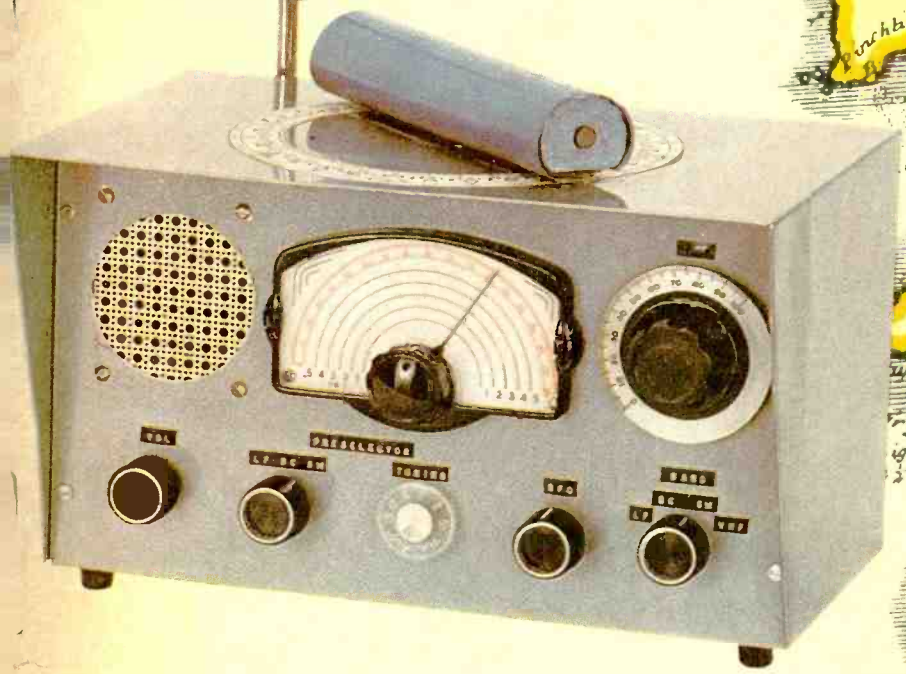
KOW YOUR OWN SPEAKERS! – See page 49

Elementary Electronics

MAY-JUNE 75¢

Build MARINER IV

portable marine receiver tunes the waves for landlubbing SWLs and old salts alike



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100% solid-state and *professional*.

Fun to build and use. Expandable, interconnectable. Great as "jiffy" projects and as introductions to electronics. No technical experience needed. Finest parts, pre-drilled etched printed circuit boards, step-by-step instructions.

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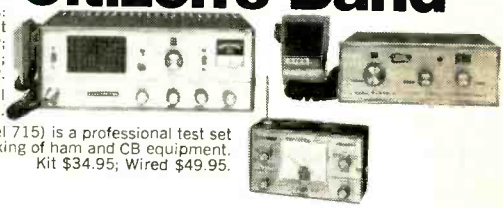
Two years ahead! Model 7923

All Solid-State 23-Channel 5W Transceiver. 4 exclusives: dual-crystal lattice filter for razor-sharp selectivity; efficient up-converter frequency synthesizer for advanced stability; precision series-mode fundamental crystals; Small: only 3"H, 8"W, 8¼"D. $189.95 wired only.

The best buy in tube-type CB—"Sentinel-Pro" 23-channel dual conversion 5W Transceiver $169.95 wired only.



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Professional Portable Multimeters by EICO.

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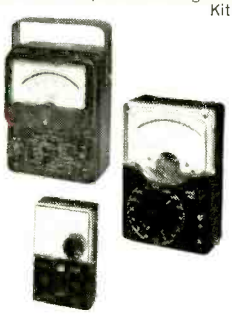
Model 4A3, 4000Ω/V, $9.95.
Model 1A1, 1000Ω/V, $5.95.



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Now you can keep your car or boat engine in tip-top shape with this solid-state, portable, self-powered universal engine analyzer. Completely tests your *total* ignition/electrical system.

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"There's COLD CASH In Repairing These Things!"

Each time a buddy of mine moans about the lousy repair job he got on his refrigerator or toaster or washing machine, I'm reminded of the fact that a good Appliance repairman is a mighty rare breed these days.

This neighbor of mine had refrigerator trouble just last month, and needed some speedy repair service. After phoning half a dozen repairmen who were booked solid for days, he finally had to settle for a bum job from a guy who had no business calling himself an Appliance repairman. This brings me to an important point. No one who wants to earn money in Appliance repair needs to learn by trial and error. There's a great, low-cost home study plan on the market that covers every type of Appliance repair in detail. The course was prepared by the Appliance Division of the National Radio Institute, one of the biggest and best schools in the field. Thousands of guys like yourself have studied with NRI, and many of them have more than paid for the low tuition fee within their first couple months servicing Electric Appliances.

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Accredited Member National Home Study Council.

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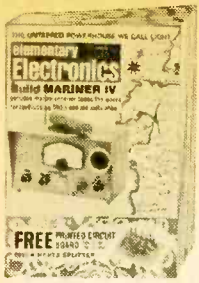
MAY/JUNE 1968
VOL. 6 NO. 2



elementary Electronics

Dedicated to America's Electronics Hobbyists

Cover Photo by Leonard Helcklen

☆ Cover Highlights

AUTHORS IN THIS ISSUE:

Len Buckwalter—K1OHD/KBA4480, John W. Collins, Joe Craig, James A. Fred, Webb Garrison, Charles Green—W6FFQ, Jorma Hyypia, Marshall Lincoln—W7DQS, William J. Millard, Marvin Townsend and the ELEMENTARY ELECTRONICS' Editorial Staff.

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FREE

with any order:

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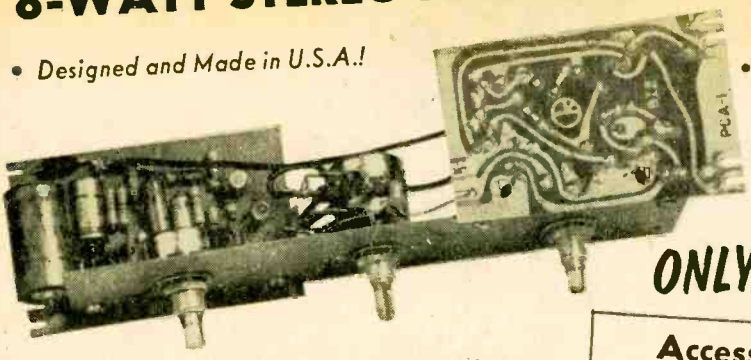
Buy anything (in person or by mail) from the following Radio Shack pages using the order blank on page 20 and we'll automatically include one of our handy "MATH-MILE" COMPUTERS. It's 7½" long and made of tough stock to give years of use. It multiplies and divides as fast as you can twirl the dial. It computes interest, figures percentages, does all kinds of auto computations. For example: you used 12 gallons of gas to drive 180 miles. How many miles did you get per gallon? Set the inner circle 12 against the outer circle 18.0 and read the answer at the black 10. It is 15 — as shown in the illustration. Complete detailed instruction for all computer functions are clearly printed on the back.

Store Addresses, Order Form, See Page 20

GIANT VALUES FOR "SOUND" HOBBYISTS

8-WATT STEREO AMPLIFIER SEMI-KIT

- *Designed and Made in U.S.A.!*
- *A Cinch to Assemble — Just Add Leads!*



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Hook Up, Install Anywhere!

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- *Two 8-Inch Round Speakers!* • *No Extras to Buy!*

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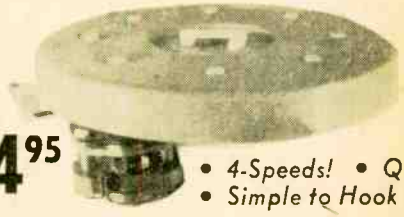
PHONOGRAPH MOTOR/TURNTABLE



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- *4-Speeds!* • *Quiet!*
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Use with stereo amplifiers! Vibration-free AC operation assured by rubber shock-mounted friction drive motor. Speed changes controlled by idler driving the 8" metal turntable. 4½ x 3⅜" mounting centers; 2⅛" below base plate. #42-129; #278-1255, AC Line Cord, .39 net.

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3-HOUR LONG PLAY PRE-RECORDED STEREO TAPES

- *4-Track, Reel-to-Reel!*
- *Same as Getting 6 Stereo Tapes!*
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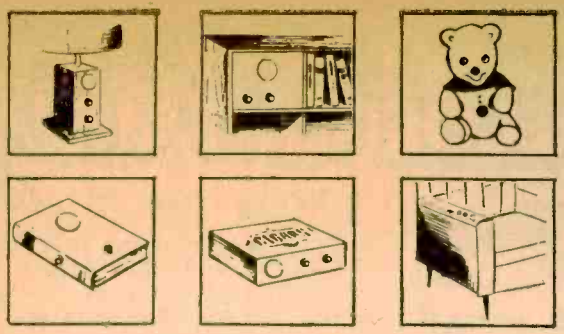

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Here's a wired transistor radio in 3 pieces. Dextrous do-it-yourselfers should have a field-day with this one.

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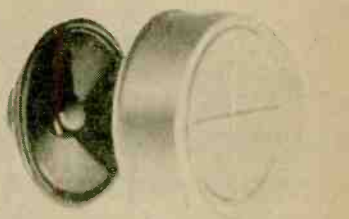
"BUILD-IN" RADIO

VOLUME CONTROL AND SWITCH



PM SPEAKER IN CASE

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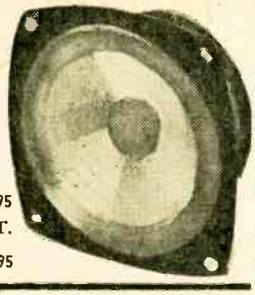

The fabulous Realistic FE-103, complete with cabinet construction details as published in Electronics Illustrated! 30-17,000 cps; 15 watts; 8 Ω.

7.95

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8 Ohm Impedance

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U.S. made with superactive rosin core. Fits fed. specs. QQ-S-571d
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4 draws with adjustable compartments.
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Over 600 pieces! Something here for everyone! All brand new—no sweepings! One full pound. Comparable value: $4.50!
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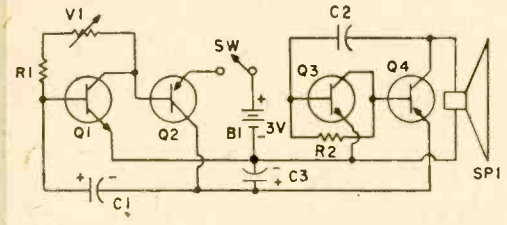
Build Yourself — or Win Cash by Sending Us Your Own Ideas!

D.C.M.
Napa, California

BEEP BEEPER

Produces Clocked One Second Pulses — Ideal for Audible Timing Devices



PROJECT PARTS LIST

Stock No.	Item	Net
272-954	30 MFD 15V Capacitor (C1)	.29
71-049	.1 MFD Capacitor (C2)	.22
272-953	10 MFD 15V Capacitor (C3)	.29
271-1716	50K Pot. (V1)	.59
70-0195	12K Resistor (R1)	.12
70-0195	1,000 Ohm Resistor (R2)	.12
276-1582	Perfboard	.59
270-385	Battery Holder	.49
23-467	"C" Cells (2 required) (B1)	.15
276-528	Transistor 2N170 (Q1, Q3) (Pak of 3)	1.00
276-1701	Transistor 2N107 (Q2, Q4)	.49
40-246	2½" PM Speaker (SP1)	.98
275-602	SPST Switch (SW)	.30

The basics of electronic clocks and timing devices are clearly illustrated with this pulsed oscillator. This circuit can be adjusted to generate pulses at the rate of one beep per second which can be synchronized to the sweep second hand of your watch. Also can be used as a basic trigger for other counting circuits. Continuously variable from .24 to 2.5 seconds.

S.P.
Canoga Park, California

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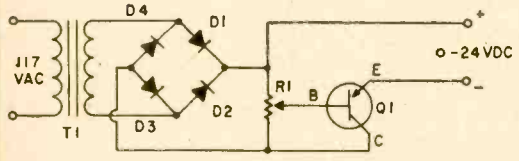
Transistorized with a Bridge Rectifier. Delivers up to 24 Volts DC. Great for Experimenters!



PROJECT PARTS LIST

Stock No.	Item	Net
276-1135	Diodes (D1, D2, D3, D4) (Pak of 2)	.29
271-1443	10K Pot. with Switch (R1)	.79
276-833	Power Transistor (Q1)	.98
273-1480	Power Transformer 117 VAC to 24 VAC (T1)	1.98
278-1255	Line Cord	.39

Here is a versatile power supply — that's easy to build! Delivers enough power to drive most solid state experiments and projects. Has a minimum output level of 200 milliamps of current. Features a heavy duty 117 to 24 volt AC line isolating transformer to eliminate shock hazard. Safe, efficient power supply for use in the shop or lab.

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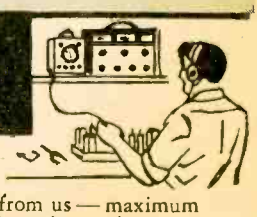
Turn Ingenuity and Hobby into Spare-Time Profits!

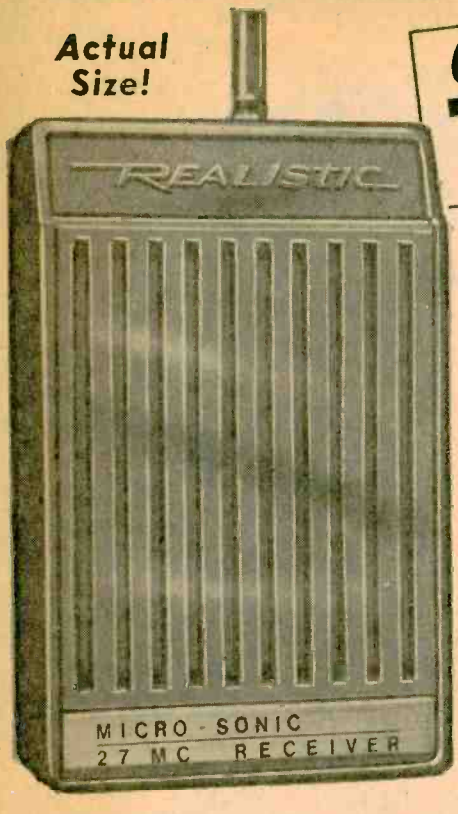


We are looking for experiments built around Radio Shack or other electronic parts. These will be published regularly in our catalogs. If published by us WE WILL PAY YOU AN AUTHOR'S FEE and reimburse you for parts bought from us — maximum $50 cost. By submitting it, you state it's original with you. If we accept it, it is understood we can publish it for use by our catalog, flyer, book and magazine readers. Submissions cannot be returned. Send description, parts list, stock numbers, and schematic. DO NOT SEND ACTUAL SAMPLE as we will build it here to see if and how it works. Write today!

SEND TO: **Radio Shack, Attn: Lewis Kornfeld, Vice-President**
730 Commonwealth Avenue, Boston, Mass. 02215

Store Addresses, Order Form, See Page 20

RADIO SHACK EXCLUSIVE! ADD A SLAVE "WALKIE" TO YOUR BASE, MOBILE, OR WALKIE TALKIES!



Actual Size!

ONLY 7.95

Crystal-controlled superhet receiver ONLY! Add as many ears to your network as you want. Fits in a shirt pocket — an excellent paging or guided tour device!

This unusual Radio Shack product, called the Realistic Microsonic 27MC Receiver, comes complete with a Ch. 11 CB crystal — and because it's a plug-in, it can be changed to any of the 23 channels. It's a teeny 3½ x 2½ x 1⅜". It includes an earphone with clip, and the phone's lead acts as the antenna. So if you want to hide it away as a pager, there's nothing showing. For DX we've included a 16" telescopic whip to be used only if necessary. Let your imagination run wild with this novel device!

21-109 Microsonic 27MC Receiver ..... Only 7.95

NEW IDEA #2 — as a companion to the above, or a wireless CB microphone (!), there's also the Realistic Microsonic CB transmitter. Same size, color, everything. But transmit only, 100mw of course, with plug-in crystal for Ch. 11. Uses? For example: one of these plus x-number of receivers and you have a guided tour technique that'll never quit!

21-110 Microsonic CB Transmitter ..... Only 7.95

FREE ACCESSORIES:

- **Receiver — earphone and whip antenna**
- **Transmitter — 35" telescopic antenna**

Note: both units include crystals but require a 9V transistor battery to operate. 23-464, 29¢ each.

RADIO SHACK'S FABULOUS SPACE PATROL® TWOSOME

STANDARD FULL SIZE

ARCHER

SPACE PATROL®

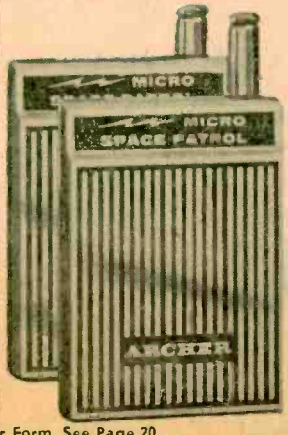
Talk up to ¼ mile with our perennial favorite in the 100MW no-license class. Over 100,000 of these transceivers now in use! "Lock-on" talk switch for continuous transmission when needed. Extra-long 43" telescopic antenna! Channel 14 crystal & battery included.

60-3030, 3 lbs. Pair 11.95

11.95 PER PAIR

ARCHER MICRO

SPACE PATROL®



Double transformer talk-power in the world's smallest (3-5/6 x 2-7/16 x 1¼") case. Fits easily in your shirt pocket (and your budget). Handsomely styled hi-impact, custom-chromed case. Easy to operate with a hideaway "push-to-talk" button. 9-section telescoping antenna. With channel 14 crystal and battery.

60-3032, 2 lbs. .... Pair 14.95

14.95 PER PAIR

For Store Addresses, Order Form, See Page 20

CB'ers MOBILE REALISTIC® TRANSCEIVERS!

REALISTIC® 12-CHANNEL SOLID STATE CB TRANSCEIVER

FREE
CRYSTAL BONUS!
With Purchase of TRC-15

4 SETS OF CRYSTALS

Channel 11 Installed in Set; YOUR CHOICE OF 3 ADDITIONAL CHANNELS — FREE!

A Regular $19.92 Value When Crystals Purchased Separately

Made in U.S.A.

Model TRC-15 89.95 NO MONEY DOWN

The $100-quality 2-way radio for any 12V (neg. ground) car, truck or boat! 5 full watts of input power; 1 μv sensitivity; solid 100% modulation! Includes built-in ANL; provision for connecting PA speaker. Complete with set of Ch. 11 crystals, push-to-talk mike with coiled cable, adjustable mounting bracket, DC cable, instructions.
21-033, Sh. wt. 5 lbs., 8¼x5⅝x2⅜" ..... Net 89.95

★ *13 Silicon Transistors; 4 Diodes!* ★ *12 Crystal-Controlled Channels!* ★ *Illuminated Channel Selector!* ★ *Adjustable Squelch!* ★ *Electronic Antenna Switching!* ★ *No Warm-Up Delay!* ★ *Die-Cast Panel; Extruded Trim!* ★ *Provision for PA!*

REALISTIC® 12 CHANNEL CB TRANSCEIVER

Single Crystal Operation for Receive and Transmit

99.95

- *Solid State Circuitry!*
- *Dual Conversion 6.2 MHZ and 455 KHZ for Greater Sensitivity & Selectivity!*
- *Mechanical 455 KHZ Filter!*
- *Push-to-talk Dynamic Mike!*

A truly versatile communications package. Incorporates advanced frequency synthesis technique used on higher priced models, the TRC-18 transmits and receives with only one crystal per channel. Up to 3-watts output with a full 5 watts of RF input. Low battery drain in any 12 VDC neg. ground vehicle. Adjustable squelch control; automatic noise limiter; illuminated channel selector and meter. Sensitivity: 0.5 μv for 10 db S+S/N. With cords, brackets, crystal for channel 11. 7½" x 6⅜" x 2⅛".
21-120, Ship. Wt. 8 lbs. ..... Net 99.95

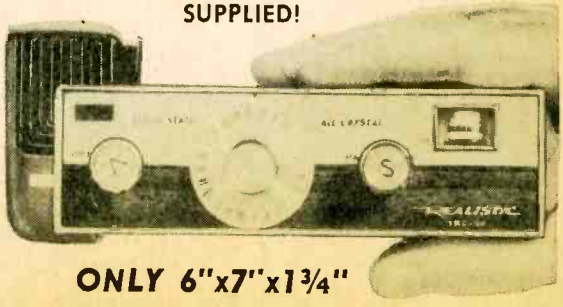
TRC-24 23-CHANNEL CRYSTAL-CONTROLLED TRANSCEIVER

- *18 Transistors, 4 Diodes!*
- *Low Battery Drain!*
- *Antenna Changeover Relay!*
- *Synthesizer Circuitry!*
- *Illuminated S Meter and Channel Selector!*
- *Chrome and Wood Grain Front Panel!*

139.95 No Money Down

Obsoletes all 23-channel crystal-controlled CB transceivers! 0.25 μv sensitivity at 10db S/N! Includes adjustable squelch, automatic series gate noise limiter . . . all wanted features! 12 VDC neg. ground. Plug-in ceramic mike, fusable DC cable, bracket, instructions.
21-124, Sh. wt. 6 lbs. ..... Net 139.95

ALL CRYSTALS SUPPLIED!



ONLY 6"x7"x1¾"

For Store Addresses, Order Form, See Page 20

CB WALKIE TALKIE VALUES!

TRC-1B 7-Transistor Superhet

13.95 Each

- *Low in Cost — High in Quality!*
- *Compact and Lightweight!*
- *With Push-Pull Audio Output!*
- *100MW — No License Needed!*
- *Rugged Die-Cast Front Panel!*

More RF output power, more audio and greater sensitivity than most others in its price class! Push-pull audio output modulator, 1 diode, on/off volume control switch, and 45" 10-section telescopic antenna. Includes set of crystals for Channel 11, battery, and carry strap. 6 x 2½ x 1½".
21-102, Ship. wt. 2 lbs. ..... Net 13.95

NOW — SAVE UP TO 15% OFF OUR ALREADY LOW, LOW PRICES!

1-WATT 3-CHANNEL TRC-44B

- *Adjustable Squelch!*
- *Automatic Noise Limiter!*
- *Push-Pull Audio Output!*

SAVE $5.00
REG. $44.50
SALE 39.50 Each

Plenty of sock! Exclusive "lock-switch" for continuous transmit; Beep Signal feature; separate microphone and speaker! Has 12 transistors, 3 diodes and a thermistor. With set of Ch. 11 crystals, batteries, telescoping antenna, carry strap. 9x2¾x2"
21-106, Sh. wt. 5 lbs. ..... Sale 39.50

1½-WATT 2-CHANNEL TRC-66

- *Center-Loaded Telescopic Antenna Increases Effective Radiated Power!*
- *Battery Meter Indicator!*
- *Beep Signal!*

SAVE $10
REG. $59.95
SALE 49.95 Each

15 times the power of 100 MW units! This husky feature-packed unit has 14 transistors, 4 diodes and 1 thermistor, plus ANL and "DX-boost" for better modulation. With crystals, batteries, earphone.
21-105, Sh. wt. 5 lbs. ..... Sale 49.95

For Store Addresses, Order Form, See Page 20

EASY-TO-USE EICO TEST EQUIPMENT!

1,000 OHMS/VOLT MULTITESTER

SPECIAL!

3.95 Factory Wired

Our Regular $5.95

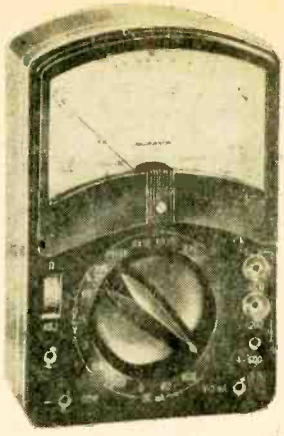
- *Convenient Thumb-Set Zero Adjustment!*
- *Reads AC/DC Volts in 3 Ranges: 0-5, 150, 1000!*

Only 3½ x 2⅛ x 1"!

Great for home or workshop! Pin jacks for all 5 ranges; 2-color 1¾" meter scale. DC Current 0-150 ma. Resistance: 0-100,000 ohms. Accuracy is ±3% of full scale value on DC ranges, ±4% of full scale on AC ranges. A rugged black bakelite case. Comes with pair of color-coded test leads, instructions, battery.

22-4027, Ship. Wt. 1 lb. ..... Net 3.95

30,000 Ω/V 26-RANGE MULTITESTER



16.95 Factory Wired

- *30,000 Ohms/VDC!*
- *15,000 Ohms/VAC!*
- *Single Knob Selector!*
- *Easy-to-Read Meter!*

Makes easy work of the big jobs with precision 1% resistors and recessed zero ohm adjustment! DC volts: 0-0.6/3/15/60/300/600/1200/3000; AC volts: 0-6/30/120/600/1200. Resistance: R x 1/100/1000/10,000. Current (ma): 0-0.03/6/60/600. −2 to +63db in 5 ranges. With leads, instructions, battery.

22-049, Wt. 2 lbs. ..... Net 16.95

50,000 OHMS/VOLT MULTITESTER

27.95 Factory Wired

- *4" Full View Meter with Mirrored Scale!*
- *Meter Protection Circuit!*
- *1% Precision Resistors!*
- *26-Ranges!*

Only 7 x 5½ x 5⅝"!

Great for technicians, mechanics and hobbyists. Specs: DC volts: 0-0.5-2.5-10-50-250-500-1000V @ 50,000 Ω/volts. AC volts: 0-2.5-10-50-250-1000V @ 12,500 Ω/volts. DC current: 0-25ma-2.5ma-250ma-1 amp-10 amps. DC Resistance: 0-10,000/100,000/1 meg./10 meg-ohms. Center scale: 90/900/9000/900,000 ohms. Decibels: −20 to +62 (5 Ranges).

22-150, Ship. Wt. 5½ lbs. ..... Net 27.95

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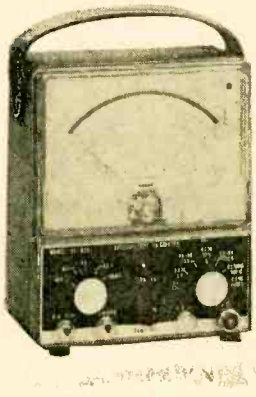
EICO 6½" VTVM METER



39.95 Factory Wired

- *Precision Resistors!*
- *Measures Peak-to-Peak and RMS (7 Ranges on Each Function)!*
- *Frequency Response: 30 cps to 10 mc!*
- *Easy-to-Read 2-Color Full View Mirrored Scale!*

Features a zero-center scale for alignment of FM-TV detector circuits. Specs: AC volts: RMS 0.1 to 1500 V. (7 ranges); DC volts: 0.1 to 1500 V. (7 ranges). Peak-to-peak 4-4000 V. (7 ranges). Output −20 db to +65 db (7 ranges). Resistance: 0.2Ω to 1000 meg-ohms (7 ranges). Tubes: 12AU7, 6AC5 and SR1A. Power: 117 VAC, 50/60 cycles.

22-025, Ship. Wt. 7 lbs. ..... Net 39.95

SEMI-CONDUCTORS FOR THE HOBBYIST

ARCHER Replacement Transistors

PNP TYPES

For high frequency, RF-IF, and converter circuits. Replaces: 2N247, 2N248, 2N252, 2N267, 2N274, 2N308, 2N309, 2N310.
276-412, Wt. 3 oz. 1.29

For mixer/oscillator converter circuits. Replaces: 2N112, 2N113, 2N114, 2N135, 2N136, 2N137, 2N140, 2N175, etc.
276-401, Wt. 3 oz. ..... .99

For universal IF circuits. Replaces: 2N111, 2N112, 2N139, 2N218, 2N219, 2N315, 2N366, 2N406, etc.
276-402, Wt. 3 oz. ..... .99

For 6 volt audio circuits. Replaces: 2N77, 2N104, 2N105, 2N107, 2N109, 2N130, 2N131.
276-403, Wt. 3 oz. ..... .99

For 12 volt audio circuits. Replaces: 2N36, 2N37, 2N38, 2N41, 2N43, 2N44, 2N45, 2N46, etc.
276-404, Wt. 3 oz. ..... .99

For 9 volt audio circuits. Replaces: 2N188, 2N189, 2N190, 2N191, 2N192, 2N195, 2N196, 2N197, etc.
276-405, Wt. 3 oz. ..... .99

For auro radio AF amplifier circuits. Replaces: 2N176, 2N178, 2N179, 2N234, 2N235, 2N35B, 2N236, 2N242, etc.
276-406, Wt. 3 oz. 1.19

For high power AF circuits in auto radios. Replaces: 2N173, 2N174, 2N277, 2N278, 2N441, 2N442, 2N443, 2N1515, etc.
276-407, Wt. 3 oz. 2.29

Silicon Epoxy high gain. Replaces: 2N940-2N946, 2N2333-2N2337, 2N3548-2N3550.
276-420, Wt. 3 oz. .... Net 1.09

Silicon Epoxy medium gain. Replaces: 2N1132, 2N923-2N928, 2N2372, 2N859, 2N865.
276-421, Wt. 3 oz. ..... Net .99

NPN TYPES

For mixer/oscillator converter circuits. Replaces: 2N193, 2N194/A, 2N211, 2N2-12, 2N233, 2N234, 2N357, 2N358.
276-408, Wt. 3 oz. 1.09

For universal IF amplifier circuits. Replaces: 2N98, 2N99, 2N100, 2N145, 2N146, 2N147, 2N148, 2N149, etc.
276-409, Wt. 3 oz. 1.15

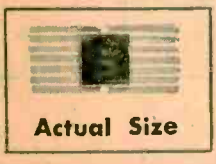
For 9 volt AF amplifier circuits. Replaces: 2N35, 2N169A, 2N213, 2N214, 2N228, 2N306, 2N312, 2N313, etc.
276-410, Wt. 3 oz. ..... .99

For 12 volt AF amplifier circuits. Replaces: 2N306A, 2N445A, 2N446A, 2N447A, 2N556, 2N557, 2N587, 2N649, etc.
276-411, Wt. 3 oz. ..... .99

Silicon Epoxy high gain. Replaces: 2N3704-2N3709, 2N3415-2N3417, 2N3877.
276-422, Wt. 3 oz. ... Net 1.09

Silicon Epoxy Medium gain. Replaces: 2N706TPP, 2N3663, 2N3843A, 2N3900, 2N3901, etc.
276-423, Wt. 3 oz. ..... Net .99

Integrated Circuit Specials!



1.98 Up

- *Ideal for the Hobbyist, Builder, Experimenter!*
- *Fantastic Savings!*

New from Radio Shack! Resistor-Transistor Logic type ICs are ideal for builders, hobbyists, labs, industry etc. Guaranteed to be 100% perfect electronically and mechanically. Each comes complete with diagram and lead locations. Power requirements: 3 volts. Flat Pak type. Size ¾ x 5/16 x 1/16".

DUAL 3 INPUT GATE. Can be used as a 6 input microphone mixer. Contains up to 6 transistors & 8 resistors in pak. Elements can be used parallel to increase current capabilities.
276-430, Wt. 3 oz. ..... Net 1.98

DUAL JK FLIP-FLOP. Construct your own binary computers, digital adding machines, etc. Contains up to 25 transistors and 32 resistors per pak.
276-431, Wt. 3 oz. ..... Net 2.49

Silicon Field-Effect Transistors

1.98

- *High Impedance Input!*
- *Low Noise! High Gain!*
- *Characteristics Similar to Pentode Vacuum Tube!*

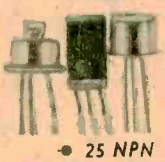
1000's of applications where pentode tubes are used in low level circuits; field strength meters, "gate dippers," receivers, flea power transmitters, etc. TO-5 case. Includes specifications.
276-664, Sh. wt. 2 oz. ..... Net 1.98

Hard-to-Find IBM Component Boards

8 For 1.00

All quality American made parts. Each board contains at least two transistors, plus loads of other components: resistors, capacitors, coils, diodes, modules, chokes, and heat sinks. Size: 2⅜ x 3⅛".
276-617 ..... 8 for 1.00

NEW! Twin-Pak Transistor Kit

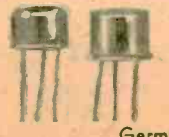


1.98 Pak of 50

- *25 NPN • 25 PNP*
- *Silicon & Planars Included*

A sensational value! Full-length leads; ideal for RF applications, switching and general-purpose audio use. Silicon and planar types included to provide replacements for many popular numbers without circuit change. Think of it — less than 4¢ per transistor!
276-1516, Wt. 2 lbs. ..... Net 1.98

100-Pc. Jumbo Pak Assorted Transistors



3.98

Includes Germanium & Silicon

PNP and NPN's in assorted cases, TO-1, TO-5, TO-3, TO-22, etc. Ideal for RF, IF, OSC., audio and power.
276-544, Sh. wt. 1 lb. ..... Net 3.98

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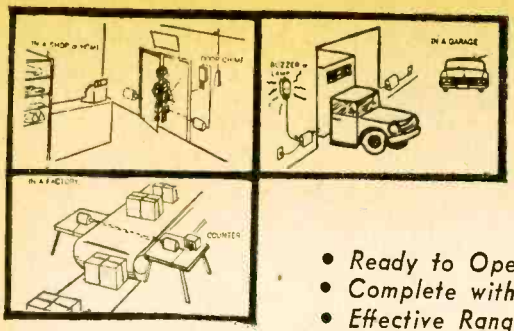


ARCHER

PHOTO-ELECTRIC RELAY SYSTEM

- *Ready to Operate — Not a Kit!*
- *Complete with Exciter Lamp and Photo-Cell Receiver!*
- *Effective Range: up to 50 Feet!*
- *Each Unit Is Separately Powered!*

ONLY 19.95

The ideal multi-purpose photo-relay for business, retail store, home or warehouse use! System consists of an exciter lamp and photo-cell receiver, each housed in a rugged metal case. Both plug into standard 117 VAC house current. The system can be used (with bell or buzzer) to signal when someone enters a room and "breaks" the beam; to count people or objects; or to trigger an alarm to deter intruders. A variable sensitivity control adjusts for ambient light level, or can be used to inactivate the system temporarily. Each unit 5½x4x2⅞".
275-489, Sh. wt. 6 lbs. ..... Net 19.95

A D Cell 23¢ Each in Box of 24

B C Cell 18¾¢ Each in Box of 24

C Penlite 13¾¢ Each in Box of 72

D 9V (Rectangular) 40¢ Each in Box of 50

RADIO SHACK "EXTRA-LIFE" BATTERIES

- *50% Longer Life!* • *Higher Lumen Output!* • *Higher MNO Content!* • *Steel Encased with Anti-Corrosive Caps!*

Radio Shack's new 50% Extra Life cells yield fresher, longer life without sacrificing "shelf life" or adding weight. Ideal for radios, recorders, flashlights, etc. Designed to exceed U.S. Government standards! Buy 'em by the box — save more!

Fig.	Cat. No.	RADIO SHACK	Interchangeable with Eveready	Burgess	RCA	Pack	Per Box
A	23-1538	1.5V "D" Cell	950	2	VS036	4/.98	24/5.59
B	23-478	1.5V "AA" Cell	915	Z	VS034A	4/.69	72/9.95
C	23-153	1.5V "C" Cell	935	1	VS035A	4/.88	24/4.49
D	23-152	9V Rect.	216	2U6	VS323	2/.98	50/19.95

AMAZING HOME BATTERY CHARGER

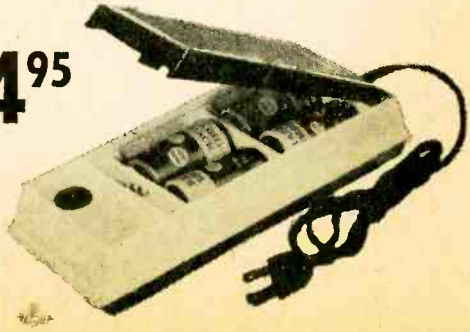
4.95

Don't Discard Your "Dead" Batteries!

Accepts All These Types:

- *1½V "AA" Cells* • *"D" and "C" Cells*
- *9V Transistor Radio Batteries*

Count the number of batteries you use around the house right now — then count how much you'd save by recharging them over and over again. End replacement costs! Get the handy battery charger that plugs into any 117 VAC house outlet and recharges batteries overnight! Accepts up to 4 batteries at a time. Cannot overcharge or burn out. Start saving money today!
270-1526, Sh. wt. 1½ lbs. ..... Net 4.95



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ANY ARCHER-PAK ON THIS PAGE **$1** PER PAK

Spring Clearance!

20 Power Resistors

Package consists of high-quality vitreous, cand-ohm and wire-wound types. Includes 5 to 25-watt power resistors; individual catalog net — $10!
271-1202, 2 lbs. ..... Net 1.00

35 Precision 1% Resistors

Large assortment of popular ½, 1 and 2-watt values; includes encapsulated, bobbin, carbon film, etc. Made by Aerovox, Shellcross, IRC, and other famous names.
271-1196, 1 lb. ..... Net 1.00

50 Tubular Capacitors

An assortment of quality tubular capacitors, 100 mmf to .1 mf to 600 WVDC. Includes molded, paper and porcelain types. $10 if purchased individually from catalog!
272-1568, 1 lb. ..... Net 1.00

4 Subminiature 455KC IF Transformers

Slug tuned, made for printed circuitry mtg., shielded. Size: ⅜ x ⅜ x ½".
273-515, ¼ lb. .... Net 1.00

8 Sets - RCA Plugs & Jacks

Quality items, ideal for use in phono amplifiers, tuners, recorders, etc. Take advantage of this Radio Shack Special low price!
274-1575, ½ lb. ..... Net 1.00

40 Micro Resistors

World's smallest ¼-watt carbon type resistors! All have axial leads; built for transistor and subminiature circuitry! Assorted values, with resistor color code chart.
271-1566, ½ lb. ..... Net 1.00

40 Coils and Chokes

Shop assortment consisting of RF, OSC, IF, parasitic, peaking and many more types. Individually purchased, this would cost you $15!
273-1569, 1 lb. ..... Net 1.00

55 Mica Capacitors

Famous name micas — Aerovox, Sangamo, C.D., etc. This assortment includes popular values 100 mmf to .01 mf, as well as silver type condensers. A $10 catalog net value!
272-1573, 1 lb. ..... Net 1.00

8 Volume Controls

Most Popular Values

Contains 8 assorted values including long and short shaft types. A tremendous bargain for servicemen!
271-127, 1 lb. ..... Net 1.00

Special! 50 Capacitors

Assortment of many types including disc, ceramic, mylar, temperature coefficient, molded, paper, oil, Vit-Q. You save $9 over industrial net catalog prices!
272-1199, 1 lb. ..... Net 1.00

60 Half-Watt Resistors

Made by Allen Bradley and IRC. Many 5% and 10% tolerance. Color chart. All most popular values. An absolute "must" for hobbyists and kit-builders.
271-1612, 1 lb. ..... Net 1.00

50 Ceramic Capacitors

Wide variety of popular values by Centralab and other famous-name makers. 10 mmf to .04 mf to KV. Assortment includes tubulars, discs, NPO's, temp. coefficient, etc.
272-1566, 1 lb. ..... Net 1.00

48 Terminal Strips

You get a wide variety of screw and solder lug type terminal strips with 1 to 6 lugs. Outstanding value at this low price! 101 uses for the builder and experimenter.
274-1555, 1 lb. ..... Net 1.00

40 Disc Type Capacitors

A varied assortment of types, including NPO's, Hi-Q, N-750's, mylar and ceramic. 10 mmf to .01 mf to 6 KV. A $10 catalog net value!
272-1567, ¼ lb. ..... Net 1.00

150' of Hook-Up Wire

Assortment consists of 6 V rolls of 25' each — solid and stranded wire, #18 through #22. Necessary for multitude of jobs and always useful!
278-025, ½ lb. ..... Net 1.00

40 One-Watt Resistors

Here are resistors for hundreds of uses! Assortment has Allen Bradley and IRC carbons, with 5% values included. This pack is a regular $8.00 catalog net!
271-1576, 1 lb. ..... Net 1.00

4 Transistor Transformers

Made by UTC and Remington Rand. Famous miniatures. Includes sub-ouncer, mike, input types. Color coded leads.
273-1581, 1 lb. ..... Net 1.00

$25 SURPRISE PACKAGE!

Loaded with Parts!

$1

The biggest surprise package yet! Enough electronics components to make your eyes pop! Resistors, capacitors, condensers, diodes . . . your guess is as good as ours. The famous-make parts are worth *at least* $25.00!
270-1251, 1 lb., Net 1.00

50 Plugs and Sockets

Ideal bench assortment for servicemen, hams, etc. Subminiature and printed circuit types included! This assortment saves you $10 over individual catalog prices!
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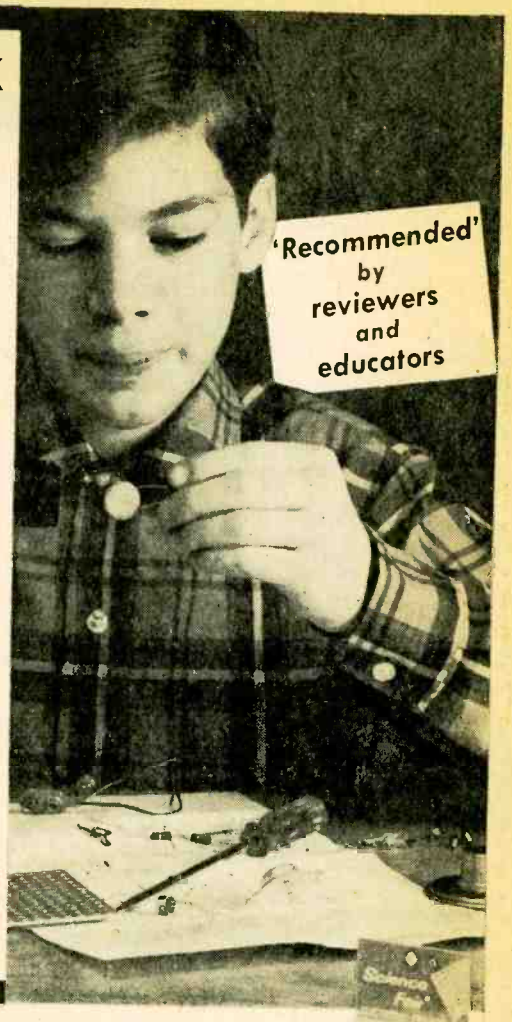

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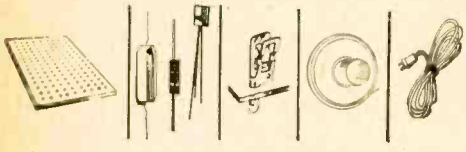

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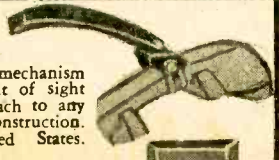

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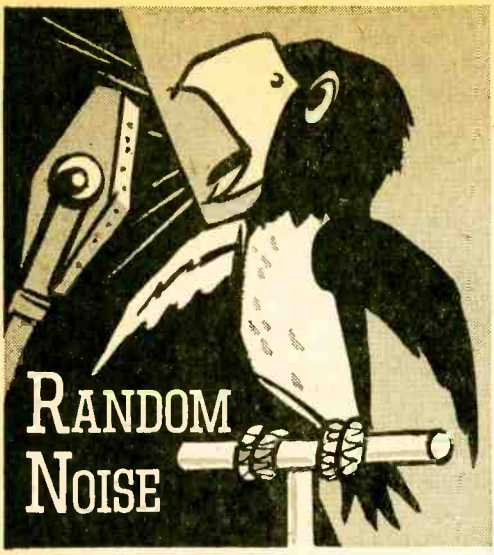


By Julian M. Sienkiewicz, Editor

One of the big headaches car owners have is the installation of a new or replacement antenna, whether it be for the AM radio, the new FM rig, ham gear or CB. Putting a hole in the side of a car is as easy as driving into a doorknob. But Detroit has a way of welding bodies together that makes the installation of an antenna almost impossible even for two men working on the same Hertz-grabber. The big problem is to affix the locking nut under the metal skin while inserting the threaded base of the antenna from the top. It's an *easy* trick for a guy with a four-foot arm with two to three wrists.

Relax, someone has the answer. Hy-Gain Electronics Corp. has come up with a unique feature to their new Hellcat CB antenna line that's worth talking about. It's called the "Claw," and it enables the antenna to be

Here's a Hellcat you CBers should tangle with—it's the new Hy-Gain CB antenna with the "Claw." Those white boots won't be for walking if you scratch the back of your mobile with the Claw.

mounted in any existing hole from ⅜ to ¾ in. —round or out-of-round. The Claw grips the hole and is secured by screws from above. None of this jazz of crawling under the car and having road mud fall in your face as you tighten a hard-to-get-at nut.

Hy-Gain has applied for the patent for the Claw. However, I'm sure other manufacturers will see the light of this development and either purchase the right to use it on their products or prod their research departments to come up with a variation that'll be just as easy on antenna installers. As for the Hy-Gain Hellcat CB line of antennas—they're good and worth knowing about 'cause there is much more to them than just the Claw. Get the facts by writing to Hy-Gain Electronics Corp., N.E. Hwy. 6 at Stevens Creek, Lincoln, Neb. 68501. Tell the folks at Hy-Gain that you read all about it in ELEMENTARY ELECTRONICS.

Call It Progress. A new corporate-wide communications program is in the works for RCA. The new look will affect every facet of RCA's appearance from trademark to office design. "This broad program has been planned to con-

After 46 years RCA has called it quits on its round trademark and switched to the emblem shown at the right.

vey the modern character of RCA as a diversified enterprise that has evolved over the last half century from a pioneering base in communications and electronics to leadership in total information technology," are the very words used by RCA's president, Robert W. Sarnoff. What most people will notice first will be the appearance of the new RCA trademark. The new trademark employs the three letters standing alone in a bold contemporary design to form a distinctive design unit. It replaces the 46-year-old design formed by the letters "RCA" underlined by a symbolic lightning flash and enclosed in a circle.

This Editor will mourn the passing of the old RCA emblem. Somehow, a dent has been placed in tradition. Many millions of Americans and foreigners will see the passing of an old friend and the introduction of a bold, brash trade symbol. This change may be labeled advancement or face-lifting, to which our British friends have a retort, "God save the Queen!" ■

NEWSCAN

Solid Greek

Pythagoras knew about the existence of all the regular polyhedrons except the *dodecahedron*. This geometrical solid was discovered in 470 B. C. by Hippasus, who, having boasted of his discovery, was drowned by the other Pythagoreans. (Theirs was not a great society). The regular polyhedrons were supposed to have certain magical properties and their study was greatly emphasized by the Greeks.

A very special dodecahedron was recently completed by carpentry students assigned to the Kilmer Job Corps Center model shop. According to Dion Porzio, staff model-maker, it may well be the only one of its type in the country.

Dodecahedrons are 12-sided figures, each side a pentagon. While solid dodecahedrons are not unusual (you frequently see small desk calendars made in this form), skeletal constructions

Dion Porzio and student gaze with pride at a 30-inch skeletal model of a dodecahedron made at the Kilmer Job Corps Center model shop.

are most uncommon. And when each of the 20 points is connected to all of the other points with colored thread, there's just the one.

Mr. Porzio became interested in "dodecas" several years ago while attending a scientific meeting in San Francisco. A mathematician he met mentioned that strings connecting the points of a *dodeca* (that's short for dodecahedron) would form every geometric figure known—except, of course, for those with round sides.

He started to build one at that time, but it was stolen before he finished it. Earlier this year he remembered the dodeca he had started, and thought that the mitering and careful measurements called for might make an excellent exercise for his students. After warming up on a couple of solid dodecas, they began construction of the 30-inch skeletal model.

It was built of 30 one-quarter-inch dowels, with each joint carefully mitered and glued. Two days were required to cut, bevel and assemble the construction, not to mention many additional hours of figuring angles and building construction jigs. Stringing the model was a tedious job as each of the 20 points had to be connected to 16 other points. It worked out to be 320 strings, about 640 feet in all. Stringing took 25 hours.

The finished model has attracted considerable attention from visitors, one of whom, a high school math teacher, asked Mr. Porzio to have the corpsmen build one for his classroom. Porzio told him it would cost at least $500 to duplicate the Kilmer model. What price education?

School for Grease Monkeys

A new training program for service specialists of Ford dealerships across the nation is now being evaluated by the Ford Motor Company. Developed jointly by Ford and Raytheon Company, the training program incorporates student responders and specially prepared color slides projected simultaneously by two projectors on a split screen. The pictures and accompanying sound track introduce the serviceman to different aspects of the many electrical, mechanical and hydraulic systems used in Ford cars and trucks.

For instance, half the screen may show a wiring diagram, the other half the actual wiring as installed in a Mustang or Cougar. Or one half may be used to show, step by step, a trouble shooting schematic or action sequence while the other half shows the corresponding part of the automobile as a color photograph. Small parts are magnified to fill the screen. This makes it possible for a whole class to inspect closely a relay, or the face of a set of worn points, or the interior of a small vacuum valve.

Typical illustrations show wear patterns in differential gears, adjustment techniques and angle measurement techniques with dial readings on one screen opposite the indicated action

New electronic training system uses split screen illustrations, multiple choice questions, and push-button responders. Service technician students indicate their answers to the questions by pressing appropriate button on their responders. An instructor's console tallies the answers.

on the other. Many of the smaller parts and complex adjustment steps are shown much more effectively on the screen than on an actual automobile.

After each key point is introduced the student is asked a multiple choice question which he answers by pressing the appropriate button on Raytheon's Edex responder. This device records and scores the individual students and gives the instructor a continuous indication of their collective performance. This is accomplished with four meters on a console. Each represents one of the four possible answers to the question posed on the screen. The meters indicate what percentage of the class selected each possible answer. Should a particular class score below an acceptable norm the instructor can stop the automatic projectors and personally take over the instruction explaining the point. There's still room for unwired, unprogrammed teachers. ■

". . . right after I switched to tape I noticed it didn't seem right!"

Process Your Voice

If you want intelligible results in transmitting by wire or radio. Sentry's *TALKPOW'R* will compress the ratio of peak level to lowest level, narrow the frequency range, and boost entire signals to high average level. *TALKPOW'R* is a 3-transistor unit that uses 9-volt drycell bat-

Sentry TALKPOW'R Speech Processor

tery power, whose only connection to transceiver is the mike cable. It provides up to 20 dB clipping for average microphone and voice; up to 40 db voltage gain for soft voices. The output is adjustable from 0.3 to 3 V rms and cannot exceed 3 V rms. Input minimum is 3 mV rms, maximum 10 V rms. In wired form it sells for $17.95; the kit form goes for $14.95. If you want to know more about *TALKPOW'R*, write to Sentry Manufacturing Co., Box 12322, Oklahoma City, Okla., 73112.

Be Anxiety-Free on the Freeway

This new product, called the Radar Detector, is a miniature microwave receiver which clips to your car's sun visor and alerts you of the approach to a controlled radar speed zone well in advance of the law enforcement vehicle's

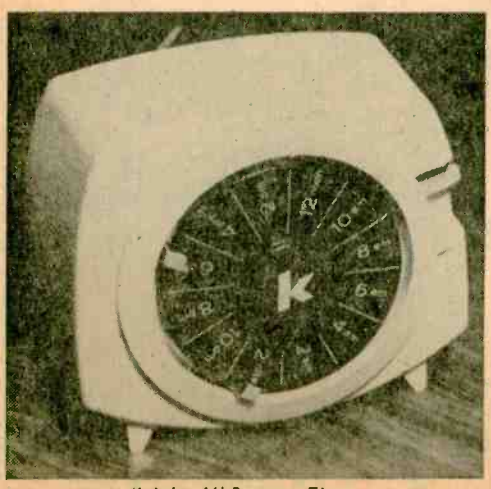
critical clocked area. The Radar Detector weighs 12 oz., operates on 2 penlite batteries, has up to 2-mile range and is completely transistorized. It emits a steady beep to remind you

Multronic Products Radar Detector

to slow down before the clocked zone is reached. The Radar Detector has no radiation of its own, will not interfere with any transmitting beam and is completely noiseless when not picking up transmitted radar signals. The Radar Detector is legal in all states except Virginia and Massachusetts, and is available postpaid for $44.95 from Mutronic Products, Dept. 170, Box 10306, Denver, Colo. 80210.

Progress on the Sands of Time

The Knight All-Purpose Timer, with its innumerable applications in the home, shop, or plant, is designed to handle loads of up to 185 watts, and it turns lights and appliances on or off at preset times. The operation automatically repeats every 24 hours. The unit can also be set to "Skip-A-Day." Minimum *on* interval is 15 minutes, maximum is 23¾ hours. A manual

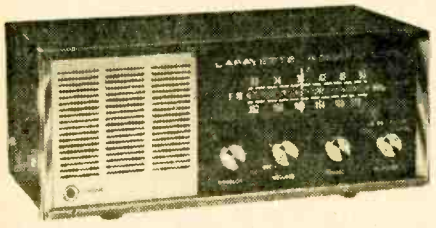


Knight All-Purpose Timer

override provides complete control. So you can start your morning coffee, turn off the TV at night, operate an aquarium, or what have you. Unit measures 5 x 4 x 2½ in., comes with 6 ft. cord, and the price is $8.77. Description and order blanks can be found in the 1968 Allied catalog which you can get by writing Allied Radio Corp., Dept. 20, 100 N. Western Ave., Chicago, Ill. 60680.

This Is a Public Service

Coming along from Lafayette is the PF-175, a solid-state dual-band FM communications receiver with crystal control or tuneable frequency selection. The unit has FM coverage of 30-50 MHz and 152-174 MHz segments of public service radio segments. There are four integrated circuits in four IF stages with complementing tuned RF and mixer in front end. There's a built-in universal 117 VAC/12 VDC

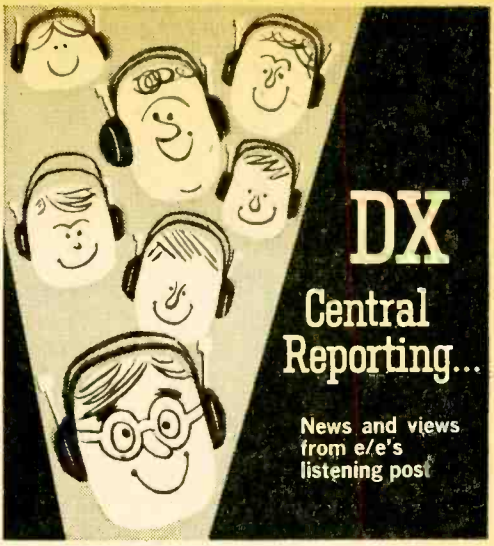


Lafayette PF-175 Dual-Band FM Receiver

power supply; variable squelch; illuminated dial; 4-in. speaker; external earphone jack; tape recording output jack. The size is 13¼ x 7½ x 6 in. and the finish is simulated wood grain. Price is $99.95 at your nearest Layafette dealer, or write to Lafayette Radio Electronics Corp., 111 Jericho Tpke., Syosset, N.Y. 11791.

Don't Try This on Your Dog!

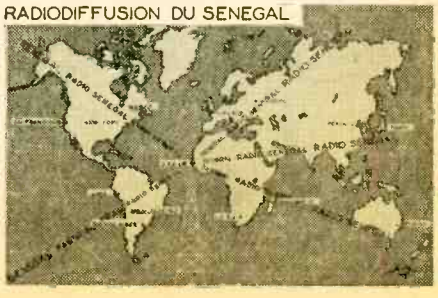
Maybe you saw this item demonstrated on the "Today" show. The Model LP-2 Ultrasonic Cleaner, to quote their brochure, "takes electrical energy from the line cord, converts it to mechanical energy at an ultrasonic frequency, and then puts the ultrasonic frequency mechanical energy into the cleaning liquid." The stainless steel cabinet is 6 x 4 x 4 in. with a crystal beaker, and can be filled, emptied and objects rinsed without moving the basic cabinet. The process of ultrasonically forming sub-microscopic bubbles which collapse and clean is called "cavitation." Use the cleaner on rings, bracelets, diamonds, dentures, electric shaver heads. combs, paint brushes. These objects are placed in a glass receptacle 3-in. in diameter and 1½-in. deep where they are vibrated 90,000 times per second by the unit's 90 kHz ultrasonic energy. Retail price is $39.95 from Electromation Components Corp. (E/MC²), 84 Toledo St., Farmingdale, N.Y. 11735. ■



Many novice SWLs, and a few old timers, too, are under the impression that stations in the newly independent African nations are hard to QSL, and that the only reliable DX targets, verification-wise, are such old timers as R. S. Africa and R. Clube de Mocambique. Nothing could be further from the truth. Most newly independent African stations QSL all correct reports.

Probably the best example of this is R. Senegal at Dakar. Although they have nothing to gain from North American reports (Dakar has no transmission beamed our way and, except for a brief 20 minute English session at 1340 EST, broadcasts entirely in French), they have sent thousands of attractive QSLs to American DXers. Their transmission to Europe and other parts of Africa is widely heard on this side of the Atlantic. For this beam, a 19-meter channel is currently used, with 15115 kHz last reported. S/Off for this transmission is 1900 EST.

Meanwhile, if the SWL doesn't mind staying up late, their 7210 kHz transmitter is even stronger at 0100 EST S/On. Or, if the DXer is going to log Africa on the medium-wave BCB at all, his best bet is Dakar's 764 kHz



Full color QSLs are the mark of Africans.

powerhouse and right now is the best time to try for it.

Although the staff has been completely revamped and many new powerful transmitters added to its arsenal, the station at Dakar dates back to colonial days and at one time was the only broadcast voice in what was then the vast territory of French West Africa. Ironically, Dakar has been a much better verifier since independence than in those good old days.

The Ultimate in Aero DX. Of late, you've heard a lot in this column about various pieces of aeronautical DX, simply because it makes available a bonanza of rare locations which otherwise would be out of reach for many SWLs using inexpensive equipment (Francistown is a good example of this). But now we'll let you in on a spot which is even rarer than all the others so far covered—Carp.

Never heard of it? Well, that's not exactly surprising as Carp appears on no map except those used for aeronautical purposes. It belongs to no country and has no permanent population. In fact, usually no population at all and no radio stations—except, of course, when an aircraft passes overhead. Carp is due East of Jacksonville, Florida and due North of the Bahamas.

Sounds like an ideal spot for a ham DXpedition, doesn't it? But Aero DXers will have no trouble at all bagging it as Carp is located on the New York-Nassau route and planes regularly pass over 24 hours a day. See the chart for frequencies. Also, to be logged on these same channels are other exotic targets like Trout (just East of Carp), and Smelt which is due North of Trout.

You may however run into difficulties with non-Aero DXers who will probably refuse to accept Carp and its neighbors as legitimate countries. Jealousy? Well, maybe. On the other hand, there is one little catch. Carp and the others consist entirely of water. They are ar-

FREE

Printed Circuit Board

Elementary Electronics has done it again! Our fourth free offer of a printed circuit board for your project building pleasure! See pages 28 and 64 to 66! More next issue!

FREE PRINTED CIRCUIT BOARD OFFER

As a special service to readers, the Editors of ELEMENTARY ELECTRONICS have arranged for you to receive a Free Divi-K Hertz Marker PC Board from Sentry Manufacturing Company. Just fill out and mail the coupon on the next page so it's postmarked on or before July 1, 1968. Should you desire to purchase the complete parts-package, place an X in the appropriate box and include a check or money order for $7.50 (price includes postage). Make checks payable to Sentry Mfg. Co.

The Editors
ELEMENTARY ELECTRONICS

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Photostats, Xerox copies, etc., cannot be accepted!

DX CENTRAL REPORTING

CARP FREQUENCIES

kHz	Time
2966 (MW)	Night
5566½	Night
6537	Afternoon & Night
8871	Days
13324½	Midday

bitrary reporting points selected by the International Civil Aviation Organization for traffic control purposes. Needless to say, as a dedicated Aero DX man, you won't let that argument stop you. After all, what could possibly be rarer than a country made up of nothing but water?

More African DX. From all that publicity which has been given the BBC's anti-Rhodesian station at Francistown (Botswana), most SWLs should be under the impression that these two nations, Botswana and Rhodesia, must be just short of a state of war. It is, therefore, a little disconcerting to tune in the aeronautical channels used in that part of Africa, 6552 and 8956 kHz, and hear Francistown Aeradio calmly working flights to and from Rhodesia in cooperation with the rebel regime's own Salisbury Aeradio.

While it may not be true, this whole bit gives shortwave listeners an eerie impression that the Botswana (BBC)/Rhodesia confrontation is some kind of bizzare practical joke which ends at the boundaries of those SW broadcast bands. Whether the impression is false or not, 6552 and 8956 kHz provide listeners with some excellent DX from east and south central Africa. Also heard on these frequencies, when conditions permit, are *aeradios* at Lusaka, Zambia (their SWBC station currently does not operate on the upper band at all), Blantyre, Malawi and Tambora. ■

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☐ Please send the Sentry parts package and the Free Printed Circuit Board for the Divi-K Hertz Marker. I am enclosing a check or money order for the sum of exactly $7.50, payable to Sentry Manufacturing Co.

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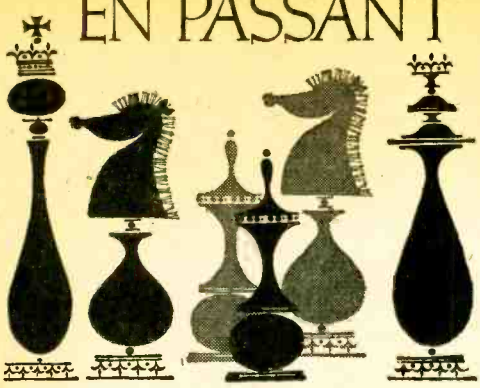
EN PASSANT

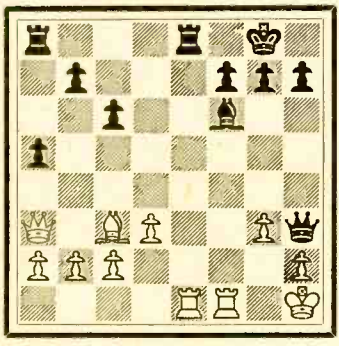


BY JOHN W. COLLINS

As I stated in an earlier column, study of the middle-game should begin with a thorough examination of its tactical motifs and I have presented five typical examples. Here are two more—more next issue.

Overworked Piece. This occurs when a piece or a Pawn has too many jobs to do—protecting two other pieces, or protecting a piece and a vital square.

Black



White

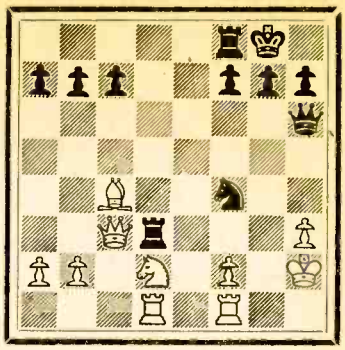
Black moves. White's Rook at K1 has the double duty of preventing 1 . . . R-K7 and of protecting his brother Rook. It's too heavy a load. So, Black exploits the situation with 1 . . . R-K7! Now if 2 RxR (Black was threatening 2 . . . QxRP mate) QxR mate.

Breaking Communication. Contact between forces is usually vital. When it is broken something often drops. See diagram top of next page.

Black moves. Black breaks the line of communication between the White Queen and its King Rook Pawn with 1 . . . R-Q6! Now if 2 BxR, QxP# 3 K-N1, Q-N7 mate. Or if 2 QxR, NxQ 3 BxN, Q-Q3# (remember Double Attack?) 4 P-B4, QxB wins. *(Turn page)*

EN PASSANT

Black



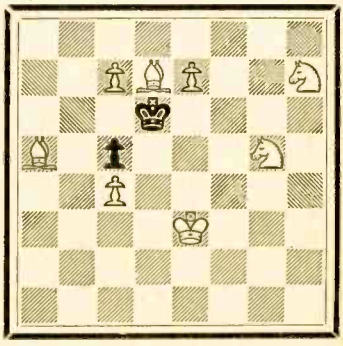
White

Solution to Problem 11: 1 N-K5

Problem 12

By J. Paul Taylor
England

Black



White

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

This unique two-mover is No. 48 in "Elementary Chess Problems" by J. Paul Taylor, published by G. C. Heywood, London, 1880.

News and Views. Bent Larsen of Denmark won the Interzonal Tournament at Sousse, Tunisia, with the grand score of 15½-5½. This qualified him, along with Geller, Gligoric, and Korchnoi, 14-7, to take part in the Challengers Tournament, the winner of which will play a match with Tigran Petrosian of the USSR for the World Championship. Hort, Reshevsky (USA), and Stein tied at 13-8 for the 6th and final place. They will have a playoff to determine the sixth qualifier. Leading the field with 8½-1½, U. S. Champion Fischer withdrew and/or was ruled out because of a dispute over scheduling. ■

ELEMENTARY ELECTRONICS ETYMOLOGY

By Webb Garrison

Tellurometer

▲ Though it's an ultra-sophisticated product of the electronic age, the high-sounding name of the *tellurometer* is simply a shorthand symbol to indicate "an earth-measuring device."

Until recent decades, surveyors had no instruments sufficiently refined to make accurate measurements at considerable distances. Because the speed of radio waves is precisely known, engineers conceived the idea of using them to measure distances—by converting time into units of length.

Principles that govern radar made possible the development of the tellurometer. Waves are directed from one operator to another and then bounced back. Elapsed time thus becomes a measure of distance. Accuracy of the instrument is so great that the margin of error in a 50-mile measurement is less than eight inches.

Lightweight and portable, this surveying device can be used in daylight or darkness, in clear or murky weather. Pioneer makers and users named the electronic instrument for surveying the earth from Latin *tellur* ("earth") plus the common suffix indicating a measuring device. ■

Tesla Coil

▲ Nikola Tesla, born in Austria-Hungry of Yugoslavian parents, came to the U. S. in 1884 when he was 28. He poured almost all of his creative energy into a life-long study of electricity.

One of the few authentic geniuses of all time, Tesla was concerned with both theoretical and practical matters. He solved many complex problems in his sleep. When working on an invention he could visualize all its components (with dimensions stipulated precisely) without producing any working drawings.

The rise of the electric railway had given a great boost to development of generators and motors. But until late in the 1880's only direct current was in commercial use. In a theoretical analysis Tesla criticized this state of affairs and suggested that AC motors be developed.

Then he tackled the problem of actually operating a motor with alternating current. He solved it with an induction motor in which voltage was induced in the rotor by a rotating magnetic field. Crude as it was by today's standards, this break-through paved the way to virtually universal adoption of AC motors.

He perfected hundreds of major processes and inventions. Yet his name survives in common speech only because his *tesla coil*, greatly modified from its original form, is a perennial favorite at science fairs and exhibits. Current of high voltage and high frequency that is produced by the coil was for a time employed in medical therapy. Today such "tesla current," like the name of the emigrant whose achievements rivalled those of Edison, is unknown to the average American. ■

Spectrum

▲ Sir Isaac Newton's fame rests largely upon his development of the theory of gravitation. But his earliest significant work was in the study of light and its characteristics.

During a three-year period that began in 1666, he purchased a number of prisms and lenses. With no other equipment, he set out to determine the nature of light.

Newton's most remarkable results were achieved by making a hole "in the shut of a window" and then placing a prism in the beam of light in such fashion that it was spread into a band of colors. Later he learned how to place a telescope lens about three feet in radius at just the right spot to cause the band of colors to converge and form white light indistinguishable from that admitted through the hole in his shutter.

From Latin for "image or specter" Newton called his ghostly band of colors the *spectrum*. Publication of his experiments with it led in 1672 to a great hue and cry among scientists. Some noted physicists and mathematicians (who didn't bother to repeat his experiments) challenged his conclusions on theoretical grounds. The spectrum, they said, existed only in Newton's imagination.

Such a commotion was created that by 1676 the Englishman had given up all attempts to convince skeptics. Otherwise, he said, he would have spent his entire time answering his critics and would have had to give up his search for new knowledge.

Eventually the eerie phenomenon that Newton had named came to be universally familiar. Because it includes all colors visible to man arranged in an orderly sequence, the notion of "a complete spread" attached to the term initially used to designate a spooky visual phenomenon.

Continued on page 38

LITERATURE

★ Starred items indicate advertisers in this issue. Consult their ads for additional information and specifications.

LIBRARY

CB—AMATEUR RADIO—SHORTWAVE RADIO

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

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

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

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

96. If a rugged low-cost business/industrial two-way radio is what you've been looking for, be sure to send for the brochure on *E. F. Johnson Co.'s* brand new Messenger "202."

103. *Squires-Sanders* would like you to know about their CB transceivers, the "23'er" and the new "S5S." Also, CB accessories that add versatility to their $-watters.

46. A long-time builder of ham equipment, *Hallicrafters* will send you lots of info on ham, CB and commercial radio equipment.

★**129.** Boy, oh boy—if you want to read about a flock of CB winners, get your hands on *Lafayette's* new 1968 catalog. *Lafayette* has CB sets for all pocketbooks.

122. Discover the most inexpensive CB mobile, Citi-Fone II by *Multi-Elmac Company*. Get the facts plus other CB product data before you buy.

50. Get your copy of *Amphenol's* "User's Guide to CB Radio"—18 pages packed with CB know-how and chit-chat. Also, *Amphenol* will let you know what's new on their product line.

121. Going CB? Then go *CB Center of America*. Get their catalog and discover the *big bonus* offered with each major product—serves all 50 states.

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

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

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

45. Hams, CBers, experimenters! *World Radio Labs* 1968 catalog is a bargain hunter's delight. Get your copy—it's free.

115. Get the full story on *Polytronics Laboratories'* latest CB entry—Carry-Comm. Full 5-watts, great for mobile, base or portable use. Works on 12 VDC or 117 VAC.

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

54. A catalog for CBers, hams and experimenters, with outstanding values. Terrific buys on *Grove Electronics'* antennas, mikes and accessories.

ELECTRONIC PARTS

132. Discover 18 new and different professional-quality amplifiers, tuners, and preamps completely assembled on PC-boards now offered by *Amperex*. Prices will amaze you!

1. *Allied's* catalog is so widely used as a reference book, that it's regarded as a standard by people in the electronics industry. Don't *you* have the 1968 *Allied Radio* catalog? The surprising thing is that it's free!

★**2.** The new 1968 Edition of *Lafayette's* catalog features sections on stereo hi-fi, CB, ham gear, test equipment, cameras, optics, tools and much more. Get your copy today.

8. Get it now! *John Meshna, Jr.'s* new 46-page catalog is jam packed with surplus buys—surplus radios, new parts, computer parts, etc.

★**23.** No electronics bargain hunter should be caught without the 1968 copy of *Radio Shack's* catalog. Some equipment and kit offers are so low, they look like misprints. Buying is believing.

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

★**106.** With 70 million TV and 240 million radios somebody somewhere will need a vacuum tube replacement at the rate of one a second! Get *Universal Tube Co.'s* Troubleshooting Chart and facts on their $1 flat rate per tube.

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

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

6. Bargains galore, that's what's in store! *Poly-Paks Co.* will send you their latest eight-page flyer listing the latest in available merchandise, including a giant $1 special sale.

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

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

120. *Tab's* new electronics parts catalog is now off the press and you're welcome to have a copy. Some of *Tab's* bargains and odd-ball items are unbelievable offers.

117. Harried by the high cost of parts for projects? Examine *Bigelow's* 13th Anniversary catalog packed with "Lucky 13" specials.

ELECTRONIC PRODUCTS

★**42.** Here's a colorful 108-page catalog containing a wide assortment of electronic kits. You'll find something for any interest, any budget. And *Heath Co.* will happily send you a copy.

★**44.** Get your copy of *EICO's* colorful 36-page catalog on 200 "best buys" products. Ham radio, CB, hi-fi, test gear, both wired and kit, are illustrated.

128. If you can hammer a nail and miss your thumb, you can assemble a *Schober* organ. To prove the point, *Schober* will send you their catalog and a 7-in. disc recording.

126. *Delta Products* new capacitive discharge ignition system in kit form will pep up your car. Designed to cut gas costs and reduce point and plug wear. Get *Delta's* details in full-color literature.

66. Try instant lettering to mark control panels and component parts. *Datak's* booklets and sample show this easy dry transfer method.

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

TOOLS

★**78.** Color-coded, regular, and hollow-shaft *Xcelite* nutdriver sets are now offered in sturdy, molded plastic cases—great for stowing. Get *Xcelite's* bulletin N567 for details.

118. Secure coax cables, speaker wires, phone wires, etc., with *Arrow* staple gun tackers. 3 models for wires and cables from 3/16" to ½" dia. Get fact-full Arrow literature.

SCHOOLS AND EDUCATIONAL

★74. Whiz through math and electronics problems without pencil and paper. Get the facts on the amazing Electronics Slide Rule and 4-lesson instruction course offered by *Cleveland Institute of Electronics*. No charge!

61. *ICS (International Correspondence Schools)* wants to send you a 64-page booklet on the most often asked questions on preparing for an electronics career. You also get "How to Succeed" and a sample *ICS* lesson.

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

59. For a complete rundown on curriculum, lesson outlines, and full details from a leading electronic school, ask for this brochure from the *Indiana Home Study Institute*.

105. Get the low-down on the latest in educational electronic kits from *Trans-Tek*. Build light dimmers, amplifiers, metronomes, and many more. *Trans-Tek* helps you to learn while building.

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

HI-FI/AUDIO

134. Discover *PlayTape*—America's newest tape cartridge and tape players. Units priced at under $17 with cartridges at 45-disc prices. *PlayTape* has one of America's largest recording libraries.

19. *Empire's* new 16-page, full-color catalog features speaker systems in odd shapes for beautiful room decor. Also, rediscover *Empire's* quality turntable line and cartridges.

124. Now, *Sonotone* offers you young ideas in microphone use in their new catalog. Mikes for talk sessions, swinging combos, home recording, PA systems and many more uses.

26. Always a leader, *H. H. Scott* introduces a new concept in stereo console catalogs. The information-packed 1968 Stereo Guide and catalog are required reading for audio fans.

85. Write the specs for an ideal preamp and amp, and you've spelled out *Dynaco's* stereo 120 amp and PAS-3X preamp. So why not get all the facts from *Dynaco!*

119. *Kenwood* puts it right on the line. The all-new *Kenwood* stereo-FM receivers are described in a colorful 16-page booklet complete with easy-to-read-and-compare spec data. Get your copy today!

131. Let *Elpa* send you "The Record Omibook." It's a great buy and *Elpa* wants you to have it free. Your records will thank you when the mailman delivers it.

16. *Garrard's* Comparator Guide clues you in on the new Synchro-Lab turntable/changer series. Discover how *Garrard* locks on to the correct disc speed.

17. Mikes, speakers, amps, receivers—you name it, *Electro-Voice* makes it and makes it good. Get the straight poop from *E-V* today.

27. 12 pages of *Sherwood* receivers, tuners, amplifiers, speaker systems, and cabinetry make up a colorful booklet every hi-fi bug should see.

95. Confused about stereo? Want to beat the high cost of hi-fi without compromising on the results? Then you need the new 24-page catalog by *Jensen Manufacturing*.

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

TAPE RECORDERS AND TAPE

123. Yours for the asking—*Elpa's* new "The Tape Recording Omnibook." 16 jam-packed pages on facts and tips you should know about before you buy a tape recorder.

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

32. "Everybody's Tape Recording Handbook" is the title of a booklet that *Sarkes-Tarzian* will send you. It's 24-pages jam-packed with info for the home recording enthusiast. Includes a valuable table of recording times for various tapes.

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

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

HI-FI ACCESSORIES

112. *Telex* would like you to know about their improved Serenata Headset—and their entire line of quality stereo headsets.

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

TELEVISION

★70. Need a new TV set? Then assemble a *Heath* TV kit. *Heath* has all sizes. B&W and color, portable and fixed. Why not build the next TV you watch?

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

97. Interesting, helpful brochures describing the TV antenna discovery of the decade—the log periodic antenna for VHF and UHF-TV, and FM-stereo. Get it from *JFD Electronics Corporation*.

ELEMENTARY ELECTRONICS
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New York, N. Y. 10022

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10 New Kits From Heath . . .

New Deluxe Heathkit "227" Color TV

Exclusive Heathkit Self-Servicing Features. Like the famous Heathkit "295" and "180" color TV's, the new Heathkit "227" features a built-in dot generator plus full color photos and simple instructions so *you* can set-up, converge and maintain the best color pictures at all times. Add to this the detailed trouble-shooting charts in the manual, and you put an end to costly TV service calls for periodic picture convergence and minor repairs. No other brand of color TV has this money-saving self-servicing feature.

Advanced Features. Top quality American brand color tube . . . 227 sq. in. rectangular viewing area . . . 24,000 v. regulated picture power . . . improved phosphors for brilliant, livelier colors . . . new improved low voltage power supply with boosted B+ for best operation . . . automatic degaussing . . . exclusive Heath Magna-Shield to protect against stray magnetic fields and maintain color purity . . . ACC and AGC to reduce color fade and insure steady, flutter-free pictures under all conditions . . . preassembled & aligned IF with 3 stages instead of the usual 2 . . . preassembled & aligned 2-speed transistor UHF tuner . . . deluxe VHF turret tuner with "memory" fine tuning . . . 300 & 75 ohm VHF antenna inputs . . . two hi-fi sound outputs . . . 4" x 6" 8 ohm speaker . . . choice of installation — wall, custom or optional Heath factory assembled cabinets. Build in 25 hours.

Kit GR-227, (everything except cabinet) . . . 114 lbs. . . . $42 dn., as low as $25 mo. **$419.95**

GRA-227-1, Walnut cabinet. 54 lbs. no money dn., $6 mo. . . . **$59.95**

GRA-227-2, Mediterranean Oak cabinet (shown above) 70 lbs. . . . no money dn., $10 mo. **$94.50**

Kit GR-227
$419.95 (less cabinet)
$25 mo.

Kit GRA-27
$19.95

New Remote Control For Heathkit Color TV

Now change channels and turn your Heathkit color TV off and on from the comfort of your armchair with this new remote control kit. Use with Heathkit GR-227, GR-295 and GR-180 color TV's. Includes 20' cable.

Kit GR-295
$479.95
(less cabinet)
$42 mo.

Deluxe Heathkit "295" Color TV

Color TV's largest picture . . . 295 sq. in. viewing area. Same features and built-in servicing facilities as new GR-227. Universal main control panel for versatile in-wall installation. 6" x 9" speaker.

Kit GR-295, (everything except cabinet), 131 lbs. . . . $48 dn., $42 mo. **$479.95**

GRA-295-4, Mediterranean cabinet (shown above), 90 lbs. . . . no money dn., $11 mo. **$112.50**

Other cabinets from $62.95.

Kit GR-180
$359.95
(less cabinet & cart)
$22 mo.

Deluxe Heathkit "180" Color TV

Same high performance features and exclusive self-servicing facilities as new GR-227 (above) except for 180 sq. in. viewing area.

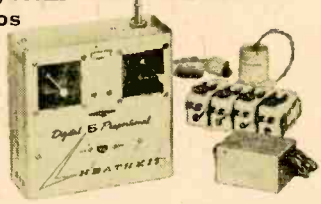
Kit GR-180, (everything except cabinet), 102 lbs. $36 dn., as low as $22 mo. **$359.95**

GRS-180-5, table model cabinet & mobile cart (shown above), 57 lbs. . . . no money dn., $5 mo. **$39.95**

Other cabinets from $24.95.

New! Heathkit/Kraft 5-Channel Digital Proportional System with Variable Capacitor Servos

System Kit GD-47
$219.95
$21 mo.



This Heathkit version of the internationally famous Kraft system saves you over $200. The system includes solid-state transmitter with built-in charger and rechargeable battery, solid-state receiver, receiver rechargeable battery, four variable capacitor servos, and all cables. Servos feature sealed variable capacitor feedback to eliminate failure due to dirty contacts, vibration, etc.; three outputs: two linear shafts travel ⅝" in simultaneous opposite directions plus rotary wheel. Specify freq.: 26.995, 27.045, 27.145, 27.195 MHz.

System Kit GD-47, all of above, 5 lbs. **$219.95**
Kit GDA-47-1, transmitter, battery, cable, 3 lbs. **$86.50**
Kit GDA-47-2, receiver, 3 lbs. **$49.95**
GDA-47-3, receiver rechargeable battery, 1 lb. **$9.95**
Kit GDA-47-4, one servo only, 1 lb. **$21.50**

New! Heath/Mitchell COLORVAL Darkroom Computor . . . Kit or Assembled

Kit PM-17
$89.95
$9 mo.

Colorval takes the work out of color printing, leaves the creativity to you. Colorval is easy to set up . . . you "program" the scan filter pack for the type of film, paper, and equipment you use . . . we show you how. Unique Color Probe allows visual determination of ideal enlarger filter combination. Color Wheel and table shows what filter changes are needed. Exposure Probe scans shadows and highlights; exposure scale on Computer indicates proper contrast for color and b/w printing. Get started in color the right way, quickly, easily.

Kit PM-17, 6 lbs., no money dn., $9 mo. **$89.95**
Assembled PMW-17, 6 lbs. . . . no money dn., $13 mo. . . . **$125.00**

See 300 More in FREE Catalog

What would you expect to pay for a Vox "Jaguar" Combo organ with a 180-watt 3-channel amp? $1000? $1250? $1500? More?

You can get both for only $598 during this Special Heathkit Offer!

Now you can get this famous professional combo organ with a versatile high-power piggy-back amp. and matching speaker system for just a little more than you'd expect to pay for the "Jaguar" alone! The Heathkit/Vox "Jaguar" is solid-state; two outputs for mixed or separated bass and treble; reversible bass keys for full 49 key range or separate bass notes; bass volume control; vibrato tab; bass chord tab; four voice tabs (flute, bright, brass, mellow); keyboard range C_2 to C_6 in four octaves; factory assembled keyboard, organ case with cover, and stand with case. Also available separately; you'll still save $150 (order Kit TO-68, $349.95).

The Heathkit TA-17 Deluxe Super-Power Amplifier & Speaker has 180 watts peak power into one speaker (240 watts peak into a pair); 3-channels with 2 inputs each; "fuzz", brightness switch; bass boost; tremolo, reverb; complete controls for each channel; foot switch; 2 heavy duty 12" speakers plus horn driver. Also available separately kit or factory assembled (Kit Amplifier TA-17, $175; Assembled $275; Kit Speaker TA-17-1 $120; Assembled $150; Kit TAS-17-2, amp. & two speakers $395; Assembled TAW-17-2, amp. & two speakers $545).

Kit TOS-1
Organ, Amplifier & Speaker Kits (240 lbs.)
$598.00

Kit TOS-2
Organ Kit, Assembled Amplifier & Speaker (240 lbs.)
$698.00

New! Solid-State Portable Volt-Ohm-Meter

So Handy, So Low Cost we call it "every man's" meter. Just right for homeowners, hobbyists, boatowners, CBer's, hams ... it's even sophisticated enough for radio & TV servicing! Features 12 ranges ... 4 AC & 4 DC volt ranges, 4 ohm ranges; 11 megohm input on DC, 1 megohm input on AC; 4½" 200 uA meter; battery power; rugged polypropylene case and more. Easy 3 or 4 hour kit assembly.

Kit IM-17
$19.95

New! Heathkit Guitar Headphone Amplifier

Kit TA-58
$9.95

Now you can play and practice your electronic guitar in private! Just plug this miniature amplifier into the jack of your guitar and use a pair of headphones. Solid-state circuit has tailored response; automatic off-on switching; self-contained battery (not supplied); and capability of operating one or two pairs of mono or stereo headphones of 4 to 2 meghohms. Ideal for practice or instruction. Easy to build.

Kit TA-58, 2 lbs. **$9.95**

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e/e Etymology

Continued from page 31

Today, in spite of the fact that they involve the ears rather than the eyes, "radio spectrum" and "sound spectrum" are often used interchangeably. Spread of this band of waves is from about near zero cycles to more than 30,000,000,000 cycles.

A far greater spread is involved in the "electro-magnetic spectrum," which includes waves ranging from the shortest cosmic rays to the longest radio waves. Only a tiny fraction of the total number of waves within the band of electromagnetic radiation stimulate the human eye in such fashion that vision results. In spite of this factor, the name that Newton modelled on that of a visual apparition is still in universal use. ■

Walkie-Talkie

▲ No one knows why, but in every age and epoch persons have tended to form two-part words which are like miniature rhymes. Psychologists think that in some way this gives pleasure related to that of writing or reading poetry.

Modern Americans have spontaneously and joyfully coined such rhyming terms as: chitchat, claptrap, deadhead, gyp joint, honky-tonk, nitwit, plug ugly, slap-happy, and dozens of others.

So it was natural rather than unusual for some user of a portable radio-telephone to rebel at so formal a name. Spontaneously and without premeditation it was dubbed the *Walkie-talkie*. Like many other rhyming terms, this one has a pleasant rhythm and is also descriptively accurate.

If the present trend continues—as seems inevitable—school children a few years hence will use "walkie-talkie" as standard English just as acceptable as words inherited from Shakespeare and the King James Version of the Bible. ■

"You were doing 60 in a 50-mile zone!"

elementary Electronics MAY-JUNE 1968

Build Mariner IV

By Charles Green, W6FFQ

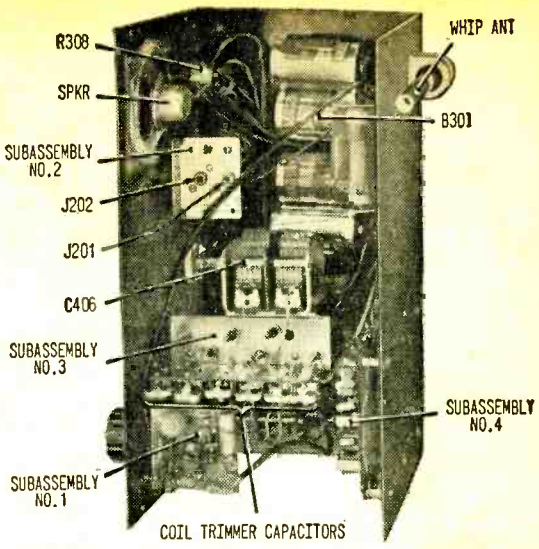
Since the early spark-gap days, radio operators have been filling the marine bands with messages from ship-to-ship and ship-to-shore. And these are exciting messages, filled with the salty talk of the sea. Tugs, fishing boats, cargo vessels, and small pleasure craft are busy around the clock with their radio transmissions. You can (Continued overleaf)

listen in on these marine band goings-on with our *Mariner IV* transistorized portable receiver. Coverage includes reception on the low-frequency (150 to 420 kHz), broadcast (550 to 1700 kHz), shortwave (1.6 to 4.3 MHz), and the VHF (144 to 162 MHz) bands. Mariner IV makes an ideal receiver for the yachtsman, too.

A telescoping whip antenna is used for reception on all bands, and a rotatable broadcast-band loop antenna can be used for direction finding. The VHF band can be received on the whip antenna, or an external VHF antenna can be connected. A BFO circuit allows CW reception, and coverage is included for the 160-, 80-, and 2-meter ham bands.

IF and AF modules are used to make receiver construction easier. Four transistors are used for the RF amplifier, convertor, BFO, and VHF detector circuits. Six D-cells supply power to the receiver, making it portable. One word of caution, though: a project of this complexity shouldn't be attempted as a *first* construction effort.

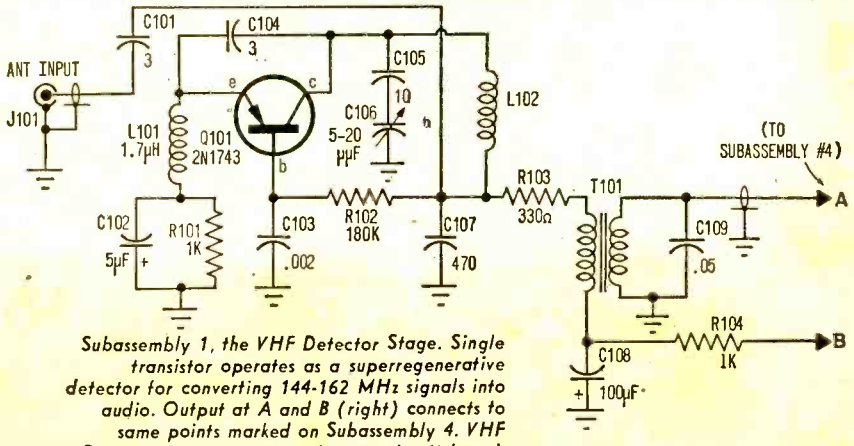
The Circuit. Look at Subassembly 2. LF, BC, and SW signals from the whip antenna are fed through choke L201 to the preselector tuned circuits and the loop antenna. The preselector's operating band is selected by switch S201, and the low-impedance output signal is fed to the emitter of RF amplifier transistor Q301 in Subassembly 3. The amplified signals are fed through band-switch S401's tuned circuits (Subassembly 4) to the base of the autodyne-convertor transistor Q302. The oscillator circuit of Q302 is tuned 455 kHz above the incoming signals.



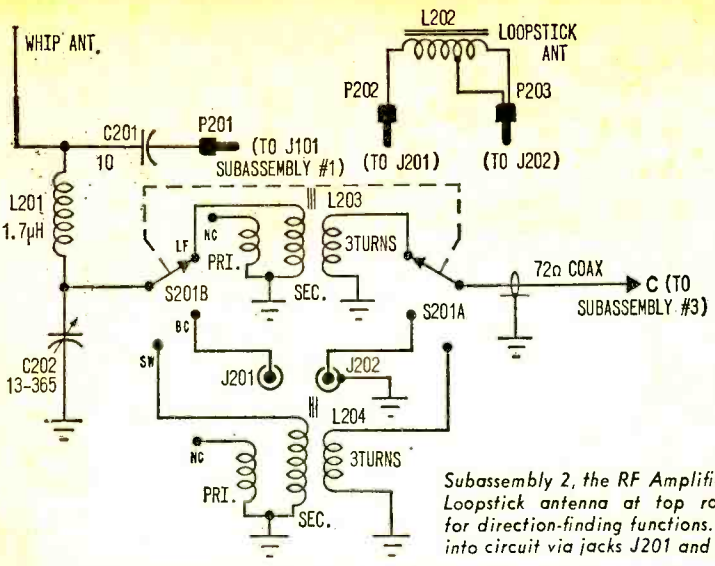
Top view of completed receiver with cover removed. Note relative position of the four major subassemblies. Other components fasten directly to case.

The resultant 455-kHz IF output signal is amplified and detected by the IF module. The detected audio signals are fed to the AF module and the speaker. For CW reception, the BFO circuit (Q303) is turned on by S301. Transformer T301 is preset close to the 455-kHz IF frequency to produce an audio beat on CW signals. The wiring capacity between the circuits couples the BFO and the IF module.

When the bandswitch is set to the VHF



Subassembly 1, the VHF Detector Stage. Single transistor operates as a superregenerative detector for converting 144-162 MHz signals into audio. Output at A and B (right) connects to same points marked on Subassembly 4. VHF Detector stage mounts on its own circuit board.



Subassembly 2, the RF Amplifier Tuning circuit. Loopstick antenna at top rotates on receiver lid for direction-finding functions. It plugs directly into circuit via jacks J201 and J202.

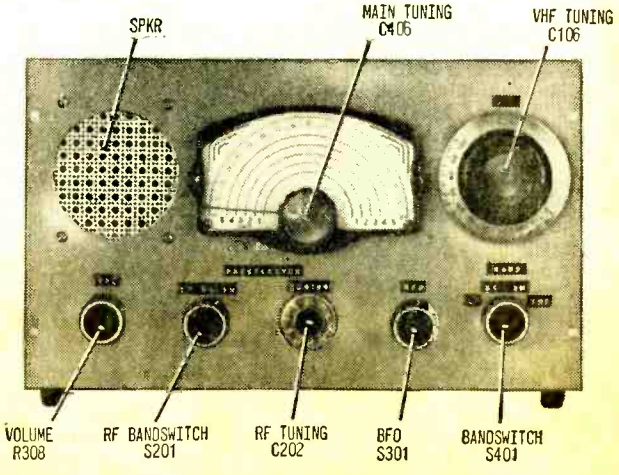
position, S401 disconnects the power circuit from the RF, convertor, BFO, and IF module, and energizes the VHF superregen detector circuit of Q101 shown in Subassembly 1. VHF signals are tuned by C105, C106, and L102. The detected audio is then fed through T101 via S401 to the AF amplifier module.

Getting Started. The receiver is built into a 7- x 12- x 8-in. cowl-type chassis-box, which holds the four subassemblies. To get started, fasten a sheet of block paper on the front panel and lay out the control locations as shown in the photos. Cut the holes and mount the controls using lock-washers. Do not install the dial glass at this time.

Remove the trimmer capacitors from C406, then mount the variable capacitor on a 4-in. long x 2¼-in. wide heavy sheet-aluminum bracket. Use a flexible coupling between the capacitor's shaft and the vernier dial. Full-capacity position should be *0* on the vernier logging scale.

The coil assembly is mounted on a 4- x 1¼- x ½-in. aluminum bracket fastened on the top of the capacitor's mounting bracket. Before mounting the coil bracket, wind three turns of hookup wire around each coil in the same direction as the coil winding. Install a 3¾ x 2-in. perf-board section on the edge of the coil bracket with a small bracket at each end as shown in the photos.

Mount the trimmer capacitors on push-in terminals on the top of the perf-board sec-



Front-panel view of receiver reveals position of tuning controls and speaker. After alignment is done, the face of main tuning dial (C406) may be calibrated with suitable frequency indications. Both switches (S201 and S401) must be hand set to the appropriate frequency band during operation.

tion. Wire the perf board as shown in schematic of Subassembly 4. Note that the oscillator circuit (3-turn coupling) coil windings are brought out to separate terminals on the perf-board so their connections can be reversed if any coil won't oscillate.

AF And IF. Cut a 3⅝ x 5¾-in. perf-board section and mount the amplifier module at one end as shown in the photos. Use insulated spacing washers to prevent wiring shorts. Carefully solder four solder lugs on the sides of the IF module, bend them out, and mount the module on the perf-board below the amplifier module. Cut holes in the board and box rear for IF tuning access. Mount the other components on the perf-board with push-in terminals, and wire the board as shown in the schematic drawing.

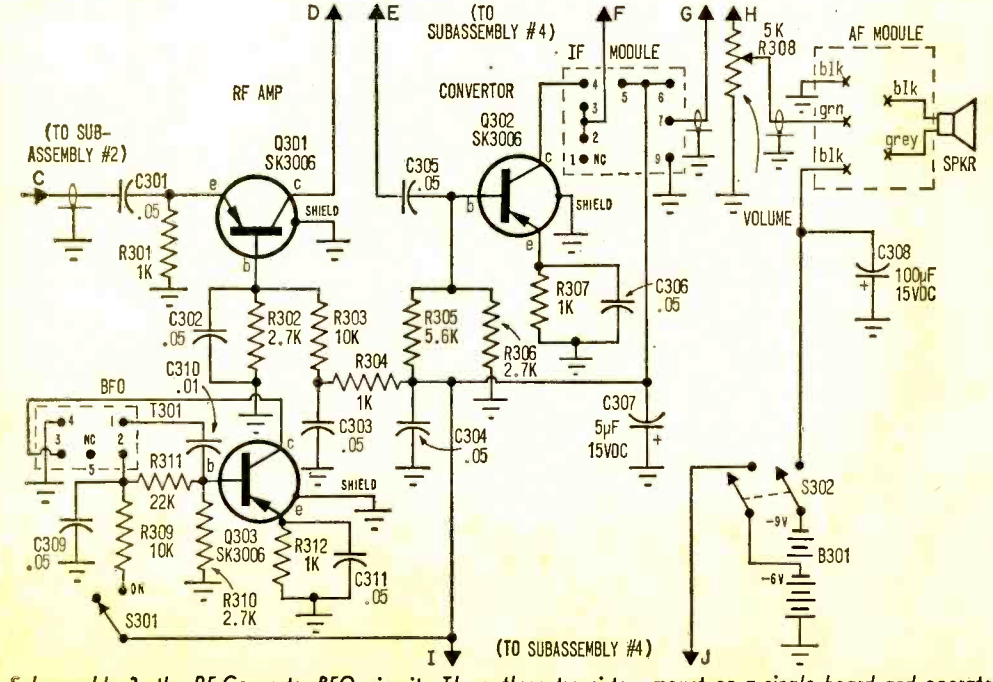
Bend a *U* bracket approximately 1 x 1 x 1-in. for the whip antenna. Mount the antenna in rubber grommets fitted into holes cut in the bracket ends. The antenna wire is fed through a rubber grommet to the terminal strip fastened with one of the bracket's mounting screws.

Antenna Mount. Mount the loop antenna with two 1- x 1½-in. balsa wood sections. The wood sections are shaped so that a length of split plastic tubing will fit snugly over them. The wood sections are cemented to the ends of the hardboard strip supplied with the loop antenna. A ⅜-in. threaded bushing fastened to the center of the hardboard strip allows the loop to rotate.

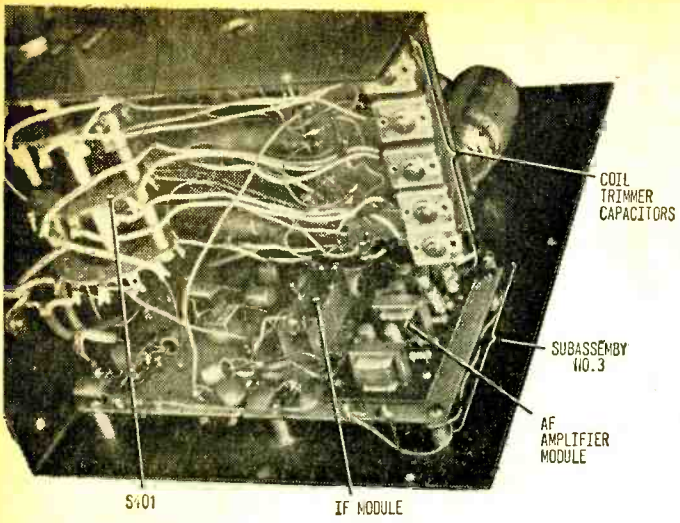
Mount a screw on the top of the receiver box lid to act as a stop for the loop antenna rotation. Match it with another screw mounted in the bottom of the loop strip, so the loop will stop after one rotation. This is necessary to prevent breaking the loop connecting wires to the receiver. Use lightweight stranded hookup wire for connecting the loop.

Remove one rotor blade from C106. Then cut a 2⅛ x 2⅛-in. section of perf-board and mount it to the bottom of C106. Wire the components on the board, using push-in clips, and cut the clip ends to prevent shorting to the capacitor's frame. Coil L102 is made by winding 3½ turns of #20 buss wire around a ¼-in. drill, then stretching it out to ½-in. and cutting the leads so they are ¼-in. long.

Aligning It. Install the batteries in the



Subassembly 3, the RF-Convertor-BFO circuit. These three transistors mount on a single board and operate for all bands except VHF. Two additional circuits appear in this schematic; the IF and AF modules. Both are factory-wired printed circuit board components installed according to number and color codes given.

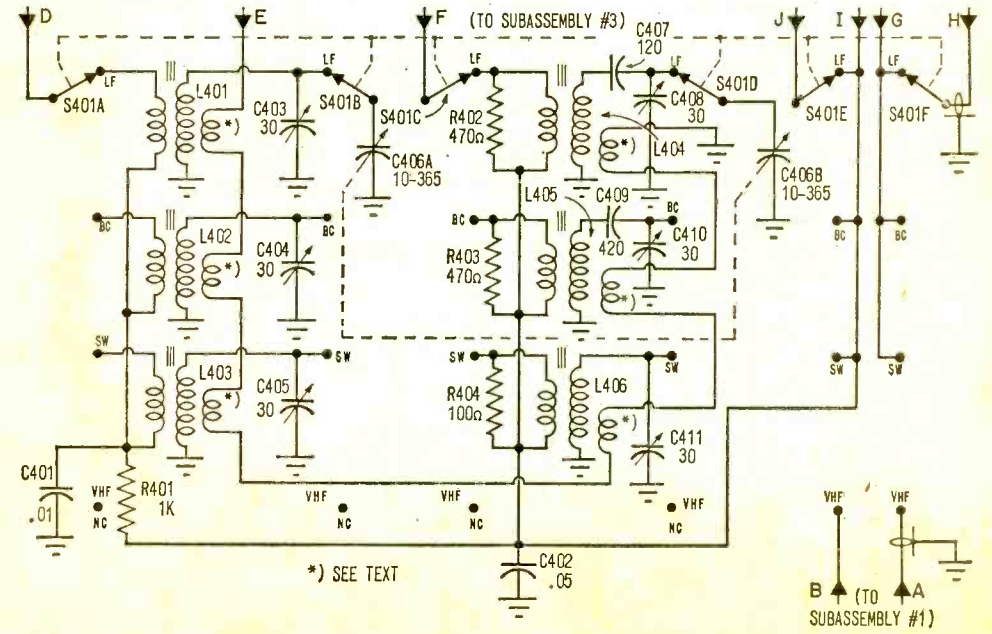


View looking into right side of receiver (as seen from front). Front panel is partially visible at top left of photo. Note position of prewired IF and AF modules. They're mounted on larger board which forms Subassembly 3. The board is raised from rear panel of metal cabinet by spacers (three posts visible under board at bottom of photo).

receiver and place the box lid adjacent to the unit, with the loop antenna leads plugged into J201 and J202. Set the preselector switch and bandswitch to LF position. Adjust the signal generator for a 455-kHz (modulated) signal and loosely couple it to the receiver's antenna by connecting to a length of wire alongside the rear of the set.

Turn the volume control clockwise and peak up the IF module adjustment tuning screw. Rock the signal-generator frequency control back and forth to make sure you are on the exact frequency the module is tuned to. Turn BFO switch S301 *on* and tune the adjustment screw on T301 until you hear an audio beat note in the speaker. Then switch the BFO off.

For easier coil alignment, set the coil tuning screws to the following lengths out from the top of the coil forms: L2—⅝ in., L3—½ in., L5—½ in., L6—⅜ in., L7—⅜ in., L8—⅝ in., L9—½ in., L10—⅝ in.



Subassembly 4, Coils for Convertor Tuning. Where an asterisk (*) is shown next to a winding it signifies a 3-turn coil of plastic-insulated hookup wire wound by hand over the main winding. If the local oscillator doesn't work on a band, reverse connections to the 3-turn coil for obtaining feedback in proper direction.

e/e MARINER IV

Set the tuning dial to 28 on the logging scale and adjust the generator for a 150-kHz signal. Peak L401 and L404 tuning screws for maximum output in the speaker. Set the tuning dial to 170 on the logging scale and the generator to 420 kHz. Peak C403 and C408 for maximum output. Go over these adjustments once more. Set the preselector and bandswitch to BC position. Adjust the tuning dial to 12 on the logging scale and the generator to 550 kHz. Peak L402 and L405 for maximum output. Set the tuning dial to 170 and the generator to 1700 kHz. Peak C404 and C410 for maximum output. Repeat these adjustments, too.

Set the preselector and bandswitches to SW position. Adjust the tuning dial to 10 on

PARTS LIST FOR MARINER IV RECEIVER

VHF Detector Circuit, Subassembly No. 1

C101, C104—3-pF capacitor
C102—5-uF, 15-VDC electrolytic capacitor
C103—.002-uF capacitor
C105—10-pF capacitor
C106—5- to 20-pF variable capacitor (Johnson 149-1 or equiv.)
C107—470-pF capacitor
C108—100-uF 15-VDC electrolytic capacitor
C109—.05-uF capacitor
J101—Phono jack (RCA type)
L101—1.7-uH RF choke
L102—4 turns #20 wire, 3/8-in. dia. x 1/2-in. long, 1/8-in. leads
Q101—2N1743 transistor
R101, R104—1000-ohm, 1/2-watt resistor
R102—180,000-ohm, 1/2-watt resistor
R103—330-ohm, 1/2-watt resistor
T101—Transistor driver transformer, 10,000-ohm pri. to 2000-ohm sec. (Radio Shack B731378 or equiv.)

RF Amplifier Tuning Circuit, Subassembly No. 2

C201—10-pF capacitor
C202—13- to 365-pF, single-gang variable capacitor (Lafayette 99C6217 or equiv.)
J201—Phone tip jack
J202—Phone jack (RCA type)
L201—1.7-uH RF choke
L202—240-uH loopstick antenna (Miller 2000 or equiv.)
L203—Low-frequency antenna coil with three turns added for secondary—see text (Miller X-5495-A or equiv.)
L204—Shortwave antenna coil with three turns added for secondary—see text (Miller B-5495-A or equiv.)
P201, P203—Phono plug (RCA type)
P202—Phone tip plug
S201—Double-pole, triple-throw, non-shorting rotary switch (Centralab 1472 or equiv.)

RF, Mixer, IF And AF Circuit, Subassembly No. 3

B301—6 D-cells in holders, series connected
C301, C302, C303, C304, C305, C306, C309, C311—.05-uF capacitor
C307—5-uF 15-VDC electrolytic capacitor
C308—100-uF capacitor 15-VDC
C310—.01-uF capacitor
Q301, Q302, Q303—SK3006 transistor
R301, R304, R307, R312—1000-ohm, 1/2-watt resistor
R302, R306, R310—2700-ohm, 1/2-watt resistor
R303, R309—10,000-ohm, 1/2-watt resistor
R305—5600-ohm, 1/2-watt resistor
R308—5000-ohm potentiometer
R311—22,000-ohm, 1/2-watt resistor
S301—S.p.s.t. rotary switch (Centralab 1460 or equiv.)
S302—D.p.s.t. switch on R308
T301—IF transformer (supplied with IF module)
1—Audio-frequency amplifier module (Lafayette 99C9042 or equiv.)
1—Intermediate frequency amplifier module (Lafayette 99H6254 or equiv.)

Mixer Tuning Circuit, Subassembly No. 4

C401—.01-uF capacitor
C402—.05-uF capacitor
C403, C404, C405, C408, C410, C411—2- to 30-pF mica trimmer capacitor
C406—10- to 365-pF dual-section variable capacitor (Lafayette 32C1102 or equiv.)
C407—120-pF capacitor
C409—420-pF capacitor
L401—Low-frequency RF coil (Miller X-5495-RF)
L402—Broadcast-band RF coil (Miller A-5495-RF)
L403—Shortwave RF coil (Miller B-5495-A)
L404—Low-frequency oscillator coil (Miller X-5495-C)
L405—Broadcast-band oscillator coil (Miller B-5495-C)
L406—Shortwave oscillator coil (Miller C-5495-C)
R401—1000-ohm, 1/2-watt resistor
R402, R403—470-ohm, 1/2-watt resistor
R404—100-ohm, 1/2-watt resistor
S401—Six-pole, four-throw, non-shorting rotary switch

Miscellaneous Parts

1—52-in. long telescoping whip antenna (Lafayette 99C3008 or equiv.)
1—3-in. dia. 8-ohm speaker
1—7 x 12 x 8-in. cowl-type chassis-box (Bud SC2131 or equiv.)
1—Section perforated board
1—Bag push-in clips for perf-board
1—Flexible shaft coupling for C406
1—Vernier dial (Lafayette 99C2566 or equiv.)
6—1/2-in. spacers for mounting perf board
6—Knobs
Misc.—Shielded cable, RG58/U coax cable, aluminum for brackets, mounting hardware, wire, solder, grommets, etc.

the logging scale, and the generator to 1.6 MHz. Peak L404 and L406 for maximum output. Set the tuning dial to 170 on the logging scale and the generator to 4.3 MHz. Peak C405 and C411 for maximum output. Repeat the adjustments.

VHF Tune-Up. Set the bandswitch to VHF and listen for the typical super-regenerative hiss. This should occur over the entire dial range of C106. Set the VHF tuning control to full capacity and the signal generator to 144 MHz. Squeeze or stretch L102 until you hear the signal in the speaker. Note: output on the VHF band will not be as great as on the other bands.

Install the box cover on the receiver and calibrate the VHF band with the generator. The prototype covered from 144 to 164 MHz. If your coverage is not the same, change the value of C105. A dial with a logging scale only was used for the VHF range, but you can cement a paper scale on the panel and use a pointer knob. Calibrate the other bands with the signal generator and install the verier dial glass.

Operation. For best reception on the LF and SW bands, the whip antenna should be fully extended. You may find better reception for VHF if the whip antenna length is slowly adjusted to peak the signal reception. The BC band can be received with either the whip or loop antenna. Rotate the loop for best reception.

The LF, BC, and SW bands can be peaked for best reception by tuning the preselector control. For greater range, connect an outside antenna on the base of the whip antenna. Note that images of strong BC stations might be received on the LF band.

Set the preselector switch for each band (except the VHF band) when you set the bandswitch. The preselector switch, for example, should be set to BC when the bandswitch is set to BC. The preselector tuning can then be adjusted to peak up weak signals on the LF, BC, and SW bands.

The preselector tuning is not used on the VHF band. Setting the bandswitch to VHF connects the VHF detector circuit to the audio stages and disconnects the lower-frequency circuits. The BFO circuit will not work on the VHF portion of the Mariner IV receiver.

Strong VHF stations can be received by plugging in the whip antenna. Weaker stations can be received by disconnecting the whip and plugging in a high outside VHF antenna. Good results can be achieved by using a TV antenna for horizontally polarized VHF signals. ■

Cop Calling Computer

Digital communications techniques will add more privacy in police communications systems, as well as provide a means for speeding message traffic to mobile radios in police cars. Greater security is one of several ways digital systems can improve the performance of law enforcement agencies.

Basically, digital overlay (a concept GE engineers have developed) sends discrete bits of information in coded form over a voice radio channel. The coded information occupies only a portion of the voice channel, and voice could be sent simultaneously on the same channel.

Voice would be used primarily for emergency calling, while coded traffic would be for routine or special-function communications. Digital techniques can be used for both one-way and two-way systems.

The one-way, base-to-mobile system will provide message security to the extent that snoopers who might intercept are not equipped with decoders and printers. In a more sophisticated form, the codes themselves could be modified on a periodic basis. It will also conserve spectrum time assuming that voice and data are transmitted simultaneously. Dispatching can be improved because routine messages can be coded and sent at any time and their receipt is assured even if the mobile unit is temporarily vacant. (Cops drink coffee, you know!) The voice capabilities of the system are preserved for emergencies and response time may, therefore, be expected to improve.

A police officer is informed that the car he spotted and 'phoned in is a stolen vehicle.

Brain Scanning—the easy way

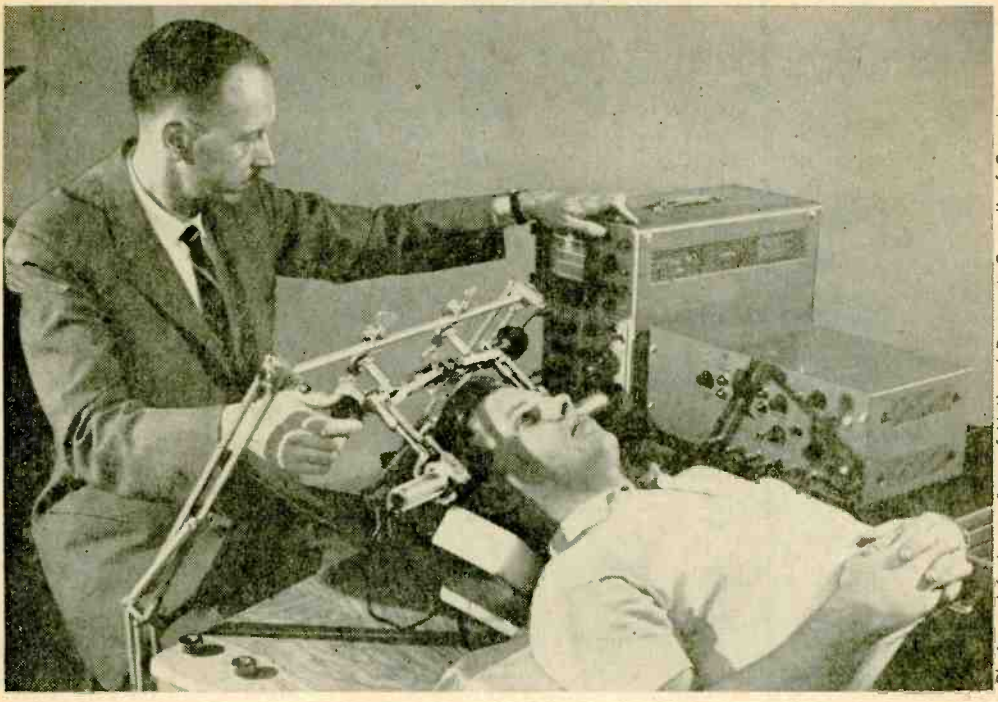


Photo and facts courtesy of National Research Council of Canada

☐ Exploring the human brain got a big electric boost back in 1954. A Swedish doctor discovered that sound waves—safe and simple—could enter the head, ripple through the brain, then emerge to paint a revealing picture on an oscilloscope. It could spot a dangerous tumor or other disease.

But it took an expert to make it work. Only the sharp eye of a surgeon could study the picture and know whether to prescribe a brain operation or just a few aspirin. Thanks to Arthur Hudson of Canada's National Research Council, a new scanning system will vastly reduce the skill needed to take what's called an "A-scan echo-encephalogram."

The basic system applies a burst of ultrasonic sound to the head. This is marked on the scope by a dab of light. So long as vibrations travel through uniform brain tissue, they're barely affected. But a change in the nature of the tissue bounces back a portion of the sound energy. The reflection is heard by a microphone-type transducer, and a second dab of light appears on the scope. The doctor knows where in the brain the bounceback occurs by noting the space between pips of light on the screen.

The big problem came from a multitude of misleading echoes from normal separations in the brain. Hudson's apparatus, in the photo above, solves much of the confusion.

Instead of one transducer, there are two (those cylinders near the patient's ears). The transducers are mounted on a mechanical assembly, being adjusted by Hudson. Both transducers can be moved around the head without losing their positions relative to each other. In operation, each transducer fires a pulse of sound toward its partner. And each picks up the other's echoes. By comparing four resulting scope patterns, it's now possible to ignore false reflections and tell whether two echoes are arriving from the same object.

So accurate and simple is the new device that it can be handled by a technician—and remove one more headache from the busy brain surgeon. ■

Tape Trigger

By Marshall Lincoln, W7DQS

Handy little control box allows most any mike to be used with that tape recorder

Tape-recorder buffs are forever finding new uses for their recorders. They're big on new gadgets that extend the recorder's versatility, too. In fact, rare is the tape enthusiast who doesn't have a box filled with patch cords, adapter plugs, mixers, and various other accessory gadgetry.

But since nearly every recorder manufacturer has his own system of input, output, and control plugs, many accessories can't easily be adapted to a specific recorder. Mikes, especially, are generally fitted with connectors that plug into a particular piece of equipment and are unusable with other gear. Another difficulty for the experimenter who wants to use a favorite push-to-talk mike with a recorder for which it is not intended, is the fact that the *on/off* control circuits in recorders are not all alike.

While most mikes have normally-open contacts in their internal push-to-talk circuits, some recorders require special mikes having normally-closed contacts. If this is the case, you have the unnatural situation of pushing the mike button to stop the recorder, and releasing it when you want to record. This can be a nuisance at best, and may cause the operator to miss much of the material he intended to record because he pushed the mike button when he should have released it.

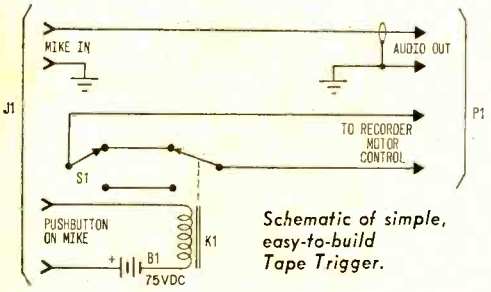
Tape Trigger eliminates this nuisance factor while enabling a recorder enthusiast to use his favorite push-to-talk mike with any recorder.

All's Under Control. Essentially, Tape

Versatile Tape Trigger lets just about any push-to-talk mike be used with any recorder.

e/e TAPE TRIGGER

Trigger matches the particular control circuit of any recorder so as to trigger the recorder into operation whenever a push-to-talk mike with the conventional normally-open contacts is used. No matter whether the recorder requires normally-open or normally-closed switching of the motor circuit, Tape Trigger keeps everything under control.



Schematic of simple, easy-to-build Tape Trigger.

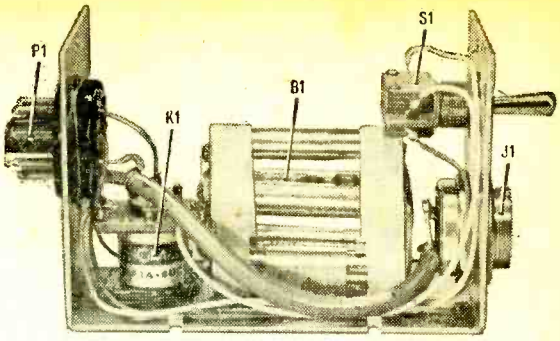
PARTS LIST

B1—5 pen-cells connected in series
J1—Connector to mate with mike being used
K1—S.p.d.t., 6-VDC relay (Sigma 65FIA-6DC, Newark 24F1981, or equiv.)
P1—Connector (see text)
S1—S.p.d.t. toggle switch
1—2-cell battery clip (see text)
1—2 x 2 x 4-in. metal or bakelite chassis box

As can be seen from the wiring diagram, the key parts of Tape Trigger are a small relay, which is sensitive enough to be operated by flashlight pen-cells, and a single-pole double-throw switch. In use, pushing the mike button operates the relay which has single-pole double-throw contacts.

The relay arm is connected to one terminal of the recorder motor-control plug, and the switch arm of the toggle switch is connected to the other terminal of this plug. The other two switch contacts are then connected across the fixed relay contacts. With this arrangement, the toggle switch determines whether the recorder is looking into a set of normally-closed or normally-open contacts.

When the switch is in the *up* position in the wiring diagram, the recorder sees normally-closed contacts. If the switch arm is in the *down* position, the recorder sees normally-open contacts.



Nothing critical about Tape Trigger and any chassis and parts layout can be used.

Mike Matching. The completed unit shown in the photos was built to allow a GE communications-type mike to be used with a Uher recorder, which requires a normally-closed motor-control switch. The same trigger unit can be used with recorders requiring a normally-open set of contacts merely by throwing the toggle switch to the opposite position.

Additional versatility is provided by using a removable cable to connect the trigger unit to the recorder. This allows you to prepare extra cables in case you want to use the unit with another recorder having a different type of control plug, or differing connections in the control plug.

For example, it was desired to use the unit shown with a Norelco recorder. This recorder uses the same type of connectors as the Uher, but the control circuit is wired to different pins in the connector. By preparing a second cable, with wiring matching that of the Norelco connectors, the change from one recorder to the other can easily be made by using the correct cable.

Any polarized connector with at least four terminals can be used for this cable connection to Tape Trigger. An eight-pin chassis-type connector was installed in the unit shown because one was available in the author's junk box. However, only four of the pins are used.

Wiring It Up. In wiring Tape Trigger, use a short piece of shielded cable to run from the input connector to the output connector.

A 2 x 2 x 4-in. metal utility box was used for the prototype, but any metal or plastic box of adequate size may be used since parts layout is not critical and a shielded box is not required.

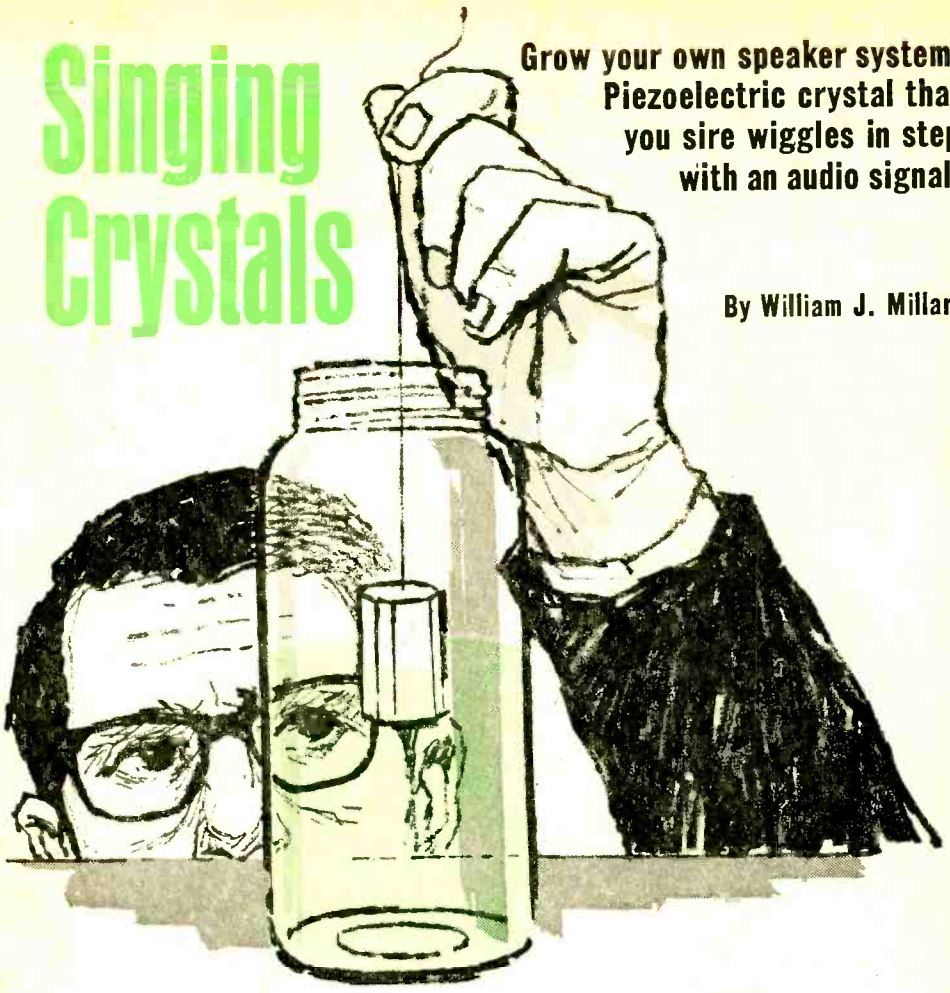
If a metal box is used, the relay should

(Continued on page 118)

Singing Crystals

Grow your own speaker system! Piezoelectric crystal that you sire wiggles in step with an audio signal!

By William J. Millard



How about growing a speaker? That's right, *growing* a speaker! Not the entire speaker, of course, just the unit that drives the large paper cone. It won't outperform commercial speakers in power or in fidelity, but it will perform creditably and it requires only simple skills or techniques. In addition to being an unusual conversation piece, it's an elegant experiment in piezoelectricity for the Science Fair bug and a natural for the dedicated do-it-yourself experimenter.

We've become so accustomed to the dynamic speaker that we forget there are other ways to transform electrical impulses into sound. One of these is piezo- (or pressure-) electricity, an impressive name for the tiny electrical currents that pressure generates in certain crystalline substances. The action is also reversible—a voltage applied to the crystal causes physical distortion or vibration to take place in the crystal. It is the latter effect which makes the crystal work as a reproducer of sound.

Of the many crystals which exhibit the piezoelectric effect, quartz is one of the most familiar. It is possible to grow artificial quartz crystals—if you have access to a well-equipped research lab. If you don't have, there is another piezoelectric material that can be produced in the home workshop with nothing more exotic than some Rochelle salt (potassium sodium tartrate—$KNaC_4H_4O_6 \cdot 4H_2O$) dissolved in distilled water. Considering the fact that Rochelle salt crystals are so easy to grow, it's a pleasant surprise to find that they are also one of the most potent performers of the entire piezoelectric family. And the Rochelle salt crystal you grow will be the swinging heart of a home-brew piezo-

electric speaker. Here are all the details.

How Crystals Grow. Crystal-growing is not as difficult a task as it may seem. All that is necessary is to provide the right environment and let nature do the rest. Essentially, the process is no more complex than stacking blocks one upon another except that it's done on an infinitely tiny scale. Starting with a single molecule, nature obligingly piles layer upon layer of identical molecules until the crystal *grows* to harvesting size. Regardless of its size, however, when the crystal grows in an orderly fashion, it will have the same shape or "habit" that its molecule has. Each crystalline substance has its own distinctive habit. For example, ordinary table salt (sodium chloride—NaCl) crystals are always cubical. Rochelle salt crystals have an "orthorhombic" system and will inevitably grow to approximate the shapes shown in Fig. 1.

At one time or another everyone has noticed that things seem to be more soluble in warm than in cold water—the warmer the water, the more molecules of a substance it can hold in solution. When water at a given temperature holds the maximum number of molecules, it is "saturated." If the temperature drops even a fraction of a degree, the solution contains more molecules than it can accommodate and it becomes "supersaturated." Immediately the excess molecules try to *precipitate* out of solution and it is this characteristic that causes crystals to grow.

If a small *seed* crystal is suspended in the supersaturated solution, the excess molecules are deposited on the seed in uniform layers until there is no longer an excess and the solution is no longer supersaturated. The growing process can be continued through many cycles by successively lowering the temperature of the solution to re-establish the supersaturated condition.

Temperature Control. Obviously temperature control is the single, most important environmental factor. It is entirely possible to grow small crystals without such control, but the superior results gained from using a temperature-regulated enclosure make the small additional effort well worthwhile.

Probably, the simplest method is to fill beforehand an abandoned aquarium, laundry tub or other large container with water and let it stand until it reaches room temperature. Then, when you have prepared the jar of Rochelle salt solution, set it in the water, taking care to keep the cap above water. The large volume of water acts as a thermal ballast (heat sink) and counteracts minute fluctuations in room temperature. This arrangement keeps the temperature fairly constant but permits no actual control. Constant temperature can be accomplished by using an immersion heater used to heat aquariums. Start out with water several degrees above room temperature and gradually reduce the thermostat setting as the crystal grows.

Another method of control, although a little more elaborate, is extremely flexible and entirely within the realm of the electronics experimenter. Line a small wooden or cardboard box with some insulating material such as old ceiling tile. Cut a hole in the side and insert a piece of glass or plastic sheet as an observation window. Mount a

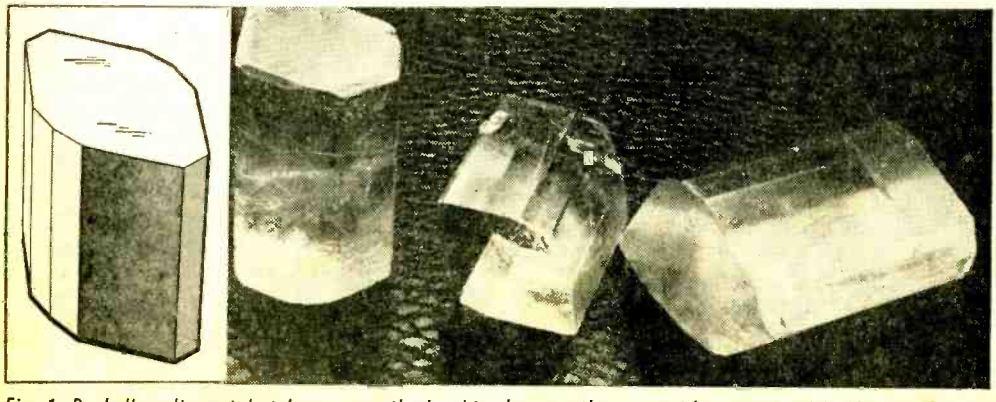


Fig. 1. Rochelle salt crystals take on an orthorhombic shape as they grow (drawing at left). Shapes will vary slightly from crystal to crystal as seen at above right. Near-perfect home-grown crystal is in center of photo.

room thermostat and a lamp socket with a 25-watt lamp inside the box and wire them as shown in Fig. 2. Note the override pushbutton across the thermostat. The pushbutton permits the light to be turned on for momentary observation when the thermostat is not calling for heat.

Preparing the Seeds. Once the temperature control problem is settled you can start on the first phase of the actual growing process. Heat 1½ cups of distilled water until it's pleasantly warm (140° F) and dissolve one pound of Rochelle salt in it. You can buy the latter at almost any drugstore. Always use a pyrex, stainless steel or enameled pan to prevent contamination of the solution.

Pour three or four tablespoonfuls of the solution into a small glass jar and the remainder into a clean mason jar. Seal the mason jar and place it in the enclosure which should be six or eight degrees above room temperature. The small amount of solution in the separate container should be left out to cool down to the room temperature. As it does so, the solution becomes supersaturated and the excess molecules usually start to crystallize spontaneously. However, if nothing happens within a few hours, drop a little powder from the original container into the solution. The powder forms a nucleous around which crystallization proceeds apace.

Keep an eye on the process and as soon as you detect some small crystals growing, use a magnifying glass to select two or three of the *shapeliest* crystals. (See Fig. 1.)

Pour the solution into a temporary container, clean the crystal debris from the bottom, replace the solution and put the selected few crystals back in to continue their growth. As the water slowly evaporates the solution continually supersaturates and provides excess molecules for deposit on the seeds.

When the seeds are ⅛ in. long or more they are ready to be planted in the mason jar. Their actual size is not too important except that the smaller they are the better. Obtain a small spool of 1-lb. nylon line from a sporting goods store for use in suspending the seed in the growing solution. The smoothness of the monofilament nylon discourages the growth of unwanted debris that accumulates so readily on ordinary cotton thread. Tie the seed securely to the end of a twelve-inch length of nylon line, cutting off the short end as closely as possible to the seed.

By the time the seed crystal is ready for implantation the solution in the mason jar should have precipitated the excess salt to the bottom. If nothing has happened after 6 or 8 hours, sprinkle a few grains of powder into the jar. That will start the process and within minutes you'll see crystals falling to the bottom. Shake the jar occasionally to hasten crystallization.

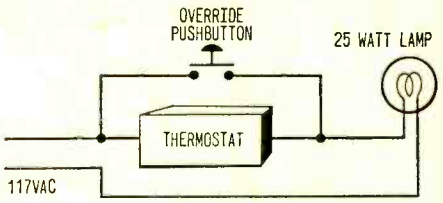


Fig. 2. Temperature control circuit anyone can build. Thermostat is kind found in most homes.

It is important that all the excess salt crystallize out so that the solution reaches equilibrium at 100 percent saturation for the growing temperature you have selected. Naturally, you can't look at the jar and tell when this condition is reached but, if you follow the routine described, in two or three days you can be fairly sure the solution is at saturation.

The next step is to add a precisely controlled amount of salt to the saturated solution. Pour the liquid carefully into another jar, making sure that the debris from the bottom is excluded. Scrape the debris into a flat glass baking dish (clean glass ash tray will do) and warm them in an oven to drive off the moisture. Weigh out one ounce of dry crystals. (You can use an inexpensive mail scale or spring balance.) Warm up the solution once more and dissolve the ounce of crystals. Clean the mason jar once again and pour the liquid into it using a filter paper of the type used in coffee makers to keep out contaminants. Seal the jar and set it in the heated enclosure.

Hang It! While the growing solution is cooling to the desired temperature, drill a small hole in a spare jar cap and thread the nylon line through it. Adjust the length of the line so that the seed crystal will hang about an inch above the bottom of the jar and hold it in place with a piece of tape as shown in Fig. 3.

Once the solution has cooled to the growing temperature it will be supersaturated by the amount of Rochelle salt just added. Suspend the seed crystal in the solution, reseal the jar and do not disturb.

Growing the Crystal. If all conditions

are correct the excess molecules will crystallize on the seed, and in two or three days the seed will have grown substantially. When there is no further increase in size you can assume that the solution has dropped to saturation for that particular temperature. Adjust the thermostat one degree lower. When the growing solution adjusts to the new temperature it will once again be supersaturated and the crystal can continue growing.

You can let the crystal grow as long as you wish, but when it is about ¾ in. long it's big enough for our purpose and can be *harvested*. If you have another seed ready, you can start another crystal. Re-dissolve in the solution along with the debris on the bottom enough powder or dry crystals to equal the weight of the harvested crystal. Set the thermostat to the original growing temperature, let the solution cool to that point and plant the next seed crystal. You can use the crystals over and over again so there should be very little waste. Just take the precaution to use a filter paper each time to reduce contamination.

Occasionally, growth is too rapid and crystals form on the nylon line above the seed crystal. If you are careful you can remove all but two or three of the best from the line and let them continue growing. They'll become seeds for future crystals and have the advantage of already being attached to the line. Another indication of too rapid growth is the appearance of *veils* in the crystal. These veils, or streaks, are voids in the crystalline structure which imprison a small amount of the liquid. Excessive veiling reduces the structural strength of the crystal making it unfit for use. Start over with the 100 percent saturated solution, cut down the amount of added Rochelle salt to ¾ ounce and try again.

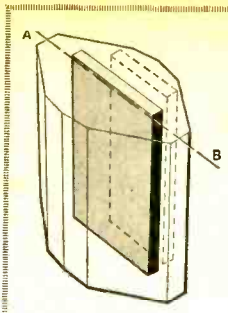


Fig. 4. The shear plate can be ground from any section of the crystal as long as it is parallel to plane A-B. If imperfections are near the center of the crystal, the shear plate can be obtained from a section shown by the dotted lines.

Grinding and Polishing. Examine your crystal carefully. It should be free of large veils and its shape should be reasonably close to the idealized configuration shown in Fig. 4. It may be a trifle misshapen due to the angle at which it was suspended in the solution but you should have no difficulty in identifying the plane in which the *shear plate* lies. The crystal *shear plate* can be ground from any part of the crystal as long as it lies in that plane. If there is any veiling or other imperfection in one part of the crystal, just grind it off and use what is left.

First, make a scratch on each end of the crystal along line A-B as shown in Fig. 4. It will serve as an index line to keep you

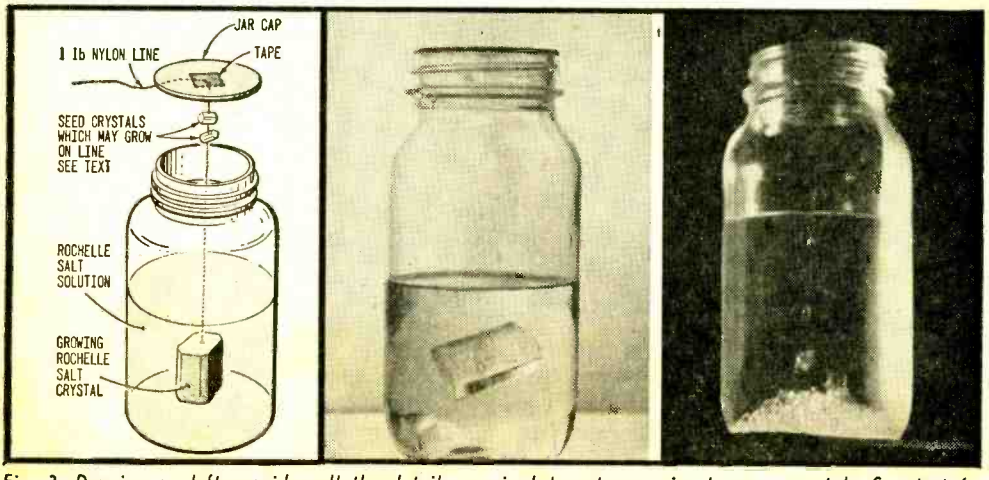


Fig. 3. Drawing on left provides all the details required to set up a jar to grow crystals. See text for details on solution and temperature control. Crystal growing in center is about ¾-in. long—it is very near perfect. Occasionally small crystals will grow on the nylon line as can be seen in photograph on right.

oriented as the crystal loses its shape during the grinding process. The actual grinding process is easy. Merely rub the crystal on a piece of medium sandpaper. Keep a watchful eye on the index scratch as you rub. A little practice and you'll be able to wear the crystal down evenly to a slab about 3/16 in. thick.

As you will have discovered by now, the crystal is quite fragile. From here on abrasion by sandpaper is too risky. Dampen a piece of cloth and spread it out on a smooth surface. Polish the crystal plate on the cloth until it's 1/8 in. to 1/16 in. thick. It won't go as fast as before, but it's a lot safer. After all, it took several days to grow the crystal, so why take a chance on ruining it by hurrying the grinding process. Incidentally, save all the powder that accumulates during the dry grinding. You can use it again.

Theoretically, performance of the shear plate depends on the ratio of length to thickness. Hence, a thin plate should outperform a thicker one. However, the improvement in response doesn't warrant the loss of strength and the increased fragility of the thinner slab. You can experiment later on, but on your initial attempt it's better to sacrifice a little performance in the interest of structural soundness.

Speaker Mounting. A knowledge of how the crystal shear plate functions will aid in understanding the whys and wherefores of the mechanical details. You will notice in Fig. 5 that when a DC voltage is applied to a shear plate clamped rigidly at one end, the opposite end rotates slightly. All it requires,

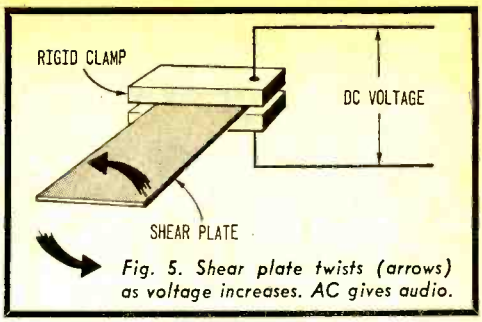


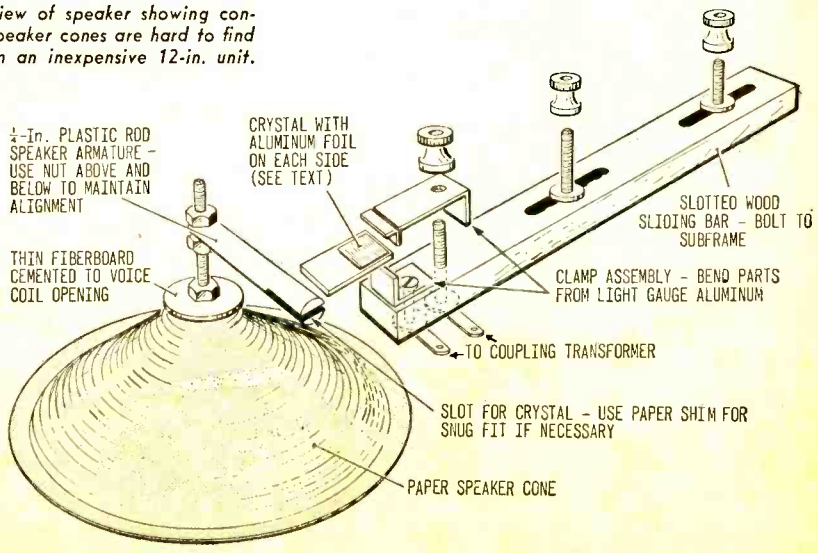
Fig. 5. Shear plate twists (arrows) as voltage increases. AC gives audio.

therefore, is an armature slipped over the free end of the shear plate to transmit the movement to the speaker cone.

Figs. 6 and 7 show one way this can be done. The speaker armature can be elevated or lowered on the bolts attached to the speaker cone to provide for vertical alignment. The slotted wood sliding bar can be moved laterally to allow for the difference in length of various shear plates. The entire assembly looks, and is, bulky, since streamlining had to yield to rigidity.

While your crystals are growing you will have an excellent opportunity to study and probably improve upon the arrangement in Figs. 6 and 7. The sky is the limit in designing your own system so long as you provide for vertical and horizontal alignment and a solid base. You can see the base details in Fig. 8. A 12-in. speaker cone is cemented to a large piece of square plywood. An 11-in. hole is pre-cut in the plywood square and the paper cone is centered on it. Airplane glue is an excellent cement to use. A platform is built over the cone at a height equal

Fig. 6. Exploded view of speaker showing construction details. Speaker cones are hard to find —salvage one from an inexpensive 12-in. unit.



to the cone's height approximately. The remainder of the construction can be seen in Figs. 6 and 7.

Mounting the Crystal. When your crystal is ready to be installed in the speaker, cut two pieces of aluminum foil about half the size of the shear plate. Spread a thin film of Vaseline on the crystal and stick the foil sheets to the sides to form a sandwich. Position the foil so that it makes good contact with the two members of the clamp to which the leads are connected. Keep Vaseline off the top surfaces of the foil.

After the shear plate is clamped in place, adjust the sliding bar and the armature until the latter will slip over the end of the crystal without undue pressure. The slot can be slightly larger than the crystal and the difference taken up with a paper shim. This insures a snug fit and prevents the metal from scratching or breaking the fragile shear plate.

Coupling Circuits. A crystal speaker has relatively high impedance and consequently is voltage-operated rather than current-operated as is the voice coil of a dynamic speaker. It can be connected to the plate of the audio output tube in your single-ended output AM table radio through a blocking capacitor as shown in Fig. 9. Disconnect the set's speaker so that the crystal speaker can be heard.

If you have a spare output transformer and don't care to go to the trouble of digging into the innards of your amplifier or radio, you can use the circuit in Fig. 10. The second transformer is mounted on the back of the speaker as Figs. 7 and 8 show. Should the transformer be of the universal output type, choose the terminals that produce the greatest impedance ratio (usually the 4-ohm output) and, hence, the maximum voltage stepup. Connect a small disc capacitor across the crystal speaker to reduce the high frequency hissing if it is loud enough to be objectionable. Start with about 250 $\mu\mu$F and increase the value until the hiss is reduced.

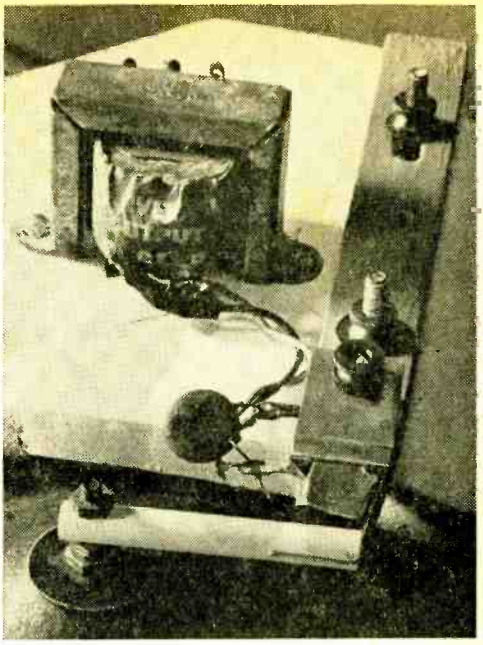


Fig. 7. Here's a close look at the speaker armature, crystal and crystal holding parts mounted on the slotted-wood sliding bar. Be very careful when mounting the crystal—avoid any undo pressure or tension. Adjust the armature (1/4-in. plastic dowel with slotted end) by positioning nuts that secure it to the speaker cone. The universal output transformer location is not critical and can be placed anywhere.

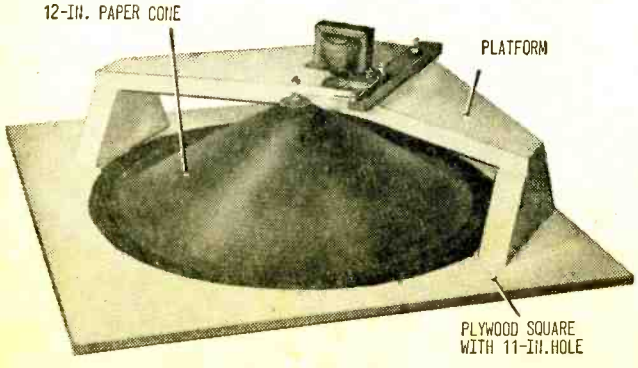


Fig. 8. Paper cones are hard to find. You can salvage one from an inexpensive 12-in. PM speaker. Optional construction methods can be used; for exomple, leove the speaker cone in the speaker frame, remove the mognet ond voice coil, and mount speaker on bose. Remoinder of construction is unoltered.

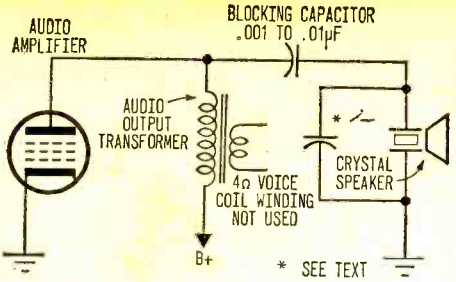


Fig. 9. The crystal speaker can be coupled directly to a single-ended output stage without need of a matching output transformer—a capacitor does it.

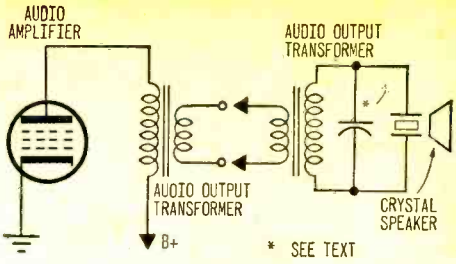


Fig. 10. If you don't care to alter amplifier circuits, you can connect directly to the speaker terminals of any output stage without any amplifier modification.

Crystal Microphone. As mentioned in the beginning, the piezoelectric effect works both ways. It will also generate a minute current when torsion is applied. Therefore, if the speaker is connected to the input of an amplifier with a coupling condenser, it will operate as a microphone. In such applications the output transformer isn't used. The output is low and probably will require a preamplifier. Use shielded cable to connect the speaker to the amplifier's high-impedance input.

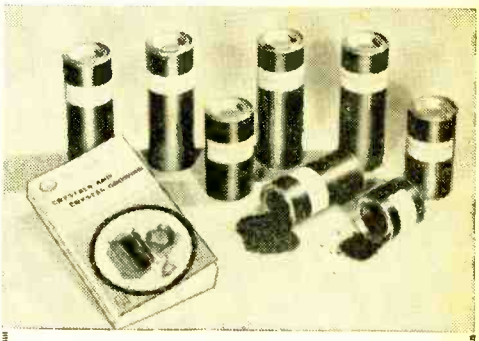
A Few Experiments. After the speaker is in operation, slip the armature off the end of the crystal. You'll have to put your ear down by the crystal to distinguish anything, but you'll hear it vibrating merrily and producing a *tiny* sound. The intensity of the sound depends upon the amount of air displaced. The power is there, with or without the speaker, but when the cone is attached it presents several hundred times a much surface to the air, with a corresponding increase in volume.

The ability of a crystal to produce an electrical current is readily demonstrated. Before you grind the crystal into a shear plate, stick a piece of foil to each side with Vaseline and hold them in place with a rubber band. Easy on the Vaseline or no contact will be made. Connect the foil contact plates either to a VTVM or to an oscilloscope.

Place the flat end of the crystal on a solid surface and tap the top sharply with a block of wood. There will be a deflection of the meter needle on the low voltage range scale. By striking a different spot on the top surface you'll find that the polarity of the generated current charges. Such currents show up as momentary sharp spikes on the oscilloscope screen.

Since Rochelle salt crystals work both as microphones and as speakers, it might be interesting to find out whether they will work as crystal filters, or in the tank circuit of an oscillator. Another avenue of investigation that holds exciting possibilities is suggested by the fact that crystals can vibrate at frequencies well beyond the range of audibility.

There's More. There is an extremely interesting paperback book, *Crystals and Crystal Growing*, by Alan Holden and Phylis Singer* which is loaded with invaluable information on crystals of many kinds. If you want a more technical exposition of piezoelectricity, read the excellent article under that heading in the latest edition of the *Encyclopedia Britannica.*



☐ You may want to become a crystal-growing expert before you try your hand on the crystal speaker. The *Editor* suggests you invest in Edmund Scientific's Crystal Growing Kit as a starter. The kit comes complete with instructions and chemicals to grow clear, purple, blue-green, green and red crystals. See footnote for price and Edmund's address. ☐

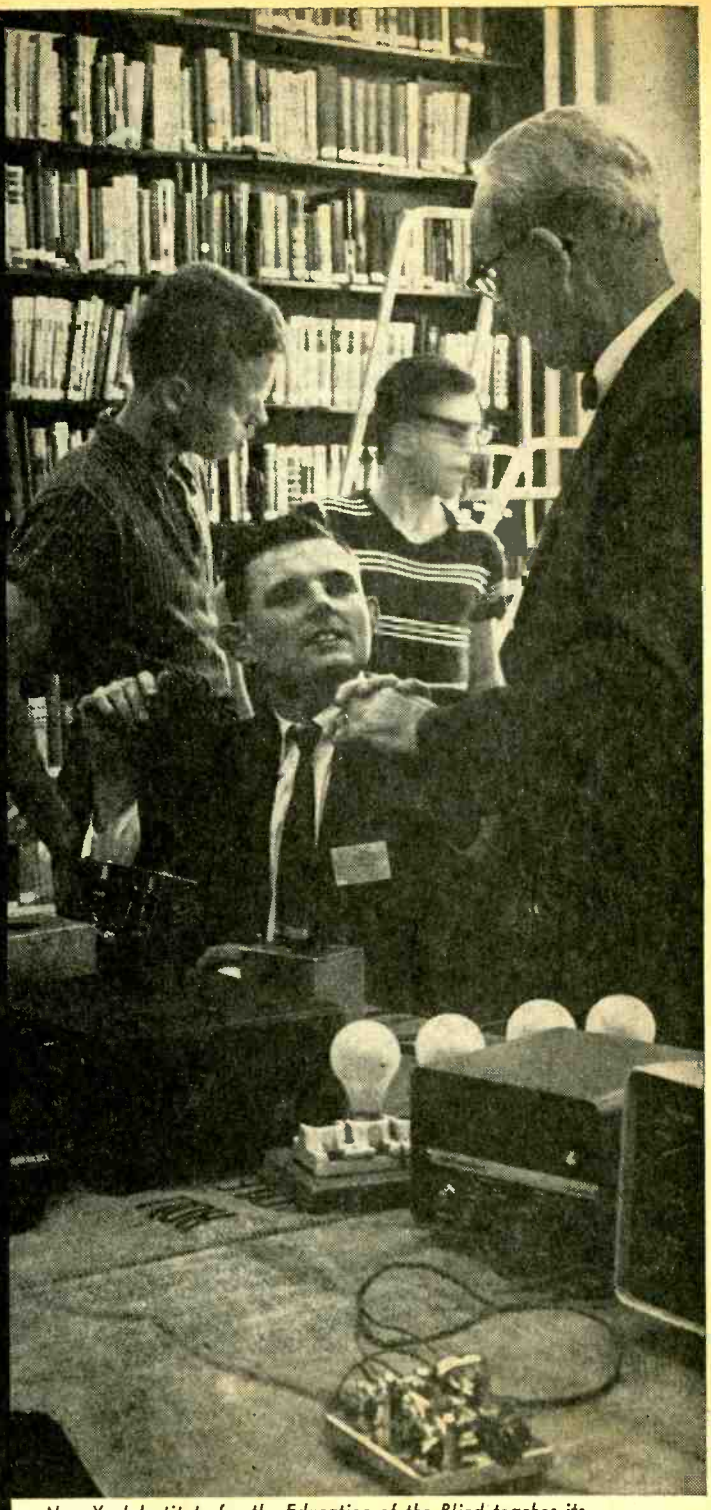
Whether you're a neophyte or an old pro, if you're tired of building rehashes of the same old circuits and want to try something really worthwhile, the crystal speaker is right down your Tin Pan Alley. ■

* Available from Doubleday & Co., Inc., Garden City, N. Y. for $1.45 postpaid. Also, available from Edmund Scientific Co., Dept. EK, 100 Edscorp Building, Barrington, N. J. 08007 as part of a Crystal Growing Kit (No. 70,336) for $9.50 postpaid.

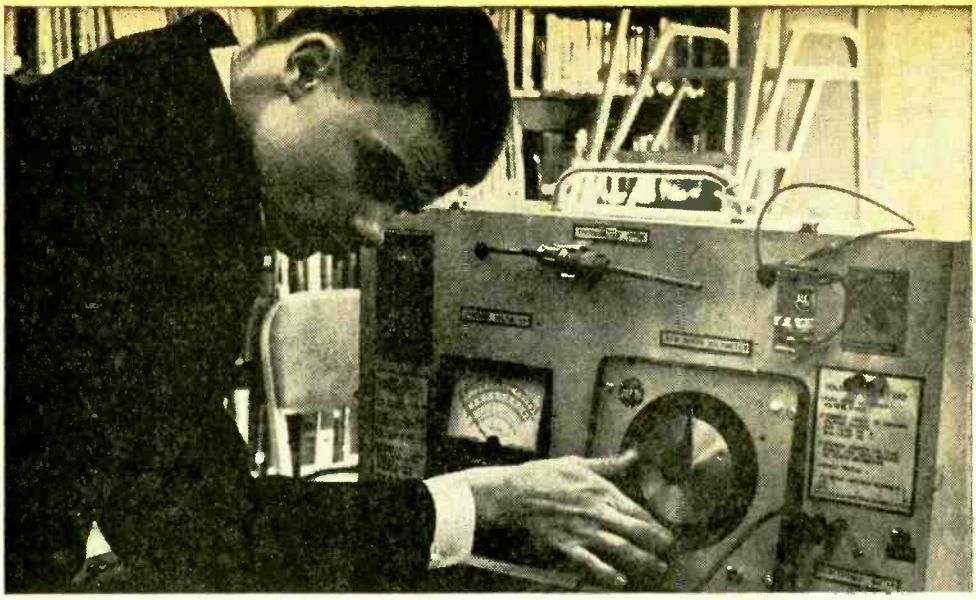
The next time you misread a meter or incorrectly set a test instrument, think of the blind student, for...

They Tell Through Touch and Tone

By Len Buckwalter
K10DH/KQA5012



New York Institute for the Education of the Blind teaches its students electronic equipment operation and repair. Troubleshooting is accomplished by special audial indicating test gear.



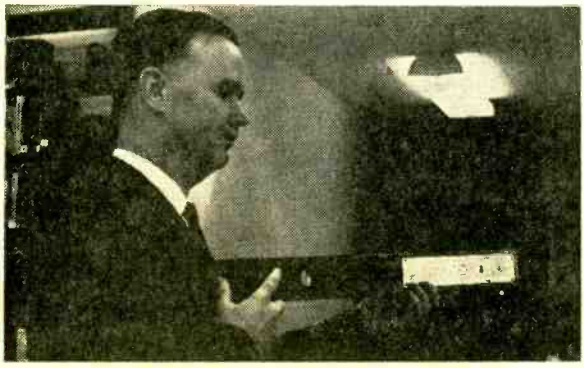
Here, blind student operates a special voltmeter that automatically reads voltage value. Pointer just above hand swings around dial and automatically stops at unknown voltage. Raised dots tell operator value.

A noisier bunch of radio bugs would be hard to find. From one end of the room came the hoot of an audio oscillator. Static barked from a ham rig. In one corner raged a debate on electronic gear. Sound like a meeting of a local ham club? Almost . . . since the affair was billed as a "Radio-Electronic Convention." The difference is that members of this group are totally blind.

Nevertheless, an array of ingenious instruments enables these high-school enthusiasts to measure and use just about anything that smacks of the electronic. As our photos show, their instruments rely on a combination of touch and tone for reading anything from Volts to Ohms to Amps. Some gadgets cleverly exploit electronics to indicate compass direction or the bubble on a carpenter's level.

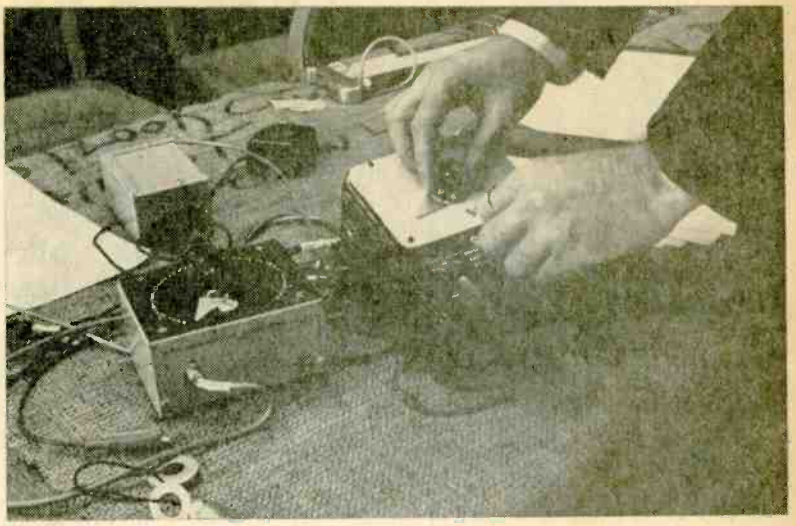
Many of the devices, shown recently at a convention held by the New York Institute for the Education of the Blind, use audio indicators. For example, here's how we watched one young fellow measure an unknown voltage. First he placed a pair

(Continued Overleaf)



Carpenter's level for the blind uses a mercury switch to silence an audio oscillator when the level is in either exactly horizontal or vertical position.

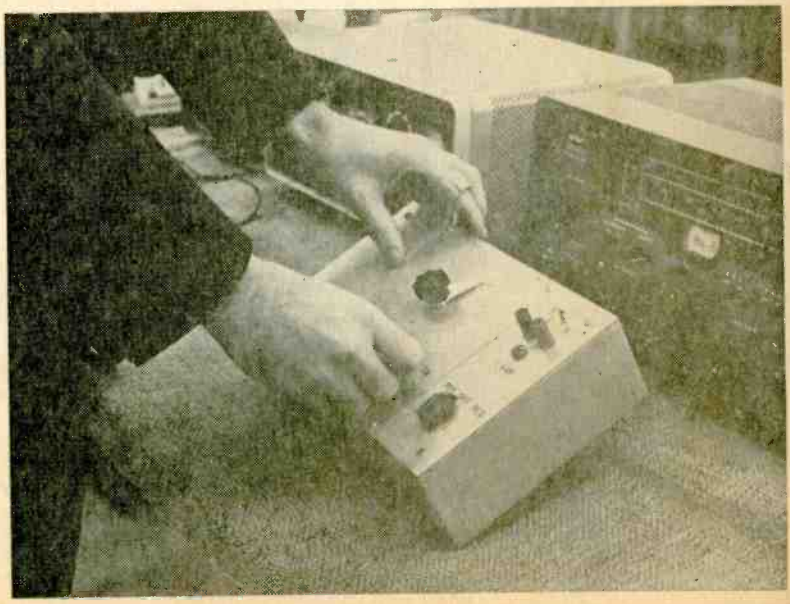
Audible compass sounds off until unit is pointed North, then pointer blocks light beam to photocell and all's quiet.



Here's an example of how a standard commercial VOM has been modified for use by the blind. The instrument is the popular Simpson 260 with its meter movement removed. Instead, there's a control knob and pointer, and a series of raised dots for a dial. The operator turns the knob until a built-in oscillator is silenced, then he feels the dial to find where the pointer is. Counting the raised dots on the dial gives the value being measured whether its Volts, ohms, or Amps.

of probes across an unknown voltage (in this case, a battery). Then he dialed a knob on the measuring instrument until an audio tone stopped sounding. His fingers then felt the raised points around the dial face. This enabled him to relate knob position to a particular, known voltage.

Most of these instruments were developed under the direction of Bob Gundarson who teaches at the Institute, where these photos were taken. Hams in the New York area may have seen Bob during his hours behind the counter at Harrison Radio answering questions. His knowledge of electronics is legendary. No-one, they say, has stumped him yet. And few of his inquisitors on the other side of the counter ever suspect that Bob's been blind since birth. ■



Other test gear has been designed for the blind using the nulling of an audio tone as the basic indicator and with a dial of raised dots so the operator can feel the value being measured. Using this equipment and provided the training, the Institute's blind students can go on to become proficient and employable technicians. Many have obtained licenses and become Hams since this is one area their visual handicap is of no consequence.

e/e PRODUCT TEST

PLAYTAPE PRODUCT LINE
Solid-State, Automatic
Cartridge Tape Players

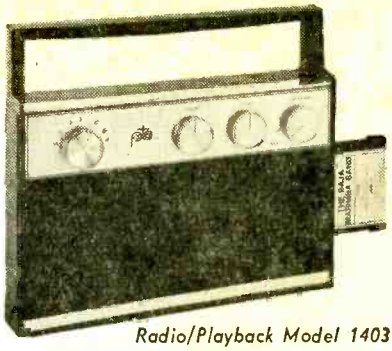
Just about the hottest thing going with the junior go-go set these days is the Playtape—a battery-powered portable tape player no larger than a decent transistor radio. For the first time, Junior and Sis need not be away from Herman's Hermits, Sonny and Cher, or the Rat Pack for even a moment. Now they can load up to 8 miniature Playtape cartridges into the hip pockets of their jeans, grab the Playtape player, and music is available to them all day.

Playtape units are built around a miniature cartridge. For comparison, the Playtape cartridge is shown below with a standard 4-track cartridge and a Norelco Cassette. The Playtape cartridge is actually a miniature version of a standard 8-track cartridge having locking notches on the side of the case and a built-in capstan roller.

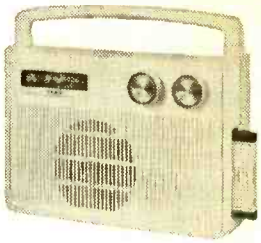
The tape is half the standard ¼-in. tape width and has two recorded tracks. The program material on the tape is usually equal time-wise to two standard 45-rpm records, with two songs on each tape track for a total of four. The cartridge costs (depending on where it's purchased) less than two 45s.

There are many different versions of the players. The three most popular and most available are the 1310 player, the 1320 (essentially a 1310 with a larger speaker), and the 1403 (a 1320 with a built-in AM radio and tone control). Model numbers also vary depending on cabinet color.

Regardless of the model and features, the tape transport mechanism is the same. As shown on the next page, a DC motor belt-drives a flywheel-weighted capstan. The motor is started automatically by a switch when the Playtape cartridge is pushed into the unit.



Radio/Playback Model 1403



Playback Model 1320

Playback Model 1310

Twin Heads. Two heads are provided with one for each track. The desired track output is selected electrically by a front panel track selector switch. Though an inexpensive mechanism, it works well. There is even an individual alignment adjustment for each head. The heads are arranged so that one is slightly higher than the other; the top half of the lower head plays the lower tape track while the bottom half of the upper head plays the upper tape track.

The lowest priced player, the 1310 at $19.95, uses the basic tape mechanism, has a small speaker, and uses four C-cells for a power supply. Two front panel controls provide for volume and track selection—the unit is turned on and off by inserting and removing the cartridge.

(Continued on page 115)

Miniature Playtape cartridge (hand-held) is smaller than 4-track unit at left and only slightly larger than Cassette. New Playtape cartridges in the works will be stereo—old and new units will play in any player.

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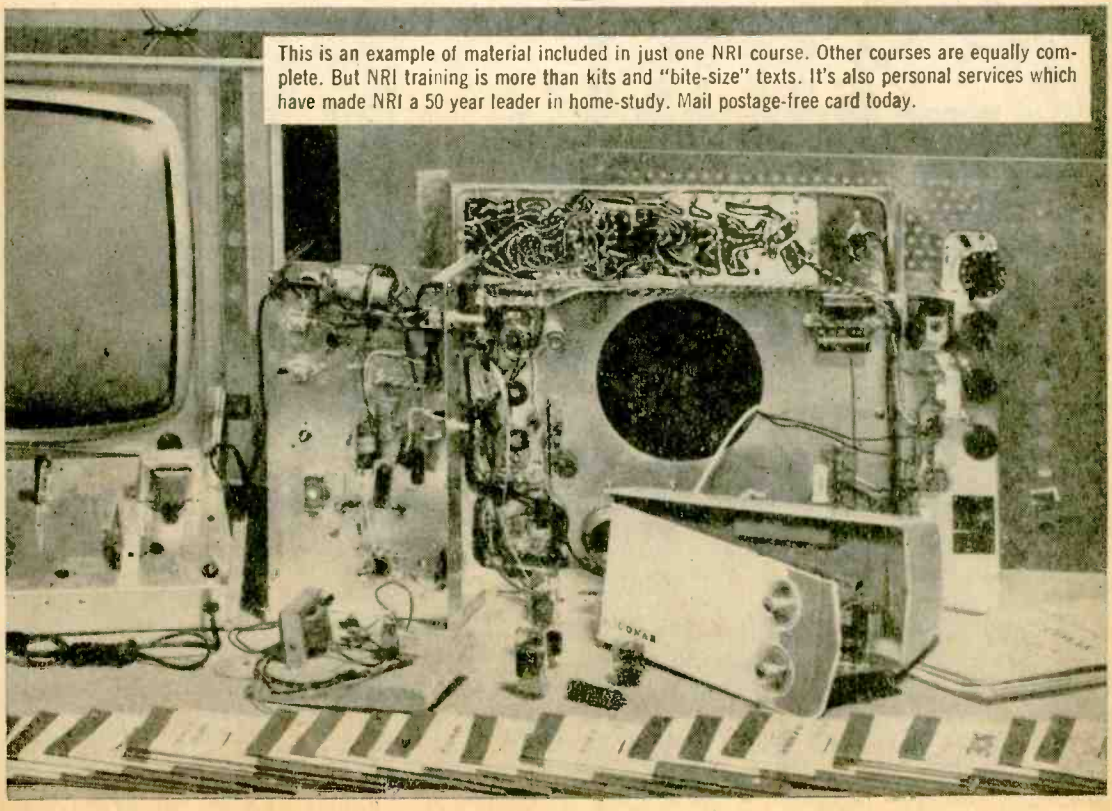
NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

OVER 50 YEARS OF LEADERSHIP IN ELECTRONICS TRAINING



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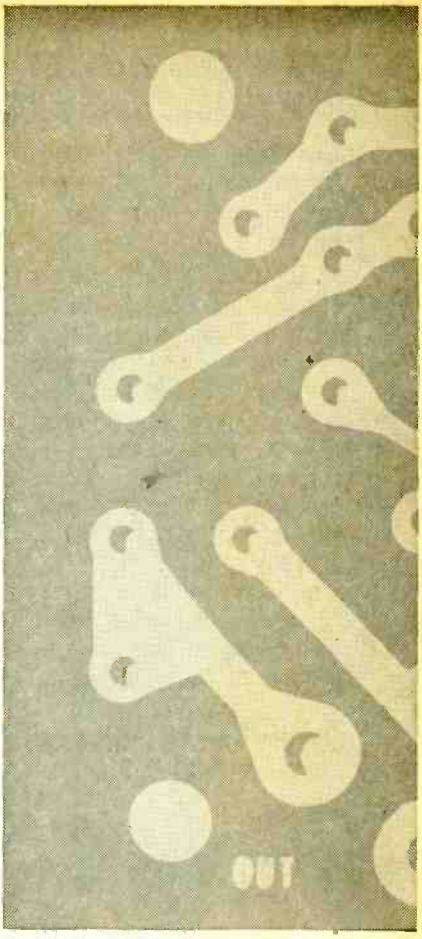
COVER STORY

- calibrate your scope sweep
- see the effects of test cables
- check your scope's frequency response

with our

DIVI-K HERTZ MARKER



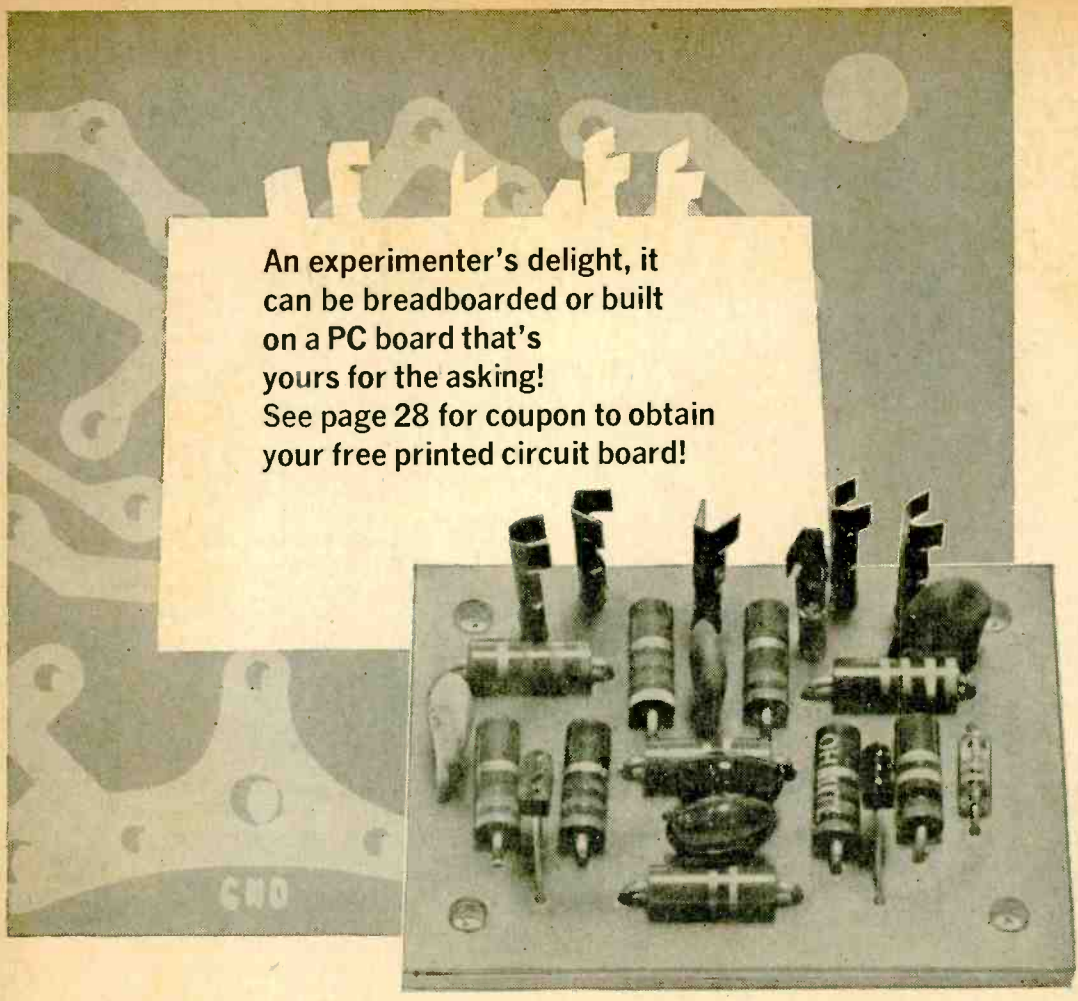
By the Editors of ELEMENTARY ELECTRONICS

If you're a typical experimenter your oscilloscope might be the best dust collector in the house. Why? Because the average general-purpose scope often doesn't do enough. Most likely the sweep has a calibration something like 10 to 100 Hz, 100 to 1000 Hz, 1 k to 10 kHz, and 10 k to 100 kHz—and no indication of exactly what the time base *really is*.

Lab-grade scopes have a *calibrated time base*. This means the sweep is calibrated in seconds of fractions of a second. You can add this useful feature to a general-purpose scope by building our Divi-K Hertz Marker. It's a 1 *u*s (1 MHz) multivibrator specifically intended for experimentation with a scope. It can precisely mark 10 horizontal units of the scope's graticule; and it doesn't matter whether graticule divisions are 1 centimeter, ¼ inch, or anything else. As long as the units are equal, you're in business.

The Divi-K's output has been specifically shaped to provide a sharp (fast rise) waveform. As shown in Fig. 1, the output, when viewed on a very wideband scope (7 MHz bandwidth), is a "spike." Fig. 1 also shows a typical use. The scope's time base has been adjusted so that 10 spikes exactly fill 10 horizontal centimeters—the scope's time base is therefore calibrated to 1 *u*s per centimeter (or other unit of measure).

Once you have a calibration it's easy to get others. Since all 10 units each represent 100 kHz or 10 *u*s, you can now feed in a signal from an AF oscillator, adjusting the oscillator until you obtain exactly one cycle across the 10 units. Then you set the sweep control (time base) to the next lower range and adjust the "fine frequency" control until 10 complete AF cycles are displayed—the scope's time base is then calibrated for 10 *u*s/unit or 100 *u*s for all ten units. (100 *u*s equals 10 kHz.) With the Divi-K you can not only measure the frequency of an input



signal, you can check your scope's sweep for linearity, the effectiveness of your low-capacity probe, and the effect of your scope's frequency limitations on an input signal's waveform. But more on this later.

The Divi-K can be built either from scratch, on a printed circuit board which you can obtain *free* of charge from Sentry Manufacturing, or from a complete Sentry kit which includes the PC board and all necessary components. (See pages 27-28 for coupon.) The free board is supplied unplated and undrilled, so you must drill your own holes with a #57 bit. On the other hand, the PC board supplied with the kit of parts priced at $7.50) is pre-drilled and nickel-plated for easy soldering. If you buy your own parts and have difficulty obtaining the 2N2492 transistors, they can be ordered direct from Sentry at $1.50 each.

Note that the schematic shows both input and output connections. The input connections have been provided for experimentation. For example, by using the output (before the diode) of the 100-kHz calibrator project in our last issue you can obtain reasonably good and accurate 1-*us* triggering—the 100-kHz input signal will "hammer" the Divi-K to exactly 1 *u*sec.

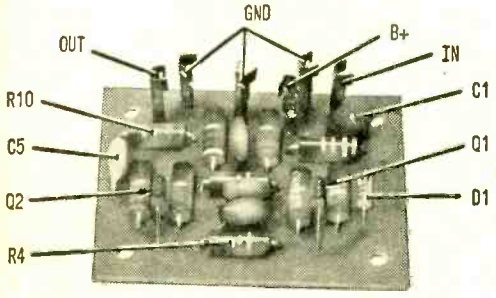
Some Experimenter Applications. The photos show some of the results that can be obtained with the Divi-K. Fig. 1 shows 10 complete "pulses" obtained on a wideband (7 MHz) scope with a standard input cable. Note the steep negative-going spikes and the "rounded" positive-going parts of the waveform. Note that on the right side of the screen each pulse (complete cycle) is exactly one unit(centimeter) wide, but on the extreme left the pulse is greater than one unit. This indicates nonlinearity in the

For Sentry PC Board Coupon see page 28

scope's horizontal amplifier.

Now look at Fig. 2—the scope is the same, but this time we have used a low-capacity scope probe. Note how the waveform has been "cleaned up," particularly on the positive-going portion. This is because the low-capacity probe has a much smaller capacity loading on the Divi-K's output.

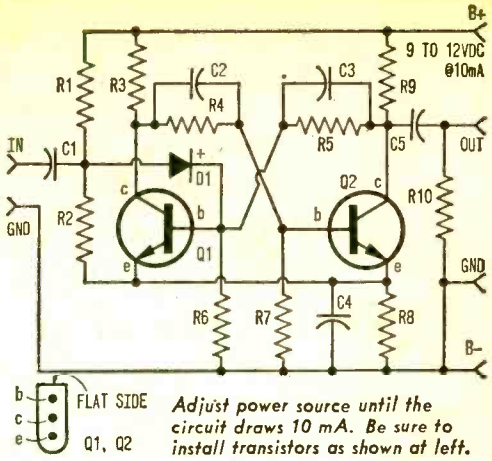
Fig. 3 shows the trace obtained when the Divi-K's output is fed through a standard cable to a general-purpose scope with a 500-kHz upper-frequency limit. Since the steep pulse of the Divi-K is mostly harmonic content, elimination of harmonics by the scope's vertical amplifier results in a display essentially of the fundamental 1 MHz. The display is, hence, almost a sine wave.



Top view of the Sentry PC board with parts mounted. Terminals installed near top carry signals and power.

Even the addition of a low-capacity probe, as shown in Fig. 4, makes little improvement in the display because the trace distortion is caused primarily by the scope's frequency limitation, not the capacity loading of the Divi-K. Note, however, the excellent horizontal linearity of the general-purpose scope: each Divi-K cycle occupies one graticule unit. The apparent non-linearity at the extreme ends is caused by the fact that the scope—a low-priced model—did not have a flat-face CRT.

Many other uses are bound to crop up as you use the Divi-K. Keep in mind that the Divi-K is an *experimental project* intended as the jumping-off point for other scope experiments that will relate your scope to modern technology, rather than having it just collect dust. ■



Adjust power source until the circuit draws 10 mA. Be sure to install transistors as shown at left.

PARTS LIST

C1—470-pF, 25-VDC capacitor
C2, C3—82-pF, 25-VDC capacitor (silver mica)
C4—.01-uF, 25-VDC capacitor
C5—12-pF, 25-VDC capacitor
D1—1N276 diode
Q1, Q2—2N4292 transistor
R1—39,000-ohm, ½-watt resistor
R2—10,000-ohm, ½-watt resistor (5%)
R3, R9—1800-ohm, ½-watt resistor (5%)
R4, R5—22,000-ohm, ½-watt resistor (5%)
R6, R7—6800-ohm, ½-watt resistor
R8—470-ohm, ½-watt resistor
R10—680-ohm, ½-watt resistor
Misc.—Wire, solder, stake terminals, etc.

The 2N4292 transistors are available at $1.50 each, postpaid, from Sentry Mfg. Co., Box 12322, Oklahoma City, Okla. 73112. They will also supply a complete kit of parts, including a plated and predrilled PC board, for $7.50 postpaid. See pages 27-28 for coupon.

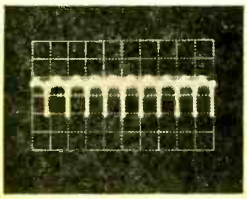


Fig. 1. Scope sweep is set for 10 cycles or 10 us per division.

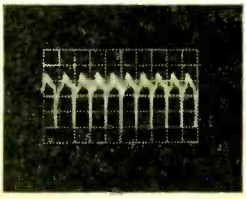


Fig. 2. Sharper trace is obtained with a low-capacity probe.

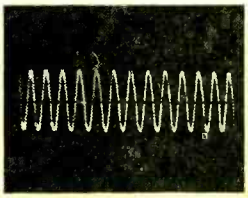


Fig. 3. Cable to scope can distort trace by shorting harmonics.

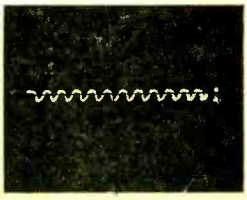


Fig. 4. Low-capacity probe can help restore harmonics in signal.

YOUR NEXT ACCIDENT...

. . . MAY BE VIDEO TAPED BEFORE IT HAPPENS

By Jorma Hyypia

The pigeons in downtown Buffalo are now sharing their roost with an electronic stool pigeon that has its beady eyes wide open, just waiting to tattle on the first driver who crumples a fender while trying to beat a red light. Most of the time this electronic stoolie just sits quietly, listening for ominous sounds. You may have heard one when you backed the car out of the garage and into a lamp post. The stoolie ignores most ordinary sounds, even loud ones. But when that distinctive crash of fender meeting fender rips through the streets, the stool pigeon is wide awake. It not only knows—and tells—what happened after the sound-causing impact, but also informs the authorities just what happened during 20 seconds *before* the collision!

Spooky? You bet it is! It will seem a lot spookier, later, when you watch the video tape playback of your mistake (*that is, if you drive like the Editor*). Somehow this electronic bird can show your car approaching the intersection, accelerating to beat the light, and screeching your tires in that futile attempt to avert an inevitable collision. It will perhaps also show you getting out of your car to take a swing at the other driver who, of course, is somehow to blame for the mishap. Embarrassing, to say the least!

Who's Big Brother. The electronic stool pigeon was conceived by the U. S. Bureau of Public Roads, a unit of the Federal Highway Administration in the new U. S. Department of Transportation. The basic idea was then incubated and hatched into a working

piece of equipment by scientists of the Cornell Aeronautical Laboratory in Buffalo, N. Y. The first test unit has already gone into operation.

The primary objective of the test unit is to gather on-site information about traffic accidents at busy urban intersections in order to improve traffic control and reduce the incidence of accidents. Traffic engineers have a pressing need of detailed information about vehicle speeds, deceleration, closing rates, lane changing, and other factors relating to accidents.

The video tape and photographic records of actual accidents will also reveal much about the accuracy of testimony offered by the drivers of involved cars and by witnesses. Insurance companies are undoubtedly watching the test program with more than casual interest.

Four Tasks. The project involved a great deal more than simply setting up video or movie cameras to take pictures of the intersection. Such a simple system would have to run continually, using an enormous amount of tape or film.

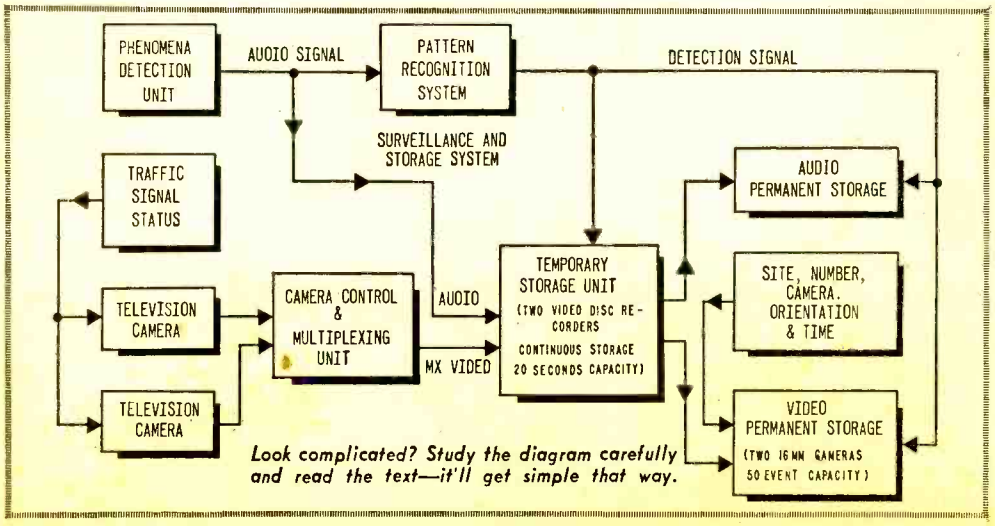
The highly sophisticated electronic system that has been devised will perform four basic jobs:

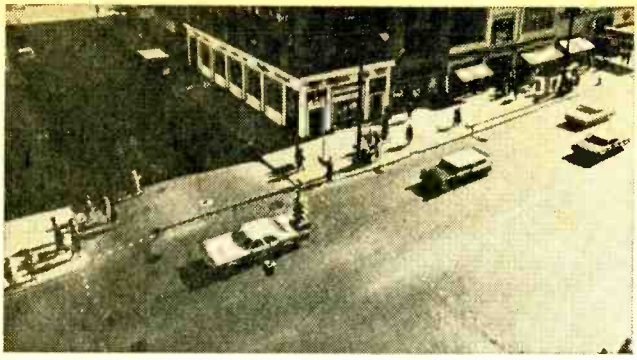
- Continuously survey an intersection and its approaches.
- Temporarily store the surveillance information.
- Automatically detect the occurrence of an accident or near accident while ignoring other events not of interest.
- Permanently record accident information held in the temporary storage unit.

To develop the most efficient system meeting these basic requirements, electronics engineers had to consider many important factors. To name just a few: accuracy of determining vehicle positions and velocities; probability of detecting all crashes; probability of detecting all *near* accidents; size of a useful surveillance area; distribution of expected vehicle velocities; operational reliability of the system; and operating environment limitations. There's much more, but let's go on with the story.

Discriminating Ear. This new accident-sensing system must listen to all traffic sounds and select those which relate to accidents or near accidents. The Phenomena Detection Unit (see the block diagram) consists of a microphone suspended about 35 feet above the center of the intersection under surveillance. The mike is contained in an aerodynamically stable enclosure designed to protect it from noise caused by rain, snow and wind. Audio signals picked up by the mike are channeled to the Pattern Recognition System and to a Temporary Storage Unit.

The Pattern Recognition System is an analog filtering and thresholding device. An audio tape library of crash sounds and a variety of non-crash sounds was used, by the engineers, to design and test this system.





ONE INTERSECTION, TWO VIEWS

Here's the intersection in Buffalo you should avoid if you drive like the Editor. Two cameras diagonally opposite each other on the south-east (right) and north-west (top) corners cover the intersection. A rotating memory disc recorder remembers what happens 20 seconds before an accident and puts it on 16mm cameras.

Here's what the engineers came up with!

The incoming audio signal of the accident is divided into four different frequency bands (200, 2200, 6000 and 8000 Hz). After being rectified, two of the filtered signals (6000 and 8000 Hz) and the total incoming audio signal are used to generate a variable threshold signal which prevents detections solely on the basis of sound energy level. When three out of four of the filtered signals *exceed* the variable threshold level within the same 200 millisecond "time window" a 20-second detection signal is generated.

Here's Looking At You! The surveillance function is performed by a pair of small synchronized TV cameras mounted on the roofs of buildings located on diagonally opposite corners of the intersection. (See diagram on next page.) Both cameras are equipped with wide angle lenses and their raster sizes are adjusted to accommodate only the useful portions of their images.

The vidicon cameras employ standard 525 line scan systems except that the 30 frames per second are not interlaced. An automatic sensitivity control on each camera compensates for light level variations over a range of 5,000 to 1 during daylight operation; for night-time operation direct illumination from vehicle headlights and tail lights is used.

Both cameras have data lights in their optical systems to continuously record which street has the red signal and when. Alternate frames from the two cameras are sequentially combined in *Camera Control* and *Multiplexing* unit so that the video output from any one camera is recorded on every second frame (every one-fifteenth of a second).

The multiplexed video signal (MX video) is continuously recorded on one of the two video disc recorders comprising the *Temporary Storage Unit*. Each of these video disc recorders makes use of a 12-in. diameter, nickel-cobalt plated disc having a protective rhodium flash. While the disc rotates at 1800 rpm, a combination record-reproduce head is spirally scanned across its surface; this records the incoming video signal while simultaneously erasing the information recorded 20 seconds earlier. The retention of a 20-second backlog of recorded information is vital to proper functioning of the entire system; this is the data that will later show what happened during the 20 seconds *before* a given accident. *(Turn page)*

e/e YOUR NEXT ACCIDENT

Crash! When the *Pattern Recognition System* decides that an accident has occurred, it shoots a detect signal to the *Temporary Storage System.* Then things really begin to happen.

The second, stand-by video disc recorder takes over the continuous recording function just in case some other autoist is headed for trouble at the intersection.

Meanwhile, the first video disc recorder switches to the reproduce mode to read out all the video information recorded during the 20 seconds preceding the detect signal. This done, the unit switches to stand-by to await the next detection signal.

Audio signals from the microphone are also recorded on the video disc recorder. Thus the sounds causing a detection signal to be generated can be used later to evaluate performance of the *Pattern Recognition System.*

Cameras in Action. The detection signal also activates two 16mm movie cameras contained in the *Permanent Storage System.* These first record auxiliary data such as site number, camera orientations, time and date. The cameras then continue running to record alternate frames of the multiplexed TV picture as it is reproduced from the video disc in the *Temporary Storage Unit* and displayed on a high resolution kinescope.

The 16mm cameras are synchronized to insure a one-to-one relationship between one particular 16mm camera and one particular TV camera.

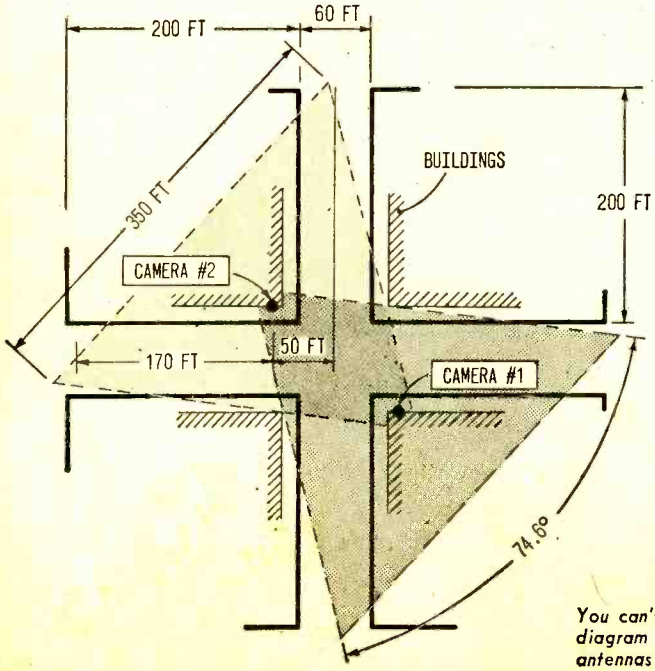
Incriminating Playback. Day and night, in all kinds of weather, the surveliance system monitors a 100 foot diameter circle at the intersection, peering to a distance of 200 feet down the length of each street.

If there is an accident, the permanent photographic record reproduces every detail with complete accuracy; the positions of all vehicles (and pedestrians) are shown 15 times every second to an accuracy of plus or minus one foot.

How do you argue against evidence like that? You can't! The system could pretty well eliminate any presumed advantages of post-accident *obfuscation* (now, this is a word everyone should look up).

It is obvious that one test unit at a single intersection in only one city won't do much to deter reckless driving. But that, after all, is not the primary purpose of the test equipment which is being used to gather information about traffic patterns. On the other hand, if many such devices could be spotted at random in numerous locations about a city, motorists might think twice before trying to beat a red light. As a matter of fact, many of the installations could be inexpensive dummy units and still serve as good deterents; after all, as far as the motorist knows, that microphone over the intersection could be one of the live ones.

If this first test unit functions as efficiently as expected, other units will surely be used in other locations. In the meanwhile, if you are driving around Buffalo these days, don't keep peering up at roof tops in the hope of spotting the electronic stool pigeon. You might have an accident! See you in court! ■



You can't sneak up to the intersection as the diagram at left shows clearly. Roof mounted antennas give unobstructed view of all lanes.

The much misunderstood IONOSPHERE

The scientific world thought him a sham. Everyone knew that radio waves, like light waves, traveled in perfectly straight lines. Aim a signal at the horizon and it would spill off the edge of the world. They dismissed his dream of global radio communications as "impossible!"

But Marconi wouldn't listen. After toying with short-distance radio transmissions, he decided to see if arrow-straight radio signals could link any two points around the earth. In 1901 he lofted a kite in Canada, and, at the appointed hour, hopefully listened for the signal that was to open an era. Through the roar of blustery wind outside the shack and crackling static in the primitive receiving apparatus, Marconi could discern the faint coded sounds that represented the letter S. The repeating trio of dots announced

(Continued overleaf)

By Len Buckwalter
K10DH/KBA4480

e/e IONOSPHERE

the first successful transmission of radio thousands of miles beyond the horizon. They were coming from Marconi's transmitting station across the Atlantic in England.

No one, not even Marconi, could venture a plausible explanation behind his success. But the evidence was there for anyone to hear. Somehow, radio waves warped around the bulging earth.

The lack of an explanation didn't stop Marconi from continuing his experiments. Within a year, the first inkling of a theory appeared. It happened at sea as Marconi observed certain differences in his transmitting range from aboard an ocean liner. During daylight hours, he could communicate at distances of about 700 miles. But at night, operating range curiously tripled to more than 2000 miles. Here was sure evidence that the range of radio signals was affected by time of day. Maybe the sun produced an electronic lift which bore signals over the horizon.

Marconi was a practical man, much occupied with tinkering and performance of his equipment. It took others to supply the breakthrough which finally revealed the remarkable circumstances that made long-distance radio possible. Two men, working independently of each other, struck upon the underlying reason. A. E. Kennelly and O. Heaviside imagined a vast electrical "mirror" situated high in the earth's atmosphere. Indeed, they reasoned, radio travels in straight lines. But as a portion of the signal angled toward the sky, it struck that "mirror" and reflected back to earth hundreds, even thousands, of miles away. Their shrewd analysis was proved beyond doubt in 1925. By shooting bursts of radio energy skyward, researchers could precisely measure returning echoes.

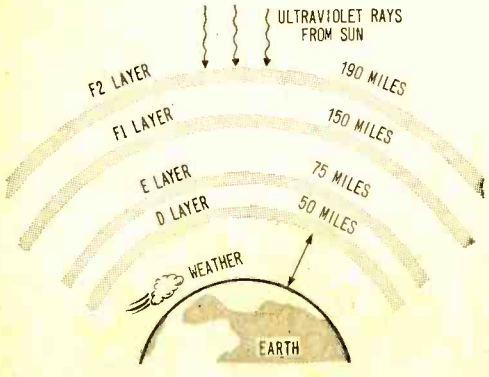


Fig. 1. Ultraviolet sunshine ionizes gases in upper atmosphere. Layering is caused by difference in weight of various gases.

What emerged was a theoretical picture of a vast electrical umbrella hovering above the earth that could bend and bounce radio signals. It was dubbed the Kennelly-Heaviside layer, though now it's commonly known as the *ionosphere*. Hidden in that name is the reason for a remarkable aerial performance. And, as early researchers guessed, the cause of the phenomena came from the sun. Let's consider the classic picture of the ionosphere as it's believed to exist.

Sunlight And Violets. In addition to heat and visible light, the sun pours an enormous stream of ultraviolet radiation. The earth's protective ocean of air prevents most of the radiant energy from destroying life on the planet (though it does cause sunburn). The upper layers of the atmosphere bear the greatest brunt of this daily solar attack. Under this bombardment, large numbers of electrons are torn from gas atoms which comprise the upper air (oxygen, nitrogen, helium and others). Electrons drift and diffuse within a region that begins about 50 miles up, and extends to over 250 miles above the earth. This process, agree the experts, forms the ionosphere, the region that reflects radio waves.

The ionosphere tends to form in distinct layers. That's because gases in the atmosphere also exist in layers; the lighter ones rising to higher altitudes. This layering effect, incidentally, hardly happens near the earth's surface because of weather. The impact of wind and irregular ground surface creates a giant mixmaster that continuously churns low-lying atmospheric gases. Only in calm upper regions can layering occur. Thus, the sun's ultraviolet rays produce levels of ionization which vary in height and numbers of free electrons floating through a particular region.

D, E, and F, Too. When the layering effect was discovered by Englishman Edward Appleton in the early 20's, three distinct levels were observed. They represent separate regions where electrons tend to crowd in high density. Appleton assigned the letters D, E and F to the layers, expecting that someday additional levels of ionization would be discovered. It is now nearly a half-century later and no one has succeeded in filling in the missing A, B and C, but

Appleton's scientific judgment may yet be redeemed. Research in the ionosphere continues at a hectic pace and remarkable discoveries occur continuously. In one year, for example, scientists engaged in atmospheric research may probe the layers with some 15 million "soundings"—radio signals that explore the ionosphere and bounce back with revealing clues.

As shown in Fig. 1, ionosphere layers range in height from about 50 to over 200 miles. Consider the lowermost level, or D, layer. Since the sun provides the activating force to create the D layer, there is a daily change in depth. In fact, the D layer is created anew each day, then promptly disappears at night. Another facet of D-layer fact is due to its relatively low height. Solar radiation has been weakened after travelling through much of the atmosphere so it produces low electrical activity in this region. Not only is the D layer difficult to measure on instruments, but it plays only a small role in most radio-wave propagation.

Higher E. Slightly higher is the E layer. It also responds to daily variations in sunlight, disappearing soon after the sun sets. Though the E layer is not the medium for reflecting long-distance radio signals, it is, nevertheless, an active region. Much amateur traffic on very high frequencies, normally used only for line-of-sight transmissions, is captured by the E layer and reflected great distances.

Finally, there's the most important area of the ionosphere—the F layer. It is the major medium that enables radio signals of low power to easily bridge oceans and continents. Note that it is divided into F1 and F2 layers. During the day, the high penetrating power of the sun creates a distinct pair of ionization bands. But with the onset of evening, the F1 layer starts to disappear.

Waning energy from the setting sun allows free electrons to wander back to the original gas atoms and restore the layer to its original, or neutral, state. The process is termed *recombination*. The higher F2 layer, however, persists through the night. Air at this level is so thin that free electrons must drift further before they encounter gas atoms. Thus the layer remains electrically active.

F1 and F2. An important effect occurs as the F1 layer disappears in the evening. If you could view it while standing on earth, it would appear to rise and merge with F2.

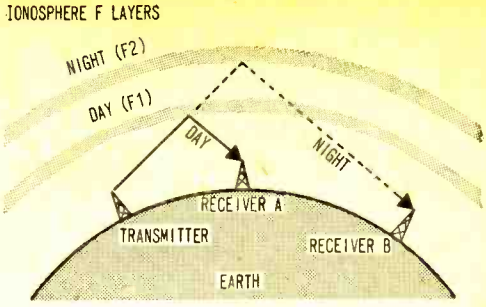


Fig. 2. Primary difference in reception distance between night and day is due to effective height change of F layer.

The net effect is that the ionosphere seems to rise about 40 miles each evening. Then it lowers at sunrise the next day as the F1 layer is recreated. This apparent rise and fall of the ionosphere accounts for a daily change in radio conditions between any two points on the globe. As the DXing ham might say; "The band came in at noon and went out at 3 p.m." How changing altitude affects signals is shown in Fig. 2.

If the radio signal leaving the transmitter

HOW TO LISTEN IN ON PROPAGATION FORECASTS FROM WWV

Frequencies: (MHz) 5, 10, 15, 20, 25

Time: Last half of every fifth minute of each hour.

Method of Announcement: International Morse Code.

Content of Announcement: Letter and Number. Example: "N6"

Meaning of Letters: W=Disturbed; U=Unsettled; N=Normal

Meaning of Numbers: (Note that numbers are grouped under basic letter category)

W (Disturbed)	U (Unsettled)	N (Normal)
1. useless	5. fair	6. fair-to-good
2. very poor		7. good
3. poor		8. very good
4. poor-to-fair		9. excellent

Examples: N6=Normal, fair-to-good; W3=Disturbed, poor

Length of Forecast: Next six hours following announcement.

Geophysical Alerts: First half of nineteenth minute of each hour. Following symbols sent in very slow Morse Code. Identified by letters "GEO" with symbol repeated five times:

M=Magnetic storm	S=Solar activity
N=Magnetic quiet	Q=Solar quiet
C=Cosmic ray event	W=Stratosphere warning
E=No geoalert issued	

(Prediction covers 24-hour period before, during or after event)

IONOSPHERE

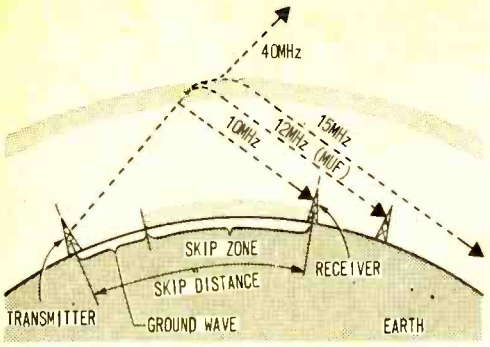


Fig. 3. Maximum usable frequency (MUF) is determined by ionosphere's electrical activity which determines its reflectivity.

is traced for daytime conditions, it is seen to rise, then reflect from the lower (F1) layer. The wave returns earthward and is picked up by receiver A. At this time receiver B "sees" little or no signal energy. But as the ionosphere apparently rises at night, the longer path carries the signal further, to receiver B. These conditions account for a basic day-night difference. In addition to height, there are a number of other variables affecting the ionosphere.

A seasonal change is one. Wintertime brings a more violent, extreme change in the day-and-night variations of the ionosphere. Although you'd expect more solar radiation in summer, there is another factor at work. During winter months in the northern hemisphere, the earth is several million miles closer to the sun than in summer. This greatly intensifies the sun's action on the ionosphere and there's heavier ionization during the day. There is also a large variation during the night, due to longer hours of darkness since there is more time for the layers to recombine. The net effect is often a more pronounced change in radio conditions than that occurring in summer. The high F layers, for example, tend to average about 60 miles lower in height during winter months.

Finding the Frequency. Along with ionosphere height at any given time, signal *frequency* determines whether there'll be communication between distant points. The same principle is visibly demonstrated by shining white light through a prism. There'll be a fanning out of various colors as the differing wavelengths contained in white light are bent at varying angles. Frequency or wavelength of the radio signal encounters a similar type of selective bending through the ionosphere. Fig. 3 shows the idea.

The fundamental rule is that the *lower* the frequency, the *more* it bends through an ionospheric layer. This explains why of the three different signals in Fig. 3 bending in the ionosphere, only one signal is useful for long-range communications. Note that the lowest frequency from the transmitting station is 10 MHz. In the ionosphere, it experiences the sharpest bend when compared to 15 MHz and 40 MHz signals from the same source. That 10 MHz signal is hitting the receiving antenna after one "hop" through the ionosphere. But the 15 MHz wave, higher in frequency, experiences less bending and, in fact, fails to return to earth and is lost to space. The same is true for the very high frequency of 40 MHz, seen to bend slightly, then departing this earth.

Maximum Frequency. This variability in reflection angle gives rise to one of the most important terms used by scientists who map the daily behavior of the ionosphere. It's MUF, or Maximum Usable Frequency. This is the *highest* frequency that, under a specific set of ionospheric conditions, will return a signal to earth. In Fig. 3, the MUF is about 12 MHz since 10 is seen returning, while 15 and 40 are escaping. The MUF is of great interest to anyone engaged in DX or other international shortwave operation. It enables a foreign broadcaster, for example, to predict his path and then shift transmitting frequency to obtain the required geographical coverage.

The MUF will vary according to effects already described; time of day, season and frequency. It may shift below 10 MHz at about sunrise since the ionosphere is high at this time and requires a relatively low frequency to produce enough bending for an earth return. As the F layers thicken later in the day, the MUF will rise to a higher frequency. A long-distance station generally chooses its transmitting frequency (if possible) at about 15% below the reported MUF. This assures the signal will return to earth. If the station dips too far below that figure, two distance-killing effects begin to set in. First, the lower transmitting frequency will bend sharply and may fall short of the receiving station. Second, the ionosphere tends to absorb signal energy as frequency is reduced.

D Absorption. This absorption effect,

incidentally, explains why you hear large numbers of distant broadcast signals on the regular AM band at night. During the day, you may recall, the D layer forms in the ionosphere. Although it contributes little to signal-bending, it can absorb energy passing through to higher layers. And the D layer gobbles more energy as frequency is reduced. Thus low-frequency AM broadcasts can't get through to create a skipping skywave. When the D layer disappears at night, though, skywaves merrily hop through the F layer from hundreds or thousands of miles away.

The familiar phenomenon of fading also springs from the ionosphere's variable bending action on the signal. One common effect is selective fading where different frequencies carried by one transmitted signal are reflected at different angles. Voice frequencies, for example, on an AM signal lie just above and below the main carrier frequency. As they strike the ionosphere, the lower frequencies bend slightly more than mid- and high-range values. The net result is that signals arrive at varying strength levels at a given point. In another type of fading, signals radiate from the antenna at slightly different angles. The parts arrive out of step as they travel slightly different reflecting paths. A third brand of fading occurs due to unstable conditions as the ionosphere undergoes electrical changes.

Spotty Reception. Besides daily and seasonal variations, the ionosphere is profoundly governed by the sunspot cycle. The spots are relatively dark areas on the sun that are about half the temperature of the adjacent solar surface. They may last a few days or months. When the number of spots is averaged, they are found to rise and fall over an 11-year period as shown in Fig. 4. Right now the sun is pulling out of a trough and heading toward a sunspot maximum which will occur in a year or so. The event causes excitement among hams especially, because the rising number of spots means a big improvement in long-haul communications. Increasing sunspots are accompanied by intensified solar radiation that boosts the electrical activity of the ionosphere. The effect raises the maximum usable frequency (MUF). If, for example, the MUF allows skip on 14 MHz during the low period in the cycle, the peak portion may cause signals as high as 35 MHz to be just as effective. Just a few years ago a ham tuning 10 meters (28 MHz) found it about as active as a graveyard. But now conditions are improving rapidly and should remain that way for several years. CBers, on the other hand, can expect skip interference as more sunspots carry 27 MHz signals far beyond local limits.

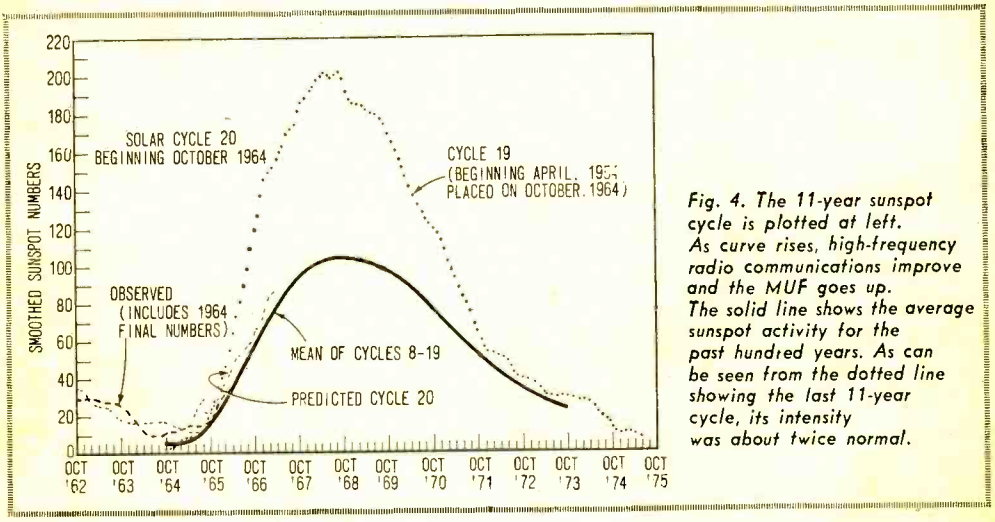


Fig. 4. The 11-year sunspot cycle is plotted at left. As curve rises, high-frequency radio communications improve and the MUF goes up. The solid line shows the average sunspot activity for the past hundred years. As can be seen from the dotted line showing the last 11-year cycle, its intensity was about twice normal.

Sunspot Problems. Sunspots aren't an unmixed joy. More of them means the beginning of the "blackout" season. Without warning, a brilliant flash erupts at a sunspot and rapidly widens over a large area of the sun. Soon the effect is felt on earth. The planet is doused with a huge quantity of ultraviolet and X-rays which may utterly wipe out communications through the ionosphere on the day side of the world. The phe-

e/e IONOSPHERE

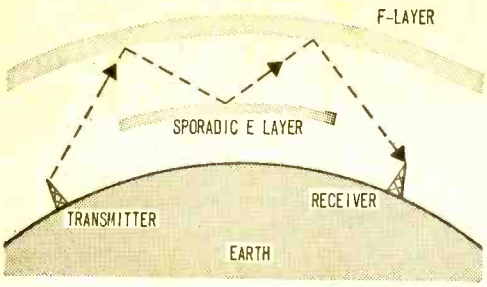


Fig. 5. The temporary appearance of the sporadic E layer can bounce 6-meter signals 1000 miles or more.

nomenon, known as the *solar flare*, may disrupt communications for periods to about an hour. One of the worst blackouts occurred in 1957. It produced an ionospheric "storm" that lasted about three days. The cataclysmic forces which generate solar flares are little understood.

E Sporadic. Another peculiarity of the ionosphere is the formation of a sporadic-E layer. As you may recall, the E layer is positioned at low altitude and normally contributes little toward radio propagation. But at unpredictable times, there forms in the E region a dense cloud-like patch of ionization. It may temporarily double the MUF. The appearance of sporadic-E is often the ham's delight since it can catapault 50 MHz signals (the 6 meter band) for distances of some 1000 miles. Normally, these very-high-frequency signals penetrate the ionosphere with hardly any bending. But increased ionization changes all that.

Sporadic-E can also add a special twist to a signal skipping through the ionosphere. As shown in Fig. 5, a signal reflected from the high F layer is prevented from striking earth by the intervening E layer. It is trapped by the ionized cloud and rebounds skyward again. The signal finally emerges and reaches earth where the E layer doesn't extend. The layer may cover several hundred miles and is most commonly encountered near the equator where solar radiation is strong. It also builds up during spring in higher latitudes where it causes havoc in TV reception. TV receivers over a large region can be swamped with interference borne by sporadic-E propagation. The interference is comprised of signals from distant TV stations transmitting on the same frequencies as local outlets.

Sounding Off. The condition of the ionosphere is of great significance to the thousands of broadcasters, hams, SWLs, researchers, overseas communications companies and others who rely on its radiowave reflectivity for pleasure and profit. Thus, it is under constant surveillance by electronic detectives around the world. The leading organization in this country covering the ionosphere's every move is the Environmental Science Services Administration (ESSA) which operates under the U. S. Department of Commerce. (This work was formerly done by the Central Radio Propagation Lab under the National Bureau of Standards.)

One of the most important tools of ESSA for probing the ionosphere is the *ionosonde*

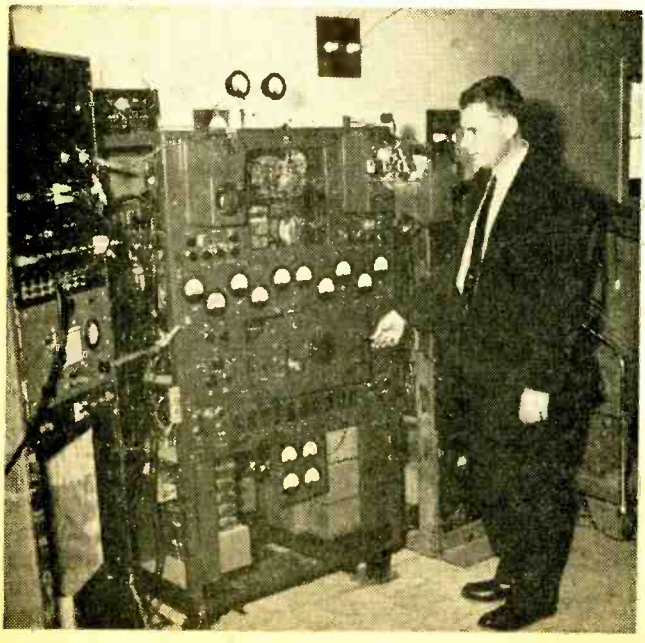


Fig. 6. The ionosonde is a sort of vertical radar used by scientists to probe the ionosphere. By sending out pulses of RF at different frequencies, and then recording the echo, various facts about the ionosphere can be determined such as its height and the MUF.

(like the one shown in Fig. 6.) It's a transmitter-receiver combination that operates on a radar technique. It fires a pulse signal vertically toward the ionosphere, then switches to receive and picks up the returning echo. The echo dabs a bit of light on an oscilloscope screen and this is photographed on a strip of film. The time difference between the original pulse and reflected signal reveals ionosphere height. The ionosonde can yield a profile of conditions in the ionosphere over a range of frequencies of about 1 MHz to 25 MHz. Let's examine a typical image.

Ionograms. In Fig. 7 is a tracing of an actual *ionogram*, or readout from the ionosonde. In this illustration, the curving line represents the behavior of the F layer at varying frequencies. For example, when an RF pulse at 2 MHz is sent upwards, it is reflected back from a height of about 180 miles. As frequency increases, the signal returns from a higher level, agreeing with the basic principle that the higher the frequency, the less it bends in the ionosphere. Note that the curve completely disappears between 4 and 5 MHz. This is the point of penetration (and MUF); the frequency is so high that bending (or reflection) is insufficient to return it to earth.

By piecing together many ionograms, sunspot and other solar data, plus shortwave reports, it's possible to predict the ionosphere's future condition with some reliability. When available data is fed into a computer, ESSA can come up with the propagation forecast like the one shown in Fig. 8. It's a page from its monthly "Ionospheric Predictions" (a publication at a subscription rate of $1.50 per year). The chart aids in choosing the best skywave frequency at any given hour and day. The top of the chart indicates it's to be used during March 1967 at Universal Time 12. Numbers spotted over the world map indicate the maximum usable frequency (MUF) to fling a signal through the F Layer. These charts are issued three months in advance. For a modest fee, ESSA will put anyone's propagation problems through its computer and come up with an exclusive book of predictions. This service might be used by an overseas common carrier, for example.

Further Up. We've just scratched the surface of the ionosphere. With advancing space exploration, it's being prodded with a tremendous amount of research designed to shake loose more of its secrets. Scientists are discovering strange "whispering galleries," (flickering signals on the tails of meteors). With rockets and satellites they're sounding out the ionosphere from "topside," and exploiting new radio signal pathways that lie below the conventional electrified layers. These and other remarkable new developments promise to soon revamp many current radio propagation theories and may provide unprecedented long-range low-power communications that Marconi never even dreamt about in his most prophetic dreams. ■

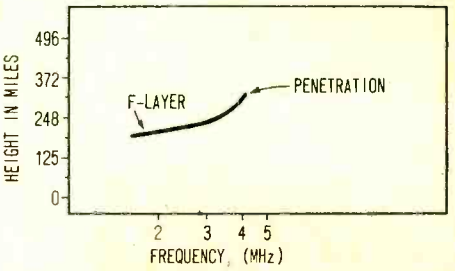


Fig. 7. Ionogram above, is produced by echo of signal sent by ionosonde, and provides visual indication of MUF.

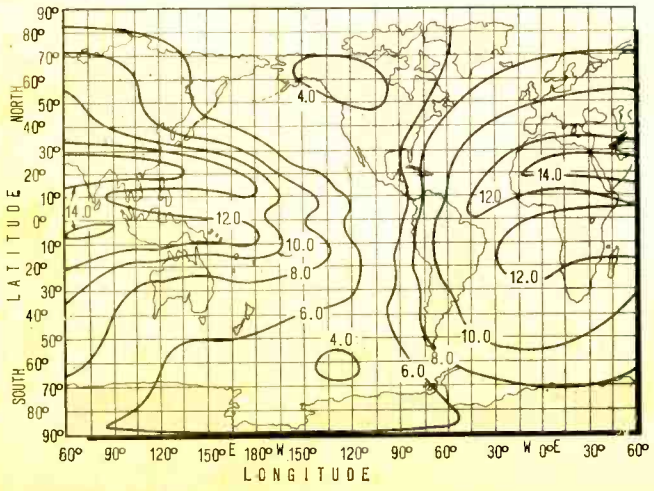


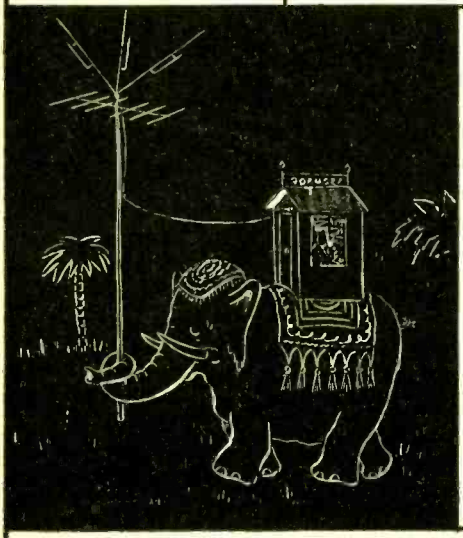
Fig. 8. Charts, like the one of left, are prepared by the Environmental Science Services Administration (ESSA) for shortwave broadcasters and other users of radio needing an overall picture of regional MUF shown by the numbered lines in MHz.

THE GIFT OF GAB

By Marvin Townsend

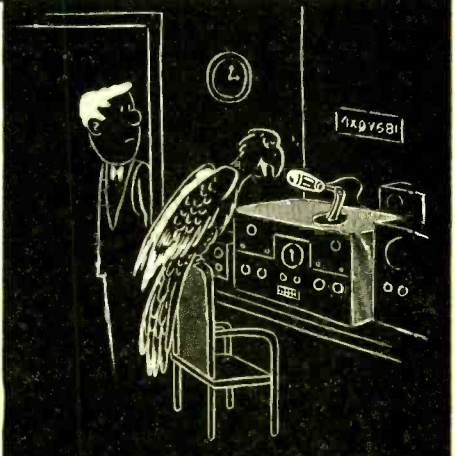
"He converts completely assembled equipment into hopelessly unassembled kits!"

"Roger! Will relay message as soon as I get a fire going!"



"Oh Gladys, she's talking to our former next door neighbor!"

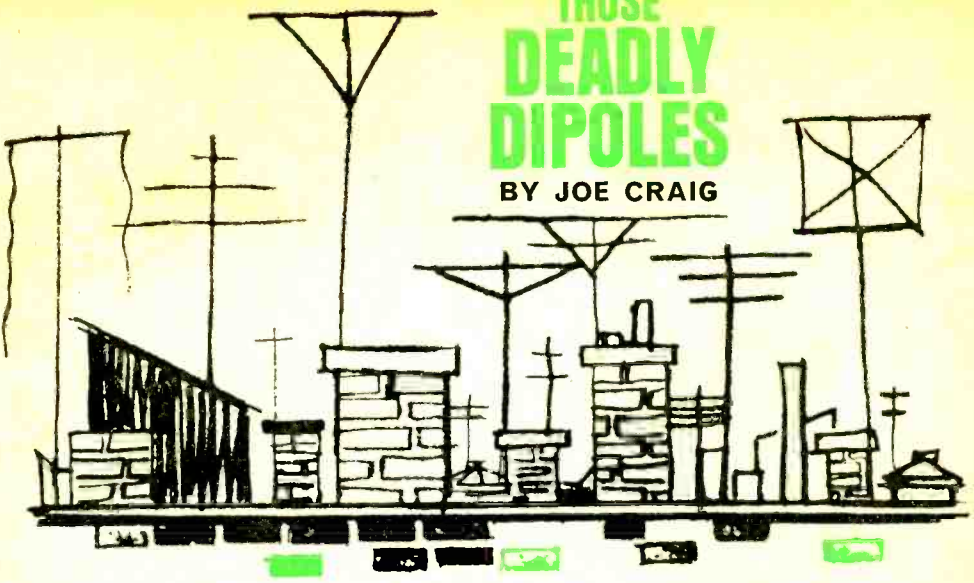
"Well, let's have it! What little gem of advice did the marriage counselor give you?"



"I suggest, WA2CQL, that you try two 2N455's and one IN3324, but . . ."

THOSE DEADLY DIPOLES

BY JOE CRAIG



To the life or death of FM and TV reception, the dipole makes the difference.

Never has your antenna been so important. Color's been added to black and white, stereo heaped onto FM. And UHF-TV is spreading like lava down the side of Vesuvius. To capture the maximum in microvolts from any of these signals, the antenna system, electronically speaking, has got to swing. Trouble is, an aging antenna stumbles out of step for several reasons.

Oxidation of the aluminum elements is one. It forms a coating that fends off part of the signal. Dust, like that from cement and steel factories, is also bad for antennas. And so is soot from "on-the-chimney" installations.

Old transmission wire, the "lead-in" that carries the antenna signal to the TV set, can also hurt reception. If this lead-in is dried and brittle it can crack and moisture can get to the conductors thereby shorting out the signal.

Wind-deformed elements, if bent badly enough, can be another cause of deterioration of antenna performance—which means a poorer picture.

And finally in the stable of defects in aging antenna installations, the wind may push your antenna *off target*, changing its direction and reducing signal pickup.

Especially In Color. More and more people are buying color sets; close to six million were bought in 1967 and 1968 is running ahead of last year. If you are thinking of buying a color set, you should give some thought to your antenna, for it may not be good enough to give you the color picture you will be paying plenty to get.

If you are getting perfect reception now, the chances are you will get excellent reception with your color TV set. But the fact is that many viewers, without realizing it, put up with many forms of poor TV reception, such as smear, ghosts, and moderate snow on weaker stations. While ghosts, fuzzy pictures and snow may be watchable on black-and-white TV, they are intolerable on a color set, because you haven't seen anything until you've seen multi-hued ghosts and the good old red, green and blue everywhere it doesn't belong.

To overcome most poor-signal problems, you need a good directional high-gain antenna to bring home a strong signal. In addition, an antenna for color TV must have minimum gain variations on each channel. Some antennas actually attenuate specific frequencies of a TV signal. This may not hurt black-and-white signals, which are carried primarily on only one frequency in each channel (the sound is on another frequency), but when color is added on an additional frequency on the channel a little signal-attenuation can go a long way towards ruining the color.

Color signals are carried at the main frequency and at another frequency, called the

color subcarrier. If both frequencies are not sent down by the antenna to the TV set with equal strength, some colors may come in stronger than others or worse still, you may lose color entirely. The results may range from unreal colors to only partial color. In either case, it's not what you bargained for when you bought your color set. A carefully designed, color-rated antenna will pull in all frequencies at full strength for better black-and-white and color reception.

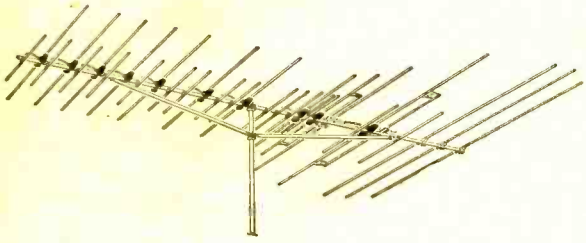
Not To Mention FM. At one time, FM was something for long-hair music fans who lived in the cities. There were few FM stations and many of these were going off the air at an alarming rate. However, with the advent of high fidelity records and equipment, more people got to know this noise-free broadcast band with its good music programming. Now there are FM stations practically everywhere and more coming with all kinds of programming. Many are broadcasting in stereo. To match renewed interest in FM, radio manufacturers are producing low-cost FM radios, and most high fidelity consoles and component systems include an FM-stereo tuner.

FM radio requires the use of an antenna just as television does. Once you get out of the immediate broadcast area, an outdoor antenna becomes necessary. Many people use their TV antennas for mono FM reception with good results. But often this is inadequate for good stereo FM pickup. Why? Because the signal needs to be stronger in the receiver for good stereo results than it does for mono.

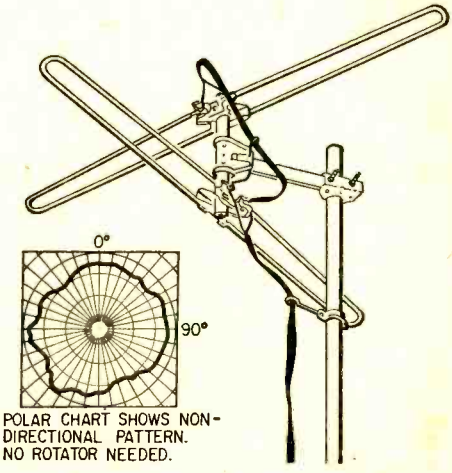
Reason is that the stereo tuner or receiver has a multiplex circuit which separates the received stereo signals into their left- and right-channel components. During the separation process, much of the signal is lost. The end result of a poor FM antenna will be weak reception of nearby stations, loss of the stereo effect and no reception of distant stations. A more powerful, directional antenna will make up for these losses, and also eliminate FM ghosts which come through the speakers as distortion.

Some of the new TV antennas are also designed for FM-stereo reception, and they are a logical choice for anyone who now has FM receiving equipment or hopes to get it in the future. However, you must ascertain that the antenna is indeed designed for FM reception. Sometimes a separate FM antenna is best, but we'll go into that later.

UHF TV Too. UHF television is the band that encompasses channels 14 to 83. That's about all UHF has meant for many years, just a definition. There were a handful of UHF telecasting stations scattered about the U. S., but mostly small educational stations. And not long ago, few sets could get UHF without a convertor. But Congress passed an FCC-backed law that said that TV sets sold after April 1964 had to be able to receive all 83 TV channels assigned in the U. S. This means, of course, that all recent sets can receive the complete VHF-UHF spectrum. With more sets in circulation having UHF capabilities, more stations will come on the

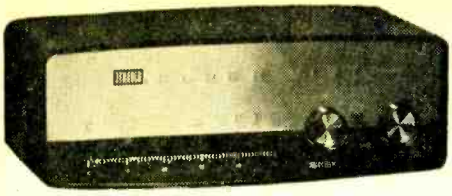


Ultra fringe-area VHF reception is possible with this Winegard yagi. Broadband response is achieved by staggered elements.



POLAR CHART SHOWS NON-DIRECTIONAL PATTERN. NO ROTATOR NEEDED.

Winegard turnstile FM antenna has nearly circular pickup pattern making it useful for urban reception.



More and more new TV stations are coming on the UHF frequencies in urban areas around the country. For sets without UHF tuners, convertors are available like the Jerrold above and the Channel Master at right.

air (new ones are a-building) and UHF will gradually become a national television service like VHF. People who do not have UHF sets will be able to view UHF programs by getting a convertor.

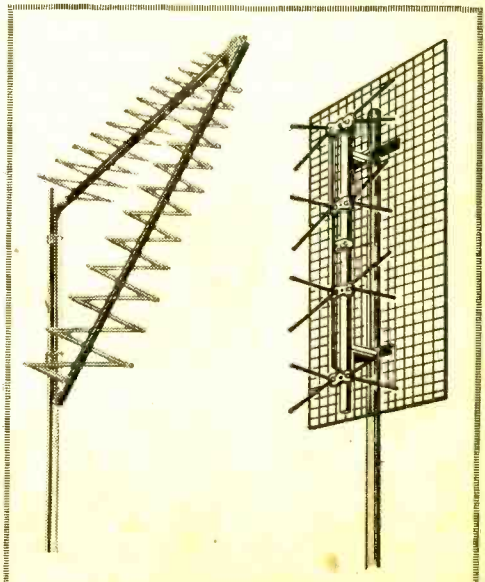
Why bring this up here? Because, naturally, UHF needs a special kind of antenna. The UHF (which stands for *ultra-high frequency*) band covers 470 to 890 MHz, from two to four times as high in frequency as the VHF channels. To put it another way, UHF signals are about one half to one quarter as long as the V's. Therefore, an antenna for UHF need be only about one half to one quarter the size of a VHF antenna, which makes it rather compact. Because of this compactness, highly efficient UHF antennas can be designed. This is important because UHF signals do not travel as well as the V's; they lose more strength in the atmosphere and get bounced around more by trees, water towers, etc. What this amounts to is that for satisfactory UHF reception, a separate antenna is a must.

Now that we've covered the general facts about antenas for TV and FM, how about getting down to cases. Specifically, your case. Let's assume you're in the market for an antenna—there are lots of them for sale, which one do you buy?

Get The Right Antenna. The first question to ask yourself is: what do you want to receive? TV only, or TV and FM? Don't let the current reception situation be the deciding factor; that is, if there is no FM station in your locality now, don't rule out FM because there may be such a station near you soon.

Antenna engineers tell us that a well-made antenna should give excellent results for a minimum of 5 years, depending on the corrosiveness of the air, wind conditions, and unforeseen accidents. Don't short-change your antenna investment by buying something that you will have to add to or change later on. Another thing: if there is no FM station in your locality, there may be one 80 to 100 or more miles away which you will be able to receive with a high-gain antenna if the terrain is favorable (no mountains in between, etc.).

The next question is: are you content to settle for locals or do you want to receive distant stations? If you live in or near a big city with five or more TV stations available locally, then you will probably be content with an antenna that does not have exceptional gain. But if you do want to pull in TV stations up to 100 miles away, or even more, then you will need a top-gain antenna installation.



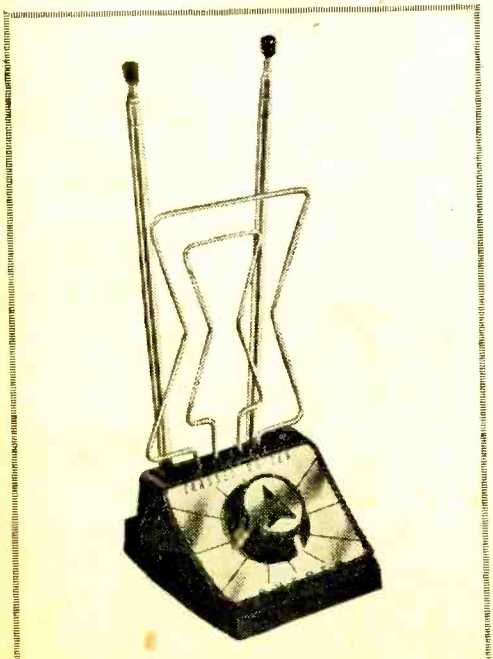
Two potent answers to UHF reception are the JFD helical antenna at left, and the Allied stacked conical at right.

e/e DEADLY DIPOLES

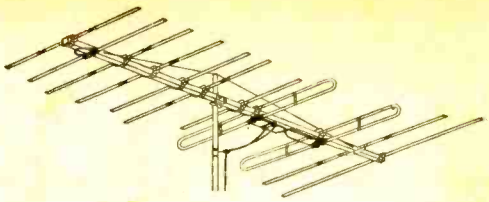
You may be in a local area for some stations but in a fringe or ultra-fringe area for others. In this case you would therefore need a fringe-area antenna to receive the lot. Duluth, Minnesota, for example, is a city with few local TV stations, so many viewers put up big antenna installations and pull in stations from Minneapolis-St. Paul, 150 miles away. Here, fringe-area FM antenna installations are also common.

Another thing to consider is where the TV and FM stations you want to bring in are located. Are they all in the same direction from you or widely scattered? If, for example, you live in the suburbs of a big city and all the stations you are likely to view come from the city, you will merely have to point your antenna in that direction. But if there are a few stations in another city in a different direction, you might require an antenna rotator.

Selecting Your Antenna. Let's say you have decided that you need a VHF-TV antenna; you live in a city with several TV and FM stations and your neighbors get good results with indoor antennas, so that's for you. Now which one do you get?



Typical of better indoor-type antennas, this Channel Master Aurora receives VHF and UHF-TV as well as FM.



This Finney Duo-Twin-Drive yagi VHF antenna has twin-driven folded dipoles, two reflectors, and six directors and claims 175 mile TV reception.

First off, look for one that matches your TV set's antenna requirements. All modern TV sets are designed to work with a 300-ohm antenna, so check that the antenna you get has a 300-ohm impedance. Secondly, make sure that telescoping "rabbit-ear" rods of the antenna will extend to the full length of 96 inches, which is what's needed for the best reception on channels 2 and 3. You can stop here if you don't mind fiddling with the telescoping rods and turning the antenna every time you switch from channel to channel.

The alternative is to get a switchable antenna that incorporates a resistor-capacitor network that electrically varies the lengths of the rods as the selector is switched to the correct position for each channel. When the switch is combined with a series of directional elements, it helps tune out ghosts and interference, eliminating the need to manipulate the antenna's elements by hand.

As good as some indoor antennas are, they are still second best, and if you can install a rooftop antenna, do so. The simple act of moving a good indoor antenna from within a room to the top of the roof of the same house will often improve the signal to the TV set by as much as 20 dB. Why? Because a house with its network of electric wires and metal wall lathing and plumbing is like a big shielded cage, intercepting much of the signal before it can penetrate into the rooms. What's left bounces around inside the room creating a pattern of "hot" and "cold" spots, which is the reason that an indoor antenna must be moved around to find the best reception spot.

Enough's Enough. Getting enough signal to drown out interference is important at any location, no matter how close to the TV station. Within a house, interference may come from motor brushes, a bad electric light bulb, or a washing machine timer. Out-

side of the house, interference comes from passing cars' ignition systems, other TV stations and the reflection from passing airplanes. And every TV set generates its own internal noise, all of which may cause a poor picture or "snow." A TV set will eliminate much of this interference and noise if given a strong enough signal to work with.

In local areas, a simple outdoor antenna will often work fine. Antennas, such as the conical or high-low band folded dipole, are dependable performers where there is lots of signal and little interference. Neither one, however, is designed for FM reception. And worse still, the conical does not offer uniform reception across the band.

A modern solution is to get a "local" version of the newer, more efficient wideband antennas. Many of these new designs were developed primarily to overcome the vexing problems of fringe and ultra-fringe areas, but their operating principles have been applied to smaller versions for local reception.

Judgment Day. At this point it might be instructive to go into the question of how to judge an antenna. Most antenna manufacturers furnish electrical specifictions and reception pattern diagrams for their models and these may be trusted to be correct. The only problem is that not all engineers measure performance the same way. Many claims of unbelievably high gain may be deflated a couple of dB when the antenna is actually up there on the roof, especially since many new antennas are merely worked-over variations of the time-proven Yagi, whose gain is limited to about 9 dB.

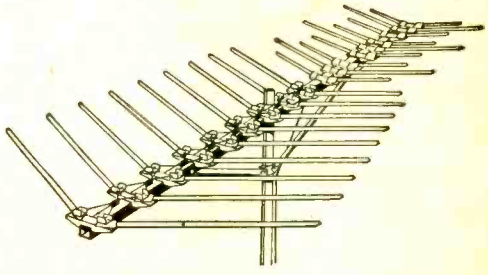
As important as gain is an antenna's directional sensitivity and this is given in terms of "front-to-back ratio." A high figure here indicates that the antenna receives well from the front but practically nothing from the rear and sides—which is good for interference rejection.

In addition, the antenna needs to have an impedance of 300 ohms to match the antenna input circuit of a TV set. (Some 72-ohm systems for coaxial cable are also available.) A mismatch leads to ghosts and loss of signal power. Also, an antenna should be designed so that there is even signal pickup from one channel to the next so the antenna always presents the same impedance to the TV set.

Besides electrical characteristics, good antennas are ruggedly constructed to withstand rough physical treatment from rain, snow, hurricane, and corrosive atmosphere. A good antenna should have a protective coating to prevent oxidation.

Antenna Cover Up. Anodizing is one such coating often used on aluminum elements, but since the anodized surface is an electrical insulator, it must be removed wherever metal to metal contact is required —like between the elements and the boom. This removes the oxidation protection at these points where it is really needed most. Some better antennas are coated after the complete antenna is assembled, protecting the contact points. The best coatings, unlike anodizing, are the conductive ones.

Another thing to look for is reinforcement of the elements at the points of stress, such as at the swivel points. Most antennas come collapsed and need to be opened like an umbrella by unfolding the elements and snapping them into place. Ideally, the elements should be self-locking and not require special tools. The insulators should be large and made of high-impact plastic material.



Lafayette Radio offers this 18-element log-periodic ultra-fringe antenna for VHF color and black-and-white reception in the 175-mile range.

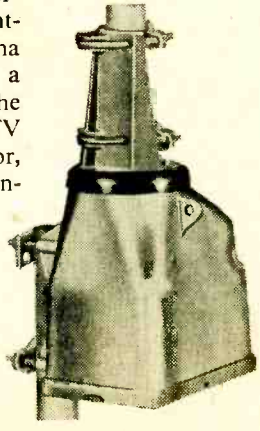
All of these physical characteristics are especially important for suburban and fringe area antennas since they are large and complex and present a lot of surface to wind and snow stresses.

TV Numbers Game. It's popular for antenna makers to claim superiority for their product by claiming their antennas have more elements than their competitors' models. Beware. The only time the number of elements makes one antenna inherently superior to another is when comparing two antennas of the same type by the same manufacturer. For example, if one manufacturer puts out a five-element antenna and a seven-element model of the same type, the seven-element unit will have more gain and be more directional. But this does not necessarily hold true in comparing one antenna make to another because a five-element antenna of

a particular design may be more directional and give higher gain than a ten-element antenna of another design. Also, all the elements may not be active and have relatively little effect on performance. The number of driven elements, that is, the ones connected to the transmission line that carries the signal down to the TV set, is most important, as is the number of directors. Other elements may contribute little but look good.

Meanwhile, back at the suburbs, we discover that we've run into a directivity problem. It seems that there are three receivable stations, two broadcast from the tall office building downtown, and one from a tower north of town. Our antenna is a high-gain job with sharp directivity to reduce ignition noise and other interference and give us best stereo FM reception as well. But if we aim the antenna at the office building downtown, we get poor reception from the telecasting tower on the north side and practically no FM from the station at the other end of town. What do we do now?

Tenna-Turner. Well, the best answer is to get a rotator. This consists of two parts: a motor in a weatherproof housing mounted under the antenna on the mast, and a control console in the house near the TV set. With a rotator, you can turn the antenna to point to the station you want to watch as you flick the channel selector knob to that station. This allows you to get the most efficient use out of a high-gain, highly directional antenna.



A rotor may be needed for your antenna. This one's a Channel Master.

The rotator can be used to "tune out" ghosts, bring in stations from distant locations and re-orient the antenna after a windstorm if necessary. Because a rotor (the motor unit) adds weight to the antenna, the mast will probably require additional guying, that is, the use of enough support wires running from the top of the mast to the roof at three or more points to ensure that everything stays put.

An antenna mounted amplifier will effectively increase signal-to-noise ratio and thereby improve picture quality. Just be sure to get a sturdy unit that'll survive wind and weather.

If you live in a fringe or ultra-fringe area, you will have to accept one fact of TV life: no one can guarantee you perfect reception with any antenna installation. What you get, indeed if you get anything at all, will depend on how far you are from the station or stations, what kind of country lies in between you, and how powerful the transmitter is.

Over water or flat country, 150- or 200-mile reception is possible; in hilly country, you may not get anything worth watching from a station 50 miles away if the antenna is down in a valley blocked off by high hills or mountains.

There have been cases where fringe-area viewers discovered that they got best reception from a TV station by pointing the antenna slightly away from it to get the signal bounce off a nearby hill. (For this, they used a rotator to pinpoint the spot of best reflection.)

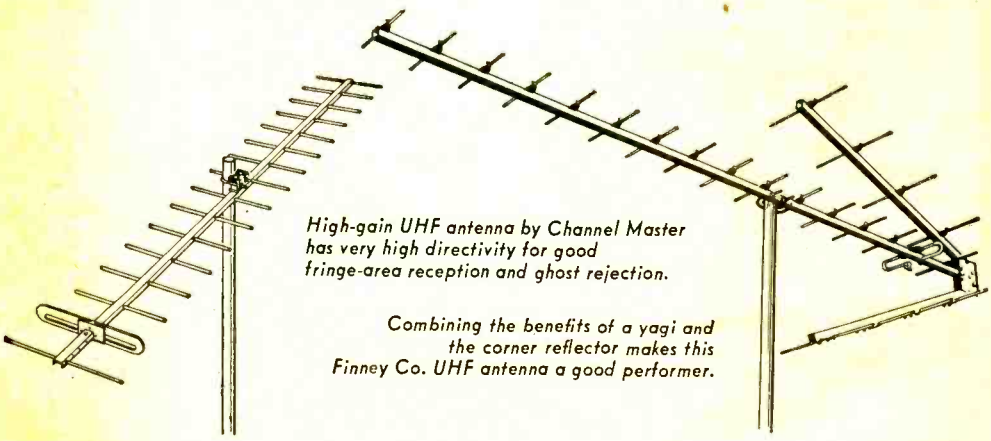
For greater gain than can be gotten with one antenna, you can stack one above the other and use connecting rods. This provides almost double the gain of a single antenna.

Another effective gain booster is the mast-mounted transistor amplifier. These cover

the TV and FM bands and serve to amplify the signals as they come from the antenna.

Specific Antenna Types. There are many (perhaps too many) types of antennas available for TV and FM use. Each of these has its own particular advantages and disadvantages. We'll describe some of the various types of antennas but we won't compare the antenna of one manufacturer against that of another, or even compare one type against another since individual requirements will decide which type is most advantageous; in other words, one type isn't inherently superior to another. It all depends on what you need.

It is obvious that the more elaborate arrays will give better directivity, gain, front-to-back ratio, and will cost more money.



High-gain UHF antenna by Channel Master has very high directivity for good fringe-area reception and ghost rejection.

Combining the benefits of a yagi and the corner reflector makes this Finney Co. UHF antenna a good performer.

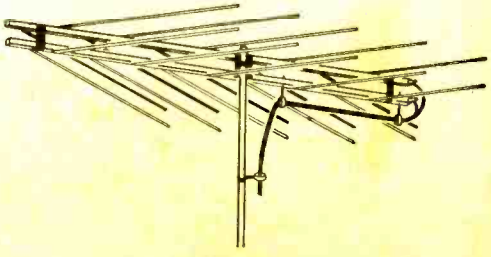
An elaborate array is not necessary for all installations. It is a waste of money in strong signal areas where the minimum antenna is quite adequate.

Broad-band antennas (such as the flying arrow for VHF-TV or the bow-tie for UHF-TV) will provide good gain over an entire band while narrow-band antennas (such as the Yagi) provide excellent gain over a small portion of the band—you can't have both at the same time. Highly directional antennas will eliminate ghosts and interference by virtue of having a reception pattern only in one direction thereby reducing stray pickup. Unless the station antennas are in line with each other from your location, don't expect this same antenna to pick up two stations equally well though.

In short, no one antenna will do everything. You must select the antenna to meet the needs of a particular installation. If the signal is strong, any one of a dozen simple antennas (perhaps even an indoor antenna) will bring in a good picture. As the signal gets weaker, you will have to use a higher-gain antenna, and perhaps even add a booster or amplifier. If there is a particular ghost or interference problem in your location, the narrow-beam antenna will give the best results. If you are concerned with only one frequency, it is possible that a special antenna will give the best results at that frequency.

VHF Antennas. The simplest of all VHF antennas is the *flying arrow*. It is basically a dipole with a single director element. The length is cut (usually) so that it will give maximum gain near the center of the VHF band (Channels 2 to 13), although it is basically a broadband antenna. The flying arrow is not highly directive since it has only one directive element and should be used where the signal is strong from all stations to be received, and there are few (if any) ghost problems.

Next in line for VHF antennas is the *conical* array. This is similar to the flying arrow, except that it has two forward elements fanned out to simulate a cone-shape. This gives the antenna more interception area to pick up "hot" signal spots.



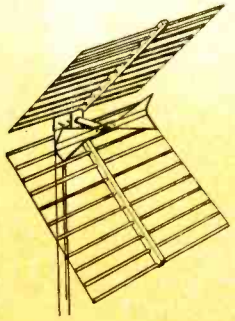
Blonder-Tongue makes this modified log-periodic VHF antenna designed for broadband reception characteristics needed for color signals.

e/e DEADLY DIPOLES

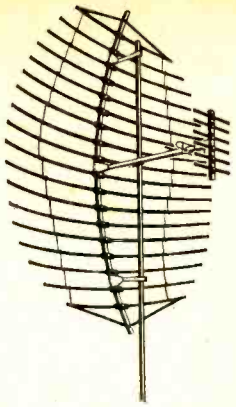
The remaining VHF antennas can be divided into two major classifications—the Yagi and the long-periodic types.

Yagi Antennas. In its various forms, the Yagi is a popular narrow-band, highly directional version of the half-wave dipole. The high directivity of the Yagi is obtained by placing several director elements in front of the dipole. These elements are cut shorter than the dipole, but they are all of the same length. Therefore, all of the elements resonate at the same frequency, providing high gain at that frequency. Signals coming from directly in front of the elements will have maximum gain since they receive the benefit of all director elements, while signals from either side will have less gain since they receive benefit of only a few director elements. This accounts for the high directivity. Usually only one reflector is placed behind the dipole to eliminate the rear lobes. Any number of director elements may be used; more elements provide higher directivity and gain.

The narrow frequency response of the Yagi antenna has advantages and disadvantages. Its selectivity and gain are very useful for a single channel where reflections produce ghosts that cannot be easily eliminated. If several channels are available, however, a simple Yagi may not be able to receive all of them equally well. Various manufacturers have devised methods to eliminate this problem. The modified Yagi antenna covers a wider band than usual by having dipoles of different lengths. Elements of different lengths provide more than one resonant point across the band—increasing overall frequency response.



Representative of sturdy, low-cost UHF antennas commonly used in urban areas, this popular UHF skyhook consists of a corner reflector and a bow-tie pickup element. It's by Allied Radio.



For commercial use, Finney makes a UHF antenna featuring a parabolic reflector to concentrate signal on the dipole.

Log Periodic. The log periodic antenna obtains high directivity with broad-band reception by several forward-swept elements. These elements are progressively, or *periodically*, longer than the next, increasing in a *log*arithmic progression. Signals directly in line with the dipole will have maximum gain since they receive boost from several elements. This provides the increased directivity. Broad-band coverage occurs since the antenna is resonant at various points across the band.

UHF Reception. Almost everything that we've said about VHF antennas and reception could be applied to UHF with one qualification: on UHF, troubles show up sooner. If the fringe area for VHF starts about 50 miles from the TV station, for UHF it's about 40 miles and often less. Today's UHF tuners need more minimum signal to give a good TV picture than is required by a VHF tuner. More sensitive TV tuners for the U's will probably be developed, but for now, we're stuck with what's available.

For local areas, where the UHF signal is strong, an indoor antenna is usable. Most often used in the *bow-tie* as the driven element with a screen reflector behind it to cut out interference and ghosts. The bow-tie is about a foot wide, so the antenna makes a compact package for the top of the TV.

In areas where both U's and V's are strong, a combination antenna can be effective. This often has rabbit-ear telescoping elements for the V's and twin bow-ties for the U's.

Out's Best. Whenever possible, an out-

(Continued on page 90)

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DEADLY DIPOLES

Continued from page 86

door antenna should be used for UHF reception. However, local and even suburban UHF antennas are so compact that they can readily be added to any existing antenna installation. A simple bow-tie with reflector, for example, is hardly larger than the indoor version and is much more effective when used outdoors. However, many much more efficient and higher-gain types are available as we move out of the local reception areas and have less available signal for the TV set.

One type UHF antenna is the bow-tie with corner reflector, in which the screen reflector behind the bow-tie dipole is formed into a right angle, like the wide-open mouth of a crocodile. The reflector effectively shields the bow-tie from interference at the same time that it focuses head-on TV signals onto the active element.

Ghosts. A major problem with UHF-TV is that high-frequency radio waves can be reflected easily by solid objects. The reflected signal picked up by the antenna is delayed a few microseconds. The resulting double image on the TV screen occurs when a receiver picks up both a direct and reflected signal. About the only solution to the problem is to use a more directional antenna. Fortunately, most UHF antennas are more directional than VHF antennas. They can be oriented toward the transmitter, attenuating signals from other directions.

However, this high directivity creates a problem in itself. If a UHF antenna is not *on target,* considerable signal strength can be lost. The problem becomes more serious when more than one UHF channel is available. Unless the transmitting antennas of all the stations are close together, several receiving antennas or a rotating antenna might be needed.

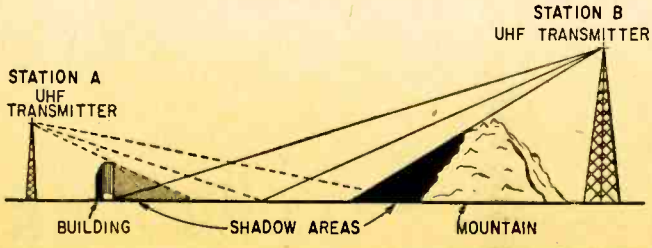
There are other UHF transmission characteristics that make reception difficult. All other things being equal, a UHF transmitter requires greater power to cover a given broadcast area than a VHF transmitter. Fortunately, this is offset by the fact that the FCC allows more power for UHF stations.

Now You See It . . . One of the more annoying problems is the line-of-sight effect. VHF and UHF transmissions differ from lower frequencies in that the VHF and UHF radio signals do not bounce off the ionosphere; they pass straight through. Only the direct wave can be picked up by the receiving antennas. There is some refraction of VHF radio waves in the troposphere, so reception will occasionally occur at distances greater than the actual line of sight. However, reception of UHF signals is limited to points in a straight line from the transmitter. However, because of the line-of-sight effect, any obstruction between the transmitting and receiving antennas will attenuate, if not completely block, the signal to the receiving antenna. This blocking effect is known as a *shadow.*

An antenna in the shadow area is blocked from receiving signals from one of the two transmitters. In metropolitan areas, tall buildings can create very effective shadows. Mountains, even low rolling hills, can produce the same condition in country areas. Very little can be done about shadows. The only practical solution is to raise the receiving antenna as high as possible, out of the shadow, so there will be a line-of-sight path between the transmitting and receiving antennas.

Half Shadow. In shadow areas where the signal is attenuated but not completely blocked, it is possible that a high-gain antenna will produce a strong enough signal for good reception. However, obstructions (tall buildings or mountains) will usually block the signal completely rather than attenuate its strength.

In many areas there are a large number



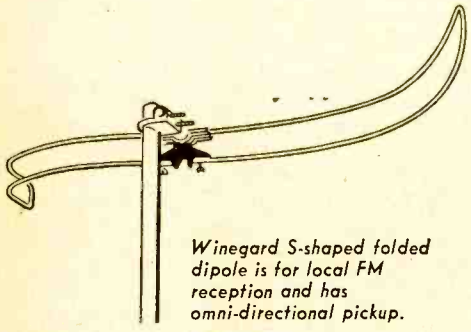
Areas of little or no signal exist in the shadow of obstructions because high-frequency RF is essentially receivable only in line-of-sight of the transmitter. Solution to a receiving problem of this nature may require an expert and some costly remedies.

of FM stations that can be received. To get "round the compass" FM reception, you can use either an omnidirectional antenna or a directional type with a rotator. The directional antenna has more gain and will bring in stations from greater distances.

The most common omnidirectional antennas for FM are the Sigma (S-shape) and the turnstile. For fringe areas there are FM Yagi antennas, from 3- to 10-element models. Because of their directional characteristics, the Yagis must be used with a rotator unless you are interested in receiving stations from only one direction.

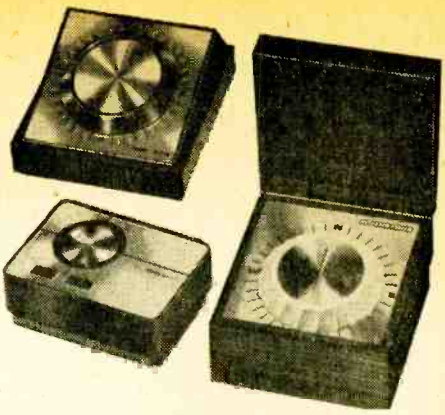
If you have an FM antenna for monophonic reception, but plan to get a stereo receiver, you may require a better antenna. Try using the antenna you have. If reception is not satisfactory, the trouble may very well be in the antenna. In this case, you may need to get a higher-gain model.

Rotators. Rotators have long been a popular antenna accessory in fringe and deep fringe areas where the viewer has to direct his antenna towards widely scattered TV stations. With the increase in FM listening and the need of exact antenna orientation for FM-stereo, and with the increasing number of TV stations that are receivable with the higher-gain antennas, more suburban viewers are using rotators.



Winegard S-shaped folded dipole is for local FM reception and has omni-directional pickup.

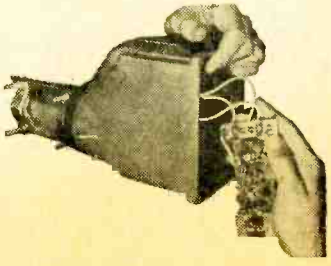
Of primary importance in a rotator is how convenient is it to operate? The automatic rotator is very convenient: set it to the channel you want and forget it. The antenna will slowly and smoothly turn to face the desired station and stop. The nonautomatic rotator demands your constant attention: you must keep your finger pressed down on the control while the antenna is turning. When the antenna is facing the desired direction, as indicated by a pointer on a scale, you lift your finger and the rotator stops.



Antenna rotator control consoles come in various shapes and sizes, some automatic, and some manual. Here are three typical units made by Channel Master.

Some nonautomatic rotators do not have direction indicators and must be kept going until the TV picture is clearest. If you habitually view only two stations all evening, then a nonautomatic antenna rotator is probably all you need; however, if you switch from one channel to another, or one FM station to another, then you'll probably find fiddling with the nonautomatic control rather tiresome and time consuming—reducing your viewing pleasure.

Rugged Motor. When it comes to the motor unit, something more than convenience is at stake. The motor and gear train must be rugged and generate enough torque to handle stacked high-gain antennas. For this, the mechanism needs precision-machined, heavy duty gears, preferably spur type. Built-in ball thrust bearings and ball or stainless steel collar bearings for smooth action under load. An automatic brake should lock the rotator instantly in the exact position desired, without coasting. The motor housing should be completely weatherproof, since it will be up at the antenna permanently. *(Continued overleaf)*



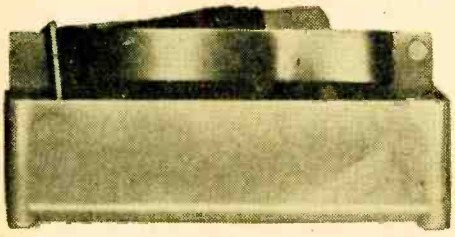
An antenna rotator with a built-in signal amplifier is a Channel Master innovation. Two models are produced, one is for TV only, and the other is for both TV and FM signals.

e/e DEADLY DIPOLES

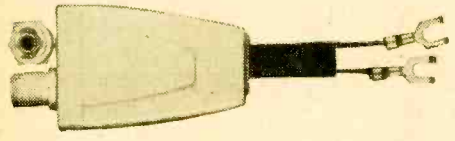
Incidentally, if you now have a nonautomatic rotator control and are frustrated at the fiddling required to get the best picture, you can convert your rotator to an automatic model by getting an automatic control console made by Channel Master.

This console contains a motor which is synchronized with the motor in the rotor housing; when both reach the dial-selected position they stop simultaneously. The rotor may be moved one degree at a time, if desired, because of this continuously-monitored motor control. The automatic console is adaptable to any 1-rpm manual rotator merely by changing cable connections.

A rotor is installed close to the top of the mast and holds the antenna on a short, additional mast. When the rotator is atop a 10-foot mast or higher, the mast must be guyed.



Using coaxial cable for lead in has certain advantages over regular twin-lead such as reducing noise and ghost pickup. However, to match the 300-ohm antenna and TV tuner to 75-ohm coax requires matching transformers like this pair from Jerrold.



The control console-to-rotor connections are made via a 3- or 4-conductor cable, which is separate from the antenna transmission line. The rotator and antenna cables should be separate and on opposite sides of the mast.

Transmission Wire. The wire from the antenna to the receiver is the lifeline of the installation; no matter how strong a signal the antenna captures, if it does not get to the set, reception will be poor. So it pays to get good lead-in wire.

There are several transmission line types (or lead-ins) available for TV and FM antennas. Each has its own particular advantages and disadvantages. The open wire line has least loss, because the insulation is mostly air. The two conductors are separated at intervals by polyethylene spacers. There is little chance for dirt or moisture to build up across the open leads, so an open-wire line is a good choice for very long runs (say, over 200 feet) where losses must be kept to a minimum. However, open wire is difficult to install, and it deteriorates from exposure to the elements faster than other types of line. Open-wire line is almost never used for anything but UHF-TV antenna systems.

Coaxial Cable. Because of its shielding, coaxial cable is good where there are radiation or pick-up problems (routing near metal surfaces or wires), or where you want to bury the line. This cable consists of an inner conductor enclosed in a copper-braided shield and a vinyl jacket for weather and abrasion protection. Coaxial line is virtually unaffected by moisture and dirt on the outside jacket of the line. Also, nearby metal will not absorb energy from the line, nor will interference signals enter the line.

Coaxial line is fairly simple to install, but it does require a hole at the feed-through point. (Flat ribbon line can usually be slipped under a window.) Coaxial-line impedance varies from 50 to 75 ohms, which does not match the normal antenna and receiver impedance of 300 ohms, so matching transformers are required.

Flat Ribbon Line. Flat ribbon or twin-lead is the most popular TV and FM lead-in. Reasons for this is that it can usually be routed into the house without drilling holes, and it's inexpensive. It is readily available from a number of sources, including most variety stores. Its impedance is normally 300 ohms so it will match most TV and FM antennas.

In addition to the conventional flat ribbon, twin-lead is available in a punched or slotted ribbon (a form of open wire line) where a large percentage of the insulating material betwen the leads has been removed—this reduces losses.

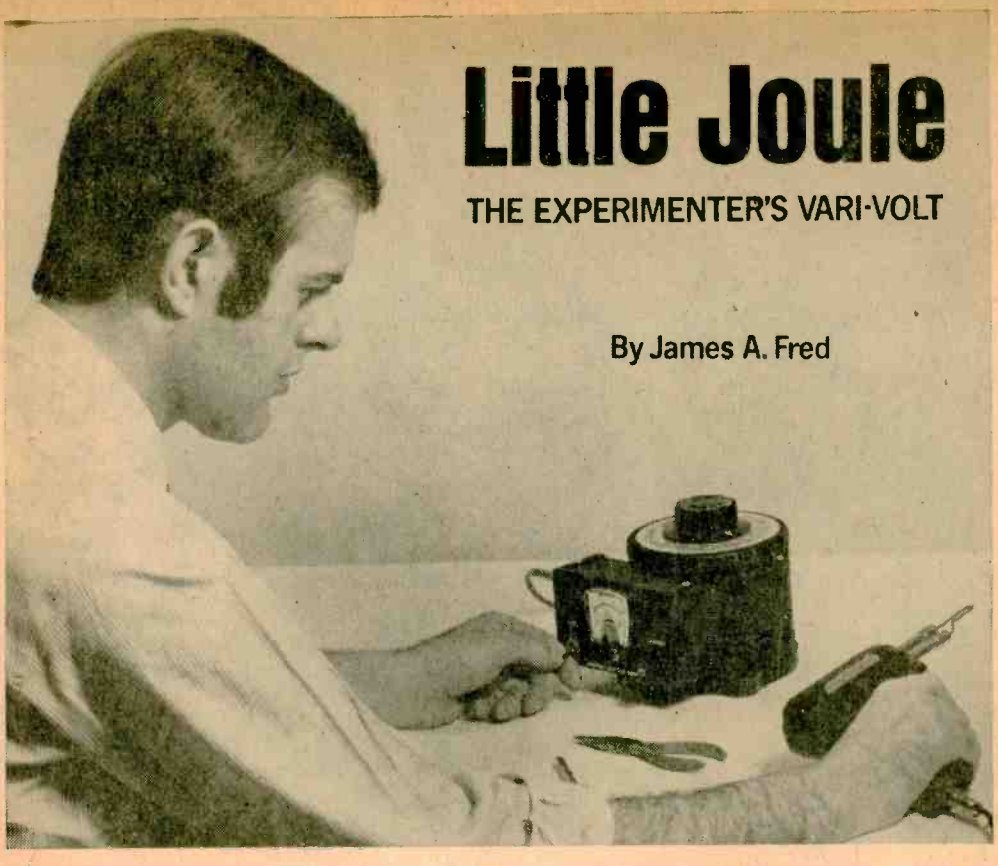
Another version of the ribbon line has a polyethylene covering or sheath placed over the line. This keeps the line protected from the elements, and gives it considerably lower losses than other types of line when wet.

(Continued on page 117)

Little Joule

THE EXPERIMENTER'S VARI-VOLT

By James A. Fred



Inexpensive metered variable-voltage transformer lets you dial power.

One thing most home-electronic workshops don't have is a variable voltage transformer. The high purchase price is enough to keep most experimenters from buying one, though most probably understand the need for one in their shops.

Trade names for this device range from *Variac* by General Radio, *VT* by Ohmite, *Volt-Pac* by General Electric, to *Powerstat* by Superior Electric. But whatever the trade name, it is basically a transformer with one winding on a circular iron core that operates as an autotransformer.

The line voltage is applied to a portion of the winding. The voltage used is taken from the winding by use of a sliding contact on the bare wire track on top of the winding. The last 25-percent of the winding has a voltage induced into it from the part of the winding to which the line voltage is applied. Thus, we can increase the line voltage to 140 volts and tap off any amount from 0 to 140 volts with the sliding contact.

Fortunately, Radio Shack has an inexpensive variable voltage transformer on the market. By adding an AC voltmeter, plugs, on/off switch, and a fuse to the basic transformer, you have an extremely versatile and useful addition to the shop. We call it our Little Joule.

Uses for Little Joule range from controlling the heat of a soldering iron to just the right temperature, to varying the input voltage to a power supply so the exact desired voltage appears at the output. Other applications include slowly increasing voltage applied to an untried project from zero thereby avoiding a smoking catastrophe, and controlling the speed of an electric drill to suit the material being worked on. Sound good? Here's how.

Getting Started. When you have all the parts we've listed, you are ready to begin construction. Lay out the holes in the aluminum box and drill or punch them. If you like, you can label the receptacles. But since the switch has an indicator plate, the fuse holder is labeled, and the AC meter marked

with its range, no other markings are needed.

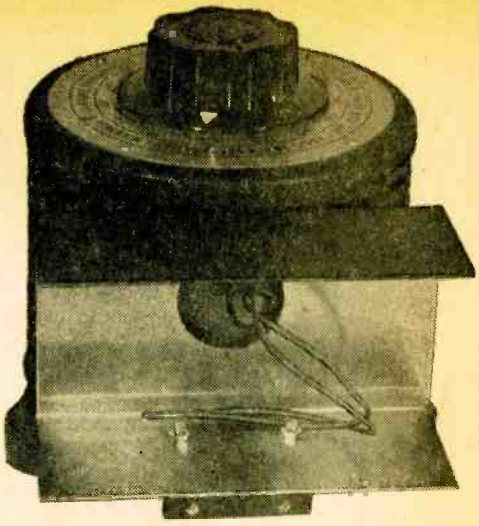
If you have an unpainted box, carefully clean it with steel wool and spray it with a coat of zinc chromate. Wet-sand the zinc chromate, then spray on two coats of your favorite paint. If you add decals or press-on letters, spray the box with a clear finish to protect the lettering.

While the paint is drying, take the variable transformer apart. Remove the two screws from the plastic casing of the transformer and cut the blue wire, black wire, and the core wire. Take out the fuse holder, switch, and line cord—save fuse for use later in the construction of Little Joule.

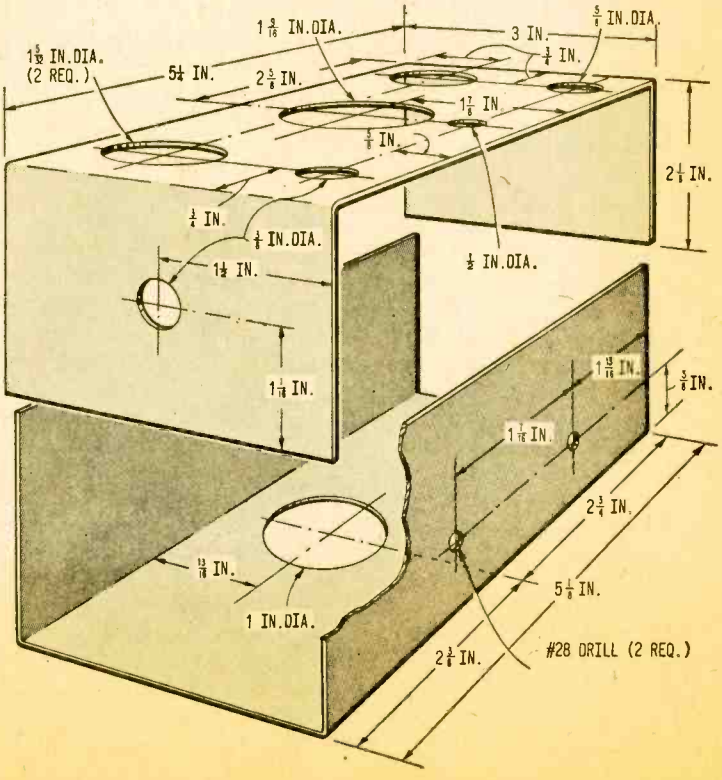
Now cut a ⅞-in. piece off the bottom of the plastic casing. This piece will fasten to the side of the lower box half. Remove the set screw from the knob on the transformer and lay it aside.

Next remove the four screws that hold the perforated metal cover to the base. Carefully unsolder and remove the blue wire from the side of the transformer winding. Solder a piece of #18 stranded hook-up wire ten in. long to the core wire.

Transformer Wiring. Remove the black wire from the center terminal and replace it with a piece of #18 hook-up wire six in. long. Now replace the perforated cover and knob. Fasten the ⅞-in. piece of plastic casing to the lower box half with two 6-32 screws and hex nuts. Fasten the plastic piece to the original holes with the screws you previously removed. Feed the wires you soldered to the transformer through the rear of the lower box half before screwing it down tight.



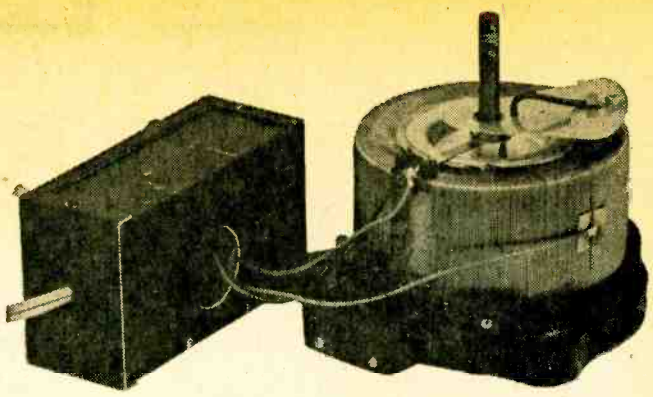
You are now ready to build up the top half of the box. Mount the two AC receptacles, the fuse holder, pilot light, switch, and meter, in that order. Be sure to use salvageable



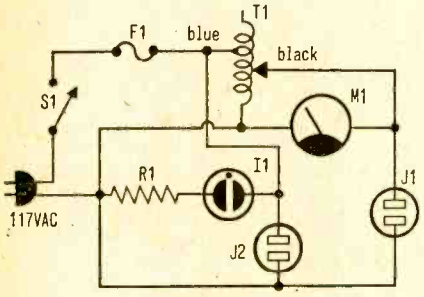
First step to building Little Joule is to prepare the control box. The large holes can be made with a chassis punch or hand nibbler. After holes are made and all ragged edges smoothed and deburred, the chassis box should be primed with zinc chromate, wet-sanded and then painted to suit to obtain a neat, professional appearance of the finished unit.

At left, bottom half of the chassis box is attached to the transformer with two screws through the section of casing that was formerly used to hold the AC receptacle.

Right, the transformer wires have to be lengthened to reach their tie-points in the control box. Be sure to use wire of adequate gauge to carry the rated 5 Amps.



Below is the schematic of Little Joule. Note that J2 provides a fixed output since it's hooked directly across the AC line.



PARTS LIST FOR LITTLE JOULE

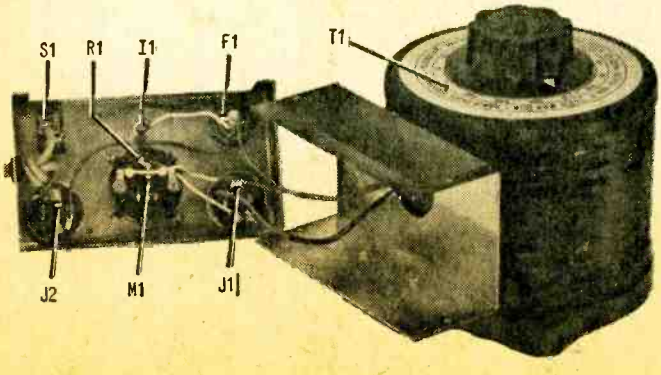
F1—5-A fuse and holder (Supplied with T1)
I1—Neon pilot light assembly (Radio Shack 272-328 or equiv.)
J1, J2—Standard AC receptacle (Amphenol 61-F, Allied Radio 47B0677 or equiv.)
M1—150-VAC voltmeter (Radio Shack 22-016 or equiv.)
R1—Resistor supplied with pilot light I1
S1—S.p.s.t. 117-VAC, 5-A toggle-switch (Supplied with T1)
T1—Variable voltage transformer (Radio Shack 273-043 or equiv.)
1—5¼ x 3 x 2⅛-in. aluminum chassis box (Bud 3006A, Radio Shack 77-0683 or equiv.)
Misc.—Line cord and plug, rubber grommet, wire, solder, etc.

parts. Use #18 stranded hook-up wire on all connections except for the meter and pilot light: here you can use #22 solid hook-up wire. Do not solder either connection on the variable-voltage receptacle or the end connection on the fuse holder.

Connect and solder the wire from the side of the transformer to the end of the fuse holder. Solder the wire from the solder lug on the transformer to the copper-colored terminal on the variable receptacle.

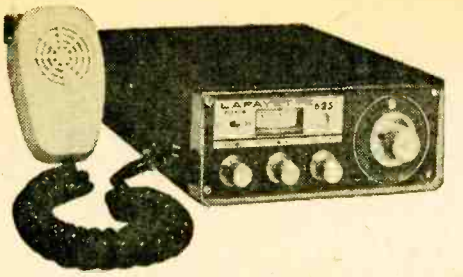
Twin Receptacles. Note that the left hand receptacle is wired to the line voltage and isn't variable as the right hand receptacle is. Splice a 6-in. length of wire to the other core wire on the transformer. Insulate this solder joint with a length of sleeving. Solder this wire to the white terminal on the variable receptacle.

If you have carefully followed the directions, you are ready to put the front of the aluminum box onto the bottom half fastened to the transformer. Set the knob to zero volts and the switch to off. Plug the line cord into a wall outlet and turn on the toggle switch. As you turn the transformer knob, the meter reading should begin to increase. You should have close to 150-VAC no-load voltage on your meter at full knob rotation. With a full 5-A load, the meter reading of your Little Joule should be about 140 volts. ■



When the various parts have been installed in the top half of the chassis box, wiring up the control box is a quick task. Since the circuit carries up to 5 Amps, be sure to get a good mechanical and solder joint on all connections.

e/e COMMUNICATIONS



LAFAYETTE MODEL HB-625

Solid-state, IC Design

23 Channel CB Transceiver

Sporting a reasonable price tag, Lafayette Radio's HB-625 CB transceiver fits into the "modest" CB price range. Yet from the viewpoint of features and performance, it's strictly up there with the gold-plated specials.

The HB-625 is part of a system which, with accessory equipment available, converts the basic 12-VDC mobile transceiver to AC-powered base or battery-powered portable operation. Accessories include a matching power supply, desk-type microphone, and a clamp-on C-cell battery pack for portable operation. For multiple-transceiver operations, there is a tone-coded selective-calling device which connects to a pre-wired socket on the HB-625's rear apron.

And just in case you like to listen to music between monitoring the CB channels, this rig has an external audio input which allows a signal source such as a tape deck or tuner to play through the transceiver. To return to CB operation, you simply flip the channel selector from *EX* to the desired channel.

In the way of features, the HB-625 includes full 23-channel coverage through frequency synthesis; delta tuning from the front panel approximately 1800 Hz either side of channel center; a standard noise limiter and an RF noise silencer; S-meter; public-address operation; plug-in microphone; and a mechanical filter for good adjacent-channel rejection.

The HB-625 is one of the first CB transceivers we can think of utilizing ICs (integrated circuits). There are three, all told. One is used as the RF noise-silencer amplifier; another provides nearly the whole second-conversion IF amplifier; and the third functions as most of the audio/modulator stages (less the microphone preamplifier and output/modulator stage).

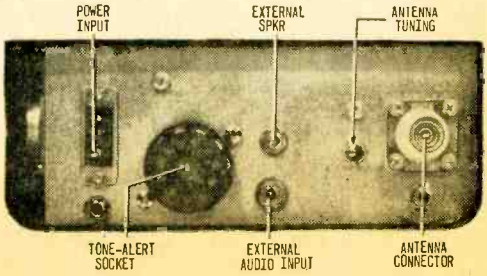
As far as we can determine, the ICs' function is not so much to improve performance, but rather to reduce total price by eliminating many components. For example, a previous Lafayette noise-silencer required two stages of RF amplification. In contrast, the HB-625 uses a single IC for the entire noise-silencer RF amplifier—and the single IC uses less components than just one stage of RF amplification in the older model.

The second IC replaces a single IF stage in an older model, with fewer components used. The third IC replaces an AF preamplifier and the output-driver in an older model. The corresponding reduction in components, increases the HB-625 reliability.

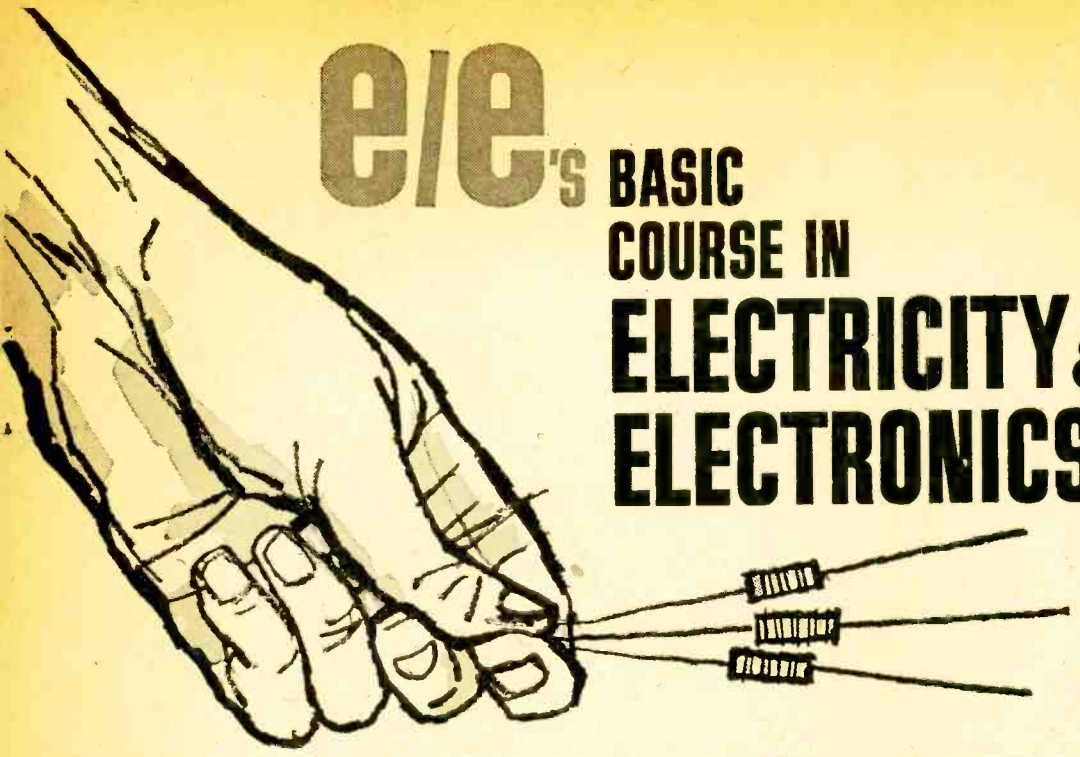
Quieting X Two. The HB-625 has two noise-reduction circuits: the silencer and the limiter. The silencer is effective only on very sharp impulse noise such as from auto ignition. It works by actually silencing the receiver during the period of a noise impulse.

Normally, the signal from the first converter to the second passes through a pair of forward-biased (conducting) diodes (the second mixer). When a sharp noise impulse is received, it is amplified by a second reriving circuit connected to the antenna input and rectified into a DC pulse. The DC

(Continued on page 116)



The HB-625's rear apron has AF input jack for radio or tape recorder input—great idea for passing time between emergency calls.



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

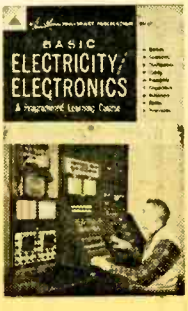
PART II—UNDERSTANDING RESISTORS

WHAT YOU WILL LEARN. Voltage, current, and resistance are closely related within a circuit. Where you find current, you find the other two. Current cannot flow unless there is voltage. How much will flow is determined by how much voltage and how much resistance are present in the circuit. You will learn what resistance is, what it does, and how it is used.

WHAT LIMITS CURRENT FLOW?

You have learned that voltage is a pressure which forces current to flow through a circuit. You also have learned that current has the ability to heat a lamp filament white-hot and thus produce light. But have you ever wondered why a 40-watt lamp produces less light than one rated at 100 watts? After all, the amount of voltage pushing current through both lamps is the same. The answer, of course, is the individual characteristic of each lamp which limits the amount of current that will flow.

The 100-watt lamp glows more brightly because more current is allowed to pass through the filament, heating it to a higher degree, thus causing it to give off more light. Less current is allowed to flow through the 40-watt filament. The reason for the different amount of current through each of the two lamps is an electrical character-



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

istic called *resistance*. Resistance *limits* or *controls* the flow of current.

WHAT IS RESISTANCE?

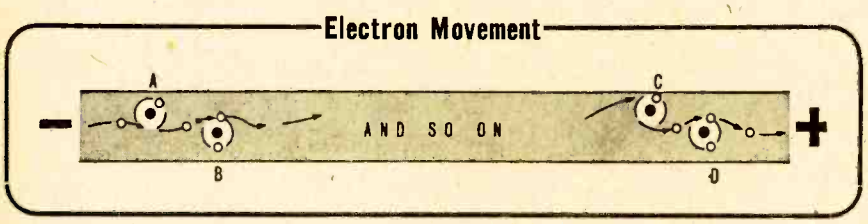
Resistance is a physical property of all materials and is directly responsible for the amount of current which will flow through a material with a given voltage applied.

Atomic Structure

All matter is made up of invisible particles called *atoms*. There are over 100 different atoms, or *elements*, as the physicist calls them. One of the features that makes one atom different from another is the number of *electrons* each contains. A hydrogen atom has one electron, an oxygen atom has eight, and a uranium atom has 92.

You know that current is a flow of electrons and that electrons are made to move by a voltage. This does not mean that an electron leaves the negative pole of a battery and speeds around the circuit to the positive terminal. Instead, there is a general movement or drift of electrons throughout the complete circuit.

The illustration shows a greatly magnified and exaggerated depiction of a length of wire with four atoms—A, B, C, and D. In the shortest possible length of a very thin wire there are actually many millions of atoms.



Electron Flow

As shown in the illustration, electrons orbit about the center of an atom. At the instant voltage is applied, two things happen simultaneously—negative voltage at one end of the wire pushes against the electrons, and positive voltage at the other end of the wire pulls them toward that end. In moving, electrons strike other electrons. One electron is bumped out of atom A, and it in turn pushes another out of atom B. At the positive end, an electron is pulled from atom D and another leaves atom C to replace it. The atoms of some materials give up their electrons more easily than the atoms of other materials.

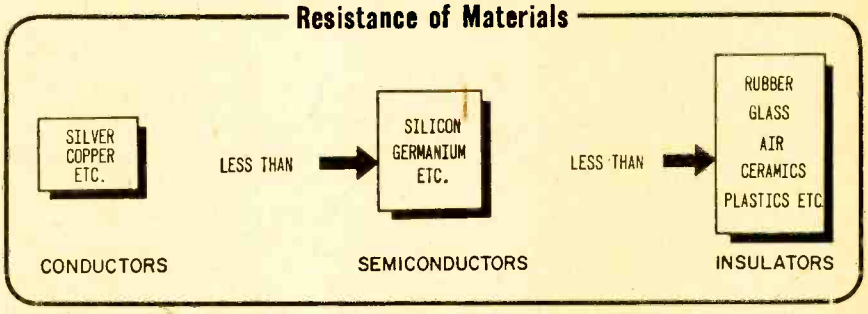
Resistance of Materials

There is no perfect conductor. Even the best conductors, such as those having silver or copper atoms, resist the pressure to release electrons. On the

other hand, the best insulators have atoms which, under conditions of sufficiently high voltage, give up some electrons. The resistance of a material, then, is *determined by its atomic structure.*

The size of the columns in the illustration shows the comparative resistance of certain materials. Keep in mind that no material is a perfect conductor or a perfect insulator.

Most metals contain atoms that release electrons very easily. These materials, therefore, offer the least resistance to current flow. Insulators have the greatest resistance because their atoms resist the release of electrons. The in-between materials are neither good conductors nor insulators. Among these are certain materials, the *semiconductors*, from which *transistors* are manufactured.



Unit of Measurement

Resistance is measured in *ohms;* the device for conducting such measurement is called an *ohmmeter*. The resistance of a 1.5-volt lamp, for example, is approximately 6 ohms. In other words, the lamp offers 6 ohms of resistance to the electrical pressure of a 1.5-volt cell, and the result is a current flow of 0.25 amp.

Q.1 What is the difference between a conductor and an insulator?

Q2. The resistance of a material is determined by its – – – – – – structure.

Your Answers Should Be:

A1. Conductor atoms give up their electrons more easily than insulator atoms.

A2. The resistance of a material is determined by its *atomic* structure.

Volts, Ohms, and Amperes

Since resistance limits the amount of current that flows and voltage forces an amount to flow, there must be some numerical relationship between them.

You would see current decrease to half its former amount when a second lamp is added in series with the lamp circuit just mentioned. Current is divided by two when resistance is multiplied by two. Mathematicians say, then, that

current is inversely proportional to resistance. In other words, *current decreases* by the same amount that *resistance increases.*

You can also discover, by experimenting, what happens to current when voltage increases. You will find they increase together (they are directly proportional to each other). This makes sense because the pressure of voltage causes current to flow. If the pressure increases, flow increases.

These relationships of voltage and resistance to current can be expressed in an arithmetic statement as:

$$\text{Current in a circuit} = \frac{\text{voltage applied to a circuit}}{\text{resistance of a circuit}}$$

Using mathematical symbols, this statement becomes:

$$I = \frac{E}{R}$$

where,

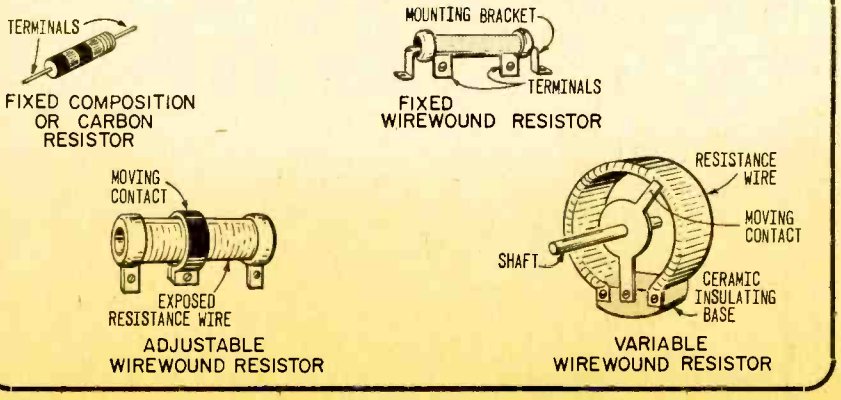
I is the current in amperes,
E is the voltage in volts,
R is the resistance in ohms.

If voltage *(E)* is increased, current *(I)* will increase. When E decreases, I also decreases. The relationship between I and R is just the reverse. A decrease in R causes I to increase. The larger R becomes, the smaller I will be. The formula above is known as *Ohm's law.*

TYPES OF RESISTORS

Resistors are classified in two ways: 1) in terms of their construction (wirewound and composition); 2) in terms of their type or function (fixed, adjustable, variable).

Types of Resistors



Wirewound Resistors

Wirewound resistors are made by wrapping resistance wire around a ceramic or other high-insulation cylinder. The assembly is then covered with enamel glaze and baked. The wire has a known value of ohms per inch. The resistance value desired is then merely a matter of wrapping on the required length of wire.

Composition or Carbon Resistors

Composition or carbon resistors are molded from a paste consisting of carbon (a conducting material) and a filler. Terminal wires (sometimes called *pigtails*) are inserted into the paste before it hardens. The resistor is then covered with a plastic coating. The resistance of a composition resistor is determined by the ingredients (percentage of carbon) and its diameter and length.

Fixed Resistors

A fixed resistor has only one nonvariable ohmic value.

Adjustable Resistors

Adjustable resistors provide a range of resistance within the limits of their total value. When placed in a circuit, the sliding contact can be positioned and secured to accurately provide the required resistance value. This type of resistor is not designed to be continuously variable.

Variable Resistors

Variable resistors are designed for continuous adjustment. A shaft to control the resistance value is usually connected to a knob on the front panel of an electrical or electronic device. The volume control of your radio or TV set is an example.

A rheostat is a variable resistor. The material that the moving contact presses against may be either resistance wire or a carbon mixture.

Q3. Composition resistors are made from a – – – – – – and – – – – – – mixture.

Q4. The control that dims the dashboard lights in an automobile is a(an) – – – – – – – – resistor.

Q5. – – – – – and – – – – – – – – – – resistors are not designed to be continuously variable.

Your Answers Should Be:

A3. Composition resistors are made from a *carbon* and *filler* mixture.

A4. The control that dims the dashboard lights in an automobile is a *variable* resistor.

A5. *Fixed* and *adjustable* resistors are not designed to be continuously variable.

Resistor Applications

Typical applications for each kind of resistor are presented below.

RESISTOR APPLICATIONS

Type	Applications
Composition or Carbon	Composition resistors are the least expensive of the types discussed. They are, therefore, the type most widely used. However, composition resistors have certain limitations. They cannot handle large currents, and their measured values may vary as much as 20% from their rated resistance.
Wirewound	Wirewound resistors are more expensive to manufacture. They are used in circuits which carry large currents or in circuits where accurate resistance values are required. Wirewound resistors can be made to within 99% or better of the desired value.

RESISTOR POWER RATINGS

As you already know, current passing through a resistor generates heat. If too much heat is generated, the resistor will be damaged. Wire in the wound resistor will melt and become open, or some of the carbon in the composition resistor will burn away.

The current-carrying capacity of a resistor is rated according to the amount of heat it can safely release in a given period of time. A resistor cannot be used in a circuit where current causes heat to build up faster than the resistor can dissipate it. When such a condition exists, the resistor may become so hot that it will be destroyed. Even if the resistor doesn't melt and become open, the excessive heat may cause a permanent change in its resistance value. In addition, heat from the overloaded resistor may damage other components that are near by.

Since heat is a form of energy, the heat-releasing rate of a resistor is measured in energy units. The unit is a *watt*. A 100-watt lamp dissipates 100 watts of heat. In the process, the lamp also gives off light.

Heat energy depends on the amount of current flowing through a resistor. The arithmetic involved is:

$$\text{Heat energy in watts} = (\text{current in amps})^2 \times (\text{resistance})$$

This means that the number of watts dissipated by a resistor can be found by multiplying the resistance in ohms times the square (a number multiplied

by itself) of the current in amperes. The electrical term for heat energy is *power*.

For example, a 10-ohm resistor has three amps flowing through it. What must be its power rating in watts?

$$\text{Power} = (\text{amps})^2 \times (\text{ohms}) = (3)^2 \times (10) = 90 \text{ watts.}$$

Composition resistors usually come in power ratings of ¼ watt, ½ watt, 1 watt, and 2 watts. If larger power ratings are required, wirewound resistors are used.

A design engineer determines the value of resistance needed and the amount of current that will flow through it. He then specifies the resistor wattage that must be used. If the value falls between two of the ratings mentioned above, he selects the higher rating.

Q6. Which of the standard composition-resistor ratings would you select for a resistor of 10 ohms through which 1/10 of an amp flows?

Q7. A 1-watt wirewound resistor (will, will not) safely carry more current than a 2-watt composition resistor.

Your Answers Should Be:

A6. Power $= \left(\frac{1}{10}\right)^2 \times 10 = \frac{1}{100} \times 10 = \frac{1}{10}$ watt

The next highest standard rating is a ¼-*watt* resistor.

A7. A 1-watt wirewound resistor *will not* safely carry more current than a 2-watt composition resistor.

RESISTOR TOLERANCE

As mentioned previously, a resistor will rarely measure the exact number of ohms specified by its label. The amount it will vary is called *tolerance*. Every resistor has a tolerance rating.

Resistor tolerance is given as a *percentage value* which indicates the amount that a resistor may vary above or below its labeled value. Standard tolerances for composition resistors are 5%, 10%, and 20%. Wirewound resistors may have tolerances as low as 1 or 2 percent.

Try a 1000-ohm, 10% tolerance resistor as an example. Ten percent of 1000 is 100 ohms. The tolerance factor thus indicates this resistor will measure somewhere between 100 ohms above and 100 ohms below the labeled value of 1000 ohms. This is a range from 900 to 1100 ohms. The same resistor with a 20% tolerance will have a true ohmic value somewhere between 800 and 1200 ohms.

If you have trouble working with percentages, here is another way of computing tolerance:

$$\text{Resistance variation} = \frac{\text{resistance} \times \text{tolerance}}{100}$$

The answer will be the number of ohms the resistor may vary above and

below its labeled value. For example:

$$\text{Resistance variation} = \frac{2000 \text{ ohms} \times 10}{100}$$

$$= \frac{20{,}000}{100} = 200 \text{ ohms}$$

A 2000-ohm resistor with a 10% tolerance may vary as much as 200 ohms above or below—1800 to 2200 ohms.

Resistor tolerance is not an indication of poor manufacturing. Closer tolerances can be achieved, but at greater expense. As you will discover, for a given ohmic value a 20% tolerance resistor costs less than one rated at 10%. And a 10% tolerance resistor is less expensive than one rated at 5%.

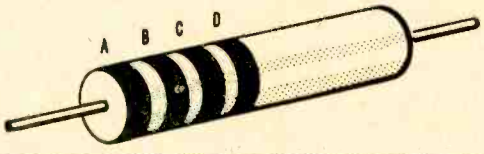
Required resistor tolerance depends on circuit design. If current flow must be controlled within very close limits, the engineer specifies a 1% resistor. On the other hand, a 20% tolerance is satisfactory for circuits which have less critical operating requirements. Your radio or television set, for example, has more 20% resistors than all the other tolerances combined.

RESISTOR COLOR CODES

Wirewound resistors normally have their value in ohms and tolerance in percent stamped on them. For carbon or composition resistors a *color code* is used.

For several years, resistance values have been coded by three colored bands painted around the body of the resistor. If the tolerance is either 5% or 10%, a fourth color band is added. Position of the bands is shown in the drawing.

Color Bands Indicate Resistance Value



Colors and Numbers

Each of the colors represents one of the ten digits—0 through 9.

Color	Number	Color	Number
Black	0	Green	5
Brown	1	Blue	6
Red	2	Violet	7
Orange	3	Gray	8
Yellow	4	White	9

The order of reading the bands is from the end of the resistor toward the middle.

The first two colors (A and B in the illustration) indicate the first two digits in the resistance value. The third band (C) indicates the number of zeroes that follow the first two digits. Sometimes a fourth band (D) is present. This band indicates tolerance and will be either gold or silver. A gold band denotes 5% tolerance, silver 10%, and no fourth band 20%. Here is an example in reading the first three bands:

Band	A	B	C
Color	Blue	Red	Orange
Numbers	6	2	3 zeroes

The blue-red-orange bands signify 62 followed by three zeroes and would be read as 62,000 ohms. Another example:

Band	A	B	C
Color	Violet	Green	Red
Numbers	7	5	2 zeroes

Digits seven and five are to be followed by two zeroes. Combined to form a number, they read 7500 ohms. Though rare, you may find a resistor with the following colors:

Band	A	B	C
Color	Violet	Green	Black

The resistance value is not 750 ohms. The third band specifies the number of zeroes. Black decoded is zero. So there are *no* zeroes after the first two digits, indicating a value of 75 ohms.

If black appears as the second color, it is read as a digit. Brown-black-red, for example, reveals that the composition resistor has a value of 1000 ohms.

Q8. The color bands are read from the – – – toward the – – – – – – of a resistor.

Q9. The first two bands are decoded as – – – – – –.

Q10. The third band indicates the number of – – – – –.

Q11. Decode brown-black-green.

Q12. Decode blue-red-red.

Q13. What is the color code for a 10k resistor?

Q14. Decode orange-green-brown-silver.

Your Answers Should Be:

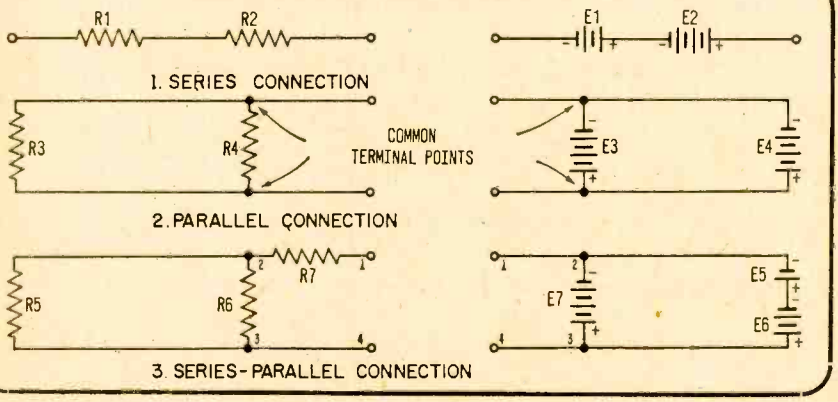
A8. The color bands are read from the *end* toward the *middle* of a resistor.
A9. The first two bands are decoded as *digits.*
A10. The third band indicates the number of *zeroes.*
A11. Brown-black-green decoded is *1,000,000 ohms.*
A12. Blue-red-red decoded is *6200 ohms.*
A13. *Brown-black-orange.*
A14. *350 ohms, 10% tolerance.*

RESISTOR CONNECTIONS AND CIRCUITS

There are only three different ways in which electrical or electronic parts may be connected—*series, parallel,* and *series-paralled.*

The illustration shows the three different connections and also the accepted method for labeling components. R stands for resistor; E designates a voltage source. Numbers are used with the letters to identify a specific component.

The Three Basic Circuit Connections



Series Connection

The first figure in the illustration shows components in series. A terminal of one component is connected to a terminal of the other. Since they are connected together in a line, R_1 is in series with R_2. Voltage sources may also be series-connected. E_1 is in series with E_2.

Parallel Connection

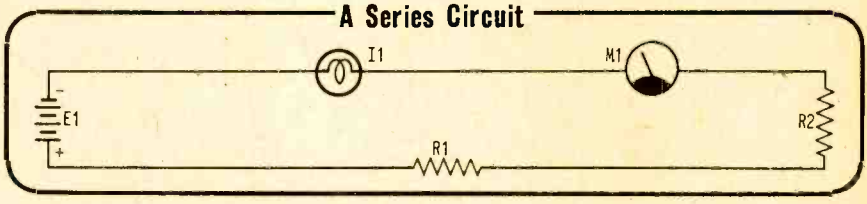
The second figure shows components connected in parallel. Each terminal of one component is connected to a terminal of the other. The connections are called *common terminal points.* R_3 is in parallel with R_4; E_3 is in parallel with E_4. In parallel, one component is connected *across* the other.

Series-Parallel Connection

As the third figure shows, series and parallel connections are combined to form a series-parallel arrangement. Two different combinations are illustrated. R_7 is in series with the parallel combination of R_5 and R_6. E_7 is in parallel with the series combination of E_5 and E_6.

SERIES CIRCUITS

If all the components in a circuit are connected one after the other, it is called a *series circuit*. By circuit tracing, you can determine that in the circuit shown, the same current that leaves E_1 flows through the lamp, the ammeter, R_2, R_1, and returns to E_1 again. Therefore, the circuit must be a series type.



Current in a Series Circuit

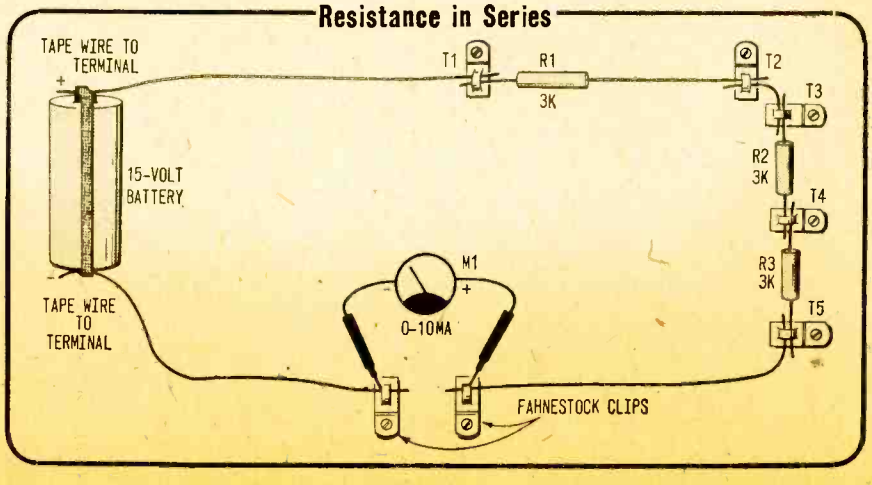
It can be proved that the value of current remains the same in all parts of a series circuit by constructing the circuit shown in the next illustration. Fahnestock clips are used as terminal connections.

If the current is measured by connecting the ammeter as shown, the reading should be between 1.6 and 1.7 milliamps. This is the value of the current entering terminal 5.

Connecting the ammeter in series with the two resistors at terminal 4, another reading may be taken. Remember, an ammeter must *always be in series* with the circuit in which current is being measured. In this case, T4 is disconnected and each resistor terminal reconnected to one of the ammeter clips. The same results will be obtained at terminals T3, T2, and T1.

Resistance in a Series Circuit

Total resistance in a series circuit is equal to the *sum of the resistance* of its parts.



This is logical, because the total resistance in the circuit determines the amount of current allowed to flow with a given voltage source. Therefore, to find the total resistance in a circuit, add the values of the individual resistances.

In the circuit shown, the resistances are 3000 ohms each. Their sum is 9000 ohms. The ammeter also adds resistance in series. But since this resistance is normally less than 1 ohm, it adds so very little to the total that it can be disregarded.

Q15. In a series circuit, all of the parts are connected in ------.

Q16. R_1 and R_2 are connected in series. Their values are 3000 ohms and 1500 ohms, respectively. If current through R_1 is 2 milliamps, what is the value of current flowing through R_2?

Q17. Draw a schematic of the three resistors as they are connected in the above diagram. Show how an ohmmeter (schematic symbol) would be connected to read total resistance of the three.

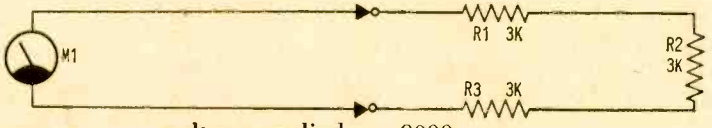
Q18. If the ohmmeter measures 9000 ohms, how much current will flow if the three resistances are connected across a 15-volt battery?

Your Answers Should Be:

A15. In a series circuit, all of the parts are connected in *series.*

A16. *Current through R_2 is also 2 milliamps.* (Current through all parts of a series circuit is the same).

A17.

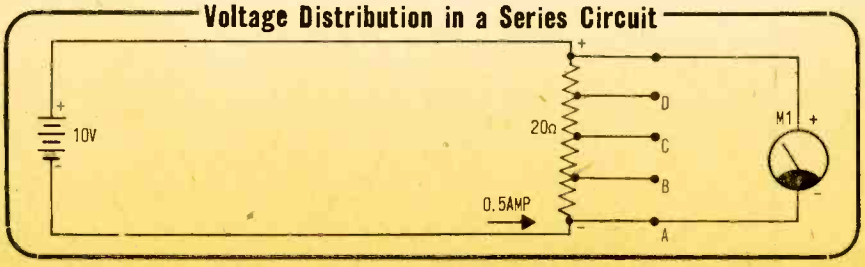


A18. Current $= \dfrac{\text{voltage applied}}{\text{total resistance}} = \dfrac{9000}{15}$

$= 0.00167$ *amp, or 1.67 milliamps*

Voltage Distribution in a Series Circuit

The voltage of a source is distributed *across and within* any load connected to it. Though this is a simple statement, the concept is often misunderstood.



If a 20-ohm resistor is connected across a 10-volt source, as shown in the illustration, a voltmeter reading across the resistor will be 10 volts. This means that the voltage of the source is not only applied *across* the load, but it also exists *within* it.

The *taps* (connections) shown are equal distances apart. If the lower test probe is moved to tap B, the voltmeter will be across ¾ of the resistor. And ¾ of the total voltage is 7.5 volts. Half the resistance (between C and E) will result in a measurement of 5 volts. From D to E is ¼ of the resistance and ¼ of the voltage, or 2.5 volts.

Can voltage distribution be estimated without making the measurements? Yes, and the reason is based on the familiar relationship that exists between voltage, current, and resistance:

$$\text{Current} = \frac{\text{voltage}}{\text{resistance}} \text{ or } I = \frac{E}{R}.$$

If you do not know the value of voltage applied across a resistance of 20 ohms, but you do know the current through it is 0.5 amperes, how would you determine the voltage? You can find the value of voltage by reasoning that E/R must be a ratio that equals ½. Since R is 20, E would have to be 10 volts. Or you can restate the relationship to read E = IR, meaning current multiplied by resistance. To prove that it is the same equality, ½ amp times 20 ohms does equal 10 volts.

Voltage developed across a resistance is termed an *IR drop*, or, substituting E for IR, it may be called a *voltage drop*. "Drop" does not indicate voltage has been lost. Instead, it identifies the amount of voltage existing between two points of a resistance when current is flowing.

The IR (or voltage) drop between points A and E in the illustration is 10 volts. IR equals 10 volts. What is the voltage (IR drop) between taps A and B? I is still 0.5 amp. but the value of R is different. It is ¼ of the total resistance or 5 ohms. Therefore, E = IR = 0.5 × 5 = 2.5 volts.

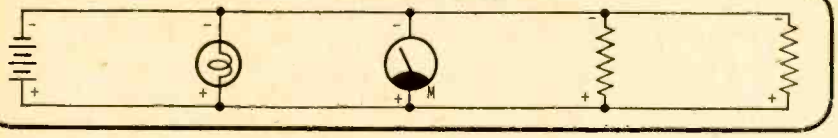
Q19. What is the value of voltage between taps A and C?
Q20. What is the voltage drop between taps B and E?
Q21. What is the IR drop between taps B and D?
Q22. The sum of the resistances in a series circuit is equal to the total – – – – – – – – – – – of the load.
Q23. The sum of the – – – – – – – – – – – – – in a series circuit is equal to the total voltage across the load.

Your Answers Should Be:
A19. *5 volts* between taps A and C.
A20. *7.5 volts* between taps B and E.
A21. *5 volts* between taps B and D.
A22. The sum of the resistances in a series circuit is equal to the total *resistance* of the load.
A23. The sum of the *voltage* (or IR) *drops* in a series circuit is equal to the total voltage across the load.

PARALLEL CIRCUITS

If all the components are connected across each other, the circuit is a *parallel circuit.* In the example shown, the components are all connected to the same terminal (a wire in this case) and are therefore in parallel.

A Parallel Circuit



Polarity across each component is determined by circuit tracing. The terminal that current enters is negative.

Voltage Distribution in a Parallel Circuit

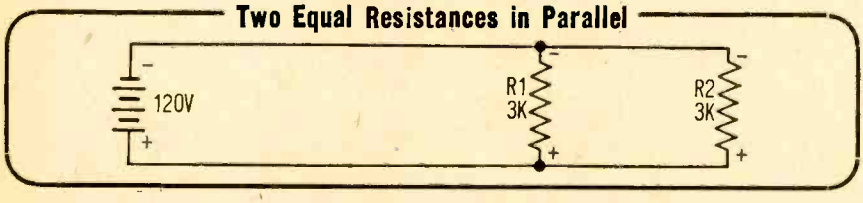
Each component (the lamp, the voltmeter, and each resistor) is connected across the voltage source. Thus, the voltage drop across each part is the same value as the source. This is true even though the resistance of each component may be different.

Current in a Parallel Circuit

Each component in a parallel circuit draws its own separate current. Each leg is connected directly to the voltage source, which means each leg can be considered as a separate circuit to determine its current.

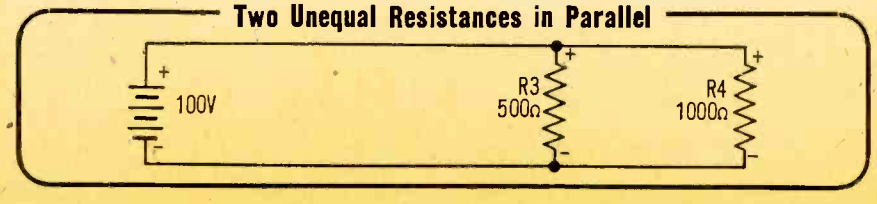
In the diagram, two equal resistors are shown as being in parallel across a single voltage source.

Two Equal Resistances in Parallel



To find the current through R_1, divide the voltage across the resistor by the value of R_1. The result of this calculation is 0.04 amp. Since both resistances are equal and have the same voltage source, the current through R_2 must also be 0.04 amp. Both currents are supplied by the same voltage source, so the total current drawn must be 0.08 amp.

Two Unequal Resistances in Parallel



Using the same reasoning (I = E/R), it will be found that the current through R_3 in the above circuit is 0.2 amp. The current through R_4 is 0.1 amp. The total current is 0.3 amp.

Q24. In a parallel circuit, voltage across each leg is (the same as, different from) the voltage at the source.

Q25. In a series circuit, voltage across each resistor is (the same as, different from) the source voltage.

Q26. In a parallel circuit, total current is the (same as, sum of) currents in each leg.

Q27. In a series circuit, total current is the (same as, sum of) currents in each resistance.

Q28. R_1 (20 ohms), R_2 (40 ohms), and R_3 (60 ohms) are in parallel across a 12-volt DC source. Draw the schematic.

Q29. Find the total current and the current in each leg.

Your Answers Should Be:

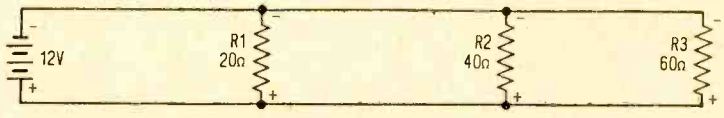
A24. In a parallel circuit, voltage across each leg is *the same as* the source.

A25. In a series circuit, voltage across each resistor is *different from* the source.

A26. In a parallel circuit, total current is the *sum of* currents in each leg.

A27. In a series circuit, total current is the *same as* currents in each resistance.

A28.



A29. I in R_1 = 0.6 amp. I in R_2 = 0.3 amp. I in R_3 equals 0.2 amp. Total I = 1.1 amps.

Resistance in a Parallel Circuit

How would you find the total resistance in the parallel circuit you drew in A28 above?

At this point you have used two of the three arithmetic statements that express the relationship existing between voltage, current, and resistance. To find current:

$$I = \frac{E}{R}, \text{ or current} = \frac{\text{resistance}}{\text{voltage}}$$

To find voltage:

$$E = IR, \text{ or voltage} = \text{current} \times \text{resistance}$$

The third way the relationship can be stated is:

$$R = \frac{E}{I}, \text{ or resistance} = \frac{\text{voltage}}{\text{current}}$$

You know the total voltage across the circuit (12 volts), and you found the total current through the circuit (1.1 amps). What is the total resistance of the circuit? Using the resistance formula above, the answer is approximately 10.9 ohms.

As you suspected, total resistance is smaller than the smallest resistance in the parallel network. Total current is the sum of the parallel currents and is therefore an amount that can flow only if the total resistance is smaller than that in any of the legs.

Total resistance cannot be found by adding the values of the individual resistance. The sum would be a resistance much larger than any one of the resistances. This would mean the total current would be smaller than any of the leg currents. Obviously, such a solution cannot be correct. For those who like to work with numbers, total resistance can be obtained by adding reciprocals.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \text{etc.}$$

The electrical wiring in your home consists of parallel circuits. This includes the ceiling fixtures, wall outlets, and whatever else is energized electrically. Each parallel circuit is fused. If you plug one too many appliances into a circuit, the fuse blows. You have just learned the reason why. You added one more resistive path that draws current. As a consequence, total current increased beyond the capacity of the fuse, and it performed its job.

Comparisons between series and parallel circuits are shown below:

	Series Circuit	Parallel Circuit
Voltage	Divides across resistances	Same voltage across all resistances
Current	Same current through all resistances	Divides through each resistance
Total Resistance	Sum of all the individual resistances	Less than the smallest Resistance

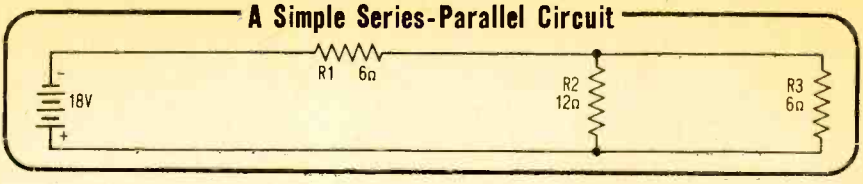
Q30. Two 6-ohm resistors are in parallel across a 6-volt battery. What is the total resistance?

Your Answer Should Be:

A30. ***Three ohms.*** **Current through each leg is 1 amp. Total current of 2 amps divided into 6 volts (total voltage) is 3 ohms.**

SERIES-PARALLEL CIRCUITS

A *series-parallel circuit* contains a combination of a series- and parallel-connected components. The simplest example is the one shown below.



The best way to work with a series-parallel circuit is to reduce all parallel combinations to an equivalent resistance. When this is done, the total current or the total resistance for the resulting series circuit can be readily found.

In the example shown above, how would you find the total resistance? Think about it before you continue reading. Yes, you could do it with reciprocals, but there is another method that is more easily applied, even when the resistance values are difficult.

Cover all the circuit except for the parallel network. Apply a mythical voltage, the value of which is easily divisible by either resistance. Perform the E/R division to find the mythical current flowing in each leg. Divide the sum of the currents into the mythical voltage to find the *real* total resistance. The following table uses three different voltages to show it will work with any assumed voltage.

Mythical Voltage	6 Volts	12 Volts	24 Volts
$I = E/R_2$ (12 ohms)	0.5 amp	1 amp	2 amps
$I = E/R_3$ (6 ohms)	1.0 amps	2 amps	4 amps
Total I	1.5 amps	3 amps	6 amps
$R = E/I$	4 ohms	4 ohms	4 ohms

The total resistance (4 ohms) is the equivalent resistance of the parallel network. The 4 ohms is in series with 6 ohms for a total circuit resistance of 10 ohms (add resistances in a series circuit). The total circuit current (E/R) is 1.8 amps.

WHAT YOU HAVE LEARNED

1. Resistance is a property of all materials which limits the flow of current.
2. Conductors have a low resistance; insulators have a high resistance.
3. Since voltage causes a certain amount of current to flow and resistance limits the amount that will flow, there is a special relationship between current, voltage, and resistance. This relationship is expressed by the following:

(Turn page.)

$$I = \frac{E}{R}, \text{ or current} = \frac{\text{voltage}}{\text{resistance}}$$

$$R = \frac{E}{I}, \text{ or resistance} = \frac{\text{voltage}}{\text{current}}$$

$$E = IR, \text{ or voltage} = \text{current} \times \text{resistance}$$

4. The unit of resistance is the ohm. The value of resistance in ohms can be measured with an ohmmeter.
5. Current flowing through a resistance generates heat. If temperature rises greatly, electrical resistance of the material increases.
6. Resistors are designated by construction (wirewound or composition) and by intended use (fixed, adjustable, or variable).
7. Resistances are rated by their heat-dissipating capability in terms of watts.
8. Resistor tolerance is given as a percentage value which indicates the amount a resistor may vary above or below the labeled value.
9. Four characteristics of any resistor are type, value, tolerance, and power rating.
10. Wirewound resistors have their value and tolerance stamped on the body. Composition resistors are read by decoding colored bands painted around the body of the resistors.
11. Resistors, or any other electrical/electronic component, have only three possible ways in which they can be connected—series, parallel, and series-parallel. These terms are also the names of the circuits in which they appear.
12. Algebraic and arithmetic statements of Ohm's law are used to determine I, E, or R in a circuit or a portion of a circuit.
13. In a series circuit:
    a. Total voltage is divided among the load resistances.
    b. Current is the same through all the resistances.
    c. Total resistance is the sum of all the resistances.
14. In a parallel circuit:
    a. Source voltage appears across all the resistances.
    b. Total current divides among the resistances.
    c. Total resistance is less than the smallest resistance.

NEXT ISSUE: Part III—Understanding Capacitors

This series is based on material appearing in Vol. 1 of the 5-volume set, BASIC ELECTRICITY/ELECTRONICS, published by Howard W. Sams & Co., Inc. @ $19.95. For information on the complete set, write the publisher at 4300 West 62nd St., Indianapolis, Ind. 46268.

Playtape Test Report

Continued from page 59

The slightly higher priced 1320 has a larger speaker, uses four D-cells, and has an earphone jack. It also has an external power jack for an AC power supply.

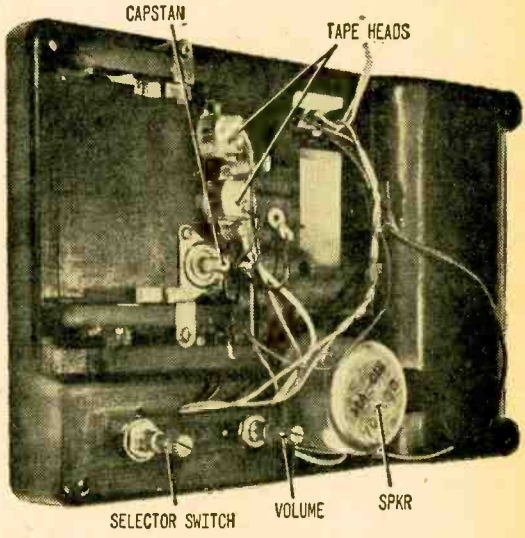
The deluxe 1403, priced at $29.95, has a built-in AM radio and a tone control in addition to the features of the 1320. Unlike the straight tape-player models whose amplifier and tape drive power are controlled by the cartridge, all functions of the 1403 are controlled by a 4-position panel switch.

How It Works. Naturally, there are limitations to any tape system at Playtape's prices. The two models we tried, the 1320 and 1403, had sound quality just about equal to a transistor radio in the $35 price range —reasonable volume, distortion not excessive, and certainly acceptable fidelity (allowing for the 3½-in. speaker). Wow and flutter was just about equal to a battery-portable tape recorder in the $50 or more price range.

Sound fidelity on the tape cartridges proved quite good, just about equal to the frequency range of a standard AM broadcast station. The AM performance of the 1403 was essentially equal to that of a typical transistor pocket radio.

Cartridge Life. While the amount of program material on the tape is the equal of that contained by two 45 rpm discs and there's a tremendous catalog selection in the pop music field—everything from Herb Alpert to the Mamas and the Papas, Hank Williams to Henry Mancini—cartridge life far exceeds that of a 45 disc. Four different cartridges were cycled over 100 times; without noticeable change in sound quality.

For more information and a complete catalog, write to Playtape, Inc., Dept. IZ, 1115 Broadway, New York, N.Y. 10010. Do it now. Playtape units and cartridges make excellent graduation gifts for teen-agers and pre-teens. ■



Inside view of the Model 1320 playback-only unit shows capstan that drives tape in cartridge past the tape heads. Selector switch picks either head to send signal to amplifier. External power jack disconnects internal batteries when AC power supply is used. Similarly, plugging in earphone disconnects internal speaker for personal listening.

Playtape Hits the Road

Volkswagen dashboard with Playtape's Sapphire I.

□ Hang onto the wheel, Harry, 1968 is the year tape cartridges made it big in the automotive market place. Approximately 470,000 Volkswagens to be delivered this year will have installed, as original equipment, Sapphire Playtape I combination radio/continuous-loop cartridge playback equipment. And, the 2½ million Volkswagen owners now on the road can install a hang-on playback unit, Sapphire Playtape II, under the dash of their Beetles. Detroit iron doesn't have to take a back seat to anyone—Playtape Model 1901, a third model, will be available to the estimated 9 million new car buyers this year. Motorola joined with Playtape in the design of the new units, and will manufacture all models for automobiles. The tape library is very large and extensive. Cartridges cost from $1.00 for two songs to $2.98 for eight selections. ■

Lafayette HB-625

Continued from page 96

pulse is then used to reverse-bias the diode pair in the receiver. When the diodes are reverse-biased, they no longer conduct a signal and the receiver is effectively muted for the duration of the noise impulse.

A combination S/Power-Output meter is provided. While the meter was calibrated to indicate S-9 on 100 μV input signals, we could find no relationship between S units, and it must therefore be considered a relative signal-strength indicator. The power output meter is calibrated in watts output and tests indicated that when the transmitter was connected to a 50-ohm load, the calibration between 2 and 3.5 watts (the test range) was correct.

Performance. Features are of course worthless if the overall performance is lacking in communications effectiveness, but the HB-625 stays up there with excellent measured performance.

The receiver section's sensitivity checked out at 0.65 μV for a 10 dB S+N/N (signal plus noise to noise) ratio. Adjacent-channel rejection measured slightly better than 53 dB. Image rejection, the ability of the receiver to reject signals at the desired frequency plus or minus the IF frequency, was better than 88 dB. In fact, we could not pick up any spurious signals in the range of 16 to 40 MHz with less than 88 dB suppression.

The speaker output impedance is 8-16 ohms for both internal and external speakers. The maximum power output of the HB-625 into a 16-ohm load was 2.5 watts.

While the AGC action was not as good as is usually expected of solid-state rigs, a 2 to 50,000 μV (88 dB) input signal range was reduced to an audio output variation of 12 dB. In other words, if you have the AF gain cranked wide open for a weak signal, a very strong signal suddenly appearing on the channel will come in somewhat loud, but not ear-shattering.

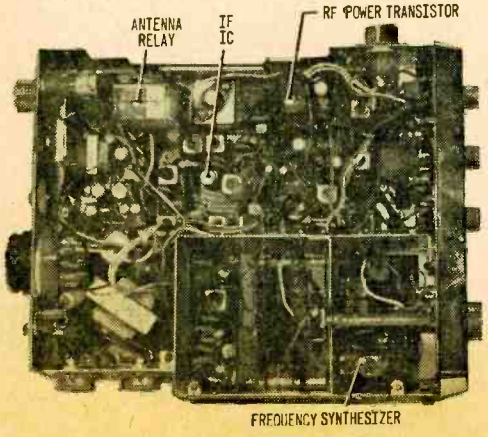
When AC powered, the transmitter delivered 3 watts into a 50-ohm load and 3.5 watts when the power supply was 13.8 volts, simulating a typical maximum voltage found in a car. While an antenna loading adjustment is provided on the rear apron, it appeared sealed, so we made no attempt to obtain maximum loading even though it is suggested in the instruction manual.

The HB-625 is a mobile unit, but optional AC power supply provides a desk-type mounting base and allows the unit to be used with land line as a base station.

The modulation was very good with very little waveform distortion up to about 90% modulation. (The modulation is limited to 90%.) Microphone sensitivity is average (−22 dB by our standards), and a voice louder than average activates the range boost circuit—a very effective speech compressor.

The actual operating "feel" of the HB-625 is very good. Though the speaker is small and in a metal cabinet, the sound is not overly tinny. The squelch takes over quickly and is to some degree noise-immune. The release from transmit to receive is instantaneous, no doubt due to the use of a relay rather than electronic switching.

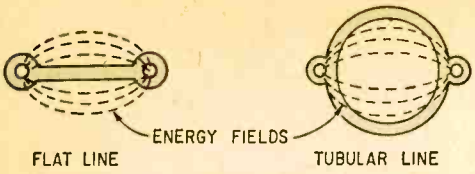
Summing Up. We can say that from both measurement and operating experience, the HB-625 shapes up as a top CB performer. And with its $189.95 price tag, it's a best buy. For additional information write to Lafayette Radio, Dept. D, 111 Jericho Tpke., Syosset, N.Y. 11791. ■



HB-625's chassis is jam-packed with circuits and components. ICs look like nothing more than ordinary transistors. Note size of the frequency synthesizer.

Deadly Dipoles

Continued from page 92



To prevent signal attenuation, tubular line keeps dust, soot deposits, and water film out of line's RF field which flat line does not.

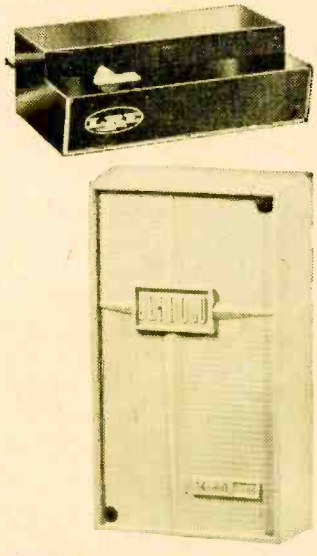
Tubular Line. One of the best all-weather lead-ins is the tubular line, which was designed to keep losses down when the lead-in is wet, or covered with dirt or snow. Since the energy fields between the two conductors of a transmission line are essentially circular, these energy fields are outside the insulation with conventional flat line. When moisture is present, it acts as a high-resistance shunt between the conductors, causing additional losses. On tubular line, the moisture remains outside the field of energy so no losses are incurred. One thing to check here is that the exposed ends of tubular line are sealed against moisture when it is installed. This is done by heating the end of the line and pinching the tubular sides together with pliers. The tube-like line can also be sealed with a plug. Usually, the manufacturers recommend that a small hole be punched at the bottom of a drip loop to drain moisture that may accumulate from condensation inside the hollow tubular line. Tubular line has a drawback in that a fairly large hole must be drilled at the feed-thru point into the house.

Shielded twinlead is one of the latest types designed to meet the stricter requirements of color TV reception. It combines the best features of coaxial cable and flat ribbon. It has a shield to keep out interference and weather, but is rated at 300 ohms so no matching transformers are required.

Boosters. Any antenna can be converted to an "electronic antenna"; all you need do is buy a transistorized booster and attach it directly to the antenna terminals at the set or on the mast. The booster package contains a transistor amplifier, which takes the signal directly from the antena (if mounted on the mast) and amplifies it before it gets the chance to pick up noise and interference en-route to the set. The power supply for the booster is located at or near the TV set in a second package which also contains a coupler that will allow you to connect two or more sets to the single antenna.

Naturally, if you are using your antenna for TV and FM, the booster must have the ability to work well on FM—some do not. (For those interested primarily in boosting FM stereo signals, there is at least one FM stereo booster available for connection to an FM-TV or FM-only antenna.)

The booster designed to be mounted on the mast at the antenna should be completely weatherproof and as trouble-free as possible. To this end, it should not contain components that are likely to need replacement after extended use, such as electrolytic capacitors and selenium rectifiers. In addition, it is helpful for the booster to have built-in lightning protection. In reading the specifications for boosters, pay particular attention to the noise figure—it must be low.



Mast mounted amplifiers or amplified couplers such as these units by Lafayette Radio (top) and Jerrold are one popular way to improve overall performance of an existing antenna installation.

Ideally, transistor boosters should be installed as close to the antenna as possible; right at the antenna terminals is best. The signal lost over even five feet of twinlead in wet weather can hurt the TV picture.

And Finally. Anything else to improve your antenna? You can give it that extra touch of built-in luxury by wiring your whole house for TV and FM. This can be

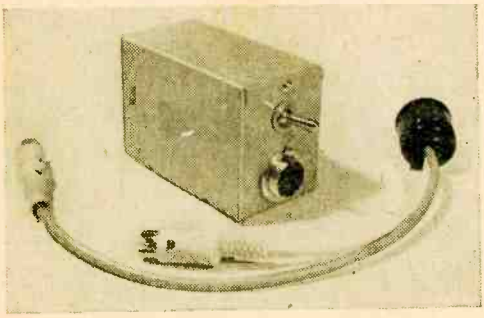
(Continued on page 118)

Tape Trigger

Continued from page 48

be insulated since the mounting base of the relay is connected to the relay switch arm. Since the shell of the mike connector is also connected to the box which houses Tape Trigger, an undesirable short between the control circuit and the shielded audio circuit might result, causing trouble with a recorder having an unusual wiring system.

Relay Mount. Isolating the relay from the case is easy. Just apply a couple of drops of epoxy cement to the case where the relay will be installed, and then press in place a small piece of thin plastic. After the cement dries, apply another couple drops to the top side of the plastic and carefully place the relay in position on top of the plastic.



When Tape Trigger has been assembled, suitable patch cords for mike and tape recorder will have to be made up.

Completed Tape Trigger lets you use your favorite mike with most any recorder regardless of the type of control circuit hookup.

The cement holds the relay in position, and the plastic insulates it from the case. If a plastic or bakelite box is used to house Tape Trigger, the relay may be cemented directly in place, or attached with two 4-40 metal screws.

The simplest way to mount the five pen-cells is to use Keystone battery clips attached to the bottom of the box to hold two cells, then tape the remaining three cells to the mounted two, as shown in the photo. The cells are connected in series by soldering hook-up wire from the positive pole of one cell to the negative end of the next cell. Use only enough heat to make a solid connection.

No *on/off* switch is necessary, since there is no battery drain as long as the mike button is released.

The mike connector on the box should be whatever is required to match the mike you intend to use. The connector shown is an Amphenol four-pin communications-type. ■

Deadly Dipoles

Continued from page 117

done simply and inexpensively by using a four-set coupler at the house end of the antenna lead-in wire. Put the coupler near the main TV set and run leads from it to different rooms in the house, terminating the wires in wall plate TV outlets, which are available in electronic supply stores. One of the wires can lead to another coupler, if it is desired to have more than four antenna outlets. Bear in mind, though, that some losses will occur in the couplers, so be sure there is enough signal strength to begin with. ■

"I just hope you're not charging while you're in there, Mr. Gus!"

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