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See page 29

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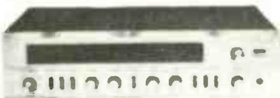

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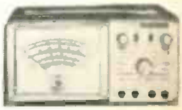

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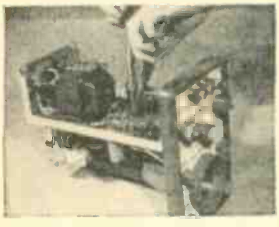

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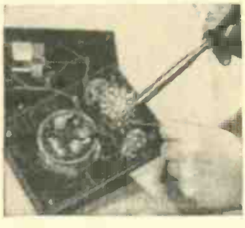

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• July/August 1970 • Vol. 10 No. 3

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Dedicated to America's Electronics Hobbyists

☆ Cover Highlights

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Cover Photo by Manny Greenhaus

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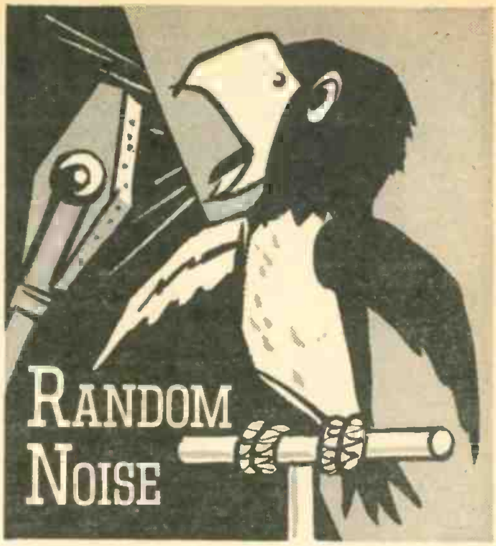
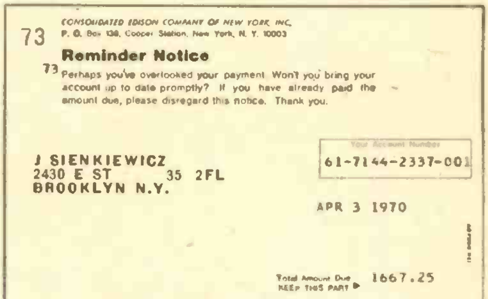


By Julian M. Sienkiewicz, Editor

THIS MAY BE the Age of Aquarius to some, but to me and many other consumers, it's the age of the hokey computer. By now, many of my readers have been either directly or indirectly caught in a computer snafu. Some of the typical irritations consumers suffer at the hands of inhuman computers are billings marked past due that were paid months ago, incorrect charges for items never purchased, a mailing that you didn't order from a book club—you name it. But the most notorious of computer chicanery is the overcharge that is outright ridiculous. And this Editor believes he holds the world's Gold Cup for overcharges.

One day this past spring I received in the mail a bill from my local electric utility—New York's good ol' Consolidated Edison, plain Con Ed to its patrons—a whopper of a bill for only $1667.25. Now I'll be the first to admit that I may leave the VTVM turned on all night once in a while, that we have three electric clocks in the house, and that our oil burner has

(continued on page 99)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APR 3 1970

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Watta bill! This is probably the largest electric bill any general consumer has ever received. Or is it?

Hellоooo Out There

For those of you who don't want a permanent hunch from trying to do something (change the baby, take notes) while cradling the telephone, here's a telephone amplifier, Model FTA-4, from Fanon Electronics. The FTA-4 is a desk-top instrument that consists of a receiving and transmitting unit, and a small, powerful 2-in. diameter extension speaker. The unit measures 9½ x 4 x 2½ in. and weighs less than 4 lb. The amplifier can be lowered to a

Fanon Telephone Amplifier

whisper for privacy, or raised to fill a room to carry on a telephone conference. The FTA-4 is turned *off* simply by removing the telephone handset from the cradle. A 4-transistor, battery-powered circuit eliminates the need for a line cord, so it's completely portable. A 9-volt battery is included with the unit, the price of which is $24.95. For additional information write Fanon Electronics, 100 Hoffman Pl., Hillside, N.J. 07205.

Here's a Car that Won't Pollute!

Heathkit has something for the new generation of radio-controlled model car racers. Called the Spectre, the car is ⅛-scale and measures 19¾ in. in length. The snap-on body is a sin-

Heathkit Spectre R/C Car Model

gle piece of white high-impact plastic, and the car reaches scale speeds of up to 200 mph. The Spectre features independent front-wheel coil spring suspension with adjustable toe-in and caster, live rear axle, chrome plated steel chassis, and rubber tires for nylon "mag" type wheels. The sidewinder-type engine mount accepts any 0.15-0.23 cubic inch R/C engine. There's an adjustable centrifugal clutch, gear train with a 5.5:1 ratio, automatic brake. The Heathkit GD-101 Spectre car kit includes the car body, chassis, wheels and tires, 4-oz. fuel tank and tubing, equipment case, centrifugal clutch and gears, axles, servo linkages and mounting tape, all hardware, decals, numbers, and a manual. Mail order price of the GD-101 is $49.95 FOB. For more details write Heath Co., Benton Harbor, Mich. 49022.

Dial Your Speed Control

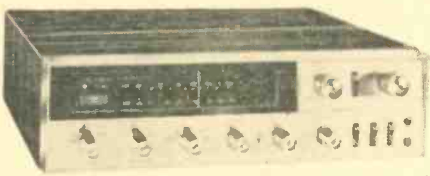
Unlike conventional halfwave controls the Solid-State Motor Speed Control from Dremel Mfg. Co. gives controlled full-wave output. Motor Speed Control comes with an *on/off*

Dremel Motor Speed Control

switch and built-in pilot light, 3-wire grounding cord, and overload protector with manual reset button. The unit can be used with all universal (brush type) motors and fixed-load, shaded-pole motors. Speed can be dialed from zero to full rpm. Also, Motor Speed Control can double as a temperature control on soldering irons or guns to provide just the right heat. Price is $16.95. More information can be obtained from Dremel Mfg. Co., Box 518, Racine, Wis. 53401.

"Most Advanced Receiver to Date!"

Lafayette's new LR-1500TA AM/FM-stereo receiver puts out a big fat 220 watts (IHF) ± 1 db at 4 ohms. The unit has an electronic tuning circuit which Lafayette calls Acri-Tune, three front-end silicon FETs, and FET tone controls. Elsewise, there's fuseless automatic overload protection circuit, automatic stereo/mono switching, 4-gang FM tuning capacitor, four IF stages, wide-band ratio detector, center channel



Lafayette AM/FM-Stereo Receiver

output, built-in AM/FM antennas, *off/on* muting control, loudness compensator, low and high filters, dual system speaker control (main/remote, or both simultaneously), front and rear panel tape output jacks, and much, much more. The LR-1500TA sells for $299.95. For more details, write Lafayette Radio Electronics Corp. 111 Jericho Tkpe., Syosset, N.Y. 11791.

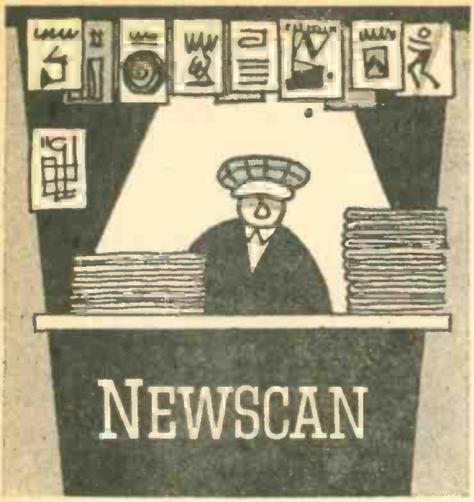
Take Sinatra for a Ride

Selectron International calls their new AIWA Model TPR-2010 the *Touch 'n Go*. The unit, which is smaller than a cigar box, combines a solid-state receiver with a cassette tape player

AIWA Touch 'n Go FM Receiver/Cassette

(it measures only 7⅛ x 8 x 2⅛ in.) "Touch 'n Go" describes the controls: a flick of the finger converts from FM-stereo to cassette. The AIWA TPR-2010 mounts with quick-attach, under-the-

(Continued on page 100)



Time for Life

Those of us tyrannized by our alarm clock may shudder when we learn that at Holy Name Hospital in Teaneck, N. J., new-born infants start their lives with the sound of an alarm, but in their case at least, the clock helps them get a healthier start. Too bad we can't say the same.

Actually, the alarm clock is a pair of Gulf-Western, Eagle-Signal timers installed in the delivery room at Holy Name Hospital. And the newborn baby, if he's listening as he should be, hears the buzzer at intervals of one and six minutes after birth.

The timers eliminate the time variable in a busy delivery room between the two series of Apgar tests given to every newborn child. Devised by Dr. Virginia Apgar about 15 years ago, the Apgar test is simply a 5-point check on the newborn baby to be sure he's starting out with all systems functioning. The tests help identify problems immediately after birth so that in many cases they can be corrected before any permanent damage is done, thus saving many lives and preventing many children from living a lifetime with some physical handicap that could have been corrected had it been recognized early enough.

Nurse actuates timer at moment of birth so that an alarm sounds precisely one and six minutes later to signal start of Apgar test on baby. Anesthesiologist checks new-born twice to be certain all systems are go.

The doctor scores the baby from 0 to 2 on each of the following five points, so that a perfectly healthy newborn will have a score of 10.

- Heart rate—strong and steady
- Respiratory effort—is he breathing frequently and regularly?
- Muscle tone—is he kicking his feet and making fists?
- Reflex irritability—does he cry lustily when a catheter is pushed up one nostril or when he is prodded on the soles of his feet?
- Color—is he pink all over, or are his feet and ankles slightly blue?

So, two Eagle-Signal electromechanical timers were installed in each delivery room and established the timing procedure. A nurse pushes the *START* button on one timer the instant the umbilical cord is severed. At the end of 60 seconds, a buzzer signals the anesthesiologist to make the first series of Apgar tests on the infant; at the same time the first timer starts the second timer. Precisely five minutes later, this timer signals the anesthesiologist to take the second Apgar series for comparison with the first.

Between 2000 and 2500 babies are born in Holy Name Hospital's three delivery rooms each year. All of them start out with punctual health checks.

1001, 1002, 1003, . . .

A new gadget-computer totals the freckles on a face faster than you can wink an eye. However, its designers ironed its purposes to counting the spots on metals. The electronic particle counter, designed and constructed by the metallurgical research division of Reynolds Metals Company, analyzes materials at speeds never before possible. With its 300-power microscope, the device can count the thousands of tiny silicon particles in a polished surface area of an aluminum-silicon alloy in less than a second. Manual counting requires several hours for the same operation.

"Development of this device constitutes a major breakthrough in metallurgical research," said J. Harry Jackson, general director of Reynolds metallurgical research division. "It provides us with a tool for accurately measuring the size and distribution of particles which affect the characteristics of aluminum, such as hardness, strength, elasticity and resistance to

(Continued on page 14)

corrosion. The knowledge gathered by the particle counter will help our staff design alloys and practices for specific product applications."

Known as MAPES I (microscopic analysis of particles by electronic sensing), the counter is programmed to count particles, spaces between them or particles of a specific size. Attachments are provided for microscopic and telescopic study and all data is automatically recorded.

Although MAPES I was designed primarily for the company's metallugical research, it also has tremendous potential in other areas. Feasibility tests have demonstrated the counter's potential value as a medical tool for recording cancer cells. In the plastics and paint industries, it could be used to determine the sizes and shapes of pigments and particles. Applications

Research scientist R. D. Dewey tests an aluminum engine cylinder sleeve for strength, elasticity and resistance to corosion. A long-reach microscope attched to a television camera explores the cylinder wall. While the study area is viewed on a television screen, the instrument electronically counts the thousands of microscopic silicon particles on the metal's surface in a matter of seconds.

in the studies of mineralogy, powder technology, bacteriology, astronomy and air pollution are just around the corner.

For the counting operation, a closed-circuit television camera scans a surface and flashes the picture on a monitor. Electrical pulses from the particles in the study area are fed into the instrument's logic network, the counting device is then triggered and the analog computer begins its work. While data is being received and photographed simultaneously, the whole process is viewed on the television screen.

Studies of photographs, slides and three-dimensional objects are handled with equal ease, and a long reach snorkel-type 300-power microscope is used for exploring the usually inaccessible internal areas of automotive cylinder sleeves, desalination plant tubing and other industrial products. ■

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32 easy ways to get out of refinishing?

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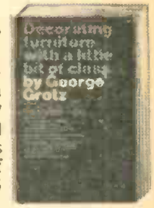
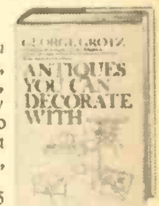


Want to refinish the quick and easy way?

2. *Instant Furniture Refinishing and Other Crafty Practices* is for you. It's newer and bigger than Grotz's own *From Gunk to Glow* – with professional trade "recipes" organized for amateur craftsmen, including how to get a "new look" without refinishing; how to remove paint cheaply and easily; how to "antique." $1.95

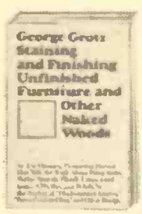
Looking for antiques in the middle-price-range?

5. *Antiques You Can Decorate With* is the Furniture Doctor's own practical, Yankee-shrewd guide to what they are, where to find them, how much to pay for them, how to refinish, and how to avoid fakes. With 400 drawings that cover the whole gamut of old pieces, from beds to wall things. Hardcover, $4.95



Staining, shellacking, varnishing or waxing?

3. Using bleach, linseed, lemon oil, or polish? Grotz's *Staining and Finishing Unfinished Furniture and Other Naked Woods* is the one eye-opening, pioneering manual that tells the truth about using them all – which to use, when, how to prepare surfaces, and how always to get that expensive, quality, finished look. $1.95



In the market for Victorian furniture?

6. *The New Antiques: Knowing and Buying Victorian Furniture* is the one, up-to-date, illustrated guide that will help you identify, appraise, and refinish American Victorian furniture. Covers Gothic, Renaissance, Art Nouveau, all other important styles. Includes up-to-date Price Guide on all pieces. Hardcover, $5.95

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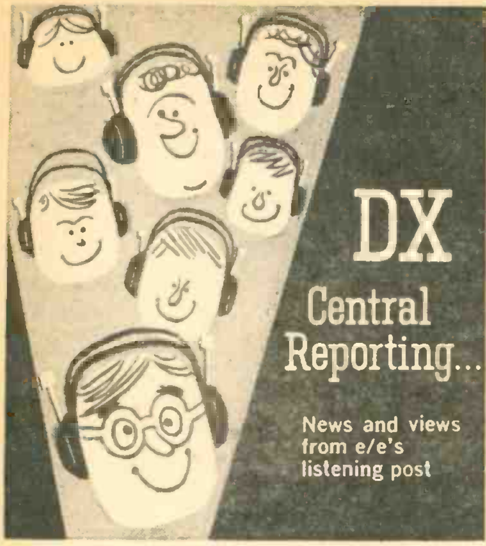


by Don Jensen

EVERY special interest group has its own jargon. But DXers must sometimes feel that their hobby has more than its share of abbreviations, acronyms, and "in" language.

This column sticks to the most common ones, like kHz (kilohertz), and GMT (Greenwich Mean Time). But there are hundreds of others frequently used by radio hobbyists. It's not surprising that SWLs (shortwave listeners) are ready to toss in the towel when they run across something like this in a radio club bulletin:

"R. Wewak, P/NG, 3,335 kHz., w/CW mx and lang. anmts to 1230 GMT s/off w/GSTQ." Freely translated from DX-ese, it means that Radio Wewak, a shortwave station located in the Australian Territories of Papua and New Guinea, was heard on a frequency of 3335 kilohertz, broadcasting a program of country and western music (believe it or not, guitar-twanging is popular there), with announcements in some language other than English, until 1230 hours Greenwich Mean Time (7:30 a.m. EST), when it signed off with "God Save the Queen," national anthem of British Commonwealth countries. Phew! That mouthful helps explain the popularity of abbreviations.

Some of the lingo was lifted from amateur radio operators, who, in turn, borrowed them from telegraphers of a bygone era. These include symbols such as 73, which means, roughly, goodbye, when tacked on the end of a letter to an SWL friend. Others taken from the hams' lexicon are Q-code combinations of letters: QRM (interference from other stations); QRN (atmospheric noise or static); QTH (address or location); and the favorite, QSL (verification of reception).

Other abbreviations seem to have just cropped up like weeds. Some are formed by simply adding X to the initial letter of common hobby words. This has resulted in things like DX (listening to distant stations), Rx (receiver, not prescription), Tx (transmitter), Wx (weather), Nx (news broadcast), and Mx (music).

A weird sort of logic has gone into coining some other abbreviations. In noting program content, BCBers (those who favor the medium-wave bands) use SS to designate a *S*panish-*S*peaking station. Makes sense, right? But how about things like EE, FF, GG and even JJ, meaning, respectively, English, French, German and Japanese-speaking broadcasts? (There are no such animals.)

Capitalized, some letter groups mean one thing, lower-case another. AM, for example, means amplitude modulation, while a.m. means morning. But Am., that's American, boy, American!

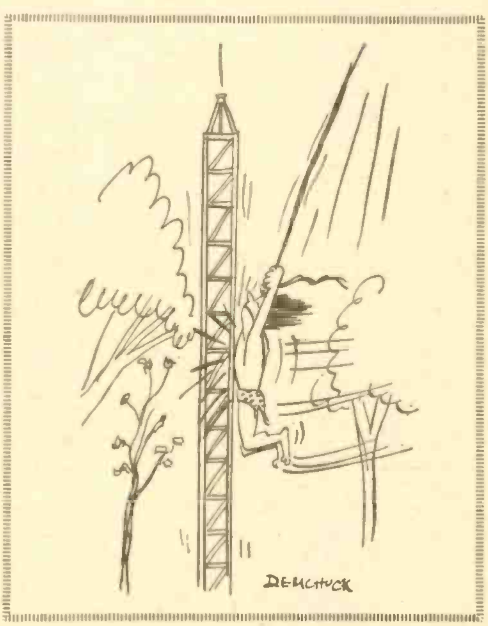
And a PoP is a proof of performance test conducted by an Am. AM station, usually during the early a.m. hours. On the other hand, pop means, simply, popular music programming.

New abbreviations are coined regularly in answer to a particular need. Some become widely recognized and used, while others never catch on. Once in a while we receive a letter so filled with homebrew DX abbreviations that it is completely intelligible!

But take heart . . . there is hope. The ANARC, whoops, the Association of North American Radio Clubs, a non-profit organization linking the major U.S. and Canadian DXers clubs, has just come out with a 38-page booklet listing all these abbreviations and their meanings.

A must in any DXer's library, it is available

(Continuued on page 18)



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(Continued from page 16)

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Tip Topper. The pirates no longer rule the airwaves, but there are hints that they may be staging a comeback. The small fleet of illicit commercial stations that plagued the stodgy European state radio monopolies a few years back was scuttled by stringent new laws. Of the original pirate crew, only R. Veronica, anchored off The Netherlands, managed to survive.

Recently, though, Veronica was joined by another shipboard pirate, R. Nordsee International. To the delight of SWLs, RNI, unlike its predecessors, broadcasts on shortwave. Furthermore, its 6210-kHz transmitter is potent enough to push its programs to this side of the pond.

R. Nordsee International, the self-proclaimed Sound of Europe, is operated by Mebo Ltd. Telecommunications, headquartered in Zurich, Switzerland. The company's name was coined from the first letters in the surnames of its owners, Erwin Meister and Edwin Bollier.

Word of a proposed buccaneer broadcaster, then billed as just R. Nordsee, filtered out of Europe in the fall of 1968. The station, supposedly, was to be located aboard the motor vessel *Galaxy*, former R. London pirate ship, and was to broadcast from the North Sea, off the mouth of the Elbe River. When the year ended with no R. Nordsee, DXers wrote it off as just another bit of wishful thinking by some underfinanced promoters.

SWLs were doubly dubious when the same story cropped up again last December. But this time the tales were more than public relations ballyhoo. There *was* a R. Nordsee International, now aboard a 20-year-old, 570-ton converted coaster, renamed the *Mebo II*. After a quick trip to Lisbon to be outfitted with American-made radio gear, it returned to the North Sea to begin tests.

At 2130 GMT, January 23, RNI began broadcasting from an anchorage about five miles off the Hook of Holland, using initially 1605 and 6210 kHz. Within a few weeks a number of U.S. DXers had logged the rock-music programs aired by its 10-kW shortwave transmitter. Now, a few commercials, which its promoters hope will make RNI pay its own way, were heard. Programs are mostly in German, though some English and French announcements have been heard.

West Germany, its prime target, is a bit shook up about the unlicensed station, but thus far the Bonn government hasn't been able to do much about it. It operates from international waters, its administrative offices and studios are in Switzerland, and it is supplied by a second ship, *Mebo I*, operating out of Spain.

Though things are going well for RNI now, it's too early to predict a long and prosperous future. If you'd like to hear an honest-to-goodness pirate station, you'd better look for it now. Its schedule runs from 0500 until 2300 GMT. Eastern and midwestern DXers should have a good shot at R. Nordsee International during the late afternoon. West Coasters will have better luck with the 0500 sign on time. Reports go to Box 113, 8047 Zurich, Switzerland.

Bandsweep. All frequencies in kHz, all times in GMT. **844**—A new one for medium-wavers is R. Tarawa, a rare Pacific goodie that recently put a new transmitter on the air. It has been logged as far east as Virginia between 0700 and 0930 . . . **3339**—Popping up, seemingly out of nowhere, has been R. Tanzania Zanzibar, heard by shortwave DXers at 0330 sign on. Wild chanting follows opening announcements in the Swahili language. . . **4825**—It's the old one-two-three exercise bit again at 0215 when the Russian regional station at Ashkabad airs its physical fitness program for its home audience . . . **5015**—The Windward Islands Broadcasting Service at Grenada in the Caribbean has moved here recently and has been heard around 2255 . . . **7140**—Best of the Indonesian regional services lately has been R. Republik Indonesia at Ambon. Powerful signals some mornings around 1100. . . **9580**—Voice of the Philippines, Manila, using ex- VOA transmitter, logged here at 0900. You've gotta get there before about 0945 when R. Australia blocks the channel. . . **15,185**—They've been shifting frequencies a lot, but try this spot for FEBA, the new missionary station in the Seychelles, around 0345. A new, more powerful transmitter is due shortly.

(Credits: Alan Merriman, Va.; A.R. Niblack, Ind.; Bill Berghammer, N.Y.; Dan Henderson, Md.; Alvin Sizer, Conn.; Bill Sparks, Calif.;

(Continued on page 102)

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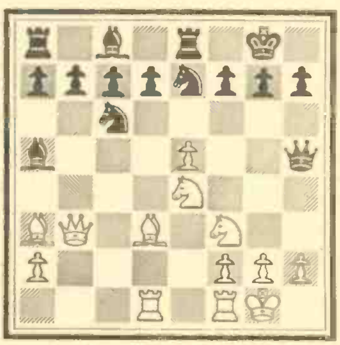
Four more well known, basic openings, with the tactical and strategical ideas behind them, continue our survey of the first third of the game.

Evans Gambit. This is named after Captain W. D. Evans, an English mercantile mariner, who introduced it a hundred and forty years ago, and not after Larry Evans, 1968-69 U.S. Champion. It is an offshoot of the Giuoco Piano, shown in a previous column, and sacrifices the Queen Knight Pawn to accelerate development. Exciting and tricky, it succeeds very well when pitted against the following Compromised Defense -

1	P-K4	P-K4	8	Q-N3	Q-B3
2	N-KB3	N-QB3	9	P-K5	Q-N3
3	B-B4	B-B4	10	NxP	KN-K2
4	P-QN4!	BxP	11	B-R3	0-0
5	P-B3	B-R4	12	QR-Q1	R-K1
6	P-Q4!	PxP	13	B-Q3	Q-R4
7	0-0	PxP?	14	N-K4	....

Black



White

And, with a big lead in development and the Black Queen crowded, White has a distinct advantage.

Black does best to go into the Normal Variation with 7 . . . . B-N3! (instead of 7 . . . . PxP?) 8 PxP, P-Q3.

Two Knights Defense. Players who have some aversion to meeting the Giuoco Piano, the Evans Gambit, and the Max Lange Attack (to be given in a later column) often adopt the Two Knights Defense. Involving a Pawn sacrifice, lively complications, it wrests the initiative from White right at the beginning and appeals to enterprising players. Here is the Main Line -

1	P-K4	P-K4	9	N-KB3	F-K5
2	N-KB3	N-QB3	10	N-K5	B-QB4
3	B-B4	N-B3!	11	P-QB3	Q-B2
4	N-N5	P-Q4	12	P-Q4	FxF e.p.
5	PxP	N-QR4	13	NxQP	B-Q3
6	B-N5#!	P-B3	14	P-KR3	0-0
7	PxP	PxP	15	0-0	B-KB4!
8	B-K2	P-KR3			

Black

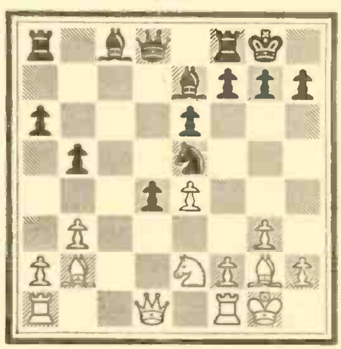
White

Equal Chances. Black's superior piece play compensates for the Pawn- minus.

Catalan System. The "Cat", subtle and deep, exerts pressure on the KR1-QR8 diagonal and resembles the Reti Opening and the Queen's Gambit. An example -

1	P-Q4	P-Q4	8	P-N3	P-QR3
2	P-QB4	P-K3	9	B-N2	P-QN4
3	P-KN3	N-KB3	10	N-K5	NxN
4	N-KB3	B-K2	11	PxN	N-Q2
5	B-N2	0-0	12	PxQP	BPxP
6	0-0	QN-Q2	13	P-K4	P-Q5
7	N-B3	P-B3	14	N-K2	NxP

Black



White

(Continued)

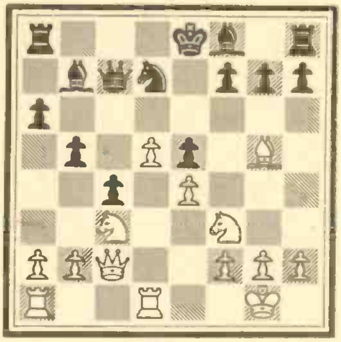
(Continued from page 22)

The position is about even.

Queen's Gambit Accepted. This is as old as the Queen's Gambit itself. It avoids a shut-in Queen's Bishop. And the surrender of the center is only temporary. Thus -

1	P-Q4	P-Q4	9	B-N3	P-B5
2	P-QB4	PxP	10	B-B2	N-QN5
3	N-KB3	N-KB3	11	N-B3	NxB
4	P-K3	P-K3	12	QxN	B-N2
5	BxP	P-B4	13	P-Q5!	Q-B2
6	0-0	P-QR3	14	P-K4	P-K4
7	Q-K2	N-B3	15	B-N5	N-Q2
8	R-Q1	P-QN4			

Black



White

White's superior center is balanced by Black's Queen-side Pawn-majority.

Game of the Issue. Alexander Mac Donnell (1798-1835), British champion born in Belfast, was one of many great masters who played many great games, but never became World Champion. A bachelor, business man, secretary to the Committee of West Indian Merchants, writer on economic questions, he spent his leisure hours at the Westminster Chess Club. A very slow player, he nevertheless was known for blindfold exhibitions and odds-giving. And he always preferred to play Black!

In 1834 Louis Charles Mahe de Labourdonnais, the French champion, challenged Mac Donnell to a series of matches. And what matches they were! Eighty-four games—without clocks! Despite the fact that the Englishman sometimes took over an hour and a half on a single move, and consumed three-quarters of the time of the entire match, Labourdonnais was the victor with 45 wins, 27 losses, and 13 draws. Paul Morphy, United States, unofficial champion of the world, then chess editor of The New York Ledger, described many of the games as "these beautiful models of chess strategy."

MacDonnell, although the loser of the marathon matches, was by no means disgraced by the results, but rather established himself as a Titan of the game in his day. And his win of the 50th Game is described by Dr. Reuben Fine as "the first immortal game of chess history." It was a Queen's Gambit Accepted and was played at London, 1834. MacDonnell, handling his beloved Black pieces of course, intuitively sacrifices his Queen for two inner pieces in a high flight of genius and then manipulates the two springers with murderous effect.

1	P-Q4	P-Q4	20	R-N1	P-QN4!
2	P-QB4	PxP	21	BxP	BxN
3	P-K4?	P-K4!	22	PxB	N-Q5!
4	P-Q5	P-KB4	23	B-B4	NxP#
5	N-QB3	N-KB3	24	K-B2	NxR/7
6	BxP	B-B4	25	RxP#	K-B3
7	N-B3	Q-K2	26	R-B7#	K-N3
8	B-KN5	BxP#!?	27	R-N7	N/7xB
9	K-B1?	B-N3	28	PxN	RxP
10	Q-K2	P-B5	29	Q-N1	B-N3!
11	R-Q1	B-N5	30	K-B3	R-B6
12	P-Q6?!	PxP	31	Q-R2	N-B5#
13	N-Q5	NxN!!	32	K-N4	R-KN1
14	BxQ	N-K6#	33	RxB	PxR
15	K-K1	KxB	34	K-R4	K-B3
16	Q-Q3	R-Q1!	35	Q-K2	R-N3
17	R-Q2	N-B3	36	Q-R5	N-K6
18	P-QN3?	B-QR4		Resigns	
19	P-QR3	QR-B1			

Position after 36 . . . . N-K6

Why did White resign? Because he is way behind in material and will soon lose his Queen and be mated. Here is the analysis -

A. If 37 K-R3, N-N7# 38 Q-B3, RxQ mate.

B. If 37 Q-B3 (37 Q-K2 amounts to the same thing) N-N7# 38 QxN, RxQ 39 P-R3, R/6-KN6 40 P-R4, R-KR7 41 P-R5, R/7xP mate.

B. If 37 QxR#, PxQ 38 P-R4, R-B1 39 P-R5, R-R1 mate.

C. If 37 QxP, N-N7# 38 K-R5, R-R6 mate.

D. If 37 P-R3 (or 37 P-R4) N-N7 mate.

Solution to Problem 24: 1 P-Q7.

(Continued on page 26)

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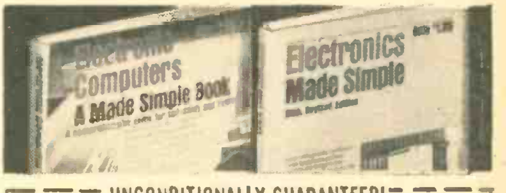

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(Continued from page 24)

If 1 . . . . K-B2 2 PxB=Q mate. If 1 . . . . BxP 2 Q-B5 mate. If 1 . . . . B-R4 (or B2 or N3) 2 P-Q8=N mate. And if 1 . . . . N-N3 (or 1 . . . . N-B2) 2 P-Q8=N mate. Under-promotion was the theme.

Problem 25

By W. Speckmann
Chess Echo, 1941

Black

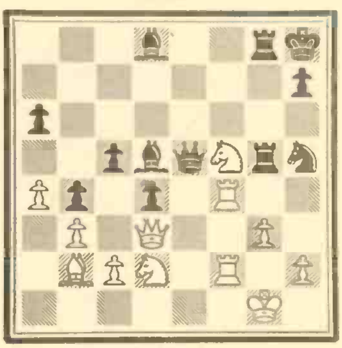
White

White to Move and Mate in Two.
Solution in Next Issue.

This pyramid-shaped problem has a sort of pinwheel solution and was created by Dr. Werner Speckmann, Germany, a well-known composer and collector of two movers.

Brilliant Combination #2.

Black



White

From Tarrasch-Walbrodt, Hastings, 1895.

1	RxP!	NxP!	4 K-B1	RxQ
2	NxN	RxN#	5 R-N4!	Resigns
3	PxR	RxP#		

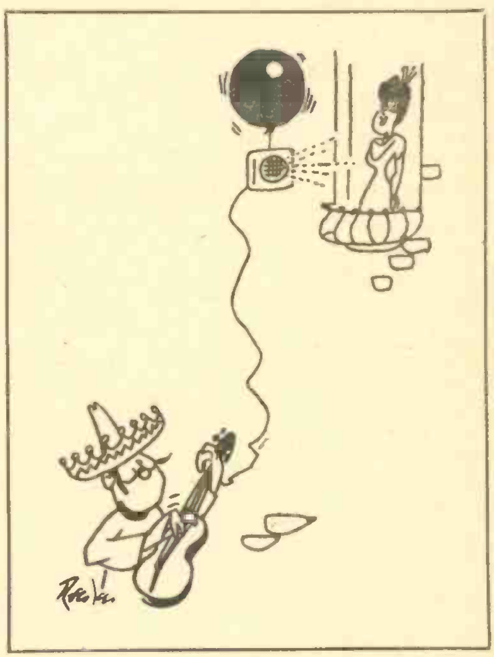
There is no defense to the double threat of 6 BxQ# and 6 R-B8# B-N1 7 R/8xB mate. A delightful use of the Bishop.

News and Views. The U.S. Team, comprised of Zuckerman, Soltis, Tarjan, DeFotis, Verber, and Thornally, only finished seventh in the XVI World Student Team Championship held at Dresden last August. They were under USSR, Yugoslavia, Bulgaria, W. Germany, E. Germany, and England.

International Grandmaster Lubomir Kavalek of West Germany captured the first prize of $1000 in the Second Annual Continental Open in Chicago. He scored 5½-½. Next in line were R. Byrne, 5-1, and C. Brasket, 5-1. One hundred and fifty-seven players participated in the event.

Palma de Mallorca, with its walled citadel, harbor, mountain background, and its tourists, is a favorite tournament site for itinerant grandmasters. The Fifth Annual International Tournament held there last November-December was won by Bent Larsen with 12 points. Tigran Petrosian, former World Champion, was second with 11½. No Americans were in it this time.

Many readers have been writing to this columnist asking about the availability of back issues of ELEMENTARY ELECTRONICS. Well, it's nice to know readers want back issues of this magazine because of this chess column, but . . . I'm not the one you should write to. Address all letters to the magazine and enclose one dollar for each magazine requested. All 1970 issues to date and some 1969 issues are still available. ■



ELEMENTARY ELECTRONICS ETYMOLOGY

By Webb Garrison

Uranium

▲ In 1781 William Herschel discovered what he thought to be a comet. Soon it was found to be moving about the sun in a nearly circular orbit whose diameter is about 19 times that of Earth's. It was a new planet: the 7th.

Herschel named it *Georgium Sidus* in honor of England's ruler. But on the continent the name was never accepted. German astronomer Johann Bode suggested Uranus, from the name of "the father of Saturn" in Greek mythology.

Bode's name stuck. Chemist Martin Klaproth thought of the planet when he found a new heavy metal that seemed to be at the other edge of the universe of matter. At first known only as an oxide, *uranium* remained a scientific curiosity for more than a century after it was named in 1789.

It took atomic fission and the arms race of World War II to elevate the stuff named for 18th-century astronomy's "outermost planet" to a central place in the lives of men.

Neptunium, Plutonium

▲ Early in this century a few physicists suggested that there may be elements "beyond uranium." It wasn't until 151 years after the radioactive element was discovered, however, that the next heavier element was produced by neutron bombardment.

Element 93, found in 1940 by Edwin R. McMillan and P. H. Abelson, is to uranium as Neptune is to Uranus. It was all but inevitable that the man-made stuff should be called *neptunium*.

Just a year later element 94 was produced. It is to neptunium as Pluto is to Neptune so *plutonium* it became.

Early experiments showed that plutonium is as elusive as the distant and long-unseen planet whose name it bears. Because it combines so readily with oxygen the volatile stuff was nicknamed "the diabolical element." Still, it gained a place in both atomic research and practical applications of that research.

Plutonium has at least 15 isotopes. One of them, Pu_{239}, decays by emission of alpha particles and becomes U_{235}. One pound of Pu_{239}, whose half-life is 24,360 years, has energy equivalent to 10^7 killowatt-hours.

In May, 1969, "the diabolical element" demonstrated its savagery. Fire started by it at the AEC's facility in Rocky Flats, Colo., caused $45,000,000 damage.

Astrologers nodded their heads knowingly when they heard the news. Disaster was inevitable, many said. For according to students of the occult the outermost planet of our solar system has many sinister properties. That being so, a man-made element named for Pluto couldn't fail to bring havoc to those trying to harness its demonic power!

Bubble

▲ However much they vary in other respects, all the languages of mankind have one element in common. Some of the basic terms in every vocabulary are the result of man's attempt to imitate everyday sounds.

As everyone who's spent any time in a kitchen knows, a boiling pot makes a pattern of sounds unlike anything else. Moreover, that pattern is reasonably easy to imitate. Before the 14th century, Englishmen used *bubble* to label "the sound of the boiling pot."

Curiously a person with saliva in his mouth who slowly says "bub-ble" is likely to blow a quick-bursting air-filled sphere.

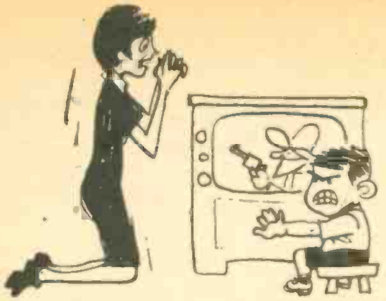
Many scientists have been intrigued by the physical properties of bubbles. Isaac Newton studied soap bubbles to find clues about the nature of light. Later physicists have devoted much time and energy to bubbles made from glycerin and other substances.

A few years ago scientists at Bell Telephone Laboratories found that orthoferrites (iron oxides of rare earths like ytterbium and thulium) can be blown into bubbles. Not ordinary bubbles—but bubbles with strange magnetic properties.

Working with complex miniature structures it was found that these magnetic bubbles can be arranged in precisely defined positions. Once that was done, a new component for computers and switching systems was born.

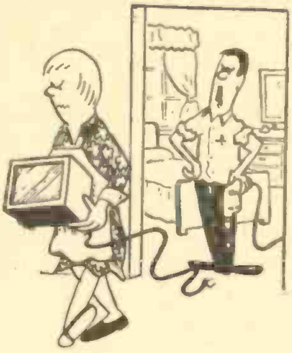
Bell scientists estimate that by use of bubbles it will be possible to create data storage systems that will hold 15 million bits of information in a few cubic inches—and operate on a fraction of a watt of current.

This breakthrough, potentially as revolutionary as development of the transistor, promises that in the future more and more information will bub-ble, bub-ble, bub-ble from more and more big pots of data. ■



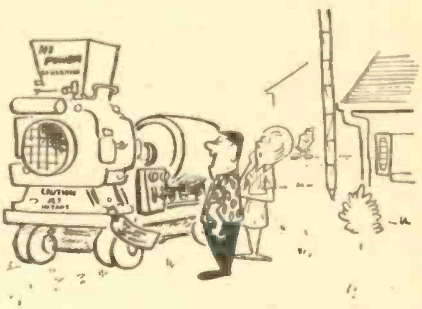
DECLARATION OF INDEPENDENCE

by Jack Schmidt

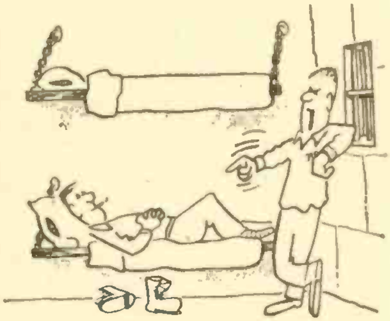


"...and I say that that speaker is going in this room whether you like..."

"I just want to tell you what you can do with your new long-distance rates!"



"Bye, bye electric bills for us!"



"So I told this FCC cat that I'd broadcast anywhere, anytime I wanted to!"

"The treasurer is on the test circuit! He's on Tahiti and not coming back!"

elementary Electronics JULY-AUG 1970

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

TennaBoost

by George Hattlett

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

To log real BCB DX (the flea-power locals in the band), you'll need a long-wire antenna supported as high as possible above buildings and tree tops and free of obstructions. Catch is, what city dweller can find such a spot? Fortunately, you don't have to. For by connecting our *TennaBoost* in place of whatever makeshift antenna you've been putting up with to date, you should be able to snag plenty of these distant weaklings. What may have appeared to be dead spots on your dial before *TennaBoost* will now come alive with stations you never knew existed. And signals that were once puny to the point of being unreadable will now blast in like a herd of buffalo heading for Injun country.

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

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

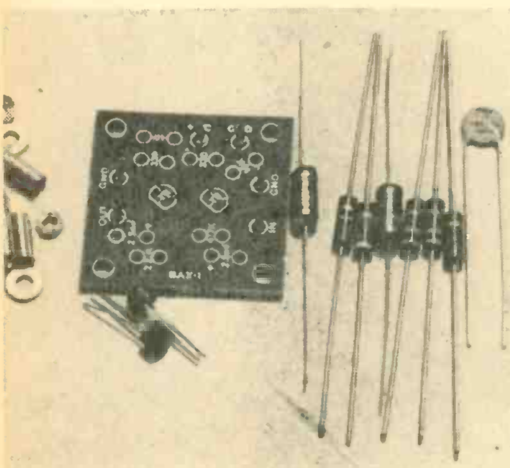
We made one change in the kit. Since it's intended to cover the 50 Hz to 150 kHz range, it comes with two 2.5-μF electrolytics. For optimum performance in the BC band we substituted two 0.001-μF subminiature ceramics. The two 2.5 μFs are the only electrolytics furnished in the kit, so you should have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

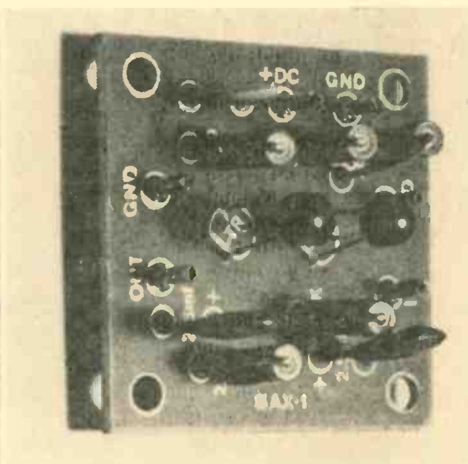
We recommend that you first assemble the kit and solder all components in place. Be very careful not to use excess heat on the transistors and other miniature components. In fact, you should use a small alligator clip as a heatsink while soldering them. A small pencil-type soldering iron rated at about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

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

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

Place the amplifier so its input terminals





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

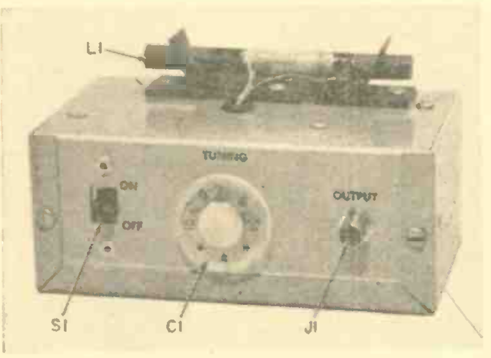
face the battery holder and its output terminals face the edge of the minibox. Mount switch S1, tuning capacitor C1, and output jack J1 on the front panel as dimensioned in our drawing. Jack J1 should line up with the center line of the amplifier board and S1 should be in line with one of the battery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

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

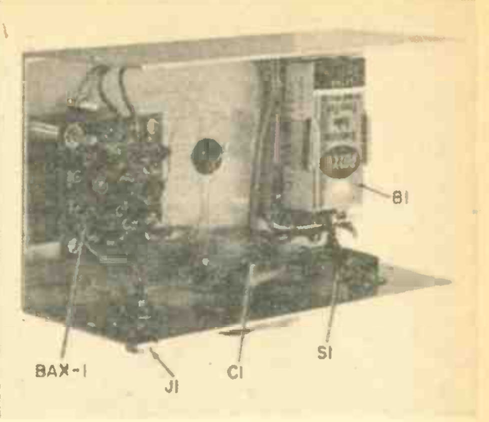
Be careful not to break the delicate leads of very fine wire from the loop. Also, install a ¼-in. rubber grommet in the hole for the leads to ensure that the loop leads will not be cut by the rough edge of the hole drilled in the minibox. Use the full length of the leads when connecting it to tuning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

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

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



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



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

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

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

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

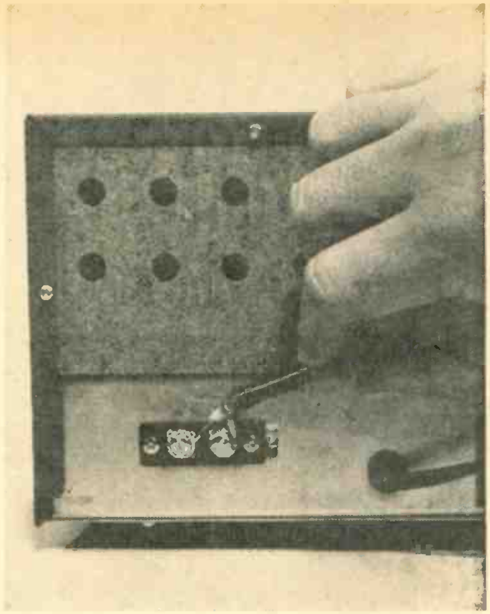
Since there is no check-out or alignment needed before putting *TennaBoost* into service, close up the minibox, being sure to use all of the screws furnished. If the box you use should be one of those having a snap fit to keep it closed, you'll have to drill it and install sheet metal screws to be sure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

e/e TENNABOOST

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

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

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



If your BCB set has terminals for external antenna and ground connections, here's how TennaBoost is connected. If it uses a built-in loop, our text tells how.

ON OUR COVER

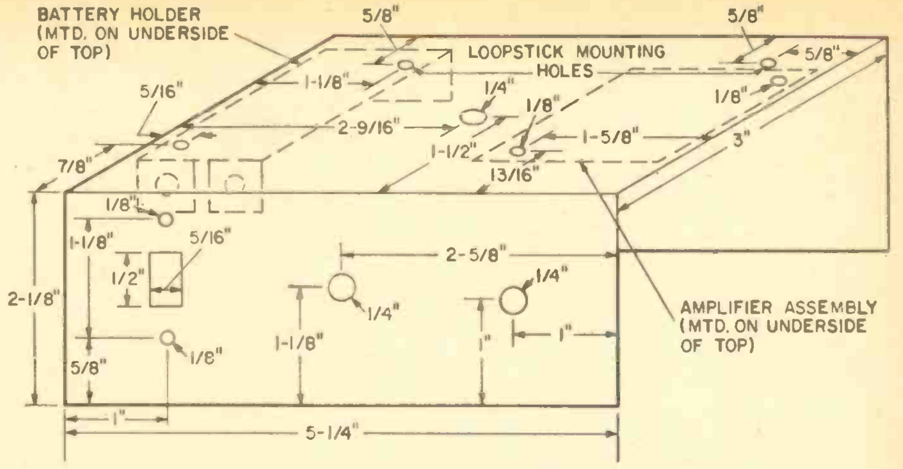
Hallicrafters' new Star Quest broadcast and shortwave receiver shown on our cover incorporates many features normally found only in more complex and expensive general-purpose communications receivers.

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

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

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

Hallicrafter's Model S-120A Receiver



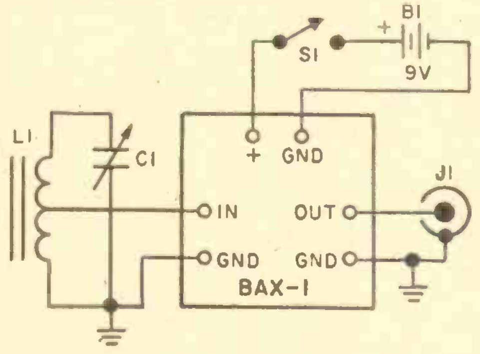
This pictorial will help you lay out your TennaBoost for maximum efficiency.

PARTS LIST FOR TENNABOOST

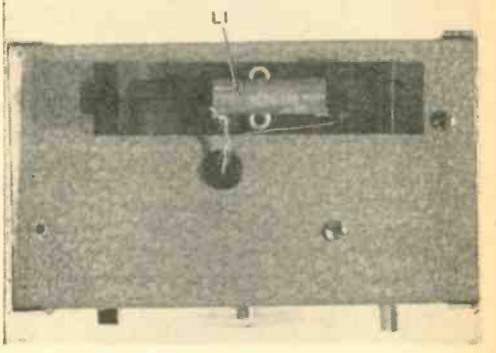
BAX-1—Broadband amplifier, International Crystal Mfg. Co. type BAX-1
B1—9-V transistor radio battery (Eveready 216 or equiv.)
C1—385-pF tiny tuning capacitor with dial (Lafayette 99E62176 or equiv.)
J1—RCA type phone jack, single-hole mount (Lafayette 99E62341 or equiv.)
L1—Miller type 2001 miniature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

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

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



Schematic shows how easy it is to hook up.



Bird's eye view giving correct L1 location.

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

If you find that adjusting capacitor C1 of *TennaBoost* tunes stations on the receiver, or the receiver blocks, chances are you have a feedback loop between the receiver and *TennaBoost* because of their proximity to one another. Should this occur, moving *TennaBoost* further away from the receiver should bring things back to A OK condition. Now everything's OK so set back and enjoy.

Good DXing! ■

MATH a la MOD

JEANNE D'ARC didn't know she was a feminine activist. Neither did Rosie the Riveter, that World War II character of assembly-line fame. But enough said for yesteryear heroines. Many a modern lass shows as much enthusiasm about electronics as her hairychested peers. In England, she can learn her new-found vocation in a girls' school—where else!

Forget any preconceived thoughts of sweet young things piddling their time away with cookery and crochet. While a modern secondary-school curriculum undoubtedly includes many traditional subjects, it also exposes the girl to the business-world skills she'll need. Like stenography and bookkeeping, typing's essential. Chances are she'll even have a heavy math and computer background when she graduates. Better yet, she might have even *built* a computer as a class exercise!

Truth to tell, the girls of Sion Manning Comprehensive School in London are approaching the end of what must be one of the most ambitious class projects ever undertaken by a group of schoolgirls: they're building their own computer!

Building a Behemoth. Building a computer is by no means an overnight task. An order for one of these electronic behemoths can be placed with the computer manufacturer anywhere from six to nine months in advance, with the expectation that the unit will be ready on time. Then the fun begins. With thousands of connections to be soldered, and hundreds of transistors to be tested before installation, a group of technicians can generally complete the job in the allotted time. So can you imagine how long 50 girls could take working part time?

It took them *three* months to build and 50,000 soldering jobs. And when it's finished the computer will become part of the school equipment.

The girls have done all the work themselves—some of them have even given up their lunch hour and stayed behind after school closed for the day in order to get on with the work. Imagine this group of girls, soldering irons in hand, creating their own personal black box computer. Let's see, we'd have a couple of them sawing and preparing perforated board. Some might be snipping transistor leads, while others are busying themselves with cable harnesses. A few students of the fearless variety might be seen shaping up the computer's power supply. And some, to be sure, are standing there, simply wondering how they could manage to break so many fingernails in a single afternoon.

How's She Perform? The computer will add, subtract, divide, or multiply. It will do sums in pounds, shillings, or pence; solve problems, or work out square roots. The school plans to use it as part of the girls' training for computer programming examinations.

"It was just a matter of simple arithmetic," says Dharam Malhotra, the mathematics master at the school who designed the do-it-yourself computer. "We worked out that even a second-hand model would cost us £7000 ($16,800.00). Doing it ourselves we could build one for £100 ($240.00), so we went ahead."

The girls' computer has all the impressive gadgetry of an expensive commercial model. At the moment it looks a bit like a huge complicated piece of knitting as the girls struggle to mold the different pieces together. But when it's finally assembled it will contain some 2500 resistors and 600 transistors, have a panel of more than 60 flashing lights, be able to store 5000 words, and

Intently working upon section of computer's innards, these girls show professional propensity for wiring, construction details.

work at a speed of 2500 words a second. The girls plan to extend the memory banks later to bring the computer up to the most modern standards.

"I don't think that such a complex machine has ever been attempted in a school before," Mr. Malhotra boasts, being familiar enough with the basics of computers to design the school's model.

A Bargain, Yet. The entire operation has had to be done on a shoestring budget. Three quarters of the £100 bill has been met by the Inner London Education Authority and the girls have raised the rest of the funds themselves. By careful shopping

Short of cash, but long on ambition, girls of Sion Manning Comprehensive School embark upon homebrew computer (affectionately named electronic knitting) class project.

around they have also been able to make some considerable savings. They went to various shops, for example, and eventually found a place where they could buy transistors at 6 pence each as opposed to the normal price of 4 shillings and 6 pence.

There is no full-time careers master as yet at the school. Chances are such a gentleman won't be needed for a while, either. Mr. Malhotra's pioneer efforts may have already spurred the girls to consider computer technology as their livelihood. Chances are, it's teaching the Inner London Education Authority a few new educational tricks, too.

Girls school curricula in the United Kingdom have trod a traditional path since veddy Victorian codes of "conduct for females" were established. To this day some British schools for women foster the sole belief in a girl that her life's effort is to remain home-bound. Pursuing a business career wasn't considered lady-like.

It's possible that other schools'll follow Sion Manning's example. Dharam Malhotra, and his girls, have proven how classroom projects can be designed to bring students closer to real-life work situations. The girls consider themselves fortunate that their school can provide them with a proper business-like secretarial foundation; stenography, doing sums, business English, and the like.

But most of the girls already have a fairly clear idea of what they want to do after they graduate: become computer operators, of course! ■

Staying late, often giving up their lunch hour, girls give class projects lots of attention. Looks like they'll soon finish.

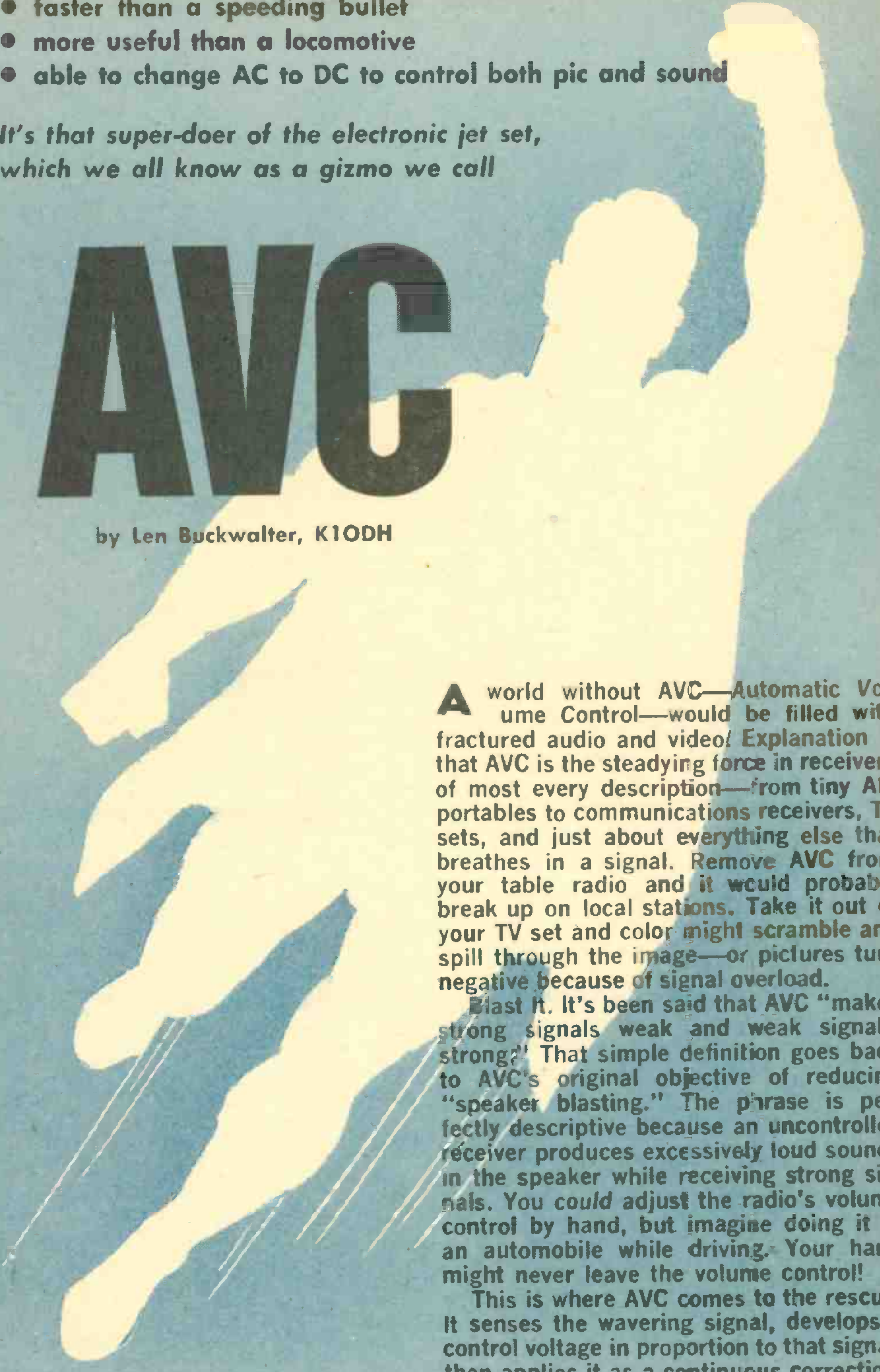
Dharam Malhotra, Sion Manning's mathematics teacher, instructs eager group of students in fundamental computer technology. Most'll be programmers upon graduation.

- faster than a speeding bullet
- more useful than a locomotive
- able to change AC to DC to control both pic and sound

It's that super-doer of the electronic jet set, which we all know as a gizmo we call

AVC

by Len Buckwalter, K1ODH



A world without AVC—Automatic Volume Control—would be filled with fractured audio and video! Explanation is that AVC is the steadying force in receivers of most every description—from tiny AM portables to communications receivers, TV sets, and just about everything else that breathes in a signal. Remove AVC from your table radio and it would probably break up on local stations. Take it out of your TV set and color might scramble and spill through the image—or pictures turn negative because of signal overload.

Blast It. It's been said that AVC "makes strong signals weak and weak signals strong." That simple definition goes back to AVC's original objective of reducing "speaker blasting." The phrase is perfectly descriptive because an uncontrolled receiver produces excessively loud sounds in the speaker while receiving strong signals. You *could* adjust the radio's volume control by hand, but imagine doing it in an automobile while driving. Your hand might never leave the volume control!

This is where AVC comes to the rescue. It senses the wavering signal, develops a control voltage in proportion to that signal, then applies it as a continuous correction.

e/e SUPERDOER CALLED AVC

It also cures a problem that no amount of volume-control fiddling can cure. It's an overload condition where strong signals drive the receiver's early stages into highly distorted operation, resulting in mushy, unintelligible audio in the speaker.

Though a car in motion is one cause of fluctuating signals, there are others. Atmospheric fading due to changes in the ionosphere has a tremendous effect on the strength of shortwave (3 to 30 MHz) stations. At higher frequencies (VHF and UHF-TV, for example), passing vehicles, changes in tree foliage, and even moisture content in the air vary the number of microvolts induced in an antenna by a distant transmitter.

In all of these cases, an AVC circuit attempts to compress or expand the signal into some mid-range or average value. As you might suspect, AVC can't recover a signal deeply submerged in atmospheric noise and make it readable. Nor can it clean the snow from a faraway TV station arriving in a remote fringe area. But it is capable of some pretty miraculous stunts, as we'll see shortly.

The AVC Idea. Almost every AVC circuit follows a similar general route. First, it taps into the receiver circuit at some point to sample a bit of the incoming signal. The sample provides information on the relative strength of the arriving station. Next, the sampled signal is processed into a form which enables it to control the radio-frequency amplification of the receiver. This becomes the AVC control voltage and it's fed back to some earlier point in the receiver.

If a powerful station is being received, it produces a high AVC voltage, which reduces the receiver's ability to amplify. Upon receipt of a weak signal, little AVC voltage develops, so the receiver runs at high amplification.

From Carrier to Control. The overall idea appears in Fig. 1. We've shown a standard broadcast station transmitting a signal whose carrier is increasing from weak to strong in three steps. Note that the carrier is assumed to be originating from the station at three fixed levels, with no audio modulation at this time. (Audio causes a complication we'll get to in a moment.)

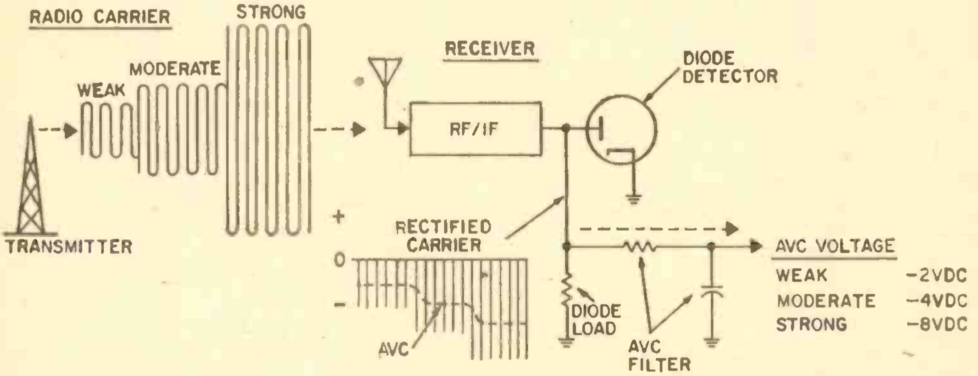


Fig. 1. Diode detector develops AVC voltage in typical tube-type receiver. For simplicity's sake, carrier is shown unmodulated but is assumed to originate in three fixed levels.

The changing carrier signal enters the receiver antenna and proceeds through RF and IF stages until it reaches the diode detector. Since the alternating carrier can go through the diode in one direction only, it's rectified so only the negative portion appears at the resistor forming the diode load. The AVC signal, however, is still hidden within the rectified carrier, as shown by the dotted line. This means that it must be processed further before it becomes a suitable control signal—a DC voltage which varies in step with carrier strength.

This is where the problem of audio modulation (voice or music on the carrier) complicates AVC development. The trouble is that intelligence on the carrier is AM, or amplitude modulation, which is electrically similar to the changing carrier strength AVC will attempt to fight. It would hardly be suitable if AVC attacked loudness changes in the program, rather than average

Fig. 2. Some receivers—this Hammarlund, for one—permit operator to control AVC rate.

faster than 0.1 second (the lowest audio tone is about 20 times per second), the filter smooths out any audio in the AVC circuit. Yet, the AVC filter must not respond *too* slowly. When driving in a car, for example, you might receive a fluttering signal and need fast-acting AVC to exercise quick control.

The 0.1-second filter, therefore, is designed as a compromise which attempts to fit AVC response between the two extremes. In some advanced receivers, an AVC selector switch (Fig. 2) enables the operator to choose his rate to improve the receiver's performance on certain specialized signals such as code (CW), single sideband, or other non-standard carriers.

DC Up Front. To this point the circuit has developed a control voltage that's synchronized to incoming carrier strength. As shown in Fig. 1, the carrier has produced

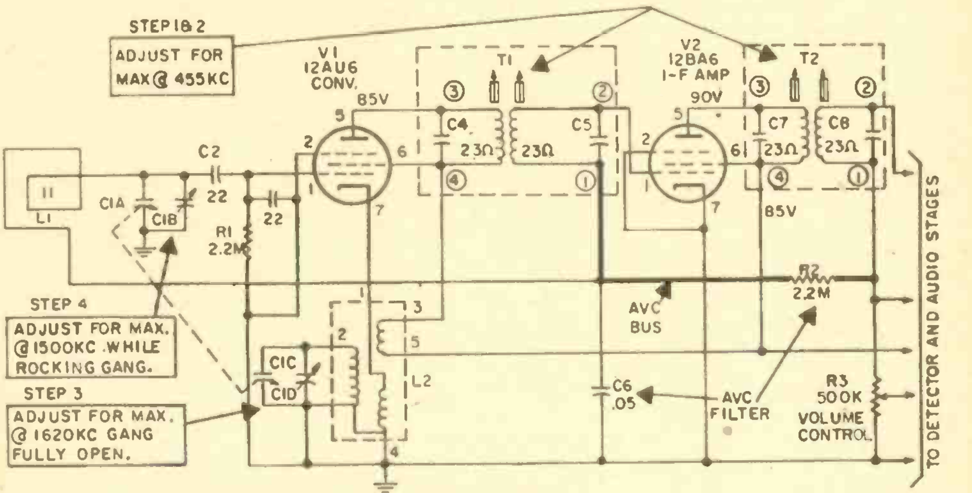


Fig. 3. Partial schematic of GE tube radio, showing AVC filter and bus. Since cathode of V2 is grounded, tube relies on AVC voltage appearing on control grid (pin 1) for bias.

changes in carrier signal. Fortunately, it's possible to fashion a filter which ignores audio in the sampled carrier.

As shown in Fig. 1, there's an AVC filter comprised of a resistor and capacitor. In a typical tube circuit these values are a few megohms for the resistor and about .05μF for the capacitor. They form a filter which responds at the rate of about 0.1 second (its *time constant*). This interval of time has been carefully selected to fulfill certain boundaries of AVC operation.

First, the filter must remove any audio modulation from the sampled portion of carrier. Since audio variations occur much

a shift of from -2 to -8 DC volts at the output of the filter. This is approximately the AVC voltage you'd measure in typical tube-type receivers. Now it's only necessary to provide a feedback loop to carry the AVC back to an earlier stage. How this is done is illustrated in the actual schematic of a typical tube radio in Fig. 3.

The AVC signal is developed across the diode load resistor and filtered in the resistor and capacitor indicated (R2 and C6). From there, the line is usually termed the *AVC bus* and extends back to the control grid of the IF amplifier. As an incoming signal grows stronger, a correspondingly higher negative AVC voltage is created. Result is that the gain of the IF stage is reduced accordingly.

Solid AVC. Millions of tube receivers still survive, but solid-state should end that era in a few years. Transistor receivers are subject to the same signal fluctuations and similarly require AVC circuitry. In looking

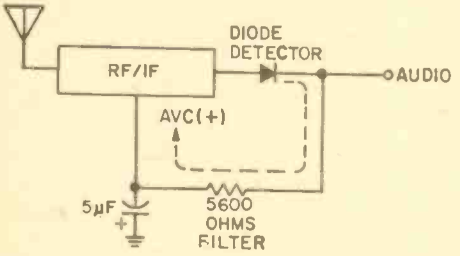


Fig. 4. As in tube sets, AVC in solid-state circuit is tapped from diode detector.

at transistor circuits, you may find that the term *voltage* is often supplanted by *current*.

When discussing amplification in tubes, it's almost always a matter of controlling grid *voltage*, which is generally negative in polarity. (The current flow in a receiving tube grid is infinitesimal and usually ignored.) Transistors, though, may be discussed in terms of current since the terminal voltages (unlike tubes) are very low. Because of these differences, AVC action in tube circuits is usually described as *negative grid voltage*, while the solid-state version is in terms of *base current*.

Another difference is that the polarity of a receiving tube grid is almost always negative; transistor current, in contrast, may flow in either direction, depending on whether an npn or a pnp transistor being controlled.

Schematics for solid-state AVCs are fairly close in appearance to tube versions, as shown in the typical portable in Figs. 4 and 5. Note that a sampling of carrier signal is taken at the output of a diode detector. At this point the carrier is already rectified to DC and needs only to be smoothed in the AVC filter. Note that the polarity of AVC voltage is shown as positive (+) since the transistors being controlled are of pnp type (Fig. 5).

In pnp semiconductors, a positive-going voltage applied to the base causes lower current and a reduction in amplification (the reverse of a tube circuit). You will also find transistor AVC which runs in the negative direction. This indicates an npn transistor is being controlled since its amplification decreases with the application of negative voltage.

Fig. 5 traces the major AVC points in a commercial solid-state circuit. Note that the carrier sample isn't tapped from the regular AM detector; instead, a separate AVC diode is connected to an earlier point in the receiver (see lower right of Fig. 5.) This car receiver has an RF amplifier up front and it produces sufficient AVC voltage for the tap-off to occur at this early point. The re-

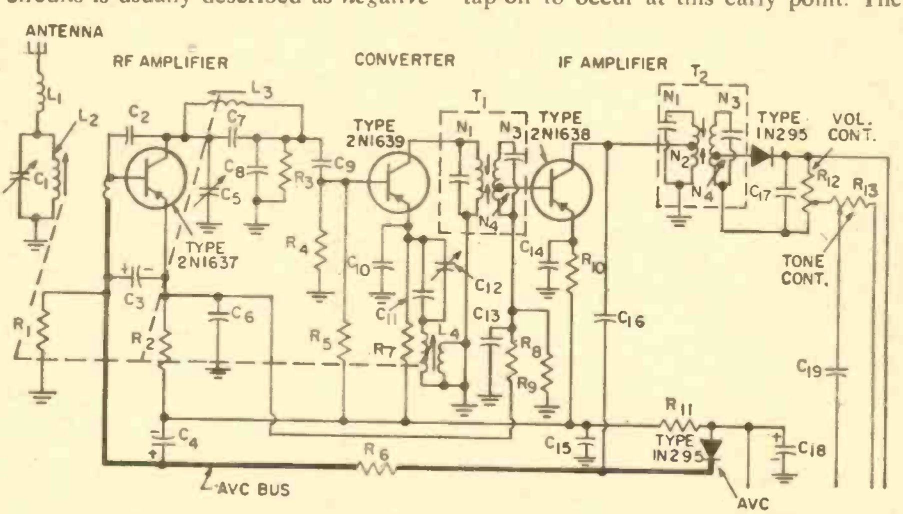
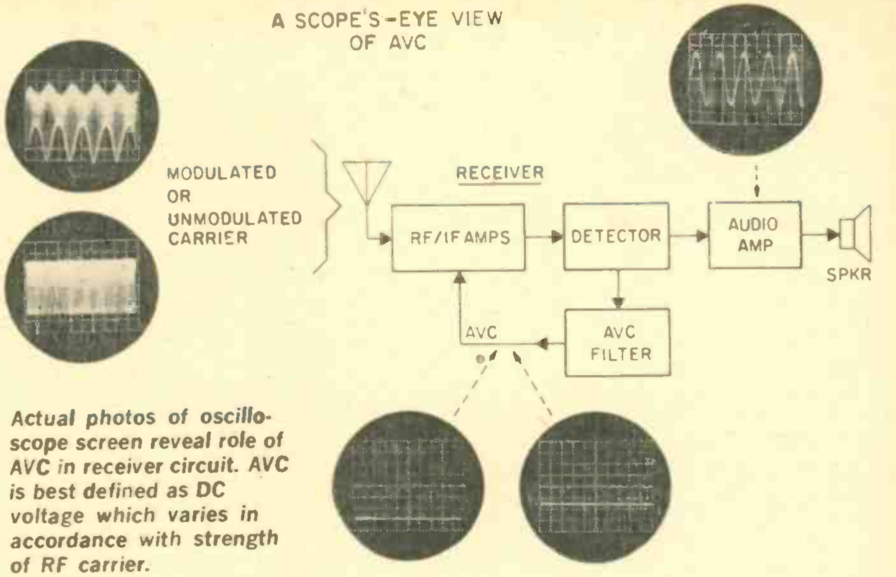


Fig. 5. Partial schematic of RCA car radio, showing separate AVC diode (lower right) and AVC bus. Since transistors here are pnp's, AVC voltage is positive rather than negative.



Actual photos of oscilloscope screen reveal role of AVC in receiver circuit. AVC is best defined as DC voltage which varies in accordance with strength of RF carrier.

mainder of the AVC bus resembles the tube circuit; the carrier is rectified, filtered, and applied back to the input stage. Since the RF transistor is a pnp type, an increasing carrier produces rising positive voltage and a consequent drop in transistor gain.

What's the Delay? AVC circuitry described to this point works well for table and other consumer type radios. But there's always something better. One improvement is *D*AVC, for *d*elayed AVC, to overcome one disadvantage of regular AVC on weak signals. To operate at highest sensitivity, a receiver should run wide open, or at maximum amplification. The trouble occurs when a weak signal entering the receiver commences to generate a small, but effective, AVC voltage. AVC comes on too soon and receiver sensitivity is prematurely reduced.

In the delayed AVC scheme, AVC must first overcome some fixed reference voltage before it starts to reduce amplification in the receiver's front end. For example, a conventional receiver may start to generate AVC voltage when a carrier of about 5 microvolts is in the antenna. A high-performance ham or communications set, though, might delay AVC action until the signal attains a strength of 10 microvolts.

Another improvement in deluxe receivers is amplified AVC, meaning the control voltage is boosted before being applied back to an earlier stage. This could produce AVC voltage swings of from 0 to 35 volts, instead of a more conventional range of 0 to 7 volts. The net result is better control of the receiver under dynamic changes in signal strength.

It's AGC, Too. Though AVC began as a technique for controlling average audio level, nearly identical concepts are applied in receivers which produce pictures, navigational read-outs, or other intelligence of a non-audio nature. Since latter-day AVC may no longer control volume, its designation changes to *AGC*, for *A*utomatic *G*ain *C*ontrol. Incidentally, this term is technically more accurate even for regular radios because it's receiver radio-frequency gain, *not* audio volume that's directly regulated. A good example of AGC is in TV receivers for keeping picture contrast reasonably constant over a wide swing of signal strength. Let's examine the TV signal in some detail because the method of generating a control signal is different from that of a radio.

The video carrier which brings the TV signal to the home is not a suitable source of AGC voltage. The picture carrier changes strength with lights and darks in the scene which happens to be on the screen during a particular moment. Back in our simple radio, we could filter out audio modulation fairly easily. However, video modulation can persist over long time periods which nal that does reflect accurate changes in signal strength due to distance, power, etc., rather than modulation.

That reference is the horizontal sync pulse transmitted at the beginning of each picture scanning line. Though its purpose is to lock the home set with the transmitter, it also serves as an AGC reference. As shown in Fig. 6, the pulses are captured from the set's video detector, then filtered and fed back to the receiver front end (i.e., RF, IF, and detector).

Though AVC—or AGC—originated as an equalizer of speaker volume, then went on to do the same for pictures, the circuit has other applications as well. In color sets it keeps the color signal constant by adjusting the gain of a color amplifier according to incoming color signal strength. The reference here for developing a control voltage is the color burst, a brief shot of sine-wave energy transmitted during each horizontal scanning line.

To be sure, the burst is really intended to help the receiver create an accurate color subcarrier. However, it also contains strength information which can operate the automatic color control found in most current TV sets. It's just one more example of an old idea brought up to date. In fact, the next time you see the words *control, feedback,* or *automatic* used to describe a circuit, chances are it borrowed an idea or two from early AVC. ■

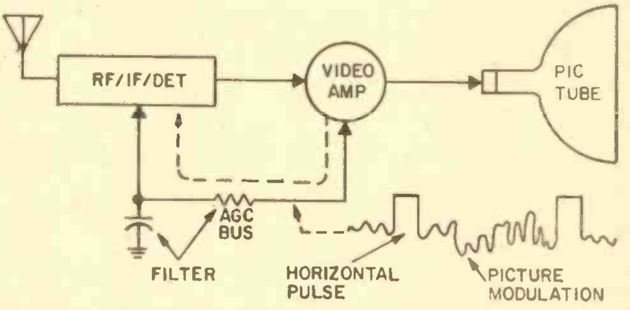


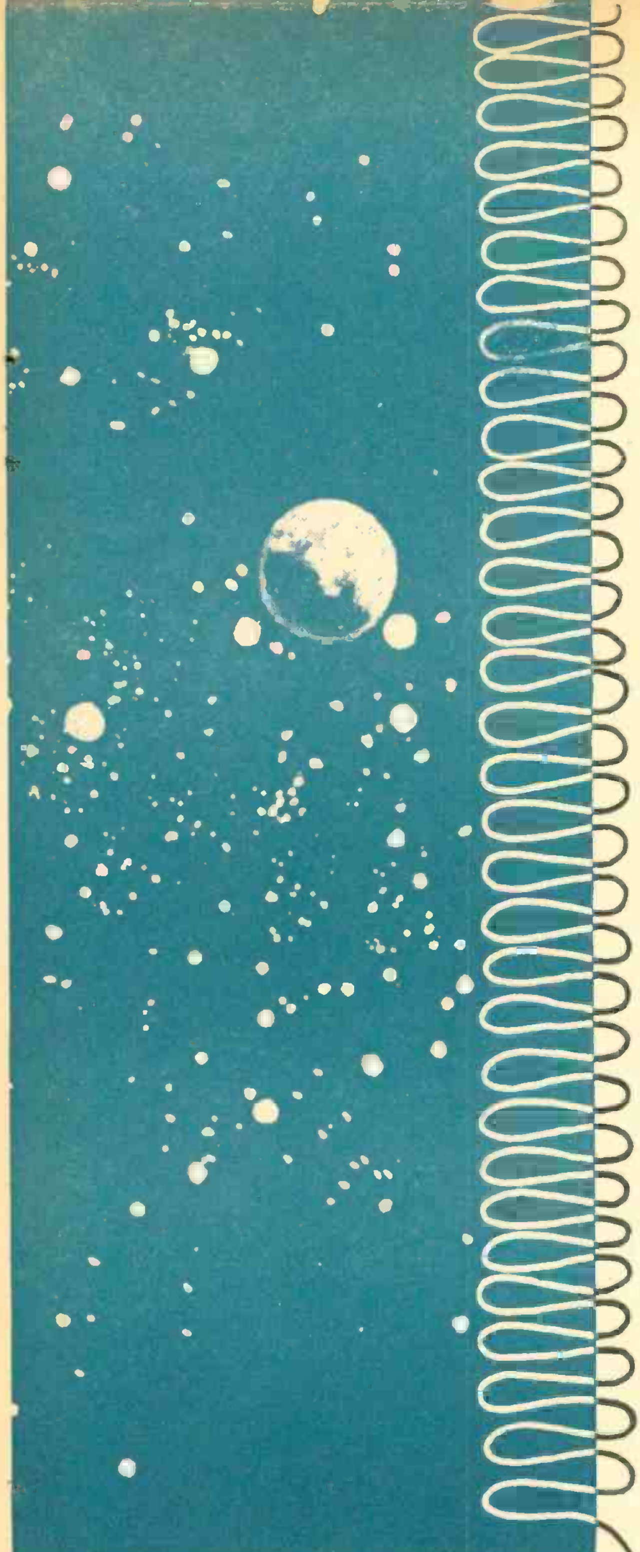
Fig. 6. In TV receiver, horizontal sync pulse must provide AGC voltage since video carrier itself isn't suitable. Note that basic idea is same as that used in AM and FM receivers.

SOUND ALL AROUND

Join the latest stereo revolutionary movement without getting shot at—in your wallet! RCA, one of the nation's recording giants, is entering the four-channel stereo race with a $200.00 cartridge tape player system that ensures compatibility between the proposed quadrasonic carts and their now-available 2-channel kin. The system'll be sold as an 8-track player main unit with two built-in speakers and a pair of outboard speakers placed behind the listener.

You'll find the same cartridge tape width and speed in the quad unit as in a conventional 8-tracker; the new cart provides up to 25 minutes of sound on both 4-channel programs. Emphasizing that this player is capable of reproducing both tape formats, RCA feels that no existing 8-track library'll become obsolete. And if you want to groove to a different sound at musical mid-stream, push a button and let the machine do the rest. ■

Our ladyfriend's preparing to surround herself with Quad-8 ambience. Recording biz has been working on 3-D sound goal since its birth decades ago.



by George Haydon

the promise of those MERRY MICROWAVES

In the 25-odd years since World War II, the electromagnetic spectrum has been gobbled up faster than a bushel of bananas at a monkey Bar Mitzvah. The sad truth of the matter: the demand for frequencies has been growing faster than technology has been able to supply them.

Some parts of the radio spectrum are already overcrowded; others are rapidly becoming saturated to the point of bursting. To make matters worse, new communications techniques will mean that additional services will soon be clamoring for spectrum space as well.

Highway safety systems of the future, for example, will require frequencies for computerized traffic control, automatic guidance systems, visual and audible hazard warnings, and highway sign control. Picturephones, now being developed by Bell Laboratories, will also require spectrum space for their operation. And these are but two drops of the torrent expected to engulf the spectrum as we know it.

Expert Opinion. How will the problems created by frequency congestion be solved? Experts differ, and many solutions have been proposed. One report, recently made public, was prepared by some 200 of the nation's top telecommunications experts and took four years to complete. The 6-lb., 1200-page document, *Spectrum Engineering—The Key to Progress*, deals with the manner in which the spectrum is now being utilized, as well as the technical aspects of using it even

more efficiently. The report also recommends increased research to find ways to better utilize those parts of the electromagnetic spectrum that are now largely unused. In particular, the sparsely used microwave portion of the spectrum, because of the vast amount of space available in that range, appears to be the last frontier in what is otherwise a morass of congestion.

Frequency-wise, the microwave portion of the spectrum extends from 1000 MHz to the far infrared range of electromagnetic radiation, up to frequencies of 300,000 MHz! Imagine! Two hundred and ninety-nine thousand MHz of spectrum space! When we consider that the entire shortwave spectrum comprises a paltry 27 MHz, we realize what a bonanza the full use of the microwave region would be to communications.

Evidence indicates that in the years to come a great deal of research and development will be concentrated in this portion of the spectrum. If so, chances are that terms such as tropo scatter, magnetron, klystron, TWT, and waveguide will be as common as ionosphere, diode, and transmission line are to communications today.

Because microwaves truly represent the waves of the future, let's take a closer look at them so we can get a better understanding of their potential. Many telecommunications experts believe that microwaves will bring about a communications revolution before long. Here's why.

Microwaves have wavelengths that lie between those of radio waves and of ordinary light—30 centimeters to 1 millimeter. Because of this, they display characteristics that are common to both. Like radio waves, their generation stems from the use of low-frequency systems, and they can be modulated to carry intelligence, such as voice, teletype, pictures, etc.

And like light, they travel in straight lines, are blocked by most solid objects, are affected by the weather, and can be focused and beamed in an optical system.

Tropo Scatter. Fig. 1 shows how microwaves are propagated. As anyone who has driven through a fog at night knows, the light from the headlights striking the fog is scattered and dissipated. Similarly, microwaves traveling through the Earth's lower atmosphere (the troposphere) are scattered. This scattering enables the transmission of some signals far beyond the Earth's horizon. Unlike shortwave signals, microwaves aren't affected by the ionosphere and pass completely through it. Tropospheric, or tropo, scatter is therefore the only means of transmitting over relatively long distances without the use of intermediate repeater stations.

A number of military scatter circuits are currently in operation, including one across the Pacific Ocean in island-hopping fashion, and one across the Arctic, linking our early warning radar stations. Significantly, the distance for a microwave scatter "hop" varies with the frequency. But at 1000 MHz, hops of several hundred miles are possible.

Commercial microwave scatter links are also in operation. One such link provides 72 telephone circuits between Miami and

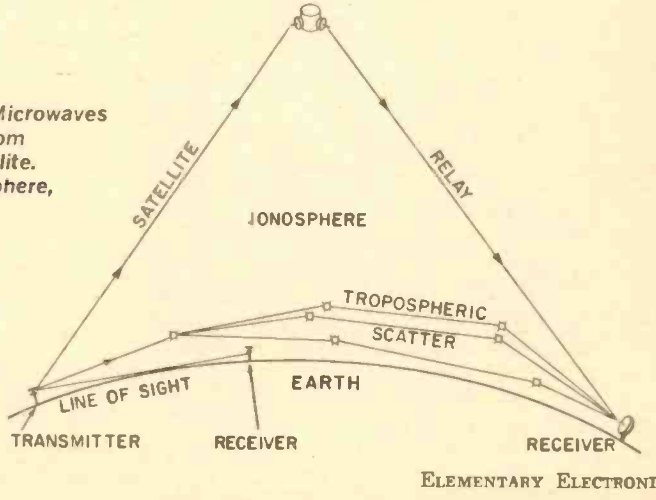
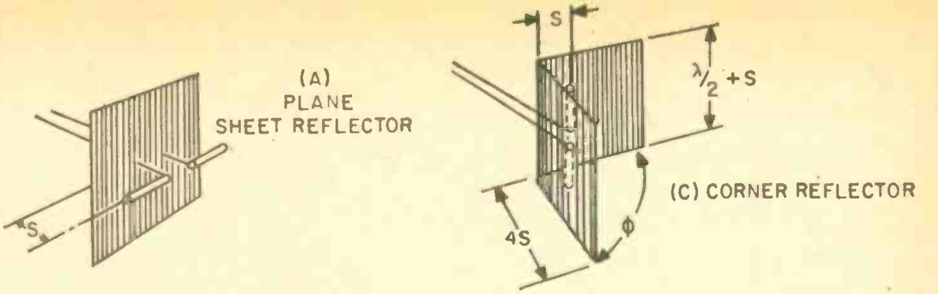
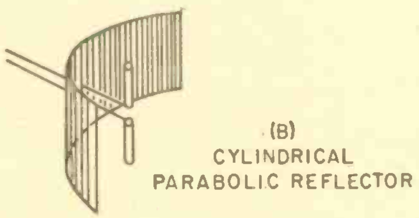
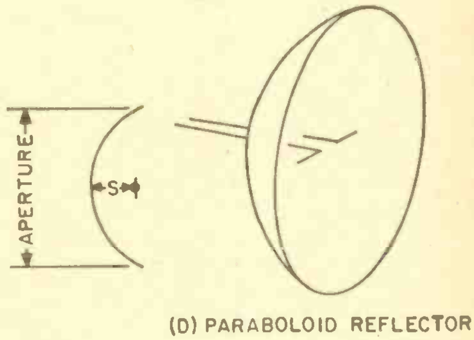


Fig. 1. Microwave propagation. Microwaves are propagated in straight line, from transmitter to receiver, or to satellite. They are also scattered in troposphere, which explains why they can be transmitted to locations which lie well beyond horizon.







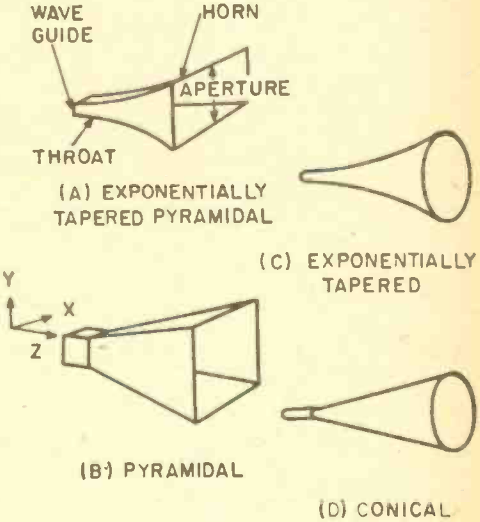


Fig. 2. Microwave antennas. Reflector antennas above intercept microwave energy, reflect it to dipole elements. Shown are a) plane sheet reflector, b) cylindrical parabolic reflector, c) corner reflector, and d) paraboloid reflector. Horn antennas at right gather energy, transmit it to antenna elements, which are not shown in drawings.

the string of islands called the Bahamas.

Unfortunately, the energy transmitted by tropo scatter is extremely small. Because of this, high-power transmitters and high-gain antennas are required for successful communications.

Repeater Circuits. A second method of propagation is via line-of-sight propagation. In such circuits, the microwaves travel in essentially straight paths direct from the transmitting antenna to the receiving antenna. In general, the transmitting and receiving antennas are spaced about 30 miles apart.

Energy entering the receiving antenna is often amplified and retransmitted to another repeater, some 30 miles further away. In practice, the distance between transmitting and receiving antennas is slightly greater than true line-of-sight distance because some bending of the signal occurs as it passes through the lower atmosphere.

Numerous microwave networks, making extensive use of repeaters are in operation within the U.S. Many of these run from coast to coast.

Satellite Relays. In addition to tropo scatter and repeater circuits, another use of microwaves involves satellites to relay the signal to some distant point on Earth. All new-generation COMSAT communications satellites operate in the microwave portion of the spectrum, enabling the transmission of a great deal of information. Ground stations receiving this microwave energy require the use of elaborate antenna systems because the incoming signal is very weak.

Antennas. Since antenna elements are proportional to the wavelength of the radiated signal, microwave antennas lend themselves to designs that would be unwieldy at lower frequencies. A half-wave dipole operating the 6-MHz band, for example, is roughly 25 meters long. At 1000 MHz, a half-wave dipole antenna is 15 centimeters (about 6 in.) long. And at 10,000 MHz, an antenna element less than an inch long can be used.

As a result, a wide variety of exotic shapes and sizes of antennas have been developed; some of these are shown in Fig. 2. In general, all microwave antennas are designed to gather as much energy as possible. Reason is that some microwave signals, particularly those coming from satellites and those operating on scatter circuits, are very weak.

Because of the large number of antenna elements that can be used for transmitting or receiving microwave signals, antenna gains of the order of 30 dB and more are possible. This enables the reception of very weak signals over vast distances. The Mariner VI spacecraft, for example, transmitted television pictures over a distance of approximately 60 million miles!

Microwave Oscillators. Special tubes have been developed to produce microwave energy because ordinary vacuum tubes don't work effectively at frequencies in the microwave range. In a vacuum tube, electrons travel between the electrodes. At microwave frequencies, the electrons oscillate so rapidly that they change directions before

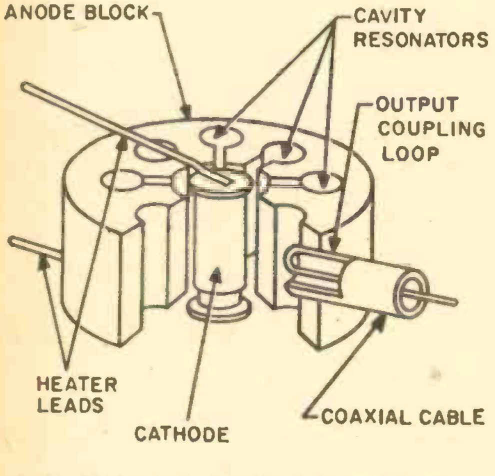


Fig. 3. Magnetron. Electrons from cathode move in circular orbits inside tube, generating microwaves in cavities. Tube is actually diode in structure, requires external magnet to provide magnetic field.

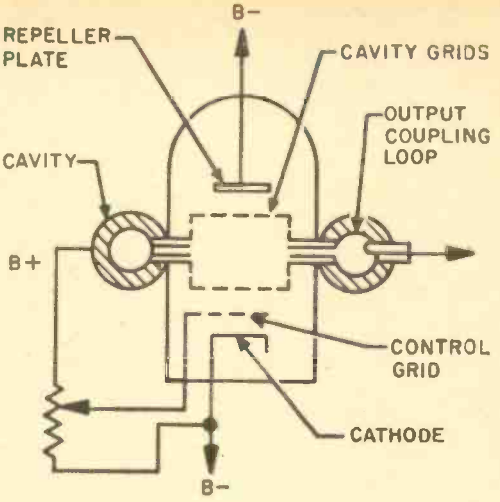


Fig. 4. Klystron. Electrons passing between electrodes are bunched at regular time intervals by changing voltages. Electron beam passes opening of cavity, produces microwave oscillation or amplification.

they've been able to pass from one electrode to another. As a result, the electrons literally get hung up within the tube.

Solving this problem introduces another: at microwave frequencies, capacitance between the electrodes tends to short out the elements in the tube. To cut the capacitance, the spacing between electrodes can be increased. But this makes the first problem of electrons not getting from one electrode to another even greater.

To overcome these stumbling blocks, tubes of a radically different design have been developed. Three of these, the magnetron, the klystron, and the TWT are shown in Figs. 3, 4, and 5.

The Magnetron. A resonant cavity is responsible for the magnetron's ability to produce microwave energy. Each cavity has a characteristic resonant frequency depending on the inductance of the walls of the cavity and the capacitance due to spacing between the walls. Thus, the cavity resembles a simple tank circuit that employs capacitances and inductances to form a resonant circuit at a particular frequency.

The magnetron of Fig. 3 has a series of cavities, and the entire tube is operated between the poles of a powerful electromagnet not shown here. The cathode emits electrons which travel in circular paths because of the influence of the magnetic field. The shape of the tube is such that the electrons graze the openings of the cavities, passing energy to them and setting them into oscillation.

Magnetrons can be made to deliver pulses of very high power, but they have two limitations. First, they require a heavy magnet to propel the electrons in circular orbits inside the tube. Second, the cavities are extremely small at higher frequencies, making manufacture difficult.

The Klystron. Illustrated in Fig. 4, the klystron doesn't require a magnet because electrons travel a straight line within its electrodes. Grid voltages are adjusted so that bursts of electrons flow past the cavity openings only at certain times. These bursts are synchronous with the resonant frequency of the cavity, and the electrons transfer their energy to the cavity, developing high power oscillations inside the cavity. The process has been compared with the periodic pushing of a swing to make it go higher.

beam, the energy of the beam of electrons is passed to the signal in the helix, thus amplifying it. Similarly, by feeding pulses of energy into the helix, it will generate microwaves by amplifying the pulses.

The traveling wave tube can be tuned over a wide range of microwave frequencies and is very sensitive. Its disadvantage is that it delivers much less power than magnetrons or klystrons.

Waveguides and Cables. At microwave frequencies ordinary wire can't be used to transmit energy because the values of inductance and capacitance in the wire combine to block any current flow. To allow for transmission of microwave energy through transmitter and receiver circuits, new components had to be developed to carry the energy. Coaxial cable and waveguides were found to carry microwave energy efficiently.

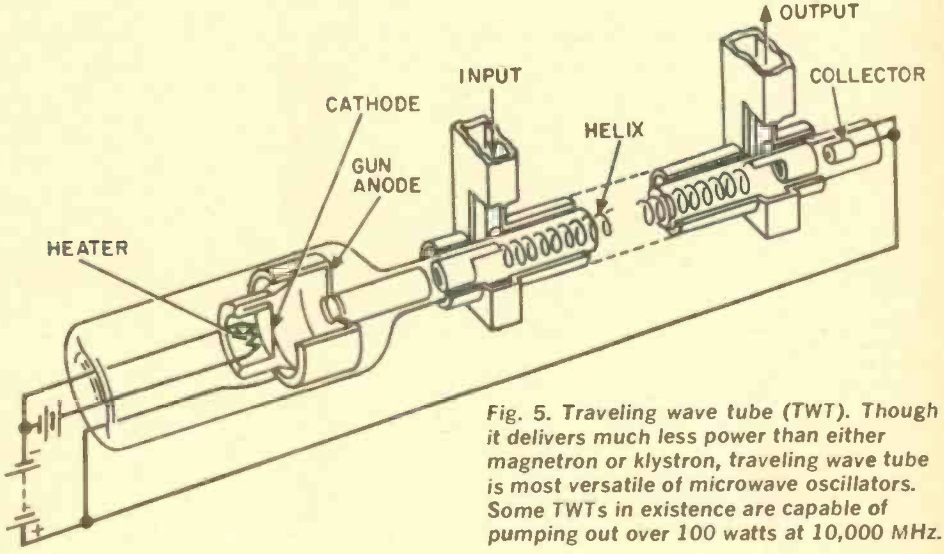


Fig. 5. Traveling wave tube (TWT). Though it delivers much less power than either magnetron or klystron, traveling wave tube is most versatile of microwave oscillators. Some TWTs in existence are capable of pumping out over 100 watts at 10,000 MHz.

Klystrons can operate at frequencies well above 100,000 MHz, but at these frequencies output power is very low.

The Traveling Wave Tube. A very convenient device for space applications is the traveling wave tube (TWT), which amplifies or generates microwave energy with very low noise and high sensitivity. Shown in Fig. 5, the tube consists of a narrow evacuated tube with a wire helix wound around it. A beam of electrons is sent along the inside of the tube while the signal to be amplified is fed into the helix.

By controlling the speed of the electron

Coax, as you may know, consists of a wire surrounded by a dielectric, or nonconducting material, such as polyethylene, surrounded by a cylindrical outer conductor. Microwave energy flows through the dielectric between the inner and outer conductors.

In contrast, waveguides are usually rectangular tubes which conduct the microwave energy within their walls. The tubes can be bent into many shapes without affecting their ability to carry microwave energy.

In both coaxial cable and waveguides, dimensions are highly critical and depend on the frequency of the microwave to be transmitted. With both types of conductor, efficiency and power-handling capacity diminish with increasing frequency.

The Future. Of the 299,000 MHz available in the microwave region of the spectrum, only some 10% is now being used, and much of this is still experimental. Essentially, the problems are generating power at frequencies of 10,000 MHz and above, and of developing components that will operate at frequencies of 30 to 40 GHz and higher (1 GHz equals 1000 MHz).

A great deal of research is now going on in search of techniques and materials that will produce useful results at the mid- and upper-end of the microwave region. Experimentation involving solid-state devices is being successfully conducted in hundreds of laboratories. The general feeling is that technology will continue to expand the useful range of frequencies in this region of the spectrum.

Most of these studies are being financed by the government, and they are costly. But progress has been good—and steady. For hardly a week passes without some news of another breakthrough in this vast region of the spectrum, pushing the frontiers of usable spectrum space ever higher. ■

NIGHT PATROL'S THIRD EYE DOESN'T SQUINT

Two new night-vision systems to aid mariners in night navigation, search, and rescue operations will soon be introduced by the Raytheon Company.

These devices, the MS-101-10 and the larger MS-103, will receive their first public limelight by Raytheon's Special Microwave Devices Operation at the Electro-Optical Systems Design Conference in the New York Coliseum, September 16-18.

Looking much like a small telescope, the MS-101-10 magnifies its subject four times and has a 10° field of view. Its range varies from 275 meters when viewing a low-contrast subject, such as a man, in starlight conditions, to 600 meters for a high-contrast subject, such as a vessel, under moonlight conditions. A radiating subject such as a flashlight can be seen to the horizon.

The MS-101-10 miniaturized night-vision system weighs a scant 3 lb and measures a foot in length by 3 in. in diameter. No bigger than a flashlight, it can be adapted to almost any nighttime use from night navigation and piloting to station keeping and port security.

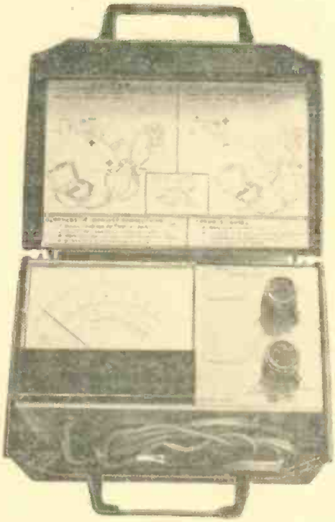
Searching coastline or patrolling harbor during nighttime's now easier task for law-enforcement agent (above). Below, device's infrared eye scans through sextant for red-light emitting objects. It can pick out infrared sources as far away as horizon.

Readily mounted on any sextant with slight modification, the MS-101-10 will be worth its weight in gold to the Sunday sailor who finds himself lost in a heavily trafficked, fog-shrouded bay. Attaching MS-101-10 to a sextant permits star sights all through the night, not only during periods of twilight. By amplifying the sky glow through the sextant-mounted scope, the night horizon appears as a clear pencil line.

The larger MS-103 direct-view night-vision system weighs 13½ lb and is a dual objective unit. Its two objective lenses are mounted on a revolving turret and provide 30° and 15° field of view with 1X and 2X magnification respectively. Intended for pedestal- or tripod-mounted applications on larger vessels, it's effective for such uses as night surveillance, navigation aid, or naval exercises.

Both night-vision systems, now offered commercially for the first time, are manufactured at Raytheon's Special Microwave Devices Operation in Waltham, Mass. and employ advanced image intensifier tubes made by the company's Machlett Laboratories in Stamford, Conn. ■

e/e TEST GEAR



HEATHKIT Model ID-29 Combination Tach and Dwell Automotive Tune-Up Meter

As most Saturday mechanics know an automotive tune-up meter contains, basically, a tachometer and dwell meter regardless of all the oddball features thrown in to boost the price. Eliminate the ohmmeter functions, spark testers, capacitor checkers, and the like and you eliminate a lot of scale markings that could confuse you when making the important tach and dwell readings. Also, eliminate the oddball features and you can eliminate the extra calibration controls that have to be set for each measurement.

In short, you'll wind up with an extremely easy-to-use, and very accurate, combination tach and dwell meter, which describes the Heathkit ID-29. Fact is, the ID-29 is the easiest to use and most accurate of any of the consumer type tune-up meters, and we could add a goodly number of professional meters.

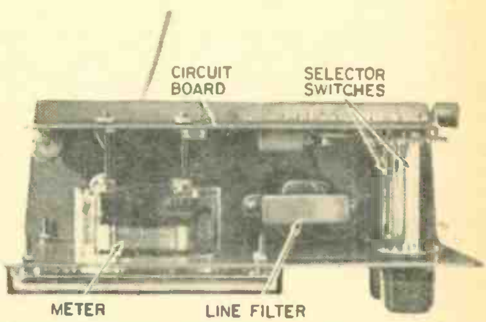
Easy-To-Read Calibrations. The ID-29 indicates just three major measurements: DC voltage to 15 volts full scale; high and low tachometer ranges of 1500 and 4500 rpm; and dwell angle (how long the distributor points remain closed). The meter has two tach scales, one for the high, and one for the low range, and two dwell scales for 3/6 and 4/8 cylinder engines.

The calibration adjustments are permanent and are made just once—at the time of initial calibration. After calibration has been completed, only two operating controls select the ID-29's operating function. One control provides built-in compensation for 3, 4, 6, or 8 cylinders so that a single rpm scale is used for any type of engine. A second panel control selects the meter function: DC volts, low rpm, high rpm, or dwell.

How It Works. The Heathkit tune-up meter operates in a considerably different manner from run-of-the-mill engine analyzers, particularly the budget variety. For one thing, there are no power-supply connections, either to the car battery or to internal batteries.

Unlike the conventional tach, which connects from the distributor to ground, the Heathkit is connected across the ignition coil and receives the 6 or 12 volts from the car battery each time the distributor points close. (When the points close the bottom of the coil is connected to ground while the top remains connected to the ungrounded side of the battery supply. This is the instant the ID-29 receives its operating voltage, which may be either 6 or 12 volts, depending on the car battery.)

Each time the points close a voltage pulse is developed across the ignition coil and also is fed to the ID-29. This pulse is filtered in the ID-29, to eliminate inductive transients across the coil, and then is

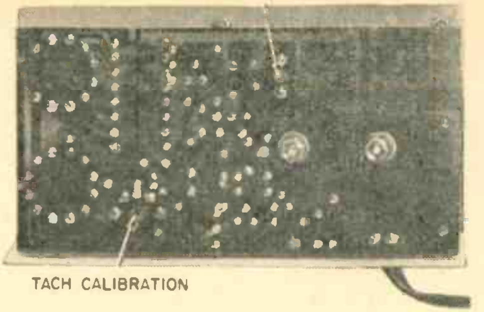


A bird's eye view of the insides after cover has been removed. You'll note most parts are mounted on rear circuit board.

clamped by a voltage regulator to the 2.8 volts needed to operate the meter. In the dwell mode a constant current source generates square wave pulses of constant current whose rise and fall timing is determined by the operation of the points. The longer the points are closed the higher the average current and therefore the higher the dwell meter reading, indicating the points are closed for a longer time or are set at a greater angle.

In the tach operation only the leading edge of the coil pulse is used to trigger a pulse generator built into the ID-29. The pulse duration of the built-in generator is shorter than any pulse obtained across the coil. Therefore, speed of the engine cannot affect the accuracy of the ID-29. The average current reading of the amplitude of the pulses generated in the ID-29 is translated into rpm readings by the meter.

Building the Kit. All electronic components are assembled on a small printed-circuit board which mounts on the back of the meter and selector switch terminals. At most, complete assembly of the ID-29 should not require more than an evening's work. The calibration controls for the dwell and tach are internal. To calibrate the dwell function the calibration cable, furnished with the kit, is connected to any 5 to 15 volt source and an internal potentiometer is adjusted for full-scale reading. To calibrate the tach function, the calibration cable is connected to the 117-VAC power



ID-29 is so stable once you've set just two calibration controls, that's it. They're accessible only from inside unit.

line and a potentiometer is adjusted for a 1200-rpm reading on the 6-cylinder scale. It's all very simple and doesn't require any special test equipment.

Performance. As you may have surmised we were impressed with the accuracy and ease of operation of the ID-29. The only disadvantage is that it cannot be used with solid-state ignition systems because they place a high voltage across the ignition coil. To use the Heathkit ID-29 tune-up meter with solid-state ignition systems it's necessary to temporarily disconnect the solid-state unit and reconnect the wiring to the original low-voltage coil. After you make your tests and adjustments, disconnect the low-voltage components and reconnect the solid-state ignition.

The Heathkit ID-29 Tune-Up Meter is priced at $29.95, complete with carrying case. For additional information write to Heath Co., Dept. 19, Benton Harbor, Mich. 49022. ■

TV by Pee Wee Cigarette Glow

Paul Revere's one-if-by-land, two-if-by-sea would have produced much too intense a light for the scene at right. Would you believe? It was illuminated only by the glow of a cigarette and picked up by RCA's new silicon intensifier tube (SIT). This SIT-equipped television camera virtually sees in the dark. This means that it will undoubtedly have many applications for use in future exploration of space—not to mention oceanography, nighttime surveillance, low-light level observation devices by the military, and crime-detection work.

BUILD TVamp

Donald A. Smith W3UZN

- adds pleasure to your viewing
- lets you enjoy TV's true hi-fi sound

WHO SAYS the radio-TV industry has removed the incentive to experiment with new circuits and devices? Just because the electronics manufacturers make such broad product lines is no reason there's little left for the experimenter to create or build. For proof, you're about to meet a project that presents real challenge—our *TV amp*. When you

TELEVISION AMP

listen to the average TV set, it's hard to believe that the sound coming out of its speaker is actually derived from high-quality FM normally associated with hi-fi reproduction. To be sure, most modern sets produce excellent pictures. Thing is, the sound portion of the program, as reproduced by many TVs, leaves much to be desired.

Odd as it may seem, if you take the sound off at the FM demodulator and feed it to a good quality amplifier and speaker system, you get quite acceptable sound quality. This really is easy to explain. Competition forces the TV manufacturer to cut corners, and this usually is done in the audio rather than the video section of the TV set. The push has been to please the viewer's eyes, maybe because many people have tin ears anyway. Besides, because viewers are still enthralled by getting pictures through the ether, why spend money for good audio in order to stimulate sales?

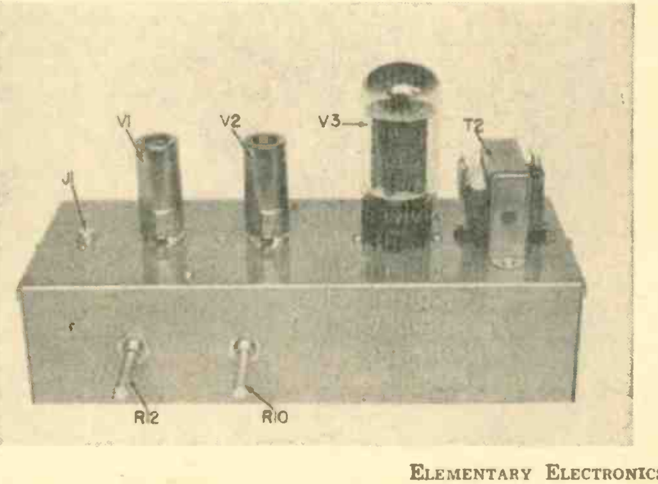
At best, the audio sections in TV sets are minimal. Just their 3½-in. speakers are evidence enough that they were never intended for full-range reproduction. Add to this the poor baffling for the speaker because of lack of proper acoustic design in the cabinet, and you have most of the elements contributing to the overall poor audio quality of the average TV set. If you raise the volume to approach that necessary for good orchestral reproduction, the distortion usually is so high you can't enjoy the music.

In some instances, feed the audio from the FM demodulator into a good-quality audio amplifier and speaker system, and you wish you'd left well enough alone. This certainly is true in the case of sets that have inadequate filtering in their power supply, resulting in much too high a hum level. And it's hard to tell if a set is in this category until tested because the limited range of both the audio amplifier and speaker in the TV set spell death to the lows. Only when you feed its output to audio equipment with extended range will the deficiency in filtering show up. Best thing to do in such a situation is to get rid of the TV set. It's cheaper in the long run than trying to improve its basic design.

What Can Be Accomplished. If you're reasonably sure that your TV has adequate filtering and basically good design all the way through the FM demodulator to the audio, be venturesome, build our *TVamp* amplifier and add new dimensions to that TV. *TVamp* is a wide-range, low-distortion, medium-power amplifier especially designed to fit within the confines of the average TV set cabinet. In spite of its size, it has sufficient output to drive the popular bookshelf speaker systems (which are relatively inefficient).

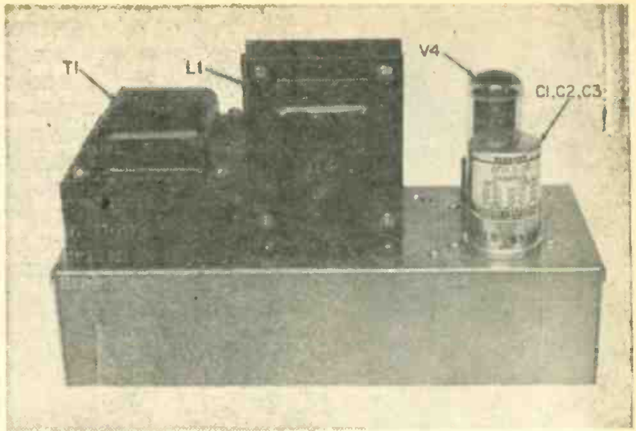
In order to fit the *TVamp* into available space in the TV cabinet, the power supply is built on a separate chassis from the amplifier. Also, *TVamp* was designed so that it's possible to connect it to a TV with a minimum change in the TV's wiring. This permits quick restoration of the TV to its original state, in the event you dispose of the TV and want to keep the amplifier for another application.

How It Works. *TVamp* is a conventional class-A, beam-power output power amplifi-



Here's amplifier chassis in all its glory. We've identified all major parts and tubes that are on view when looking at top side of TVamp. You can't tell how good it works from how good it looks, so go ahead and build it.

Separate power supply looks just as good as amplifier chassis and it produces hum-free high-voltage DC needed to excite tubes in amplifier. Husky components make it reliable.

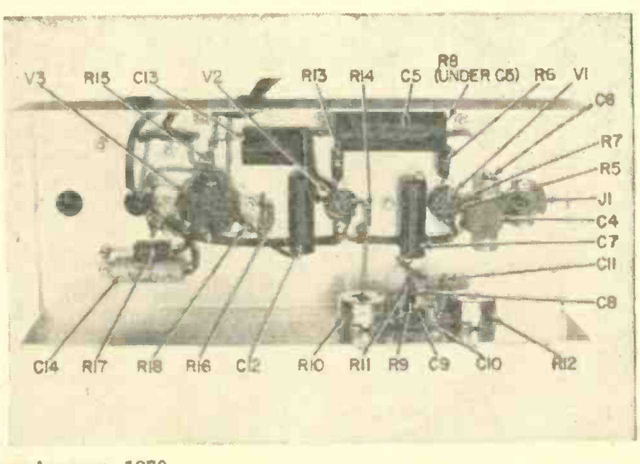


er. Two 6AV6 tubes are connected in cascade as voltage amplifiers to drive a single 6L6 beam-power output stage. The 6AV6s were used because they are readily available, either from the average experimenter's inventory or from supply houses. Resistor R15 and capacitor C13 provide inverse feedback from the output stage to its driver, the second 6AV6. Separate bass and treble boost and cut controls are used to adjust the amplifier's response to the listener's taste.

A separate power supply is used for several reasons. You might ask why not use the TV's power supply? For one, in most cases the low-voltage B supply of the TV set isn't designed for the extra load *TVamp* would place on it. Another reason is that many TV sets have tube heaters connected in series across the 117-VAC power line and it would be necessary to redesign the series circuit to power the heaters of *TVamp* (unless, of course, a separate filament transformer were used). This would be costly since there are plenty of power transformers available at bargain prices that have both heater and high-voltage windings; in fact, you may even have one in your shop that would do the job. With such a transformer you can build a separate supply for both heater and plate power.

Since most TV cabinets are built to surround the chassis and picture tube, there is little unused space within the cabinet. By mounting *TVamp's* power supply on a separate chassis from the amplifier you have a better chance of locating each of the two smaller chassis in unused spaces in the cabinet than if the unit were mounted on a single large chassis. Also, since the name of the game is to improve the audio response of the TV with minimal changes in its original circuitry, and to maintain loading on the set's power supply so as not to disturb voltage limits designed into the set, it's wisest to use a separate power supply.

In fact, when you connect the new amplifier across the TV's volume control (described under the paragraph on connecting



Here's what important side of amplifier looks like if you use same parts we did and decided to follow our layout. Just stick to good wiring practices in hooking it up. There's nothing critical to need special precautions.

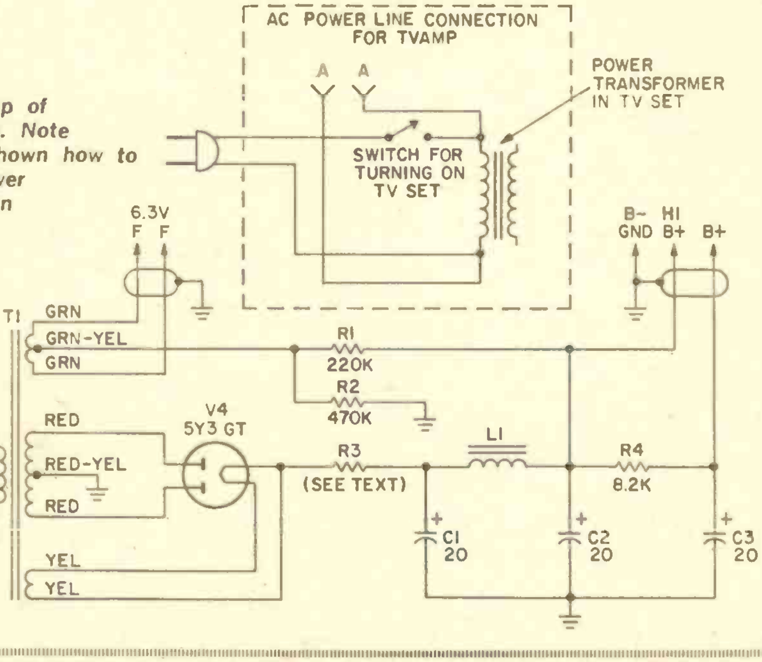
TVamp to the TV set), don't forget one important step. Even though you've removed the need for audio amplification in the TV, be sure to substitute a 3 to 5 ohm, 5-W resistor in place of the voice coil of the speaker. In other words, you disconnect the speaker but leave the audio tubes still operating. This is necessary to maintain the load on the power supply so the voltages required for the RF portion remain at their design levels for stable TV operation.

Building TVamp. We used two chassis, each 10 x 4 x 2½ in. Lay out all parts as shown in our photos and use a sharp, pointed awl to mark the centers of all holes. After center punching the holes, drill and deburr them. We purposely didn't include a pictorial layout since you have a wide choice of parts that could have different mounting dimensions.

Since the circuit isn't especially critical as to layout, we leave this to your discretion to suit the parts you purchase (or already have). Shielded 2-conductor cable is used to feed the heater voltage from the power-supply transformer windings to the amplifier chassis to reduce the possibility of stray induced hum from these leads. The value of R3 is based on the high voltage output of the particular power transformer you use. The transformer listed in the Parts List develops 300 VAC either side of the CT and we used a value of 50 ohms for R3. To calculate the value of R3 for higher volt-

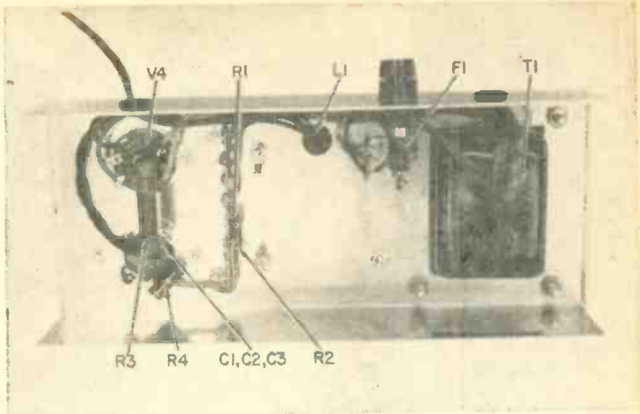
PARTS LIST FOR TVAMP

C1, C2, C3 20-20-20-uF, 450-V electrolytic capacitor (Lafayette 34E74236 or equiv.)
C4, C10 0.01-uF, 600-V tubular paper capacitor (Lafayette 34E82510 or equiv.)
C5 16-uF, 450-V electrolytic capacitor (Lafayette 34E55672 or equiv.)
C6, C14 25-uF, 25-V electrolytic capacitor (Lafayette 34E55210 or equiv.)
C7 0.1-uF, 600-V tubular paper capacitor (Lafayette 34E82700 or equiv.)
C8 470-pF, 1000-V ceramic disc capacitor (Lafayette 33E22997 or equiv.)
C9 0.001-uF, 600-V tubular paper capacitor (Lafayette 34E82312 or equiv.)
C11 0.005-uF, 600-V tubular paper capacitor (Lafayette 34E82445 or equiv.)
C12 0.05-uF, 600-V tubular paper capacitor (Lafayette 34E82643 or equiv.)
C13 4-uF, 450-V electrolytic capacitor (Lafayette 34E55631 or equiv.)
F1 Type 3AG-2 amp fuse in panel mount fuse holder (holder Lafayette 13E11-778, fuse Lafayette 13E10150 or equiv.)
L1 4.5-H, 200-mA filter choke (Stancor C1411 or equiv.)
R1, R9 220,000-ohm, ½-watt resistor



Here's hookup of power supply. Note we've also shown how to use TV's power switch to turn on TVamp.

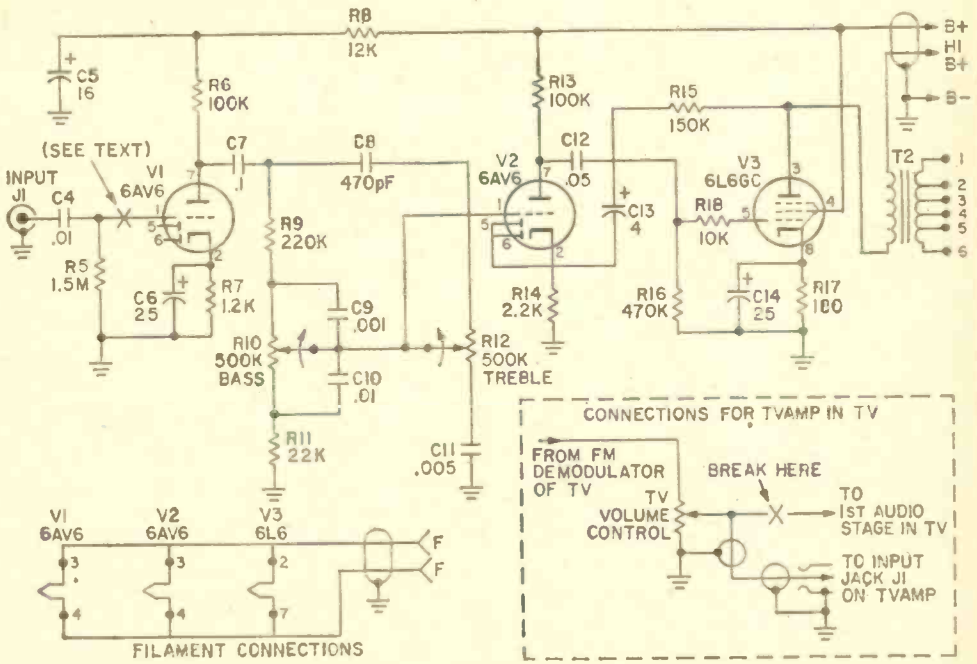
We showed you wiring side of amplifier on page 53, so here's what wiring side of power supply looks like. Simple, isn't it? With all that room under chassis you can do neat wiring job.

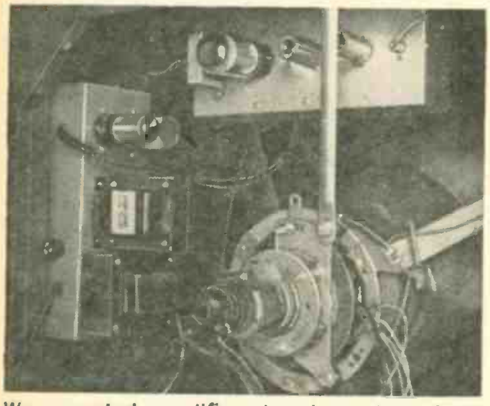


ages divide the amount of voltage in excess of 300 V by 0.075 (e.g. if voltage is 360 V the excess is 60 V so 60 V divided by 0.075=800 ohms). This is how you utilize

R2 47,000-ohm, ½-watt resistor
R3 10-W resistor (see text for resistance)
R4 8200-ohm, 2-watt resistor
R5 1,500,000-ohm, ½-watt resistor
R6, R13 100,000-ohm, ½-watt resistor
R7 1200-ohm, ½-watt resistor
R8 12,000-ohm, ½-watt resistor
R10, R12 500,000-ohm, linear taper potentiometer (Lafayette 33E11487 or equiv.)
R11 22,000-ohm, ½-watt resistor
R14 2200-ohm, ½-watt resistor
R15 150,000-ohm, ½-watt resistor
R16 470,000-ohm, ½-watt resistor
R17 180-ohm, 2-watt resistor
R18 10,000-ohm, ½-watt resistor
T1 Power transformer; 600-V CT @ 90 mA, 5-VAC @ 1 A, 6.3-VAC @ 3 A (Stancor PM 8409 or equiv.)
T2 Universal output transformer: primary, 1.5 to 10-K ohms; secondary to voice coils (Stancor A 3849 or equiv.)
V1, V2 6AV6 vacuum tube
V3 6L6GC vacuum tube

Misc. Two 10 x 4 x 2½-in. interlocking chassis (LMB 144 or equiv.), shielded cable Belden #8450 hookup wire, solder, knobs, hardware, screws, nuts, etc.





We mounted amplifier chassis on top of set so controls would be readily available. Power supply can go anywhere it fits.

whatever transformer is in your stock pile.

You may want to include a separate volume control on *TVamp* so you can use it as an auxiliary amp (say for playing records or handling the output of an AM/FM-stereo tuner in addition to the audio from the TV). Replace R5 with a 1.5-M pot. Connect its wiper to grid of V1 after breaking lead at X.

Installing TVamp. As mentioned previously, the purpose of mounting the amplifier and its power supply on separate chassis was to facilitate fitting it into available space within the TV cabinet. Our photo shows how we placed the units in an old model Philco set. We drilled holes in the top to let the controls extend outside the cabinet for ease in adjusting. The power supply was placed on the side of the cabinet, in a clear space near the top.

Again, the final choice of how you position your two chassis is left to you and is dependent on the available space in the particular TV you're using. The amplifier and power supply chassis are held in their respective locations in the cabinet by short bolts and nuts fastened through the chassis and the cabinet.

You will have to remove the TV chassis in order to make connections to its volume control and also to its power switch so that the amplifier will be turned *on* whenever the TV is *on*. Trace the power connections to the TV set's power transformer and connect the (primary) power leads of the *TVamp* transformer so that they will be connected to the power line in parallel with the power transformer of the TV through its switch. Use two different colors of hookup wire to connect the B+ and B− from the power supply to the amplifier chassis for easy identification.

Now that you have the modifications for using the TV's power switch to control power to *TVamp*, the only other change necessary to the TV while the chassis is out of the cabinet is to bring output from the FM demodulator to the input of *TVamp*. To do this, disconnect the wire or coupling capacitor now connected to the center contact of the TV's volume control; in its place connect the center lead of a piece of either coaxial cable or low-capacity shielded cable long enough to reach the input jack of *TVamp*. The shield of the cable is connected to the ground side of the volume control.

It's best to ground the lead removed from the volume control, thus removing the possibility of having stray signals induced into the audio portion of the TV. Danger is that they might be of sufficient magnitude to change the load on the TV's power supply and thus affect the overall operation of the set. Don't forget to disconnect the TV's speaker and substitute a 3 to 5 ohm resistor in its place.

When these connections have been made, the TV chassis can be put back in its cabinet. Remember, you need a pair of leads from the output transformer of *TVamp* to the external speaker system. And when locating this speaker system, remember to keep it near the picture tube so as not to ruin the illusion that the sound is coming from the picture. If you place the speaker across the room you won't affect the tone quality, but you'll most certainly ruin the illusion of the sound coming from the performer appearing on the picture tube.

Now that you've built the amplifier and tested it, sit back and really enjoy your TV. Look and listen to a musical group and find out what you've been missing. You'll be able to listen to it at reasonable volume and hear all of the instruments with little or no distortion; soloists will be more enjoyable because of the improvement in reproduction. You'll discover that what we said about the quality of sound available at the output of the FM demodulator is correct—it's truly high fidelity. Then, too, you've got a bonus if you decide to use this high-quality amplifier for a hi-fi phonograph. Why not take advantage of its excellence for this application too? ■

KATHI'S CB CAROUSEL

Hi! My name is Kathi Martin and I'm your new CB Editor. It'll be my job to poke around the CB marketplace and report on what's new and groovy. The best way to do this is to actually test the latest and hottest gear, and report the facts to you. Naturally, I'll have the assistance of the entire editorial staff of Elementary Electronics, not to mention the use of the finest CB laboratory available. What am I going to do for you? Well, look below and you'll find my unbiased test reports on two fine 5-watt transceivers.

LAFAYETTE MICRO-12

LAFAYETTE'S MICRO-12 CB transceiver is a solid-state, 12-channel, 5-watt unit that's only 1¾-in. H x 5-in. W x 7½-in. D. More than 26 Lafayette Micro-12s can fit into a cubic foot space if you disconnect the mikes first. Micro-12 is normally supplied with receive and transmit crystals for channel 10. The power supply is for 12 VDC. Two simple wire exchanges convert the unit from negative-ground to positive-ground operation. Receiver and transmit current requirements are so low that the Micro-12 can be powered from a battery pack of flashlight batteries.

Though the transmitter tuning is internal (fixed), the antenna loading is external (it's available as a trimmer on the rear apron, and is a prewired selective calling adapter socket). There is no PA operation; however, there is an external speaker jack which automatically disconnects the internal speaker.

Front panel controls are volume, channel selector, and squelch. The PTT (push-to-talk) microphone plugs into a socket on the

(Turn to page 58)

The tiny Micro-12 by Lafayette

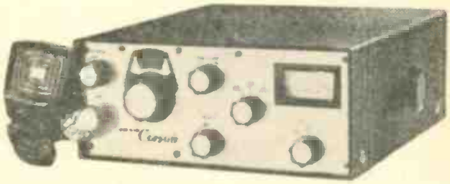
TRAM'S CORSAIR

THE TRAM CORSAIR is a 23-channel, solid-state AM-sideband CB transceiver that provides for both AM and AM-sideband operation through a single AM-LSB (lower sideband)/USB (upper sideband) selector switch. When the selector switch is set to the AM mode both the receiver and transmitter operate in AM. When the switch is set to either sideband position, the transmitter operates in double sideband/suppressed carrier (DSB) while the receiver receives either LSB or USB signals—depending on the switch setting. DSB signals can be received in either sideband position.

To ensure proper sideband reception there is a fine tuning control that varies the receiver tuning approximately 1200 Hz either side of center (carrier) frequency. This allows the Tram Corsair to compensate for off-center operation of the received signal and prevents "Donald Duck" chatter. I found the training time required to master this control to be about 15 seconds.

Down With Noise. Impulse noise suppression is through a noise blanker (an expen-

(Continued on page 59)



Introducing the Corsair by Tram

LAFAYETTE MICRO-12

(Continued from previous page)

driver's side of the case.

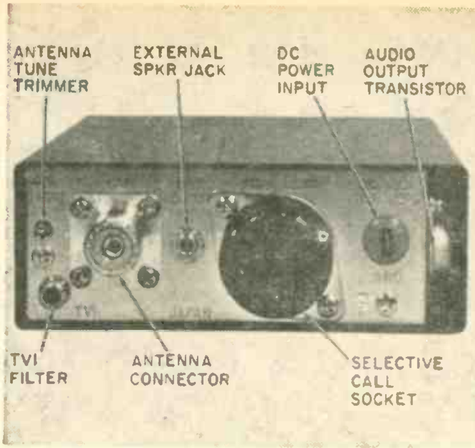
Circuitry. The receiver section is single-conversion with a 455-kHz IF and a mechanical filter. Sorry, no noise filter. The three-stage transmitter uses overtone type crystals. Internal switching is by relay.

Performance. I measured the receiver sensitivity at 0.6 *u*V for a 10 dB S+N/N (signal-plus-noise-to-noise) ratio. The background noise level is unusualy low; even with the receiver's volume wide open there is an apparent absence of noise as though the squelch were slightly *on*. Adjacent channel rejection was -54 dB at 10 kHz removed from the center frequency; very good performance—considerably better than most micro-miniature equipment. Image rejection measured 25 dB, which, though considerably less than that available with double-conversion equipment, is about the maximum performance from single conversion.

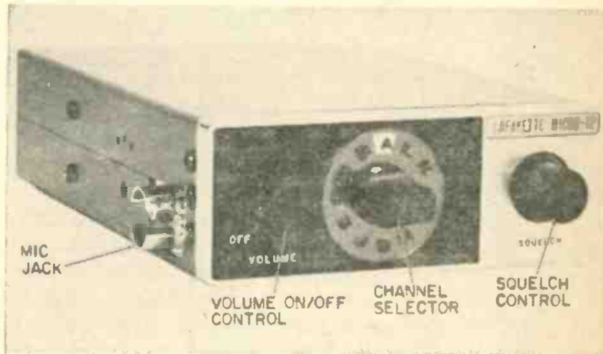
AGC action for an input signal range of 1 to 50,000 *u*V was 20 dB, which is about equal to some tube receivers and not as efficient as most solid-state equipment.

Squelch can be set to release on the minimum usable signal (very good) and will fully release on a signal level differential of less than 1*u*V (also very good).

The transmitter delivered 3.4 watts output into a 50-ohm load. I discovered that the output circuit is very sensitive to SWR; for example, an SWR of 1:2 will reduce the output power to 2.4 watts if the antenna loading control is not readjusted. The



Hey, fellahs, the Micro-12 is one of the few micro-minis prewired with a selective calling adapter socket (above). Three-knob front panel (below) makes CBing easier than pushing a shiftless Mustang on the road.



micro-12's transmitter should be tuned after each installation to obtain maximum performance.

The modulation system, which employs a so-called range boost, is one of the best found in CB gear. Fully limited to 85% modulation, the Micro-12 requires only -33 dB (relative input) for maximum modulation. Compression takes over above the input level of -21 dB—the normal level for a voice. With an input signal of -12 dB, approximating a shout, there is virtually no distortion. In short, the Micro-12 is all talk power.

Summation. I found Lafayette's Micro-12 packs a whale of a lot of performance into a micro-miniature package. The price is right, too! Only $79.95.

For additional information write to Lafayette Electronics, Dept. EE 2, 111 Jericho Tpke., Syosset, N.Y. 11791. ■

LAFAYETTE MICRO-12 TEST CHART

Dimensions: 1¾-in. H x 5-in. W x 7½-in. D
Power supply: 12-VDC, positive and negative ground
Input sensitivity: 0.6 uV
Adjacent channel rejection: 54 dB
Image rejection: 25 dB
AGC action: 20 dB
Squelch release differential: less than 1 uV
Receive current drain: 87 mA
RF output: 3.4 watts
Relative sensitivity for 85% modulation: -33 dB
Compressor rating: range boost, very good
Transmit current drain: 800 mA at 85% modulation

TRAM CORSAIR

(Continued from page 57)

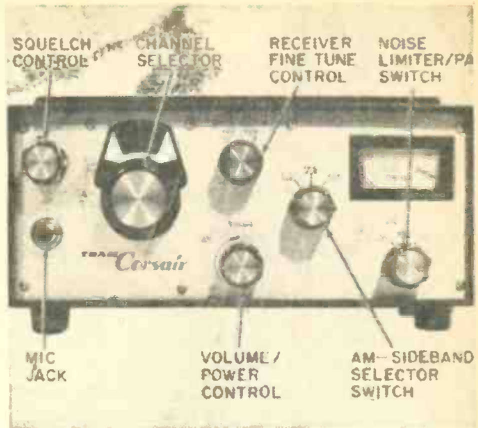
sive communications receiver feature) rather than the ordinary noise limiter. Part of the IF signal is tapped off at the input to the second IF amplifier and is fed to a *noise blanker amplifier*. The noise blanker, in turn, is used to electrically "lock out" the remainder of the IF amplifier on noise pulses, thereby effectively punching a hole in the received signal corresponding to the noise pulses. This method contrasts to the more common noise limiter that simply reduces the noise-pulse peak level to that of the audio signal peaks. In short, a noise blanker eliminates the noise pulse instead of attenuating the pulse. It's like a shooting gallery where no one misses.

After the noise blanker circuit, the IF signal passes through a mechanical filter, an integrated circuit IF amplifier, an FET IF amplifier, and on to the AM and sideband detectors. That's a lot of electronics for one receiver.

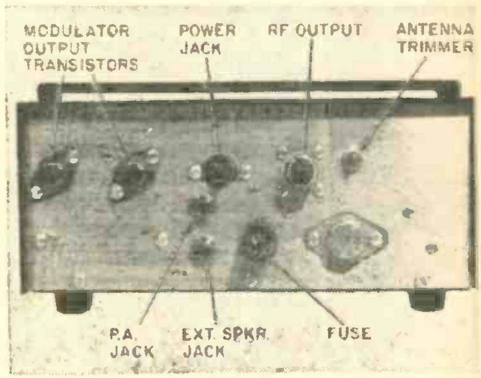
More On Features. The transmitter tuning is internal, with an antenna loading control that allowed me to match the Corsair to my antenna. PA operation is provided through a third position on the noise blanker's *on/off* switch. When the switch is set to *PA*, depressing the mike's PTT (push-to-talk) switch does not turn the transmitter *on*; only the modulator is activated, with its output fed to a PA speaker jack mounted on the rear apron. (An external speaker jack is also provided on the apron for the receiver section.)

Extra features include a plug-in DC power cable, a plug-in microphone using a standard three-terminal phone plug (making it easy to test out different microphones), and a combination S/RF meter which indicates the relative signal strength in S-units or the Corsair's relative output power. There are no crystals to buy—the Corsair comes with a full set of rocks. Also, all critical frequency circuits are voltage regulated.

TRAM CORSAIR TEST CHART
Dimensions: 3¾-in. H x 8⅞-in. W x 9½-in. D
Power supply: 12 VDC, negative ground
Input sensitivity: 1.1 uV
Adjacent channel rejection: –63 dB
Image rejection: 74 dB
AGC action: 12 dB
Noise blanker rating: excellent
Squelch release differential: 0.5 uV
Receiver current drain: 300 mA
RF output: 3.8 W
Relative sensitivity for 85% modulation: –36 dB
Transmit current drain: 1.5 A at 85% modulation



Gee whiz! The Corsair has more controls up front (above) than a wedding dress has buttons up back. And with so much electronics inside the Corsair, the back panel (below) makes like a chassis for power transistors.



Performance. I found that the receiver sensitivity measured 1.1 uV for a 10 dB S+N/N ratio (signal-plus-noise-to-noise). Though the background (interstation) noise was somewhat higher than average, the noise blanker really cleans up a weak signal, and reception under mobile conditions is exceptionally good, with very high intelligence extraction.

Overall receiver selectivity measured a *superb* 63 dB on adjacent channels, with very good symmetry—meaning selectivity

(Concluded on page 101)

Clip Book Circuits

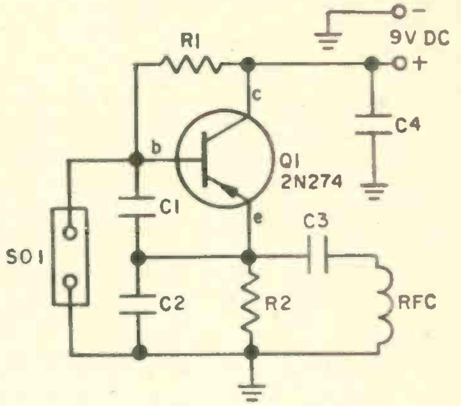
SW FREQUENCY SPOTTER

Can't find that rare, weak SW signal from Lower Slobbovia? You will if you use this SW frequency spotter. Obtain crystals on or near your favorite SW stations, plug 'em into the spotter and you'll transmit powerhouse markers on the shortwave bands. If your receiver has a BFO it will sound a loud *beep* when you tune the spotter's signal. With no BFO, simply tune around the frequency until the receiver gets deathly quiet. Either way, you'll calibrate your receiver with great accuracy.

The spotter can be assembled on a small section of perfboard with flea clips for tie points. For good performance, all components must be firmly mounted and well soldered. A common 2U6 9-volt battery in the circuit will last for months, if not for its total shelf life.

Crystals in this circuit are fundamental type, not overtone. Many low-cost surplus crystals are available, but even if you can't get the correct frequency, 25¢ might get you right next door. A few dollars for a new crystal will put you directly on frequency if you want the utmost accuracy.

A connection between the spotter and receiver is not needed. Simply position the spotter near the receiver antenna and start tuning until you find the marker signals.



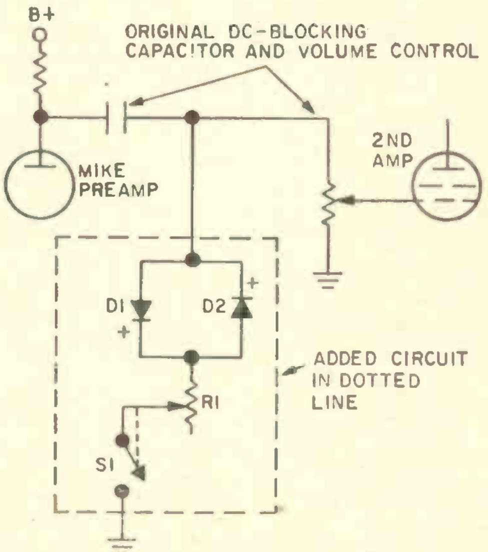
PARTS LIST

C1—1200-pF silver mica capacitor
C2—75-pF silver mica capacitor
C3—250-pF, 100-V disc capacitor
C4—0.01-uF, 25-VDC capacitor
Q1—RCA 2N274pnp transistor
R1—220,000-ohm, ½-watt resistor
R2—1000-ohm, ½-watt resistor
RFC—1-mH RF choke
SO1—Crystal socket

BUILT-IN FUZZ BOX

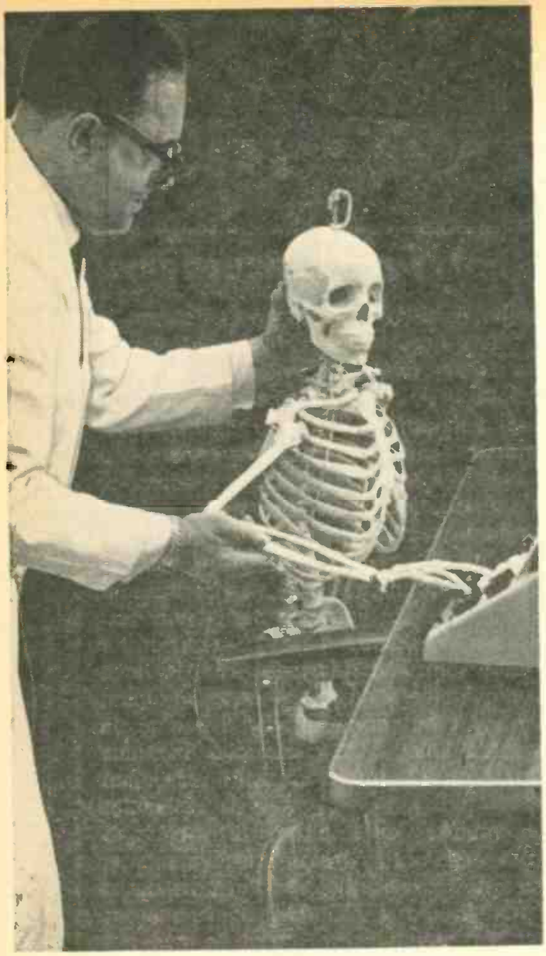
Want fuzz for the Now sound, but haven't got the loot for a fuzzbox? Try this one until you come across some extra "bread". The cost will be under three bucks.

Install the two diodes and potentiometer across the guitar amplifier's volume control. The diodes clip the normal sound, producing the fuzz effect. R1 sets the degree of fuzz. It's not as much as you would get from a professional fuzzbox, but fuzz it is. One restriction is that an audio signal at the plate of the amplifier before the fuzz must be at least 1-volt RMS—generally true in most amplifiers.



PARTS LIST

D1, D2—1N60 diode
R1/S1—10,000-ohm miniature potentiometer with spst switch



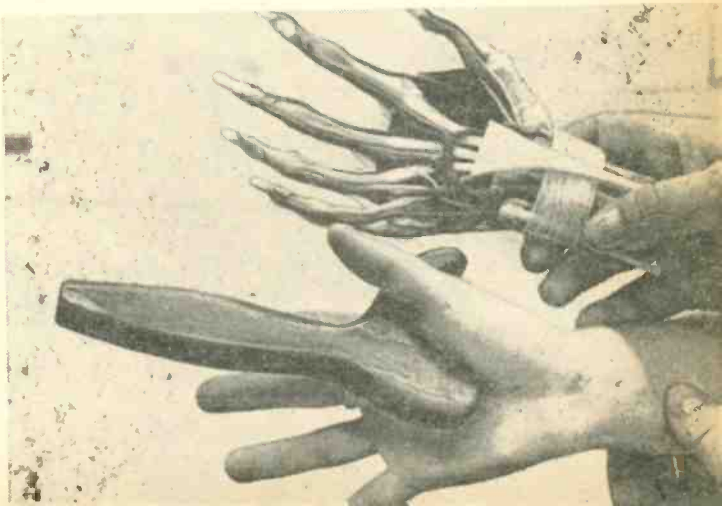
"Miss America, meet Doctor Tichauer."

Common tools undergo close study so they can be reworked for least worker fatigue.

THE GENTLEMAN above isn't greeting a dieting office worker. Actually, he's extending a helping hand to his secretary, Miss America. Doctor Erwin Tichauer's his name; he's a Berlin-born biochemist conducting America's first exhaustive ergonomic studies.

Ergonomics is a relatively new science; it's a melding of anatomy and engineering. Together they form a discipline seeking to match machine to man—and not, as is

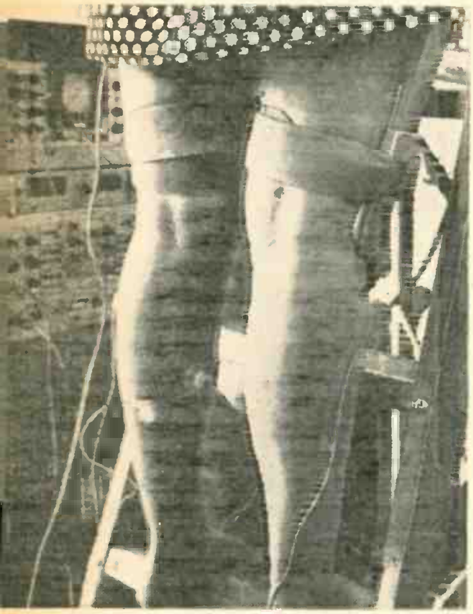
Besides winning beauty contests, our Miss America also paints ceilings—for science, of course! She's strapped to hip-joint kinematometer, letting Dr. Tichauer analyze her torso movements. Right, redesigned scraper handle's easier to grip, reduces strain.



e/e MISS AMERICA

If ergonometric design principles were more closely followed by auto manufacturers, there'd be fewer road accidents. Electrodes fixed to model measure eye-hand coordination—most influential factor determining speed of driver's response in emergencies.

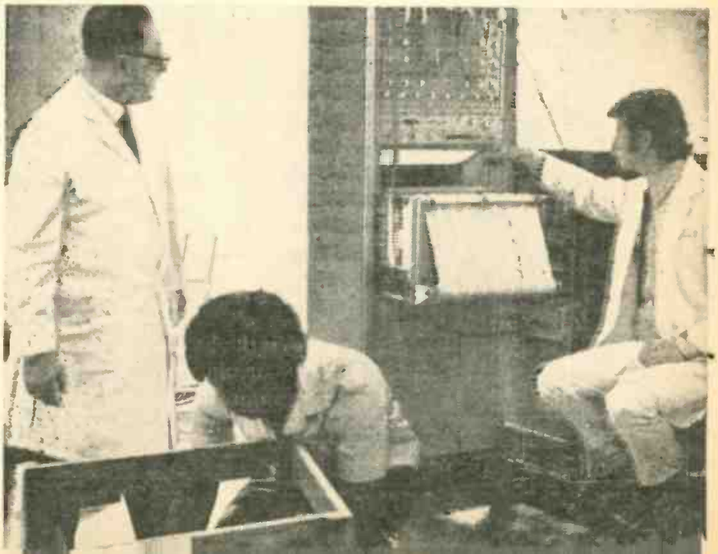
Wired for work, Gal Friday stands on stepladder, feeding leg muscle stresses via electrodes to laboratory oscilloscope. Test findings will probably alter future design of common household objects.

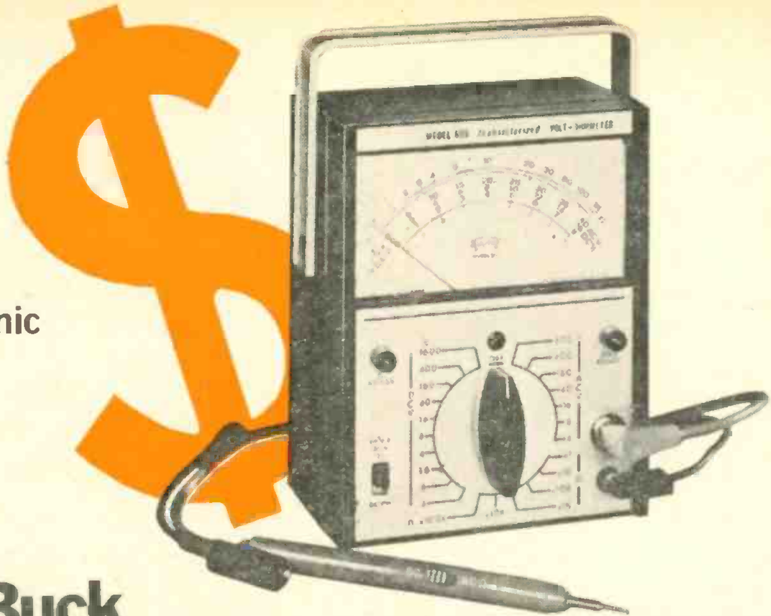


too often the case, the other way around.

While Miss America may not take dictation or sit on Dr. Tichauer's lap, she works elbow-to-shoulder with the doctor and his team of researchers as they design ergometrically correct office furniture. Miss America and Dr. Tichauer have already helped flesh-and-blood mortals—sacroiliac sufferers and the like. Redesigning a typist's chair was one of their special projects. The wrong kind of back support, the doc points out, hurts a secretary's posture. ■

Dr. Tichauer tests "lifting tolerance of women for bulk rate ratio" plus women's ability to muscle merchandise about. Help's soon to come for wives who're in charge of lifting that supermarket bundle, toting that laundry bag on their daily routines. Results of biomechanical tests wind up in package manufacturers' design studio.





Teach your electronic pets new tricks with our

No-Buck SEMI CONDUCTOR Tester

by Joseph J. Carr

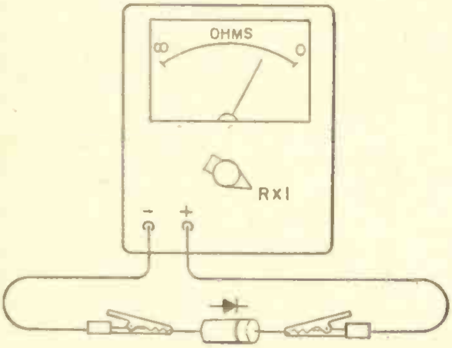
THERE'S a semiconductor tester hiding in your workshop. Don't believe us? Mosey up to your trusty multimeter and, presto, it changes, Cinderella style, into a transistor/diode checker! How, you ask, can such a simple device give you the lowdown on a semiconductor's health? Easy! By interpreting the multimeter's ohmmeter scale properly, you can measure diode front-to-back resistance and determine if the diode's leaky. You'll even be able to tell which end is cathode (or anode) when no markings are there to guide you.

Buying transistors by the bagful can be a very profitable way of stocking your supply shelves for those forthcoming projects. On the other hand, lots of those bargain beauties often turn out to be bargain beasties—if they aren't marked by lead function they're as good as worthless. Thing is, you can unravel this mystery with your multimeter. You can even tell whether the unit's npn or pnp. What's more, by carefully tagging each transistor as you go along, you'll know which of those black beauties will perk in RF and audio gear, and which are going to be relegated to power-supply projects.

Ohmmeter Orientation. Before jumping into the semiconductor test pool, let's wet our toes with a little ohmmeter theory. Remember how ohmmeters work? A battery inside the multimeter is hooked up in series with the meter movement. Battery current pushes its way through the meter movement into an external circuit, and back to the battery. If we make it hard for current to flow by putting a resistance in series, the meter pointer won't swing as far along the dial. That's why you'll find highly accurate resistors in any multimeter—they limit meter pointer travel so that the pointer always comes to rest at a specific place on the dial. Short an ohmmeter's leads together, and that place, of course, will be zero ohms.

When we connect our multimeter across an external resistance (with the multimeter in the ohms mode), the meter receives even *less* current than it did before; so there's *less* swing on the pointer's part.

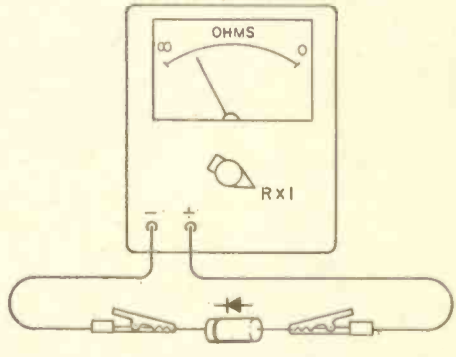
Testing Diodes. Our lives should only be so diode-simple. Diodes are the easiest to test, so we'll tackle them first. Like that famed airplane pilot, Wrong-Way Corrigan, diodes do their thing best in a single direction. We rely on diodes to pass current *unidirectionally*. This unique ability forms the basis for our test. There are four states of being for any diode. They can be open, shorted, leaky, or OK. Before you start testing, it would be wise if you had a sheet of paper and pencil before you to jot down readings.



Place positive multimeter probe on diode lead emerging from banded end. Attach negative probe to unbanded diode lead end. If diode's good, meter pointer will swing upscale.

With the ohmmeter at Rx1, gently place the probes onto the diode leads. Record your reading—then swap probes and take a second resistance reading. After you take both readings we're ready to interpret what you've found.

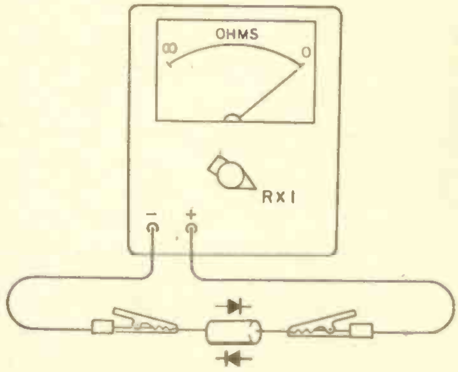
Let's assume your first diode under test checked out OK. How'd we know? If the diode's healthy, one of your resistance readings will be much higher than the other. The actual resistance values aren't important; it's the *ratio* between readings that counts. Consider ten to one (10:1) a normal resistance ratio for small-signal diodes. For instance, if one reading were 500 ohms, then the second reading should fall in the 5000-ohm range (or higher) if we're going to consider this diode OK. You'll find that power diodes yield slightly lower resistance



Negative multimeter probe attaches to banded diode end with positive multimeter probe sitting on other diode end. Resistance ratio is prior reading divided by this reading.

ratios. Generally, a five to one (5:1) ratio is considered normal because power diodes don't have to be as efficient as small-signal units.

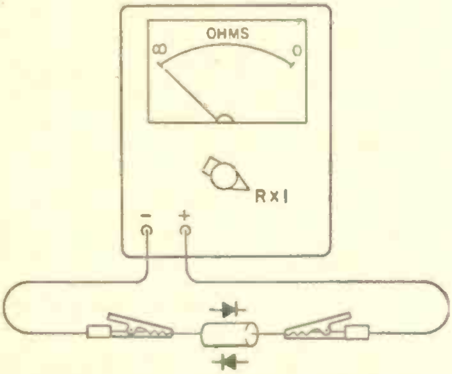
Suppose your first and second readings were almost identical (but not zero ohms). You've got a leaky diode—and for all practical purposes it's as useless as a donkey at a Republican convention. Shorted and open



Here's what dead short looks like. Meter pointer rests at zero ohms with diode affixed to meter probes in either direction. Short can also show as low reading in either direction.

diodes test exactly as you'd expect them to. The term shorted includes those diodes exhibiting very low resistance values in both directions (50 ohms one way and, say, 75 ohms the other). An open diode wouldn't deflect the meter pointer when tested in either direction.

Last, but not least, you'll want to know which end is cathode or anode on unmarked diodes. Here's where you've got to know relative ohmmeter lead polarities. Take any known quality diode and connect the positive ohmmeter lead to the cathode end. This end always has some kind of band, letter, or mark indicating cathode. Connect the negative ohmmeter lead to the anode and take a resistance reading.



If meter pointer doesn't budge from infinity, chances are you're looking at open diode. Confirm open condition by testing diode in both directions on Rx100 ohmmeter scale.

Swap leads—the new reading (ohm-wise) should be lower! The reason's simple enough; when a diode anode is positive with respect to cathode, current flowing through the diode sees less resistance. Now you know that when the positive meter lead's connected to an anode end, resistance readings will be lower. That's how you'll be able to identify any unmarked diode!

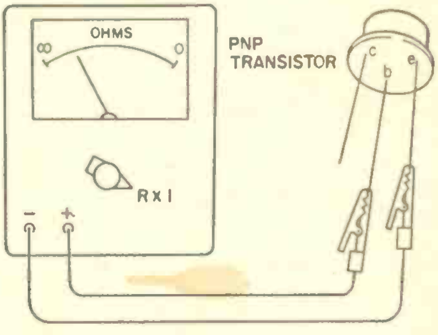
There's one more rule you should follow. While testing diodes or transistors, always stick to the same ohmmeter range, whether it's Rx1, Rx10, or Rx100. The Rx1 range should give you sufficient meter pointer deflection. If it doesn't, switch to a higher range. Switching ranges midstream invalidates your readings for that particular semiconductor under test, because you're introducing different currents into it.

Testing Transistors. Just as there are thousands of personality types amongst members of the human family, transistor types can be (and often are) categorized in terms of family behavior—and even sex! Look in any transistor catalog. You'll see that many consecutively numbered transistor types share like characteristics. And while a pnp transistor may not wear eyelashes and makeup, it exhibits polarity characteristics equal to and opposite that of a like npn transistor.

Let's start by examining a small-signal pnp unit first. The method for checking transistors with a VOM or VTVM is no different than for checking a diode. Perform your tests with the ohmmeter on the Rx1 scale. Connect your negative ohmmeter probe to the transistor base lead. Separately touching the collector and then emitter leads with the postive probe, first you'll detect a high-resistance and then a low-resistance reading. Reversing the procedure (with the positive probe on the base) will show up as low collector resistance reading and high emitter reading.

By now you're wondering what all this resistance hokus-pokus has to do with transistor testing. You've just killed two measurement birds with one stone. First, you found out if the transistor was leaky, shorted, or open between elements. This would become apparent as you made your resistance measurements. Next you either confirmed or discovered the transistor's sex, that is, whether it's pnp or npn.

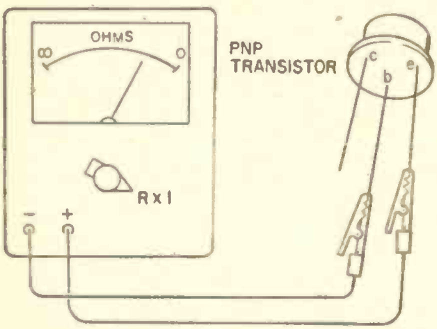
Suppose the base-emitter junction tests open. This situation is revealed as a very high resistance, whether the positive probe is connected to the base, or the other way



Base-emitter resistance test for pnp junction transistor; npn transistors show similar result with ohmmeter probes reversed. Be sure you perform test with ohmmeter in Rx1 mode.

around. If the base-emitter junction tests shorted, you'll see that this condition shows up as a very low resistance, no matter which way the ohmmeter probes are placed. Leaky transistors give you a real run for your measurement money. Indicating abnormal base-emitter resistance values, they won't test open or shorted—normal resistance characteristics for that particular transistor family under examination simply won't show.

Finding out whether a transistor's pnp or npn merely amounts to noting lowest resistance values as you check base-emitter junctions. For pnp units, the lowest reading occurs when the positive probe's connected

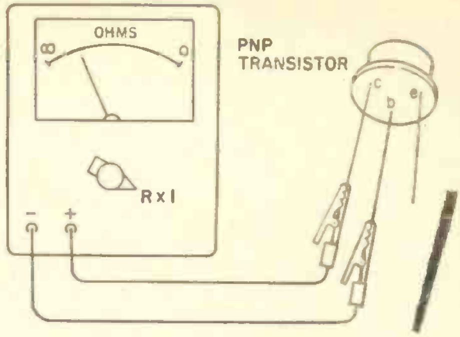


With positive probe on emitter and negative probe attached to base, meter pointer should deflect upward toward low ohms reading. Be sure to switch probes around for npn unit.

to the emitter, and the negative lead is hooked to the base. For npn transistors, it's just the opposite. That is, you'll bulls-eye when the ohmmeter positive lead is connected to the base and the negative lead goes to the emitter.

Explaining the Unknown. Even if you didn't know that a pnp transistor was under test, you could still play the switch 'n swap ohmmeter lead game. Our procedure isn't more difficult—you'll simply need to pay more attention to your readings. First, mount a transistor to a surface that's easily written on—a piece of paper or cardboard will do. Label each transistor lead X, Y, and Z.

Now pick a lead (say lead X), and attach the positive ohmmeter probe to it. Connect your negative probe to another transistor lead, say lead Y. Take a reading, writing the value recorded between the leads on the paper. Now reverse your ohmmeter probes, taking another set of readings between the



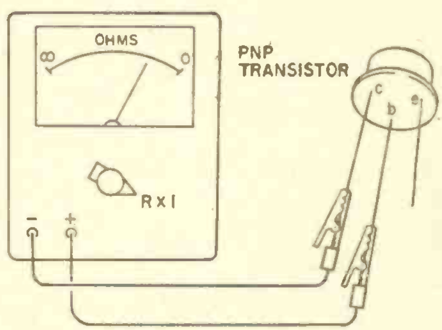
Base-collector junction test reveals excessive leakage. With multimeter connected as shown, pointer should barely deflect. Transistor's power rating greatly influences leakage value.

same two transistor leads. Again, write the value between the leads.

Move your ohmmeter probes to a second pair of leads (Y and Z for instance). Repeat the resistance recording operation. Eventually, you'll want a set of values between all transistor leads.

Let's interpret our readings. One set of resistance readings will be almost identical. You've found the emitter and collector—label one lead *E* and the other *C* (for the moment, it's entirely arbitrary which lead receives either letter). Since you've located both emitter and collector it stands to reason that base is your only unmarked lead. Write *B* next to this lead.

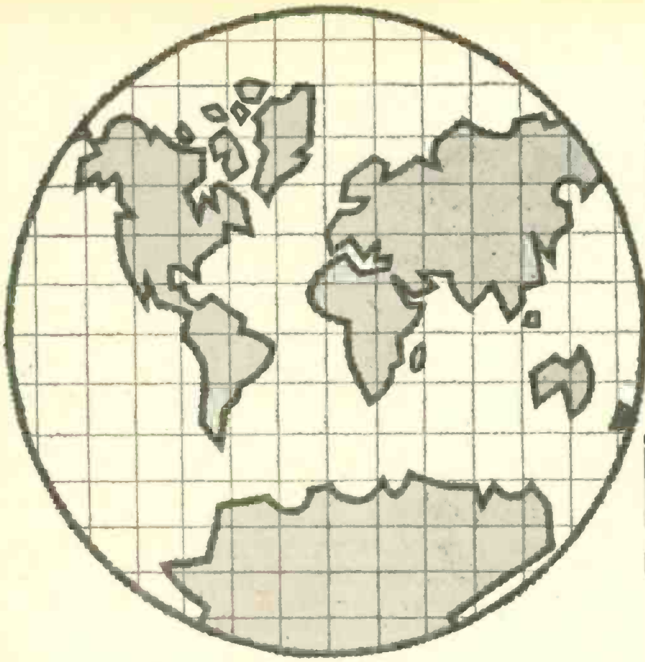
Assume, for the moment, that you've got an npn transistor labeled. If your base-emitter resistance reading was lower with the



Leakage reading is also affected by temperature. Therefore, transistor should be at room temperature for leakage test; results'll be deceptive with unit connected as shown.

positive ohmmeter probe connected to base (base-emitter junction test), *and* the base-collector reading was higher with the posi-

(Continued on page 101)



the quest for international TV

By C.M. Stanbury II

ALMOST FROM the moment that broadcasting began, man has dreamed of transmitting pictures, as well as his voice, to the distant corners of this planet. If shortwave sound broadcasting has revolutionized life in places like Africa, Latin America, and Southeast Asia, think what the sudden appearance of international television would do in North America, Europe, or the U.S.S.R. For the first time, the populace would be exposed to TV pictures which could not be controlled by the local power structure.

Strange as it may seem, the first crude experimental TV stations came far closer to achieving international coverage than those much more sophisticated operations now so familiar to all of us. Radiovision, as it was called, originally appeared on the scene during the late 20s and operated in what was then known as the 140-Meter band. Such frequencies (around 2100 kHz) can of course be received regularly at night up to a thousand miles away, and often even further. In addition, the modulation systems used would have worked equally well on shortwave frequencies which opened up a few years later.

These systems included such devices as the Jenkins Televisor (which combined a neon lamp, scanning disc, and magnifying lens) and the Peck system, which replaced that lens with a series of mirrors. Needless to say, Jenkins and Peck produced nothing more than animated shadows on viewers' screens. With the advent of the cathode tube, however, many more elements and therefore much more detailed pictures could be transmitted and received. Catch was that this additional detail required substantially increased bandwidths than those occupied by the original Jenkins stations.

Net result was that all TV was forced onto frequencies above 30 MHz (vhf and later uhf), which, for practical purposes, ended prospects of international reception. Reason is that vhf and ufh are not normally propagated around the curvature of the Earth by the ionosphere, though skip does occasionally produce distant reception below about 100 MHz.

The Space Age. Just as the cathode tube and man's conquest of frequencies above 30 MHz made possible high-quality TV pictures, so too will high-flying satellites eventually bring about global video coverage. But none of the communications vehicles launched to date can serve this purpose. All lack power to reach the average viewer,

(Continued on page 72)

You get more for your money from NRI—

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Shown below is a dramatic, pictorial example of training materials in *just one* NRI Course. Everything you see below is included in low-cost NRI training. Other major NRI courses are equally complete. Text for text, kit for kit, dollar for dollar—your best home-study buy is NRI.

which means that their signals must be received on giant dish-like antennas, tremendously amplified, and fed to the public via conventional facilities.

In order for a satellite-based TV station to be truly an international broadcaster, it would have to carry a transmitter with at least 50-kW output. But what 99.9% of the population doesn't realize is that since the U.S. and the U.S.S.R. can put payloads in excess of 100,000 lb into orbit, the Earth's first international TV station could now be launched any time someone wants to spend that kind of money. Only wrinkle is that a scant few hours of air time would cost millions of dollars.

Putting the transmitter itself into orbit is the smallest part of the problem. There is already a 50-kW rig available commercially which weighs a mere 6000 lb; the still more advanced portable units which both Washington and Moscow are undoubtedly keeping under wraps must weigh much less and be even more compact. Toughening them for space travel and adding video tape and receiving facilities wouldn't create any significant weight problems, either.

A power source is the limiting factor. Solar energy is presently impractical for this purpose. And even 90,000 lb of high-powered fuel cells would keep a 50-kW TV station on the air only a matter of hours.

With that kind of time limitation, the only value such an international TV station could have would be shock. For example, just think what could happen on election day '72 if a powerful TV signal appeared over various American communities via a secret satellite in polar orbit, claiming to be from an alien space ship, and ordering Americans to vote for a certain candidate or face extermination! Sure, this *sounds* like science fiction. Just remember that unlike most sci-fi themes, it *could* happen.

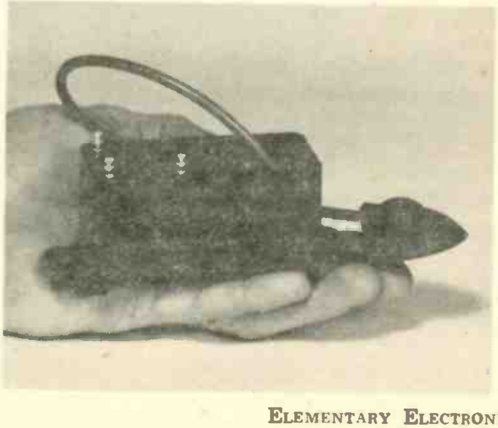
UHF DX. No matter how and when it comes, international TV will almost certainly use uhf, if for no other reason than the number of clear channels as compared to vhf. Obviously, the ultra-high frequency channels represent the TV DX of the future. All of which means that DXers should get in on the action now, especially with prospects for distant vhf reception being strangled a little more each day by QRM.

Of course skip-type DX is completely absent from the uhf scene. Therefore, anything you catch (before those satellites make their appearance) will be by the "trop" route—i.e., an unusual ratio between temperature/pressure/water vapor at a certain height in the troposphere, resulting in the bending of radio waves around the curvature of the Earth. The absence of uhf skip is compensated for not only by the vastly increased number of QRM-free channels but also by the much greater variety of programs.

The actual DX tuning technique is markedly different for uhf because, unlike vhf, most TV sets offer continuous coverage (like a radio) rather than a channel switch. To locate uhf DX, first turn the main dial very slowly until black horizontal or diagonal lines appear. This done, rotate the uhf fine tuning back and forth until (hopefully) a picture becomes visible. You might even say that uhf tuning techniques are very similar to those employed for shortwave dialing. Could this be an omen of things to come? ■

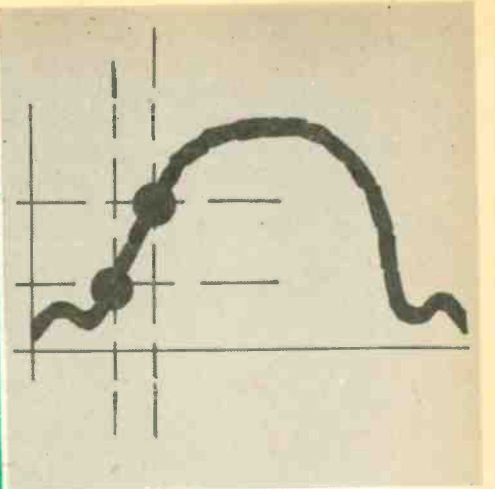
It's SS for TV's HV

REMEMBER when color TV set manufacturers were called on the carpet by the Congress? Seems there was quite an uproar over excessive X-ray emission, giving new-set owners the jitters. Sylvania Electric Products took the bull by the horns. By developing a solid-state replacement for the high-voltage rectifier and shunt regulator sections found in these sets, they licked the radiation problem and made precautionary shielding unnecessary. Sylvania says the solid-state replacement offers longer operating life, increased reliability, and short-circuit protection. TV manufacturers semi-conductorize color-set circuits as it becomes feasible; the high-voltage section was a last holdout. ■



RISE TIME SPECIAL

by A.A. Mangieri



TIME WAS when the words "square wave generator" meant visions of pie-in-the-sky-priced test gear. Those hobbyists adventurous enough to homebrew a square-waver found the conclusion to this undertaking in an aspirin bottle or a jug of something stronger. Order of The Ohm Devotees, hassle your minds no longer! For 25 bones and some build 'em patience, our Rise Time Special will reward your urge to plot and compensate.

Rise Time Special (RTS) really shines in the *clean* square-wave department; over its frequency range of roughly 1 Hz to 100 kHz the instrument cranks out waveforms totally devoid of overshoot, excessive rise time, ringing, or undershoot.

Audio buffs are sure to take a special shine to RTS. Your system's moment of truth has arrived. Plug RTS into your favorite amplifier; by hanging a scope across the amplifier load, you'll quickly judge amp behavior as it is. The highest frequency passed through your amp *without* visible waveform rounding, times ten, clues you in on your amplifier's high-frequency response.

The face of poor frequency response can wear six distinct masks. Note our drawings showing low- and high-frequency-deficient square waves. All amplifiers, regardless of advertiser claims, suffer in varying degrees particularly at the hands of low frequencies. Don't be too surprised when you see one of these patterns staring back as you make your frequency check rounds. Whether you want to check out a recently completed kit-built amplifier, or if you're the individualist who prefers to roll his own, RTS helps you to extract more hi from your fi.

Any oscilloscope owner who doubts his

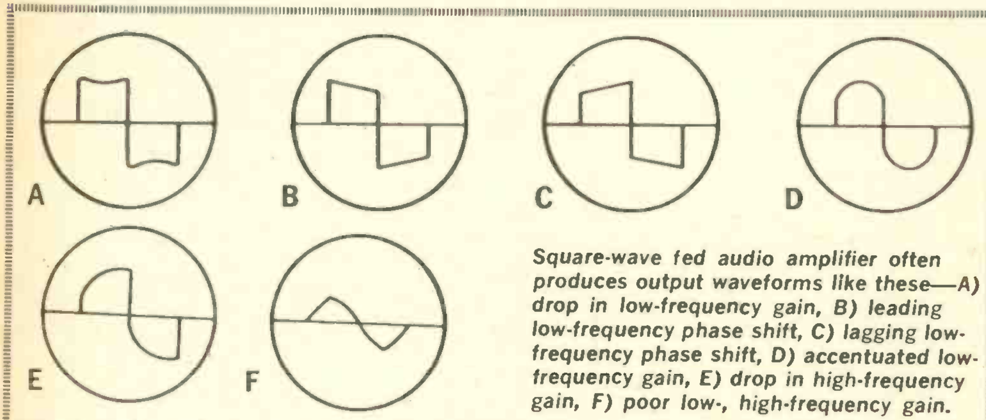
Sweeten your test-gear cake with a square-wave frosting!

instrument waveform reproduction accuracy's off has reached the end of his alignment rainbow. RTS'll give your scope a real shot in the arm when you retrim the vertical amp and compensation capacitors.

Super-complicated instructions aren't needed to operate our Special, either. There's a *frequency* and *level* pot, a *multiplier* and *on/off* switch. And last, but not least, RTS delivers 2 volts peak to peak at 200 ohms

Generating pulses this way gives some built-in benefits. If the load draws power only half the time, then it follows that the battery is *on* half the time. Theoretically, this arrangement is 100% efficient. In practice, the gadget that does the flip-flopping needs a few milliwatts to remain in the *off* state—indeed a small price to pay for Rise Time's performance.

Think of this flip-flop action as a battery hooked up in series with a switch and connected to a load (see our drawing). You'll see that when the switch is open at time 1, voltage appearing across the load is at one



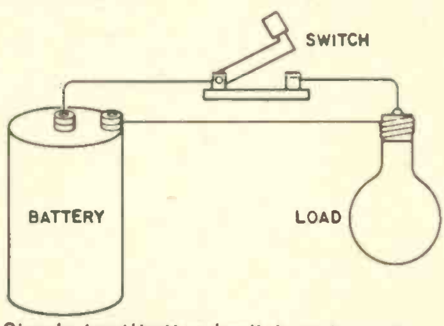
Square-wave fed audio amplifier often produces output waveforms like these—A) drop in low-frequency gain, B) leading low-frequency phase shift, C) lagging low-frequency phase shift, D) accentuated low-frequency gain, E) drop in high-frequency gain, F) poor low-, high-frequency gain.

from universal binding posts labeled *Output* and *Gnd*. Consider most of your test equipment needs met if your scope can meet the demands placed upon it by our RTS.

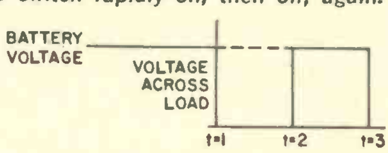
How It Works. Looking at the schematic you'll see that there are three major circuit sections. Unijunction transistor Q1, connected as a relaxation oscillator, feeds sawtooth-shaped pulses to buffer Q2. An npn silicon job, Q2 is direct-coupled to bi-stable flip-flop IC1. Each time IC1 receives *two* pulses from Q2, *one* clean square wave emerges from it. Output travels to *level* pot R2, then on to output jacks J1 and J2, which are connected to the intended load.

As you may have already guessed, IC1 is responsible for those really clean square waves. Packed into its innards are a dozen transistors and a handful of resistors. When IC1 receives an input pulse (or *toggles*, in integrated-circuit lingo), it rapidly shifts from one voltage condition to another. The IC holds this new condition until another toggling pulse arrives at the input. Then the IC reverts to its original voltage state. Technically, we've just described a bi-stable flip-flop—every output pulse is generated by two input pulses.

value. The value in this case is zero. Toggling the switch at time 2 (flipping it to the closed position) puts a different voltage across the load. Of course, this new voltage is equal to the battery voltage. Another toggling operation at time 3 opens the switch



Simple load/battery/switch series setup can be considered square-wave generator. If switch contacts are clean, you'll see pseudo-square waves on your scope as you flip switch rapidly on, then off, again.

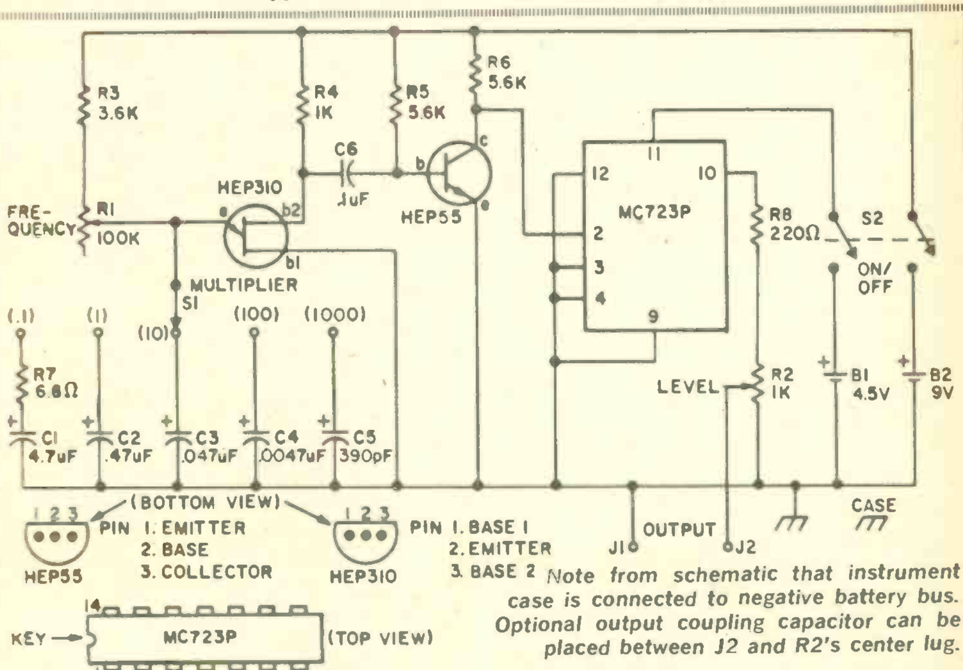


—now the load voltage is equal to zero again.

Economy of operation isn't RTS's only virtue. Most square-wave generators work by clipping a sine wave. This brute-force method employs driving an ordinary amplifier until it saturates (there's no further increase in output with an increase in input voltage). Electrically pounding away at an amplifier is an easy way of generating square waves—that's why you find this circuit arrangement appearing in the cheapest test equipment.

Back-to-back diode clipper/DC source circuits also produce square waves when fed with sine waves. But if the DC source has even a trace of ripple in its output, your square wave will look like a Turkish belly dancer grinding across the scope screen! Integrated circuit technology allows RTS to neatly step around both compromising configurations.

Sawtooth Oscillator. Congratulate yourself—the stickiest part of the circuit theory is now under the belt. We'll finish circuit discussion with a brief description of the sawtooth generator, Q1, and buffer Q2. A unijunction transistor, Q1 is hooked up as



Note from schematic that instrument case is connected to negative battery bus. Optional output coupling capacitor can be placed between J2 and R2's center lug.

PARTS LIST FOR RISE TIME SPECIAL

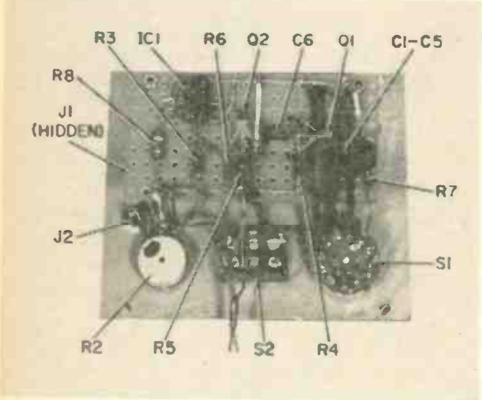
B1—4.5-V battery (3 "D" cells, Burgess 230 or equiv.)
B2—9-V transistor battery (Burgess 2U6 or equiv.)
C1—4.7-uF, 10-V tantalum capacitor (Mallory TAC 475K010P02 or equiv.)
C2—0.47-uF, 200-V, 10% capacitor
C3—.047-uF, 200-V, 10% capacitor
C4—.0047-uF, 100-V, 10% capacitor
C5—390-pF, 1000-WVDC, 10% capacitor
C6—0.1-uF, 400-V, 20% capacitor
IC1—J-K flip-flop integrated circuit (Motorola MC723P)
Q1—Silicon unijunction transistor (Motorola HEP 310)
Q2—Silicon transistor, npn (Motorola HEP 55)
R1—100,000-ohm linear carbon potentiometer (Mallory U41)
R2—1000-ohm linear carbon potentiometer (Mallory U4)
R3—3600-ohm, ½-watt, 10% carbon resistor
R4—1000-ohm, ½-watt, 10% carbon resistor
R5, R6—5600-ohm, ½-watt, 10% carbon resistor
R7—6-8-ohm, ½-watt, 10% carbon resistor
R8—220-ohm, ½-watt, 10% carbon resistor
S1—1-pole, 5-position switch (Mallory 3215J)
S2—Dpst toggle switch (Arrow-Hart 20902CX)
Misc.—Battery holders, 4 x 5 x 6 cabinet (Bud AU-1029-HG), 14-pin IC socket (Allied 47D5701), knobs, Vector 32A-A18 pre-punched terminal board, Vector T 9.4 push-in terminals, hardware, clear lacquer spray, dry transfer lettering, etc.
*All semiconductors available from Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680. Order MC723P as 50D26MC723PMOT.

a relaxation oscillator. As the switch-selected capacitor (C1 through C5) is charged through resistor R3 and pot R1, Q1's emitter voltage rises toward the 9-volt supply, B2.

When sufficient voltage reaches the emitter, it becomes forward biased. Emitter/base 1 resistance falls sharply, allowing the capacitor to discharge through the emitter/base 1 junction to ground. The emitter voltage continues to drop to its original voltage level, and the entire operation starts all over again.

Transistor Q1's sawtooth output is tapped off R4 via C6 and fed to buffer Q2. Note that Q2 is direct-coupled to the IC; this ensures positive IC toggling on the lowest frequency range.

Construction Procedures. You've got lots of leeway with circuit layout; point-to-point wiring is the most important rule here. Begin construction by cutting out a piece of 2½ x 5-in. pre-punched terminal board, and drilling a couple of mounting holes at the

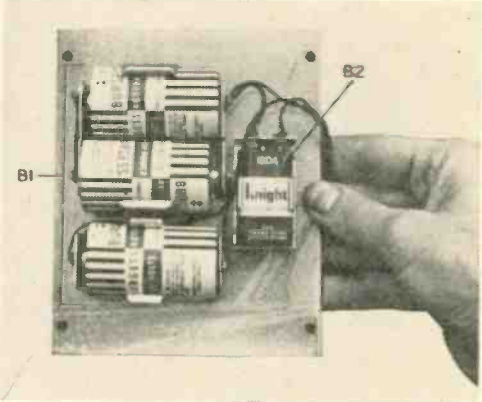


Follow author's perf-board parts layout. Though it's hidden from view, pot R1 (Frequency) is mounted on instrument front panel. Also note author's S2 is DPDT job.

corners. After inserting the push-in terminals, concentrate your efforts on the plus and minus 9-volt busses. Figure out which components directly connecting to these busses go where and solder them first.

Now steer your peepers towards capacitor C1. Though it's rated in *u*F, *don't* buy an electrolytic. You'll need the tantalum job called out in the Parts List. It has the tighter tolerance (10%) needed to maintain capacitor ratios.

Positioning and soldering IC and transistors on the board is your next job. Exercise caution when soldering these heat-sensitive devices home. Even if you do follow the industry-wide precaution of grasping the semiconductor leads with a pair of pliers while soldering them, it would be a good idea to wrap an alcohol-soaked cotton wad



Rear instrument panel holds both batteries B1, B2. B1 consists of three D-size cells connected in series. Remember to connect both B1, B2 negative leads to minus bus.

around the transistors as you apply heat to their leads. No special precautions are needed when soldering the IC socket to the push-in terminals.

Tackling the front panel next, drill 5⁄16-in. holes for jacks J1 and J2, touching up the holes with a round file. Next, drill holes for R1, R2, S1, and S2.

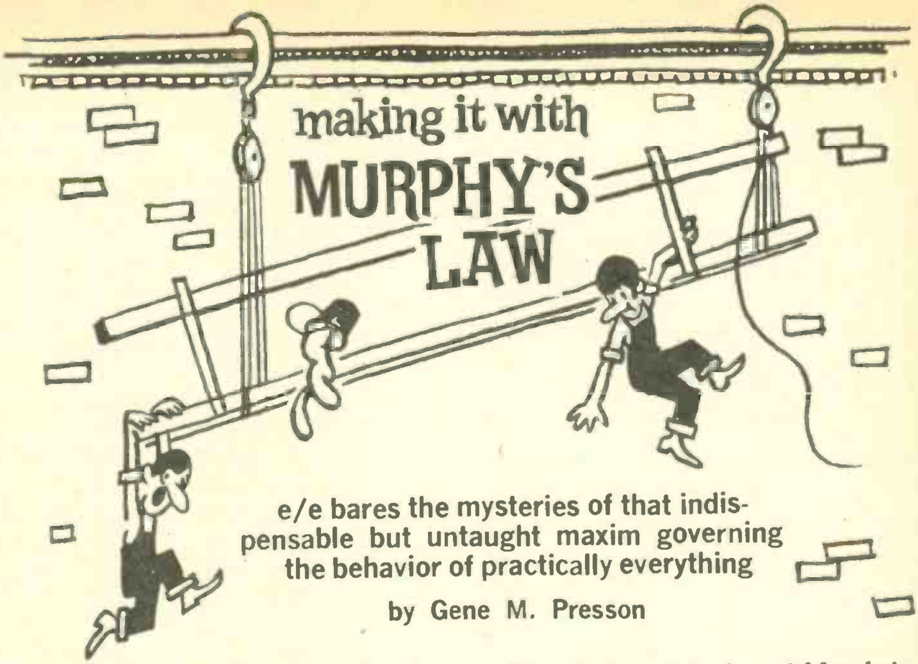
Spare parts box depletion is a perfectly acceptable way to scrounge up these various control elements. For instance, you can get away without a separate S2 if you can dig up an old 3-pole, 6-position rotary switch. Two of the poles are substituted for each half of S2 while the third pole retains its original capacitor selector function.

Another acceptable switch alternate substitutes a 1000-ohm IRC Q Control pot (Q11-108) for the Mallory U4 called for in the Parts List. Attach an IRC Q Control dpst switch (IRC #76-2) to the rear of the pot and, presto, another good idea invades your workbench! These substitutes are mentioned because some members of the Order are too lazy to drill and properly dress a third hole for S2.

Take a breather. Check your efforts for the usual bugaboo-boos—cold solder joints,

(Continued on page 98)

making it with MURPHY'S LAW



e/e bares the mysteries of that indispensable but untaught maxim governing the behavior of practically everything

by Gene M. Presson

IN TODAY's institutes of higher education, students learn Ohm's Law, Kirchhoff's Law, and other engineering and technical necessities. However, a more basic and infinitely more important law is never mentioned. Everyone at one time or another encounters Murphy's Law or one of its corollaries. Often these encounters are quite shocking and leave the victim bewildered. The purpose of this article is to prepare the younger readers for future encounters and to show them that they will not be alone.

J. Edsel Murphy and his contributions have never been fully appreciated. A victim of his own Law, Murphy was destined for a place in the engineering Hall of Fame when something went wrong. The mere discovery of the Law which bears his name was not his most important contribution, but more important was its impact and universal application. The Law itself, though basically simple, has formed a foundation on which future generations will build. It has been reported that Murphy's Law, in all its simplicity, first came to him when his bride-to-be informed him of the forthcoming birth of an heir to the family estate.

Murphy's Law, as first recorded, states "If anything can go wrong, it will." Expressed in more exact mathematical form this would be: $1 + 1 \approx 2$
where $\approx$ is the mathematical symbol for hardly ever is.

First known expansion of Murphy's Law occurred when H. Snizel stated, "If anything can go wrong, it will—during the demonstration."

The following examples, collected through personal experience and conversations with various associates, are presented with a twofold purpose: first, to show the wide-ranging nature of Murphy's work, and second, to provide the reader with a greater appreciation of Edsel Murphy, his Law, and its importance.

In the Area of Mathematics

1. All constants are variables.
2. Any error that can creep in, will.
3. A decimal will always be misplaced.
4. In any miscalculation, if more than one person is involved, the fault will never be placed.
5. In a complex calculation, one factor from the denominator will always move into the numerator.
6. Any error that does occur will be in the direction that will cause the greatest error.
7. In any set of calculations, the figure that is most obviously correct will be wrong.

General Engineering Principles

1. An important instruction manual or operating manual will have been lost or misplaced.
2. Original drawings will be destroyed by the copying machine.

3. Dimensions will always be expressed in the least usable terms. For example, furlongs per fortnight would denote velocity.
4. All warranty and guarantee statements become void upon payment of invoice.
5. The less important a change of design appears, the more its influence will be felt.
6. The closer a system is to completion, the greater the necessity of making a major change.

Specifications and Dollars

1. Cost of equipment will exceed any given estimate by a factor of 2.8, or more.
2. Budgets and labor timetables, which have been set as the result of practical experience, will be exceeded.
3. Manufacturers' specification sheets will be incorrect by a factor of 0.6 or 2.5, depending upon which multiplier gives the most optimistic value.
4. Salesmen's claims on estimated costs will be incorrect by factors of 0.1 or 10.0.
5. Specified environmental conditions will always be exceeded.
6. In any instrument which is characterized by a number of plus-or-minus errors, the total error will be the sum of all errors adding in the same direction—cancellation of errors does not occur.

In the Shop

1. A dropped tool will land where it will do the most damage. (This is sometimes known as the Law of Selective Gravitation.)
2. After an instrument has been fully assembled, extra components will be found on the bench.
3. If a particular resistance is needed, that value will not be available. In addition, it cannot be developed with any parallel or series combination of available resistors.
4. Identical units, which have been tested under identical conditions, will not be identical in actual use.
5. The more delicate the component, the greater the probability that it will be dropped.
6. Interchangeable parts won't.
7. That which should amplify will oscillate, and that which should oscillate will only amplify.
8. A fail-safe circuit will destroy others.
9. A pnp transistor will be npn.
10. Any transistor which is protected by a fast-acting fuse will protect the fuse by blowing first.
11. After the last of 35 mounting screws has been removed from an access cover, it will be discovered that the wrong cover has been removed.
12. After an access cover has been secured by the last of 35 holddown screws, it will be discovered that the gasket has been left out.
13. Any wire which has been cut to premeasured length will be too short.
14. The possibility that a dimension will be omitted from a drawing is directly proportional to its importance.
15. If N components are needed for a project, there will be N–1 units in stock.
16. A failure will not appear until a unit passes final inspection.
17. The probability of failure of a component or assembly is inversely proportional to its ease of repair or replacement.
18. Any device randomly selected from a group having 99% reliability will be a member of the 1% group.
19. Any carton thrown away before assembly is guaranteed to contain at least two essential parts.

Additional examples were to be included with the preceding list, but in accordance with Murphy's Law, the notes and references have been misplaced. These will invariably be found after the article has gone to press. ■

by Joseph J. Carr K4IPV

TEENY GENII

Won't let you forget to turn off the lights or ignition—saves your battery.

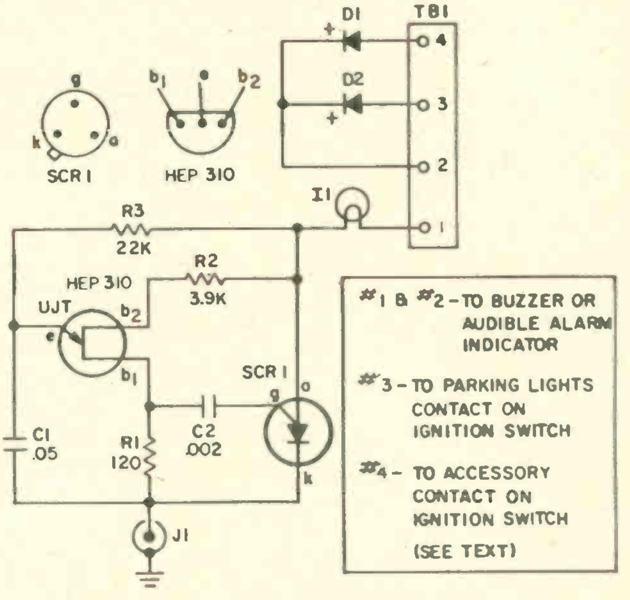
Do you curse every time the battery in your car runs down because the stupid dolt who was driving (most probably that's you) forgot to turn off the lights before dashing for the train early in the morning? Not everyone is fortunate enough to have a fairy godmother who turns 'em off for you when this happens.

But, *you can overcome* by building our Teeny Genii. Once it's installed, every time you open the car door in preparation for your dash to the station, a buzzer sounds if you forget to turn off the lights, be they parking or headlights. Or, you may leave the key in the ignition switch and the switch turned *on* in your rush to reach the platform. Makes no difference—Teeny Genii will warn you of that, too.

Best of all, you don't have to deplete the bank account or go into hock to buy a new car that's factory-equipped with such a device. For just a few dollars and about one evening's time you can build Teeny Genii and have it ready to install in your vintage model.

How Genii Functions. Since the majority of cars now have the negative side of the battery grounded, Teeny Genii has been designed for this kind of a car battery polarity. Unijunction transistor (UJT) Q1 is a relaxation oscillator pulse generator. Its operating frequency is determined by the time constant of the RC (resistor-capacitor) network C1/R3. Resistor R1 charges capacitor C1 until there is sufficient voltage to *break down* the emitter-base 1, base 2 junction of Q1. When this occurs Q1 conducts heavily, discharging capacitor C1, at which time the charge cycle starts all over again. Thus an output pulse is produced every time the charge on C1 reaches the breakdown voltage of the UJT. The RC combination we used produces pulses at a 1-kHz rate, approximately.

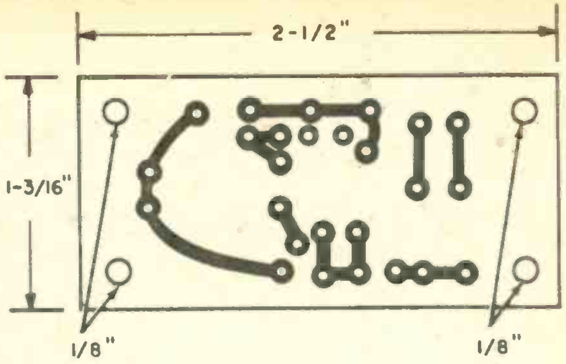
These pulses are coupled to the gate of the silicon-controlled rectifier (SCR1) via capacitor C2. SCR1 turns *on* whenever a



PARTS LIST FOR TEENY GENII

C1 0.05-uF, 75-V ceramic disc capacitor (Lafayette 33E69071 or equiv.)
C2 0.002-uF, 75-V ceramic disc capacitor (Lafayette 33E69030 or equiv.)
D1, D2 1A, 50-PIV silicon diode, Motorola HEP 154 (Lafayette 19E54379 or equiv.)
I1 Indicator lamp and holder (Lafayette 32E66160 for lamp, 99E63414 for holder, or equiv.)
J1 Shielded phono jack, RCA type (Lafayette 99E62341 or equiv.)
R1 120-ohm, ½-watt resistor
R2 3900-ohm, ½-watt resistor
R3 22,000-ohm, ½-watt resistor
SCR1 1-A, 500-PIV silicon controlled rectifier, Motorola MCR 1906-2
TB1 4-point barrier strip (Lafayette 33E86042 or equiv.)
UJT Silicon unijunction transistor, Motorola HEP 310
1 4 x 2⅛ x 1⅝-in. minibox (Lafayette 12E83696 or equiv.)
Misc. Bolts, nuts, spacers, wire, solder, 2½ x 1 3/16-in. circuit board (copper clad one side only to make printed circuit card, if hard wired use perfboard), push-in pins, solder lugs, etc.
Note: For instructions on making printed circuit card see Touchdown Twin Hailer in September/October 1969 issue of ELEMENTARY ELECTRONICS.

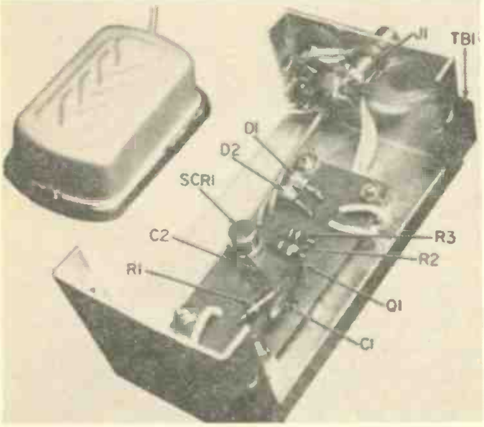
If you want to make a professional looking job of it here's a full-sized printed-circuit board layout. Place a piece of carbon paper between copper laminated plastic board and this pattern to trace circuit for etching. Parts List has reference data on where to find etching instructions. You can, of course, use perf board and hard wire between components if etching isn't your thing.



pulse is applied to the gate, and remains *on* until the flow of current across the cathode/anode junction is interrupted.

Diodes D1 and D2 isolate the headlight and ignition switch auxiliary circuits, either one of which can trigger the audible alarm. Whenever the door opens, the dome or other interior light circuit is energized and Teeny Genii is triggered, should either parking lights or headlamps or the ignition be left turned *on*.

The door light switch that turns *on* the dome and/or other interior lights by grounding their return side, activates Teeny Genii by grounding it. This switch, located in the front pillar of the door frame along side the driver's seat, is *normally open* when the door is closed and *normally closed* when the car door is opened. Thus when the car door is closed the ground return side of the interior lamps is not connected to ground, the lamps are not lit, and so, no current flows in the line.



How Teeny Genii's innards are oriented to conserve space. Separate buzzer helps in locating both under crowded dashboard.

On most cars the ignition switch energizes accessories (e.g. heater, defroster, radio, air conditioner) whenever it is turned *on* to keep the engine running. It will also turn *on* these accessories with the engine turned *off* when the switch is turned to the accessory position.

The door switch is connected to Teeny Genii by a single conductor via the RCA type phono jack J1 and plug P1. Parking lights and accessory ignition switch leads are connected to it via TB1. Teeny Genii won't draw any current from the car battery unless it's triggered by the opening of the driver's door, provided he has left the lights turned *on* or has left the ignition switch turned *on*.

Be a Genii Maker. We mounted Teeny Genii in a 4 x 2⅛ x 1⅝-in. minibox. This gives you plenty of room to hook up all of the components and the printed circuit board mounted within the minibox. This is a very stable unit and therefore, except for good wiring practices, it can take any form you find most suitable to fit your car. For those who can accommodate the size box we used, we've included detailed photos and a printed circuit board layout. You may prefer using a small plastic box instead of the minibox—in which event you're on your own for a layout. If you should decide on using a plastic box, be sure the common ground of the circuit is connected to the car frame.

We used an ordinary door buzzer designed for 6-volt operation. Since the car battery has 12-volt output, some protection against overheating the buzzer coil is required, because of the excess voltage. We used a 6-volt lamp in series with the buzzer, which serves a dual function. In addition to dropping the battery voltage, the lamp will light when-

(Continued on page 98)

YIPES! IT HIKES!

Didja ever see a suitcase walking? "Well I did!" confessed a passerby as Louis Montilla's electronically controlled suitcase strolled by under the expert guidance of Miss C. C. Ruku. A TV comedienne, C. C. actually demonstrated the suitcase of the future. Battery-powered and radio-controlled, Mr. Montilla's hiking suitcase weighs about 15 lb prior to packing and is expected to sell for perhaps 25% less than its non-hiking counterpart. Word is that it'll be replacing Redcaps, who seem to have gone the way of all hens' teeth, anyhoo. ■

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

PART 5
UNDERSTANDING ALTERNATING CURRENTS

What You Will Learn: In this unit you will learn how Alternating Current is generated. When you have finished you will also be able to recognize and describe different types of Alternating Current (AC) waveforms. A good understanding of the material in this installment prepares you for elementary AC circuit analysis and computation.

ALTERNATING CURRENT SOURCES

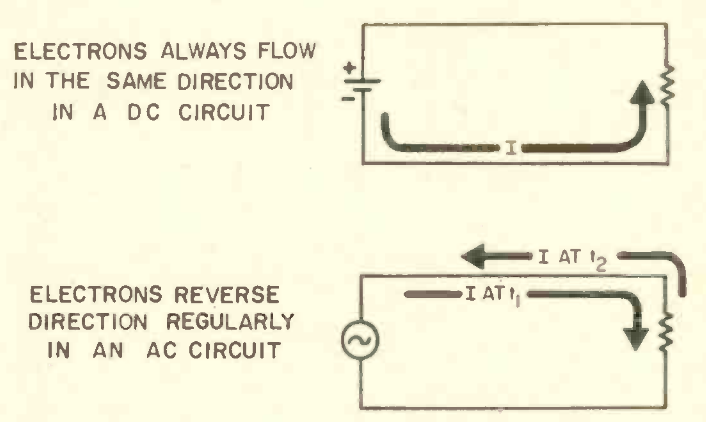
How does alternating current differ from direct current? The electrons in direct current always flow in the same direction. Electrons in an alternating current reverse directions at periodic intervals. The AC brought into your home is generated in a *power*

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

plant where it's produced in very large quantities. The characteristic of AC to change direction enables us to easily increase or decrease the value of an AC voltage by passing it through a transformer.

For example, when it's necessary to transmit electricity over great distances (from the power plant to a city miles away), the power-plant voltage is increased by transformers to a very high value (such as 69,000 volts) and sent through relatively small diameter transmission lines. If the AC were sent at the power-plant voltage, the diameter of each

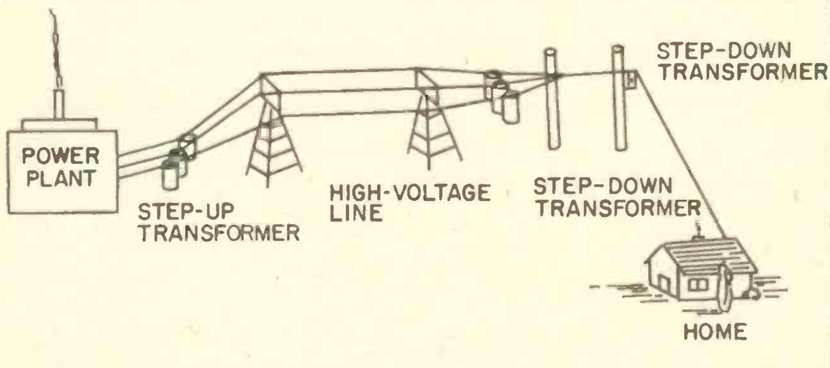
Direct Current vs. Alternating Current Flow



transmission line would have to be much larger. Transmitting generated AC at a lower voltage means a higher current will have to flow in the wires. Thus, larger diameter (and more expensive) lines from the power plant to the user would be required. The AC is reduced by transformers at the city end of the transmission line, and then still further reduced to 240 or 120 volts by another transformer near the home or factory.

Another source of AC is the *oscillator*. Designed mainly for professional application in a laboratory or shop, oscillators primarily serve as highly accurate signal sources in electronic equipment.

AC can be Transmitted Long Distances at Low Cost



ALTERNATING CURRENT APPLICATIONS

Large amounts of alternating current are used in homes for illumination, heating, cooking, and the operation of appliances. In industry, alternating current is used to operate motors and for many other applications.

Q1. The electricity used in homes is produced by generators in power plants. Power plants are one important - - - - - of AC.

Q2. Name the most common kind of current used for lighting.

Q3. It is difficult and expensive to transmit DC current over long distances, or to raise or lower DC voltage. State two advantages of alternating current.

Your Answers Should Be:

A1. The electricity used in homes is produced by generators in power plants. Power plants are one important source of AC.

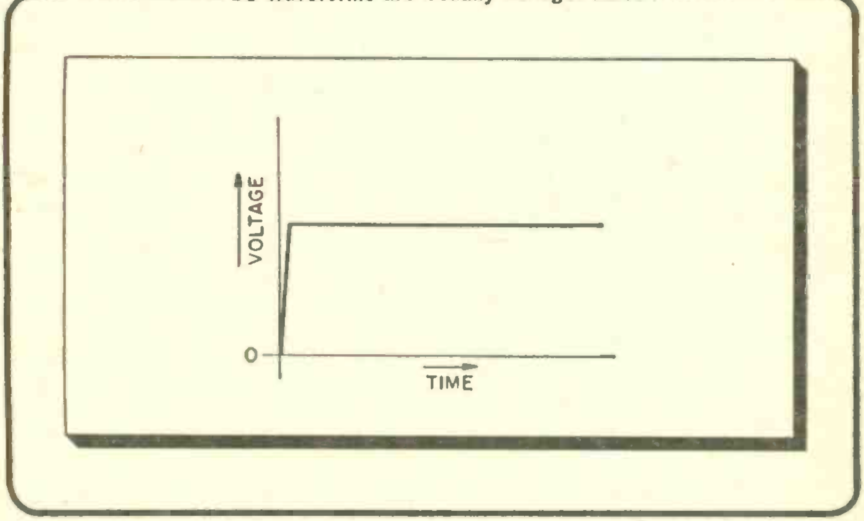
A2. The most common kind of current used for lighting is AC.

A3. Two advantages of alternating current are: **It is less expensive and easier to transmit over long distances.**

WAVEFORMS

Waveforms are pictures showing how currents and voltages change over a period of time. The value of voltage or current is usually represented in the vertical direction, while time is represented in the horizontal direction. If the observed waveform passes

DC Waveforms are Usually Straight Lines



through the horizontal (or "time") axis, and exhibits a mirror-image symmetry on both sides of this axis, then we're looking at an AC waveform. DC waveforms, on the other hand, appear only on one side of the time axis. For example, the illustration above shows that most DC waveforms are straight lines.

Pulsating DC voltages may have various shapes, but the two most common types are shown at the top of page 90. *(Continued on page 90)*

8 New Action-Packed Kits From Heath —

NEW Heathkit "Spectre" ⅛ Scale R/C Car
Join The Most Exciting New Hobby In America . . .

building and racing radio-controlled Grand Prix cars up to scale speeds of 200 mph. The Heathkit "Spectre" R/C car reaches that speed and has already proven itself a winner. And no wonder; its design is unique. It has a chrome plated steel chassis, adjustable caster and toe-in, specially formulated rubber tires that lock onto the cast nylon wheels, independent front suspension for excellent cornering and a 5.5:1 gear ratio for maximum torque at all speeds. The snap on, ⅛ scale car body (length: 19¾") is of high impact plastic — almost indestructable. Suspension is by real coil springs. The radio equipment compartment is dirt and oil proof. The Heathkit "Spectre" is the only complete car kit available. You get the body, chassis, wheels & tires, 4 oz. fuel tank & tubing, equipment case & protective foam, centrifugal clutch & gears, axles, servo linkages & mounting tape, all hardware, decals, numbers and a comprehensive manual. The "Spectre" accepts any .15 to .23 cubic inch R/C engine and any proportional R/C electronics system. It requires only two servos to operate the steering, brake and throttle. Get in on all the thrills of R/C car racing at the lowest possible price . . . order a Heathkit "Spectre".

Kit GD-101, R/C car only, 8 lbs. **$49.95***
Assembled GDA-101-1, Veco .19 R/C engine, 1 lb. **$19.95***

NEW Heathkit 3-Channel Digital Proportional R/C System
For Planes, Gliders, Cars And Boats

Ideal for use with the new Heathkit "Spectre" R/C car to give you total control . . . ease of handling. Here's what the Heathkit GD-57 R/C system includes: Transmitter with assembled, factory aligned RF circuitry; new 2 oz. miniature receiver that needs no IF alignment, in a tough nylon case; you also get two servos; all plugs; connectors; cables; charging cord; new flat-pack rechargeable nickel-cadmium transmitter and receiver batteries . . . and a special soldering iron. You can have your choice of five operating frequencies in each of three bands . . . 27, 53 or 72 MHz. This is the most value ever offered in a 3-channel rig.

Kit GD-57, transmitter, receiver, 2 servos, batteries, charging cord, switches and soldering iron, (specify freq. desired), 11 lbs. **$129.95***
Kit GDA-57-1, transmitter, battery, charging cord, (specify freq. desired), 5 lbs. **$54.95***
Kit GDA-57-2, receiver only, (specify freq.), 1 lb. **$34.95***

NEW Heathkit Siren/PA
For Licensed Emergency Vehicle Only

Hey Chief! Save up to 60% on a new electronic siren/PA system by ordering the low cost Heathkit GD-18. The siren gives both "wail" and "yelp" warnings at 55 watts output power, and you can adjust the pitch. As a public address it will amplify your voice with a full 20 watts of power, and it's practically immune to acoustical feedback. (Either PA or siren can be interrupted to use the other.) Incoming radio calls can be channeled through the GD-18 so you can hear them when away from your vehicle. Use it on any 12-volt auto electrical system with either positive or negative frame ground. It will operate from -20° to 150° F conditions. Control panel is lighted. Comes with gimbal bracket mounting. Take your choice of speakers . . . concealed or exposed.

Kit GD-18, Siren/PA Amplifier, 7 lbs. **$54.95***
Assembled GDA-18-1, Exterior Horn, 9 lbs. **$49.95***
Assembled GDA-18-2, Concealed Horn, 4½ x 4½ x 13", 9 lbs. **$49.95***
System GD-18A, (includes GD-18 plus exterior horn), 16 lbs. **$99.95***
System GD-18B, (includes GD-18 plus concealed horn), 16 lbs. . . . **$99.95***

NEW Heathkit Solid-State Portable Fish Spotter

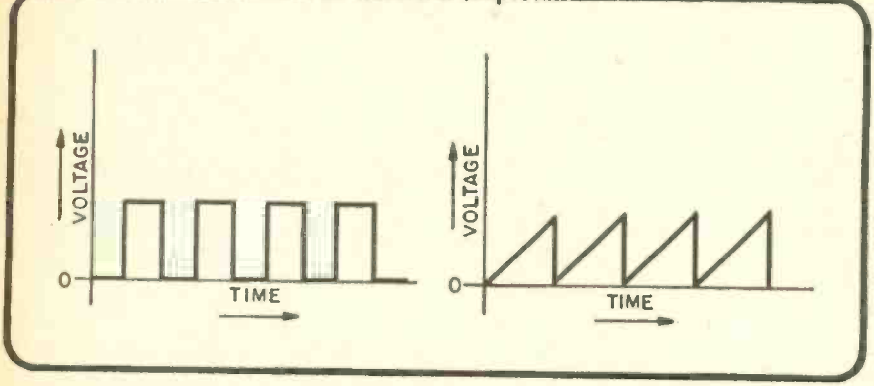
Costs half as much as comparable performers. Probes to 200 ft. Doubles as depth sounder. Transducer mounts anywhere on suction cup bracket. Adjustable Sensitivity Control. Exclusive Noise-Rejection Control stops ignition noise. Runs for 80 hrs. on two 6 VDC lantern batteries (not included). Manual explains typical dial readings. Get set for next season; order your Heathkit MI-29 today.

Kit MI-29, 9 lbs. **$84.95***

e/e Basic Course

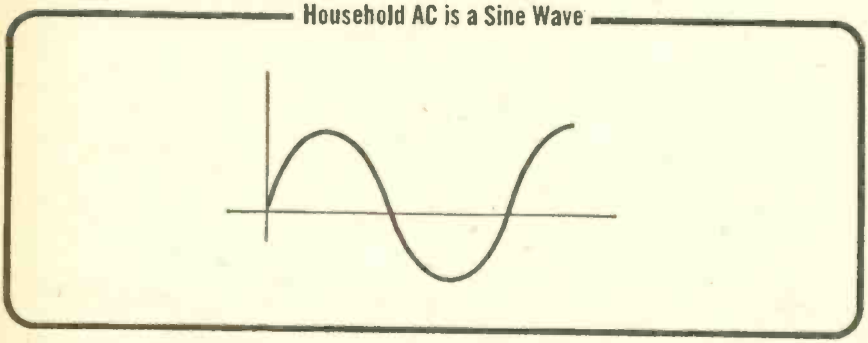
(Continued from page 85)

DC Waveform Shapes

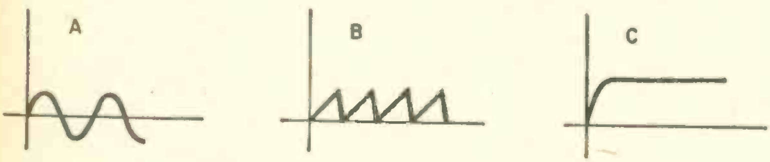


By far the most common AC waveform is the sine wave. In fact, the sine wave is so widely used that when we think of AC, we automatically think of sine waves.

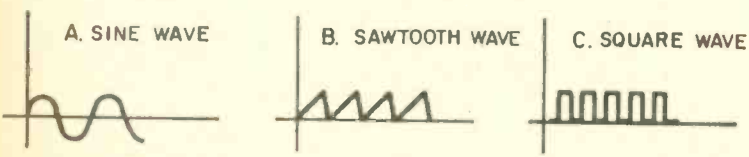
Household AC is a Sine Wave



Q4. A waveform is a picture of how currents or voltages change over a period of time. DC waveforms look like which of the following?



Q5. AC currents and voltages usually change regularly in a smoothly curved form. Which of the following is the AC waveform?



Q6. The most common DC waveform is a - - - - - - - -.
The most common AC waveform is a - - - - -.

Your Answers Should Be:
A4. The DC waveforms are (c), a straight line, and (b), a sawtooth DC voltage.
A5. The AC waveform is (a), a sine wave.
A6. The most common DC waveform is a straight line.
The most common AC waveform is a sine wave.

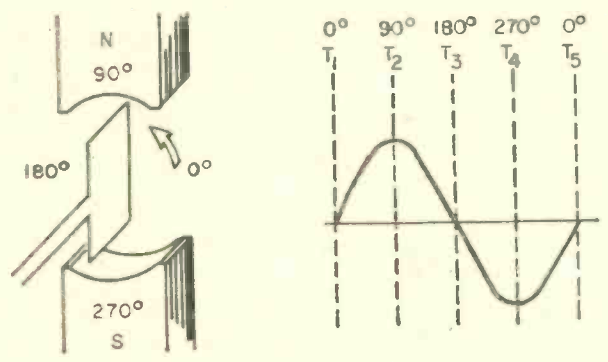
GENERATION OF A SINE WAVE

You can visualize how a sine wave is generated by looking at the illustration below. As a rotating coil cuts the lines of force between two magnetic poles, a current is produced that will flow if the coil is connected to a complete circuit. As the coil rotates at a constant speed, it cuts more and more lines of force in the magnetic field, and the current increases. At 90° it is moving at right angles to the lines of force, so it cuts the maximum number of lines per second. Therefore current is maximum.

At 180° (and at 0°) the coil is moving parallel to the lines of force, and therefore cutting none. Thus, the current generated is zero. Beyond 180° the coil is cutting lines of force in the opposite direction, so the generated current has the opposite polarity—negative in this case. The output waveform of the illustrated generator is a sine wave.

Imagine a line like the hand of a clock. This line is called a voltage vector. A voltage

Rotating Coil can Create a Sine Wave



vector rotates counterclockwise through the full 360° of a circle. The distance measured from the arrow-head end of the voltage vector to the base line at any time during the rotation of the vector represents the exact value of voltage at that instant. As you can see on the following page, the value of voltage is zero at 0° and 180°. At 90° the value of voltage is maximum positive, and at 270° it is maximum negative.

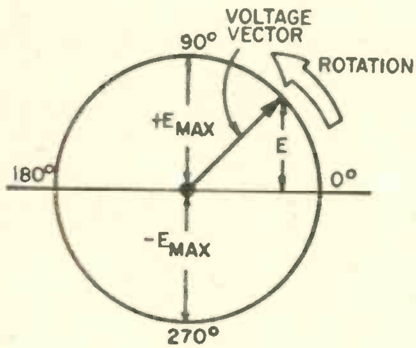
One complete cycle of a sine wave (from zero to a positive peak, down to a negative peak, and back to zero) simply represents one complete rotation of the voltage vector.

The simple sine wave is the building block from which all AC waveforms are constructed. Even sawtooth and square waves are really just complicated combinations of simple sine waves.

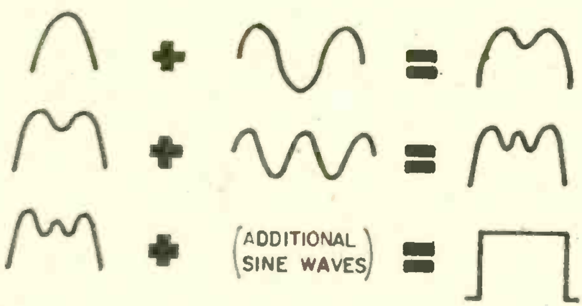
Q7. A sine wave represents the rotation of a line called a voltage - - - - - -.
Q8. With the right mixture of sine waves, can square waves be made?

Your Answers Should Be:
A7. A sine wave represents the rotation of a line called a voltage vector.
A8. Any kind of AC waveform can be made with the right mixture of sine waves.

Rotating Vector Represents a Sine Wave



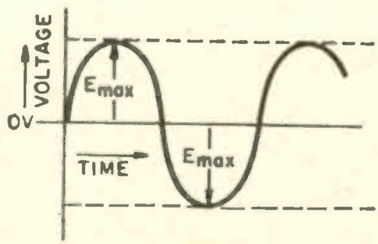
Many Sine Waves make a Square Wave



SINE-WAVE MEASUREMENT

In a previous part of this course you learned that DC voltage has only one value. This value is measured in volts. In AC, however, the voltage is constantly changing. Looking at a sine wave you can see that it reaches a certain peak. That value is known as maxi-

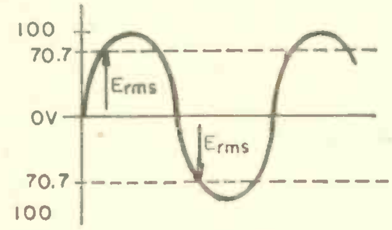
Sine-Wave Voltage Reaches a Peak Value



mum voltage, or peak voltage (E_{max}). Notice that the waveform has the same shape and value both above and below the zero line.

A more practical value of AC voltage and current is the **rms** value (rms stands for root-mean-square). The rms value is the actual "working value" of a voltage or current.

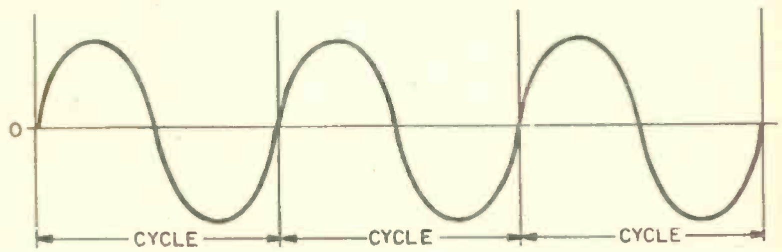
RMS Voltage is the Working Voltage



The current and voltage value most often used is rms. In fact, the standard household voltage of 117 volts is the rms value. An rms voltage of 117 volts corresponds to a peak voltage of 165.4 volts. In all sine waves the rms value is equal to 0.707 of the peak value. Conversely, the peak value is equal to 1.41 times the rms value.

You have seen how AC voltage first increases in value to a peak value, then decreases to zero, increases to a negative peak value, and then returns to zero. This sequence is known as a **cycle.** The cycle is normally repeated many times each second and is identical in waveform with the one before it and the one following it.

Sine-Wave Cycles are Normally Identical



Q9. Another name for peak voltage is - - - - - - - - - - - - -.
Q10. Rms is the working value of voltage. Which is less, rms or peak voltage?
Q11. Maximum voltage is also called - - - - - - - - - - -.
Q12. Working voltage is called - - - - - - - - - -.
Q13. The symbol for maximum voltage is E_{max}. The symbol for rms voltage is - - - -.
Q14. Rms voltage is 0.707 times peak voltage. If peak voltage is 100, rms voltage is ______.
Q15. Peak voltage is 1.41 times rms voltage. That is, if rms voltage is 100, peak voltage is ______.
Q16. To change rms voltage to peak voltage (which is larger), multiply by ______. To change peak voltage to rms voltage, multiply by ______.
Q17. To give a complete picture of how an AC voltage (or current) changes, a waveform diagram must show at least - - - - complete cycle(s).

Your Answers Should Be:

A9. Another name for peak voltage is maximum voltage.

A10. Rms is the working value of voltage. Rms is less than peak voltage.

A11. Maximum voltage is also called peak voltage.

A12. Working voltage is called rms voltage.

A13. The symbol for maximum voltage is E_{max}. The symbol for rms voltage is E_{rms}.

A14. Rms voltage is 0.707 times peak voltage. If peak voltage is 100, rms voltage is 70.7.

A15. Peak voltage is 1.41 times rms voltage. That is, if rms voltage is 100, peak voltage is 141.

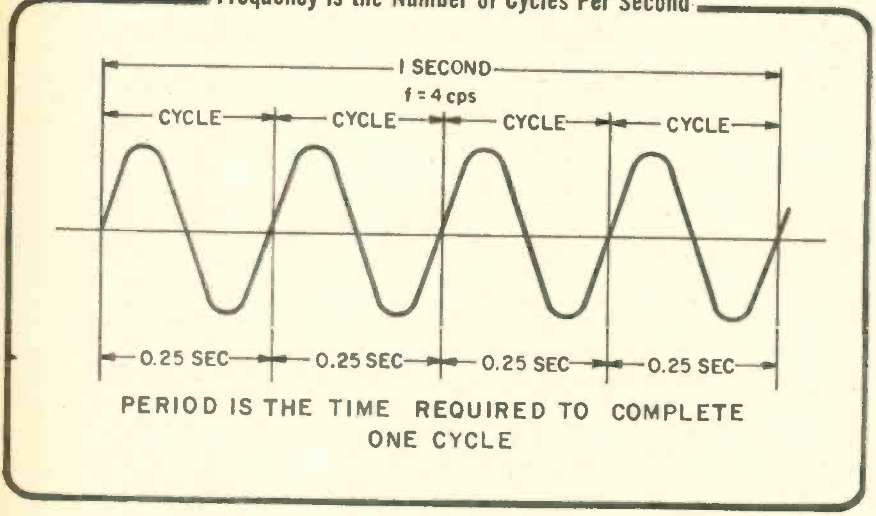
A16. To change rms voltage to peak voltage (which is larger), multiply by 1.41. To change peak voltage to rms voltage, multiply by 0.707.

A17. To give a complete picture of how an AC voltage (or current) changes, a waveform diagram must show at least one complete cycle.

Frequency

It is sometimes necessary to know how many times a cycle is repeated each second. The number of cycles completed each second by a given AC voltage is called the **frequency.**

Frequency is the Number of Cycles Per Second



Frequency is measured in **Hertz (Hz).** The symbol for frequency is **f.** The most common type of current (household current) has a frequency of 60 Hz in most localities.

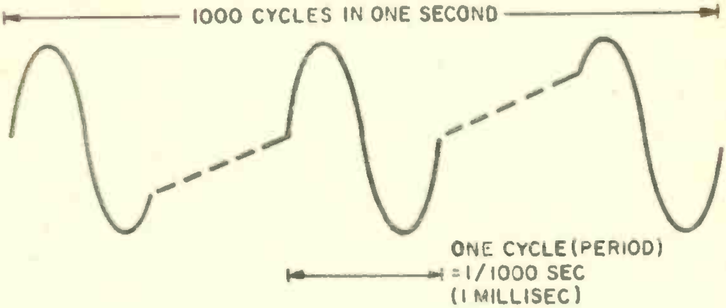
The time required for one cycle is called a **period.** A period is measured in **seconds, milliseconds,** or **microseconds.** A millisecond is 1/1000 of a second, and a microsecond is 1/1,000,000 of a second. Since household electricity has a frequency of 60 Hz, its period is 1/60 of a second, or 0.0167 second. This time can also be expressed as 16.7 milliseconds.

The period of a sine wave represents the time needed for the voltage vector to make one complete rotation. The frequency of a sine wave depends on how rapidly the voltage vector rotates.

Q18. The - - - - - - - - - of household current is 60 Hz.

Q19. Frequency is usually measured in - - - - - -.

Period is a Measure of Time



Q20. If the frequency of a voltage is 60 Hz, how would you find its period?
Q21. How many milliseconds are there in a second?
How many microseconds are there in a millisecond?
Q22. If the frequency of an AC voltage is 1 million Hertz, state its period in the most convenient unit.
Q23. In a certain sine wave the rms voltage is 20 volts. What is the peak voltage?
Q24. A sine wave has a peak value of 70.7 volts. What is the effective (rms) voltage?
Q25. If a current has a frequency of 100 Hz, what is the period of one cycle? Give two answers—one in seconds and one in milliseconds.

Your Answers Should Be:
A18. The frequency of household current is 60 Hz.
A19. Frequency is usually measured in Hertz.
A20. Divide 1 second by 60 cycles. Thus the period of a 60-cps current is 1/60 of a second, or 0.0167 second.
A21. There are 1000 milliseconds in a second, and 1000 microseconds in a millisecond.
A22. 1 microsecond.
A23. $20V_{rms} \times 1.41 = 28.2V_{max}$
A24. $70.7V_{max} \times 0.707 = 50V_{rms}$
A25. 0.01 second, or 10 milliseconds.

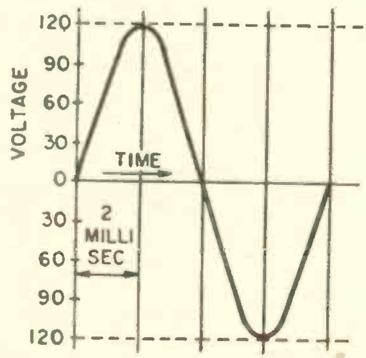
PULSES

You have been introduced to the definition and methods of AC pulse generation. In modern electronics, considerable use is made of these pulses. In the following paragraphs you will see two practical applications.

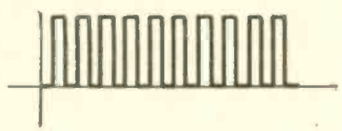
A radar set sends a pulse of energy speeding into space. Traveling at the speed of light, the pulse hits an object (an airplane, for instance) and is reflected back to the set. By measuring the time it takes for this signal to travel to the object and return, the distance between the set and the object can be calculated.

Pulses are also found in the factory at the assembly line. For example, machines can count a series of cans moving on a conveyor belt. A light beamed at a photoelectric cell is cut every time a can goes by, and the resulting pulse is counted. Digital computers also employ various operations with pulses at very high speeds.

Q26. Look at the sine wave in the figure on the next page and write down the values for:
E_{rms} = _____ Period in second = _____ - - -
E_{max} = _____ Frequency = _____ - - -
Period = ___ - - - - - - - - - - - -



Q27. The signal from a radar set looks like this:



What type of signal does a radar set send out?

Q28. Name one characteristic that a radar set and a digital computer have in common.

Your Answers Should Be:

A26. $E_{rms} = 84.4V$ Period = 0.008 sec
$E_{max} = 120V$ Frequency = 125 Hz.
Period = 8 milliseconds

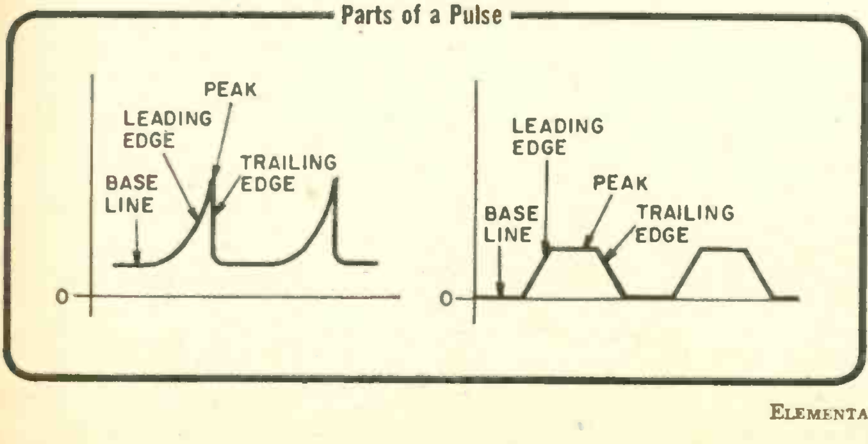
A27. A pulse signal is the type of signal a radar set sends out.

A28. One characteristic that a radar set and a digital computer have in common is that both use pulse waveforms.

PULSE MEASUREMENT

Pulses are usually described in terms of four parts—base **line, leading edge, peak,** and **trailing edge.** It is easiest to understand these parts by looking at them.

It is often necessary to know how long it takes a pulse to rise from the base line to its



Parts of a Pulse

peak (rise time) or to go from its peak value back to the base line (decay time). These times are measured between 10% and 90% of peak value.

Like AC sine waves, pulses have an rms value. The rms value of a pulse is its working value.

When pulses are repeated at a regular rate, the number of pulses per second is called the **repetition rate**.

Q29. Rise time is the time during which the pulse goes from 10% of peak to _____ of peak. During decay the pulse decreases from _____ of peak to _____.

Q30. The time required for a pulse to go from 10% to 90% of peak is called - - - - time. The same time along the trailing edge is called - - - - - time.

Q31. What is the working value of a pulse called?

Q32. The number of times a pulse is repeated per second is called its - - - - - - - - - - - - - -.

Your Answers Should Be:

A29. Rise time is the time during which the pulse goes from 10% of peak to **90%** of peak. During decay the pulse decreases from **90%** of peak to **10%**.

A30. The time required for a pulse to go from 10% of peak to 90% of peak is called **rise** time. The same time along the trailing edge is called **decay** time.

A31. The working value of a pulse is its **rms value**.

A32. The number of times a pulse is repeated per second is called its **repetition rate**.

WHAT YOU HAVE LEARNED

1. AC current changes direction regularly.
2. Most household appliances and electronic devices use AC electricity.
3. AC waveforms are usually sine waves.
4. AC is created by generators and oscillators.
5. The working voltage of an AC sine wave is the rms voltage, which is 0.707 times the peak voltage.
6. A cycle is one complete change from zero to the positive peak value, back through zero to the negative peak, and back to zero. This represents the rotation of a voltage vector around the 360° of a circle.
7. Frequency is the number of cycles generated in a second, and a period is the time it takes to complete one cycle.
8. The four main parts of a pulse waveform are the leading edge, the peak, the trailing edge and the base line.

NEXT ISSUE: Part 6—Calculating Resistance

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.

Teeny Genii

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ever a warning is triggered, thus giving both audible and visual alarms.

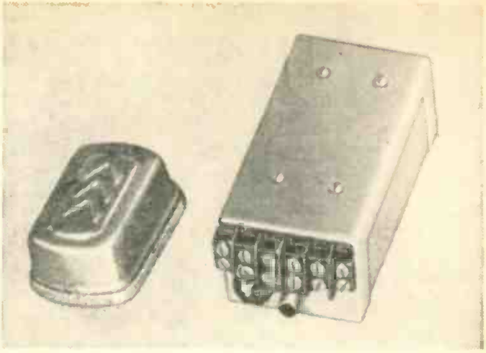
If you wish, you can use other audible warning devices in lieu of the buzzer. You may prefer either an electronic siren or a dual flasher, both of which are available in modular packages from Allied Radio, Lafayette, Radio Shack, etc., or, there's the Mallory Sonolert electronic audible signal device.

The buzzer will draw nearly 1 amp at 6 V so that you will need an SCR rated at 1 amp/50 V or more. The electronic devices require much less current, of course, so that an SCR having lower current rating can be used.

Checking It. If you have a source of 12 VDC on your bench, such as an extra 12-V storage battery, or a 12-V power supply, or two 6-V lantern batteries that can be connected in series, it will be much easier to check out your Genii on the bench before installing it. Just connect the minus side of the DC source to the case or ground of Genii, and the plus side to either terminal 3 or 4 of TB1. Connect the audible device you have selected to terminals 1 and 2 of TB1.

Momentarily touch a jumper wire run from the ground of Genii to the center conductor of J1. If you've done a good construction job the alarm will be triggered and be stopped only by interrupting the DC source. Repeat the process several times to be sure your unit is functioning OK and then you're ready to install it in the car.

Installing Teeny Genii. Because so many gadgets are crowded behind the dashboard it's difficult to reach the parking light and ignition switches. Don't despair—there's an easier way. Just locate the fuse block and



This is how teeny Genii can be! Box size isn't critical so long as parts fit in it.

make your connections at the block. In all probability you'll find a fuse marked either *Parking, P.L.,* or *Tail Lights;* and another marked *Accessory, Radio, Heater,* or some other accessory item that is energized by turning *on* the ignition switch. Connect terminal 4 of TB1 to the fuse (either side will do) for the parking lights and terminal 3 to the fuse for accessories. If you use a metal box to house Teeny Genii, as we did, make certain that the box is grounded to the car's frame. If you use a plastic box, be sure to connect Teeny Genii's ground to the car body or frame. Teeny Genii can be mounted on the firewall, under or behind the dash, or in any available spot near the driver's seat.

Now to make sure your installation procedure is correct, turn *on* the lights and then open the door. Teeny Genii should sound off until either the lights are turned *off*, or the door is closed. Then turn *on* the ignition switch and open the driver's door. Once again Teeny Genii should sound off. Now that you've completed the installation, you need never worry about a run-down battery because you rushed out of your car and forgot to turn *off* the lights or the ignition. Teeny Genii won't let you forget! ■

Rise Time Special

Continued from page 76

reversed transistor leads, and other construction traumas. One of the least sought after experiences in a hobbyist's life appears as the all-buttoned-up-flick-the-switch . . . NUTS!—nothing happens syndrome. If you're reasonably sure that the wiring is AOK, then it's alright to proceed into the home stretch.

Mount the battery holders to the cabinet rear plate and make the necessary circuit connections. Again, spare parts box exploration can pay off. Finish the innards construction by mounting the circuit board, pots, jacks, and switches to the front panel and solder the necessary interconnections between these components.

Calibrating and labeling Rise Time Special is like taking lollies from a baby. First, treat the multiplier switch to instant lettering. Note that for capacitor C1 through C5 called out in the schematic, a corresponding multiplying factor exists. Label the multiplier switch area on the front panel according to these factors. Finish by labeling the output level pot and jacks.

Reading Lissajous patterns from a scope face is the easiest way to calibrate the *Frequency* control. Feed a signal from the Special into the scope's vertical input. Set the frequency calibrating source to 60 Hz (an audio oscillator or 60-Hz line source will do), and connect up to the horizontal channel. With the *Multiplier* switch in the X1 position and the *Level* control open half way, rotate the *Frequency* control until a stationary circle or ellipse appears on the scope screen. You've just found the 60-Hz frequency setting for the square-wave generator.

Continue turning the control (in either direction) until the pattern you see on the scope face stops jittering. If the new pattern looks like two or more whole circles stacked on top of one another, you're looking at an even sub-harmonic of 60 Hz (30 Hz, 20 Hz, 15 Hz, etc.) Divide 60 by the number of ellipses seen on the screen—that's your new frequency-control setting. If whole ellipses lined up in a horizontal row greet you, you're looking at harmonics of 60 Hz. This time *multiply* the number of ellipses by 60 to get the new frequency.

Remember that any frequency can serve as the reference; 60 Hz is the most convenient since it comes out of a wall socket. Merely follow the multiply/divide rules when working with these new reference frequencies. If the multiplier capacitors have reasonable tolerances, only one calibration scale will serve all multiplying factors. Otherwise, calibrate each scale. ■

Random Noise

Continued from page 8

an electric motor—but $1667.25? That's a lot of scratch for any private house.

But my troubles have only begun! The billing was made by computer, and Con Ed doesn't own a boss computer to tell the working computer he made a mistake. In fact, if Con Ed did own a boss computer, he would never fire the working computer because the boss computer would have to do all the work thereafter. So you see, my dear readers, I am in trouble. My wife jokingly suggested we pay the bill before the computer billed us for interest on the unpaid amount. My neighbor suggested that I do nothing and find out how high the bill would get before Con Ed disconnected the entire neighborhood from its service.

Not everyone can go into the wild blue with a Bunny and Koss headset—but dream!

No matter what happens, I'll keep you posted. And as a favor to me, I would like to know the troubles you've been through. For example, is there anyone out there who has received a bill larger than mine for no good reason? If so, let me know, and if possible, send me a copy of the bill. There must be some very interesting number games played by computers with consumers that everyone should know about.

For Playboys Only. Among the niceties of life that makes publisher Hugh Hefner's Big Bunny airplane a legend is its crew of Bunnies. "No," say the boys from Koss Electronics. They claim that their Koss stereophones, which allow guests to enjoy private listening of music, to be the cat's meow! Well, we leave it to the readers of ELEMENTARY ELECTRONICS to decide. Just take a gander at the photo showing one of the crew wearing the Koss model PRO-4A stereophone with customized white earcups. Our vote goes to Koss if you care to listen to music. However, if you should want to *make* music . . . **Meet Kathi!** Your Editor is one lazy fellow. He's given up CB testing to his new CB Editor, Miss Kathi Martin. Now if only the staff will do the same and let Kathi get her work done! Kathi's new column appears on page 57 of this issue with unbiased test reports on two new CB transceivers. I suggest you take a peek at this column. ■

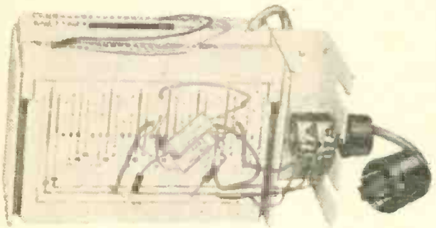
Hey, Look Me Over

Continued from page 11

dash brackets. A 4-prong connector, head cleaner, and fuse are supplied with the unit. Price of *Touch 'n Go* is $109.95; for more dope write Selectron International Co., Inc., 4215 W. 45th St., Chicago, Ill. 60632.

No Mo' Breadboardin'

Heath Company has just introduced the EU-53A Stack-n-Patch, a technique for circuit design and teaching which is faster and easier than conventional breadboarding. Stack-n-Patch consists of a desk-top chassis, a power patch card,



Heath Company Stack-n-Patch

and a component patch card. You pick your choice of power supply and connect it to the power patch card, stack the component and power patch cards in the chassis, and patch components or hookup wire into the component card. The special connectors on the cards make a tight, electrically stable connection just by inserting the wire into the connector. The 177 connectors on the component patch board are arranged according to common circuit board practice. Price of the EU-53A Stack-n-Patch is $37.50, and Heath says they've a goodly selection of power supplies to use along with it. For details write Heath Co., Dept. 139, Benton Harbor, Mich. 49022.

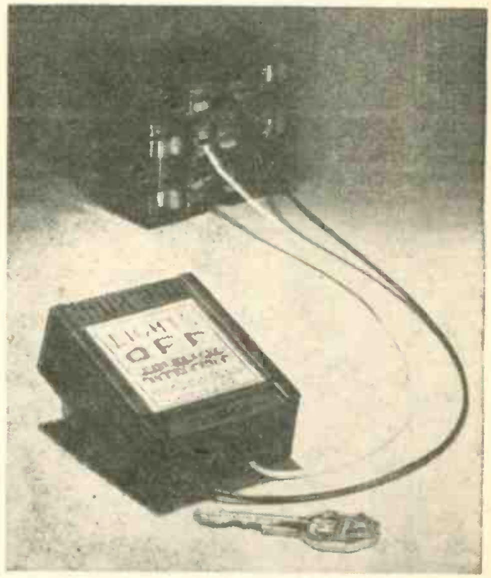
Low on Impedance

Shure Brothers have a new omnidirectional dynamic microphone, the Vocal Sphere Model 579SB. The state that its uniformly omnidirectional pickup pattern minimizes unnatural voice coloration that occurs when the speaker moves from side to side in front of the mike. Built-in wind and pop filters render the Vocal Sphere useful for intimate, close-up situations. The shock-mounted, isolated cartridge reduces mechanical noises. Price of the Vocal Sphere 579SB is $75.00. For additional information write Shure Brothers Inc., 222 Hartrey Ave., Evanston, Ill. 60204.

Shure Vocal Sphere Microphone

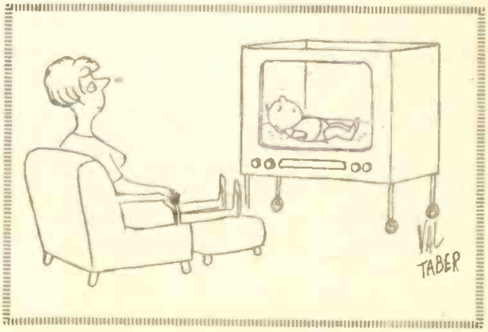
Lights Off, Everybody!

No more dead batteries from forgetting to turn off your headlights. Lights Off, from PRS Products Company, is a simple electronic monitor which requires no tools to install. The cigarette-pack size monitor is installed by pushing



PRS Lights Off Headlight Warning Monitor

two special terminals into the vehicle's fuse-block. The solid-state circuit monitors the lighting system and buzzes when lights are *on* but ignition is *off*. Fits all American car models from 1963 through 1970. With a 30-day warranty, Lights Off sells for $3.95. Write for a brochure from PRS Products Co., Box 222, Huntington Beach, Calif. 92648. ■



Tram Corsair

Continued from page 59

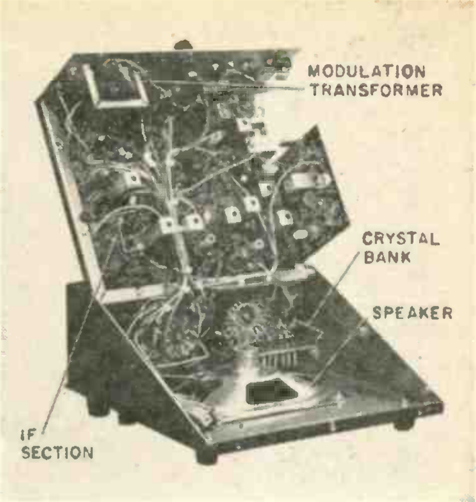
was essentially equal on both sides of center channel. This is a rare feature on super-selective receivers which generally have reduced selectivity on one side of center channel. Also, due to the FET front end, even the strongest of signals could not overload or desensitize the Tram Corsair.

Image rejection of the double-conversion Tram Corsair measured an *excellent* 74 dB.

AGC action for an input signal range of 1 to 50,000 *u*V was 12 dB—about equal to a good tube receiver but not as good as is possible with solid-state design. The squelch performance was good; it could be set to release on the minimum usable signal with a release differential of 0.5 *u*V.

The S-meter was very *hot*, indicating a 20 *u*V input signal as S9. Just about any usable signal I pulled in appeared on the S-meter as a "powerhouse." The S-unit calibration was essentially relative, with an S-unit representing a signal strength change of from 2 to 6 dB, depending on the particular section of the meter scale.

The transmitter delivered 3.8 watts RF output into 50 ohms when the Tram Corsair was powered from a 13.6 V source. The modulation system is extremely sensitive, producing essentially 100% modulation with a -36 dB input signal to the microphone—the equal of a whisper. (The so-called "average voice level" is -21 dB.) The modulation is limited to 100% on negative peaks, with the limiting accomplished by clipping the modulation. As you would expect, clipping (without filtering) creates distortion as it "squares" the waveform. With low voice levels the modulation is excellent with very low distortion.



The Corsair can flip its top just like my Dad! But here, the result is just groovy!

Summing Up. With one of the best noise limiters available, and "gold plated" receiver performance, the Tram Corsair is an outstanding performer. The price tag of $415.00 puts the Tram Corsair out of the cheapie class. However, in the dollar-value department, the Tram Corsair is a winner!

For additional information write to the Tram Corp., Dept. EE 1, Box 187, Winnisquam, N.H. 03289. ■

No-Buck Tester

Continued from page 66

tive ohmmeter probe base connected (base-collector junction test), you're looking at an npn unit. That's why the emitter and collector were arbitrarily marked—you might have to switch the *E* and *C* around in order for things to make sense.

We won't deny that this process takes a little practice. Therefore, you might want to mount a known transistor to the paper first and experiment with this unit in order to get the hang of things.

As expected, pnp units give opposite resistance readings with this method. Always remember to find the emitter and collector first, and then go ahead and make your measurements between base-emitter junction, then base-collector junction.

We've gone through a lot of work sorting out good, bad, and indifferent npn and pnp transistors. Was it worth the effort? Our most immediate test result enables us to sort the wheat from the chaff. Good transistors go in one pile, and the others sheepishly slink off to your things-I-wasted-my-money-on collection.

Those transistors with the highest base-emitter resistance ratios happily serve in RF and audio gear. Units with lower ratios perk in power supplies as pass transistors. Those pnp's squeaking along with horrible resistance ratios can be put to work in your next project requiring not-too-critical diodes. Cut off the collector lead; the emitter now serves as the new diode anode with base serving as cathode. ■

DX CENTRAL

Continued from page 18

National Radio Club, Box 99, Cambridge, Mass.)

The Courier Lives. Remember the *Courier?* If you've been in the SWL game for more than a few years, you'll recall the *Courier*, a 339-ft., 8300-ton Coast Guard cutter, as the Voice of America's Floating Flagship of Truth. From 1952 to 1964, docked at the Greek Isle of Rhodes, she beamed VOA programs throughout the Middle East and behind the Iron Curtain.

Built in 1945, she was too late to see wartime duty. So the inter-island cargo carrier was leased to private shipping lines and for seven years plowed the Caribbean as a banana boat. Meanwhile the Cold War was heating up and the government realized the need for a more

The Courier today.

flexible response to the Soviet propaganda bombardment. Transmitters which could be moved and quickly set up to beam VOA programs, with solid signals, to critical areas of the world were needed. So the almost forgotten ship was reclaimed, outfitted with a medium-wave station and two 35,000-watt shortwave transmitters, and renamed the *Courier*.

Early summer 1952 found the ship in the Panama Canal, conducting radio tests in Spanish. These brief trials gave some lucky DXers a chance, not since repeated, to log a new country—the Canal Zone. Later that year, the vessel headed for Rhodes and a 12-year broadcasting stint.

Though intended as the prototype of a new type of portable broadcasting station, the *Courier* played a lone hand. No sister ships ever joined her. Several years later the VOA changed its approach to portable relay stations and developed a series of more compact, efficient air-transportable units. These were used

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10. Extent and nature of circulation	Average no. copies each issue during preceding 12 months	Actual number of copies of single issue published nearest to filing date
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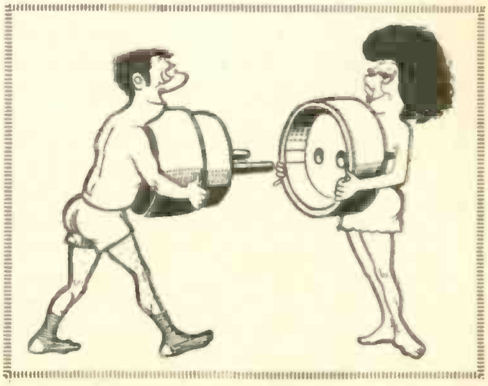
B. Paid circulation 1. Sales through dealers and carriers, street vendors and counter sales	41,510	38,000
2. Mail subscriptions	51,856	67,000
C. Total paid circulation	93,366	105,000
D. Free distribution (including samples) by mail, carrier or other means	2,858	1,470
E. Total distribution (Sum of C and D)	96,224	106,470
F. Office use, left over, unaccounted, spoiled after printing	80,507	85,290
G. Total (Sum of E & F—should equal net press run shown in A)	176,731	191,760

I certify that the statements made by me above are correct and complete. K.C. Stanila

in Florida, during the Cuban crisis, in Liberia, and currently are in the Philippines, where they are being used until permanent, high-powered facilities are completed.

In the 60s, the government decided to replace the aging ship with a shorebased station at Rhodes. In 1964, the Courier returned home, jobless, to the Coast Guard's Reserve Training Center at Yorktown, Va. For a year her fate was pondered, then, early in 1965, it was decided that she'd be ideal as a training ship. Her radio gear was removed and she now spends much of each year visiting U.S. ports, where Reservists come aboard for two weeks of port security training.

Sporting a fresh coat of white paint in place of her former gray, the *Courier* still cuts a trim figure as she visits East Coast and Great Lakes harbors. And, DXers, seeing her, may get a twinge of nostalgia as they recall the glory days of a ship that has served her country well. ■



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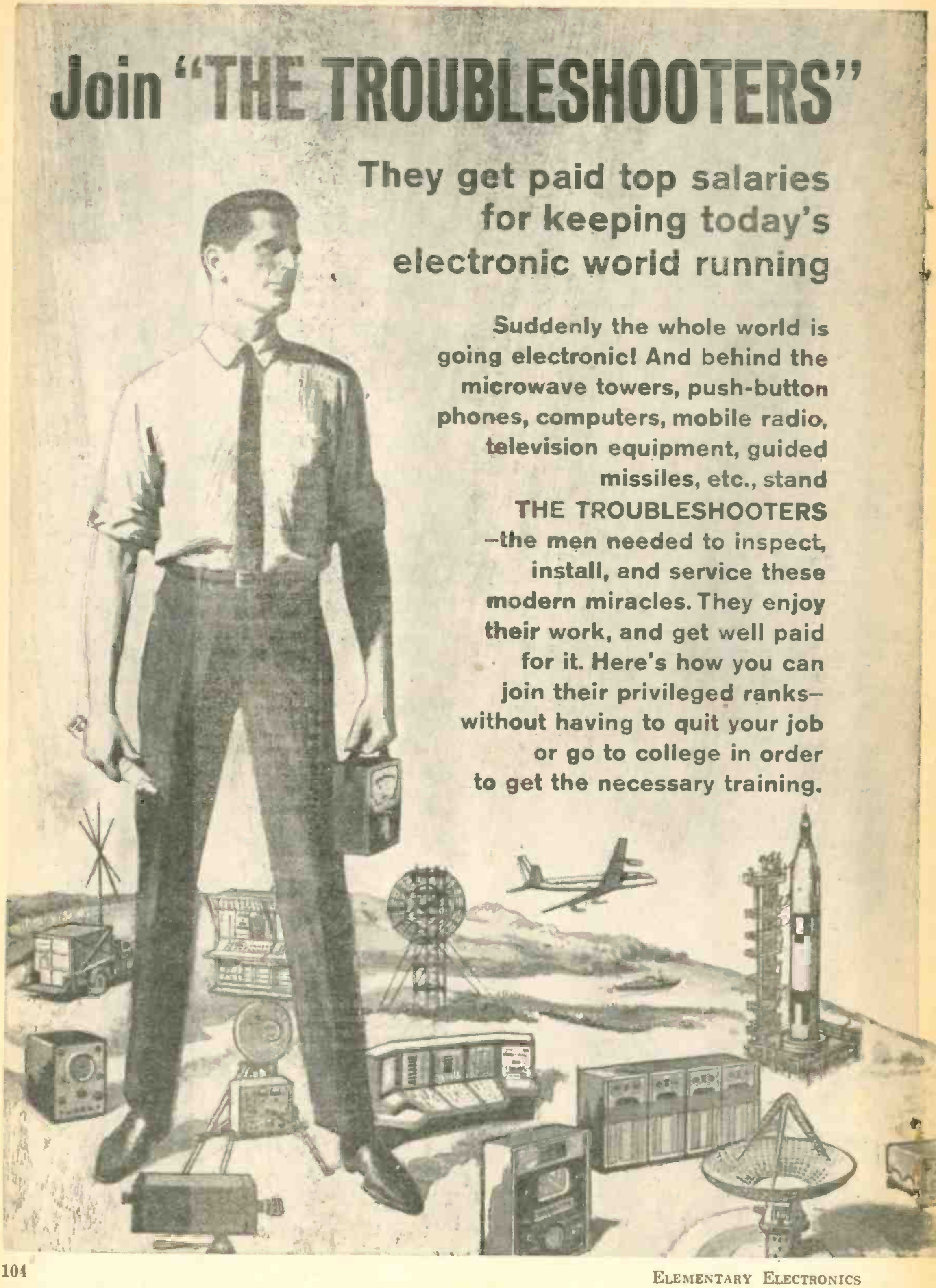
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