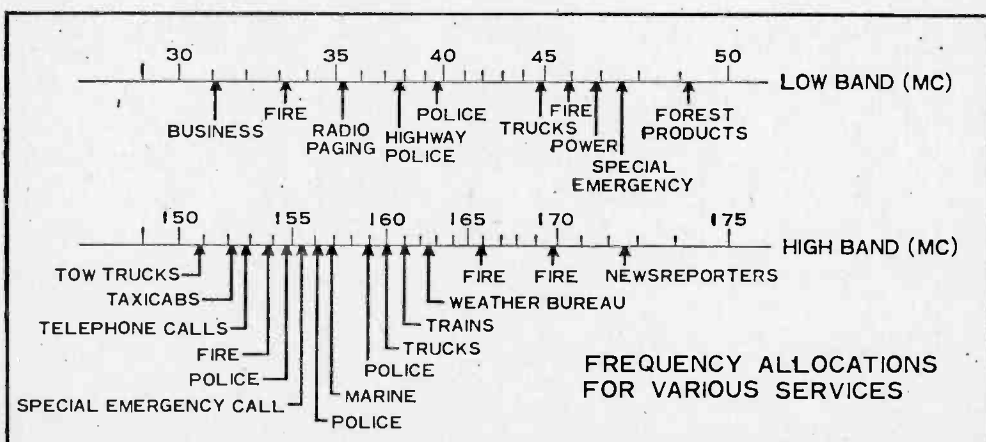


Two snaps release the rear cover which provides access to the AC line cord, the battery holder and the AC-DC switch. Line cord holder and tie-down straps are supplied with radio.

on one's ear). Maximum sound level (before distortion becomes objectionable) is just about equal to that of a good quality solid-state table radio.

Summing Up. The Omniband III (high-band model) priced at $39.95, including batteries and earphone, would be a good value as either an AM/FM *or* VHF radio. As a combination AM-FM-VHF radio it is an *excellent* buy worthy of your consideration if you're looking for a VHF totable with AM and FM coverage.

For additional information on the Omniband III write to Unimetrics, Inc., Dept. TEC, 39 Werman Court, Plainview, N.Y. 11803. ■



You need a score card to spot the stations and the above diagram fills the bill. For emergency station listings, we suggest you check White's Radio Log every issue.

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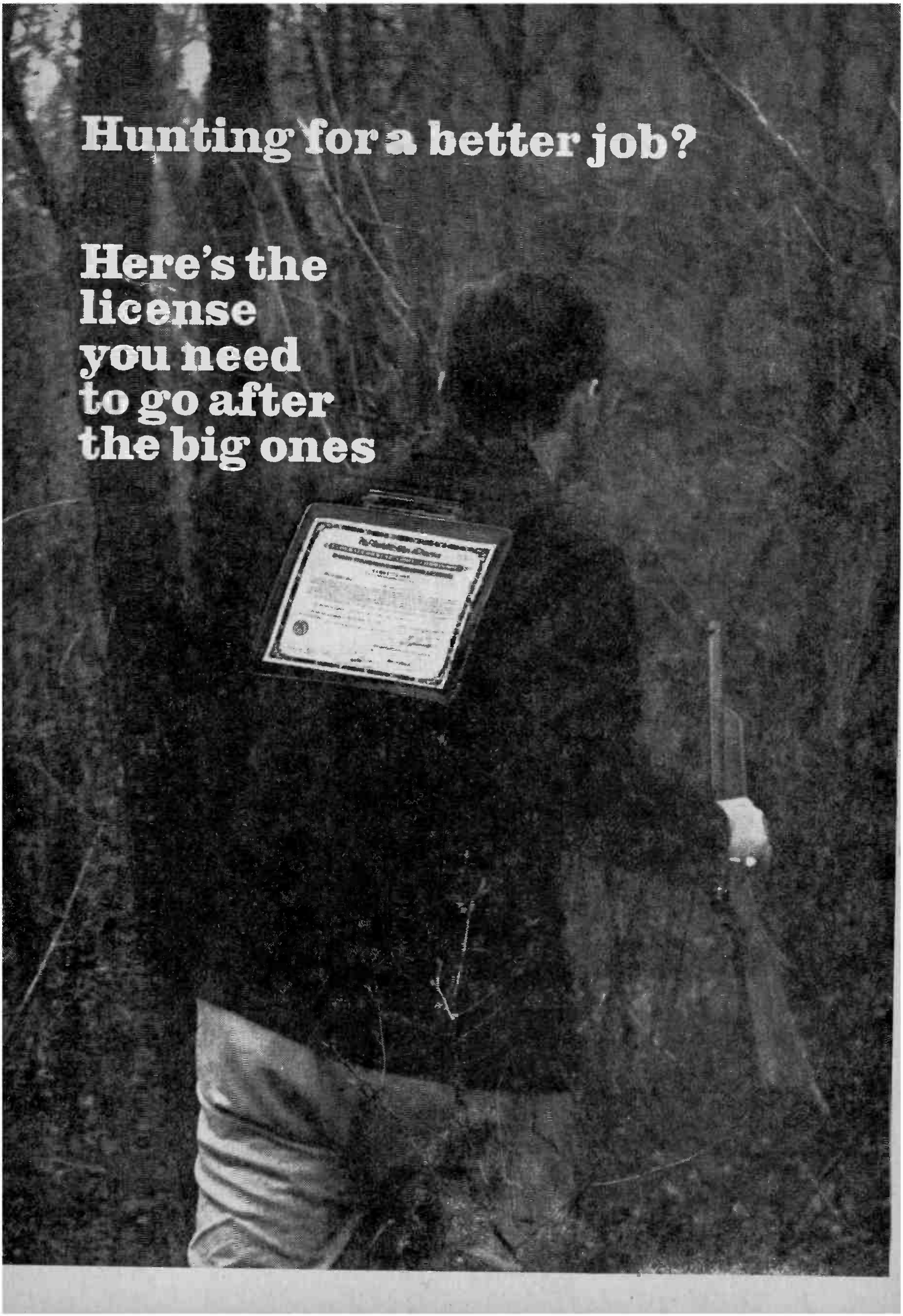
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Daniel J. Smithwick started his CIE training while in the service, and passed his 2nd Class exam soon after his discharge. Four months later, he reports, "I was promoted to manager of Bell Telephone at La Moure, N.D. This was a very fast promotion and a great deal of the credit goes to CIE."

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

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- ★ Sold In 79 Countries

YOU DON'T HAVE TO SPEND HUNDREDS OF DOLLARS FOR A RADIO COURSE

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing. THIS IS A COMPLETE RADIO COURSE IN EVERY DETAIL.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester, Square Wave Generator and the accompanying instructional material.

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.

THE KIT FOR EVERYONE

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 a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

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

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

THE "EDU-KIT" IS COMPLETE

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

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

Progressive "Edu-Kits" Inc., 1186 Broadway, Dept. 531DJ, Hewlett, N. Y. 11557

FREE EXTRAS

• SET OF TOOLS

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

SERVICING LESSONS

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

FROM OUR MAIL BAG

J. Stataitis, 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."

UNCONDITIONAL MONEY-BACK GUARANTEE

Please rush my Progressive Radio "Edu-Kit" to me, as indicated below:
Check one box to indicate choice of model

- ☐ Regular model $26.95.
- ☐ Deluxe model $31.95 (same as regular model except with superior parts and tools plus valuable Radio & TV Tube Checker).

Check one box to indicate manner of payment

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

Name ....

Address ....

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

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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.