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Our bookshelf speaker system that everyone wants to make! You get flat response from a speaker only 13/16-in. thick!
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• May/June 1970 • Vol. 10 No. 2

e/e elementary Electronics

Dedicated to America's Electronics Hobbyists

☆ Cover Highlights

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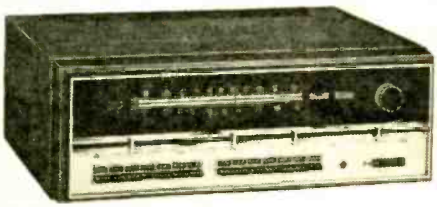
Cover photo by Leonard Heicklen

100 Watts for Little Brother

The new Heathkit AR-29 AM/FM/FM-Stereo receiver kit is the result of a two-year project, and, they say, borrows liberally from the technology of the Heathkit AR-15. The AR-29 features FET and IC designs, ultra-sensitive FM tuner, selective IF design, built-in test circuitry, and the first use of computer-designed fixed-tuned L-C IF filters. Frequency response is 5 to 30,000 Hz with less than 0.25% harmonic distortion at any power level. There's a regulated power supply, and 4 heavy-duty individually heat-sinked output transistor protected against short-circuit conditions by a special dissipation-limiting circuit. Then there's a big break for the kit builder in the form of plug-in circuit boards, which simplify checking of circuits. You can eliminate on-station FM background noise and harsh noise bursts between stations by pushing a button activating the Noise Muters. Styling features the Black Magic panel lighting, revealing no dial or scale markings until set is turned *on*. The AR-29 is priced at $285.00 and for further information, write Heath Co., Benton Harbor, Mich. 49022.



Heathkit AR-29 AM/FM-Stereo Receiver

Cordless Brilliance

Campers, boaters, outdoor livers, patio party-ers, and just plain folk who have a power

elementary Electronics

May/June 1970 Vol. 10/No. 2

Dedicated to America's Electronics Hobbyists

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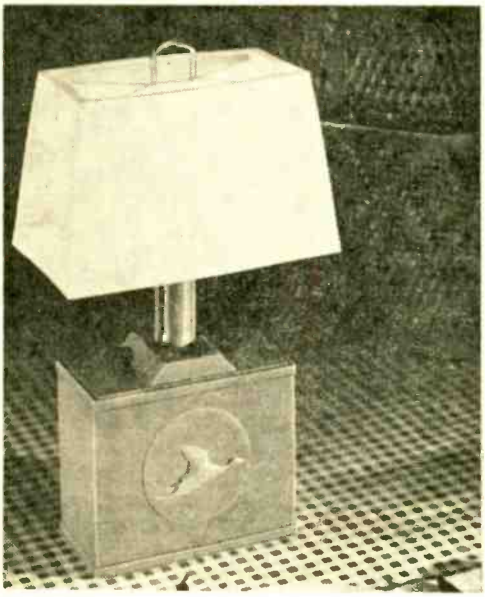
failure now and then will welcome the Porta Lite from Marathon Battery. Attractively styled, it's powered by a 6-volt No. 896 Marathon battery, molded from polyethylene in green or blue, and its No. 1651 bulb provides up to 100 hours of intermittent light. The shade can be moved up or down and there's a hang-up loop. Price is $10.99 and for complete information contact Marathon Battery Co., Box 1246, Wausau, Wis. 54401.



Marathon Battery Porta Lite

Mod, Mod Modular

Here's a hot combo from Lafayette Electronics, the LSC-45 stereo modular hi-fi phono system. It combines a Garrard 4-speed automatic record changer, a 20-watt solid-state stereo amplifier, and a pair of acoustically

Lafayette LSC-45 Stereo Phono System

matched speaker systems. The record changer has tubular tone arm with stereo turnover cartridge and diamond LP needle, plus cueing control. It will play 7-, 10-, and 12-in. records at $16\frac{2}{3}$, $33\frac{1}{3}$, 45 and 78 rpm. Amplifier controls include Balance, Bass, Treble, Volume, Selector, Automatic Shut-off Switch, front panel stereo phone jack, auxiliary input jack for tuner or tape recorder. The speakers are 8 in. and you get a plastic dust cover, 45-rpm spindle, and speaker cable. The LSC-45 has walnut veneer cabinetry and the price is $99.95 for all. Write for further specs to Lafayette Radio Electronics, 111 Jericho Tpke., Syosset, N.Y. 11791.

Cleaner Heads Will Prevail

Robins Industries has come out with what they call "a pair of new combos and a couple of singles." The combos include the Test-N-

Robins Cassette and Cartridge Cleaners

Clean cassette Model THC-6 and cartridge Model THC-8, both listing at $2.80. They'll remove accumulated oxide, grime and foreign matter and test heads for both alignment and stereo balance between channels. For gentler head cleaning, there's the lintless, non-woven polyester cloth Head-Kleen cassette Model THC-4, which sells for $3.00. Finally, there's the Head-Kleen cassette Model THC-7, which cleans by means of polishing tape and sells for $2.50. For more information write to Robins Industries Corp., 15-58 127th St., College Point, N.Y. 11356.

Switched-on Saser Beam

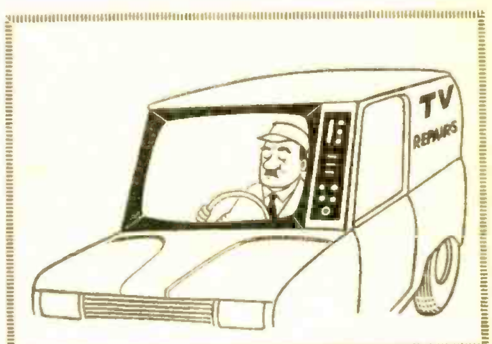
The Saser Beam antenna line, says Mosley Electronics, cuts through CB interference like a laser cuts through steel. Model DMS-3D is a deluxe 12-element Saser Beam, a combination of two MS-3D beams stacked, and features the sturdy construction of a beam plus the choice of polarization usually found only in the quad design. Each of the six horizontal and six vertical elements has two high "Q" coils, so powerful they can be used on a 10-meter ham antenna. A double "T" matching system provides balanced feed horizontally and vertically. A turn of the dial of the polarization switching control, located at the transceiver, permits selection of polarization. Complete with color-coded parts and instructions, the DMS-3D is priced at $198.41. For complete specs, write Mosley Electronics Inc., 4610 N. Lindbergh Blvd., Bridgeton, Mo. 63042.

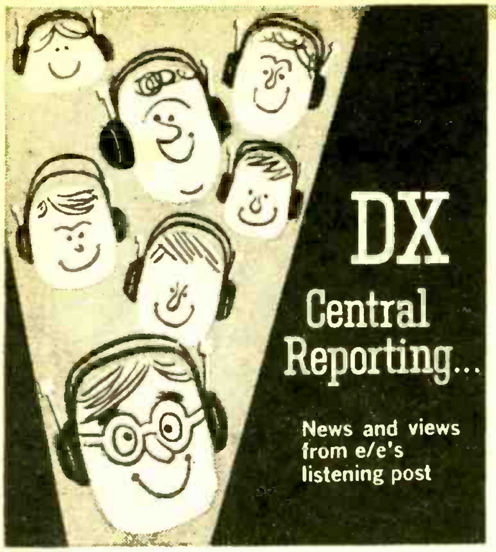
Get Your Signals Straight!

EICO's Model 150 solid-state signal tracer is just what the doctor ordered for trouble-shooting AM, FM and TV receivers as well as hi-fi and PA systems. There are two separate probes for testing both radio and audio frequency circuits. Results are judged from an audible output from an 8-ohm speaker or visually from a built-in meter. The unit has 400-mW continuous power output; power requirements are 105-132 VAC, 50-60 Hz, 5 VA. Handy-dandy size is $7\frac{1}{2}$ x $8\frac{1}{2}$ x 5 in., weight a mere 6 lb. Model 150 sells for $49.95 in kit form, $69.95 wired. For more info write to EICO Electronic Instrument Co., Inc., 283 Malta St., Brooklyn, N.Y. 11207.

Quick-Mount Flush Speaker

Those Poly-Planar people have come out with a new quick-mount speaker/grille assembly, model G51P. It's designed to permit customized surface or flush mounting with a minimum of effort by means of newly engineered mounting brackets and grille. The G51P requires only ⅞-in. mounting depth—great for custom-mounting in walls, ceilings, furniture, doors, under eaves. With its new brackets, no cutout of the mounting surface is required, and the brackets form a natural sound chamber. Unit can be mounted in a few minutes. The Poly-Planar G51P has a power handling capacity of 5 watts, frequency range of 60 Hz to 20 kHz and input impedance of 8 ohms. Size of grille is 6 x 10 in., it comes in ivory, walnut, and black, and sells for under $11.00. For more information write the Magitran Co., Moonachie, N.J. 07074. ■





by Don Jensen

DXERS' attention again has been drawn to the Near East's forgotten war, the intermittant seven-year civil strife in Yemen.

Since September 1962, it has been an on-and-off war between the tribal followers of deposed Imam Mohamed al-Badr and the Egyptian-backed republican regime. Under a 1967 cease fire agreement between the Saudi Arabian-supported royalists and the republicans, the Saudis stopped sending military supplies to the Imam's tribes and the Egyptians withdrew an estimated 70,000-man expeditionary force from Yemen.

But since the murder, last July, of the royalist commander, Prince Abdullah ben Hassan, the war has flared up again!

From an SWL's standpoint, one of the most mysterious clandestine stations around today is the Yemini Royalist Radio, which only recently has been audible in the U.S.

Its history is obscure, but it has operated at least since 1965, when supposedly it was located near Amara in royalist-held territory. Two years later, a New York Times correspondent actually visited the secret station.

He reported it located in a rocky cave at Idda, in northern Yemen. The five kilowatt shortwave transmitter, furnished by Saudi Arabia, was operated by a German technician, Herbert Stoltz.

Stoltz, unlike the other British, French, Belgian and German mercenaries aiding the royalists, has been singled out for special attention by the opposition. A Cairo Radio broadcast alleged he was "a fugitive Nazi." The rugged job and the "honor" of making Cairo's list reportedly were worth $1000 a month to the German radioman.

It's not known if the station is still at Idda or if Stoltz still runs it. And, considering the fact that American DXers are now logging it occasionally, it may have a new transmitter.

Try for it on 9,976 kHz., around 0400 to 0415 GMT. Programming is all in Arabic, of course, and you'll probably run into some interference from "utility" stations, but with the right conditions you can log it.

Also a challenge, but somewhat easier to hear is the official voice of the government of Yemen, Radio Sana on 5,804 kHz.

East Coasters, in particular, have been reporting good signals at times from sign on at 0300 GMT. Listen for the anthem, the "Huna Sana" identification, and the typically Arabic music. It usually fades out before 0330 GMT.

Tip Topper. It's no secret to most DXers that Paraguay is one of the hardest countries in this hemisphere to log.

One reason is that it's farther away than most people realize. From New York, for example, Madrid, Monrovia and Moscow all are closer than our "neighbor," Paraguay. Secondly, only a half dozen shortwave stations, all low powered, are listed as operational.

Currently, about the only one heard by norteamericanos is Radio Encarnacion, which, through heavy QRM (interference), is audible on 11,947 kHz., around 0100 GMT. Luckily, it is a pretty good verifier, by Latin American standards, and director Senor Antonio Efrin Cabrero QSLs correct reports. Registered mail is the best guarantee that your report reaches him.

But for those who can't hear Radio Encarnacion there is good news. In the near future, Radio Nacional de Paraguay will initiate a foreign service with new 100,000 watt transmitters. This government station now has just a three kilowatt shortwave outlet on 6,025 kHz., where it is smothered by Radio Portuial.

The new service, in Spanish, French and English, will use 9,735 kHz., and either 11,915 or 11,940 kHz., it's reported. Watch for this one during the coming months.

Bandsweep. All times GMT—**925 kHz.**—Radio Victoria, PJA6, on "the Sunshine Island of Aruba," squeezes through on this split frequency during the evening hours. Incidentally, this missionary station uses a unique stainless steel tower to thwart the corrosive effects of the sea air. . . . **5,026 kHz.**—East Coast DXers should try for Radio Uganda, Kampala, just before sign off at 2107. An English newscast precedes sign off. . . . **5,095 kHz.**—Best bet for beginners is Colombia's Radio Sutatenza around 0200. Its signal is strong, the frequency is easy to find, and its Spanish identification is easy to understand. . . . **7,115 kHz.**—The new five kilowatt transmitter of the Solomon Islands Broadcasting Service, Honiara, was activated early in February. Try for it around local sun-

(Continued on page 12)

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rise. . . . **8,905 kHz.**—The best way for SWLs to log Alaska is via the Federal Aviation Administration (FAA) aeronautical weather broadcasts on KIS-70, Anchorage at 20 and 50 minutes past each hour. . . . **11,900 kHz.**—Still testing at this writing is the Far East Broadcasting Associates station on Seychelles, in the Indian Ocean. Times and frequencies have been changing faster than a woman's mind, but FEBA was last reported here at 0530 sign off. . . . **15,165 kHz.**—Radio Damascus, Syria, is being received with fine signals during a new English time period, 2145 to 2200.

(Credits: Gray Scrimgeour, Canada; Art Poulis, Mass.; Dr. F. Earle Hall, Mass.; Gregg Calkin, Canada; John Boessenecker, Cal.; Richard Wood, Hawaii; A.R. Niblack, Ind.; National Radio Club, Box 99, Cambridge, Mass.)

Switcheroo. The Russian radio operator at the Cape Stolbovoi weather station on remote Novaya Zemlya island was puzzled, one night in 1940, to hear an unexpectedly powerful English-speaking station on his shortwave receiver. By all rights, the program from a Nazi-controlled transmitter in Holland should have been beamed toward the U.S. In fact, the Germans thought it was. But a bit of technical sabotage by a wily Dutch engineer had altered the transmission pattern and cut the station's potential audience to a few thousand reindeer and a few hundred settlers on the Russian island, far north of the Arctic Circle.

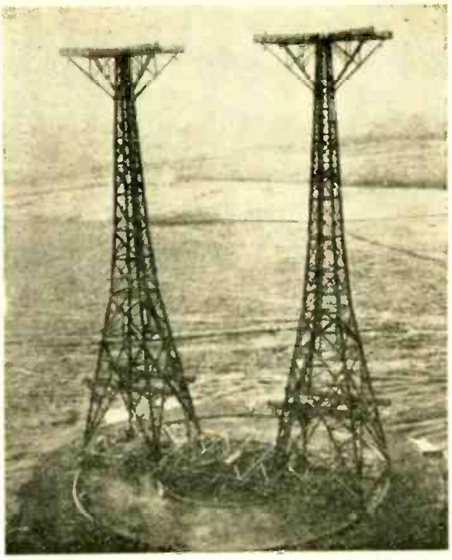
The story's beginning goes back to 1927, when the engineer, P.C.J. Vulling went to work for the Philips Holland-Indes Broadcasting System, the forerunner of today's Radio Nederland. The station (coincidentally, its "call," PCJ, matched Vulling's initials) at first broadcast only to the Dutch East Indies, 8,000 miles away, but later its scope was widened.

With space limited at the transmitter site near the town of Huizen, Vulling had to design a novel rotatable antenna system.

Two wooden masts, each 200 feet high, were mounted on railroad wheels, which rode on concentric circles of track. This "turntable" had an inside diameter of about 70 feet and an outside rail diameter of roughly 150 feet. A vertically polarized antenna array was suspended from the masts. By moving the towers around the track, the PCJ signal could be beamed to any part of the world.

When the war broke out, the company of 138 Dutch soldiers assigned to the station was unable to destroy the antenna before it was taken over by the Nazi invaders.

Occupation authorities replaced Vulling with a Dutch "quisling," who, though he knew nothing about broadcasting, tried to run PCJ as a link in Berlin's propaganda machine. It relayed English, Arabic and Hindustani programs.



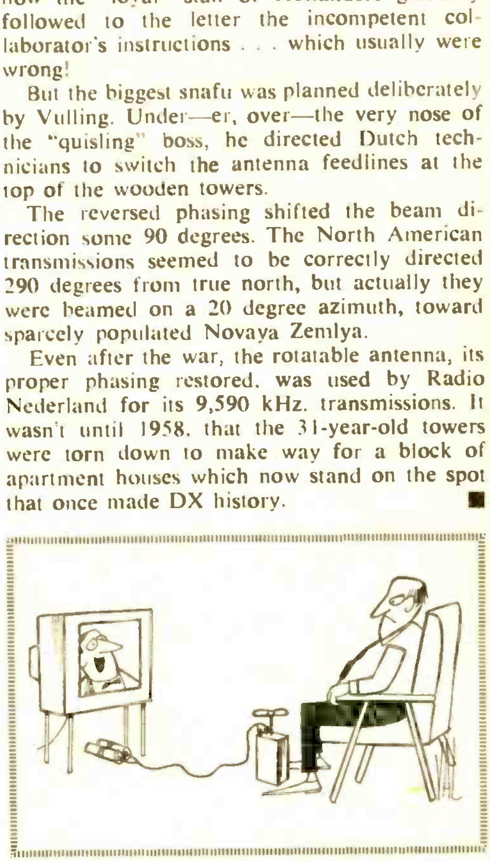
Towers of R. Nederland's PCJ near Huizen.

Vulling remained on at PCJ, but in a subordinate position. Now retired, he still recalls how the "loyal" staff of Hollanders gleefully followed to the letter the incompetent collaborator's instructions . . . which usually were wrong!

But the biggest snafu was planned deliberately by Vulling. Under—er, over—the very nose of the "quisling" boss, he directed Dutch technicians to switch the antenna feedlines at the top of the wooden towers.

The reversed phasing shifted the beam direction some 90 degrees. The North American transmissions seemed to be correctly directed 290 degrees from true north, but actually they were beamed on a 20 degree azimuth, toward sparcely populated Novaya Zemlya.

Even after the war, the rotatable antenna, its proper phasing restored, was used by Radio Nederland for its 9,590 kHz. transmissions. It wasn't until 1958, that the 31-year-old towers were torn down to make way for a block of apartment houses which now stand on the spot that once made DX history. ■



Take Me Along

The most effective way to demonstrate a computer/software package for stockbrokers' "back office" is to pick up the entire hardware system and carry it into the prospect's office, according to Richard Dunsheath, president of Futuristic Applications Corporation here.

That's exactly what Dunsheath and his associates are doing—escorting a general purpose digital computer by private car, taxi and on foot to as many as two demonstrations a day around lower Manhattan.

Futuristic Applications Corp.'s 35-pound computer was developed for small stock brokerage firms, over-the-counter dealers, funds and sophisticated traders.

Waiting for an opening to cross Wall Street, Richard Dunsheath hustles to an appointment with one of Futuristic Applications Corp's 35-lb Varian Data 620/i computers.

One exciting feature of the computer is ticker monitoring, a system which eliminates the need for physically watching the tape. The user inputs as many symbols as he requires and receives typewritten output only if activity takes place in the selected securities or when predefined limits are exceeded. This is of particular interest to mutual funds or those wanting real time margin accounting. The feature is relatively easy to understand by the lay reader. Many more features are available, but are so complicated that only stock brokers and accountants can fully understand them.

Hot Spot for Cool Heads

"Fire in medium pine timber, quite a few down logs on fire, must be an acre or more, burning hot, some crowning. . . .," the excited voice crackling over the radio is that of a U.S. Forest Service trail crew foreman who has just arrived at a lightning-started fire at the 7,000-foot line in the steep-walled, desolate Ponderosa National Forest in the Sierra Nevada Mountains.

Although the voice on the radio suggests the tempo that will build as war is declared on the fire, this fire will not burn a single bush or tree, deface a forest, fell a fleeing fawn, or threaten a home.

The fire appears on a projection screen upon which five different projectors are casting their images to create a scene of unusual realism. The fire simulator, installed at the U.S. Forest Service fire training center at Marana, Arizona, is used to train fire bosses, the "generals" who

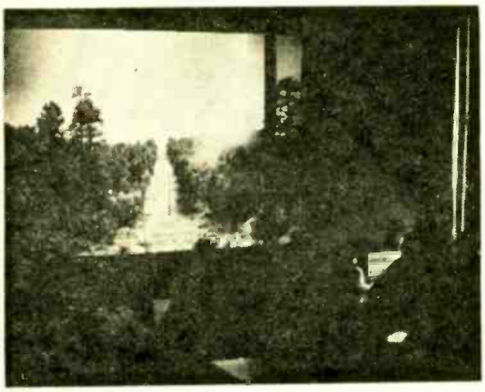
Fire bosses direct their firefighting forces by radio as they watch developing "fire" leap out of control on realistic simulator at U.S. Forest Service's fire management school, Marana, Arizona. Five projectors create realistic picture which responds to control action taken by foresters in training.

must assess a fire situation and deploy men, aircraft, bulldozers, vehicles and materials.

In the specially constructed bell-shaped room near Tucson, the fire boss plays his role and his actions bring prompt and sometimes embarrassingly dramatic results.

If, for example, he directs the pilot of a fire-fighting tanker plane to make his drop of chemicals at the head of the fire, the colorful fire scene on the screen will diminish in intensity at the head of the fire but the flanks will crown and spot as they compete for attention.

In the advanced fire management course, the training follows a branching sequence. The action can follow to some degree a course of events that would be a fair response to comands given by the fire boss in training.



Forester Edward G. Heilman of the National Fire Training Center sets up instructor's console of Raytheon EDEX student response system prior to a firefighting exercise. Student observers will watch simulated fire projection and answer questions at key points using responders at their seats. Their responses help influence course of the exercise and aid the "umpire" in directing the activities.

There are at the present time, more than a dozen fire simulators throughout the United States, used by various federal and state forestry agencies for intensive, professional fire training. The fire simulator at Marana is unique, however, in that it has an additional instructional system, the Raytheon EDEX student response system, which increases the number of trainees from four to 40.

By using the student response system and a special program prepared with the help of Raytheon earning Systems Company, the "observers" become active, participating trainees.

Using selector buttons at their seats, these additional trainees answer multiple choice questions at key points in the exercise and their responses may be used by the "umpire" in directing the activities.

Although every fire represents a loss in timber, watershed, scenic value, or wildlife the course for "generals" is aimed particularly at controlling those catastrophic fires that burn 1,000 or more acres. Of the 12,000 forest fires annually in the United States, less than 50 cause 80 per cent of the total loss.

Fires of this magnitude challenge the fire boss' organizational ability as well as his hard-won fire line experience.

The Raytheon-aided program helps the foresters to deal efficiently with uncertainties, evaluate risks, prepare for contingencies and cope with the varied risks of normal and unusual fire behavior.

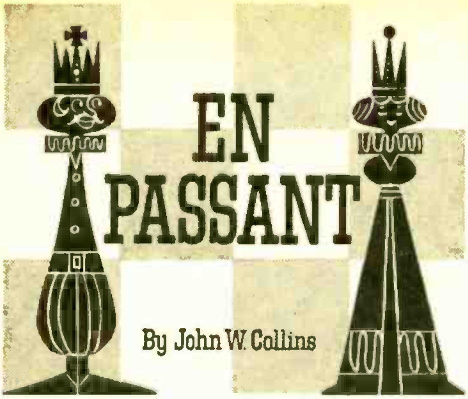
Each trainee has an opportunity to size-up the fire, order and deploy the various resources, plan and execute strategy, and direct his forces —even to the extent of planning what and where they will eat and sleep and how they will be replaced by fresh crews.

An essential ingredient in the program is its dynamic quality. The trainee must constantly make new decisions based on the effects of his earlier decisions. Like the proverbial painter who paints himself into a corner, the trainee at the simulator might even "burn" himself out of his command post.

As part of the realistic details associated with an actual first magnitude fire, the fire boss receives radio reports that some of his equipment is being held up by sightseers blocking the highway. And just as he is expecting a call from a key unit on the fire line he gets one instead from a "newspaper reporter" requesting an in-depth interview on the progress of the campaign.

At another point in the program, a group of residents near the edge of the fire calls to ask if homes in the area should be evacuated.

To insure that he really feels the immensity of the organization and command role, the pilots of the several types of aircraft at his disposal pose typical logistics problems as they report their fuel remaining and the time required to return to their bases. ■



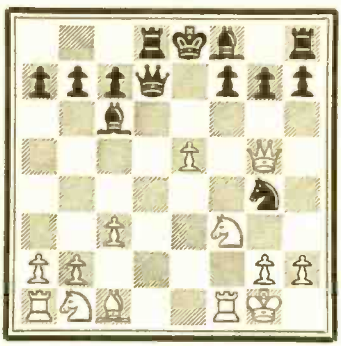
EN PASSANT

By John W. Collins

A batch of typical combinations, attacks and maneuvers, continues our look at the *middle Game.*

Attack On The Square KB7. This occurs frequently. The attackers are usually the Queen, supported by a minor piece, or the King Bishop, supported by the King Knight. And it happens both before and after the opponent has castled.

Black



White

Black moves, 1 . . . . B-B4# 2 K-R1 (if 2 N-Q4, BxN# 3 PxB, QxP# and Black can force a mate in four moves) N-B7# 3 RxN, Q-Q8#! 4 N-N1, QxN# 5 KxQ, R-Q8 mate.

Broken-up Castled Position. This is a situation where the KBPs are doubled, the KRPs are doubled, or the KNP is missing altogether, and the King is subject to attack on the resulting open KN file.

See game top of page 22

The winning combination begins with a Queen *sacrifice.* 1 Q-B3! QxQ (else the Queen is lost) 2 R-N1# K-R1 (interposing the Queen delays the end for only one move) 3 B-N7# K-N1 4 BxP# Q-N5 5 RxQ mate.

(Continued on page 22)

LITERATURE

ELECTRONIC PARTS

2. Now, get the all-new 512-page, fully illustrated *Lafayette Radio* 1970 catalog. Discover the latest in CB gear, test equipment, ham gear, tools, books, hi-fi components and gifts. Do it now!

★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.

4. *Olson's* catalog is a multi-colored newspaper that's packed with more bargains than a phone book has names. Don't believe us? Get a copy.

1. *Allied's* catalog is so widely used as a reference book that it's regarded as a standard by people in the electronics industry. Don't *you* have the 1970 *Allied Radio* catalog? The surprising thing is that it's free!

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.

8. Get it now! *John Meshna, Jr.'s* new 96-page catalog is jam packed with surplus buys—surplus radios, new parts, computer parts, etc.

★140. How cheap is cheap? Well, take a gander at *Cornell Electronics'* latest catalog. It's packed with bargains like 6W4, 12AX7, 5U4, etc., tubes for only 33¢. You've got to see this one to believe it!

135. *RCA* Experimenter's Kits for hobbyists, hams, technicians and students are the answer for successful and enjoyable building, creating, experimenting and learning. Find out for yourself by circling 135 now!

106. With 70 million TV and 240 million radios somebody somewhere will need a vacuum tube replacement at the rate of one a second! Get *Universal Tube Co.'s* Troubleshooting Chart and facts on their $1.50 flat rate per tube.

10. *Burstein-Applebee* offers a new giant catalog containing 100s of big pages crammed with savings including hundreds of bargains on hi-fi kits, power tools, tubes, and parts.

11. Now available from *EDI (Electronic Distributors, Inc.)*: a catalog containing hundreds of electronic items. *EDI* will be happy to place you on their mailing list.

6. Bargains galore, that's what's in store! *Poly-Paks Co.* will send you their latest 8-page flyer chock-full of *Poly-Paks'* new $1.00 electronic and scientific "blis-dor" paks and equipment.

23. No electronics bargain hunter should be caught without the 1970 copy of *Radio Shack's* catalog. Some equipment and kit offers are so low, they look like misprints. Buying is believing.

CB—AMATEUR RADIO SHORTWAVE RADIO

102. No never mind what brand your CB set is, *Sentry* has the crystal you need. Same goes for ham rigs. Seeing is believing, so get *Sentry's* catalog today. Circle 102.

146. It may be the *first*—*Gilfer's* specialty catalog catering to the SWL. Books, rigs, what-nots—everything you need for your listening post. Go *Gilfer*, circle 146!

100. You can get increased CB range and clarity using the "Cobra-23" transceiver with speech compressor—receiver sensitivity is excellent. Catalog sheet will be mailed by *B&K Division of Dynascan Corporation*.

141. Newly-designed CB antenna catalog by *Antenna Specialists* has been sectionalized to facilitate the picking of an antenna or accessory from a handy index system. Man, *Antenna Specialists* makes the pickin' easy.

130. Bone up on the CB with the latest *Sams* books. Titles range from "ABC's of CB Radio" to "99 Ways to Improve your CB Radio." So Circle 130 and get the facts from *Sams*.

107. Want a deluxe CB base station? Then get the specs on *Tram's* all new Titan II—it's the SSB/AM rig you've been waiting for!

96. Get your copy of *E. F. Johnson's* new booklet, "Can *Johnson* 2-Way Radio Help Me?" Aimed for business use, the booklet is useful to everyone.

129. Boy, oh boy—if you want to read about a flock of CB winners, get your hands on *Lafayette's* new 1970 catalog. *Lafayette* has CB sets for all pocketbooks.

46. Pick up *Hallicrafters'* new four-page illustrated brochure describing Hallicrafters' line of monitor receivers —police, fire, ambulance, emergency, weather, business radio, all yours at the flip of a dial.

116. Pep-up your CB rig's performance with *Turner's* M+2 mobile microphone. Get complete spec sheets and data on other *Turner* mikes.

48. *Hy-Gain's* new CB antenna catalog is packed full of useful information and product data that every CBer should know. Get a copy.

111. Get the scoop on *Versa-Tronics'* Versa-Tenna with instant magnetic mounting. Antenna models available for CBers, hams and mobile units from 27 MHz to 1000 MHz.

45. CBers. Hams. SWLs—get your copy of *World Radio Labs'* 1970 catalog. If you're a wireless nut or experimenter, you'll take to this catalog.

101. If it's a CB product, chances are *International Crystal* has it listed in their colorful catalog. Whether kit or wired, accessory or test gear, this CB-oriented company can be relied on to fill the bill.

103. *Squires-Sanders* would like you to know about their CB transceivers, the "23'er" and the new "SS5." Also, CB accessories that add versatility to their 5-watters.

TOOLS

78. You can drive nuts and screws, ream, scribe, pierce holes wtih Xcelite's Series 99 handles and interchangeable blades. Catalog 166 illustrates a variety of kits and sets. Send for your copy now!

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143. Bring new life to your hobby. Exciting plans for new projects—let *Electronics Hobby Shop* give you the dope. Circle 143, now.

★44. Kit builder? Like wired products? *EICO's* 1970 catalog takes care of both breeds of buyers. 32 pages full of hi-fi, test, CB, ham, SWL, automotive and hobby kits and products—do you have a copy?

★42. *Heath's* new 1970 full-color catalog is a shopper's dream. Its 116 pages are chuck full of gadgets and goodies everyone would want to own. Mostly kits are shown but many factory-wired products are available. Get your catalog today!

144. Hear today the organ with the "Sound-of-Tomorrow," the Melo-Sonic by *Whippany Electronics*. It's portable —take it anywhere. Send for pics and descriptive literature.

12. *C. B. Hanson* new Automatic Control records both sides of a telephone call automatically—turns off automatically, too! Get all the details—today!

126. Did you dig *Delta's* new litera-

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ture package chucked full of pics and specs on such goodies as an FET-VOM, SCR ignition system, computerized auto tach, hi-voltage analyzer, etc.? Man, then let *Delta* know you're alive! Circle 126 now!

109. *Seco* offers a line of specialized and standard test equipment that's ideal for the home experimenter and pro. Get specs and prices today.

★9. Troubleshooting without test gear? Get with it—let *Accurate Instrument* clue you in on some great buys. Why do without?

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TELEVISION

★70. The all new Heathkit 1970 catalog is jammed with 7 color TV kits, plus buys on antennas, rotors, towers and other accessories, and TV test gear. Get your copy by circling item 70 below.

127. *National Schools* will help you learn all about color TV as you assemble their 25-in. color TV kit. Just one of *National's* many exciting and rewarding courses.

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★3. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools and instructions come with course.

142. *Radio-Television Training of America* prepares you for a career—not a job. 16 big kits help you learn as you build. 120 lessons. Get all the facts today!

114. Prepare for tomorrow by studying at home with *Technical Training International*. Get the facts today on how you can step up in your present job.

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HI-FI/AUDIO

26. Get with 1970's hi-fi jet set. *H. H. Scott* sets the pace with their fantastic line of audio components, some in kit form, too! *Scott* will send you their 20-page catalog if you circle 26!

104. You can't hear FM stereo unless your FM antenna can pull 'em in. Learn more and discover what's available from *Finco's* 6-pages "Third Dimensional Sound."

119. *Kenwood* puts it right on the line. The all-new *Kenwood* FM-stereo receivers are described in a colorful booklet complete with easy-to-read-and-compare spec data. Get your copy today!

30. *Shure's* business is hi-fi—cartridges, tone arms, and headphone amps. Make it your business to know *Shure!*

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99. Get the inside info on why *Koss/Acoustech's* solid-state amplifiers are the rage of the experts. Colorful brochure answers all your questions.

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31. All the facts about *Concord Electronics Corp.* tape recorders are yours for the asking in their free 1970 catalog. Portable, battery operated to four-track, fully transistorized stereos cover every recording need.

34. "All the Best from *Sony*" is an 8-page booklet describing *Sony-Superscope* products—tape recorders, microphones, tape and accessories. Get a copy today before you buy!

35. If you are a serious tape audiophile, you will be interested in the all new *Viking Telex* line of quality tape recorders.

ELEMENTARY ELECTRONICS
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229 Park Avenue South
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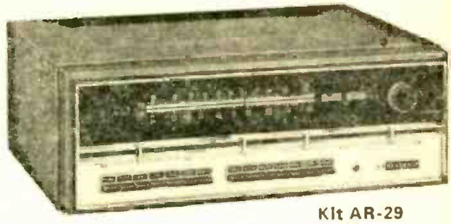
Exciting New Kit Ideas from Heath

New Heathkit 100-Watt AM/FM/FM-Stereo Receiver

World's finest medium power stereo receiver . . . designed in the tradition of the famous Heathkit AR-15. All Solid-State . . . 65 transistors, 42 diodes plus 4 integrated circuits containing another 56 transistors and 24 diodes. 100 watts music power output at 8 ohms — 7 to 60,000 Hz response. Less than 0.25% distortion at full output. Direct coupled outputs protected by dissipation-limiting circuitry. Massive power supply. Four individually heat sinked output transistors. Linear motion bass, treble, balances and volume controls. Push-button selected inputs. Outputs for 2 separate stereo speaker systems. Center speaker capability. Stereo headphone jack. Assembled, aligned FET FM tuner has 1.8 uV sensitivity. Two tuning meters. Computer designed 9-pole L-C filter plus 3 IC's in IF gives ideally shaped bandpass with greater than 70 dB selectivity and eliminates alignment. IC multiplex section. Three FET's in AM tuner. AM rod antenna swivels for best pickup. Kit Exclusive: Modular Plug-In Circuit Boards . . . easy to build & service. Kit Exclusive: Built-In Test Circuitry lets you assemble, test and service your AR-29 without external test equipment. The AR-29 will please even the most discriminating stereo listener.

Kit AR-29, (less cabinet), 33 lbs. $285.00*
AE-19, Assembled oiled pecan cabinet, 10 lbs. $19.95*



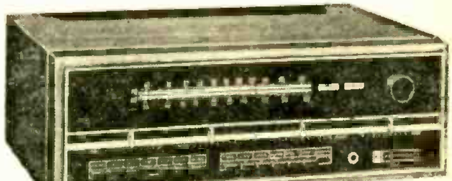
Kit AR-29
285^{00}*

New Heathkit 60-Watt AM/FM/FM Stereo Receiver

The AR-19 circuitry reflects many of the advanced concepts of the AR-29. It uses 108 transistors and 45 diodes including those in 5 integrated circuits. It delivers 60 watts music power at 8 ohms. At any power level, Harmonic and IM Distortion is less than 0.25%. Frequency response ranges from 6 to 35,000 Hz. Direct coupled outputs are protected by dissipation-limiting circuitry. A massive power supply includes a section of electronically regulated power. The assembled, aligned FET FM tuner has 2.0 uV sensitivity.

A preassembled and factory aligned FM IF circuit board gives 35 dB selectivity. The multiplex IC circuit provides inherent SCA rejection. It features two switched noise muting circuits; linear motion controls for bass, treble, volume and balance; input level controls; outputs for 2 separate stereo speaker systems; center speaker capability; two tuning meters; stereo indicator light; front panel stereo headphone jack. The Modular Plug-in Circuit Board design speeds assembly. Built-in Test Circuitry aids assembly, simplifies servicing. "Black Magic" panel lighting, black lower panel, chrome accents. Compare it with any model in its price range . . . the AR-19 will prove itself the better buy.

Kit AR-19, (less cabinet), 29 lbs. $225.00*
Assembled **AE-19**, cabinet, 10 lbs. $19.95*



Kit AR-19
225^{00}*

New Heathkit Deluxe 18-Watt Solid-State Stereo Phono

Looks and sounds like it should cost much more. Here's why: 16-transistor, 8-diode circuit delivers 9 watts music power per channel to each 4½" high-compliance speaker. Speaker cabinets swing out or lift off . . . can be placed up to 10' apart for better stereo. Has Maestro's best automatic, 4-speed changer — 16, 33-1/3, 45 & 78 rpm. It plays 6 records, shuts off automatically. Ceramic stereo cartridge with diamond/sapphire stylus. Has volume, balance & tone controls. Changer, cabinet & speaker enclosures come factory built . . . you build just one circuit board . . . one evening project. Wood cabinet has yellow-gold & brown durable plastic coated covering. This is a portable stereo you can take pride in.

Kit GD-109, 38 lbs. $74.95*

Kit GD-109
74^{95}*

New Heathkit 80-10 Meter 2 KW Linear Amplifier

Incomparable performance and value. The new SB-220 has 2000 watts PEP input on SSB & 1000 watts on CW and RTTY. Uses a pair of Eimac 3-500Z's. Pretuned broad band pi input coils. Requires only 100 watts PEP drive. Solid-state power supply operates from 120 or 240 VAC. Circuit breaker protected. Safety interlocked cover. Zener diode regulated operating bias. Double shielded for max. TVI protection. Quiet fan — fast, high volume air flow. Also includes ALC to prevent over-driving. Two meters: one monitors plate current; the other is switched for relative power, plate voltage and grid current. Styled to match Heath SB series. Assembles in about 15 hours.

Kit SB-220, 55 lbs. $349.95*

Kit SB-220
349^{95}*

New Heathkit Portable Fish-Spotter

Costs half as much as comparable performers. Probes to 200 ft. Spots individual fish and schools . . . can also be used as depth sounder. Manual explains typical dial readings. Transducer mounts anywhere on suction cup bracket. Adjustable Sensitivity Control. Exclusive Heath Noise-Reject Control stops motor ignition noise. Runs for 80 hrs. on two 6 VDC lantern batteries (not included). Stop guessing — fish electronically.

Kit MI-29, 9 lbs. $84.95*

Kit MI-29
84^{95}*

SEE MORE FROM HEATH ON NEXT PAGES

Continued from page 15

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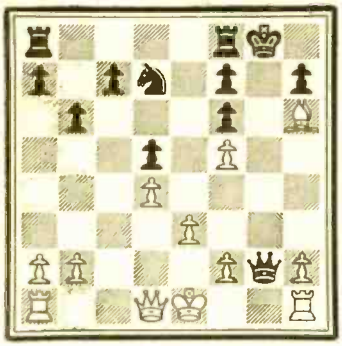
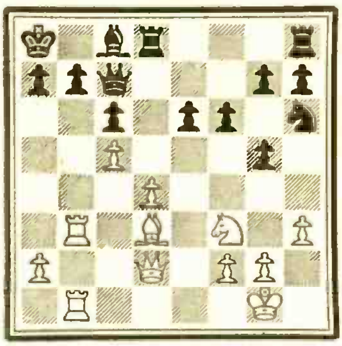


White

Attack Along The Knight File. This motif is similar to the previous one. And the combination begins again with a surprise move.

Black



White

1 B-R6! (threatening to snare the Queen and achieve a winning position with 2 BxP# BxB 3 RxB, QxR 4 RxQ, KxR 5 Q-N4#) PxB 2Q-R5! Q-B5 (if 2 . . . . QxQ 3 R-N8 mate: and if 2 . . . . R-Q2 3 QxQ, RxQ 4 R-N8 mate) 3 P-N3 and White mates or wins the Queen.

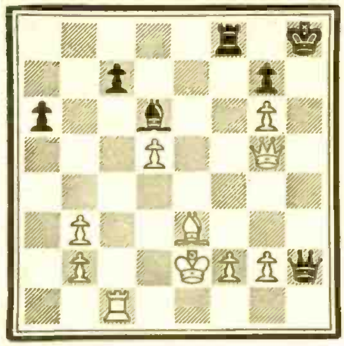
Attack Along The Rook File. And the threats in this maneuver are apt to be even more dangerous than those on the Knight file, a mate usually being involved.

See game top of next column

1R-B4 (threatening to win the Queen with 2 R-R4#) K-N1 2 R-KR4, Q-K4 3 R-R8#! Kx R 4 Q-R4# K-N1 5 Q-R7 mate. A Pawn at KN 6 can be a dagger at the throat!

Game of the Issue. Grandmaster Samuel Reshevsky of Spring Valley, N.Y., is again Champion of the United States. After a hiatus of about a decade, caused by successes of Grandmasters

Black



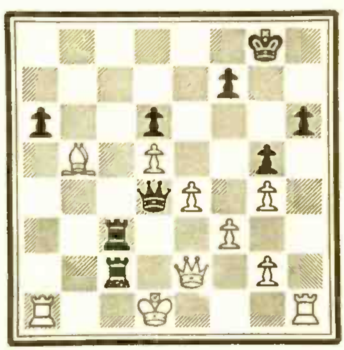
White

Evans and Fischer, the 58-year-old veteran, once a prodigy, regained the title he had held six times before by scoring 8-3 in the 20th Annual Championship, held in New York at the Group Health Insurance Building, during November-December, 1969. Earlier in the year, he won the Eighth International Tournament at Natanya, Israel. A good year!

Reshevsky considers the following game against Dr. Anthony Saidy of California to be his best in the Championship. In the 9th Round, on the Black side of a Benoni System, the new champion sacrifices his QBP in order to open the QB file and the QR2-KN8 diagonal, and then wins with a fierce onslaught on the two White Monarchs.

1	P-QB4	P-KN3	11	B-N3	N-R4
2	P-Q4	B-N2	12	N-Q2	NxB
3	N-QB3	P-QB4	13	RPxN	N-Q2
4	P-Q5	P-Q3	14	P-KN4	N-K4
5	N-B3	N-KB3	15	P-B3	P-R3
6	P-K4	O-O	16	P-R4	B-Q2
7	B-K2	P-K3	17	P-R5	P-N4
8	B-N5?	P-KR3!	18	PxP e.p.	QxP
9	B-R4	PxP	19	R-QR2	P-B5!
10	BPxP	P-KN4	20	NxP	NxN

Position after 29 . . . . Q-Q5#!



21 BxN	KR-B1	26 BxB	R-B7!
22 B-Q3	BxN#	27 Q-Q3	Q-B7#
23 PxB	RxP	28 K-Q1	R/1-B6
24 Q-Q2	QR-QB1	29 Q-K2	Q-Q5#!
25 R-R1	B-N4	Resigns	

Why did White resign? Because he is about to lose his Queen and be mated. Here is the analysis—

A. If 30 K-K1, R-B8# (30 . . . . RxQ#, 30 . . . . R-K6, and 30 . . . . PxB clearly win too) 31 RxR, RxR# 32 Q-Q1, RxQ# 33 K-K2, mate.

B. If 30 K-K1, R-B8# 31 Q-Q1, QxQ# 32 K-B2, QxR and Black is a Queen and the Exchange up with a continuing mating attack.

C. If 30 Q-Q3 (30 Q-Q2, QxQ mate) RxQ# 31KxR (31 BxR, QxB# 32 K-K1, Q-K7 mate) R-Q7# 32 K-N3, R-N7# 33 K-R3, Q-N5 mate.

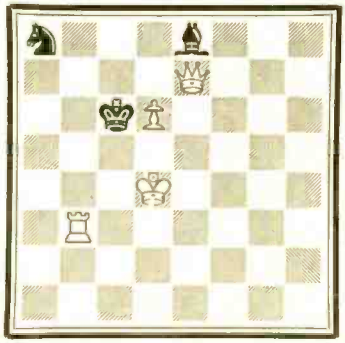
D. If 30 B-Q3, RxB# (or 30 . . . . RxQ) 31 KxR (31 QxR, QxQ# 32 K-K1, Q-K7 mate) R-B6# 32 K-N1 (32 K-N2, Q-N5# 33 K-R2, R-R6 mate) R-N6# 33 K-B2 (33 K-B1, QxR# 34 K-B2, Q-B6# 35 K-Q1, R-N8 mate) Q-N7# 34 K-Q1, QxR# 35 K-Q2, Q-B6# 36 K-Q1, R-N8 mate.

Who says "they never come back"?, and will stick to this old saying!

Problem 24

By E. Boswell
The Problemist, 1953

Black



White

White To Move And Mate In Two.
Solution In Next Issue.

(Continued on next page)

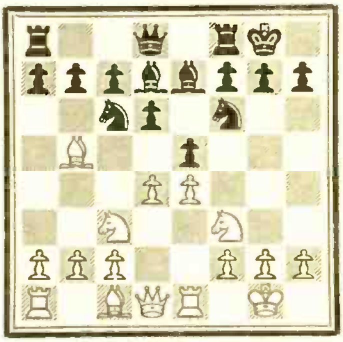
Solution To Problem 23: 1 N-B2.

If 1 . . . . B-K4 2 Q-R2 mate. If 1 . . . . B-Q5 2 P-B4 mate. If 1 . . . . BxP (or any other Bishop move than B-K4 and B-Q5) 2 Q-K4 mate. A threat, complete block, type problem.

Traps. A famous old trap, which somebody falls into every day in some chess club, is the Tarrasch Trap in the Steinitz Defense to the Ruy Lopez. It goes like this—

1 P-K4	P-K4	5 N-B3	N-B3
2 N-KB3	N-QB3	6 O-O	B-K2
3 B-N5	P-Q3	7 R-K1	O-O?
4 P-Q4	B-Q2		

Black



White

Stepping into it. Correct is 7 . . . . PxP.

8 BxN	BxB
9 PxP	PxP
10 QxQ	QRxQ

Or 10 . . . . KRxQ 11 NxP, BxP 12 NxB, NxN 13 N-Q3, P-KB4 14 P-KB3, B-B4# 15 K-B1, R-KB1 16 K-K2, B-N3 17 PxN, PxP 18 N-B4, P-N4 19 N-R3! P-N5 20 N-B4 and White is a piece ahead.

11 NxP	BxP

If 11 . . . . NxP 12 NxB, NxN 13 NxB# K-R1 14 PxN and this time White is two pieces ahead.

12 NxB	NxN
13 N-Q3!	. . . .

Not 13 RxN??? R-Q8# 14 R-K1, RxR mate.

13	P-KB4	16 B-N5	R-Q4
14 P-KB3	B-B4#	17 B-K7	R-K1
15 NxB	NxN	18 P-QB4!	RxB

If 18 . . . . R-Q7 19 BxN, RxR# 20 RxR, RxP 21 R-K8# K-B2 22 R-K7# and White wins.

19 RxR	. . . .

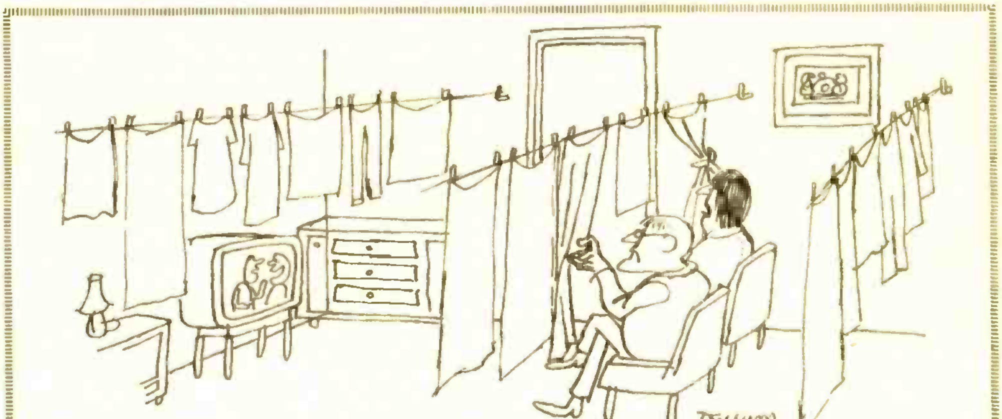
And White has gained the Exchange.

"Castle if you must, or if you wish, but not when you can!"—Napier.

News And Views. Final Standing in the 1969 United States Championship: Reshevsky, 8-3, Addison, 7½-3½, Benko, 7-4, Lombardy, 6-5, D. Byrne, 5½-5½, Evans, 5½-5½, Mednis, 5½-5½, Zukerman, 5½-5½, R. Byrne, 4½-6½, Saidy, 4½-6½, Bisguier, 4½-6½, and Burger, 2-9. As this was an FIDE Zonal Tournament, the top three players qualify for the next Interzonal Tournament.

The 1969 Canadian Championship and Zonal Tournament was held at Pointe Claire, P.Q. during August. Duncan Suttles of Vancouver, B.C., and Zvonko Vranesic of Weston, Ont., tied for first with 13-4 each.

Anatoly Karpov of the USSR is the new World Junior Champion. ■



"You wanted TV. I wanted an automatic dryer!"

ELEMENTARY ELECTRONICS ETYMOLOGY

By Webb Garrison

Helium

▲ Joseph N. Norman was one of the last great scientists to be largely self-educated. In spite of his lack of formal training he became a world authority in solar physics.

Norman recognized the importance of solar eclipses, pioneered in organizing expeditions to observe them. One such jaunt took him to India in 1868. There he discovered a previously unnoticed bright yellow spectral line. He correctly concluded that it pointed to the existence of an element not yet discovered on earth.

Since clues to the exotic stuff were found in the solar spectrum it was natural for Norman to name it from Greek *helios* (sun). Sir William Ramsay isolated minute quantities of sun-gas, or *helium* in 1868. Inert, it had no known use.

Now produced by radioactive changes and by bombardment of such elements as lithium and boron with high-speed particles, on Earth helium is rare in the natural state.

Helium-bearing natural gas was discovered in Kansas just after the turn of the twentieth century. Cost of extracting it ran to more than $2,000 per cubic foot. Lighter-than-air craft of World War I and afterward created a demand for the gas. By 1932, its price had dropped to less than 5¢ a cubic foot.

Now generally used to inflate toy balloons, the inert gas found important industrial uses in cooling electric motors and fireproofing high-tension switch boxes. Today the element that was discovered from a distance of 93,000,000 miles accompanies man on journeys into ocean depths and other formerly inaccessible places.

Glass

▲ Precisely when and where men first learned to melt and cast sand, no one knows. In his volume on *Natural History*, the famous scholar Pliny credited Syrian artisans with having discovered techniques behind commercial production of glass.

He had little tangible evidence for that verdict. But Pliny's guess is plausible since Syria had great quantities of suitable sand—plus forests from which to secure fuel for furnaces.

Very early, merchants took articles made of the brittle substance into Northern Europe. An ancient Teutonic prefix, *glo-* or *gla-* was already attached to names of many shiny substances. Vases and bottles imported from Africa glowed almost like amber. So the queer stuff from afar came to be called *gles* in Old Saxon, *glaes* in Old English, and *glas* in Old High German.

With spelling standardized as *glass*, the product of the furnace was put to many uses. With the possible exception of paper and a few major metals, glass was the most important raw material used in bringing the modern age to birth.

Thousands of different kinds of it are manufactured today. Many instruments require special types, high or low in particular ingredients. X-ray tubes, for example, require glass with little or no lead, barium or antimony.

If our planet were not supplied with abundant raw materials from which to make many kinds of glass our whole technology would be radically different.

Whatever its composition and function, every type of glass still gives at least a bit of the "glow" from which Teutonic tradesmen and artisans named it.

Calibration

▲ Arabic *qualib* (mold for casting metal) is believed to have shaped the word *caliber*.

Military men were the first Europeans to use the word. It was important that they determine with some accuracy the outside dimensions (calibre) of cannon balls, bullets, and other projectiles. Most of these were produced by molding, so the connection with primitive devices for casting metal was logical.

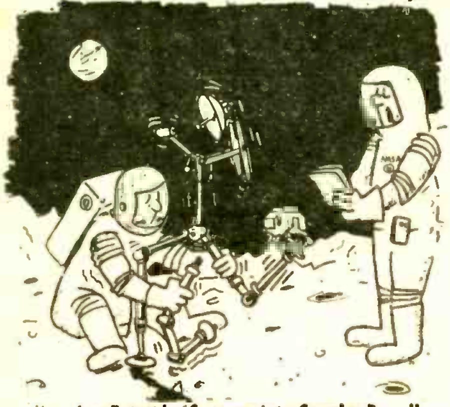
In time, increasingly sophisticated methods of production made it important to know the bore or inside dimension of guns, tubes, and other devices. Physicians borrowed the military word and applied it to measurement of their most vital instrument—the thermometer. Makers of precision tubes eventually found out how to compensate for irregularities.

Importance of determining calibre spread to scientific instruments as well as weapons and thermometers. Firmly fixed in speech as a result of this circuitous journey, *calibration* is now a general term for the process of measuring variable quantities or elements—or determining deviation from a fixed standard.

So the word born in primitive Arabian smelters names one of the most important processes linked with the electronic revolution. Whether a professional or an amateur, a person who expects to get good results from his equipment has to know at least a little about calibration. ■

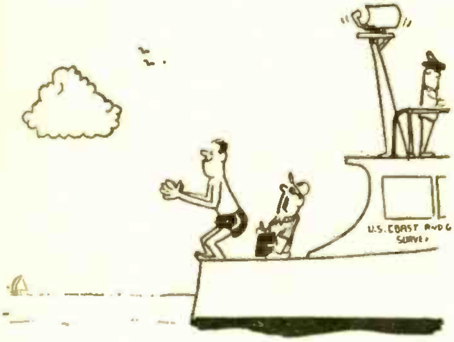
THE EXPERIMENTS

by Jack Schmidt



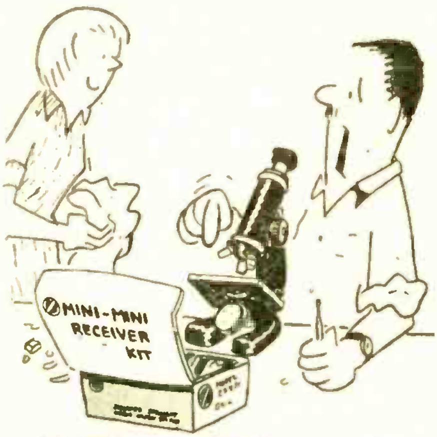
"... Leg Extender C screws into Coupler R ..."

"Right now he's measuring my tolerance level!"



"Now listen, Marvin, couldn't we measure water temperature just as easily with a buoy?"

"Your father planted a wireless bug, but he can't remember where!"



"See if this matches the living room motif."

"Watch that laser, Melvin!"

elementary Electronics MAY-JUNE 1970

Everybody loves
to make a speaker system!
So try our . . .

POLAR-PLUS

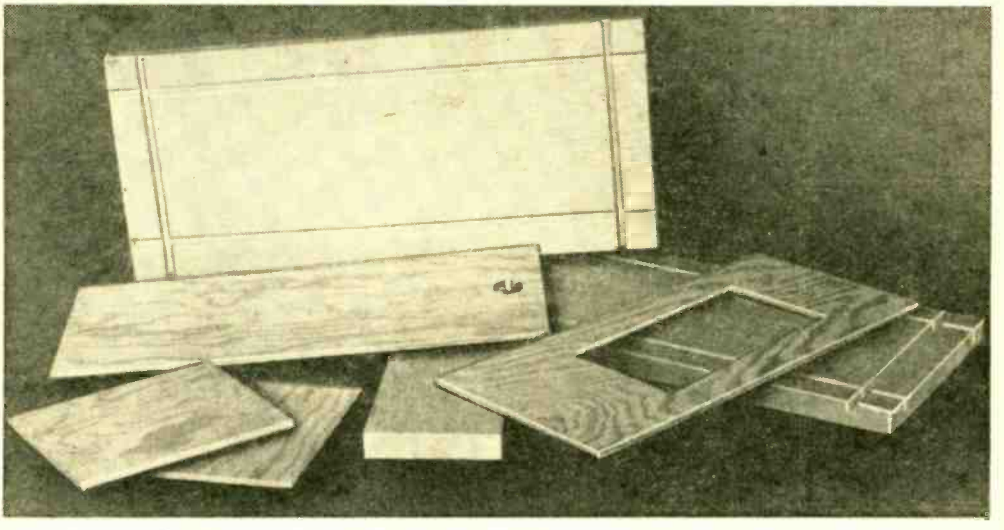
by Charles Green, W6FFQ

You keep hoping, as do most audiophiles, that someone will come up with a design for a better speaker system, whose reproduction approaches the natural tone of the original performance, yet is simple enough that you can make it at a reasonable cost. You should be able to build our Polar-Plus speaker system for about $10.00 (depending on local prices for plywood, etc.). Make two, and the speakers for your new stereo system will cost less than one of the conventional budget-priced speakers.

Vast changes in technology have developed over the past few years. The space age, with men walking on the surface of the moon, has brought new materials to the foreground that replace older established ones. Traditionally, speaker cones have been made of paper. Now, one of the space-age materials, compacted bead-structure expanded polystyrene plastic, has been used in our Polar-Plus speaker system to make a radically different type of speaker. We used this new type of speaker in our compact speaker enclosure, which was designed especially for it.

Plastic Speaker. The Poly-Planar speaker's *modus operandi* is the same as a conventional paper cone type permanent magnet, moving coil dynamic speaker. But, except for the moving coil-PM structure, the Poly-Planar speaker differs radically from the conventional. A plastic, foam-like, flat panel, made rigid with a special surface skin treatment, replaces the conventional paper cone, diaphragm and permanent magnet, which, by the way, along with the voice coil, is the only metal in the speaker. The model P-5 Poly-Planar was housed in our enclosure, which has been designed to conserve space and yet provide sufficient baffling to compensate for the roll-off at the low end of the spectrum. Poly-Planar P-5 speaker mechanism measures 4½-in. wide by 8½-in. long by 13/16-in. deep. The manufacturer states that its frequency range is from 60 Hz to 20 kHz with a power handling capability of 5 watts maximum, and that its sensitivity is 80 dBm for 1W electrical input. Input impedance of the Poly-Planar is 8 ohms.

Enclosure. We designed a simple bass-reflex enclosure for the P-5 Poly-Planar.



Here's how all plywood needed for Polar-Plus looks after you've cut it to sizes specified in list of materials. Sand two ¾-in. pieces to a satin smooth finish since grille cloth doesn't cover them and they finish best when smooth.

making the speaker a very compact unit. The Poly-Planar speaker used in our Polar-Plus enclosure is less than one inch in depth.

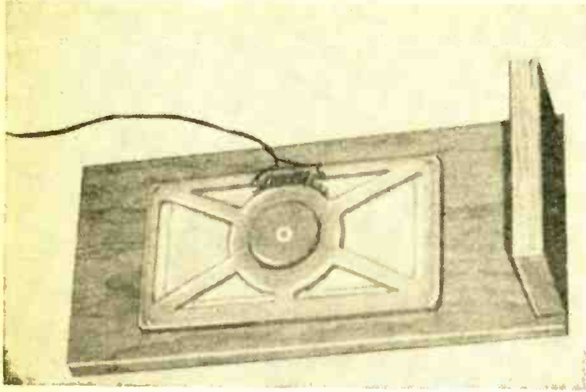
The speaker's plastic panel diaphragm is made from expanded polystyrene, and, since the expanded material is largely air, the weight of this plastic panel is very low. The manufacturer states that the flat rectangular panel, acting as an air piston, moves a greater volume of air than a paper cone of an equivalent size. This accounts for the superior low frequency response.

The Poly-Planar speaker also employs a plastic frame, molded from the same material as the panel so that both will have the same coefficient of expansion, to support the This enclosure is 17¾-in. high by 7½-in. wide by 7½-in. deep.

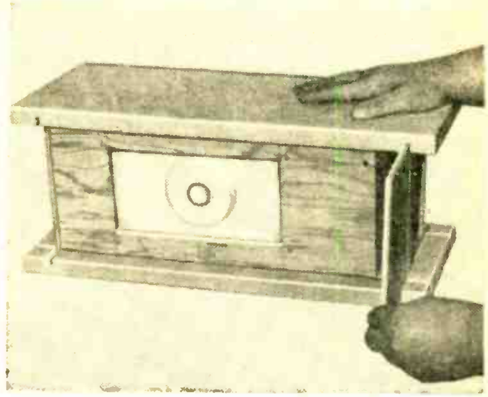
The unbaffled P-5 was found to resonate at approximately 120 Hz. The enclosure port opening was adjusted to lower the low frequency resonance point to approximately 76 Hz.

The small size of the enclosure makes it adaptable for either bookshelf or floor locations. The efficiency of the speaker system makes it ideal for operation from low audio power-output equipment having a maximum output of 5 watts.

Construction. The enclosure for Polar-Plus is made from ⅛-in. plywood panels glued to ¾-in. white pine end pieces. Start



Here's how Poly-Planar speaker mounts on baffle (E). Piece D is fastened to bottom of E so that it's just 1-in. above bottom panel B, forming with side panels A, 1-in. port.



Once you've set side panels A and baffle E in place and glued them you're ready to finish enclosure by sliding bottom and top B in place. Seal joints with glue for tight fit.

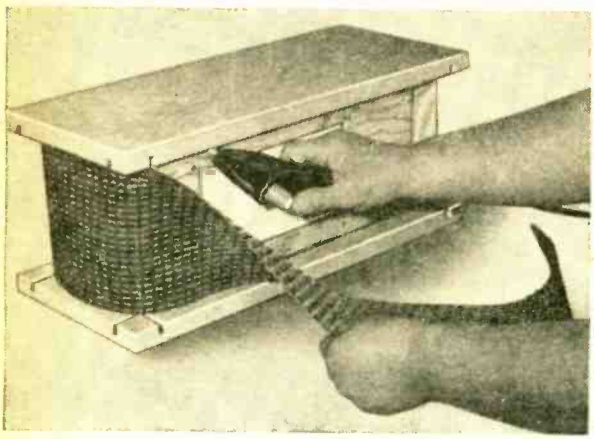
the construction by cutting all of the wood panels to the sizes specified in the drawing.

Position the cut-out for the speaker so that the bottom of the speaker frame will be 4 in. up from the bottom of the front panel (E), and centered within its width. After the speaker opening is cut out, locate and drill the four speaker-mounting holes in this panel. After mounting the speaker on the front panel, we used a glue gun to seal the plastic frame of the speaker to the inside of the wooden panel (E). Then fasten the 5½-in. long section of piece D to the bottom of this panel with wood screws and glue. Since the front panel is 6½-in. wide, and piece D is 5½-in. wide, it should be centered so that there will be ½ in. of clear space at each end at the bottom of the front panel.

Solder lengths of stranded hookup wire approximately 24-in. long to the speaker terminals. Drill a hole and mount a phono jack (J1) approximately 1 in. up from the bottom of the rear panel (C).

Cut a groove ⅛-in. wide and ⅜-in. deep, 1 in. in from the edge around the periphera of both side panels (A) on their inner surface. (A total of four grooves on each panel.) Make sure that the grooves are straight and parallel to each edge.

Place one of the side panels (A) on your workbench with the grooves facing up, and position front panel E in the groove so that



Electric glue gun serves two purposes here. It glues various panels to side pieces and is also used to glue grille cloth around outside of enclosure. See text for details.

We finished two sides in dark brown stain that blends well with grille cloth and makes white pine look like walnut. Newspaper wrapped around sides protects grille cloth.

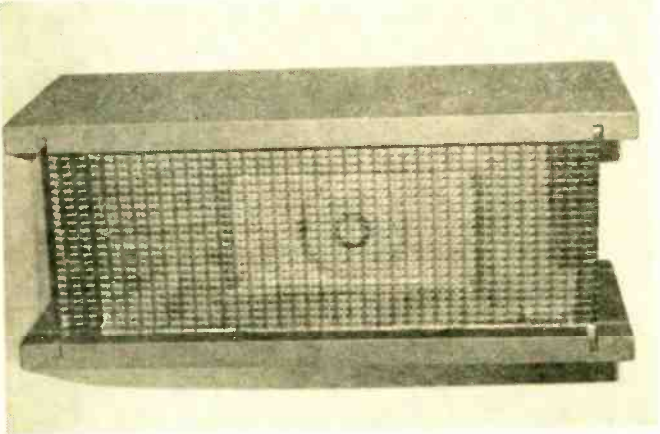
its top edge is flush with the bottom edge of the groove at the top of panel A. The bottom edge of the front panel E (with the D section fastened to it) should be 1 in. from the top edge of the bottom groove. Glue the front panel to the side panel groove.

Next, position the rear panel (C) in the groove on this side panel (A) so that its ends are flush with the bottom edge of the top groove and top edge of the bottom groove. Glue the rear panel in this groove. At this stage of construction, connect the speaker wires to the terminals of jack J1, making certain that you allow some slack in the wires. Glue or staple the wires to the inside to prevent movement and rattles.

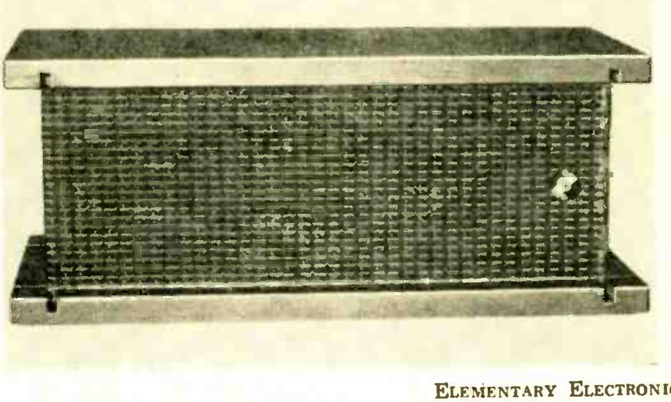
Carefully position the other side panel (A), so that the front and rear panels that have been glued to one side panel (A) fit into the grooves of this second side panel (A) and that the side panels are parallel to each other. Glue the second side panel (A) in place. Slide the top and bottom panels (B) into their respective grooves on both side panels (A) and glue them in place. It may be necessary to sandpaper the edges of the various panels so that they will fit snugly in the grooves. Seal off all joints with glue so that there is no leakage of air at the seams.

Cut the grille cloth to size so that one piece can completely surround front, rear, top, and bottom panels, and glue it in place around the panels, thus covering all surfaces except for the two side panels. Make sure the grille cloth fits snugly around the phono jack. We removed the jack temporarily from the unit, cut a small hole in the grille cloth for the wires and remounted the phono jack over the cloth after it was glued to the rear panel.

The side panels (A) are stained or painted to blend with the color of the grille cloth. Carefully cover the grille cloth with newspaper before painting or staining the side panels to keep paint or stain from getting on the cloth. ■



Here's how your Polar-Plus speaker will look from front when you've completed construction. Two of these make an ideal pair for bookshelf or floor placement of your stereo system.

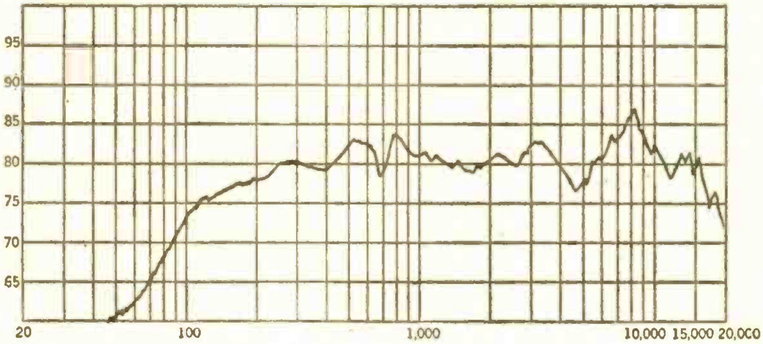


And here's the back of Polar-Plus. Back looks almost identical to front except for jack used to make connections between Polar-Plus and your amplifier. Decorate speakers to suit your own scheme.

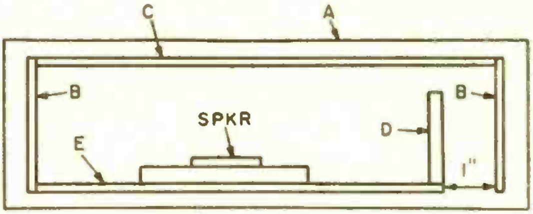
BILL OF MATERIALS FOR POLAR-PLUS SPEAKER

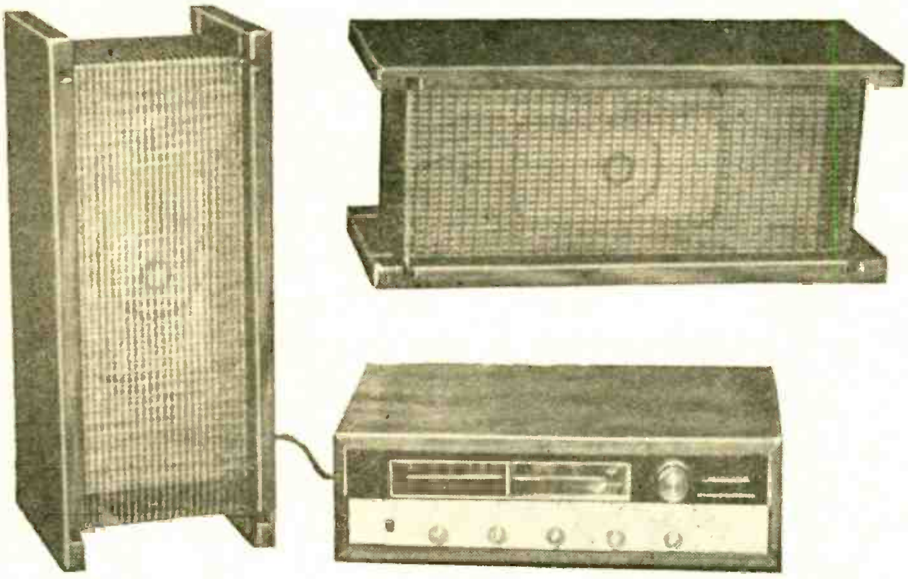
A—17¾ x 7½ x ¾-in. white pine (2 required—see text regarding grooves to be cut into each panel)
B—5⅜ x 6½ x ⅛-in. plywood (2 required)
C—15 x 6½ x ⅛-in. plywood (1 required) (see text on mounting speaker)
D—3¾ x 5½ x ¾-in. white pine (1 required)
E—14 x 6½ x ⅛-in. plywood (1 required)
J1—Phono jack (Lafayette 32E64587 or equiv.)
SPKR—Model P-5 Poly-Planar speaker (Lafayette 21E56024 or equiv.)

Misc.—Grille cloth, paint or wood stain, glue, wood screws, hook-up wire, staples



Curve above shows wide range of Poly-Planar 5. At right we've removed one side (A) of enclosure to show placement of parts. A pair of Polar-Plus's are connected to a Midland AM/FM-stereo receiver. One's been set upright to show they work both ways.



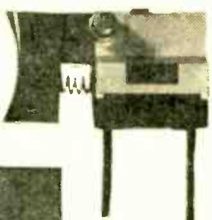


Add

How many times have you wished for a variable speed, ¼-in. electric drill instead of your old trusty single-speed job? You, as do most average electronic hobbyists, undoubtedly work with many materials from plastics, to Bakelite, to metals. Yet, quite often, the single speed of the average quarter-incher causes more grief than a houseful of termites. Reason for this is that the high bit speeds of the average ¼-in. drill shatter soft and hard plastics and Bakelite. Another problem with high speed drills is that the bit slips from a too shallow center mark and usually ruins the finish of the material you're drilling, whereas a slow speed drill has much less tendency to slip out of the center punch starter. Then, too, if you're drilling a large hole the slow speed drill is recommended over a high speed one.

To overcome this problem you can either invest in one of the newer vari-speed drills, or use an external variable-speed control. In both instances, you can expect to dent your wallet. But now, for only $5.65, you can update your beloved quarter-incher with a Variable Speed Trigger Control that equals the vari-speed triggers used in the latest drills priced from $30.00 on up.

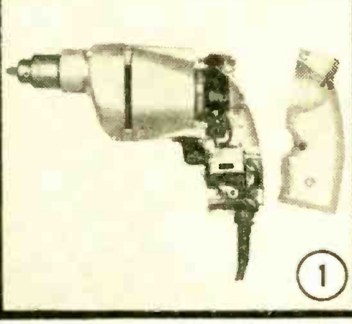
Model TC101 (Bathtub style)



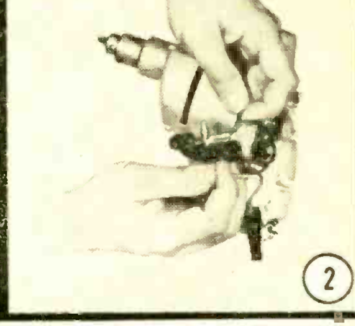
Model TS-102 (Contour style)

How It Works. The TS101 and TS102 Variable Speed Trigger Controls, available from Motors-Controls Company, Mequon, Wis. (see photos at left), are just about the same size as the trigger switch in your present single-speed drill, and have been designed to replace it. These trigger con-

First disconnect power! Open handle and lift out old switch (photo 1); if wires plug in, use small drill, paper clip, etc., as probe to release (photo 2). With old switch removed you wind up with empty space, 2 line-leads, and 2 motor-leads (photo 3).



1



2

Speed Control

trollers contain a linear, slider-type variable resistor and an SCR. The controller is connected in the same way as the standard trigger switch in your single-speed drill (in series with one motor lead), thus placing the SCR in series with the motor.

As the trigger is pulled, the mechanically linked slider reduces the resistance in the SCR gate circuit, allowing the SCR to pass more current as it conducts over a larger angle of half the AC cycle. (Remember, the SCR is a rectifier and eliminates half the AC cycle.)

Simple To Install. The trigger control is installed in place of the existing trigger switch assembly. First step, open the handle (photo 1) of the drill to expose the old *on-off* trigger switch. Generally, it can be lifted out of the handle as few drills have the trigger switch secured with a screw. The switch leads, usually connected by wire nuts (photos 2), are disconnected, the old switch is removed (photo 3), and the new one connected in its place (photo 4), and then the handle is reassembled.

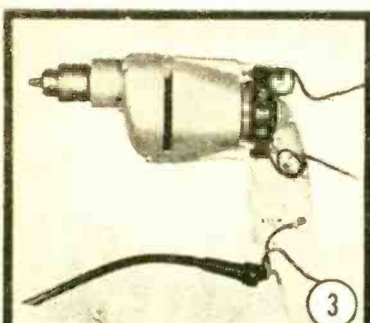
Performance. By comparison, the TS101 or TS102 trigger control works just as well as the vari-speed control of the $30.00 or higher drill. Typically, a short thrust of the trigger of about ½-in. operates the drill from *off* through a slow crawl to full speed. Because the SCR rectifies the AC input, the converted drill's top speed drops to about 85% of its original speed. This will create no problem and isn't even noticed by the average user. (An SCR controlled drill runs 85% of top speed for comparable single speed models.)

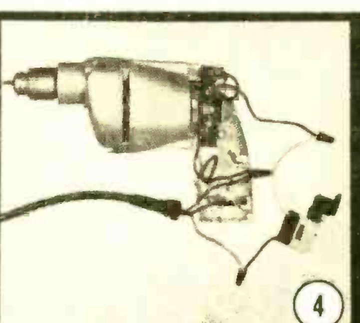
Is Vari-Speed Useful? The answer is a big YES! The slow speed crawl makes stirring paint or mixing epoxy a simple one-two, no-splatter job. Drilling plastic without gumming the bit or cracking the plastic is now child's play. You will find the variable speed most useful when using the drill to drive screws, for drilling concrete, for polishing, and for sanding. You can even drill accurately located holes without center-punching; just start hole using crawl speed.

Once you've used a variable speed drill you will wonder how in the world you got along without it. Before the availability of the inexpensive, small, solid-state SCR you either invested in both high and low speed drills, or else you bought a rheostat to use between the power outlet and the drill for slow speed work. At best, external speed controllers are a big nuisance, as they are always in your way and take up extra bench or work space unnecessarily.

The TS101 (Bathtub Assembly Trigger Control) will fit most modern ¼-in. drills However, when ordering, you must specify the make and model of the drill in which it will be installed. A companion Contour Style trigger control, model TS102, is available at the same price.

For additional information write directly to the manufacturer, Motors-Controls Co., Box 9A, Mequon, Wis. 53092. ■



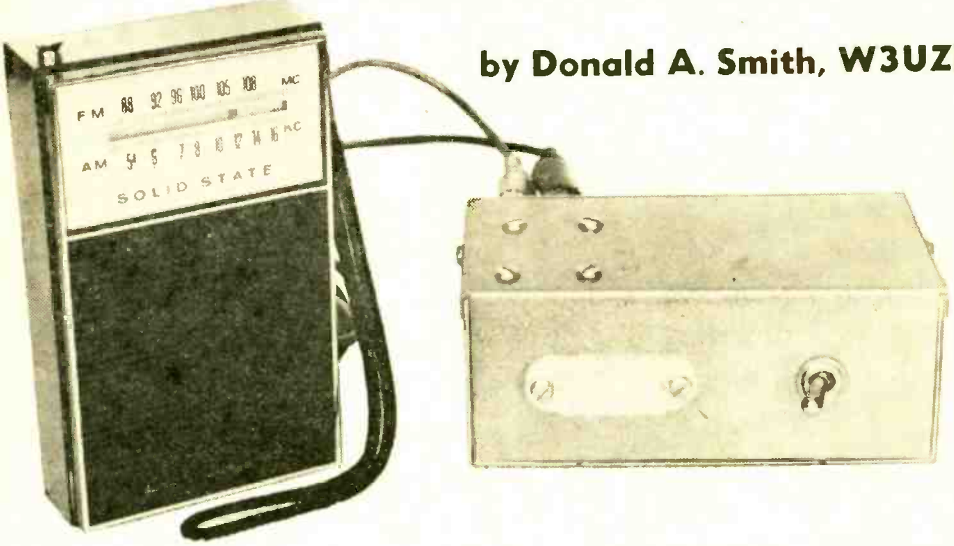


Connect black line-lead to one motor-lead, other motor-lead to one trigger control-lead. White line-lead goes to remaining trigger control-lead (photo 4). Position trigger control in handle, dress leads neatly, and close handle. You are ready to drill anything.

TLPS...

Build our TLPS for a happy home and

by Donald A. Smith, W3UZN



ARE YOU TIRED of continually buying new 9-V batteries for Junior's transistor radio because he insists on using his sets excessively (like maybe 16 hours a day) in the house, where, most likely, more than one line-powered receiver that's capable of reproducing rock music can be found? From the number of inquiries we get in the mail there must be a vast number who are tired of this and would gladly spend an evening on our simple construction project to rid themselves of this chore.

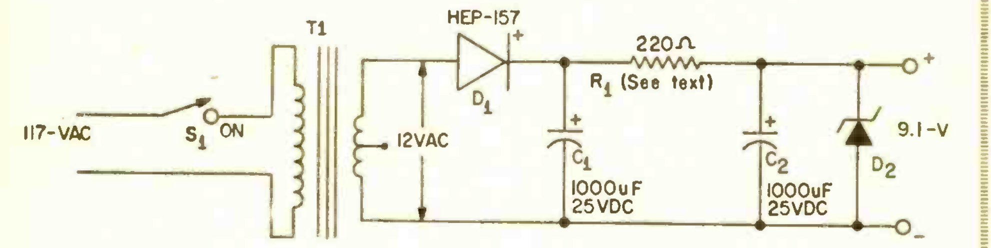
As you may have guessed from the title, we're going to show you how easy it is to get out of that rut by building our TLPS (transistor line power supply). It's simple and easy to build, provides ample, well filtered, regulated 9 VDC to power the receiver directly from the line without concern of damaging it by excessive high voltage, a condition easily encountered with poorly regulated power supplies.

How It Works. The nominal 117-V, 60-Hz line power is reduced to 12 VAC by T1. Diode D1 rectifies this AC voltage and capacitors C1 and C2, along with R1, act as a brute force filter to remove most of the AC ripple. Resistor R1 serves another purpose too. It acts as a voltage dropping resistor to bring down the 12 VDC from the rectifier to 9 VDC, and to limit the current flow through the Zener diode regulator when the load is removed. If, by chance, you require 12 VDC instead of the 9-V output featured in our supply, two minor component changes are all that's required to effect the change in output voltage: 1) change resistor R1 from 220 ohms to 100 ohms, and 2) change the Zener diode from the 9-V HEP-104 to a 12-V HEP-105.

Construction. The photos show two different styles of construction for the TLPS: one an open chassis, and the other housed in a minibox similar to an LMB #138. You can use either one, or, for that matter, mount it in whatever type of housing suits your particular application. The parts layout isn't critical, so make it in whatever form you

power supply

declare your independence from batteries

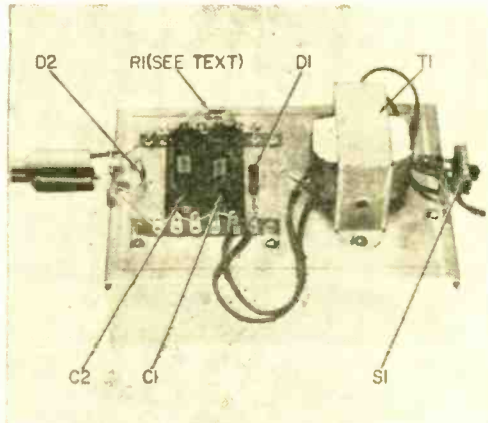


PARTS LIST FOR TLPS

C1, C2—1000-uF, 25-VDC electrolytic capacitor (Cornell-Dubilier BR1000-25 or equiv.)
D1—400-PIV, 1-A silicon rectifier (Motorola HEP-157 or equiv.)
D2—9.1-V, 1-W Zener diode, (Motorola HEP-104 or equiv.—see text)
R1—220-ohm, ½-watt resistor (see text)
T1—Power transformer; 117-V 50-60 Hz pri., 12-V secondary (Stancor P-8130 or equiv.)
Misc.—Suitable box (LMB #138 as shown or Premier AMC 1006), wire, multipoint tie strips, 2-conductor, jacketed cable, solder, connectors (see text), hardware, etc.

prefer. The use of multi-point tie strips for mounting filter capacitors, diodes, and resistor R1 is an excellent way to do the job. You may prefer binding posts or banana jacks to connect to the output if the supply is to be used for general transistor projects. You could extend the output to a length of 2-conductor cable, terminated in a connector made from the terminal board removed from a discarded 9-V battery so you can plug the power supply directly into the device being powered by it.

A word of caution: be sure the capacitors, diodes, and output terminations are correctly polarized before soldering them into the circuit. Because of the simplicity of this project, you shouldn't encounter any problems, just double-check your wiring for accuracy before plugging the supply into a wall outlet. Now you can let them use their sets to their hearts' content and not be pestered by run-down batteries again. ■



This version built on a conventional chassis instead of in a minibox as the one shown on opposite page. Since circuit isn't critical build it to fit your needs. Tie strips hold parts neatly in place.

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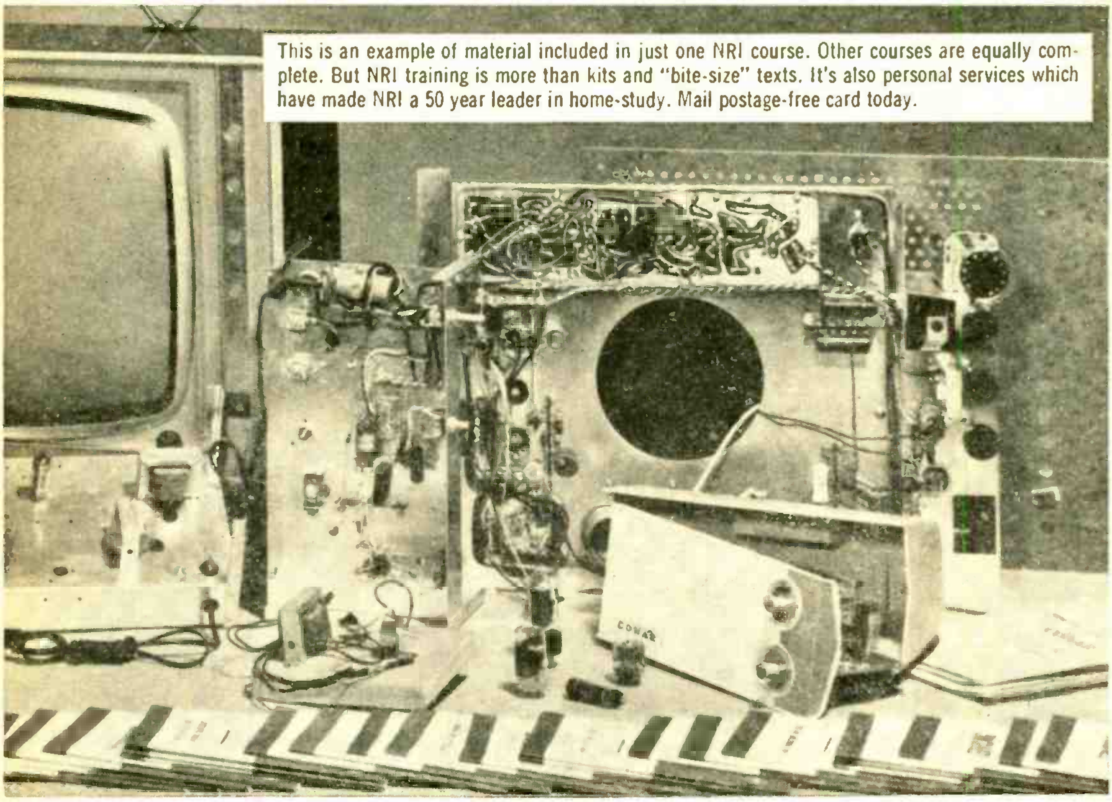

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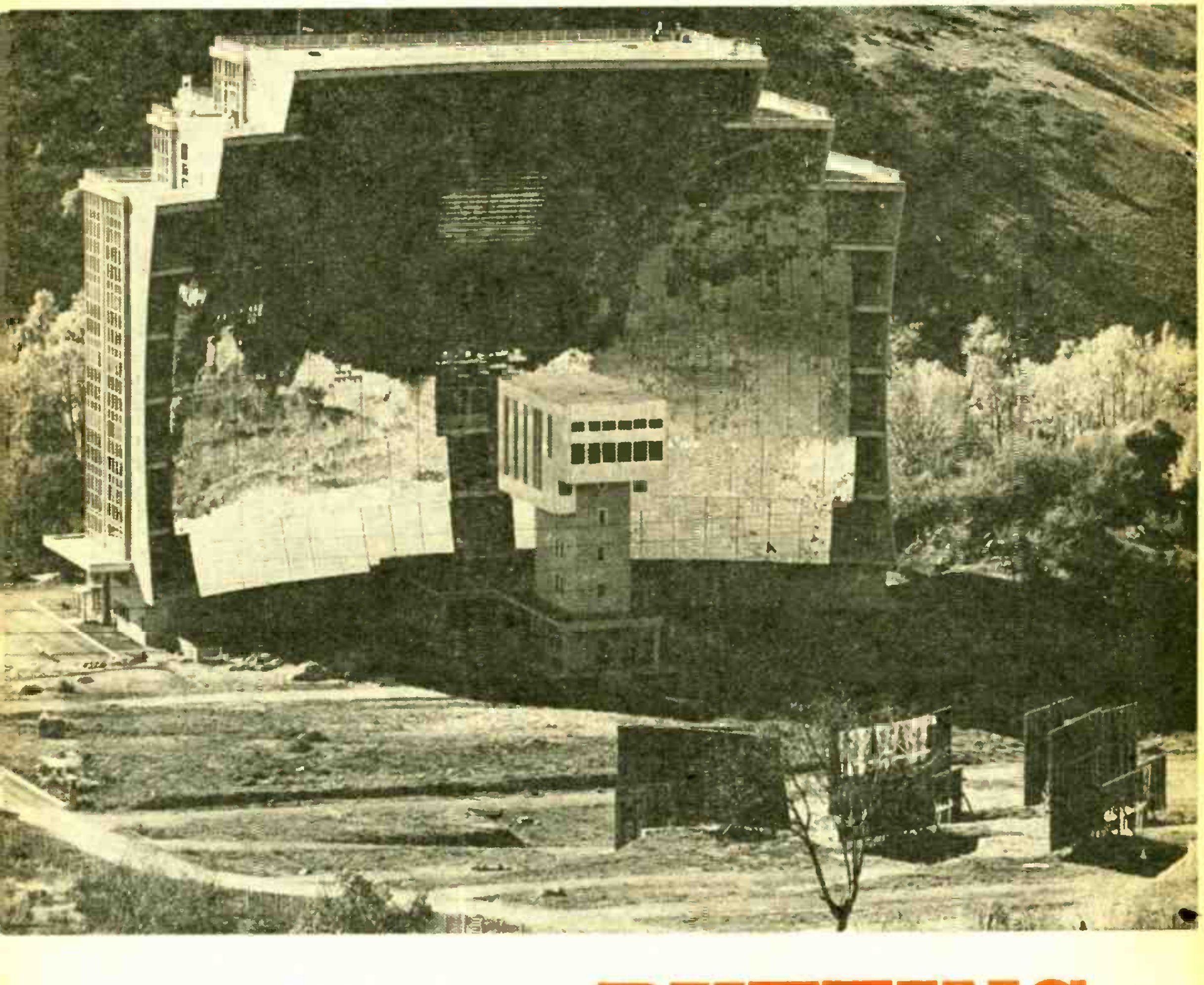


PUTTING OLD SOL'S WARM HEART TO WORK

■ For centuries men have gathered warm and sustaining sustenance from the sun's rays. From it they have gathered the physical and spiritual fruits of its high existence, and by man's interest and upward gaze we realize the power and life-giving force of this fascinating and as yet completely unexplainable phenomenon.

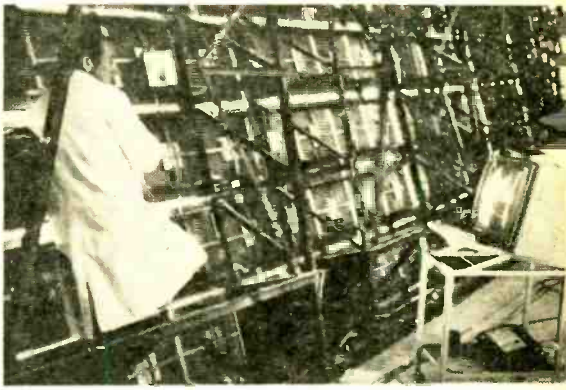
Sun worship and sun myths are found in ancient mythologies of many races. Ancient and modern men have constructed their mathematics and time tables from our planet's travel on its course around the sun. This blazing white circular disc as it is seen through a telescope, and red to the eye, has been the object of worship and study since man first looked up.

It is by looking at these facts that we see the history of the interest in the sun. From the great sun god Ra in Egypt (the pyramids are said to be constructed to symbolize the sun's rays descending), to the present moon shots the importance of the sun and its influence on our lives is sometimes a fact that we take for granted. But the power of its rays and influence is an everyday reality that is becoming more and more recognized. Thus, we see some men of science, in a little French town in the Pyrenees Mountains called Odeillo, building a modern temple to the sun to study its power. Here they are getting closer to its understanding by the ways they are trying to use its power and energy for many domestic uses.

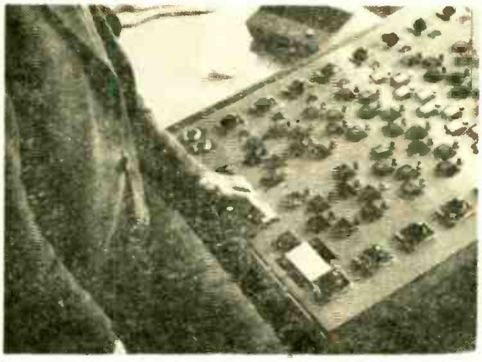
Here, at Odeillo, scientists come from all over the world to study the sun. For this new laboratory, this new scientific temple to the sun, is one of the biggest in the world.

These scientists hope to harness the sun's rays for many uses. They have been able to design units that heat houses, and are now experimenting with the sun's high heat intensity to cut through thick metal. A curved mirror 120-ft. high and 170-ft. wide accompanied by 9000 other smaller mirrors capture the sun's heat to about 2000°F. That's more than enough heat to bore

Looking like creature from outer space, this electric eye controls Odeillo's many mirrors. Unit is at front, reflection in rear.

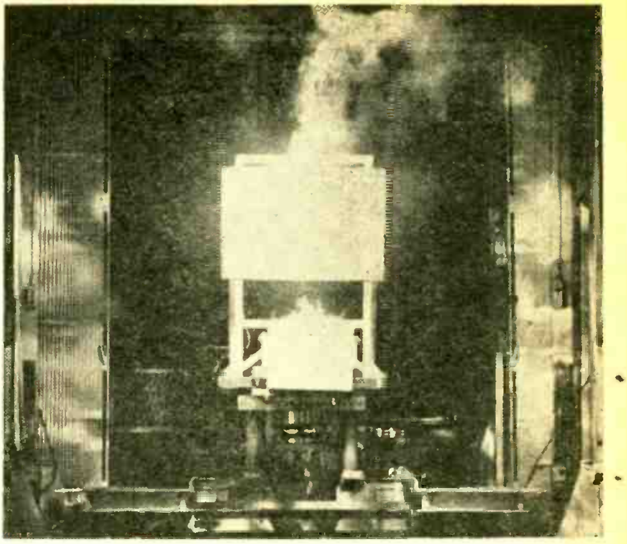


Many mirrors located inside complex demand individual attention to focus them on central focal point inside laboratory's oven. Here, one of Odeillo's engineers relies on TV hookup to aid him in zeroing in on sun.



Engineer stands before central control board of Odeillo's mirror-spangled solar furnace.

e/e OLD SOL TO WORK



By concentrating sun's rays on one central focal point, energy is sufficient to melt 1-in. plate of steel in 50 short seconds.

through a 1-in. plate of steel in *fifty seconds*.

With these many mirrors offering a very large sunshine capture area, scientists have been able to magnify the sun's heat by bringing its rays to a central focal point, much like that of a small magnifying glass. But, it's much more complex than the simple picture painted. An electronic system controlled by electric eyes directs the mirrors to reflect the rays of the sun via thousands of concave mirrors that capture the sun's heat and energy at one point in the laboratory.

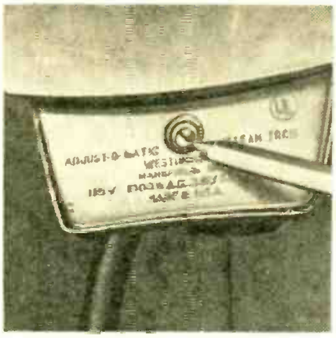
Study of the sun and its potentialities has been somewhat sadly neglected in the last few years, but we must give praise and thanks to scientists like Prof. Felix Trombe who has spent the last 20 years in this field, and his chief technical engineer, Mr. Le-Phat-Winh. Both men have left other more glorifying fields of study to pursue this one.

But others may take notice that the spots on the sun can affect the investment trends of Wall Street; and that the sun cycle and the stock market have something in common. Perhaps it is the sun and not the moon to which we should turn our attention. ■

France's Professor Felix Trombe is one of pioneers in study of use of sun's power. Here, he holds piece of 'pure' chemical substance produced at Odeillo. Substance is called pure because it is devoid of foreign substances introduced by normal smelting procedures.

PUT YOUR ELECTRIC IRON BACK ON THE LINE

by John McNarney



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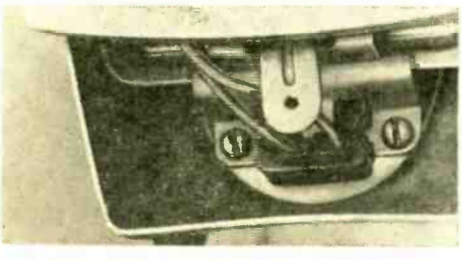

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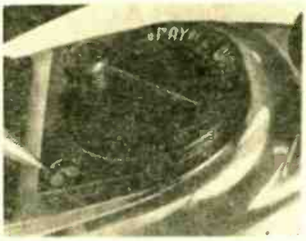
A toaster that won't toast, a mixer that won't mix, a heater that won't heat and an iron that won't iron can very well have one common fault—a defective line cord. There's no need to throw out the appliance, just replace the line cord—it's that easy!

The photos show clearly the problems involved in changing the line cord on a Westinghouse steam and dry iron. This electric iron was singled out mainly because too many are discarded solely because the average home repairman believes that an iron of this type is beyond his repairing skills. This, we will show you, is not so. As a bonus, tips are tossed in to cover other repairs in an electric iron. Numbers in parentheses (   ) refer to photos.

First off, locate the identification plate (1). Model number will come in handy when ordering parts from dealer located through the yellow pages. On some irons, plate may conceal a hinge for easy opening. Others may have a stud under the control knob to release the hinge. You'll have to poke around the decorative handle and trim, or control knob, to release a catch to unhinge the iron.

This iron (2) is built without a hinge as discovered by removing the identification plate. The handle must be removed. To do so, remove some trim (3) to discover the screws that are hidden. Be careful not to damage decorative trim or plates when prying them off.

Unfortunately, after lifting the trim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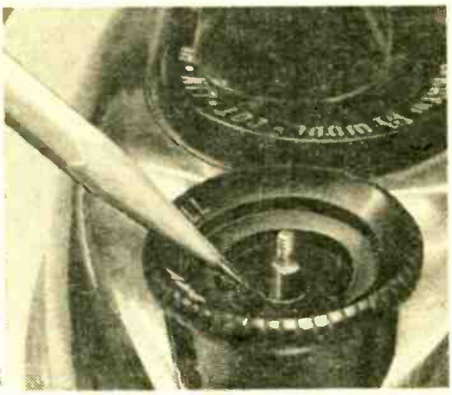
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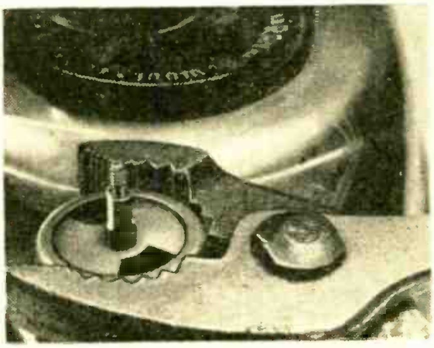
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plate from this iron (4) it was discovered that both the handle and the temperature control knob are secured from inside the case on top of the iron. Next step, open the iron! You see, we did not pick an easy example.

A close look at the valve assembly (5) shows that a hex nut on top of the stem is recessed into a chrome trim follower. The follower does not move when the water knob is turned. Inspection showed that when the knob is turned to the lowest (dry) position, it is possible to remove the hex nut. It pays off to examine what you are about to do very carefully!

Now, stop! This is a good time to get a picture of the lay of the parts (6). With the hex nut and follower out of the way, but before lifting out the control knob, check the location of all parts and openings for all switch control settings. In fact, it pays not to trust to memory. Draw a sketch of the relationships of the parts to each other now and reassembly will be easier, even if it's done the following day or week.

With the control knob out of the way (7), the valve can be unlocked with a pair of pliers. Again, the original positions of the openings should be observed. In this case, the top of the assembly is cast in one piece and just about a quarter turn will release it. Be careful—cast metal pieces break easily with pressure from tools. On some irons you might find a snap ring used here, or a flanged ring threaded into the mouth of the tank. Don't fret—once the assembly is out in the open, the method of removal is fairly obvious.

Here is a view of the valve stem assembly (8) and the lugs which engage the tank nut and lock the top of the iron in place. Lift the valve stem assembly and the lugs which engage the tank nut. The valve stem can be lifted out and cleaned, but the tip is easily damaged and should be treated gently. An old tooth brush will do the cleaning job well. Again, the position of any springs, washers or spacers should be noted during disassembly to ensure that reassembly is correct.

Finally, with the tank nut and valve stem assembly removed, the iron can be opened, exposing the line cord

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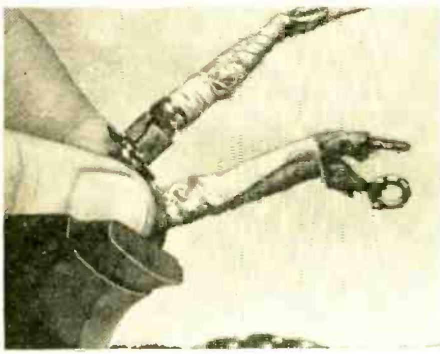

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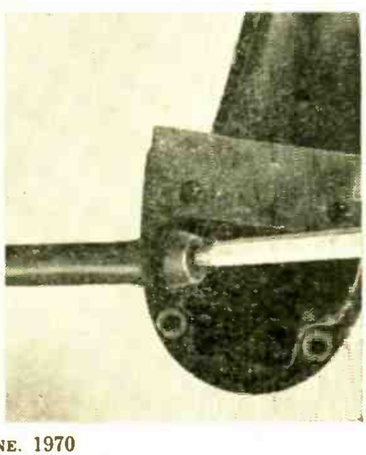

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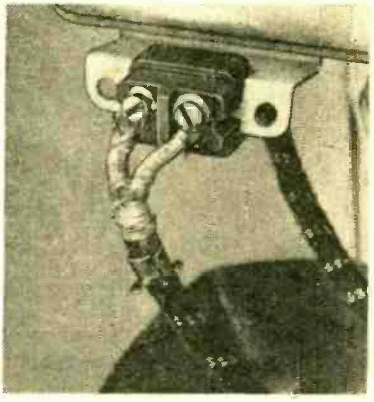
terminals. In this case, the old taped cord has jammed in the handle and had to be cut away. This view (9) also shows the stem of the temperature control emerging near the center of the tank and the mouth of the tank near the lip.

While not necessary when changing the line cord, the tank itself would be easy to remove. It is held in place by a shoulder on the valve seat. Depending on the make of the iron, the valve seat can be unscrewed and withdrawn through the mouth of the tank.

It's always wise to follow the leader —especially when the leader is the manufacturer of the iron. The manufacturer has more experience with his own electric iron than a legion of repairmen. When it comes to installing the metal strain relief on the new line cord (10), keep the old line cord handy to measure exact position from ends. If you are lucky and use an exact replacement, the manufacturer may have the strain relief molded on the cord—no sweat here.

If a new line cord sleeve is used (11), install it first. Under no circumstances should you leave this part ouf of the final assembly. The rubber sleeve serves as an oversized grommet that keeps the line cord from fraying or kinking at the point where it enters the iron. The sleeve prevents almost sure line cord replacement after a few weeks' use. Also, the sleeve helps keep the line cord away from the iron while in use.

One point should be stressed before we proceed with our picture story. Use only exact replacement line cords made by the manufacturer or suitable products designed for electric irons. Under no circumstances are you to use plastic-coated or rubber-coated wire intended for products that do not generate large amounts of heat. One quick visual check of a line cord is to look for the asbestos insulation wrapped around the line cord's leads under an exterior cloth-weave covering. If the asbestos is not there, do not use that line cord on the iron. Also, check for mechanically fixed eyelets or lugs that are secured to the line cord. These offer the best mechanical connection. Wire wrap-around connections are hazardous at best. *(Turn page)*



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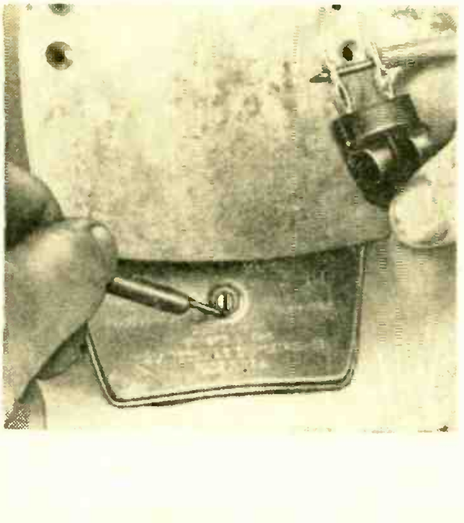

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The new line cord is now in position (12) and mechanically secured. Note the clean connection the eyelets make under the screw heads without any frayed wires sticking out. Also, the metal strain relief is mounted on the cord—the iron can now be reassembled.

With the cover in place (13), but before replacing the valve stem assembly and tank nut, be sure that the stem from the thermostat is properly engaged in the heat control knob. This will be easier if the stem is set in either at the HIGH or OFF position before the cover is lowered.

Don't trust to your skills alone. Pull out your ohmmeter and check continuity between the two prongs on the line cord's plug. Also, short both prongs with one test lead and check for short or leakage from the prongs to the iron's metal body. Skip this step and you're fooling with serious hazards like electrocution and fire!

If you cannot obtain replacement parts for your electric iron locally from the maker's authorized dealer or repair service, then write directly to the manufacturer. Be sure to give the manufacturer all the facts on your unit's nameplate and identification plate. Try to describe the parts needed. A line cord is easy to describe, but small parts may not. So, draw a simple sketch—this will help. You can also write to SECO Division, Simmons Electric Company, 112 South 20th St., Birmingham, Ala. 35233. For only 50¢ they can send you a catalog that every appliance repairman at home should own. Get a copy—parts replacements on tough dogs will be easier whether it's an iron, mixer, hair dryer, or what not!

The differences between a coffee maker, a rotisserie, and the steam iron shown on these pages are a lot more apparent than their similarities. Yet, in a surprising number of cases when a what-ever-it-is just sits there on your workbench sneering, the fault will be found in the power link between the wall outlet and the output side of the unit's on-off switch. You'll discover that the basic techniques used successfully on an electric iron will be found to apply with other appliances, too! Now, fall out and attack those defective appliances and put them back on the line. ■

Parallel Resistance Nomograph

Pick out the value of paired, parallel resistance—by Thomas R. Sear

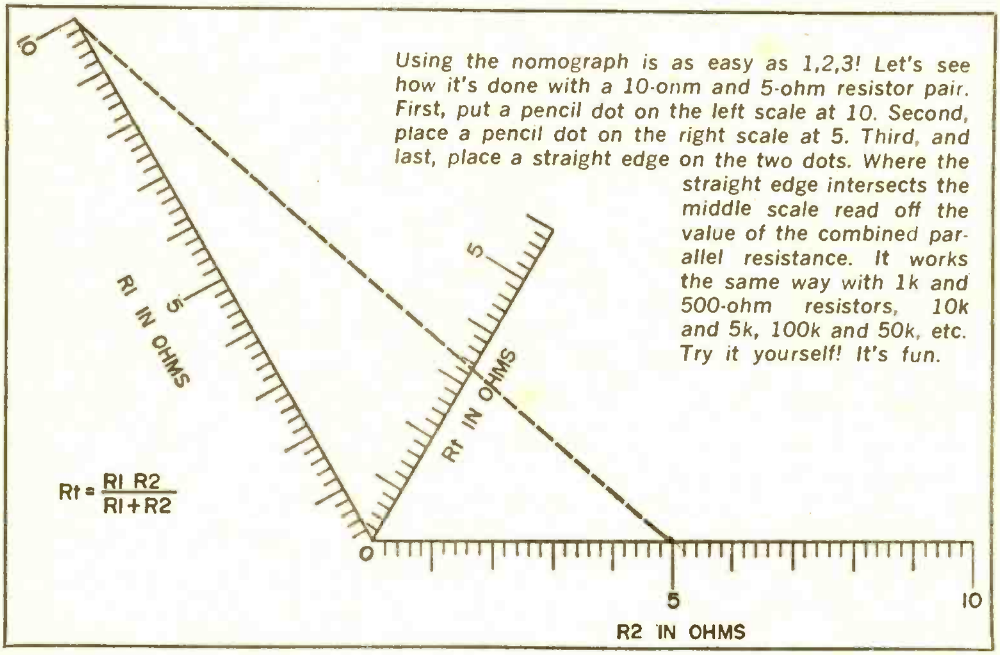
WHETHER you're working at home on the final stages of a pet project, or on the job servicing an electronic system, nothing is quite as frustrating as discovering that the resistance value you need isn't available. And, your usual source of supply either is closed or doesn't stock that partitcular value. Or maybe you want a resistance within a tolerance of 1%, and just don't feel justified in paying the extra cost.

Whatever the problem, the experienced guy doesn't lose his cool, because he knows he can come up with any resistor value he needs by connecting available resistors in series and/or parallel. This combination can either be left in the circuit or replaced at some later time with a single resistor.

Making Resistors. Making resistors by *series-ing* several resistors to reach a desired value poses no problem as the resistances are additive; i.e., if you connect a 51-ohm resistor in series with a 68-ohm resistor the final resistance of the combination is 119 ohms.

However, when you parallel resistors, the resultant resistance is no longer so easy to calculate. If you connect a 51-ohm resistor in parallel with a 68-ohm resistor the net resistance value is about 29 ohms. About the only thing you know is that the equivalent resistance of a parallel combinattion will be less than the value of the smallest resistor in the combination. You can't determine the equivalent resistance of a parallel combination with simple mathematics. The formula isn't complex, but it does take time to write down and solve. The easiest, fastest modern method for determining the values of parallel resistor combinations for the serviceman is by using an equivalent resistance nomograph.

What's A Nomograph? Everyone's familiar with the old old Chinese proverb about one picture being worth a thousand words. A nomograph is simply a graphic picture of a simple approach to solving a mathematical calculation. And technicians in all fields are using nomographs in ever-increasing numbers. A nomograph can be constructed to solve almost any problem, and though the actual construction may require a master's degree in math, anyone can use the final end product to solve problems which might normally require a college de-



$$Rt = \frac{R1\ R2}{R1 + R2}$$

Using the nomograph is as easy as 1,2,3! Let's see how it's done with a 10-onm and 5-ohm resistor pair. First, put a pencil dot on the left scale at 10. Second, place a pencil dot on the right scale at 5. Third, and last, place a straight edge on the two dots. Where the straight edge intersects the middle scale read off the value of the combined parallel resistance. It works the same way with 1k and 500-ohm resistors, 10k and 5k, 100k and 50k, etc. Try it yourself! It's fun.

gree and bushels of valuable time.

This is one of the most appealing features of most nomographs: i.e. that you don't need theoretical knowledge of the subject to use a nomograph to solve problems in that field. All that's necessary is to lay a straight edge, or draw a line, between two known values on given scales, and read the answer where the line intersects a third scale.

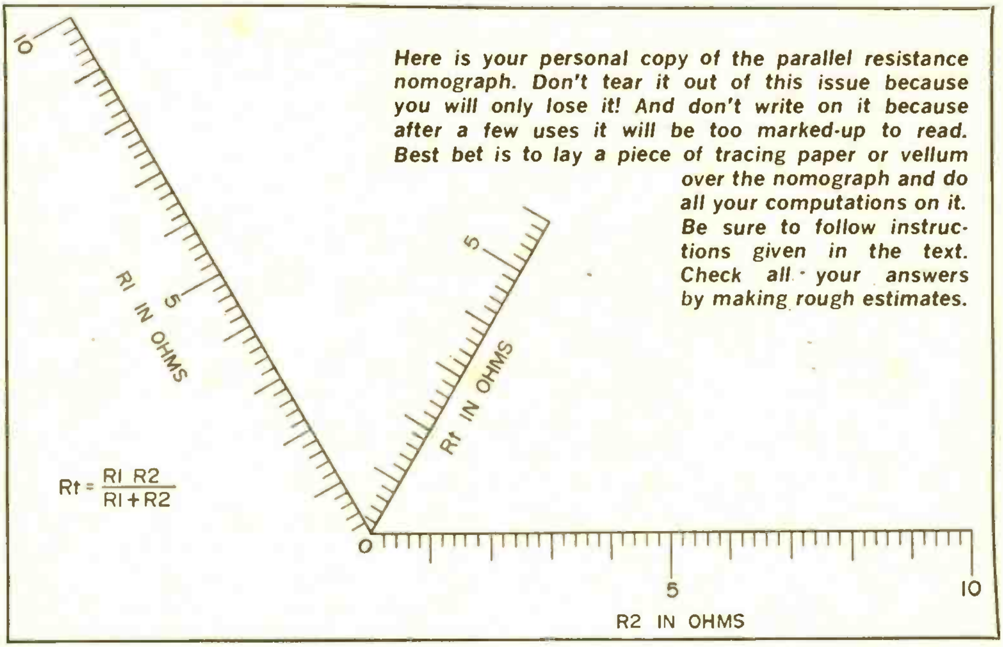
Making A Nomograph. The nomograph printed in these pages is an equivalent resistance nomograph that can be cut out for use in your work. With it you can determine the resistance of any two resistors connected in parallel in much less time than you could normally write down the mathematics required to solve the problem.

The R1 and R2 scales are equal in length, and positions at an angle of 120° with respect to one another. The R_t scale is a little more than one half the length of the other two scales, and bisects the angle between them. The scale lengths and angular positioning are usually by courtesy of some slaving mathematician somewhere, but, if you have the time and patience, you can construct some nomographs by trial and error. The graduations on all scales of our nomograph are of the same length and can be assigned any value that you desire as long as the same size and values are used on all scales. For example, if one major division on the R1 scale is valued 100 ohms, then one major division on the R2 scale and one major division on the R_t scale must also be valued 100 ohms. With this in mind, let's find out how to use the equivalent resistance nomograph to solve parallel resistance problems.

Using A Nomograph. The equivalent resistance nomograph can be used in either of two ways. In one application you have two resistors connected in parallel and want to know what value single resistor will be needed to replace the parallel combination. This situation often arises in breadboarding new circuits. To solve this problem you simply locate one resistance value on the R1 scale, and the other resistance value on the R2 scale. Then lay a ruler, or draw a straight-line between the points located on the R1 and R2 scales. The equivalent resistance will be where the straight edge crosses the R_t scale.

In another application you know the value of one resistor and want to know what value of resistance must be connected in parallel with it to obtain a desired value. This problem may arise because your stock of resistors is depleted, or because the required resistor is not a standard value. Non-standard values

(Continued on page 104)



Here is your personal copy of the parallel resistance nomograph. Don't tear it out of this issue because you will only lose it! And don't write on it because after a few uses it will be too marked-up to read. Best bet is to lay a piece of tracing paper or vellum over the nomograph and do all your computations on it. Be sure to follow instructions given in the text. Check all your answers by making rough estimates.

For DXers Who Love a MYSTERY

by Russell Roberts

Tune in the clandestine stations and pick up unexpected QSL boons

☐ Remember the unidentified station that played the American song, "Kiss Me, Honey" over and over again for weeks on end until it was the talk of the shortwave world? Or the Latin station that kept popping up on 1570 kHz at all hours of the day or night? Ever hear of stations calling themselves "The Voice of Truth" or "The Voice of Freedom?"

If you've monitored any of the above stations, or others that aren't listed in the *World Radio-TV Handbook*, then chances are you've picked up one of the many secret stations currently flooding the airwaves.

These secret or "clandestine" broadcasters serve a variety of purposes, from the transmission of inflammatory propaganda to the direct call for the overthrow of a government. Some of these stations are alleged to be transmitting information to subversive groups or sending instructions to secret agents. Many have been accused of being sponsored by the military or an intelligence arm of certain countries.

Generally, clandestine stations operate from hidden, or undisclosed locations. And they often transmit without the consent of the government on whose territory they are located.

DXing the secret stations, if you know where and when to look for them, can be fun. Some, as a matter of fact, will send QSL cards on request. Collecting them makes for an interesting and exciting pastime on its own.

The "Kiss-Me" Station. One of the most interesting clandestine outlets is R. Peyk-e Iran, whose mail address is Box 49034, Stockholm, Sweden. The station operates on 11695, 11410, and 9560 kHz from 1530-1620 and from 1720-1810 GMT; QSL requests can be sent to the above address. Peyk-e Iran gained international fame some time ago by playing the song, "Kiss Me, Honey" repeatedly on 11695 kHz. It soon became known as R. Kiss Me, Honey, and was the subject of much speculation.

What actually happened, of course, was that the station used the song to test its transmitters prior to inaugurating programming. The transmitters are believed located behind the Iron Curtain, in southeast Europe. The programs are pro-Communist, and are critical of the Iranian Government and its policies, particularly as these relate to relations with the West.

Oldest Clandestine. Two secret stations transmitting in Spanish to Spain are worth mentioning. One of these, R. España Independiente, is the oldest clandestine station in operation. It began broadcasting in 1941 and has been active ever since. R. España Independiente carries anti-Franco programs and claims to be operating from the Pyrenees Mountains, on the border between France and Spain. Programs in Spanish are carried by this station, which represents the views of the Spanish Communist Party, from 1600-2300 GMT, on 15505, 12140, 9955, 9430, and 7690 kHz.

A second secret Spanish station is R. Euzkadi, which also carries anti-Franco programs. These are scheduled at 2030, 2130, and 2230 GMT and the broadcasts open with announcements in English as well as Spanish. Frequencies vary, but are in the vicinity of 15080 and 13250 kHz. Reception reports are requested, to be addressed to Box 59, Paris, France. Be sure to send International Reply Coupons to cover costs for surface or airmail reply.

Latin Clandestines. One of the few anti-Communist clandestine broadcasters is R. Libertad, which transmits irregularly on 15050-15055 kHz. Programs are in Spanish, with station announcements also made in English. Reception reports are requested, to be addressed to Box 2214, Miami Beach, Fla. R. Libertad began broadcasting shortly after R. Americas, the controversial Swan Island station, left the air. Some DXers believe there is a connection between these stations. However, judging from the weak signal of R. Libertad, it probably operates from a location in Central or South America with relatively low power.

Speaking of Central America, a military coup took place in Panama a year ago last October which overthrew President Arias. Almost immediately a rash of secret stations began broadcasting pro-Arias, anti-junta programs. Among these were R. Soberana, R. Impacto, R. Capital, R. Panamerican, R. Libre, the English-language "Your Community Station," and a host of others.

The junta that seized power moved quickly to close down most of these until a single violently pro-Arias, anti-junta station remained. It moved about on various frequencies, finally settling on 1570 kHz and calling itself R. Rebelde. The station operated about ten days after which it suddenly went off the air. It was reported in a Panamanian newspaper that the operators of the station had been arrested while operating from an automobile in the Canal Zone.

A short time afterward, a new pro-junta station began broadcasting on 1575 kHz, just 5 kHz away from R. Rebelde's former frequency. Gradually, the strength of the new signal improved, and the frequency shifted downward, until it finally settled on 1570 kHz. It does not identify itself, but continues to send pro-junta programs.

Two For Europe. One country with more than its share of secret stations is Cyprus. The eastern Mediterranean Island Community is made up of Greeks and Turks who have been at odds for years, and the secret stations broadcast primarily in the Greek and Turkish languages. R. Bayrak, Famagusta R., and the Voice of the Falcon are some of the local secret broadcasters whose transmissions are rarely audible in this hemisphere.

However, Bizim R. and The Voice of Truth are sometimes heard here during the afternoon hours. Bizim R., in Turkish, operates from 2000-2100 GMT on 5915 kHz; The Voice of Truth, in Greek, operates between 1800 and 1930 GMT on 21350, 9580, 7335, and 7300 kHz. Both of these stations are believed to be operated by the Communists, with transmitters probably located in East Europe.

German Freedom Station 904 has been a thorn in the side of the West German Government since it began broadcasting in August 1956. Operating on 904 kHz throughout the evening hours, the station, which expresses the viewpoint of the outlawed West German Communist Party, claims to be on West German soil. The West Germans vehemently deny this. The West German magazine *Church and State* recently carried the following item about station 904 which is characteristic of the West German attitude toward the station:

"The lie that Freedom Station 904 is located in West Germany is still being propagated by East Germany. A letter from R. East Germany to the Association of German-speaking DX fans and DX clubs claimed that Freedom Station 904 is not an East German station and that it did not know where the station was located. In fact, the transmitter is located near Magdeburg in East Germany. In spite of this, their daily sign-on starts with: 'This is the only broadcasting station of West Germany which is not under government control.' "

The West Germans have understandably been up in arms about this station for some time, but there isn't much they can do about it.

In addition to the stations we've just described, there are literally scores of others that operate as secret stations. Some, such as the ones we have mentioned, operate regularly. Others come and then disappear in a matter of days. For the alert DXer, logging and trying to verify these secret radio stations can fill many an exciting hour in a highly rewarding way. ■

BUILD MINI-MAXI

by William F. Splichal, Jr.

A novel vhf superregen receiver that can tune in stations from 50 to 200 MHz

OUR MINI MAXI is a novel superregenerative receiver, covering the 80 to 175 MHz band. Though designed with minimum circuitry, it provides good sensitivity and output. This simple and easy-to-build receiver is unique in that no coupling capacitors or transformers are used between stages and almost any impedance speaker or earphone can be connected to the output. Of course, a low-impedance one will have higher output. Another feature is the use of non-critical components which can vary in value to permit using a wide range of readily available parts without impairing performance of the receiver. The Mini-Maxi will receive television, FM, aircraft, amateur, and police transmissions with just a 2-ft. whip antenna. A smaller version of the receiver, using subminiature components, was built into a little metal cuff-link box that could be carried in a pocket.

How It Works. Transistor Q1 is a superregenerative detector. The resonant circuit (inductor L1, capacitor C5, and tuning capacitor C4) is tunable over the frequency range mentioned above. Capacitor C3 provides feedback for oscillation and capacitor C2 couples the signal from the antenna to the tuned circuit. Potentiometer R3 is used as the regeneration control to set transistor Q1 to the point of oscillation.

The audio signal developed across resistor R4 is directly coupled to the base of transistor Q2, which is in a complementary configuration with transistor Q1. Output of transistor Q2 is developed across R6 and is coupled via transistor Q3, which takes the place of a coupling capacitor between transistors Q2 and Q4. A high beta silicon transistor used for Q3 will provide a small amount of gain as well as a means of coupling transistors Q2 and Q4. The audio is further amplified by transistor Q4 and its output is applied across a suitable earphone or speaker that may be plugged into jack J2.

Construction. The recommended layout and wiring of Mini-Maxi as shown in the photograph can be followed provided components identical to those specified in the Parts List are used and it will fit in a 2¼ x 2¼ x 5-in. minibox. If you build the receiver in a different container, it must be a metal one to avoid hand capacitance effects detuning the receiver. Mount J1, R3, C4, S1, and J2 before wiring in the remaining components. The lead lengths on Q1, L2, C2, C3, C4, C5, and L1 should be kept as short as possible to minimize stray capacitance effects. Layout and lead length of the other components are not as critical and can be varied to suit the builder. *(Turn page)*

e/e MINI-MAXI

Transistor Q1 can be almost any pnp germanium vhf type transistor capable of oscillating at 175 MHz. Many types of small signal npn germanium audio transistors can be substituted for Q2 and Q4 with satisfactory results.

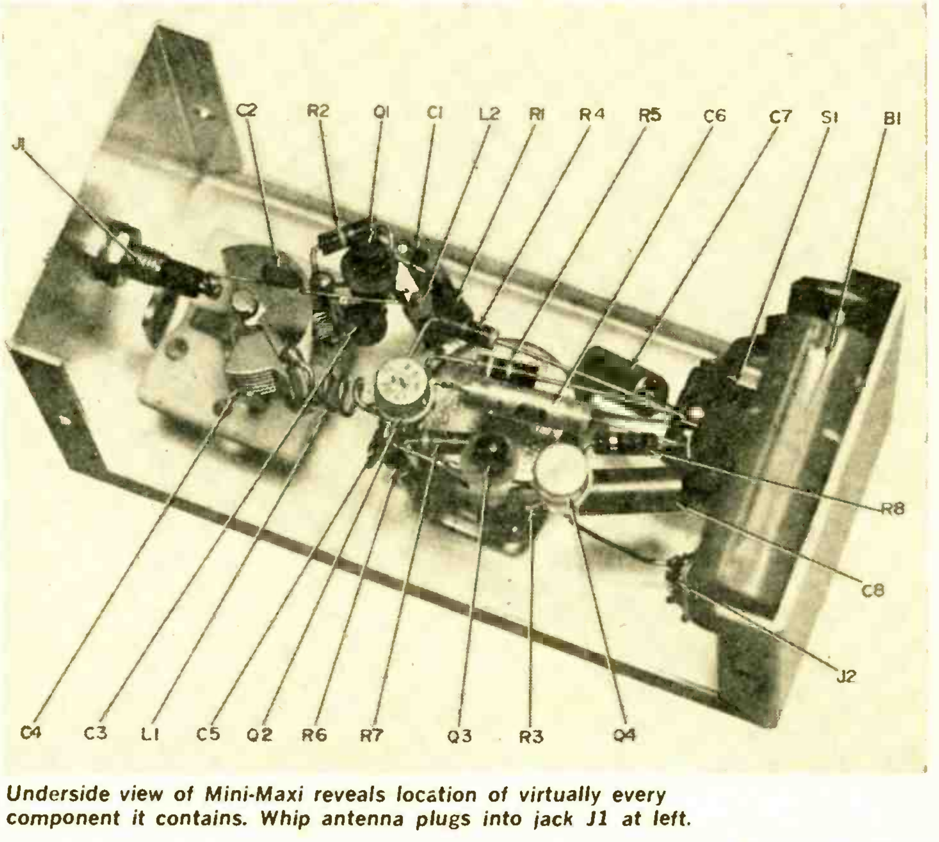
The battery is connected to a battery plug obtained from an old discharged 9-volt battery. One terminal of the plug is soldered to one of the switch terminals via a small strip of flexible metal which is insulated with tape to prevent shorting out to the box.

The 2-ft. whip antenna was made by removing the insulation from a length of #14 wire and soldering it into the end of a tip plug (P1) which will plug into J1. A more compact antenna can be made by attaching a small telescoping antenna (similar to Lafayette 18E54009) to a tip plug which will plug into J1.

Overall tuning range of the receiver can be changed by using different sizes for inductor L1. By making it with six turns instead of the three previously specified, the receiver will tune from 50-100 MHz, and with two turns it will tune from 100 to 200 MHz.

Receiver Operation. Almost any speaker or earphone having an impedance from 4 and 2000 ohms can be connected across Mini-Maxi's output. The lower impedances will give higher output. After turning switch S1 *on*, regeneration potentiometer R3 is set by first turning it clockwise until oscillations are heard and then turning it counterclockwise until the oscillations stop and hissing is heard. Tuning capacitor C4 is then tuned to a station. The setting of the regeneration control will vary with the frequency to which the receiver is tuned and will require resetting for optimum operation. By experimenting in tuning in various type stations, the dial can be marked where the following different types of transmissions occur:

54-88 MHz	Television
88-108 MHz	FM
108-136 MHz	Aircraft
144-148 MHz	Amateur
148-175 MHz	Police and Fire

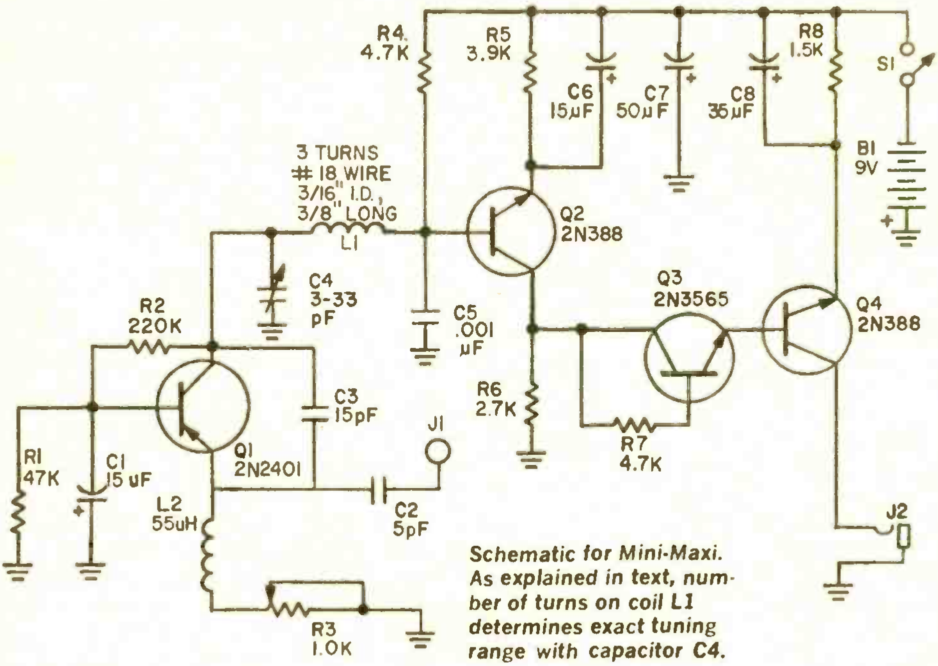


Underside view of Mini-Maxi reveals location of virtually every component it contains. Whip antenna plugs into jack J1 at left.

When receiving very strong stations, the regeneration control may have to be turned counterclockwise to reduce volume and produce an undistorted output. In some cases it may also be necessary to slightly detune the station to reduce volume further. A nice finishing touch is to identify the controls, using press-on letters (Datak or equiv.) covered with several coats of clear, spray-on lacquer for protection. ■

PARTS LIST FOR MINI-MAXI SUPERREGEN RECEIVER

B1—Transistor radio battery (Eveready 216 or equiv.)
C1, C6—15-uF, 15-VDC electrolytic capacitor (Sprague 1152 or equiv.)
C2—5-pF, 1000-VDC ceramic disc capacitor (Sprague 5GA-V50 or equiv.)
C3—15-pF, 1000-VDC ceramic disc capacitor (Sprague 5GA-Q15 or equiv.)
C4—3.7 to 52-pF variable tuning capacitor (Hammarlund HF50 or equiv.)
C5—0.001-uF, 1000-VDC ceramic disc capacitor (Sprague 5HK-D10 or equiv.)
C7—50-uF, 15-VDC electrolytic capacitor (Sprague 1160 or equiv.)
C8—35-uF, 15-VDC electrolytic capacitor (Sprague 1159 or equiv.)
J1—Tip jack, nylon insulated (H.H. Smith 240 or equiv.)
J2—Subminiature phone jack (Lafayette 99E62119 or equiv.)
L1—3 turns #18 bare copper-tinned wire, 3/16-in. ID x 3/8-in. long (see text)
L2—55-uH RF choke (J.W. Miller 4629-E or equiv.)
Q1—Pnp germanium vhf transistor (Sprague 2N2401) (see text)
Q2, Q4—Npn germanium audio transistor (RCA type 2N388) (see text)
Q3—Npn silicon, high beta audio transistor (Motorola type 2N3565) (see text)
P1—Plug to fit tip jack
R1—47,000-ohm, 1/2-watt resistor
R2—220,000-ohm, 1/2-watt resistor
R3—1000-ohm, linear taper, potentiometer (Mallory U4 or equiv.)
R4, R7—4700-ohm, 1/2-watt resistor
R5—3900-ohm, 1/2-watt resistor
R6—2700-ohm, 1/2-watt resistor
R8—1500-ohm, 1/2-watt resistor
S1—Spst toggle switch (Cutler-Hammer 8280-K-14 or equiv.)
1—2 1/4 x 2 1/4 x 5-in. minibox (Premier PMC 1004 or equiv.)
4—Transistor sockets (Lafayette 32E42211 or equiv.)
Misc.—Wire, solder, bolts, nuts, earphone or speaker (any low-impedance unit —see text), press-on letters or embossed tape, etc.



Schematic for Mini-Maxi. As explained in text, number of turns on coil L1 determines exact tuning range with capacitor C4.

Clip Book Circuits

AUTOMOTIVE TACHOMETER

You can adjust a car engine to specified idle and choke rpm with this easy-to-build one-transistor tachometer.

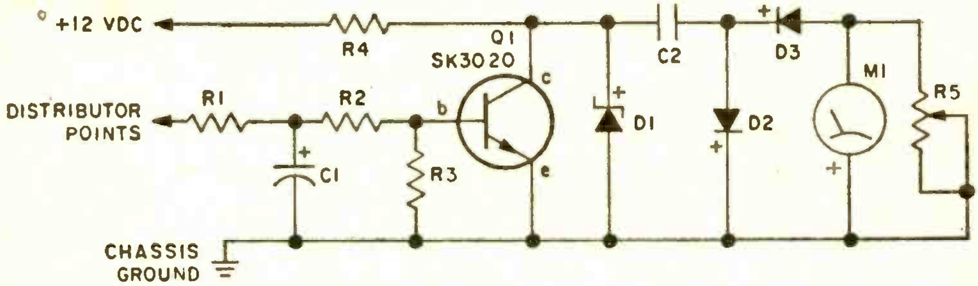
Wiring is not critical and the unit can be assembled in a plastic box or metal cabinet. Zener diode D1 is any 250-milliwatt unit rated at 9.1 V.

The unit can be used only on cars with a negative ground. The power lead connects to a positive 12-V point in the car's wiring; the ground lead connects to the car chassis. The distributor lead connects to the lead between the distributor and ignition coil. Do not connect it to a solid-state ignition system.

The meter scale is linear, with full scale representing approximately 10,000 rpm. Calibrate the tach against a commercial tach (at your local garage?) by noting the commercial tach's reading and adjusting R5 til your tach reads the same.

PARTS LIST

C1—1-uF, 100-VDC electrolytic capacitor
C2—0.47-uF, 15-VDC capacitor
D1—9.1-V, 250-mW Zener diode
D2, D3—100mA, 50-PIV silicon rectifier
M1—0.1 mA DC meter
Q1—SK3020 npn transistor (RCA)
R1—200-ohm, ½-watt resistor
R2—220-ohm, ½-watt resistor
R3—1500-ohm, ½-watt resistor
R4—330-ohm, ½-watt resistor
R5—1000-ohm, potentiometer



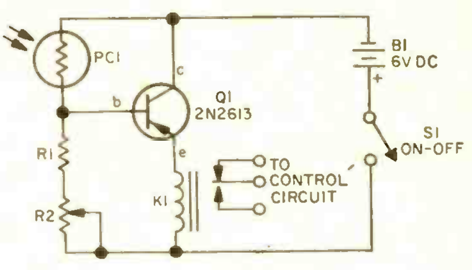
AUTOMATIC LIGHT SWITCH

With only a handful of low-cost components this photo relay light switch turns a light *on* or *off* according to general room illumination.

Transistor Q1 can be any general-purpose pnp transisitor of the 2N109 or 2N217 variety, though greater sensitivity is obtained with the 2N2613 type. Relay K1 is a high-sensitivity type like the Sigma relays used by model radio control hobbyists.

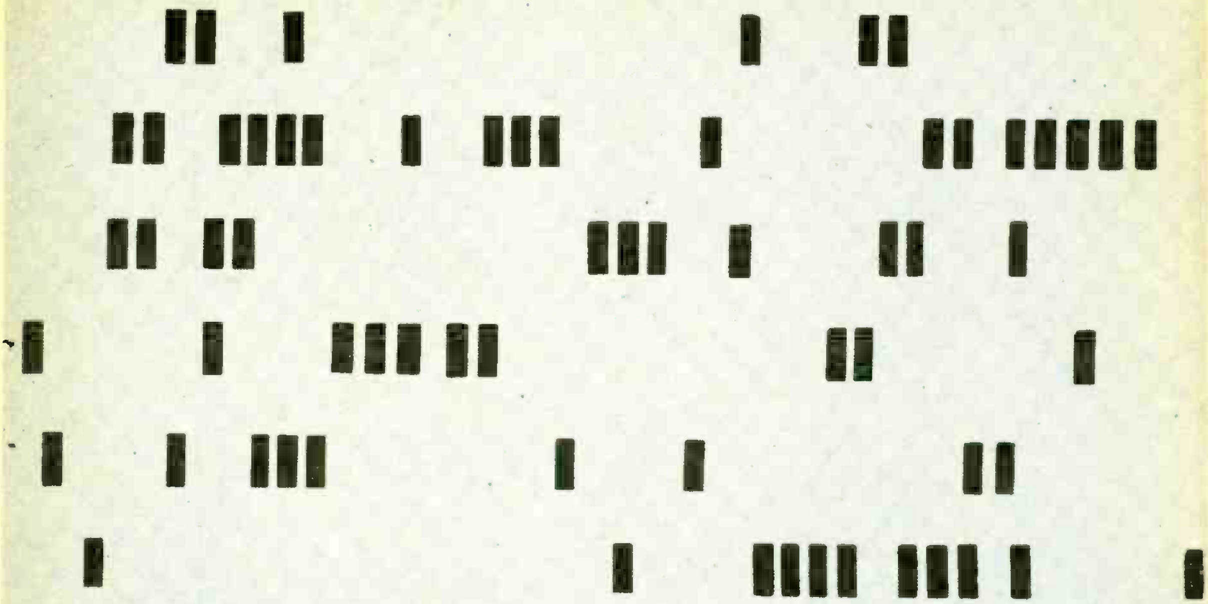
Potentiometer R2 (part of a voltage divider consisting of photocell PC1, R1, and R2) is set so that with normal illumination falling on PC1 the base bias current (through PC1) is just below the value needed to generate the collector-emitter current required to activate relay K1. When additional light falls on PC1, photocell resistance decreases, thereby increasing the base bias, which causes greater collector current to flow and relay K1 to close.

This circuit can be controlled by sunlight so relay K1 drops out at dusk to turn on a night light. Or use a flashlight to trip K1 for "killing" TV commercials by shorting the TV speaker connections.



PARTS LIST

B1—6-V battery
K1—1000-ohm, 2-3 mA sensitive relay
PC1—RCA 4425 photocell
Q1—2N2612 pnp transistor
R1—120-ohm, ½-watt resistor
R2—5000-ohm potentiometer
S1—Spst switch



Logic and Electronics

by Roy and Jeff Colvin

Logic in electronics is no different than logic in reasoning, argue the authors. And that, more or less, is what old George Boole always said.

THE DICTIONARY defines logic as a science that deals with the canons and criteria of validity in thought and demonstration; the science of the normative formal principles of reasoning. Logic comprises the doctrine of influence. *Traditional* or *Aristotelean logic* is concerned principally with deduction. It assumes logic is capable of reduction to formal rules directly applicable to correct thinking. *Modern logic* conceives all truth to be interrelated and tested by its coherence and therefore, its predictability. *Symbolic* or *mathematical logic* is a mode of developing and representing logical principles through the use of symbols for classes, propositions, etc., rather than a theory of logic. It provides an exact canon for deduction from postulates and definitions.

George Boole's Contribution. The science of logic has been considered the domain of philosophers for nearly all of the ~~recorded~~ history of man. Even though the formulation of the principles of mathematical logic were first presented in The Investigation of Thought, written by the English mathematician George Boole, and published in 1847, it created little interest then. In fact, to those who were aware of its existence, Boolean algebra, as mathematical logic has since been named, was considered nothing more than a mathematical curiosity.

Nearly a century after its publication, a scientist at Bell Telephone Laboratories first recognized the application of Boolean algebra to electrical circuits. Boole's presentation, commonly called binary arithmetic, has, a century after publication, become the basis for modern digital computers, automatic digital control systems, and other forms of inhuman decision-makers. In this connection it's important to understand that logic in electronics is no different than logic in reasoning. The end result is the same in either case. A choice or decision is made between two or more alternatives in a situation by applying logical decision to certain given rules of action and initial conditions that are the input or premises to the situation. Electrically, this is equivalent to saying that the output of a circuit is affected by what the circuit will do to the given inputs in making a logical decision.

Boole was able to demonstrate that logical statements can be written in symbolic form and that symbols can be handled in a manner similar to those for algebra. For this reason, Boole's symbolic logic is referred to as Boolean Algebra.

We are all familiar with the four basic operations in arithmetic: addition, subtraction, multiplication, and division. Symbolic logic, or Boolean Algebra, has but three. They are: *AND*, *OR*, and *NOT*. The origin of this non-mathematical terminology stems from the fact that logic originated with words and it was not until much later that symbols were used to represent logic.

Truth Statements. The terms *AND*, *OR*, and *NOT* fully describe in words these three basic logical operations. This can readily be demonstrated by adapting familiar arithmetical symbols so that letters A, B, and C or any other combinations of three letters become statements of truth. This then makes it possible to demonstrate the three basic operations as follows:

The *AND* operation is written as multiplication and indicated as:

AB; (A) (B); A x B; A · B; A and B

The *OR* operation is written as an addition and indicated as:

A + B which means A or B

The *NOT* operation is written with a bar over the symbol and indicated as:

$\bar{A}$ means *NOT* A, while $A\bar{B}$ means A *AND NOT* B

The rules of logical decision are merely those involved in the ordinary logic concepts of *AND* and *OR*. They are:

If A is true *AND* B is true, then C is true (similarly, if given A *AND* B, then C can be found. Also, if A is true *OR* B is true, then C is true (analagously, if given A *OR* B, then C can be found).

Boole's master stroke in representing these logic concepts mathmetically was in the creation of a number system using just two numbers, 1 and 0. All of the customary rules of arithmetic of our decimal system (ten base numbers) can be converted into terms predicated on the new binary (two base numbers) system. A distinct advantage of the binary system is that the rules of logic can now be easily represented mathematically. Binary 1 can be used to represent the condition *true* and binary 0 can be used to represent the condition *not true*.

Basic Logic. Now the symbolic *AND* logic presented earlier in this article can be expressed mathematically as in the following Truth Tables:

AND Truth Table of A · B = C

A	· B	=	C
0	0	=	0
1	0	=	0
0	1	=	0
1	1	=	1

In a similar manner *OR* logic presented symbolically as A + B = C can be expressed mathematically as shown in the following tabulation:

OR Truth Table of A + B = C

A	+ B	=	C
0	0	=	0
1	0	=	1
0	1	=	1
1	1	=	1

From these Truth Tables we see that logic is quite easily expressed in binary language, since all conditions of logic are either true (1) or false (0). Since the value of binary language to electronics is fairly obvious, it's difficult to believe that it was ignored for so long. In an electrical circuit we know that it will produce a certain output with the presence of a given input and with the absence of that given input, it will not.

There can be a higher positive voltage at the output of an electronic circuit with inputs that may be (a) of a lower positive voltage, (b) a negative voltage, or (c) zero voltage, in which event we state the output of the circuit is *High*. ($\uparrow$). The converse of this will produce a *Low* ($\downarrow$) output. From this it can be seen that all circuits can have either a *High* ($\uparrow$) or *Low* ($\downarrow$) output. We can arbitrarily reference this in our binary numbering system so that binary 1 can be either *High* ($\uparrow$) or *Low* ($\downarrow$) output. If we elect to reference it to *High* ($\uparrow$) output we call our logic level *High* and represent this symbolically thus ($\uparrow$), which means that symbol ($\uparrow$) is logical 1 (binary 1) and that it is *High* ($\uparrow$) with respect to logical 0 (binary 0).

Basic logic circuits, therefore, follow the *AND* and *OR* concepts of logical decision that have been discussed previously. We can depict the *AND* circuit symbolically as shown in Fig. 1.

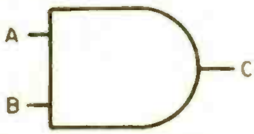


FIG 1

This represents a circuit where a logical 1 (or binary 1) input at A and a logical 1 (or binary 1) input at B will produce a logical 1 (or binary 1) at output C. (Mathematically, $A \cdot B = C$.) From our Truth Table this equation tells us both logical 1 (true) inputs must be present for a logical 1 (true) output. It also tells us that if a logical 0 input will be present at either A or B, a logical 0 output will be produced at C, or that a logical 0 input at A and a logical 0 input at B will produce a logical 0 at C. In other words, we are told the actual logical function of an *AND* circuit (mathematically, $A \cdot B = C$).

Apparently there has not yet been a total standardization of the various symbols used by the many authors writing on the subject. However, the symbols we are using here are those more generally used, and which we feel are the easiest to understand and are more consistent. These symbols are used only to represent logic. The basic circuits will be presented later.

There are two versions of the *OR* circuit, the *OR Inclusive* and the *OR Exclusive*. The former is more commonly used. It will produce a logical 1 output at C only if there is a logical 1 input at A, and not at B, or if there is a logical 1 at B, and not at A, or if there is a logical 1 at both A and B (see *OR* Truth Table $A + B = C$). The logic symbol for the *OR Inclusive* circuit is depicted as shown in Fig. 2.

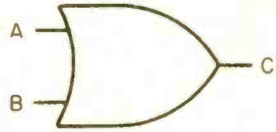


FIG. 2

[Mathematically $(A \cdot \overline{B}) + (\overline{A} \times B) + (A \cdot B)$, where $\overline{A}$ = NOT A; $\overline{B}$ = NOT B, ($\overline{1} = 0, \overline{0} = 1$)].

The *OR Exclusive* is similar to the *OR Inclusive* with the exception that there will be no logical 1 output at C if logical 1 inputs appear simultaneously at A and B. A true output logical 1 (binary 1) will appear at C only if a logical 1 input is present at A and not at B, or if there is a logical 1 input at B and not at A.

The *OR Exclusive* circuit is depicted symbolically as shown in Fig. 3.

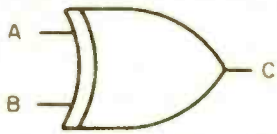


FIG 3

(Mathematically, $(A \cdot \overline{B}) + (\overline{A} \cdot B) = C$)

These three basic circuits and the many variations made by combinations of them are the entire basis of logical electronics.

In our earlier discussion of the *AND* circuit it was stated that an input 1 at both A and at B will produce an output 1 at C. It was further stated that an input 0 at either A or B will produce an output 0 at C. If you think about these for a moment you will be convinced that these statements have identical meaning (refer to Truth Tables for $A \cdot B = C$ and $A + B = C$). The latter logic statement is depicted symbolically as shown in Fig. 4.

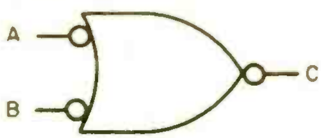


FIG 4

e/e LOGIC & ELECTRONICS

This is an *OR* circuit logic symbol with the small circles added to indicate that a 0 input at *A OR* a 0 input at B will produce a 0 output at C (mathematically, $\overline{A} + \overline{B} = \overline{C}$).

De Morgan's Theorem. Note that the *AND* functions (logical 0 input at *A AND* logical 0 input at B will produce logical 0 output at C) do the same thing but they represent different logical functions.

The equivalence of the *AND* circuit and the *OR* circuit just discussed is but one example of the general equivalence of *AND* circuits with *OR* circuits. Therefore, any type of *AND* circuit can be replaced by an *OR* circuit which is equivalent, and vice versa. This fact is a direct result of a rule of binary arithmetic known as De Morgan's Theorem, which states mathematically that:

$$A \cdot B = \overline{(\overline{A} + \overline{B})} \qquad (1)$$

$$A + B = \overline{(\overline{A} \cdot \overline{B})} \qquad (2)$$

$$\overline{A} \cdot \overline{B} = \overline{(A + B)} \qquad (3)$$

$$\overline{A} + \overline{B} = \overline{(A \cdot B)} \qquad (4)$$

These equations can be easily proven by assuming A equals 1 and 0 and B equals 1 and 0 successively.

In order to use De Morgan's Theorem to convert any combination of logics to its equivalent combination, the rules to follow are these:

(a) group the *AND* functions together

(b) negate all terms (negation of A is $\overline{A}$ and the negation of $\overline{A}$ is $\overline{\overline{A}} = A$)

(c) change all *AND* signs to *OR* signs, and the reverse

(d) negate the entire function

Let's apply these rules to the logic function $\overline{A} \cdot \overline{B}$ of equation (3) above:

(a) group *AND* functions $(\overline{A} \cdot \overline{B})$

(b) negate terms $(A \cdot B)$

(c) change the signs $(A + B)$

(d) negate the entire function $\overline{(A + B)}$

Thus $\overline{A} \cdot \overline{B} = \overline{(A + B)}$, which is the formula given at (3) above.

For a more complicated example, let's use the following function to describe a particular combination of *AND* and *OR* logic circuits:

$$A \cdot \overline{B} + C \cdot \overline{D} + E \cdot F \cdot (G + \overline{H}) = f \ (5)$$

Now applying the rules of De Morgan's Theorem we get:

(a) $(A \cdot \overline{B}) + (C \cdot \overline{D}) + [E \cdot F \cdot (G + \overline{H})]$

(b) $(\overline{A} \cdot B) + (\overline{C} \cdot D) + [\overline{E} \cdot \overline{F} \cdot (\overline{G} + H)]$

(c) $(\overline{A} + B) \cdot (\overline{C} + D) \cdot [\overline{E} + \overline{F} + (\overline{G} + H)]$

(d) $(\overline{A} + B) \cdot (\overline{C} + D) \cdot [\overline{E} + \overline{F} - (\overline{G} + H)] = f$

Thus, the expression labelled f is equivalent to the equation (5).

Let's transfer the words of equation (5) using symbolic logic wherein we reference logical 1 as High (↑). Refer to Fig. 5.

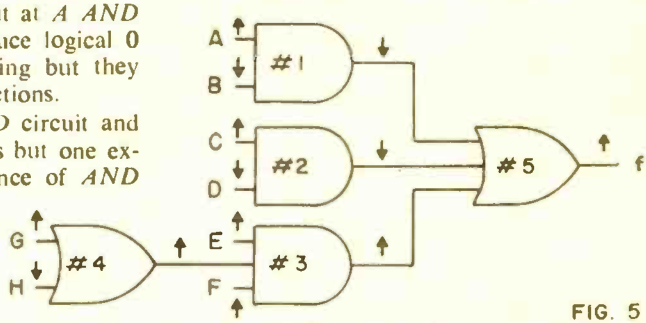


FIG. 5

As stated previously, we use symbols (↑) (↓) in Fig. 5 to indicate the states of the output or input, High ↑ or Low ↓. From this symbolic diagram we read that the output at f will be binary 1 if inputs of binary 1 are at A and binary 0 at B; or if inputs of binary 1 are at C and binary 0 at D; or if inputs of binary 1 are at E, F, and G.

The equivalent logic function (Fig. 6) is the expression labeled f, which is symbolically depicted as:

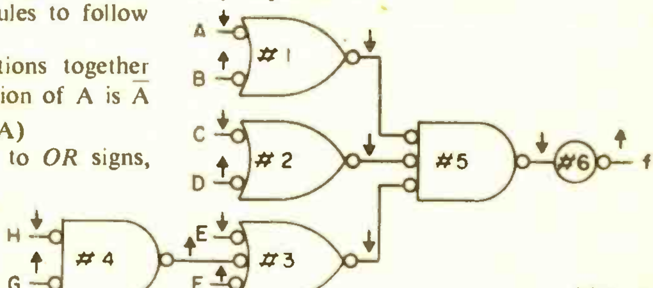


FIG. 6

The symbol ❻ represents an inverter, which converts a Low (↓) to a High (↑) or the reverse. This is required by procedure 4 of De Morgan's Theorem. Therefore the logic as depicted in Fig. 6 is related to that in Fig. 5 as

$$\overline{A \cdot \overline{B} + C \cdot \overline{D} + E \cdot F\,(G + \overline{H}} = \overline{(\overline{A} + B)}$$

$$\overline{(\overline{C} + D)\ \overline{E} + \overline{F} + (\overline{G}\,H)} = \overline{(\overline{A} + B)\ (\overline{C} + D)}$$

$$\overline{\overline{E} + \overline{F} + (\overline{G}\,H)}$$

Variations of Basic AND & OR CIRCUITS.

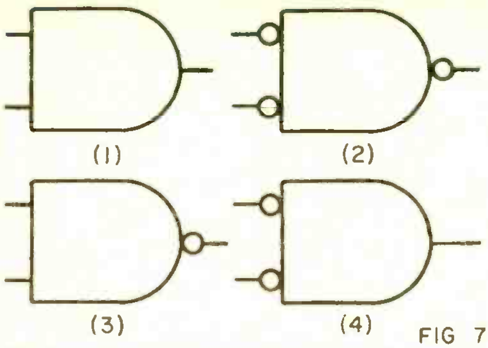


FIG 7

It's important to understand the discussion up to this point because there are so many variations of basic *AND* and *OR* circuits. However, insofar as circuit design is concerned, we can consider four different distinguishable *AND* type circuits which can be represented symbolically as shown in Fig. 7.

In accord with De Morgan's Theorem each of these can be represented by its equivalent *OR* as shown in Fig. 8.

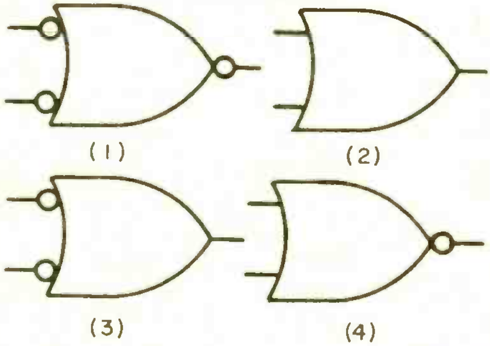


FIG 8

Symbols (1) and (2) in both Figs. 7 and 8 are referred to as: *AND/OR* logic. Symbols (3) and (4) are referred to as: *NAND/NOR* logic.

The circuit depicted in Fig. 9 is a *NAND* circuit symbol if logical 1 is High.

This means that when a logical 1 input is present at both A and B then a logical 0 output is produced at C. Hence, the name *NOT-AND* or *NAND* has been given this circuit (mathematically, $[A \cdot B = \overline{C}]$).

The symbol in Fig. 10 represents a circuit that is a *NOR* circuit if logical 1 is High. Therefore, we refer to this circuit as *NOT-OR* or *NOR*.

In this circuit a logical 1 at A or at B or at both, produces a logical 0 at C (mathematically, $(A \cdot \overline{B}) + (\overline{A} \cdot B) + (A \cdot B) = \overline{C}$)

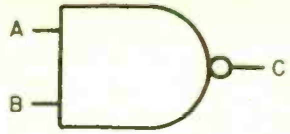


FIG 9

Thus there are four basic design logics: *AND*, *OR*, *NAND*, and *NOR*

The actual logic functions we use in a specific problem are determined by which of these four basic logic designs we select and whether the logic level is *High* (↑) or *Low* (↓). As an example, if the logic level is *High* (↑), *AND* logic will be represented by the functions (1) in Figs. 7 and 8. These same functions will conform to *OR* logic if the logic level is *Low* ( ).

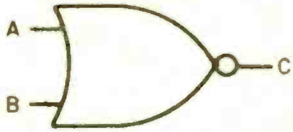


FIG. 10

If the logic level is High (↑), *OR* logical will be represented by the functions (2) of Figs. 7 and 8.

Remember, the four symbols in Fig. 7 represented *AND* functions of four separate circuits, and the symbols in Fig. 8 represent the *OR* functions of the same four circuits.

The Logic Guide, on page 63, presents a complete and comprehensive tabulation for the entire basis of design of logical electronics. For each pair of logic functions (one being the equivalent of the other, based on De Morgan's Theorem) is presented the design logic (*AND*, *OR*, *NAND*, *NOR*) which corresponds to a given logic level and mathematical equations which the functions satisfy.

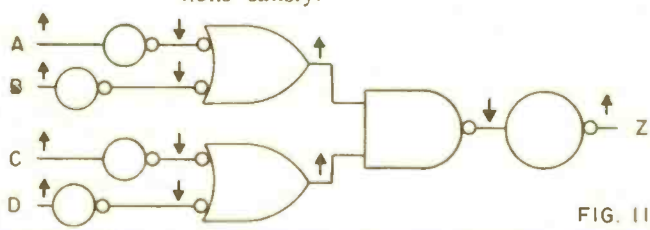


FIG. 11

Application of Theory. To apply what has been discussed up to this point, let's assume that you, as a designer of electronic logic for this project, must work with *NAND/NOR* logic of Fig. *7-3*, and that the logic level is *High* (↑). Your problem is to design a logic system of the form $(A + B) \cdot (C + D) = Z$. In other words, you require a circuit that will provide a binary 1 output at Z when there is a binary 1 input at A or at B and at C or at D simultaneously. From these conditions your circuit will be as shown in Fig. 11.

By referring to the Logic Guide (on page 63) it's evident that our design in Fig. 11 is, indeed, *NAND* logic for a high level logic and satisfies the given equation.

We now can delve into systems of logic functions that perform electronic operations.

The Binary Flip-Flop. The Binary Flip-Flop (designated F/F) is a combination of two logic functions (*AND* and *AND*, *AND* and *OR*, or *OR* and *OR*) that can count, store information and calculate.

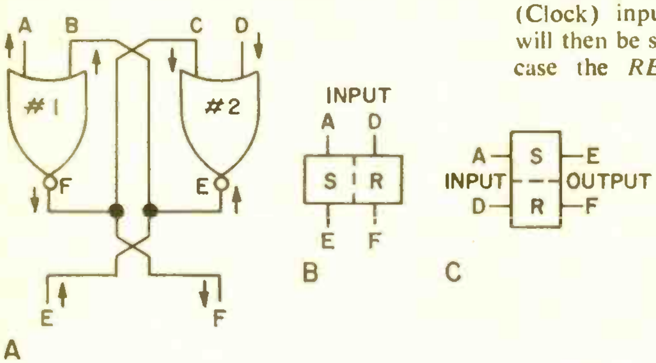


FIG. 12

The Binary F/F is a combination of two functions (gates), interconnected in such a way as to provide a latch on itself.

In Fig. 12A, if logical 1 (↑) is applied to input A of Gate 1, the output F will be a logical 0 (↓). This logical 0 (↓) applied at C will, along with a logical 0 (↓) applied at input D, cause the output of Gate 2 to be a logical 1 (↑) at E. This logical 1 (↑) output is fed back to Gate 1 at input B to serve as a latch. The input to A (↑) can now be removed (↓) and the *High* (↑) at B will maintain the two gates (F/F) in a bi-stable state. Thus a transient logical 1 (↑) at A (called the *SET* input) now maintains a logical 1 (↑) at E (called the *SET* output). The F/F is then considered as storing a logical 1 (referenced from E, the *SET* output). In a similar manner, if a logical 1 (↑) is applied to input D of Gate 2 (*RESET* input) the state of the F/F will change and the *RESET* output (F) will maintain itself in a logical 1 (↑) condition. Since the *SET* output is always referenced, and now it is a logical 0 (↓), the F/F is considered to be storing a zero when in this *RESET* state.

Now, since the makeup of the basic F/F is understood, it can be represented logically as shown by the symbology of Fig. 12B or Fig. 12C.

To advance a step further, two Gates are added to the inputs of the basic F/F as shown in Fig. 13A.

Gates 3 and 4 now control the *SET* and *RESET* inputs. The connection to these Gates (*SET* and *RESET ENABLES*) from the *SET* and *RESET* outputs is known as complementing the F/F and is used when F/Fs are connected as counters.

To understand the operation of the circuit in Fig. 13A, assume that the F/F is *RESET* (storing a zero). The *RESET* output, a logical 1 (↑) now acts as a *SET ENABLE* for Gate 3 and will allow the first switching (Clock) input to *SET* the F/F. The F/F will then be storing a logical 1 (↑), in which case the *RESET ENABLE* would allow the next switching (clock count) input to again *RESET* the F/F. To sum up, very simply, each switching input will alternately store a logical 1 and a logical 0 in the F/F. In other words, the circuit shown in Fig. 13A details a divide-by-two device. This can be seen by examining the waveforms in Fig. 13F.

The dotted line at the *RESET* input side, in Fig. 13A, means that the F/F could be entered at Gate 2 (Fig. 12A) for a direct *RESET*. Fig. 13B through Fig. 13C depict the symbology used for various conditions.

The F/F is a basic building block of advanced digital electronic systems. The ability of the F/F to store information within itself in the form of logical ones and zeros has just been discussed. A number can be used to express any quantity and any number can be expressed in binary form as a succession of ones and zeros.

Flip-Flops as Counters. It was stated earlier that F/Fs can count and calculate as well as store information.

Four F/Fs can be connected as shown in Fig. 14 to form a four-stage shift register. In this arrangement the output of the *SET* side of one F/F (G) is connected to the input on the *SET* side of the succeeding F/F (A) and the output on the *RESET* side of one F/F (H) is connected to one input terminal (F) on the *RESET* side of

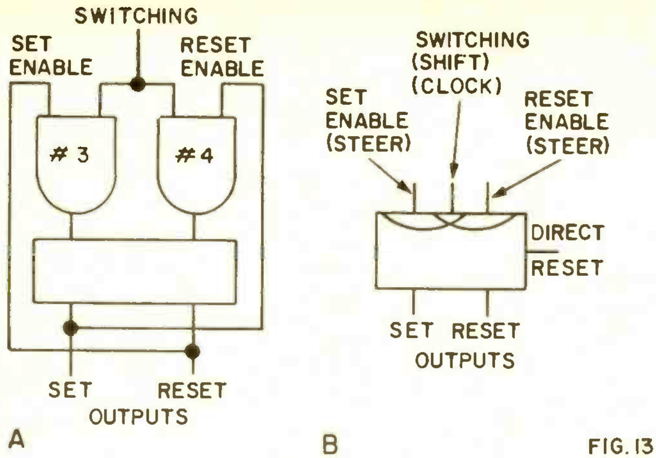


FIG. 13

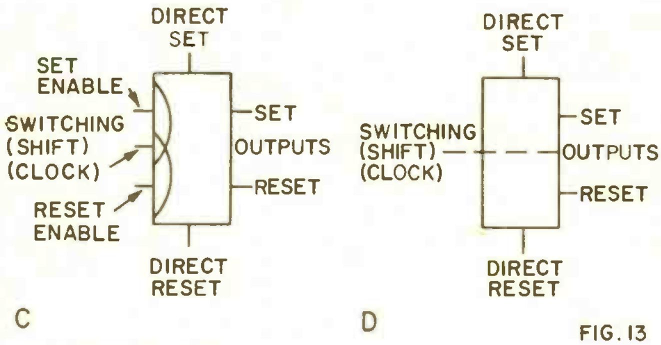


FIG. 13

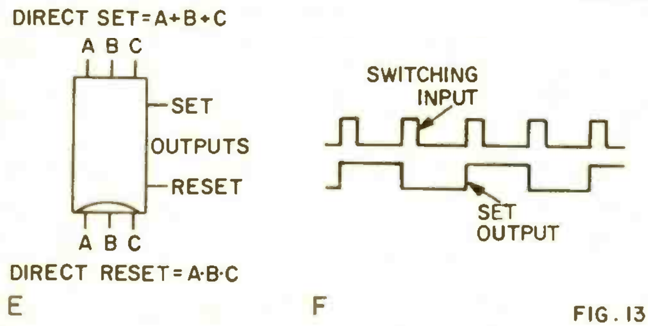


FIG. 13

the succeeding F/F. The other input terminals then serve as *SWITCHING* inputs.

In order to understand what occurs and how this four-stage register works it must first be assumed that all F/Fs (or registers) store a logical 0. Then, if logical 1 input is present at A and a logical 0 input is present at F of the first F/F in the chain, a shift pulse will *SET* this F/F. In other words, a 1 will be stored in F/F #1. Maintaining the same inputs at A and F, the next shift pulse will shift the 1 from the first F/F to the second F/F and will again place a 1 in F/F #1 because at the moment the shift pulse occurs there is a logical 1 at input A.

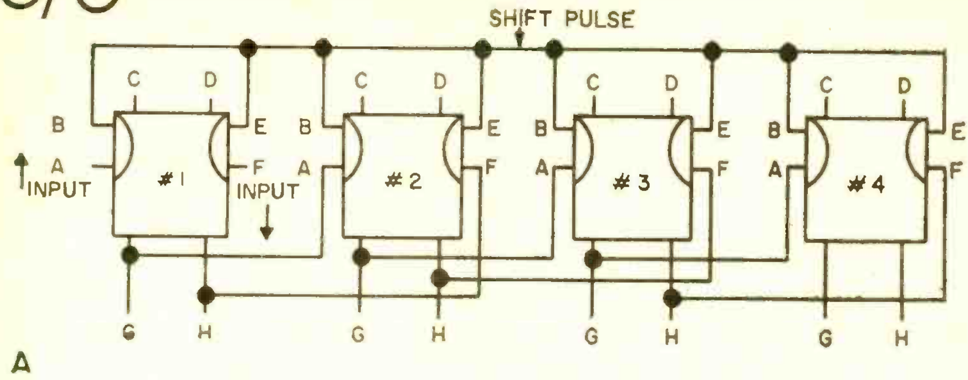
The next shift pulse will, similarly, shift the 1 from F/F #2 to F/F #3, shift the 1 from F/F #1 into F/F #2 and store a 1 in F/F #1. From this it is clearly observed that each successive shift pulse will shift whatever is in one F/F into the next F/F.

It must be obvious that logical 0s can be similarly shifted by making the input at A of the first F/F a logical 0 and the input at F a logical 1. Thus by changing the inputs at A and F between shift pulses, any combination of ones and zeros can be shifted from one F/F to the next F/F. Fig. 14B represents the symbology that would be used to represent the circuit of Fig. 14A.

The content of any one F/F can be changed without affecting what is in the others. This can be done by an input at C if it's desired to place a logical 1 in the F/F, or an input at D if it is desired to place a logical 0 in the F/F.

By connecting F/Fs in different ways many other operations can be effected. If, as shown in Fig. 15, the output on the *RESET* side of one F/F (E) is connected to become the switching input (B) for the next F/F a counter is developed. Since input B is shown at the center of the symbol it relates to both *SET* and *RESET*. Each F/F is understood as being complemented (refer Fig. 13A).

Again it is assumed that initially all four F/Fs store a logical 0. The first shift (count) pulse at B of F/F #1 switches it, thus changing its 0 state to a 1 state. Therefore, the output at E of the first F/F is logical 0, and so there will be no change in the second F/F. The next shift pulse will again switch the first F/F back to a logical 0, making E a logical 1, which, in turn, switches the second F/F to a 1 state. This then represents a count of binary 2 (01). The third shift pulse once again switches



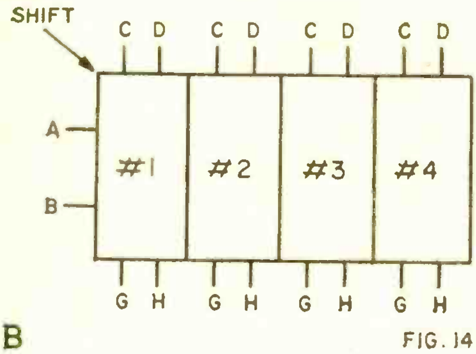


FIG. 14

the first F/F to a 1 state, leaving the others unchanged. This then represents a count of binary 3 (11). Therefore, when the F/Fs are connected as in Fig. 15A, a change from a logical 1 state to a logical 0 state will switch the succeeding F/F. For this reason this is considered an *Up-Counter*.

A *Down-Counter* is created if four F/Fs have the output on the *SET* side (D) (rather than the *RESET* side (E) as in the *Up-Counter*) of one F/F connected to the switching input of the next F/F. When connected this way, changes from a 0 to a 1 state will switch the F/F and count down, starting with all 1s, is begun. Figs. 15A, B, C, and D show symbols used to represent

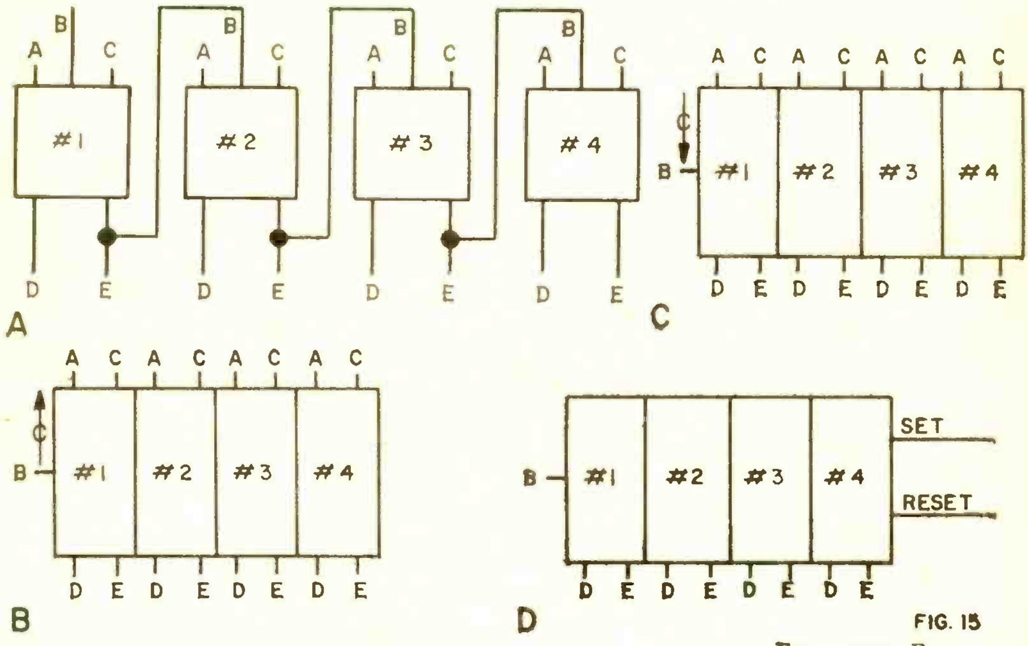
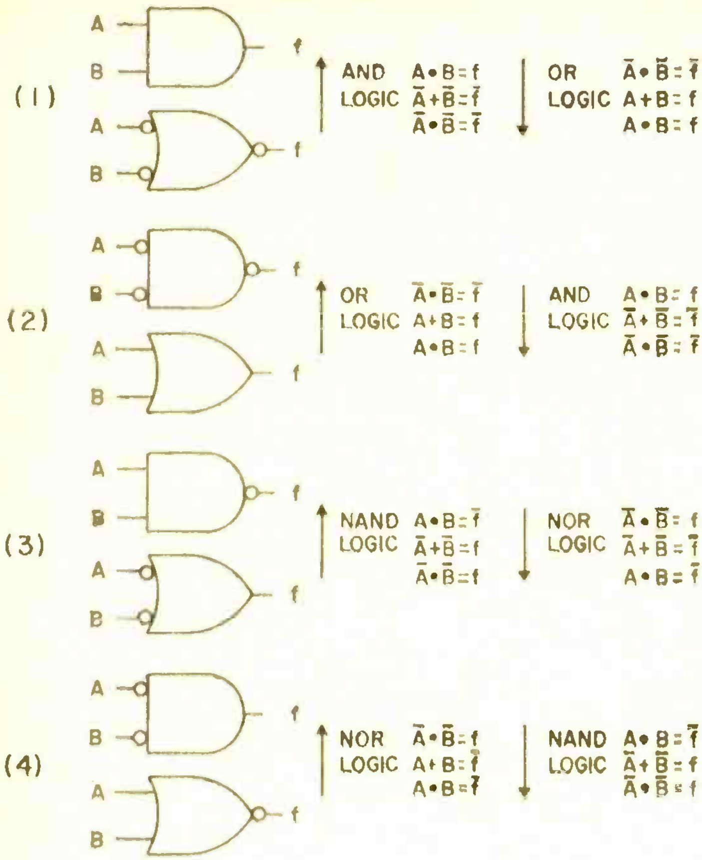


FIG. 15

LOGIC GUIDE



a four-stage counter. Inputs A and C can be used to independently *SET* or *RESET* a stage on an individual basis. If it were desired to *SET* or *RESET* all stages at the same instant, the symbology would then be as shown in Fig. 15D. Fig. 15B indicates an *Up-Counter*, whereas Fig. 15C indicates a Down-Counter.

A great many other functions can be effected with logic circuits, even though we have, because of space, limited this discussion to just a few. Engineers in this country and throughout the world are constantly expanding the application of logical electronics to communications and control problems in all phases of life.

Experiment with Flip-Flop Logic. Now that you have an understanding of the basic theory, it should be easy to go further. Why not build, for experimental purposes, a number of each *AND*, *OR*, Inverter, and basic F/F modules? The following suggested construction is predicated on the power source to activate these modules to be a standard 1½-V battery. All other components are readily available from your favorite parts supply house. Individual modules can be assembled on one, or two-inch squares of perfboard using push pins to mount the various components and also for power and interconnecting terminals.

A basic inverter building block schematic is detailed in Fig. 16. The schematic for this basic *NAND/NOR* module whose functions are the same as those depicted in Figs. 7 (3) and 8 (3) is illus-

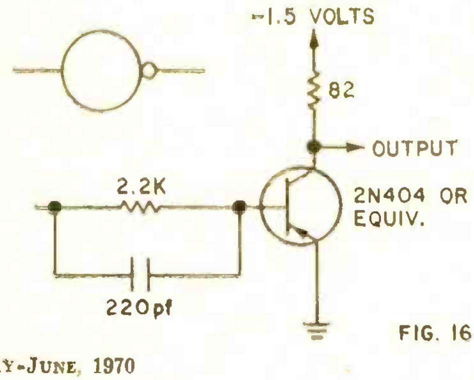


FIG. 16

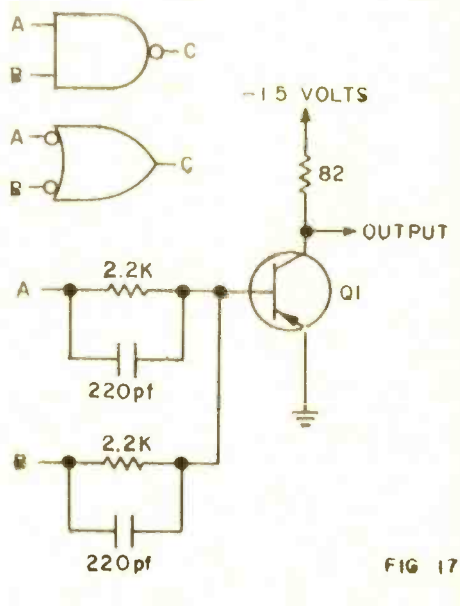


FIG 17

trated in Fig. 17. Similar details for a basic F/F are presented in Fig. 18. Additional wiring details are shown in Fig. 19 to add an indicator lamp that, when connected to the *RESET* output of an F/F, will light whenever the F/F is set (stores a logical 1). Fig. 20 is a schematic for a *Timed Pulse Generator* (a *Clock* to produce periodic shift pulses) which serves as the signal source to switch inputs of shift registers and counters.

A type 2N404 pnp transistor is used in all modules because generally it is readily available, is relatively low in cost, and is reliable. In the event you cannot get hold of 2N404s use any pnp transistor having characteristics similar to 2N404.

Note that, with the exception of the indicator, all other logic circuits are made up using the basic inverter.

You have the choice of naming your logical 1 level as Low (↓) or High (↑). Since we are using the particular circuit of Fig. 16 as our basic hardware, we have *NAND/NOR* logic. If we're to call logical 1 High (↑) then we have narrowed it down to *NAND* logic. If we decide to reference logical 1 Low (↓) then we would be dealing with *NOR* logic. Had Q1 of our basic circuit been an npn and with 1.5-V polarity change as required, then this *NAND/NOR* logic would be a *NAND* logic for logical 1 Low (↓) and *NOR* logic for logical 1 *High* (↑). Refer to the Logic Guide.

Fig. 18 is the schematic for a basic F/F. The letter *S* is the input on the *SET* side, *R* is the input on the *RESET* side and *T* is the switching input. If you want to use a visual display that will indicate whenever the F/F is set (lights where it stores logical 1) add the circuit shown in Fig. 19 using a common #48 pilot lamp for the visual display.

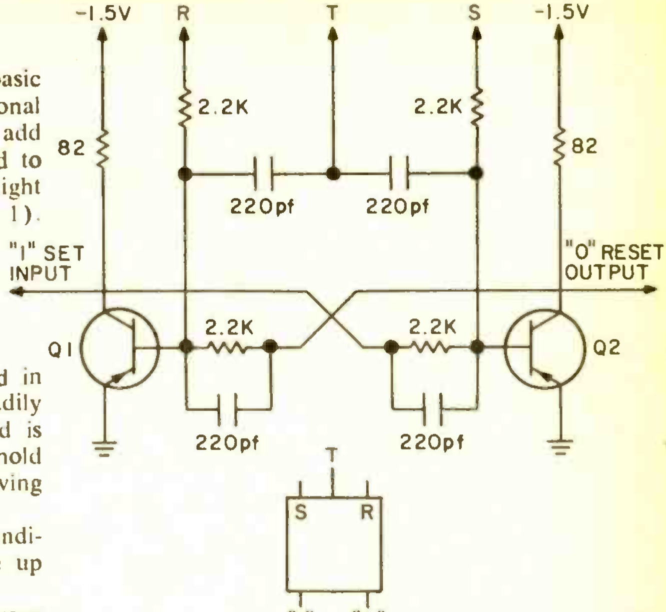


FIG. 18

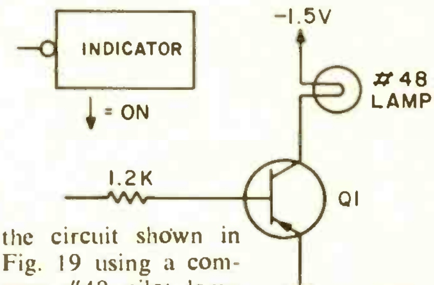


FIG. 19

In order to complete the construction of modules used to study and understand logic the circuit for a driver or clock device is detailed in Fig. 20. This module provides the timed shift pulses required to develop the switching input signal for the shift registers and counters. Note that once again this is a modification of the basic logic circuit design. A pulse rate output of one pulse per second (1 pps) is accomplished by the addition of the 50-μF capacitors shown in the schematic. The low (1 pps) clocking rate facilitates study of the logic operations of the counter and shift register. By adding indicators to the 0 outputs of the F/Fs (as shown in Fig. 19) the lamp will light each time and F/F is set. ■

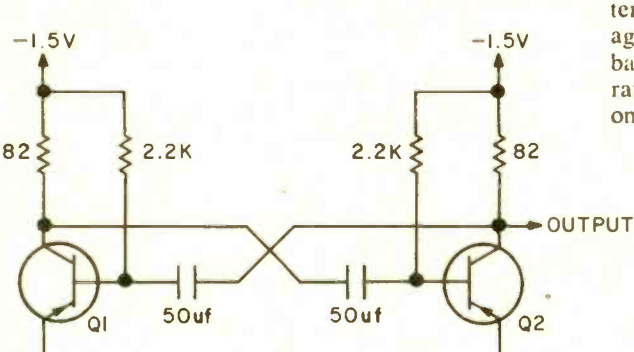


FIG. 20

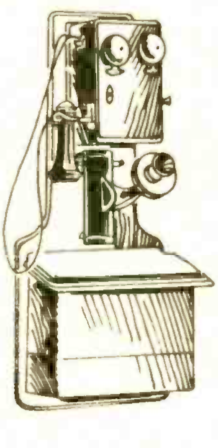
the day the dial tone came to UPTON

by Robert Angus

UPTON, KY.—Perhaps the tiniest telephone company in Kentucky will switch to dial operation at the end of the month. It is the last system in the state to use hand-cranked telephones.

☐ So said the wire service story which appeared as a human interest filler one Sunday in the New York *Times* and several hundred other newspapers from coast to coast. Nobody realized that that brief news item would make rural Upton a tourist attraction for Sunday drivers from as far away as Louisville and Cincinnati; or that subscribers to the Farmers Telephone Company would be deluged with offers from coast to coast of $40, $50 and more for their half-century-old wall phones.

What the experts underestimated in this age of satellite communications and a coast-to-coast direct-dial phone system was the fascination of the small-town phone system where the operator knows everybody, operates the switchboard in her parlor, and can locate a local resident within minutes, even if he isn't at home or at his place of business. There's a fascination, too, in the enormous walnut cabinets which housed the Stromberg-Carlson and Kellogg phones which once hung on the wall in many an American farmhouse; or in phone wires strung along a barbed-wire fence or from the tops of trees when it was more convenient to do so than to put up poles.



There's More. Upton—until recently—had all of these. What many Americans don't realize is that there still are several hundred communities—nobody knows for sure just how many, or just where they are—which still make do with the services of a local operator like Upton's Ruth Vance. In the hills of Kentucky and Tennessee, the farmlands of Indiana and Pennsylvania, the remote portions of Maine and Montana and Nevada, there once were literally hundreds of independent telephone companies and co-operatives, serving anywhere from a handful to several hundred subscribers. Some of the more successful, such as the Rochester (N.Y.) Telephone Company, today are indistinguishable from big-city service by Bell Telephone, which provides service to some 80 per cent of the nation's 92,902,194 telephones.

How It Began. Following Alexander Graham Bell's successful demonstration of the telephone at the 1876 World's Fair in Philadelphia, Bell and a group of backers rushed to set up Bell telephone systems in major population centers, where the cost of stringing wires to link subscribers would be minimal. The first Bell exchange opened in New

Haven, Conn. on January 28, 1878. Within months, there were Bell exchanges in Boston, Philadelphia, New York, Hartford, Conn. and most other eastern seaboard communities. During the 17 years while the Bell patents were in effect the company spread westward to Buffalo, Pittsburgh, Chicago and beyond. But as it moved west, there were enormous areas left without phone service. As soon as the patents expired, areas they served were small, like Upton's, their equipment was old-fashioned and they represented little in the way of income (an average annual bill for an Upton subscriber, for example, was about $35. When you multiply that by 330 subscribers, you have a total annual income barely large enough to support a middle-class family of four. But as cities expanded into the suburbs, and the suburbs began to swallow up exurbia in recent years, the rural companies have found themselves located strategically. Some of General's once-rural southern California systems now are in the densely-populated

Veteran operator Ruth Vance (above left) operates the Upton, Ky. telephone switchboard from her own living room. Although subscribers generally don't make calls after 9 p.m., Mrs. Vance sleeps in same room as switchboard to handle emergency calls at all hours. Photo (above right) shows tangle of wires that climb telephone pole outside the Vance home. Wires

around the turn of the century, rural doctors began setting up their own telephone systems, so that a patient could call if something went wrong. Small town businessmen set up local phone companies, such as the Buffalo Valley Telephone Company of Lewisburg, Pa., or the Copake Telephone Company in upstate New York. And in Upton, where neither doctors nor businessmen thought the effort worthwhile, farmers formed a cooperative to build the phone system.

Until recently Bell and the nation's second largest telephone system, General, paid scant attention to the rural companies. The suburbs of Los Angeles.

While the Bell System wasn't wildly enthusiastic about these pygmy systems, there wasn't much it could do—except to refuse to connect with them (a subscriber to Philadia's Keystone system had to find a neighbor with Bell service if he wanted to call New York in those early years, for example), and to refuse them equipment. By the turn of the century, Bell had acquired Western Electric Company and granted it the license to manufacture equipment under Bell patents. In turn, Western Electric sold all of its phone output to Bell. To service the independents, companies like Automatic, Kellogg and Stromberg-Carlson began turning out phones, switchboards and cable once the patents ran out. Among their first products were the wall-mounted magneto phones. Inside the bulky walnut cabinets were two large dry-cell batteries. In order to make a call, the user cranked the phone to generate power to reach the switchboard.

In Came the Small Guys. The Upton cooperative was typical of many rural cooperatives. The farmers bought their own phones from Automatic, Stromberg-Carlson or even some bootlegged from Western Electric. They strung and maintained the wire on their own property—which meant that instead of using poles, much of the Upton system ran along the tops of fences and through treetops. One subscriber took the switchboard into his living room and maintained it (as Mrs. Vance has done for the past 21 years) in return for a small fee. Until the Federal Government ordered Bell to connect the small companies to its system in the 1920s, the annual bills were very small indeed, and represented only out-of-pocket costs for operating the system. In recent years, Mrs. Vance's son-in-law, Allen Jaggers, has taken over the job of repairing lines for subscribers.

Because subscribers don't get a monthly bill (Mrs. Vance may not get around to sending one out for six months or a year) and because there's no phone directory (all the connections are in Mrs. Vance's head), nobody knew for sure when General announced plans to absorb the system earlier this year just who the subscribers all were, or how many of them there were. General got into the act when Farmers Telephone faced the dilemma that's gradually wiping out the rural phone company and driving the wooden wall phones off the kitchen wall and into the museum or antique shop. The equipment purchased in 1915 was wearing out, company service was suffering, and there was no money to modernize. "Actually, we took over the Upton system because the Public Service Commission asked us to, not because we wanted to expand," a spokesman for General of Kentucky said. "The first thing we had to do was to make a survey to find out just who our new subscribers would be, and where they all lived."

Gold in the Hills. As soon as word reached the big cities that there were some 330 wall telephones due for replacement in Kentucky, phones began ringing. "We received several dozen calls from people who

connect switchboard to some 330 subscribers. Dead tree (above left) provides a junction point for two Upton phone lines. Thrifty farmers use trees whenever possible to avoid cost of erecting poles. This call going through the Upton system (above right) is being made in Upton's only pay phone booth. It's a 1915 Stromberg-Carlson and it's powered by batteries.

e/e UPTON DIAL TONE

thought it was part of our system," a Kentucky Bell official reported. "They all wanted to buy phones. I referred them to General. General executive Sumter Logan acknowledged that he had received a number of calls from New York, Chicago, Los Angeles and elsewhere asking if the phones were for sale. "I explained that the phones belonged to the individual subscribers, and that they'd have to find someone who would sell."

stores have reconditioned them with new working parts. A year ago, the price in New York for a reconditioned wall phone was $59. By the time of the Upton switch, the price had climbed to $79, and Upton farmers were turning down offers of $40 and $50 for their unreconditioned, scratched, banged-up phones. Would-be antiquers from Cincinnati, Louisville and Indianapolis arrived by the carload for several Sundays in a row. Most went home empty-handed, but those that struck a deal left smiling. Their investment may double in the next few years.

But, according to the experts, nestled in

When professional phone men came to Upton they were horrified to see the interconnecting overhead wiring system. Makeshift techniques are not suitable for modern day telephone utility standards—even if they work!

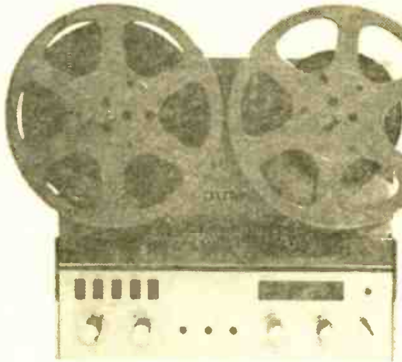
The market for walnut wall phones has developed with lightning rapidity. "Ten or twelve years ago," Logan recalls, "I was working for a phone system in Indiana which scrapped the wall phones. A local junk dealer offered us $2 apiece for them, took them to his yard and poured gasoline over them. Then he touched a match and burned the cabinets and bakelite so he could salvage the copper in the magnetos." Recently, decorators have used the phones to restore old homes. And specialty phone

some yet undiscovered Appalachian valley or on some Nevada RFD, there's another Upton—in fact there may be as many as three or four hundred—with an as-yet undiscovered treasure trove of 1915 Kelloggs or Strombergs or Automatics. Somewhere there's another town where you don't get a dial tone when you pick up the phone, but instead are greeted by name and asked how you are. After all, you can't say to a dial tone, "Hello, Central, give me number nine." ■

An Upton farmer makes a final call on his 1915 magneto telephone. Walnut cabinet houses two dry cells, and crank at right turns over the magneto to power the signalling system. This phone, reconditioned and refinished, brought $79.95 on the collector's market.

e/e HIGH-FIDELITY

REVOX Model A77 Three-Motor, Solid-State Stereo Tape Recorder



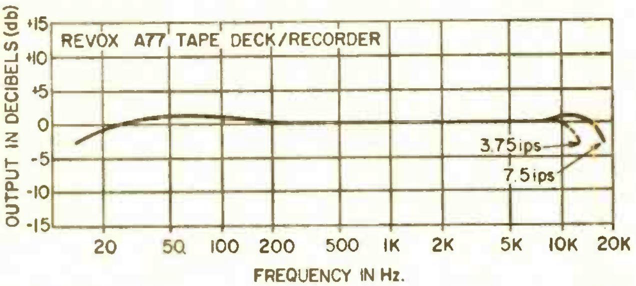
The Revox A77 is a three-motor, three-head, solid-state, 2-speed recorder designed and constructed for use as a professional studio machine. It takes reel sizes to 10½ in., and it features electronic stabilization of the line voltage to amplifiers and oscillator, which together with the solid-state electronic capstan motor speed control, makes the A77 independent of power line variations. All solenoid-operated, the A77 also has complete bias and equalization adjustments.

Several models of the basic A77 are available, depending on the track options; our test model was a 4-track unit capable of 2-track stereo or 4-track mono recording and playback. Since each channel has its own individual level controls, input selector and VU meters, the A77 has built-in facilities for sound-on-sound, sound-with-sound, echo, mono track intermix, and 2-input mixing for each channel. You can also get an oddball pre-echo effect. Separate plug-in 8-watt power amplifiers are available as an option.

Flexible Inputs. Each channel has a separate (not ganged or concentric) level control, and a separate input selector that provides gain-equalized options for Lo-Z mikes, Hi-Z mikes, radio, auxiliary, and a cross-track mix. The cross track mix operates in the following manner: if the channel 1 selector is set to the II-I position the channel 2 signal is fed to channel 1. Similarly, if channel 2 selector is set to the I-II position, the channel 1 signal is fed to channel 2.

Separate function buttons, one alongside each VU meter, determine the recording feed for both input selectors. When both buttons are depressed, each channel selector feeds its particular channel. When only one button is depressed both input selectors feed a single track. For example, if the channel 1 button is depressed both inputs feed channel 1. This allows mixing of two different sound sources: for example, a guitar feeding the channel 1 input and a mike feeding the channel 2 input could be mixed into channel 1's record amplifier.

Deck or Recorder? The basic A77 is a deck, providing a line-level output and a headphone output for low-impedance phones. The deck is pre-wired so that the addition of plug-in power amplifiers will convert the tape deck to a complete record/playback device. (The A77 can be obtained as a deck or with the power amplifiers or as a complete recorder with speakers.) When the plug-in power amplifiers are used the speak-



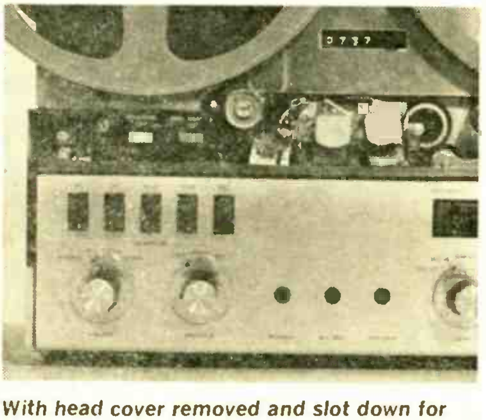
Frequency response of Revox A77 with bias adjusted for low-noise tape. Signal-to-noise ratio measured –58 dB; total harmonic distortion (THD) was a low 0.7% at zero VU reading.

er output is available at jacks. If the A77 is purchased with built-in speakers, connection to the external speaker jacks automatically disconnects the internal speakers. There is also a pre-wired DIN in/out socket for single-wire connection to receivers equipped with matching sockets.

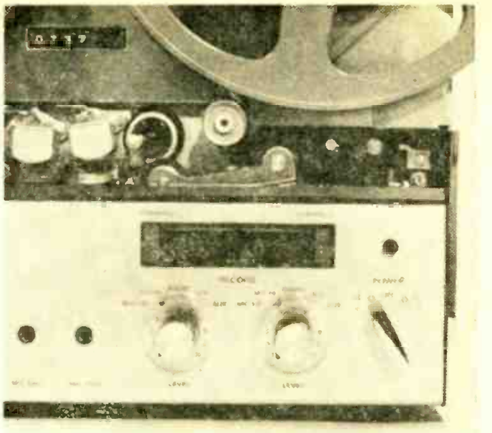
Output Controls. A single control sets the deck's output level for both line output and speakers. A separate balance control equalizes channel gain.

In-out Monitoring. The A77 is equipped with two standard playback equalization curves: NAB and IEC (European). A panel switch selects either playback curve for the playback head. A third switch position connects the playback amplifiers to the input so that the sound source can be monitored before it is recorded. Since the output impedance of the play/monitor amplifier is 600 ohms, a standard VU meter can be connected across the output to get VU measurements for both record and playback (as is done in some studios).

Doing It Your Way. Just about every aspect of the recording process has adjustable controls. As supplied, the A77 comes adjusted for type 203 (low noise) tape. However, controls are provided for each track and each speed for equalization and bias. This allows the machine to be easily readjusted to whatever brand of tape you prefer. The A77 can also be ordered pre-adjusted to a particular brand of tape. As we'll show later, even with the factory equalization, standard tape (type 111) gives per-



With head cover removed and slot down for clarity, you can see brakes-off switch which allows hand feed of tape for editing or capstan drive with no take-up for editing.



Each input has own individual selector and volume control; power switch simultaneously selects reel size, speed, and equalization.

formance at least equal to broadcast standards.

Into the Guts. A totally new and unusual type of capstan motor is used. The outer shell of the motor rotates, and into the shell is cut a "gear," a series of serations like gear-teeth. Opposite them a magnetic pickup coil is mounted whose output is fed to an 800 (3.75 ips) Hz. or an 1600 (7.5 ips) Hz. discriminator. When the motor is rotating at the proper speed the discriminator output is zero. When the motor attempts to drift off-speed the discriminator senses the speed change as an output voltage and applies proportional correction voltage to the motor. The end result is very tight speed regulation and a wow and flutter of 0.05% at 7.5 ips and 0.08% at 3.75 ips. (This is better than many studio recorders in the $2000.00 class.)

All functions are solenoid-relay controlled: there is no massive mechanical loading on the control lever when going from function to function. Pressing the start switch energises a solenoid to pull in the capstan idler while relays provide the power to the supply and take up motors for proper holding tension. Pressing a fast speed switch re-energizes the capstan solenoid causing it to drop out, thus releasing the idler, while at the same time reel motor voltages are changed for proper direction. The fast speeds are really fast with less than 60 seconds needed to rewind a 1200-ft reel.

Similarly, the record button trips a relay that applies bias current slowly so there is no click recorded as bias is applied to the head. *(Continued on page 74)*

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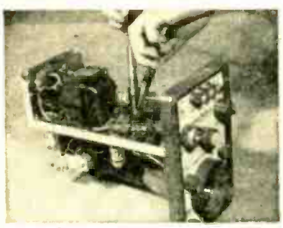
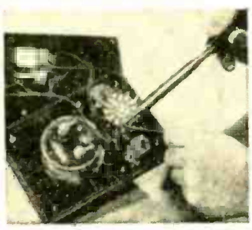
Construction of Oscilloscope.



Construction of Multimeter.



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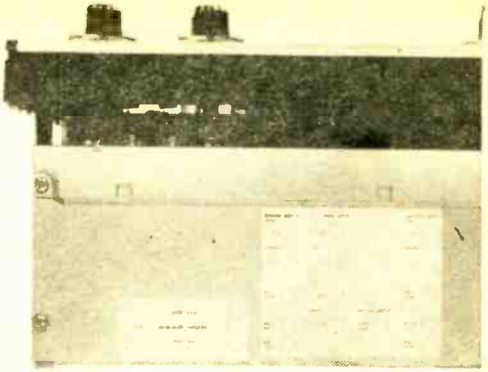
e/e REVOX A77

The automatic stop circuit is all photoelectric. A lamp and a photocell that is masked from the lamp when tape is in the head path operate a transistor gate in the stop switch circuit. When tape is broken or runs out or loses tension, light from the lamp strikes the photocell. This arrangement provides fail-safe operation if a defect in the lamp or photocell circuit disables the auto-stop circuit, and in no way interferes with normal recorder control.

An unusual feature is the *brakes off* switch which releases the brakes on the supply and take-up motors so the tape can be threaded with no stretch-creating drag. Also, with the brakes off, a special button can be operated so that the tape lifters drop away to allow the tape to contact the playback head, to allow hand cueing for editing. Also, with the brakes off and the *play* button pressed the capstan drives with the take-up motor off, allowing the tape to play and feed into a collector basket for editing.

Electrical Performance. Electrical performance is similarly outstanding. With type 203 tape, or Revox' own tape (actually Agfa PE36) the 7½ ips response measured +1.3/−3dB from 14 Hz to 13 kHz. At 3.75 ips the response was +1.5/−3dB from 14 Hz to 13 kHz. The signal-to-noise ratio was −58 dB through the mike input. Using type 111 tape (with the machine adjusted for type 203) the 7½-ips response was +2/−3dB



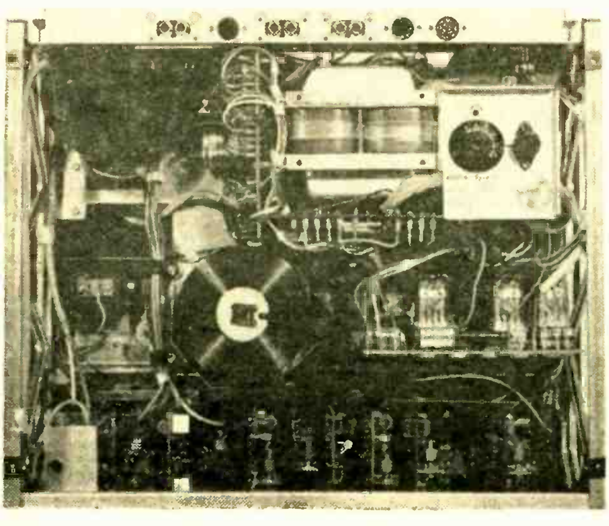
Seal covers complete bias and equalization adjustments for both tracks. To adjust, you push screwdriver through appropriate circle.

from 25 Hz to 14 kHz with a 58-dB signal-to-noise ratio. Similar results were measured at 3.75 ips. If the bias and equalization is readjusted for type 111 tape, the 111 will give essentially the same performance as the type 203. Formula 15 type Audiotape (low noise) can be interchanged between the A77 and a "standard" bias machine with very little difference in performance.

Unlike many amateur recorders, the A77's zero VU reading is not peak recording level. Our model had 8dB headroom above zero to the 1% THD tape distortion (better than many professional recorders), and produced outstanding piano recordings as the headroom absorbed the high peak sound energy that is not shown on a standard VU meter because it is damped.

Summing Up. The Revox A77 is a beautiful piece of machinery. (It is made by Willi Studer, who makes what many consider to be the finest professional recorder.) As an example of what to expect in quality, except for the heads, capstan, and pinch roller, every part in the A77 is guaranteed for life to the original purchaser.

The basic tape deck less cabinet and plug-in power amplifiers is priced at $529.00. For additional information write to Revox Corp., 212 Mineola Ave., Roslyn Heights, N.Y. 11517. ■



All amplifiers plug into bottom of deck. Note size of power transformer.

STRIPPER

Your TV set gains by excitation from our super antenna

by George J. Monser

Sooner or later you'll have to face the antenna problem when your home becomes, like the average TV viewer's, a multi-TV one. Or, perhaps you've just moved to a new building and the roof is way-up from your apartment; or, the landlord has a clause in the lease that forbids exposed lead-ins, especially on the front of the building. You have three choices to solve your dilemma; 1) a very costly roof installation, 2) inefficient rabbit ears or some other form of indoor antenna, 3) subscribing to cable TV where it exists.

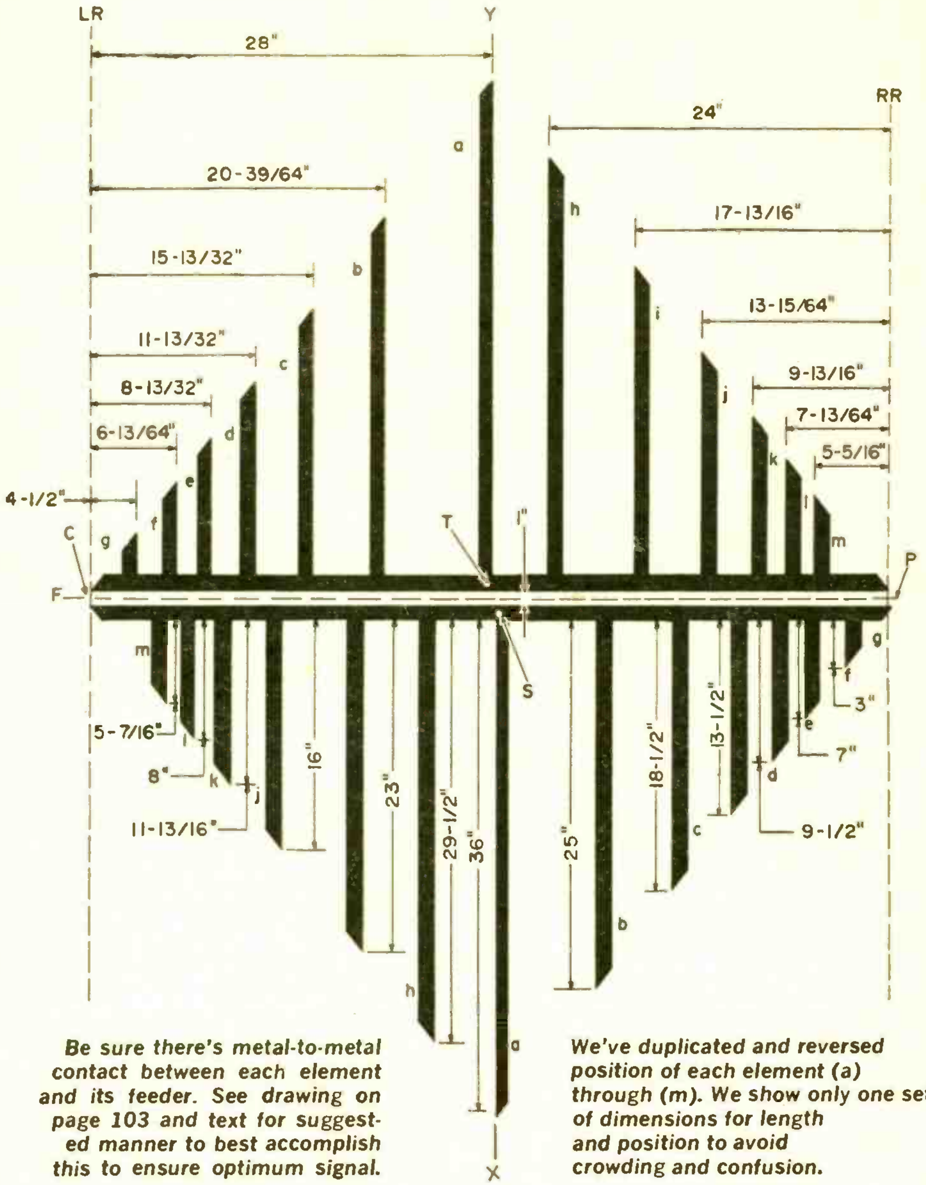
When you realize how easy it is to make our *Stripper*, an antenna that outperforms the majority of commercially produced indoor types (rabbit ears, power line couplers, etc.), that will be out of sight even when in use, and doesn't require an expensive installation on the roof, you'll want to build it.

How It Works. *Stripper*'s design provides almost constant gain of 3-5 dB over the TV band. This compares advantageously with a maximum gain of but 1-2 dB for rabbit ears, and comparable gains for other indoor types. This uniformity of gain for the *Stripper* is achieved by using log-periodic spacing along the feeders and for the important dimensions of the various elements making up the antenna.

Stripper has been designed to lie on the floor out of sight under the carpet, or, if you've access to a crawl space or attic above the ceiling, it can be placed there. Make certain you have enough room to orient *Stripper* for best signal level with minimum reflections which create ghosts in your picture.

Making It. Heavy, transparent, plastic sheeting, used as carpet protector (available from the housewares department of most discount and/or department stores) is used as the base to which self-adhesive copper or aluminum foil strips, 1-in. wide, cut to specified lengths are mounted. If you mount the strips on the smooth, rather than on the ribbed surface of the sheeting, you'll wind up with a better built *Stripper*. The drawing and photos detail the various lengths and the pattern of their layout as well as details on how best to make connections between the feeders and the elements and between

(Continued on page 103)



Be sure there's metal-to-metal contact between each element and its feeder. See drawing on page 103 and text for suggested manner to best accomplish this to ensure optimum signal.

We've duplicated and reversed position of each element (a) through (m). We show only one set of dimensions for length and position to avoid crowding and confusion.

e/e's all NEW

BASIC COURSE in ELECTRICITY & ELECTRONICS*

PART 4
UNDERSTANDING MAGNETISM

What You Will Learn. This chapter explains the principles of magnetism for DC applications. It includes a description of magnetism, natural magnets, electromagnets, magnetic properties and relationships, magnetic measurements and associated terms, and DC applications of electromagnetic principles. The DC applications include the effects of magnetic fields on current flow and electrical reactions associated with relays, motors, etc.

The fundamental characteristics and typical applications of DC

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

electromagnetism are employed in electrical machinery, radio equipment, laboratory and test equipment, automotive devices, television, radar equipment, computer systems, and many others.

When you complete this chapter you will be able to visualize and describe magnetic principles for both permanent magnets and electromagnets, perform experiments and describe the actions and reactions observed, and relate the operating principles of relays, motors, solenoids, and meters to electromagnet fundamentals.

HISTORY OF MAGNETISM

During the ancient period in the world's history, in a district in Asia Minor known as Magnesia, the Greeks noticed that a lead-colored stone had an attraction for small particles of iron ore.

In later years the Chinese made use of this stone in their desert travels. They suspended the stone or floated it on water and called it *loadstone*, meaning "leading stone." Loadstone (also spelled *lodestone*) is a natural magnet, because it possesses magnetic properties when found in its natural state. At the present time the most common method of producing electricity is through the use of the magnetic properties of certain materials.

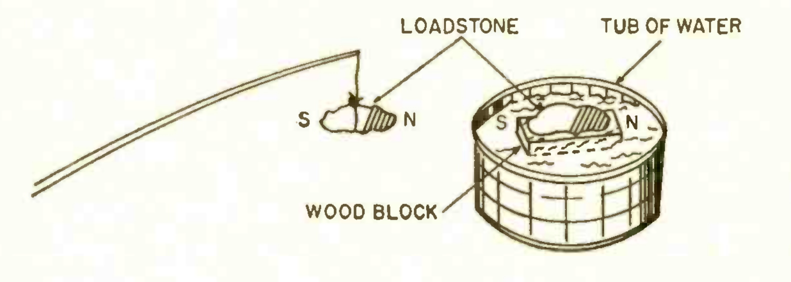
THE MAGNET

Magnets manufactured today are much stronger than the loadstone found in nature.

Iron, *cobalt*, and *nickel* are used in the manufacture of artificial magnets. Iron is easy to magnetize, but loses its magnetic properties almost immediately after the magnetizing force is removed. *Steel* is harder to magnetize, but it holds its magnetism over a greater period of time after the magnetizing force is removed.

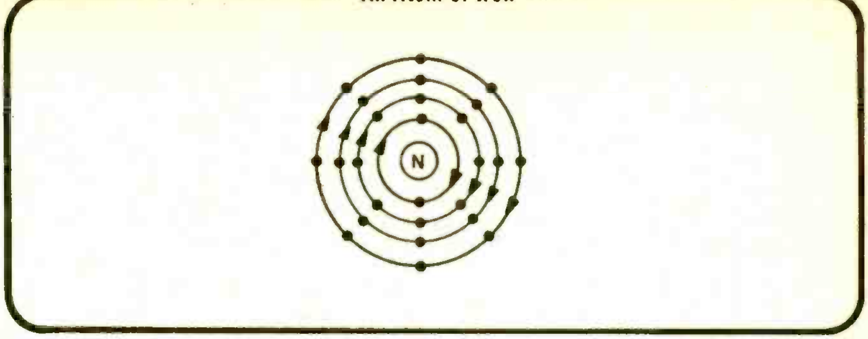
The Chinese learned that when the loadstone was suspended or it was floated on a liquid, one end of the stone always pointed in a given direction. Today we know that any magnetic or magnetized material, when suspended or floated, aligns itself with the earth's magnetic field. The end of the magnet or magnetized material that points toward the north pole of the earth is called the "north-seeking" pole or "north pole"; the opposite end is called the "south-seeking" pole or "south pole."

The Lodestone—a Natural Magnet



Since magnetism is more pronounced in iron and its alloys than in most other materials, we will take a close look at an atom of iron.

An Atom of Iron



Notice that the majority of electrons in orbit around the nucleus appear to be traveling in the same direction. This is the first clue as to why certain materials are easy to magnetize while other materials are almost impossible to magnetize. If you could take a close look at the atoms in a material that cannot be magnetized, you would see that the electrons in orbit appear to be traveling in different directions; they will cancel out each other's magnetic effects, thus preventing any external magnetic field.

You have learned that any magnet or magnetized material has a north-seeking and a south-seeking pole. One important characteristic possessed by magnets is that if the north poles of two magnets are brought near each other, they repel one another. This also occurs if two south poles are brought near each other.

Q1. What materials are used to make artificial magnets?
Q2. How do like poles affect each other?

Your Answers Should Be:

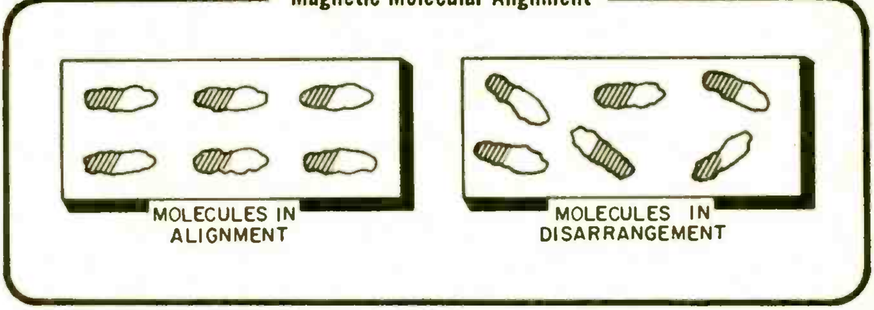
A1. **Iron, cobalt, nickel,** and **steel** are the materials used to make artificial magnets.

A2. Like poles are **repelled** by each other.

Magnetic Molecular Alignment

If you were able to view the molecules inside a block of unmagnetized iron, you would see the total disarrangement of the molecules.

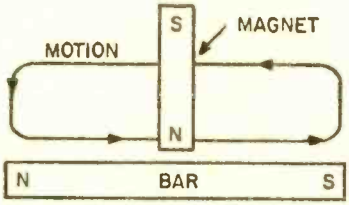
Magnetic Molecular Alignment



Each molecule within a bar of iron has its own north-seeking and south-seeking poles. Although the magnetic strength of a single molecule is very weak, there are many millions of molecules in a very small piece of metal. When magnetically aligned in the same direction, they can develop a strong magnetic field. This is known as the *molecular theory of magnetism*.

To magnetize a bar of iron, stroke the bar with a material known to be a magnet. Let us assume you choose to apply the north pole of the magnet to the iron. In the illustration below, stroke the iron bar from left to right.

Magnetizing an Iron Bar



Note that in stroking the iron bar, the same pole of the magnet is always applied to the iron bar and the stroking action is always in the same direction. Make sure the magnet is lifted free of the bar at the end of each stroke.

A steel bar can be magnetized in exactly the same way. Steel requires a greater force to align its molecules and therefore takes longer to magnetize. However, steel retains its magnetic properties for a much longer time than iron.

Because steel retains its magnetic properties, it is considered to have a high *retentivity* (the property of any material to remain magnetized).

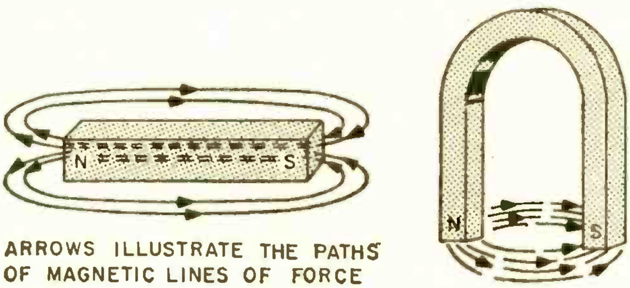
Q3. What is the retentivity of iron as compared with steel?

Your Answers Should Be:
A3. The retentivity of iron is very low.

Magnetic Lines of Force

All magnets have invisible force lines surrounding them. These lines leave the north pole of a magnet, form a loop, and enter the south pole of the magnet, completing the loop inside. These loops run parallel to each other inside the magnet and never cross or unite.

Magnetic Lines of Force



ARROWS ILLUSTRATE THE PATHS OF MAGNETIC LINES OF FORCE

The lines formed by the magnetic loops are called *magnetic lines of force*. The area occupied by these lines is called the *magnetic field*. The magnetic field is the induced energy surrounding the magnet or the space through which the influence of these magnetic lines of force can be measured. The strength of the magnetic field is measured by determining the number of magnetic lines of force per unit area surrounding the magnet.

These lines are invisible; therefore, you may wonder how their total number can be determined or what pattern they form. A simple experiment that you may wish to perform will answer these questions and enable you to see these lines for yourself.

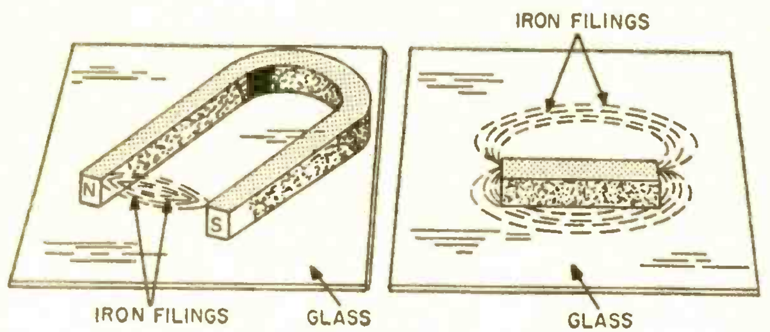
Magnetic Field Pattern Demonstration

You will need:

1. A bar or horseshoe magnet.
2. A piece of glass or clear plastic about 12 inches square.
3. A small can of iron filings.

Place the glass or plastic sheet over the magnet and sprinkle a small amount of iron filings (about a thimble full) over the magnet area on the surface of the sheet. Tap the sheet and notice how the iron filings form a definite pattern similar to that shown in the figure below.

Iron Filings Show Magnetic Field



It was stated previously the lines of force were invisible but that you could see their effects. Notice the heavy concentration of iron filings near the poles of the magnet.

It is possible to magnetize an iron or steel bar by stroking it with a magnet. A steel bar or rod can also be magnetized by placing it parallel to the earth's magnetic field and striking it several sharp blows with a hammer. The force from these blows causes the molecules in the bar or rod to change positions and to align themselves with the earth's magnetic field. If a screwdriver becomes magnetized, strike it on a hard surface a few times. Providing its original magnetic properties were rather weak, this striking will rearrange the molecules and demagnetize the screwdriver. Be sure the screwdriver isn't held parallel to the earth's magnetic field as it strikes the hard surface.

Heating, as well as jarring, reduces the magnetism of any material. When iron is heated above 770°C, it can no longer be magnetized or hold any magnetism. Heating a material accelerates the movement of the molecules, and this action causes the molecules to rearrange their alignment.

Q4. What is meant by a magnetic field?
Q5. How is the strength of the magnetic field around a magnet determined?

Q6. What part of a magnet has the greatest magnetic attraction for a steel bar?

Your Answers Should Be:

A4. A magnetic field is **the pattern of lines of force that surround** a magnet.

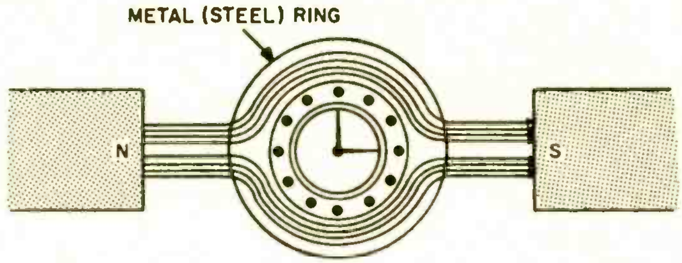
A5. The number of lines of force per unit area around a magnet indicates its magnetic field strength.

A6. The area around either pole has the greatest influence on a steel bar.

Magnetic Poles

The path of magnetic lines of force can be controlled. The lines of force concentrated at the poles of the magnet are much closer together than those surrounding the magnet. This is true because magnetic lines of force always take the path of least opposition. Iron or steel offers less opposition to these lines of force than air or other nonmagnetic material. This principle can be used to advantage. If an iron or steel ring is placed around a watch, the magnetic lines will follow a path through the ring and will not pass through the watch. This method of diverting magnetic lines of force is called *magnetic shielding*.

Magnetic Shielding



The *minimum number of poles a magnet can have is two*—a north-seeking pole and a south-seeking pole. It is possible, however, for a magnet to possess more than two poles. See drawing top of next page.

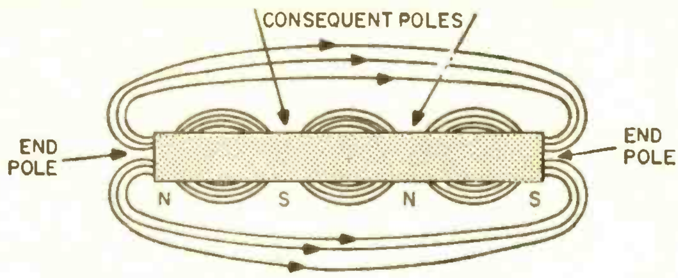
The poles between the ends of a magnet are called *consequent poles*. Notice there are magnetic fields existing between the consequent poles and the end poles. These fields are the same as the field that exists between the end poles. The magnetic lines of force leave a north-seeking pole and enter a south-seeking pole.

Q7. Magnetic lines of force always take the path of - - - - opposition

Q8. Diverting magnetic lines of force is one method of magnetic - - - - - - - - - -.

Q9. What is the minimum number of poles a magnet can have?

Consequent Poles of a Magnet



Q10. The poles between the ends of a magnet are called -------- poles.

Q11. Magnetic lines of force leave the ----- pole and enter the ----- pole.

Your Answers Should Be:

A7. Magnetic lines of force always take the path of **least** opposition.

A8. Diverting magnetic lines of force is one method of magnetic **shielding.**

A9. Two.

A10. The poles between the ends of a magnet are called **consequent** poles.

A11. Magnetic lines of force leave the **north** pole and enter the **south** pole.

TYPES OF MAGNETS

Basically, there are two types of magnets—permanent and temporary. As their names imply, one magnet retains its magnetism for a long period of time (years in some cases), and the other loses its magnetism almost as soon as the magnetizing force is removed. Manufactured magnets are called artificial magnets since the only natural magnet is the loadstone. Incidentally, a loadstone is very weak compared to a manufactured magnet; therefore, a loadstone has very few applications.

Applications

The types of magnets which have been discussed are widely used in speakers, meter movements, and magnetic compasses. You may wonder about the third use since a magnet deflects the needle of a compass. A compass installed on most boats, cars, or airplanes is usually surrounded by metal. This metal is affected by the earth's magnetic field. Small bar magnets, called compensating magnets, are placed around the compass to counteract the effects of the earth's magnetic field on the surrounding metal. This makes it possible to use the compass in such places.

Horseshoe Magnets

The magnets used in meters are shaped like a horseshoe. By bringing the two poles close together, the lines of force are concentrated and thus provide a much stronger magnetic field.

Care of Magnets

Magnets that are not properly cared for lose their magnetic properties over a period of time. How much magnetism is lost depends on many variables—how the magnet was originally magnetized, how it is used, where it is used, etc. When a horseshoe magnet is not in use, a soft iron bar should be placed across the poles. This bar will provide a path for the magnetic lines of force, and the magnet will retain its magnetic properties for a much longer period. The iron bar used for this purpose is called a *keeper*. Bar magnets should be stored parallel to each other with unlike poles together.

Reluctance

Some materials offer less opposition to magnetic lines of force than do others. In magnetic circuits this opposition is called *reluctance*.

In the study of electrical circuits, you learned that electromotive force causes current to flow in a circuit and the flow of that current is limited by resistance. There is also a magnetic circuit in which the magnetic lines of force form closed loops, called *flux loops*. The force that produces these flux loops is called the *magnetomotive force (mmf)*. The opposition to the flux loops is called *reluctance*. Notice the similarity to the electrical circuit. In a magnetic circuit the magnetic lines of force always take the path of least reluctance. This is why the magnetic lines followed the steel ring around the watch discussed previously. The steel ring offered less reluctance than the air and the nonmagnetic metal of the watch in the center of the ring.

Q12. The opposition that some materials offer to magnetic lines of force is called ------------- .

Your Answer Should Be:

A12. The opposition that some materials offer to magnetic lines of force is called **reluctance.**

Magnetic Flux

An expression for determining the amount of flux present in a magnetic circuit is:

$$\text{flux} = \frac{\text{magnetomotive force}}{\text{reluctance}}$$

Flux varies directly with the magnetomotive force and inversely with the reluctance. This is the Ohm's law expression for magnetic circuits. Compare the two formulas.

$$\text{Current} = \frac{\text{electromotive force}}{\text{resistance}}$$

Magnetic flux is the total number of magnetic lines existing in a magnetic circuit or extending through a specific region. The symbol for magnetic flux is the Greek letter Ø (phi). One magnetic line of force is equal to 1 *maxwell*.

The concentration of these magnetic lines determines the *flux density*. The symbol for flux density is *B*, and the unit of measurement is the *gauss*. One gauss is a flux density of one line of force per square centimeter.

The degree of flux density between the poles of a horseshoe magnet is directly proportional to the area of the air gap between the poles. The force of attraction or repulsion between the poles varies directly with the strength of the poles and inversely with the square of the distance separating them. This force can be determined as follows.

$$F = \frac{P_1 \times P_2}{\mu d^2}$$

where,

F is the force between poles in dynes (unit of force),

P_1 and P_2 are the strengths of the two poles,

d is the distance in centimeters between the poles,

μ is a constant that depends on the medium between the poles. It is 1 for air and greater than 1 for other mediums.

To find the total number of flux lines, multiply the flux density (in gausses) by the area (in square centimeters).

Certain materials have more opposition (reluctance) to magnetic lines of force than others. It is therefore true that some materials allow magnetic lines of force to pass more easily than others. The ease with which magnetic lines of force pass through a material is known as *performance*, the reciprocal of reluctance (permeance $= \frac{1}{\text{reluctance}}$). Any substance that allows the magnetic flux to pass with little or no opposition is said to have a high *permeability*. Iron, for example, has a high permeability. High-permeability materials can be easily magnetized, but they will not retain their magnetism. Permeability varies with the intensity of the magnetic field in which the material is located.

It is also possible to determine the flux in any material by multiplying the magnetomotive force by the permeance.

$$\text{flux} = \text{mmf} \times \text{permeance}$$

Not all materials can be magnetized. Actually, materials can be broken down into three classifications—diamagnetic, paramagnetic, and ferromagnetic. *Diamagnetic* materials are those that normally cannot be magnetized. *Paramagnetic* materials are those that are difficult to magnetize. *Ferromagnetic* materials are those that are relatively easy to magnetize. Some ferromagnetic materials are iron, cobalt, nickel, silicon steel, and cast steel.

A diamagnetic material is extremely difficult to magnetize and has a permeability of less than 1. A paramagnetic material is also difficult to magnetize, but has a permeability of slightly greater than 1. A ferromagnetic material is easily magnetized, and its permeability is quite high.

Q13. If there are 3,000 magnetic lines of force passing through a magnet, what is the magnetic flux?

Q14. If there are 2,700 maxwells in a cross-sectional area of 9 square centimeters and the lines are evenly spaced, how many maxwells are there in 1 square centimeter?

Q15. In an area of 5 square centimeters the flux density is 6,000 gausses. How many flux lines pass through the area?

Your Answers Should Be:

A13. The magnetic flux is **3,000 maxwells.**

A14. There are **300 maxwells** in 1 sq. cm.

A15. 30,000 flux lines pass through the area.

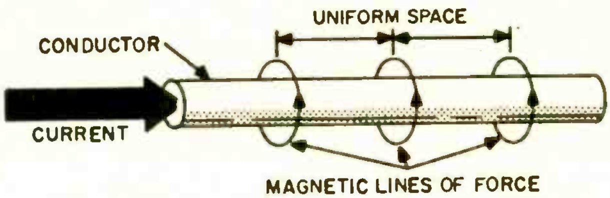
ELECTROMAGNETS

There is another type of magnet that has a wide range of applications in electricity. This is the *electromagnet*. The dictionary defines an electromagnet as "a bar of soft iron that will become a temporary magnet if an electrical current is caused to pass through a wire coiled around it."

e/e Basic Course

Electromagnetism was first discovered by Hans C. Oersted, a Danish scientist, in 1820. Oersted found that a needle placed near a wire would deflect when current passed through the wire. Further experiments led to the discovery that current flowing through a conductor creates a magnetic field about the conductor. This magnetic field is composed of lines of flux (magnetic lines) that encircle the conductor at right angles to the flow of current. The flux lines are uniformly spaced along the length of the conductor.

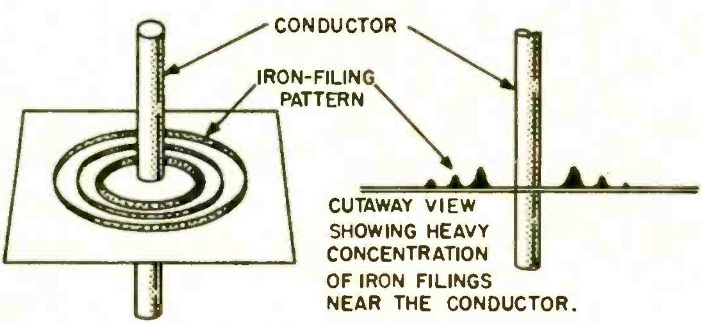
Magnetic Field Around a Current



This is another method of creating a magnet. The magnetic field around a straight horseshoe magnet is not very strong, but it exhibits the same properties as the bar or horsehoe magnet discussed previously. If a compass is placed near the conductor, the compass needle is deflected at *right angles* to the current-carrying conductor. The compass also indicates that the magnetic field around the current-carrying conductor is polarized. If the current is reversed through the coil, the position of the compass needle also reverses.

The magnetic field around a conductor diminishes with an increase in distance from the conductor.

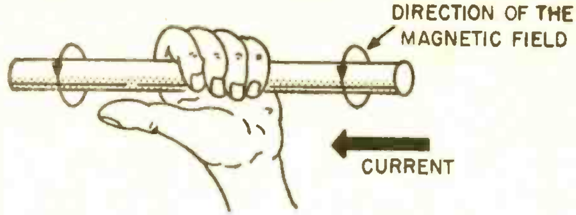
Magnetic Field Is Strongest Near Conductor



Left-Hand Rule

To determine the direction of the magnetic field around a current-carrying conductor, grasp the conductor in your left hand, with your thumb pointing in the direction of current flow. The direction that your fingers curl around the wire indicates the direction of the magnetic field.

Left Hand Rule for Conductors



A16. In what plane do the magnetic lines around a current-carrying conductor lie?

Your Answer Should Be:

A16. The magnetic lines around a current-carrying conductor lie in a plane at **right angles to the conductor.**

Magnetic Field Strength

Magnetomotive force is the force that tends to drive the flux through a magnetic circuit. The unit of magnetic force is the *gilbert.*

The unit of measurement used to express field intensity is the *oersted.* The strength of the magnetic field can be found by using the following expression:

$$H = \frac{I}{5d}$$

where,

H is the field intensity at a point nearest the wire in oersteds.

I is the current through the wire in amperes.

d is the distance of this point from the axis of the wire in centimeters (1 inch = 2.54 centimeters).

Constructing an Electromagnet

The magnetic field developed around a straight wire or conductor is seldom strong enough to be useful. However, if the wire is formed into a coil, the magnetic field becomes quite strong.

The figure at the top of page 88 shows the action that takes place when current flows through a coil. All of the magnetic lines of force enter the coil at one end and emerge at the opposite end.

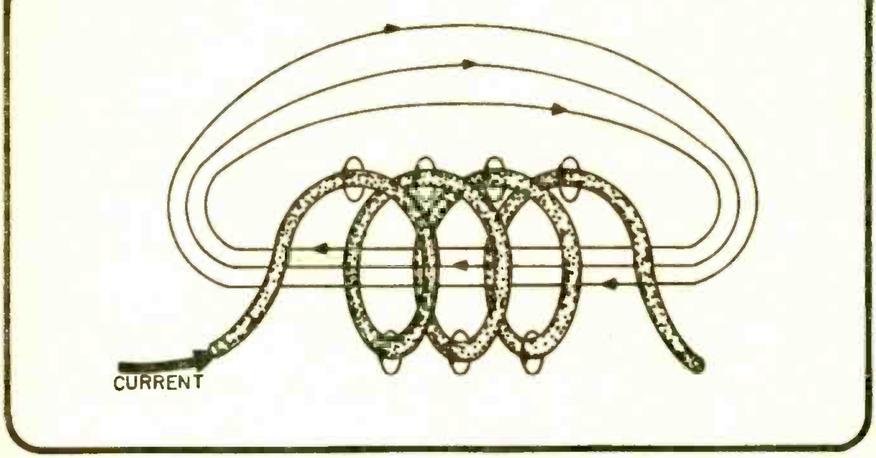
The strength of the magnetic field is directly proportional to the number of turns in the coil and the current passing through them. A coil with a large number of turns has a magnetic field of greater strength than one with a small number of turns. The magnetic field is greater when a larger current flows through the coil.

Since all magnetic lines of force form a loop, poles similar to those of a permanent magnet are established on the coil. The poles form at each end of the coil and their polarities depend on the direction of current flow.

The left-hand rule is employed to determine the magnetic polarity. Grasp the coil in your left hand with your fingers pointing in the direction of current flow. Your thumb points in the direction of the north-seeking pole of the coil. (See bottom illustration on next page.)

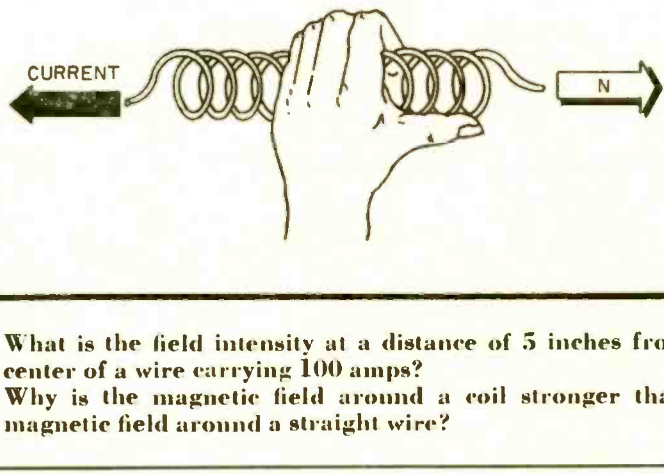
It was stated previously that the flux density is much greater in a block of iron than it is in air. Therefore, if an iron core is added to the current-carrying coil, the magnetic loops will concentrate through the core, increasing the flux density and strength of the electromagnet. The magnetic lines around the coil are called

Magnetic Field Around a Coil



induction lines. Soft iron cores are used in electromagnets because of the high permeability of iron.

Left Hand Rule for Pole Determination



Q17. What is the field intensity at a distance of 5 inches from the center of a wire carrying 100 amps?

Q18. Why is the magnetic field around a coil stronger than the magnetic field around a straight wire?

Your Answers Should Be:

A17. The field intensity is **1.57 oersteds.**

$$H = \frac{I}{5d} = \frac{100}{5 \times 12.7 \text{ cm}} = \frac{100}{63.5} = 1.57 \text{ oersted}$$

A18. When a straight wire is formed into a coil, the magnetic lines around each turn are reinforced.

(Continued on page 92)

The strength of an electromagnet can be determined by connecting a coil across a battery and placing an iron rod, suspended by a small hand scale, near the coil. When the circuit is energized, current flows through the coil and the magnetic field that is developed attracts the iron rod. The amount of pull can be read directly on the hand scale after subtracting the weight of the rod.

If the overall length of a coil is less than its diameter, the strength of the field can be calculated by the following expression.

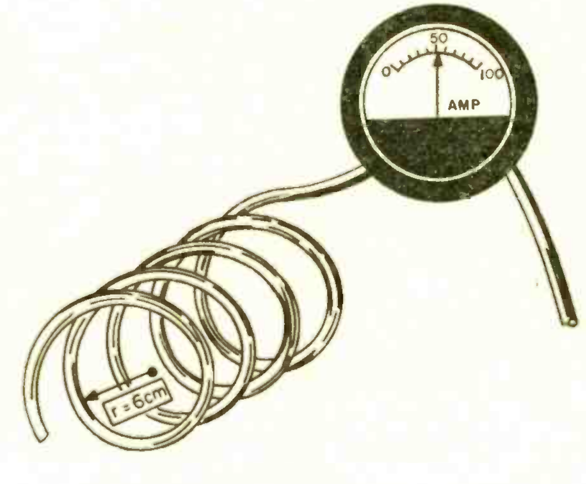
$$H = \frac{2\pi NI}{10r}$$

where,

H is the field intensity on oersteds,
N is the number of turns in the coil,
I is the current through the coil in amperes,
r is the radius of the coil in centimeters,
π is a constant equal to 3.14.

The two main factors that determine the strength of an electromagnet are the current and the number of turns in the coil. The magnetic field can be varied by altering either factor. The combination of these two factors (I and N) is called *ampere turns.* An electromagnet with 200 turns of wire through which 1 amp is flowing has a field strength equal to an electromagnet with a 10-turn coil through which 20 amps is flowing. In both cases the number of ampere turns is 200.

Calculate Magnetic Strength



Q19. What can be added to a coil of wire to make it a stronger electromagnet?
Q20. What is meant by permeable material?
Q21. Calculate the field strength of the coil shown in the figure on this page.
Q22. What determines the field strength of an electromagnet?
Q23. What is the field strength of a coil having 10 amps of current

flowing through it, if the coil has a radius of 2 inches and contains 26 turns?

Q24. **Find the current flowing in a coil having a field strength of 25 oersteds, 15 turns, and a radius of 2 cm.**

Your Answers Should Be:

A19. Adding **an iron core** to a coil increases the strength of an electromagnet.

A20. Permeable material is **any material that can be easily magnetized.**

A21.

$$H = \frac{2\pi NI}{10r} \quad \frac{6.28 \times 4 \times 50}{10 \times 6} = \frac{1.256}{60} = \mathbf{20.93\ oersteds}$$

A22. The **current** and the **number of turns** in the coil.

A23.

$$H = \frac{10r}{2\pi NI} = \frac{6.28 \times 26 \times 10}{10 \times 2 \times 2.54} = \mathbf{32.14\ oersteds}$$

A24.

$$H = \frac{2\pi NI}{10r}$$

$$2\pi NI = H \times 10r$$

$$I = \frac{H \times 10r}{2\pi N} = \frac{25 \times 10 \times 2}{6.28 \times 15}$$

$$\mathbf{I = 5.30\ amps}$$

Magnetomotive Force

Magnetomotive force is defined as the force that produces a magnetic field, and is measured in *gilberts*. In the design of an electromagnet for a particular application, it is often desirable to determine just how much magnetomotive force is required to create a magnet with a specific field strength.

A convenient method of determining the magnetomotive force in a current-carrying air-core coil is to use the following expression.

$$\text{mmf} = 1.257 \times I \times N$$

where,

mmf is the magnetomotive force in gilberts,
I is the coil current in amps,
N is the number of coil turns.

The reluctance of air is 1.257 (this number will be different for an iron-core coil). As can be seen, magnetomotive force is directly proportional to the ampere turns.

Residual Magnetism

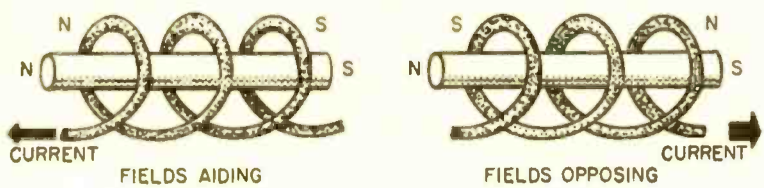
When an electromagnet is de-energized, the magnetic field collapses, but a slight amount of magnetism remains in the core material. This is called *residual magnetism*.

When the magnetic lines of force surrounding the coil concentrate inside the center of the coil, the force magnetically aligns the molecules in the core material. This is similar to the process of magnetizing a metal bar. If the core material is a bar of steel, the results will be different from those for a bar of iron. Once the molecules are aligned in the steel bar, they tend to remain aligned. The core will then retain considerable residual magnetism after the current has ceased to flow through the coil.

Hysteresis

If the current is reversed in an electromagnet (perhaps many times a second), the magnetic field and the direction of polarization will also reverse. If the core material possesses any residual magnetism, the polarity change in the magnetic field will be somewhat delayed beyond the time when the current is reversed. It is necessary to overcome the residual magnetism before the core can be magnetized in the reverse direction.

Understanding Hysteresis



When current flows through the coil in the direction shown, the north pole of the magnet is on the left, and the south pole is on the right (left-hand rule for a coil). The magnetic polarity of the core material is identical to the polarity of the coil. When the circuit is de-energized, the magnetic field collapses. Any residual magnetism remaining in the circuit retains its original polarity.

Q25. What is the magnetomotive force if 2 amperes flows through an 8-turn air-core coil?

Q26. What makes the best core material for an electromagnet?

Your Answers Should Be:

A25. The magnetomotive force is **20.112 gilberts.**

$$\text{mmf} = 1.257 \times I \times N = 1.257 \times 2 \times 8 = 20.112 \text{ gilberts}$$

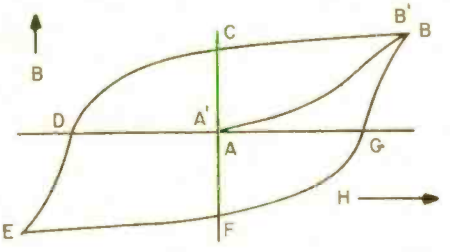
A26. Soft iron makes the best core material because its molecules tend to rearrange themselves easily after the magnetizing force is removed.

If the current through a coil is reversed, the magnetic field also reverses. Before the reverse magnetic field can build up, however, it must first overcome the residual magnetism in the core material of the coil. The residual magnetism opposes the new field, so it is first necessary to reduce the residual magnetism to zero before the new field can be developed. Instead of the magnetic field being developed immediately as the current increases, there is a slight delay. The magnetic field lags the current slightly. This lag is called *hysteresis.*

Energy is required to align the molecules in the core material. If the current through the coil is reversed frequently, considerable energy is required to realign the molecules first in one direction and then in the other. This energy is lost in the form of heat and is called *hysteresis loss.*

The hysteresis lag becomes quite evident when a curve of magnetizing force (H) is plotted against flux density (B).

B-H Curve



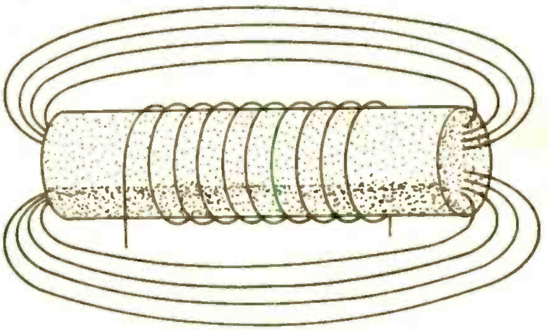
The figure above is referred to as the *B-H curve*. When current flows through a coil, the magnetic field around the coil builds up, as indicated by line A-B. When the current reaches its maximum level, the magnetic field also reaches maximum intensity, as indicated by point B. When the current ceases to flow, the magnetic field collapses along line B-C. When the current reaches zero, the amount of residual magnetism remaining in the circuit is indicated by line A-C.

If the current is reversed in the circuit, the residual magnetism must first be overcome. It falls to zero, as indicated by line C-D. The magnetic field then builds up in the opposite direction along line D-E. reaching maximum concentration at point E. When the current stops flowing in the reverse direction and falls to zero, the magnetic field collapses along line E-F. The distance between points A and F indicates the amount of residual magnetism remaining in the core at that time. If the current were to flow in its original direction, the magnetic field would collapse to zero, as shown by line F-G, and build up to its maximum level along line G-B.

Saturation

The magnetic field develops gradually as the current increases. There is a point, however, where the core material cannot accommodate additional lines of flux. When this point is reached, the core is said to be *saturated*. Any additional lines of force will have to flow through the air surrounding the core material. Since the reluctance of air is quite high compared to the reluctance of iron, it is difficult to increase the flux density beyond core saturation.

Magnetic Saturation



CORE MATERIAL SATURATED

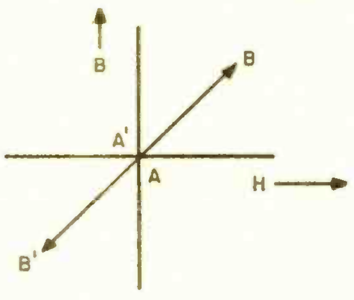
Q27. Will residual magnetism have any effect on the temperature of the core?

Q28. What would the effects be if the core material were removed?

Your Answers Should Be:

A27. Yes, the temperature will definitely be affected. When the molecular action increases, the material becomes hot, and energy is expended in the form of heat.

A28. If there were no core material **the B-H curve would increase and decrease in a linear fashion** and there would be no residual magnetism.



Magnetic Permeability

Compare the B-H curve on the preceding page with the curve above. Notice that the first curve does not vary in a linear fashion along line A-B or A′-B′. This is true because there is a slight variation in the process of core magnetization. Theoretically, the magnetic field gradually builds up by a definite quantity whenever the magnetizing force is varied by a specific amount.

For example, if the magnetizing force increases by 3 oersteds, the magnetic flux increases by 10,000 maxwells. This is true anywhere along the theoretical curve. In actual practice, however, there is a slight variation. At certain points along the curve an increase of 3 oersteds in the magnetizing force may increase the magnetic flux by only 9,800 maxwells. At other points on the curve, such an increase in the magnetizing force may increase the magnetic flux by 10,300 maxwells. This variation accounts for the nonlinearity of line A-B on the B-H curve.

The graph on the next page compares magnetizing force and flux density when a steel bar is magnetized.

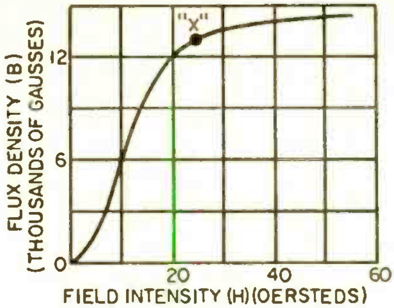
The flux density increases rapidly with only a slight increase in the magnetizing force when the core material is at a point of low field intensity (only a few thousand magnetic lines of force). At a point of high field intensity, a large change in the magnetizing force is required to cause a small change in flux density. Point X indicates the point of saturation.

Permeability can be determined by the following expression.

$$\mu = \frac{B}{H}$$

where,

μ is the permeability (has no unit of measure), Magnetic Force vs. Flux Density



B is the flux density in gausses,
H is the magnetizing force in oersteds.

When the permeability of a material is low, the reluctance is high, requiring a large magnetizing force to increase the flux density. This can be seen from the following expression for determining flux.

$$\phi = \frac{mmf}{R}$$

where,
ϕ is the flux in maxwells,
mmf is the magnetomotive force in gilberts,
R is the reluctance.

Q29. Referring to the graph above, would the permeability at the point of saturation be high or low?

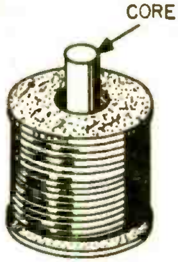
Your Answer Should Be:

A29. The permeability of the core material at saturation would be very **low.**

Solenoids

A coil wound in the shape of a cylinder or tube is called a *solenoid*. A solenoid is often provided with a movable iron core, or plunger. In this arrangement, the iron core is pulled into the coil when current flows through the turns. Thus, the core can be used to mechanically move some device.

A Solenoid



Solenoids are commonly used in relays or circuit breakers. The magnetic field build up in the center of the coil pulls the core into the solenoid, thereby breaking or making relay contact(s).

Polarized Electromagnets

A polarized electromagnet has a permanent magnet as its core.

When the current flows in the coil, the electromagnet will either add to, neutralize (cancel out), or subtract from the magnetic field of the permanent magnet. Polarized electromagnets are used in telephone and telegraph circuits.

Q30. How would you determine which is the north-seeking pole of a solenoid?

Your Answer Should Be:

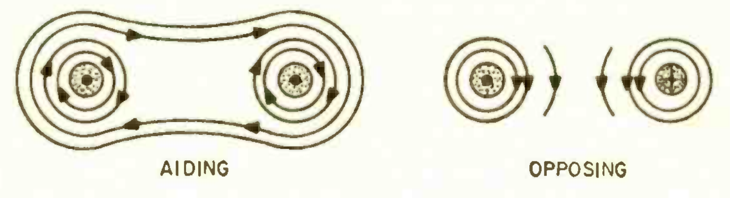
A30. The magnetic field areound a solenoid is similar to that around any coil. The **left-hand rule** used to find the polarity of a coil may also be used to determine the polarity of a solenoid.

USES FOR MAGNETS

You may ask why the permanent magnet does not become demagnetized when the electromagnetic field opposes it. Once a permanent magnet becomes magnetized, a strong force is required to disarrange its molecules. The electromagnetic field might be strong enough to do this if it remained for a very long period of time. However, the current through the coil in a specific direction lasts for only a brief period and does not noticeably change the permanent magnetic field.

When current passes through parallel wires, the magnetic fields around these wires interact. If the currents flow in the same direction, the fields repel each other; if the currents flow in opposite directions, the fields attract each other.

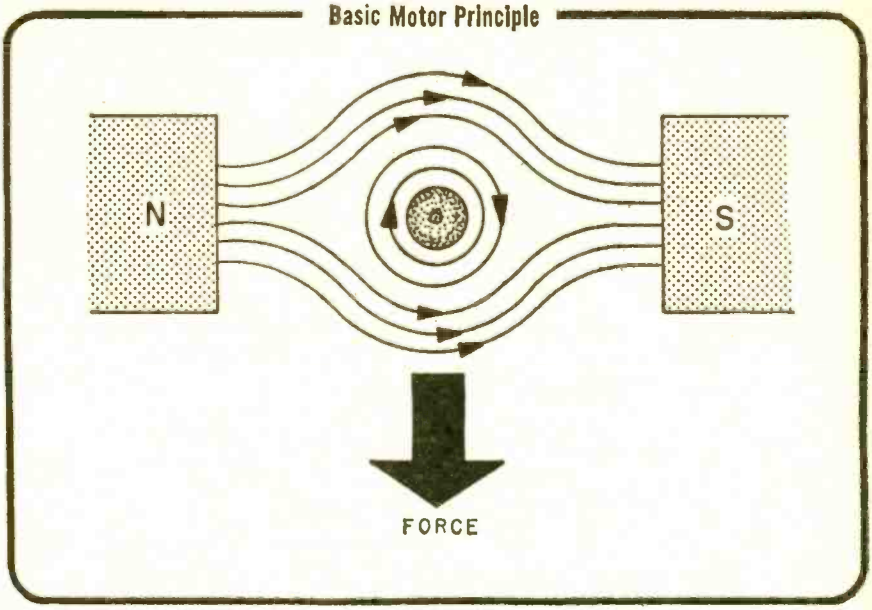
Parallel Wires Carrying Current



Electric Motors

The principle of attraction and repulsion just shown is used in electric motors and generators. Electric motors are used to provide a mechanical power output from an electrical input. Generators provide an electrical output from a mechanical input.

The force exerted on an electron in a magnetic field is at right angles to the magnetic field. When the electron is placed in both an electric and a magnetic field, the force exerted on the electron is perpendicular to both fields. A right-hand rule is used to determine the direction of force on electron flow in a magnetic and electric field.

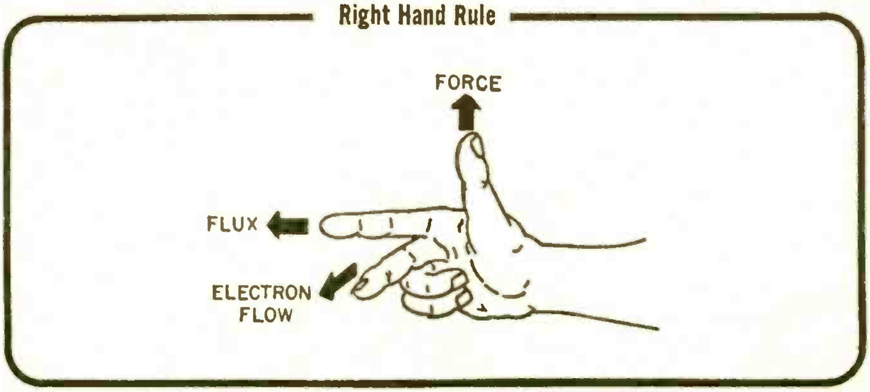


The magnetic field around the conductor in the above figure is clockwise. The current appears to be coming out of the page. The direction of the magnetic field of the permanent magnet is from the north-seeking pole to the south-seeking pole, or from left to right in the figure above. Notice that the lines above the conductor and the lines around the conductor are going in the same direction, reinforcing the field above the electron path. Below the conductor the fields are opposing each other.

Q31. In the figure above, the field around the conductor and the magnetic field of the permanent magnet ar opposing each other at a point below the electron path. What effect does this have on electron flow?

Your Answer Should Be:

A31. This weakens the fields and electron flow is forced in a downward direction.

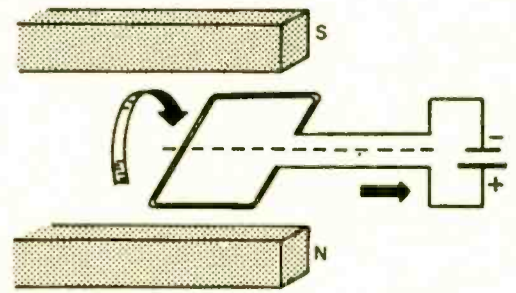


Right-Hand Rule

Arrange the thumb, index finger, and middle finger of your right hand as shown on the previous page. Point the index finger in the direction of magnetic flux and the middle finger in the direction of electron flow. The thumb indicates the direction of magnetic force on the electron (direction that the wire is repelled).

If a loop of wire is positioned in a permanent magnetic field, a force acts on the wire each time current passes through it. This force causes the loop of wire to rotate, if it is free to turn, as shown in the figure below.

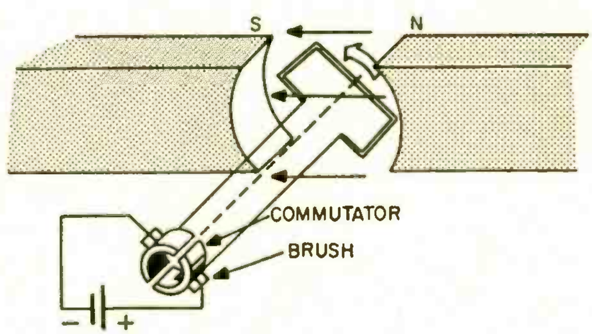
A Simple Motor



The simple motor shown in the figure above is not very practical. The coil cannot rotate very far because the current always moves through the wire in the same direction. When opposing poles appear opposite each other, the loop stops. Furthermore, any permanent connections to the loop of wire will not allow it to rotate very far.

To overcome these objections, the loop is terminated in two contacts that rotate with the loop. These contacts form the **commutator** of the motor. Electrical connections are made by carbon brushes pressing against the communtator.

Motor Commutation



When current flows through the wire loop, a magnetic field is set up so that the north-seeking pole appears above the loop and the south-seeking pole below.

(Check this by employing the left-hand rule for a coil.) The magnetic poles thus created around the loop are attracted by the opposite poles of the permanent magnet; this causes the loop to rotate in a counterclockwise direction. (According to the right-hand rule, the force is downward on the left side of the loop and upward on the right side.)

The loop and commutator rotate together. When the loop has reached a position such that the opposing poles of the electromagnet are adjacent, the commutator will have rotated to a position where the applied voltage is reversed. The current through the loop will now reverse directions, reversing the magnetic field around the loop so that the north-seeking pole of the permanent magnet and the two south-seeking poles will be opposite. The like poles will oppose each other, and the loop will continue to rotate in a counterclock direction.

Q32. If a current-carrying conductor is placed in a magnetic field so that the current appears to be flowing into the page and the polarity of the permanent magnet is such that the north-seeking pole is on your right, what will be the direction of force on the electron stream?

Your Answer Should Be:

A32. The direction of force on the electron flow would be **downward.**

DC Motors and Generators

In electric motors many loops of wire are wound around a core. This assembly is called an *armature*. Each loop is connected to a commutator segment that makes contact with the carbon brushes as the armature rotates. The use of many loops provides smoother operation and considerably more power than a single loop.

Large electric motors use electromagnets in place of permanent magnets. It is possible to obtain a stronger magnet for the same physical size by using the electromagnet.

If current flowing through a wire creates a magnetic field, it seems only reasonable that a wire moving through a magnetic field causes a current flow. The DC generator operates by use of this principle. An armature (similar to one in an electric motor) is rotated in a magnetic field. The turns of wire cut the lines of force, and a current is caused to flow in the wire loops of the armature. Connections to the commutator provide an electric current output.

Another left-hand rule is used to determine the direction of the induced electromotive force in a generator. Place the thumb, index finger, and middle finger of your left hand so that they are perpendicular and at right angles to each other. Point the thumb in the direction of motion (rotation) of the conductor (armature) and point the index finger in the direction of the magnetic flux. The middle finger will then indicate the direction of the induced current (electron flow).

WHAT YOU HAVE LEARNED

1. Magnetism is a property of certain materials to attract and repel each other.
2. Magnetized materials have north (north-seeking) and south (south-seeking) poles. Magnetic force lines flow from south to north inside the material and north to south outside.
3. Some materials may be magnetized by stroking them with a magnet or by passing current through a coil wrapped around them.
4. A permanent magnet has a high retentivity (retains its magnetism). A temporary magnet has low retentivity.
5. Permanent magnets should be stored in a manner which permits the external

field to be concentrated in a path of low flux opposition. Bar magnets are stored with N and S poles adjacent. A keeper is placed across the poles of a horseshoe magnet.

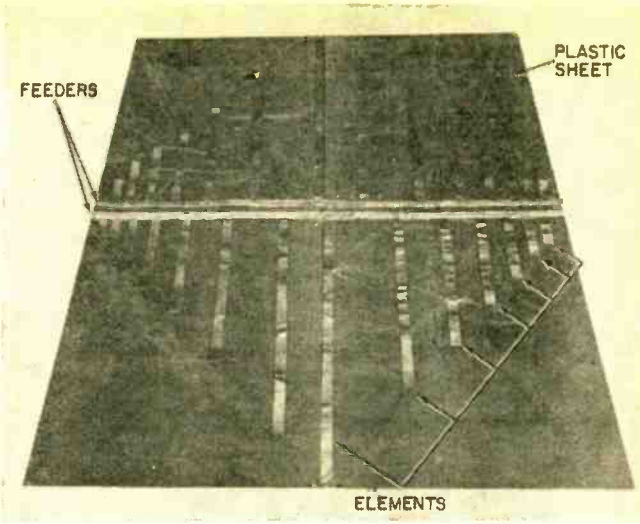
6. Reluctance is the opposition offered to the flow of magnetic flux lines. Air has a higher reluctance than iron.
7. Number of flux lines (maxwells) is directly proportional to the magnetomotive force exerted and indirectly proportional to the reluctance of the material through which the flux lines pass.
8. Permeability of a material is a measure of its ability to be magnetized. Low reluctance indicates high permeability.
9. An electromagnet is a device that has been or is being magnetized electrically.
10. Current through a conductor generates a magnetic field. If the thumb of the left hand points in the direction of electron flow, the fingers curl in the direction taken by the flux lines.
11. A coil of wire develops a stronger magnetic field than a single conductor. Field strength is directly proportional to ampere-turns (number of coil turns and the amount of current flowing). Field strength is indirectly proportional to the diameter of the coil.
12. Magnetomotive force of a coil can be determined by multiplying ampere-turns by a reluctance constant. Reluctance for air is 1.257.
13. Residual magnetism is the amount of magnetism remaining in an electromagnet after current flow has ceased.
14. Hysteresis (difficulty in realigning magnetic direction of molecules) causes changes in the magnetic field to lag changes in the current.
15. Each magnetic material has a limit to which it can be magnetized. The limit of magnetic strength is called saturation, and is the point at which a maximum number of molecules have been aligned in the same magnetic direction.
16. Solenoids are electromagnets with movable iron cores.
17. Electromagnets are used in motors, generators, meters, and other devices that make use of the electrical effects of a magnetic field.
18. The right-hand rule for motors states: With thumb, index finger, and middle finger of the right hand at right angles to each other, the index finger pointing in the direction of magnetic flux, and the middle finger pointing in the direction to current flow, the thumb will indicate the direction in which the conductor will move.
19. The left-hand rule for generators uses the same principle: If the left thumb points in the direction of the conductor movement, and the index finger points in the direction of the magnetic flux, the middle finger will indicate the direction of current flow in the conductor.

NEXT ISSUE: Part 4—Understanding Alternating Current

This series is based on material appearing in Vol. 2 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.

Stripper

Continued from page 76



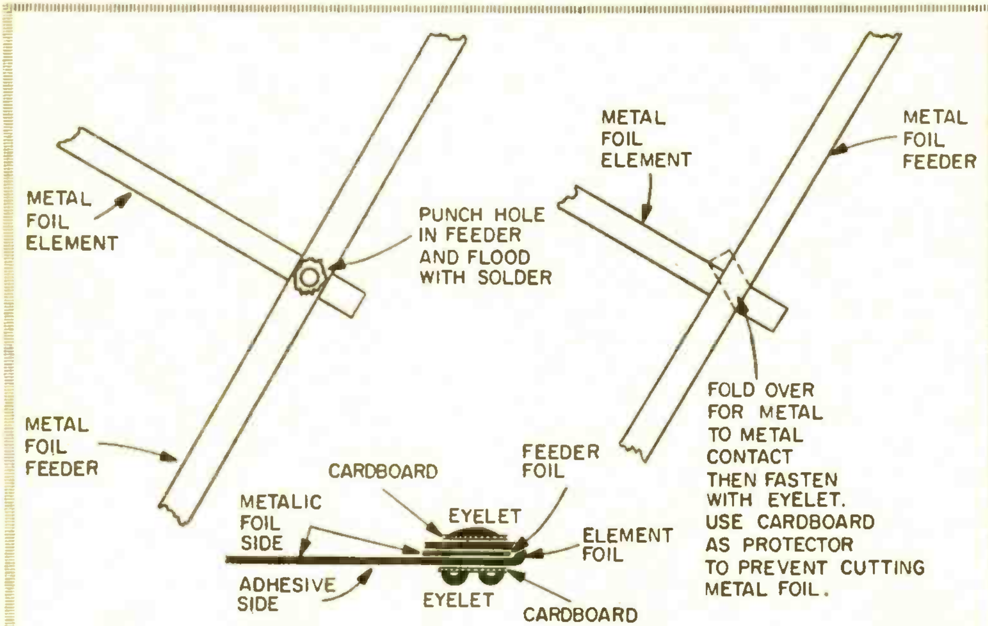
Here's how complete STRIPPER looks when ready to be put in use. We've identified different parts to help you visualize it better.

Stripper and your TV set.

Start the project by tracing the layout on a 3 x 6-ft. sheet of wrapping paper which will serve as a pattern. Place the paper pattern under the plastic sheeting to guide you in mounting the foil strips. Use a felt-tipped marking pen when drawing the pattern to make it easier for you to follow when viewed through the plastic sheet. Cut all the foil strips to sizes indicated in the drawing before starting any of the assembly. Remember, it's important to place the strips exactly as shown; the dimensions have been calculated to give *Stripper* the characteristics outlined earlier in the article.

It's important to have good electrical contact between each element and their respective feeders as well as between the feeders and the lead-in to the set. To assure good electrical connections between the elements and their feeders, several methods can be used, depending on whether you use copper or aluminum foil strips. To assure good metal-to-metal contact we brought the end of an element under its feeder and folded it over so that the metal surface of the lap is in contact with the metal surface of the feeder.

If you use copper foil, you can punch a hole in the lap and carefully flow solder into the hole so that it will run between the two metal surfaces. Be sure you scrape off the adhesive before applying the hot soldering



PARTS LIST FOR STRIPPER

12-ft. heavy, semi-transparent plastic sheet 2½-ft. wide

16 yd. 1-in. x 13 mil Scotch copper or aluminum tape with pressure-sensitive adhesive on back

Misc.—Eyelets, twin-lead lead-in wire, Scotch tape, wrapping paper, solder, etc.

iron. If, on the other hand, you use aluminum foil, which is hard to solder, use an eyelet, reinforced by cardboard squares top and bottom, to clamp the lapped piece to the feeder. Inexpensive, hand-operated eyeleters, complete with an assortment of various sized eyelets, can be purchased for under $1.00 at your favorite discount hardware counter. Use an eyelet to fasten each of the lead-in wires to the feeders by wrapping the bare copper ends of the lead-in around the eyelet before crimping it through the foil of the feeders. Be sure the wire is on the metallic side of the foil strip before crimping the eyelets (point X-X on the feeder strips).

Using Stripper. Once you've completed the assembly and placed it in position in the space you selected for it, connect it to your TV set. You may need assistance at this point, particularly if you've placed *Stripper* in the attic or crawl space where the set can't be seen when orienting the antenna. Move it around until the best clear picture, less ghosts, is obtained on the picture tube. From here on in you've solved your antenna problems. If you get additional sets just make another *Stripper* for each one. ■

Nomograph

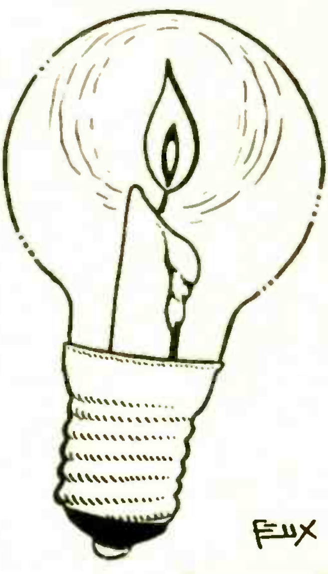
Continued from page 48

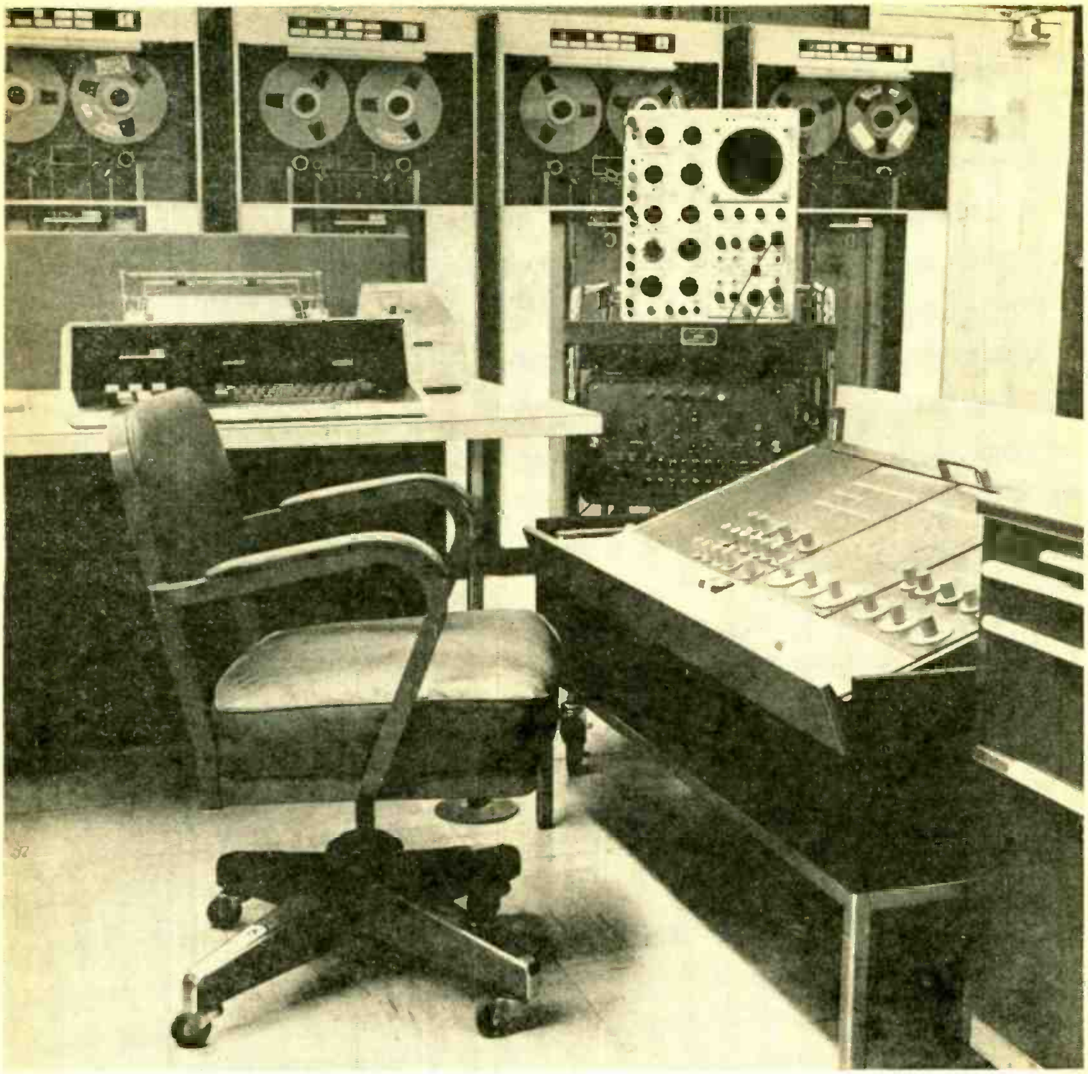
of resistance cost more, of course, and at times two resistors in parallel will enable you to get the desired resistance at a much lower cost. To arrive at the value of the resistor that you need to parallel with one of known value to reach the odd-ball resistance you want, find the mark on either the R1 or the R2 scale for the known resistance value. Next locate the resistance of the desired resistor value on the R_t scale. Then lay a straight edge between the two points, and read the value of the required parallel resistor on the remaining scale.

Typical Problems. A typical problem will serve as an example that should bring everything into sharp focus now. Let's suppose that we have two resistors, 100,000 ohms and 47,000 ohms, connected in parallel in a project that's breadboarded and now ready for finalizing. With this parallel combination in the circuit our little jewel works fine, but the combination is bulky, unsightly, and expensive for quantity production. So obviously it's desirable to replace the bulky parallel resistor combination with a single fixed resistor.

Using the Equivalent Resistance Nomograph, locate the 100,000 ohm value on either the R1 or R2 scale (we used the R1 scale). We could have chosen any point on the scale as 100,000 ohms, but for better resolution the maximum point is the best choice. Next locate 47,000 ohms on the R2 scale, remembering that each major division is equal to 10,000 ohms because of the location of our assignment of the 100,000-ohm point on R1.

Now lay a straight edge across the nomograph so that it intersects the 100,000 and 47,000-ohm points on R1 and R2. Where the straight edge crosses the R_t scale, a line can be drawn on the nomograph, or, if you prefer, you will read the resultant resistance value, 32,000 ohms, on the R_t scale. In comparison, the correct answer, using slide rule and/or pencil and paper, of 31,950 ohms, certainly will take much longer to calculate than if you use the Equivalent Resistance Nomograph. ■





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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., 1189 Broadway, Dept. 537DJ, 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 and T.V. 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.