elementary

Electronics

SEPTEMBER-OCTOBER 75c

MUST-HAVE PROJECT FOR SWLs AND HAMS!

CB Bonanza

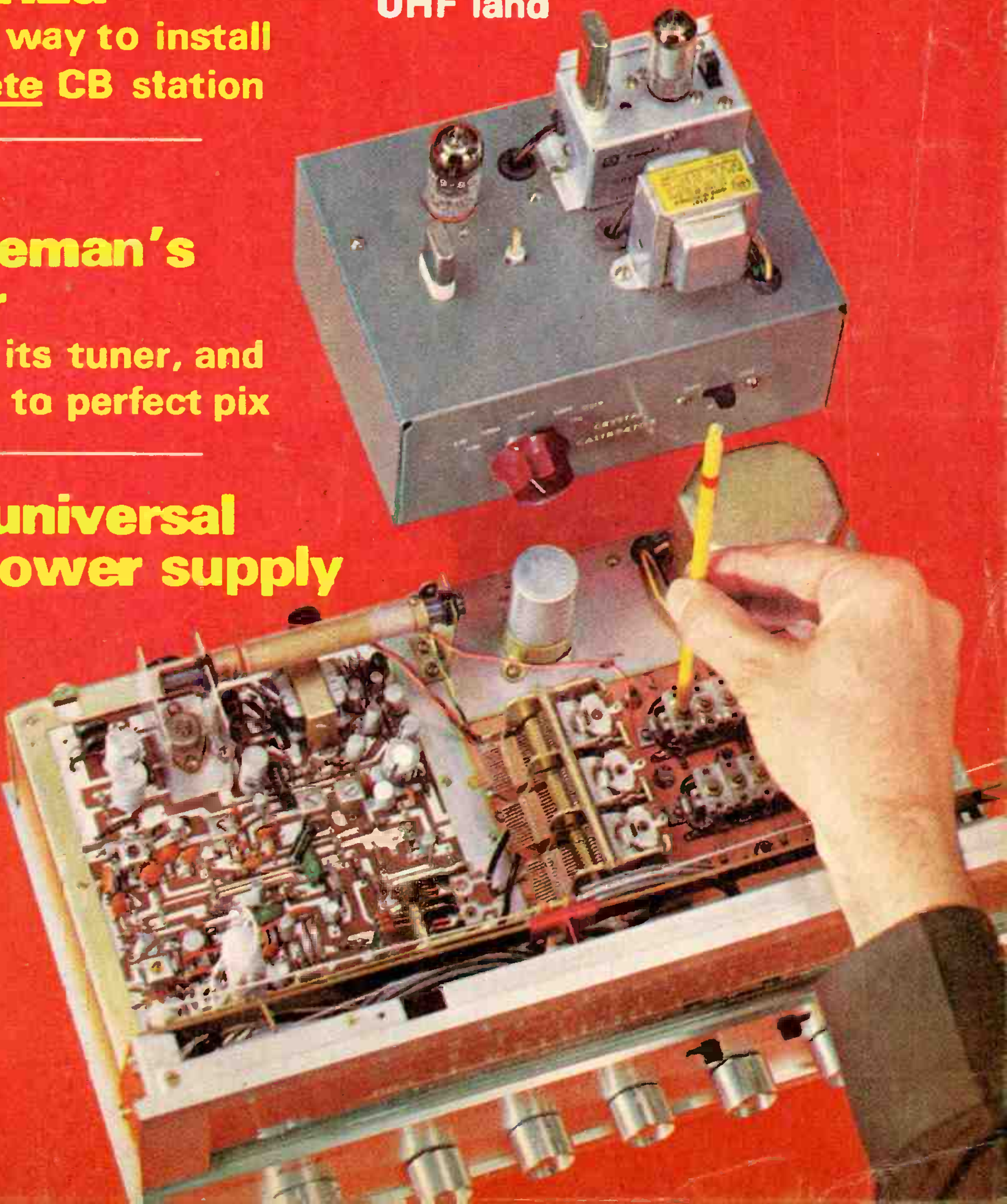
the easy way to install a complete CB station

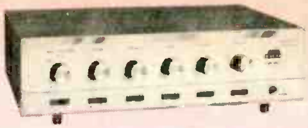
Home Serviceman's Primer

your TV, its tuner, and 13 steps to perfect pix

Build universal 4-D power supply

Bi-Hertz marker pumps out calibrating pips and blips clean up into UHF land





Introducing EICO's New "Cortina Series"!

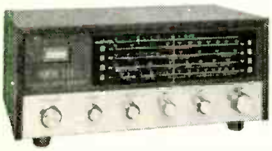
Today's electro-technology makes possible near-perfect stereo at moderate manufacturing cost: that's the design concept behind the new EICO "Cortina" all solid-state stereo components. All are 100% professional, conveniently compact (3⅛"H, 12"W, 8"D), in an esthetically striking "low silhouette." Yes, you can pay more for high quality stereo. But now there's no need to. The refinements will be marginal and probably inaudible. Each is $89.95 kit, $129.95 wired.

Model 3070 All-Silicon Solid-State 70-Watt Stereo Amplifier: Distortionless, natural sound with unrestricted bass and perfect transient response (no inter-stage or output transformers); complete input, filter and control facilities; failure-proof rugged all-silicon transistor circuitry.

Model 3200 Solid-State FM/MPX Automatic Stereo Tuner: Driftless, noiseless performance; 2.4μV for 30db quieting; RF, IF, MX are pre-wired and pre-tuned on printed circuit boards — you wire only non-critical power supply.

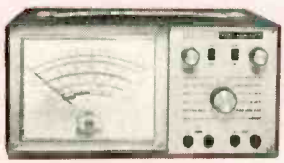
7 New Ways to make Electronics more Fun!

Save up to 50% with EICO Kits and Wired Equipment.



You hear all the action-packed capitals of the world with the NEW EICO 711 "Space Ranger" 4-Band Short Wave Communications Receiver — plus ham operators, ship-to-shore, aircraft, Coast Guard, and the full AM band. 550KC to 30MC in four bands. Selective, sensitive superhet, modern printed circuit board construction. Easy, fast pinpoint tuning: illuminated slide-rule dials, logging scale; "S" meter, electrical bandspread tuning, variable BFO for CW and SSB reception, automatic noise limiter. 4" speaker. Headphone jack. **Kit $49.95, Wired $69.95.**

More "ham" for your dollar than ever — with the one and only SSB/AM/CW 3-Band Transceiver Kit, new Model 753 — "the best ham transceiver buy for 1966" — Radio TV Experimenter Magazine. 200 watts PEP on 80, 40 and 20 meters. Receiver offset tuning, built-in VOX, high level dynamic ALC, silicon solid-state VFO. Unequaled performance, features and appearance. Sensationally priced at **$189.95 kit, $299.95 wired.**



NEW EICO 888 Solid-State Engine Analyzer

Now you can tune-up, trouble-shoot and test your own car or boat.

Keep your car or boat engine in tip-top shape with this completely portable, self-contained, self-powered universal engine analyzer. Completely tests your total ignition/electrical system. The first time you use it — just to tune for peak performance — it'll have paid for itself. (No tune-up charges, better gas consumption, longer wear) 7 instruments in one, the EICO 888 does all these for 6V and 12V systems; 4, 6 & 8 cylinder engines.

The EICO 888 comes complete with a comprehensive Tune-up and Trouble-shooting Manual including RPM and Dwell angle for over 40 models of American and Foreign cars. The Model 888 is an outstanding value at **$44.95 kit, $59.95 wired.**

New EICOCRAFT® easy-to-build solid-state electronic TruKits:® great for beginners and sophisticates alike. As professional as the standard EICO line — only the complexity is reduced to make kit-building faster, easier, lower cost. Features: pre-drilled copper-plated etched printed circuit boards; finest parts; step-by-step instructions; no technical experience needed — just soldering iron and pliers. Choose from: Fire Alarm; Intercom; Burglar Alarm; Light Flasher; "Mystifier"; Siren; Code Oscillator; Metronome; Tremolo; Audio Power Amplifier; AC Power Supply. **From $2.50 per kit.**

New EICO "Nova-23" (Model 7923) all solid-state 23-channel 5 watt CB Transceiver featuring a host of CB advances—plus exclusive engineering innovations.
EXCLUSIVE dual-crystal lattice filter for advanced razor-sharp selectivity of reception.
EXCLUSIVE highly efficient up-converter frequency synthesizer provides advanced stability and freedom from trouble in all 23 crystal-controlled transmit-receive channels. All crystals supplied.
EXCLUSIVE use of precision series-mode fundamental crystals for superior transmit and receive stability. **Wired only, $189.95**

Model 460 Wideband Direct-Coupled 5" Oscilloscope. DC-4.5mc for color and B&W TV service and lab use. Push-pull DC vertical amp., bal. or unbal. input. Automatic sync limiter and amp. **$99.95 kit, $139.95 wired.**

FREE 1967 CATALOG

EE-9

EICO Electronic Instrument Co., Inc.
131-01 39th Ave., Flushing, N. Y. 11352

Send me FREE catalog describing the full EICO line of 200 best buys, and name of nearest dealer. I'm interested in:

- ☐ test equipment
- ☐ stereo/hi-fi
- ☐ automotive electronics
- ☐ ham radio
- ☐ Citizens Band radio

Name____________________
Address____________________
City____________________
State____________ Zip______

Model 232 Peak-to-Peak VTVM. A must for color or B&W TV and industrial use. 7 non-skip ranges on all 4 functions. With exclusive Uni-Probe.® **$29.95 kit, $49.95 wired.**

ELEMENTARY ELECTRONICS is published bimonthly at $4.00 per year, by Science & Mechanics Publishing Co., 505 Park Avenue, New York, N.Y. 10022. Second class postage paid at New York, N.Y., and at additional mailing office. Copyright 1967 by Science and Mechanics Publishing Co.

Cover Photo by Leonard Heicklen

SEPTEMBER/OCTOBER 1967
VOL. 5 NO. 1

elementary Electronics

Dedicated to America's Electronics Experimenters

☆ Cover Highlights

AUTHORS IN THIS ISSUE:
Len Buckwalter—K1ODH/KBA4480, Joe Craig, Jchn W. Collins, James A. Fred, Herb Friedman—KBI9457, Webb Garrison, Edward Griffin Jr., C. Hansen, Fred H. Horan, K.C. Kirkbride, Jim Kyle—K5JKX, Francois Markette, Leo G. Sands—KOD1939, Jack Schmidt, Hartland B. Smith—W8VVD, Ronald Tom, and the Elementary Electronics Editorial Staff. ■

ELEMENTARY ELECTRONICS, Vol. 5, No. 1 is published bi-monthly by SCIENCE & MECHANICS PUBLISHING CO., a subsidiary of Davis Publications, Inc. Editorial, business and subscription offices: 505 Park Ave., New York, N. Y. 10022. One-year subscription (six issues)—$4.00; two-year subscription (12 issues)—$7.00; and three-year subscription (18 issues)—$10.00. Add 75¢ per year for postage outside the U.S.A. and Canada. Advertising offices: New York, 505 Park Ave., 212-PL-2-6200; Chicago: 520 N. Michigan Ave., 312-527-0330; Los Angeles: 6253 Hollywood Blvd., 213-463-5143; Atlanta: Pirnie & Brown, 3108 Piedmont Rd., N.E., 404-233-6729; Long Island: Len Osten, 9 Garden Street, Great Neck, N. Y., 516-487-3305; Southwestern advertising representative: Jim Wright, 4 N. Eight St., St. Louis, CH-1-1965.

SPECIAL 16-PAGE SECTION

we're celebrating Radio Shack's anniversary 44TH

Radio Shack — the nation's biggest company-operated Electronics Parts store chain — is 44 years old today. In 1923 "The Shack" was a one-store pioneer. In 1967 we're over 150 stores coast-to-coast. But we've brought our "one store" concept into your neighborhood to give you instant service on the electronics gear you need to build magazine projects, school experiments, and to repair and install things like speakers, antennas, radio-TV, intercoms, CB, and audio components. We've brought "distributor" prices to your doorstep, and 100's of items not available in any other store. Visit your nearest Radio Shack for 44th birthday bargains. Or phone. Or write. You'll discover why over 1,000,000 customers have made us #1 in electronics — nationwide!

• EXCITING IDEAS KEEP RADIO SHACK YOUNG AT 44

NEW!
perfboard kits from Science Fair . . .
PAGE 6

BUY!
a "VOM" for 3.95 factory wired . . .
PAGE 9

CA$H
for your projects! We pay for ideas . .
PAGE 7

HOLE-Y!
"Perfbox" makes it easier to build . . .
PAGE 8

RADIO!
a wired 6-TR radio "in parts" for installers
PAGE 19

STICKUP!
novel "glue gun" really works as advertised . .
PAGE 16

COPS!
our monitor portable VHF radio is "hot" . .
PAGE 18

LOST?
here's where to find the "Shack" near you . . .
PAGE 20

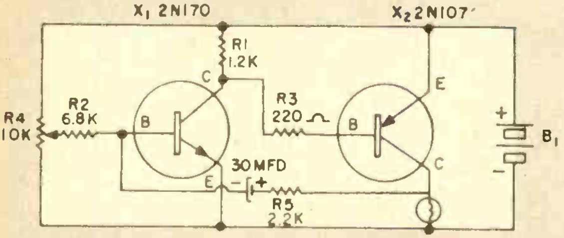
THESE ELECTRONIC PROJECTS HAVE EARNED CASH AWARDS FOR RADIO SHACK CUSTOMERS

Build Yourself — or Win Cash by Sending Us Your Own Ideas!

R.G.
Fremont, California

PILOT LIGHT FLASHER

Illustrates Fundamentals of Radar & Computers



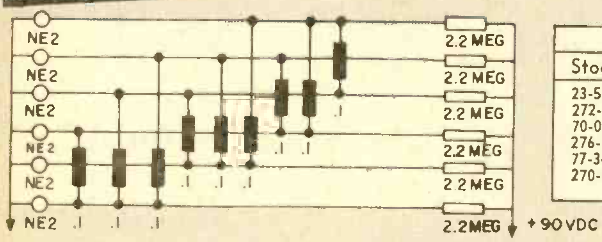
PROJECT PARTS LIST		
Stock No.	Item	Net
70-0195	1.2K ½W Resistor	.12
70-0195	6.8K ½W Resistor	.12
70-0195	220Ω ½W Resistor	.12
271-1715	10K Variable Potentiometer	.59
70-0195	2.2K ½W Resistor	.12
272-954	30MFD 15 Volts Capacitor	.29
276-1703	2N170 Transistor	.49
276-1701	2N107 Transistor	1.17
272-1535	Panel Indicators (Pak of 2)	.79
23-467	"C" Cells (4 required)	.14
270-1437	Double Battery Holder (2 required)	.25

This project, requiring anywhere from 30-45 minutes to complete, can be utilized as an ornamental device or for signalling purposes. It is a fine educational tool as well, since it demonstrates basic relaxation oscillator principles. Can be expanded to become the basis for an automobile or boat warning light; it can also be used for timing circuits, by determining the number of cycles per second.

M.H.M.
Philadelphia, Pennsylvania

"DO-NOTHING" BOX

Can Be Utilized As a Basic Timing Device



PROJECT PARTS LIST		
Stock No.	Item	Net
23-539	90 Volt Battery	3.65
272-973	.1 MFD 100 Volts Capacitor (pak of 10)	.99
70-0195	2.2 Meg. ½W Resistor (6 required)	.12
276-1582	Circuit Board	.59
77-3417	Neon Lamps (6 required)	.10
270-325	Battery Clips (pak of 5)	.69

This ingenious device is a must for anyone with a keen sense of imagination. The project's most obvious feature is a series of flashing lights, which illustrate the technique of sequential lighting. The neon bulbs produce light in much the same was as outdoor display advertising. The "box" is easy to construct — at a minimum of cost. The battery lasts indefinitely due to the relatively small amount of current required to ignite the bulbs. The device may be used, together with other circuitry, to actuate flip flops, multi-vibrators, etc. It may also be used as a basic timing device. Its action is similar to that of a ring counter circuit.

$$ FOR YOUR ELECTRONIC IDEAS!

Turn Ingenuity and Hobby into Spare-Time Profits!

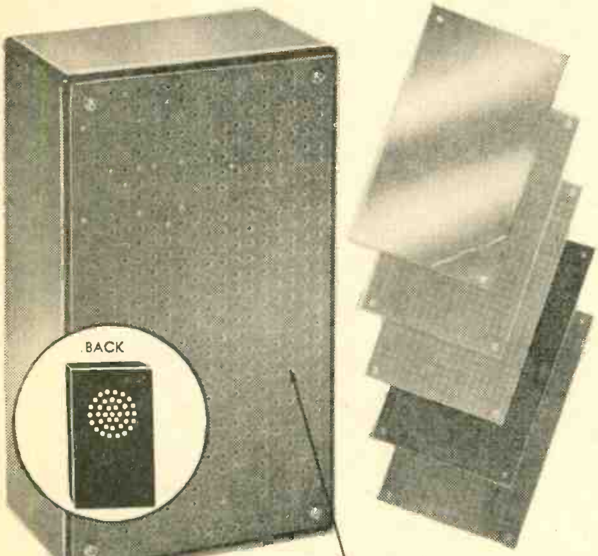
We are looking for experiments built around Radio Shack or other electronic parts. These will be published regularly in our catalogs. If published by us WE WILL PAY YOU AN AUTHOR'S FEE and reimburse you for parts bought from us — maximum $50 cost. By submitting it, you state it's original with you. If 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

For Store Addresses, Order Form, See Page 20

Ingenious New Radio Shack PERFBOX™ "Professionalizes" Project Building!

The bloody-knuckle brigade will appreciate Radio Shack's effort to eliminate chassis cutting and drilling, and make things prettier!

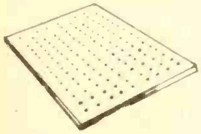


Somebody at "The Shack"—thank heaven! —must hate metal chassis and the generally sloppy look of breadboard projects. Now they've come up with a bakelite chassis box into which they've installed (4 screws) a 3½" x 6" perfboard top. But that's not all—the back of the box is pre-drilled for a 2¼" or other PM speaker, and there's a pre-drilled ¼" outlet hole on one side! This much-needed item is called the Radio Shack Experimenter's PERFBOX™. (*Cat. No. 270-097, price $1.69*) and should sell like film at Expo 67. As an added fillip, there's a companion deal they call Radio Shack Experimenter's 5-Piece Panel Set, consisting of 3 perfboards and 1 aluminum and 1 bakelite panel board, all 3¼"x6" predrilled to fit the PERFBOX™. The latter two boards are un-perfed (to coin a word), and the 5-piece set (*Cat. No. 270-100, price $1.69*) should answer just about any need for extending the usefulness of the PERFBOX short of filling it with champagne!

RECOMMENDED PARTS FOR USE IN PERFBOX PROJECTS

DESIGN, CONSTRUCT YOUR OWN CIRCUITS . . . using these time-saving phenolic boards, breadboard or permanent type. 3/32" holes punched on 0.265" centers. Can be sawed. Shipping weight 1 lb.

UNCLAD PERF-BOARD

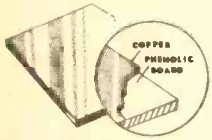


Punched

- *Accepts Miniature Components!*
- *Easy-In, Easy-Out Mounting!*
- *Ideal for Modular Construction!*

276-1582, 3.65x6.87x1/16" .... Net .59
276-1583, 6.87x9.8x1/16" .... Net 1.15

COPPER-CLAD SOLID BOARD

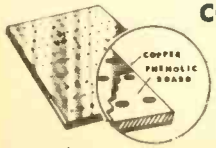


(Unpunched)

- *Make Your Own Printed Circuits!*
- *Quality-Manufactured Board*
- *Bonded with Copper!*

276-1586, 3.65 x 6.87 x 1/16" .... Net .79
276-1587, 6.87 x 9.8 x 1/16" .... Net 1.50

COPPER-CLAD PERF-BOARD

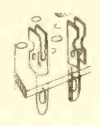


(Punched)

- *For Printed Circuit Design and Circuit Checkout!*
- *Easily Etched and Worked!*

276-1584, 3.65x6.87x1/16" .... Net. .89
276-1585, 6.87x9.8x1/16" .... Net 1.75

PUSH-IN TERMINAL KIT



1.49 Kit of 100

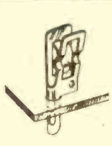
Use with prepunched perf boards. .062 diameter holes (1/16"). Serrated slots. Easy multiple connections.
270-1394, ¼ lb. Net 1.49

SPRING BANANA PLUGS

99¢ Set of 10

Ideal for 3/32" hole perforated boards. Overall length 1".
270-1543, 2 oz. .... Net 99¢

SOLDERLESS TERMINALS



99¢ Set of 15

Use with .093 diameter holes. Takes up to 7 leads without soldering. USA made. Spring action.
270-1395, 4 oz. .... Net 99¢

ALLIGATOR CLIP SET

99¢

10 brass plated 1⅜" long with insulated phenolic barrels. Strong spring. 5 red, 5 black.
270-1540, 2 oz. .... Net 99¢

For Store Addresses, Order Form, See Page 20

RADIO SHACK 44TH BIRTHDAY SPECIAL

MICRONTA TEST EQUIPMENT AVAILABLE ONLY AT RADIO SHACK

1000 OHMS/VOLT POCKET AC/DC VOM

Regular: ~~$5.95~~ **SALE! 3.95**

- *Ultra Compact Size; Only 3½" x 2⅛" x 1"*
- *Convenient Thumb-Set Zero Adjustment*

Pin jacks for 5 ranges. 2-color 1¾" meter scale. Reads AC or DC volts in 3 ranges: 0-5, 150, 1000V. DC Current: 0-150ma. Resistance: 0-100K ohms. Accuracy ±3% DC, ±4% AC. Bakelite case with test leads, instructions, batteries.

22-4027, Sh. wt. 1 lb. .... Net 3.95

HOME/AUTO TESTER

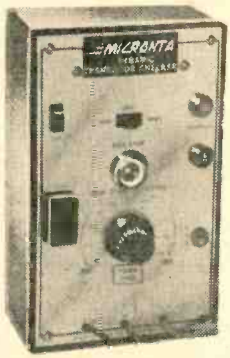
11.95 Factory Wired

- *Checks Electrical Circuits in the Home or Garage!*

Volt, ohm, ammeter, wattage and leakage checker; checks 6-12V batteries. 0-7.5/15/150/300V, 15 amps. Resistance 0-1000Ω. With leads, power cord. 6¼"x3¾"x 2⅛".

22-011, Wt. 3 lbs. ... 11.95

DYNAMIC TRANSISTOR CHECKER



9.95

- *Test Transistors "In" or "Out" of Circuit. Tests Low, Medium, High Power*

Visual indication of electrode open & short circuits, current gain, GO/NO-GO test 5ma-50ma, clip leads for in circuit tests. 6¼x3¾x2½".

22-024, Wt. 2 lbs. 9.95

TRANSISTORIZED REGULATED VARIABLE DC POWER SUPPLY

Reg. ~~$16.95~~ **SALE! 13.44**

- *25% Ripple, 0-20 Volts, Current 0-200 ma*

Continuously variable output of 0-20 VDC. 2 operating ranges deliver 0-20ma to 0-200ma. Meter reads output voltage and milliamps. 115 VAC @ 50/60 cy. Test leads. 4⅞x2⅞x 2¾". 22-023, Sh. Wt. 4 lbs. .... Net 13.44

EDGEWISE PANEL METERS

1.99 up

- *Moving Coil Type! 2% Accuracy!*
- *Compact! Easy-To-Read Scales!*

Moving coil of 1 MA with zero adjust set screw. 2% accuracy, soldier lug terminals. 1⅞" mounting hole centers. Size: 2⅛"Wx1-7/16"D x⅞"H.

22-004, Signal Strength	Net 1.99
22-006, VU, −20 to +3 (0-100%)	Net 2.50
22-003, Balance & Tuning Meter	Net 2.50

For Store Addresses, Order Form, See Page 20

ANY ARCHER-PAK ON THIS PAGE $1 PER PAK

Celebrating Our 44TH Anniversary

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

35 Miniature 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

45 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

35 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 subouncer, 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!
274-1562, 1 lb. .... Net 1.00

30 2-Watt Resistors

These quality 2-watt resistors are non-inductive, magnetic film, carbon types. Many with 5% values. Made by famous-name manufacturers.
271-1211, ½ lb. .... Net 1.00

For Store Addresses, Order Form, See Page 20

For Store Addresses, Order Form, See Page 20

SEMI CONDUCTORS FOR THE HOBBYIST

RADIO SHACK 44th BIRTHDAY SPECIAL

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 auto 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

NPN TYPES

For mixer/oscillator converter circuits. Replaces: 2N193, 2N194/A, 2N211, 2N212, 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

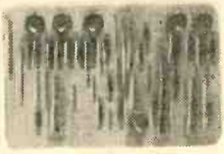
Silicon Field-Effect Transistors

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

IBM Component Boards



29¢

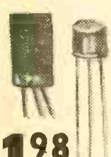
SAVE!

4 for 1.00

All quality American made parts; ideal for builder and hobbyist alike. Each board contains at least two transistors, plus loads of other components: resistors, capacitors, coils, diodes, modules, chokes, and heat sinks. Size: 2⅝ x 3⅞".
276-616, Sh. wt. ¼ lb. .... Net .29

Twin PAK "POP" SERIES

Popular PNP Types



- 5-2N107 Types
- 5-CK722 Types

1.98

Radio Shack Exclusive! Great for experimenters, hams, hobbyists . . . all audio applications. Complete with transistor base diagrams.
276-031, Wt. 3 oz. 1.98

Popular NPN Types

- 5-2N35 Types
- 5-2N170 Types

1.98

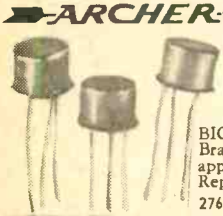
Big savings on NPN type transistors! Especially suited for audio applications. Great for hams, hobbyists! Includes transistor base diagram.
276-032, Wt. 3 oz. 1.98

Photo-Multiplier Power Transistor

1.98

Photo-sensitive cell, power transistor amplifier, electronic relay. Includes specs. and diagrams.
276-847, Wt. ¼ lb. .... Net 1.98

ARCHER Twin-Pak Transistor Kit



1.98 Kit of 25

- 10 NPN
- 15 PNP

BIGGEST BUY yet for the hobbyist or experimenter. Brand new . . . with full length leads. Ideal for RF applications, switching and general purpose audio types. Replace many popular numbers without circuit change.
276-1516, Ship. wt. 2 lbs. .... Net 1.98

750 MA Top Hat Rectifiers

25¢ PAK of 2

From 50-1000 PIV

276-1107	50 PIV	Pak of 2	.25
276-1108	100 PIV	Pak of 2	.39
276-1109	200 PIV	Pak of 2	.59
276-1110	400 PIV	Pak of 2	.89
276-1111	600 PIV	Pak of 2	1.39
276-1112	800 PIV	Pak of 2	1.79
276-1113	1000 PIV	Pak of 2	1.98

3 Amp Silicon-Controlled Rectifiers

1.95

TO-66 Case! 200V

Designed to deliver loads up to 3 amps. Ideal for use in speed control operation, power converters.
276-1065 .... Net 1.95
276-1066, TO-66 mtg. hdwr. .... .30

10 GERMANIUM DIODES

Similar to 1N34, 1N34A, 1N60

99¢

Equivalent in use to silicon diodes with lower forward voltage drop.
276-821, Ship. wt. ¼ lb. .... Net .99

Transistor Sockets

99¢ Kit of 10

Takes PNP or NPN transistors with 3 contacts in line or triangle; complete with mounting plates. For every experimenter!
274-1510, Wt. 2 oz. .... Net .99

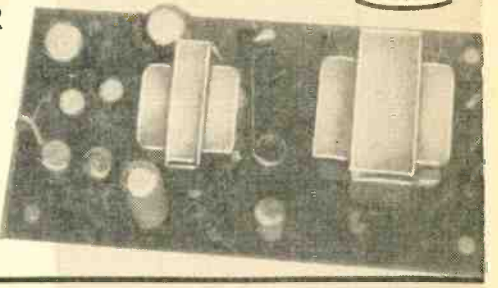
For Store Addresses, Order Form, See Page 20

SOLID STATE COMPACT PRINTED CIRCUIT BOARDS

RADIO SHACK 44th BIRTHDAY SPECIAL

COMPACT 1-WATT 4-TRANSISTOR PUSH-PULL AUDIO AMPLIFIER

WAS ~~$6.95~~ **NOW 5.44**

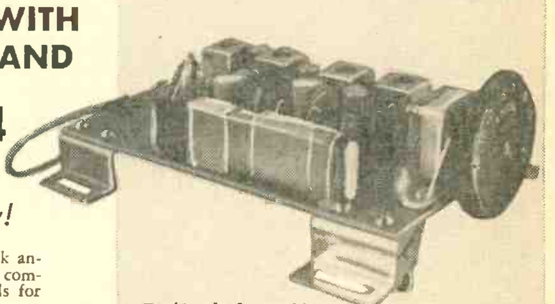


- *Completely Wired — Easy to Connect!*

Can be used as an intercom, phono, tape or microphone amplifier. Color-coded leads. Freq. response ±1.15 db. 300-15,000 cps. Input: 5000Ω. Output: 8-12 ohms.
277-038, Sh. wt. 1 lb., 2x3¾x1¼" .... Net 5.44

3-TRANSISTOR AM TUNER WITH STANDARD 540-1600 KC BAND

WAS ~~$7.95~~ **NOW 5.44**



Fully Wired!

Superhet Sensitivity & Selectivity!

Low-power tuner has variable capacitor with dial, loopstick antenna, oscillator converter, IF's, detector and associated components. Vertical & horizontal mounting. Extra-long leads for easy connection to amplifier, battery, etc.
277-329, Ship. wt. 10 oz. .... Net 5.44

ARCHER DELUXE MODULES

- *Solid State Dependability!*
- *Screw Terminal Connections!*
- *Can be Mounted in Any Position!*
- *Ideal for Builders & Hobbyists!*

4.95

MADE IN U.S.A.

SIREN MODULE

A perfect warning device! Reproduces the upward scream and downward wail of a siren. Size: 3⅞x2¼x⅞".
277-266, Ship. wt. ½ lb. .... Net 4.95

WIRELESS GUITAR AMPLIFIER

Play guitar through standard AM radio. Range up to 25 feet. For use with crystal or ceramic pickups.
277-299, Ship. wt. 1 lb. .... Net 4.95

SUPER HIGH GAIN AMPLIFIER

Extremely high gain of 100,000. Can be used as hearing aid, audio signal tracer, etc. Size: 3⅞x2¼x⅞".
277-251, Ship. wt. ½ lb. .... Net 4.95

AC POWER SUPPLY

Use with rectifier-electronic filter. Comes complete with line cord.
277-258, Ship. wt. 2 lbs. .... Net 1.95

POWER AMPLIFIER

2-watt amplifier is ideal with tuners, mikes, paging systems, or as a signal tracer. Size: 3⅞x2¼x⅞".
277-253, Ship. wt. ½ lb. .... Net 4.95

ELECTRONIC FILTER

Dual 6VDC output; low ripple and filtered! Use with any AC power supply.
277-259, Ship. wt. ½ lb. .... Net 3.95

AUTO BURGLAR ALARM

Gives instant alert when car door or trunk is forced open. Horn blows even after doors are re-closed.
277-252, Ship. wt. ½ lb. .... Net 4.95

PHONOGRAPH AMPLIFIER

Designed for phonographs using high impedance crystal or ceramic cartridges. Size: 3⅞x2¼x⅞".
277-261, Ship. wt. ½ lb. .... Net 4.95

For Store Addresses, Order Form, See Page 20

RADIO SHACK 44TH BIRTHDAY SPECIAL

SAVE BIG! ELECTRONIC PARTS NOW WAY OFF REGULAR PRICES

RUNNING TIME METER

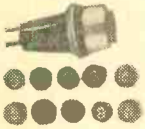
Reg. ~~$6.95~~ Sale Price 5.44

• *Records 0 to 9999.99 Hours!*

Measures elapsed operating time of electronic equipment, transmitters, receivers, industrial machines, etc. Records running time in hours, tenths and hundredths. Operates either from 40 or 110/125 VAC, 60 cy., with external resistor (supplied). Synchronous motor drive. Size: 2¼x2¼x3⅛".

273-1628, Sh. wt. 3 lbs. .... Net 5.44

NUMERAL LAMPS



Orig. ~~$1.99~~ 1.44

Bayonet type socket with 11 interchangeable lenses. For ¾" hole.

272-343, Sh. wt. 4 oz. .... Net 1.44

5-LB. ELECTRONIC MYSTERY BOX

1.98 *Worth at Least $25!*

Hobbyist's delight! Assorted switches, resistors, capacitors, transformers.

270-496, Sh. wt. 5½ lbs. .... Net 1.98

DPDT SWITCH

Neutral Center

99¢ Pak of 2

Kit of two DPDT toggle switches with long bar handles. Heavy duty excellent for power circuits, PA systems, etc. Rated at 10 amps, 125 VAC. With on/off plate, screw terminals, and mounting nut.

275-1533, Sh. wt. ¼ lb. .... Net .99

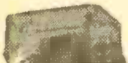
6-PDT PUSH BUTTON SWITCH

49¢

Replacement switches for most walkie talkies. May also be used in circuits where momentary action is required. Size: 1x11/66x7/16". Shaft length, with knob: ¾".

275-051, Sh. wt. ¼ lb. .... Net .49

FUSE HOLDERS



99¢ Kit of 6

Chassis mounting fuse holders for popular 1¼x¼" fuses. 3 holders accept 2 fuses, and 3 take single fuse. Each equipped with snap-on dust cover.

270-337, Sh. wt. ¼ lb. .... Net .99

COMPOSITION RESISTORS

1.99 Pak of 100

1/10, ½, 1, 2 watts. Many 5% and "Magnetic Film" types. Comes complete with free Color Code Chart.

271-810, 2 lbs. Kit of 100 Net 1.99

ARCHER TWILIGHTER

• *Automatically Turns Light On at Dusk, Off at Dawn!*
• *Silent Guardian of Your Home or Office!*

Reg. ~~$5.95~~ Sale 4.44

An electronic "eye" that automatically controls selected lights, turning them on at sunset, off at dawn, daily — without resetting. Ideal for controlling driveway lights, interior lights, displays. Size: 3⅞x1⅜x2⅜".

275-1399, Sh. wt. 1 lb. .... Net 4.44

Store Addresses, Order Form, See Page 20

500' OF HOOK-UP WIRE

Solid & Stranded 2.49

Five 100-ft. coils, sizes #18 through #22. Cotton, vinyl insulation; different colors.

278-1484, Wt. 2 lbs. .... Net 2.49

75' MINI-SPEAKER WIRE

1.19

Place speaker away from amplifier. 2-conductor #24 wire. Plastic insulation.

278-1509, Sh. wt. 1¼ lbs. .... Net 1.19

6-FOOT LINE CORDS

39¢

Feature #18 wire complete with molded plug. Ideal for home or shop!

278-1255, Sh. wt. ¼ lb. .... Net .39

COAX CABLE CONNECTORS

278-200, PL-259 .... Net .59
278-201, SO-239 .... Net .50
278-1370, UG175/U, Adapter for RG58/U cable .... Net .16

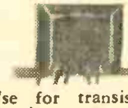
6.3 VOLT FILAMENT TRANSFORMER

98¢

Hundreds of applications! Input: 117 volts at 60 cy. Output: 6.3 volts at 1.2 amps. Tinned color-coded leads. Size: 1-15/16x1¼x9/16".

273-050, Sh. wt. 1 lb. .... Net .98

24 VOLT POWER TRANSFORMER



1.98

Use for transistor, semi-conductor circuitry conversions, etc. Operates from primary 117V 60 cy. Secondary: 24 VAC 1.2 amps. Open frame. Size: 2x1-15/16x3-3/16".

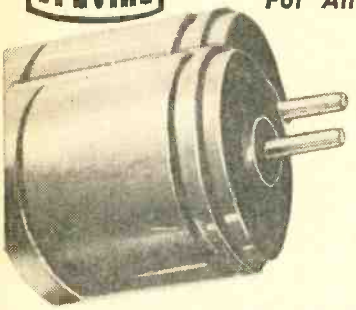
273-1480, Sh. wt. 2 lbs. .... Net 1.98

RADIO SHACK 44TH BIRTHDAY SPECIAL

Thrifty Buyers Will Save During Our 44th ANNIVERSARY SALE

MINIATURE 6 VOLT SYNCHROS

For All Remote Control Uses!



4.44 per pair

Ideal for:

- *Amateur Beam Antennas!*
- *Weathervanes!*
- *Indicating Uses!*

Used originally in aircraft equipment. Compact; ruggedly built. For 26 VAC @ 400 cycles; guaranteed to operate efficiently at 6 VAC @ 60 cycles. Includes wiring diagram. Size: 1⅝ x 1-9/16". Shaft size: ⅛ x ½".
273-2006, Sh. Wt. 1 lb. .... Pair 4.44
273-050, 6.3 VAC Transformer.. Net .98

HAYDON 1 RPM TIMING MOTORS

- *Made in U.S.A.!*

1.49

New! Rated @ 5 watts. Shaft size ⅛" x ⅝". Overall 1⅞ x 2⅜ x 1-1/6" mtg. ctrs: 1⅞". Perfect for displays, signs, & countless other timing uses!
273-1481, Sh. Wt. ½ lb. .... Net 1.49

4" VENTILATING FAN AND MOTOR

- *4-Bladed!*
- *Made in USA!*

2.44

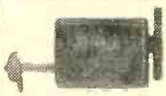
Use to cool hi-fi equipment, amateur gear, etc. Rugged laminated steel motor. Permanently lubricated bearings. Long leads. Shaft ¼" x 1⅜". 3 x 2½ x 1¼".
273-1630, Sh. Wt. 1 lb. .... Net 2.44

SLUG-TUNED FERRITE LOOP ANTENNA COIL

79¢

For transistor, tube or crystal radios! Sensitive high "Q" antenna matches all tuning condensers in broadcast band. Complete with mounting bracket and hardware. 2 x ½".
270-1430, 4 oz. .... Net .79

3-DIGIT RESET COUNTER



Orig. $1.49 **99¢**

Multi-purpose — counts to 999! Black numerals on white; steel lever actuating arm. 1¼" knob for zero reset. Size-less knob and lever arm.
275-1408, ½ lb, 1½ x ⅞" .... Net .99

POTTER-BRUMFIELD 6-VOLT AC RELAY

1.49

- *3-pole Single Throw!*

All brand new! Contacts rated @ 5 amps. Coil operated at 6 VAC. 1¾ x 1⅛ x 1".
275-096, Wt ¼ lb. .... Net 1.49

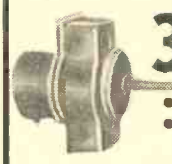
115 VAC SOLENOIDS

1.59

- *Continuous Operation!*

Max. stroke 1¼" DC resistance of 25 ohms ±10%. Max. lift: 4 to 11 lbs. Removed from equipment but guaranteed 100%. Size 2-1/16 x 2½ x 1-13/16". Mfg. by Soreng.
275-149, Wt 2 lbs .... Net 1.59

MINIATURE DC MOTORS



3 for 99¢

- *Low Battery Drain!*
- *Double Permanent Ferrite Magnets!*

Operate from a single flashlight cell, 1½ to 12V. Bronze bearings, brass shoe bearings, & connecting leads. Shaft: ½ x 1/16".
273-232, Wt. ½ lb. 1⅜" x 2" x¾", Net 3/99¢

HIGH CAPACITY, LOW VOLTAGE CAPACITOR

49¢

Ideal for power supplies, replacements, hobbyists, experimenters. 2000/400/100 mfd at 25 VDC. 2½ x 1⅜".
272-1496, Wt. 2 oz. .... Net .49

NEON PILOT LIGHTS

99¢ Set of 2

With neon lamp, jewel and socket. Includes 100,000Ω dropping resistors. Operates on 115 volts. Size ⅜ x 1¼". 1 red and 1 yellow.
272-328, Wt. ¼ lb. .... Net .99

SPST MINIATURE MERCURY SWITCH

69¢

Normally "On or Off". Tipping one side or other makes or disconnects mercury with contacts. Silent operation. For 1 amp @ 115 volts. Long wire leads.
27-9000, Sh. Wt. 4 ozs. .... Net 69¢

EXPERIMENTERS UTILITY BOX

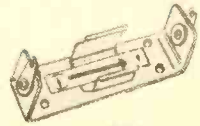
1.00

- *Sturdy Bakelite Case!*
- *Removable Aluminum Cover!*
- *3¾ x 6¼ x 2"!*

Perfect for housing test equipment, experimental circuits. Build multi-meters, speed controls, transistor checkers!
270-627, Wt. 2 lbs. .... Net 1.00

For Store Addresses, Order Form, See Page 20

METAL BATTERY HOLDERS



99¢ Kit of 8

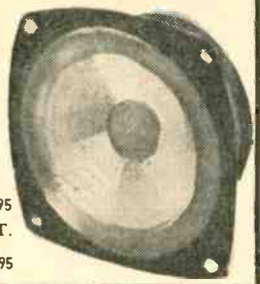
4 single "AA", 1 double "AA", 1 "C" cell, and one double "D" cell holder. All metal construction with solder lugs at each end.
270-381, Sh. Wt. 1 lb. .... Net .99

MIKES, SPEAKERS, HEADSETS, TOOLS FOR THE ELECTRONICS EXPERIMENTER

RADIO SHACK 44th BIRTHDAY SPECIAL

BUILD "EI'S" MIGHTY SUB-MINI SPEAKER

4" Acoustic Suspension FE-103 Speaker System!



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

40-1197, FE-103, Wt. 5 lbs. Net 7.95

CONTOUR NETWORK KIT. With instructions.
40-808, coil, capacitor, etc., Net 3.95

MINIATURE PM SPEAKERS FOR TRANSISTOR PROJECTS, RADIOS

8 Ohm Impedance

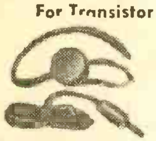
Small in size but big in sound! Three sizes to choose from: 2½", 2¼", or 2". All for the same bargain price!

40-247, 2½", ... Net .98
40-246, 2¼", ... Net .98
40-245, 2", ... Net .98

ONLY 98¢ EACH!

MIDGET EARPHONES

For Transistor Radios



98¢

Resp. 50-9000 cps. With replaceable earplug, cord. 10 ohms.
33-175, Wt. 2 oz. ...... Net .98
33-174, w/3/32" plug, Net .98

STEREO HEADSET

Separate Transducers!

2.79

Perfect for use with receivers, tuners, amplifiers, kits and recorders! 8 ohms.
33-1008, ... Net 2.79

FABULOUS THERMO-ELECTRIC GLUE GUN REALLY WORKS!

60-Second Bonding Plus Instant-set Caulking! No Clamping! No Cleaning!

5.99 *for make-or-mend jobs*

Makes all other kinds of gluing obsolete! Uses unique hot-melt glue sticks: melted glue bonds permanently in 60 seconds, providing a flexible bond that's perfect for furniture, pottery, metal, leather, plastic or fabric. Use with white sealer sticks for water proof caulking. Glue and caulking included.
64-2860, Gun, 2 lbs. Net 5.99
64-2861, 7 Glue sticks, 1 lb. .... Net .49
64-2862, 7 Sealer Sticks, 1 lb. .... Net .49

CRYSTAL LAPEL MIKE

• *For Recorders, PA, Paging!*

1.89

Sensitive! Concealable! Response: 200-300 cps.
33-100, Wt. 8 oz. .... Net 1.89

CRYSTAL MIKE CARTRIDGE

89¢

Precision made crystals! Response up to 7000 cy.
270-095, 8 oz. .... Net .89

POWERFUL CERAMIC MAGNETS

1,000's of Home, Office, Auto Uses!

64-1885
64-1875

10¢ Each For 10 | 15¢ Each Singly | 25¢ Per Pair

10 FOR 1.00

LAVALIER DYNAMIC MIKE

6.95

Neck/Hand/Desk Use!

Pencil-slim hi-Z for use at home, studio, or in PA and guitar systems! With cord, stand. 50K.
33-928, Ship. wt. 2 lbs. ...... Net 6.95

LOW COST 25-W. SOLDERING IRON

1.89

Precision designed! Comes complete with UL Cord and Plug. Uses 117V AC/DC.
64-2182, 1 lb. ...... Net 1.89
64-2178, Extra copper Tip .. Net .25

OUR OWN 60/40 SOLDER

69¢ Each

12 & UP 59¢ Each

U.S. made with superactive rosin core. Fits fed. specs. QQ-S-571d
64-0002 .... Net .69

STEEL CATCH-ALL STORAGE BOX

6"H x 8¼"D x 5¾"W

1.95

4 draws with adjustable compartments.
64-2050, 3 lbs. ...... Net 1.95

ASSORTED ELECTRIC HARDWARE

6"Hx8¼"Dx 5¾"W

99¢

Over 600 pieces! Something here for everyone! All brand new—no sweepings! One full pound. Comparable value: $4.50!
64-2890, Wt. 1 lb. .... Net .99

For Store Addresses, Order Form, See Page 20

NOW anyone can buy his own STANDARD DIAL PHONE

Comes Ready to Install
Save Time! Save Money!

Only 7.95

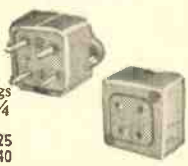
Complete with Dial, Bell, Coil and Connecting Cable!

Instant service! Most popular phone for intercom, extension, private system use! Get this modern, low-cost, easy-to-install telephone for the sheer convenience of it! Each is factory reconditioned for trouble-free service. Bakelite body, simple three-wire hook-up, handset, metal base. Plus — a generous supply of connecting cable! (Note: Use of telephone equipment not installed by a telephone company may be subject to local telephone tariff.)
279-371, Ship. wt. 10 lbs. .... Net 7.95

30 Ft. Telephone Extension Cord

Move your phone from room to room! Highest-quality 4-conductor flexible cord plus standard telephone jack and plug. Ideal for intercom. Use 2 or more for extra length.
279-1261, Sh. wt. 1¼ lbs. .... Net 2.98

Telephone Plugs & Jacks



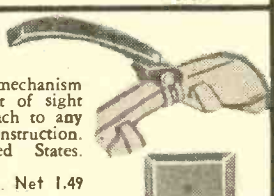
Ideal for making extensions, these plugs and jacks each weigh approximately ¼ pound.
279-366, plug .... Net 1.25
279-367, jack .... Net 1.40

Coiled Phone Cords

Stretches up to six feet. 3-conductor. Shipping weight: ¼ pound.
278-361 .... Net 1.19

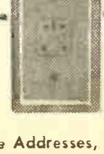
Four conductor extends up to fifteen feet. Shipping weight: ½ pound.
278-1389 .... Net 5.95

Shoulder Rest



Frees both hands! Spring mechanism enables arm to be folded out of sight when not in use. Easy to attach to any phone. Long lasting metal construction. Manufactured in the United States. Weight: 1 pound.
279-606 .... Net 1.49

Telephone Wall Jack



For 2, 3, 4-wire systems. Fits standard wall conduit boxes. 1 lb.
279-1507 .... Net 1.99

Carbon Type Handset

For Mobile and Replacement Use!

Great for use with mobiles & intercoms, or as outdoor mike for camps and construction sites. Withstands extreme temperatures. High output mike can be used with low gain circuits. Adapt to your CB transceiver or radio. Includes earpiece and 3-conductor cord.
279-1351, Sh. wt. 1 lb. .... Net 2.99

Sound-Powered Elements

Kit of two! Talk without electricity — your voice powers these devices. Hook them up and talk up to 300 feet. Shipping weight: ½ pound.
279-1353 .... Net .99

100 Ft. 3-Conductor Telephone Wire

Multi-use 100′ 3- conductor wire for telephone work. Ideal for linking temporary phones for field uses.
278-370, Sh. wt. 2 lbs. .... Net 3.49

Handset Hanger

Hang up your phone without cutting off party on other end. Ideal for wall telephones. Anodized black aluminum.
279-1528, Sh. wt. ¼ lb. .... Net 1.25

Telephone Dials

Standard Western Electric unit. Can be used with automatic control circuits, & electronic combination lock circuits.
279-359, Sh. wt. 1¼ lbs. .... Net 2.99

Store Addresses, Order Form, See Page 20

RADIO SHACK 44TH BIRTHDAY SPECIAL

SALE!

Every Walkie Talkie in Our 1967 Catalog is "Birthday Priced"!

REALISTIC® 8-TRANSISTOR TRC-2A

Have fun this summer with America's hottest walkie talkie buy — now reduced an incredible 35%! It's a rugged, no-nonsense, no-license beauty with separate speaker and mike; superhet 8-transistor circuitry; die-cast chrome finished case. Includes channel 11 crystals, carry strap, batteries, telescopic antenna.

Separate Speaker for Maximum Volume!

Separate Mike for Vastly Increased Speech clarity!

~~$19.95~~ Orig.

12.44

21-1001, Wt. 2¼ lb. .... Net 12.44
21-1200, Extra Crystals (state channel, whether transmit or receive) .... Each 2.49

2-WATT DUAL CHANNEL MODEL TRC-88

Orig. ~~$79.95~~ **74.44**

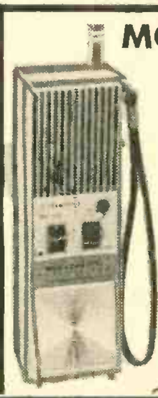
Order #21-188

1-WATT DUAL CHANNEL MODEL TRC-44

Orig. ~~$59.95~~ **54.44**

Order #21-1137

MODEL TRC-33



- Dual Channel 100 MW no license required; Superhet-tuned RF stage; Adjustable Squelch.
- Battery Level Indicator; 54" telescopic antenna; "Lock-On" Transmit Switch.
- Separate Mike and speaker; Earphone and penlite batteries.
- Carry Strap; Crystals for Channel 11. #21-906, Wt. 5 lbs.

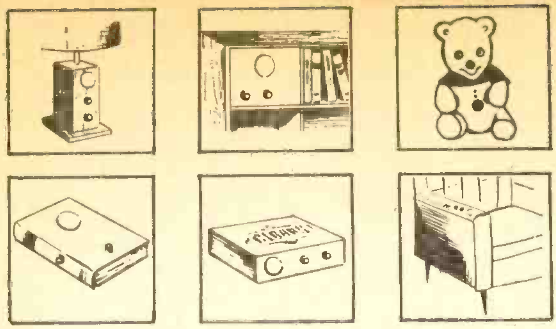
~~$39.95~~ **34.44**

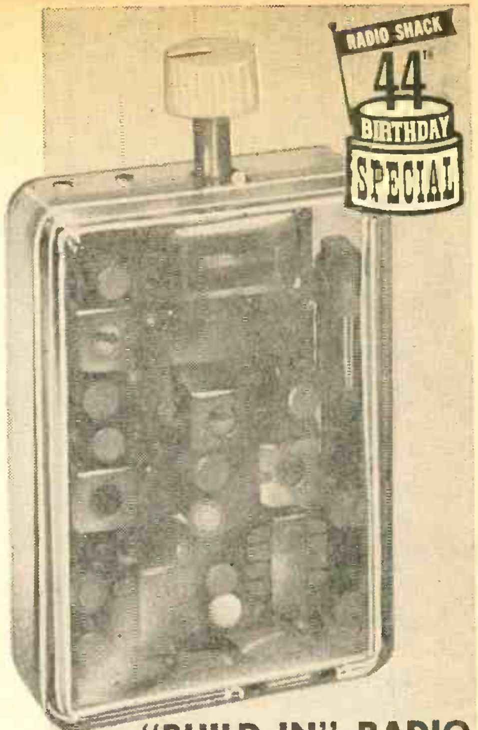
HIGH-BAND! LOW-BAND! AIRCRAFT BAND! REALISTIC PATROLMAN™ and JETSTREAM™ DUAL BAND RADIOS ARE *HOT! HOT! HOT!*

Tune in real life drama as it happens, with these amazing Realistic dual band radios, your "hot line" to news in the making. Each model features VHF plus the regular broadcast band for news and sports; Continuous no-drift tuning; batteries and AC adaptor jack. Net 1 lb. Shipping weight 3 lbs. Size: 6x3½". Built-in AM and VHF antennas. "Buy" of the year!

Patrolman. Low Band. VHF 30-50. MC. AM: 535-1605 KC	Patrolman. High Band. VHF 147-174 MC. AM 535-1605 KC	Jetstream. Air Band. VHF 108-135. MC. AM 535-1605. KC
24.95	**24.95**	**21.95**
Cat. #12-628	Cat.. #12-627	Cat. #12-626

For Store Addresses, Order Form, See Page 20





What's your project for our "Build In" radio?

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

You carpenters, metal-workers and gift designers will really appreciate Radio Shack's novel "Build In" — a 6-transistor superhet that's really *a kit that isn't a kit*. Confused? Part *one* is the radio, 100% wired, installed in a crystalline 2¼ x 1 x 3⅛" case with the tuning knob sticking out of one end, and 8 wires out of the other. Part *two* is a separate volume control with built-in switch, knob, and soldered leads. Part *three* is a 2¼" PM speaker installed in a plastic case, with soldered leads.

The three parts (plus a flat 9V battery, not included) can be installed in, on, or under anything, in just about any desired angle or position. And you don't have to be an engineer — Radio Shack's geniuses have provided a simple, idiot-proof lashup pictorial. Now all you need is the price *(just $6.98, Cat No. 12-1150)* and some Yankee ingenuity! Whether you hide "Build In" in a jug of corn likker, junior's wagon or Tillie's sewing box, the result is sure to please.

The basic radio itself looks like a little jewel, a real work of art — our photo doesn't do it justice. And the "kit that isn't a kit" is another of Radio Shacks's exciting exclusive products that can't be bought elsewhere. Get a "Build In" at your nearest Radio Shack store . . . and start your Christmas *project* early! For Store Addresses, Order Form, See Page 20

"BUILD-IN" RADIO

VOLUME CONTROL AND SWITCH

PM SPEAKER IN CASE

RADIO SHACK PROJECT BOOKS (4¢ A PROJECT)

"50 EASY TO BUILD SOLID STATE PROJECTS"

Build your own transistor radios, electronic organs, amplifiers, code oscillators, megaphones, generators, etc. Ideal for hobbyists.
62-1050 .... Net 2.00

"A MODERN TRANSISTOR WORKBOOK"

Build your own wireless microphone, AM broadcast tuner, audio preamp, PA system, experimenter's power supply, etc. 50 schematics.
62-2025 .... Net 2.00

EACH BOOK $2

POSITIVE FEEDBACK

JULIAN M. SIENKIEWICZ, EDITOR

Bye Bye Bait! Somewhere in the world's great fishing waters, a school of fish swims by. Suddenly a ring of bright light goes on around the gaping mouth of a huge underwater pipe. Simultaneously, a closed-circuit TV camera switches on to observe the scene, and a radio signal goes out to the fisherman, who may be hundreds of miles away. The fisherman pays little attention. The signal showing on his instrument panel is but one of hundreds, and everything will be taken care of automatically.

Intrigued by the lights, the fish swim closer to the pipe mouth, prodded in the right direction by mild jolts from electrodes in the water. As they near the opening, a powerful pump comes on and slurps them through into a floating trap of nets. When the entire school has been captured, the pump shuts itself off and the fish are electrically goaded into a larger holding pen where they await the fisherman's return. When he arrives, the pen is drawn up to his boat and the fish transferred to the hold, except for those too small to keep, which are sorted

out and returned to the ocean by an electronic scanning system.

Fanciful? Not any more. Many of these techniques and devices already exist, and the rest are high on the research priority list of the U. S. Bureau of Commercial Fisheries. The Russians tried the lights-and-pump idea while fishing for Krilka in the Black Sea more than 10 years ago, but the size of the catches was small compared to the cost of the project. Electric potential fields have been used successfully to empty nets in menhaden fisheries off the East Coast of the U.S., and shrimp have been shocked off of the floor of the Gulf of Mexico. (That may be why some shrimps have surprised expressions.)

Radar, loran, and other electronic systems have appeared on the majority of large fishing vessels in a revolution that has taken place since the end of World War II, when a virtually new technology and a raft of surplus hardware became available. With continued development, elaborate automatic fishing systems could operate similarly to offshore petroleum installations, with pump or conveyor systems which would periodically transfer the catch to an inshore processing plant. Why, the day may come when some farmer in Kansas, who never had salt water on his swim suit, will be the most successful fisherman in the Gulf of ʻAqaba.

(The following eight paragraphs of this editorial are reprinted from the Editor's column that appears each issue in RADIO-TV EXPERIMENTER *magazine. These paragraphs were written after the FCC made a complete about-face on denials to various rumors. It is not our practice to repeat editorials; however, we believe the issue in this instance is important enough to make an exception.)*

White Paper on a White Lie! You read it in this column and elsewhere—the FCC's *emphatic* denials that there is no truth whatever to reports that it planned to switch 27-MHz walkie-talkies to a new band located on 49 MHz. They said that there was "no such proposal," that the first publication to run the story was *misrepresenting* the facts, that someone had apparently seen a rough and early stage in-house FCC worksheet which was *meaningless* and had drawn many *wrong conclusions*, etc., etc.

Since the story had created such a furor in CB manufacturing circles and had upset users so much, just about every major publication had been only too happy to relay the FCC's message to the public—the message which squashed the entire story as a *cheap hoax*.

Funny thing about the story, though. Would you believe that only a month or so after the FCC's denials it quietly released its plan to move walkie-talkies from 27 MHz to 49 MHz? The proposal was almost word-for-word the same as the one that had been reported earlier and then denied so loudly. In short, the FCC had succeeded in hoodwinking the CBers of the nation, lying to the public, and then embarking on its irrational plan despite a barrage of complaints.

CBers, of course, are stuck with the FCC. And they are used to the shabby treatment doled out on the shores of the Potomac. Editors, however, are something else again. We don't particularly like to be told a pack of barefaced lies—especially by a tax-supported governmental agency. The FCC forced many publications to go out on a limb with their readers. And we, for one, have a feeling that when the FCC makes its humble appearance at the editorial offices for story coverage on one of their self-aggrandising projects, it may not get the hearty welcome to which it has become accustomed.

Reason has it that there are plenty of walkie-talkie people—not to mention Hams and CBers—who are nauseous and noxious over the shoddy treatment that Big Brother Frank-Charlie-Charlie has ungracefully bestowed on them in the past and will likely continue to confer in the future. To put an end to this philistine farce let's send the FCC a protest—a short message that'll wake them up to us little folk in the outside world. We propose that you join with us in sending an empty beer can to the FCC.

It's easy to do. Just address a label to the *Federal Communications Commission, Washington, D. C. 20554* and paste it on a beer can. Slap a 10¢ stamp on the can and drop it into the nearest mailbox on September 1, 1967. That's right, on the *first* of September. When our friends at the FCC return from their Labor Day fun and frolic they can play a game worthy of their talents—Stack the Cans. Thus occupied, maybe they'll leave the Rules unchanged for an hour or two.

A word of caution—we have no gripe with the Post Office, so clean out those cans (don't go out of your way to attract flies). Also, tape the edges at the open ends—Mr. Postman doesn't want any cut fingers.

Now, get on the pipe and tell all your friends. If we make the FCC look like a scrap dump, maybe they'll realize that us little folk is what America is made of.

Slowdowndare! A souped-up tape recorder that can play back voices at double speed without changing their pitch or making them unintelligible may be the key to tasks ranging from faster, better teaching, to enabling men to literally talk with animals.

The tape recorder is actually a device called

(Continued on page 26)

Now Available For Immediate Delivery...
Deluxe Heathkit Rectangular Color TV

Kit GR-295
$479^95 *
(295 sq. inch viewing area)

Kit GR-180
SAVE $30 NOW ONLY $349^95 **
(180 sq. inch viewing area)

Exclusive Features That Can't Be Bought In Ready-Made Sets At Any Price!
All color TV sets require periodic convergence and color purity adjustments. Both Heathkit Color TV's have exclusive built-in servicing aids, so *you* can perform these adjustments anytime . . . *without* calling in a TV serviceman . . . *without* any special skills or knowledge. Just flip a switch on the built-in dot generator and a dot pattern appears on the screen. Simple-to-follow instructions and detailed color photos in the manual show you exactly what to look for, what to do and how to do it. Results? Beautifully clean and sharp color pictures day in and day out . . . and up to $200 savings in servicing calls throughout the life of your set.

Exclusive Heath Magna-Shield . . . surrounds the entire tube to keep out stray magnetic fields and improve color purity. In addition, **Automatic Degaussing** demagnetizes and "cleans" the picture everytime you turn the set on from a "cold" start.

Choice Of Installation . . . Another Exclusive! Both color TV's are designed for mounting in a wall or your own custom cabinet. Or you can install either set in a choice of factory assembled and finished Heath contemporary walnut or Early American cabinets.

From Parts To Programs In Just 25 Hours. All critical circuits are preassembled, aligned and tested at the factory. The assembly manual guides you the rest of the way with simple, non-technical instructions.

Plus A Host Of Advanced Features . . . a hi-fi rectangular picture tube with "rare earth" phosphors for brighter, livelier colors and sharper definition . . . **Automatic Color Control** and **Gated Automatic Gain Control** to reduce color fading and insure jitter-free pictures at all times . . . deluxe **VHF Turret Tuner** with "memory" fine tuning . . . **2-Speed Transistor UHF Tuner . . . Two Hi-Fi Sound Outputs** for play through your hi-fi system or connection to the special limited-field speaker . . . **Two VHF Antenna Inputs** — 300 ohm balanced and 75 ohm coax . . . **1-Year Warranty** on the picture tube, 90 days on all other parts . . . plus many more deluxe features. For full details, mail coupon for FREE Heathkit catalog.

***Kit GR-295,** everything except cabinet, 131 lbs. **$479.95**
GRA-295-1, walnut cabinet (shown above) 56 lbs...19" D. x 31" H. x 34½" W. **$62.95**
Deluxe contemporary walnut & Early American cabinets also available at $94.50 & $99.95
****Kit GR-180,** everything except cabinet, 102 lbs. Was $379.95. . . . . **NOW ONLY $349.95**
GRA-180-1, walnut cabinet (shown above) 41 lbs...18¼" D. x 28¼" W. x 29" H. **$49.95**
Early American cabinet available at $75.00

Deluxe 12" Solid-State B & W Portable TV

Kit GR-104
$119^95

Unusually sensitive performance. Plays anywhere . . . runs on household 117 v. AC, any 12 v. battery, or optional rechargeable battery pack ($39.95); receives all channels; new integrated sound circuit replaces 39 components; preassembled, prealigned tuners; high gain IF strip; Gated AGC for steady, jitter-free pictures; front-panel mounted speaker; assembles in only 10 hours. Rugged high impact plastic cabinet measures a compact 11½" H x 15¾" W x 9⅜" D. 27 lbs.

a speech compressor, and your Editor heard it transform one of Julie Andrews' renditions from "My Fair Lady" into "Wouldntitbelovely" with perfect clarity. The voice of one speaker at the conference was speeded up and slowed down until the listeners broke out laughing. Yet the voice was always the same, never like that of Donald Duck or the Jolly Green Giant.

Speech compression is already being studied as a new educational tool capable of giving a student much more information in a given period of time. And according to Dr. Robert D. Gates, chief educational investigator of the Philco-Ford Corp., the info is planted much more deeply in his mind. As a result Dr. Gates envisions more and more schools switching to four-day weeks, or even shorter ones, from use of speech compression. In addition, news, statistical data, instructions, and other messages can be monitored at high speed with considerable time savings, which could mean money to hard-pressed businessmen. (No promises for a four-day work week.)

One curious phenomenon that results from speech compression is that after a while listeners find themselves speaking more rapidly and sometimes even feeling a bit rushed in other ways besides speech. The reverse is true for speech expansion, in which voices are greatly slowed down. This slowing-down feeling is actually accompanied by a slowing-down of metabolism, which could be used to produce a helpfully relaxed condition in people suffering from heart ailments.

The Navy has a problem which could easily be solved by the compressor, since the device enables the speed and pitch of a voice to be varied independently of each other. Deep-sea aquanauts who breathe high-pressure atmospheres of oxygen and helium suffer a pronounced "Donald Duck effect," which can sometimes make speech comparatively useless. An instant playback compressor would lower the pitch of their voices while maintaining normal speed. The Navy is investigating this problem with several speech compressors of its own design.

Normal speed for humans is actually less efficient than that of many animals. Research with birds and recordings of dolphins substantially slowed down give evidence that man, comparatively speaking, is operating in low gear.

Speech compression is not confined to the laboratory, however. The Presbyterian Church, for example, listens to field reports from its missionaries with the aid of a compressor. (You'd be amazed at what happens to the speech of a missionary who has lived in the jungles for 15 years with no hurries!)

The key to the compressor's operation is the fact that while the speed of a voice being played back on a tape recorder depends solely on the speed of the tape, the pitch of the voice depends on the speed at which the tape passes across the playback head of the machine. By spinning the playback head in the direction of tape travel, the relative speed of the tape across the head is reduced, thereby lowering the pitch. If the head is rotated in the opposite direction from tape travel, the pitch of the voice during playback increases.

Copper from Keystone. A couple of issues back we published a short piece in our NewScan column called "Battery Contact Corrosion." In this piece we stated: "Do not use manganese-alkaline batteries in any equipment that has unplated brass or copper contacts. Use conventional zinc-carbon batteries. If your equipment has contacts of stainless steel or nickel plating . . . any kind of batteries may be used."

However, even nickel plated brass or copper is vulnerable to contamination from manganese-alkaline batteries. Steve Wolfman of Keystone Electronics Corp. informs us that Keystone manufactures a full line of steel battery holders which have stainless steel contacts. These holders are ideally suited for replacement of original holders when manganese-alkaline batteries are to be used. Of course, due to some design restrictions, where a holder is molded into the product, replacement is difficult. Consult Radio-Electronic Master or the local electronics distributor regarding Keystone battery holders.

Our thanks to Steve Wolfman and Keystone for the information. Next time we talk about battery holders we'll keep Steve's comments in mind. ■

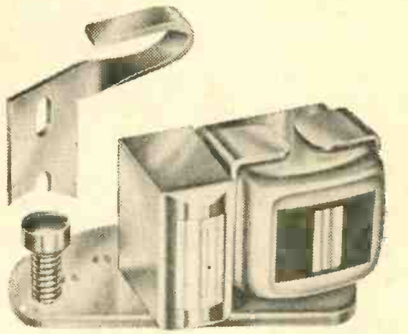
☆ ☆ ☆

FET VOM

Amphenol is producing a field-effect transistor voltohmeter that incorporates measuring capabilities never before available in a low-cost instrument. Known as the Model 870 Millivolt Commander, it measures voltages as low as 0.1 VDC full scale and 0.001 VAC full scale. Up to now, the serviceman had to have a VTVM (as a rule with maximum sensitivity of 1.2V) to work on transistorized equipment. With the Millivolt Commander he not only gets a full-scale indication of such low voltage but also a sensitivity range from 100 mV full scale to 1000 V full scale in nine increments. Audio buffs will welcome the unit's capability to measure both AC and DC voltages with only one low-cost instrument. Input resistance of the

Amphenol 870 Millivolt Commander VOM

unit when used as a voltmeter is 11 megohms on all DC ranges; when used as an AC voltmeter, its input impedance from 10 mV to 1V is 10 megohms shunted by a 31-pF capacitor, and from 3V to 300V impedance is 10 megohms shunted by a 20-pF capacitor. When used as an ohmmeter, its resistance ranges from 10 ohms center scale to 10 megohms center scale and accuracy ±3% of arc. The Millivolt Commander measures 9¼ x 6⅜ x 5¾ in., is priced at $99.95, and you can get the full story on this handy unit by writing Amphenol Distributor Div., 2875 S. 25th Ave., Broadview, Ill. 60153.



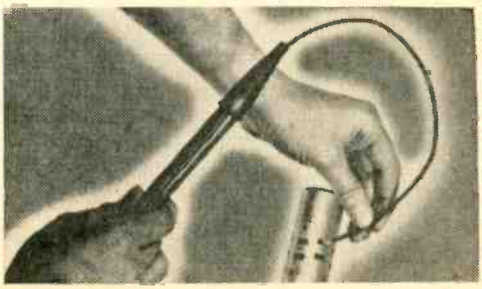
Nortronics Full-Track Replacement Heads

Don't Be Half-Tracked!

With Nortronics' new WR-30, you can convert the monophonic Wollensak and Revere transistorized tape recorders from half-track to full-track recording; thus giving you better frequency response, improved sound definition and greater recording range. The WR-30 consists of a full-track erase head and a full-track record-play head mounted on a brass plate to permit full-track recording compatible with studio-type tape transports. The all-metal erase head has a double gap for complete erasure and the record-play head has laminated cores and a very fine gap. Incidentally, Nortronics has replacement heads for almost every tape recorder ever made. If in doubt or in need of more information—drop a line to the Nortronics Co., Inc., 8101 10th Ave. N., Minneapolis, Minn. 55427. They'll put you on the right track in a jiffy.

Light That Does the Twist

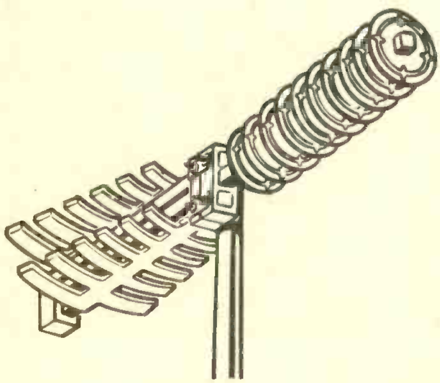
A light that bends around corners, pokes



Edmund Scientific Fiber-Optic Flexilight

☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆

through small holes into remote and inaccesible places and spotlights hidden areas (like the back of a TV), has been dubbed Flexilight by the Edmund Scientific Co. The way it works is: 64 plastic fibers are bundled together in a .130-in. outside diameter light pipe covered with vinyl. Maximum bending radius is ¾-in. The Flexilight is unaffected by temperature up to 175°F, withstands repeated vibration without loss of light transmission. Edmund supplies light guide, penlight, rubber centering guide and adapter, plus assembly instructions, and you can use the penlight separately if you wish. Edmund Scientific (107 E. Gloucester Pike, Barrington, N.J. 08007) delivers Stock No. 60,648 to your door, shipping charges prepaid, for a mere $2.75. (And for something that great, that's not bad.)



JFD Electronics LPV-UCL22 Color TV/UHF Antenna

LPV Means More UHF

The new LPV-UCL series of UHF antennas in the JFD Color Laser group employ two new advanced features. First is the disc-on-rod director system that increases the capture area and brings in higher gain than conventional thin-linear director elements. It also broadens the bandwidth and pulls in sharper color reception on all UHF channels. This disc-on-rod system is omni-polarized to intercept UHF signals that often depart from horizontal polarization. The other new feature is a wideband "zoned" trapezoid driver which is said to deliver unprecedented gain and flat frequency responses through wide log periodic dipoles, reinforcing the performance of the disc-on-rod directors on the low end of the UHF spectrum. There are four models: LPV-UCL13 (to 40 mi., $12.95); LPV-UCL18 (to 70 mi., $17.95); LPV-UCL22 (to 90 mi., $23.50); LPV-UCL26 (to 100 mi., $27.50). Model numbers indicate the number of elements. At distributors, or write to JFD Electronics Co., 15th Ave. at 62nd St., Brooklyn, N.Y. 11219. ■

NEWSCAN

No Extension Cord

If it'll fit on a G.I.'s back the Army will buy it. So, when a new portable generator weighing only 35 lbs. (with fuel) was developed by 3M Company, the dog face became a walking powerhouse. The compact thermoelectric generator is designed to deliver 300 watts of electrical power, has an eight-hour fuel supply, and can operate on kerosene, jet fuel or diesel fuel. The generator is expected to replace battery power for certain military applications and soon may take the place of engine generators in forward battle areas.

Currently being evaluated for Marine Corps field use in powering communications equipment and other field gear, the new generator also features: capability of operating in hot and humid conditions, exceptionally quiet performance, cost savings due to minimum of maintenance, and continuous power refueling can be done while the generator is still providing power.

Thermoelectric generator can be easily carried about boy scout style. It weighs only 35 pounds with fuel and is designed to be transported on the soldier's packboard.

The "man-pack" generator, a rugged solid state power unit, measures 11x17x18". It can be transported on a Marine Corps packboard, strapped to the back of the soldier, and can be rapidly and easily controlled and put into operation. Moreover, since the generator is silent, unlike engine powered generators, it also can be used to quietly charge batteries in the field without fear of alerting the enemy. Earlier models required bottled propane gas, but this new model was produced by 3M to specifically run on fuel readily available in the field.

Thermoelectric generators convert heat energy into electric energy. The thermoelectric principle involves a series of pellets of semiconductor material connected electrically by copper straps. Electricity is produced when a temperature gradient is maintained across the length of the pellets heating one end and cooling the other.

Soft Landing Wins Hard Cash

A passionate interest in space exploration, capped by the soft-landing of a home-built model spacecraft, launched a lanky 17-year-old boy into college and a probable science career today. Ronnié J. Lagoe, a high school senior of Oswego, N. Y., made a "Surveyor-R" working scale model, which he patterned after the Surveyor now on the moon. The rewards he reaped from Hughes Aircraft Company were a college scholarship, a trip to California and a summer job at Cape Kennedy. Plans for the model were drafted the day after Surveyor 1 landed on the lunar surface. Ronnie began construction of his 1/7-scale model three days later, and successfully equipped the craft with tiny retro and vernier rockets which enabled him to make five drops last October 18 from heights up to 85 feet to soft landings on the earth near his own back yard.

He has termed his experiments, and entitled a scientific paper he wrote to describe them, "Tribute to a Miracle." This, Ronnie said, is his way of paying his respects to the real Surveyor spacecrafts. Ron sent the paper to Hughes Aircraft Company, Culver City, Calif., which built the moon-landing Surveyor for NASA's Jet Propulsion Laboratory. This resulted in an exchange of correspondence and an eventual meeting with Hughes scientists.

Many boys can build a model, but Ron flew

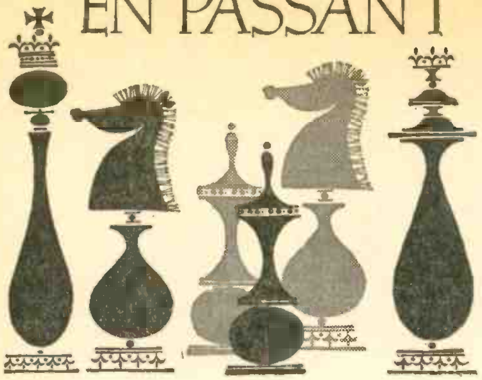
Ron Lagoe, a 17-year-old graduating senior of Oswego, N. Y., high school, displays a 1/7-scale model of the Surveyor spacecraft that he built and "soft-landed" on Earth from 85 feet up his neighboring water tower for Sheldon Shallon, chief Surveyor scientist for Hughes Aircraft Company, Los Angeles.

his spacecraft to five successful soft landings on earth, which has six times as much gravity as the moon. Ron achieved an intricate launch-in-reverse, and duplicated in many important respects the Surveyor 1 and Surveyor 3 landings on the moon. He built his model using high hopes, ½-inch maple dowling, epoxy, Elmer's glue, a bathtub calk, foam rubber for the foot-pads, and ping-pong balls and cork fishing bobbers covered with aluminum foil as dummy fuel tanks. After he built the Surveyor-R, which measures 2 by 2 feet and weighs almost 2 pounds, he had to figure out how he could test-drop it without endangering the craft in a crack-up. He decided to build a proof-test model, just as Hughes did with the actual Surveyor. He weighted his model, mounted it with tiny rockets and made about 60 tests from heights ranging up to 500 feet. He sent his proof-test model aloft with a cluster of helium balloons, then cut loose the model for a drop to earth.

When he was ready to launch Surveyor-R, he equipped it with a small radio transmitter, armed the rockets, and began the mission with a free drop from 85 feet followed by retro-fire at about 53 feet above the ground. After retro-fire, a marked decrease in spacecraft velocity was noted until retro burnout occurred at 20 feet and the verniers burned alone. Complete counteraction of gravity was achieved at two feet, after which vernier shut-off occurred and the craft dropped to the surface.

With the radio equipment, Ron maintained continuous communication with the craft during descent and after the touchdown for a period of 66 hours, 24 minutes and two seconds, he reported. Temperature data was transmitted by the craft through the use of a bimetallic strip hooked up to the craft's transmitter. ■

EN PASSANT



BY JOHN W. COLLINS

Short games are universally popular. Perhaps it is because there is a strain of sadism in chessplayers. Or perhaps it is because the punishment should fit the crime. Whatever the reason they are enjoyable, and that much more so when the victim is a famous master. In the following miniature masterpieces we find two World Champions losing in ten and twelve moves!

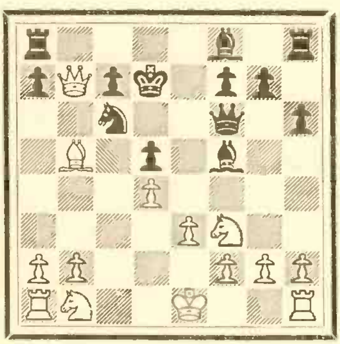
1. Dr. Max Euwe, Holland, champion 1935-1937, loses a Pawn and a Knight in this quickie. It is a Queen Pawn Opening, played at Amsterdam, 1920, and the winner was G.C.A. Oskam.

1	P-Q4	P-Q4	5	P-K3	P-KR3?
2	B-N5	B-B4	6	BxN	QxB
3	N-KB3	N-KB3	7	Q-N3!	N-B3?
4	P-B4	P-K3	8	QxP	K-Q2

Indirectly protecting the QR, for if 9 QxR?? B-N5# wins the White Queen.

9	PxP	PxP
10	B-N5!	Resigns

Black



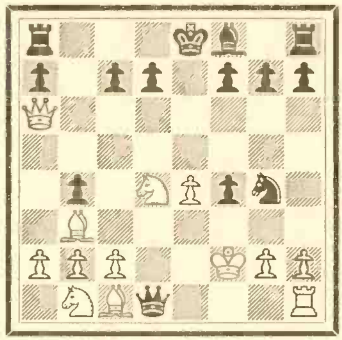
White

There is no defense to the threats of 11 N-K5#, hitting the pinned Knight a third time, or of 11 BxN# QxB 12 N-K5#, winning the Queen.

2. The name of Paul Morphy, United States, champion 1858-1859, is synonymous with brilliant, combinative, attacking chess. Even a hundred and twelve years later it is news when he is mated in twelve moves. The opening is a King's Gambit Accepted, played at Springhill, 1855, Morphy was White and gave the odds of Queen Rook, and the lucky man was Charles A. Maurian.

1	P-K4	P-K4	7	P-Q4	N-B3
2	P-KB4	PxP	8	B-N3	B-R3!
3	B-B4	Q-R5#	9	Q-K2?	NxQP!
4	K-B1	P-QN4	10	NxN	P-N5!
5	B-Q5	N-QB3	11	QxB	Q-Q8#
6	N-KB3	Q-R4	12	K-B2	N-N5 mate

Black

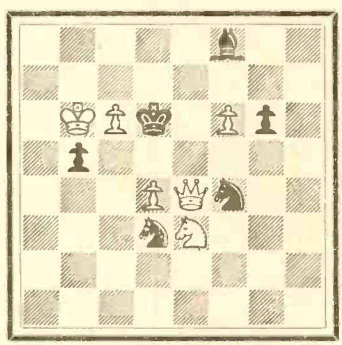


White

Problem 8

By Joseph Opdenoordt
Venlo, Holland

Black



White

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

Solution to Problem 7: 1 Q-N2.

Personal Service. The Editor of this department, a former New York State and U. S. Correspondence Champion, and Co-reviser of "Modern Chess Openings," 9th edition, will play you a correspondence game and give critical comments on every move for a $15.00 fee. Write to John W. Collins, Stuyvesant Town, 521 East 14th Street, Apt. 3A, New York, N. Y. 10009.

ELEMENTARY ELECTRONICS ETYMOLOGY

By Webb Garrison

Filament

▲ From the Latin verb *filare* (to spin), anything formed by spinning came to be called a filament. This name was applied to silk and woolen threads as well as the gossamer strands with which spiders weave their webs.

So it was natural that filaments should loom large in minds of electrical pioneers. Development of a practical incandescent lamp, they realized, was absolutely dependent upon finding a suitable filament.

Edison's lamp that first glowed on October 21, 1879, had a filament made from carbonized sewing thread. It burned for two days. But the inventor knew something more substantial would have to be devised. Using carbonized strips of paper cut from visiting cards he made filaments that lasted several hundred hours. Then for a time carbonized bamboo was regarded as "the" filament material.

About 1899, osmium was used for the first commercial metal filaments—made in Berlin and Vienna. Tantalum filaments (developed by a Russian) appeared on the U. S. market about 1906. A year later pressed tungsten came into use; it was not until a method for drawing tungsten was developed in 1913 that "spun wire" of great tensile strength yielded filaments for long-burning electric lamps.

Ham

▲ Long before members of their race became professional entertainers, many American Negroes displayed their special gift for music. Favorite instruments included the bones (a kind of clapper), tambo (tambourine) and banjo. White men borrowed the instruments of the Negro, learned his songs, blacked their faces—and the minstrel show was born.

Many performers won fame and fortune. McIntyre and Heath, perhaps the greatest blackface team of all time, were in their heyday during the 1880's. Their act called "The Ham Tree" proved one of Broadway's most celebrated attractions for month after month after month.

Through the influence of "The Ham Tree" plus impact of "Ham" as a jocular label for any minstrel, the name came to stand for any entertainer not up to opera house standards—that is, an amateur.

In that sense it attached to early enthusiasts who operated radio sets as a hobby. Instead of eliminating the role of the amateur, commercial radio has magnified it by supplying a host of instruments and techniques. As a result, the ham operator is found far more often today than in the era when minstrels fixed his name in speech.

Transistor

▲ Before electronics was a science, experimenters recognized that certain substances have odd qualities. Crystalline in structure, they are neither electrical conductors in the ordinary sense nor true insulators. Because of their paradoxical behavior, these substances came to be called semiconductors.

They entered practical use quite early. Heinrich Hertz used them in his pioneer work on detection of wireless radio waves, about 1889. This was almost a decade before discovery of the electron.

Development of the vacuum tube pushed semiconductors into the background, though. They played minor roles in radio-frequency detection, power and telephone rectification. Then Russell S. Ohl made a discovery. During World War II he found that semiconductors with "crystal mixers" are much more sensitive to radio microwaves than are vacuum tubes.

Ohl's triumph was a hollow one—for after fifty years' use, no one knew how to make semiconductors amplify. Quantum physics helped spur a breakthrough. Using point-contact principles, experimenters in Bell Telephone laboratories developed an amplifier based on strange behavior of semiconductors. John Bardeen, Walter Brattain, and William Shockley soon found a practical application for "*trans*fer by means of a res*istor*." Combining the two words, they called their novel device the *transistor*.

Their work brought them the Nobel Prize in physics in 1956. According to their analysis, a semiconductor such as germanium has two interacting energy levels. One is formed by valence electrons that bind the crystal together; the other is a product of conduction electrons. Electrons moving in one direction through the crystal are considered to form "holes" that flow in the opposite direction.

Applications for this "resistor that transfers" developed rapidly. Within a decade of its discovery, the transistor had become dominant in electronics—outpacing the vacuum tube as the most versatile and widely used electronic amplifier. ■

GET A FASTER START IN THE COURSE YOU CHOOSE WITH NRI'S REMARKABLE ACHIEVEMENT KIT

When you enroll with NRI we deliver to your door everything you need to make a significant start in the Electronics field of your choice. This remarkable, new starter kit is worth many times the small down payment required to start your training. And it is only the start . . . only the first example of NRI's unique ability to apply 50 years of home-study experience to the challenges of this Electronics Age. Start your training this exciting, rewarding way. No other school has anything like it. What do you get? The NRI Achievement Kit includes: your first set of easy-to-understand "bite-size" texts; a rich, vinyl desk folder to hold your training material in orderly fashion; the valuable NRI Radio-TV Electronics Dictionary; important reference texts; classroom tools like pencils, a ball-point pen, an engineer's ruler; special printed sheets for your lesson answers—even a supply of pre-addressed envelopes and your first postage stamp.

Learning electronics at home is faster, easier, more interesting with new achievement kit

Only NRI offers you this pioneering method of "3 Dimensional" home-study training in Electronics, TV-Radio . . . a remarkable teaching idea unlike anything you have ever encountered. Founded more than half a century ago—in the days of wireless—NRI pioneered the "learn-by-doing" method of home-study. Today, NRI is the oldest, largest home-study Electronics school. The NRI staff of more than 150 dedicated people has made course material entertaining and easy to grasp. NRI has simplified, organized and dramatized subject matter so that any ambitious man—regardless of his education—can effectively learn the Electronics course of his choice.

DISCOVER THE EXCITEMENT OF NRI TRAINING

Whatever your reason for wanting knowledge of Electronics, you'll find the NRI "3 Dimensional" method makes learning exciting, fast. You build, test, experiment, explore. Investigate NRI training plans, find out about the NRI Achievement Kit. Fill in and mail the postage-free card. No salesman will call. NATIONAL RADIO INSTITUTE, Electronics Division, Washington, D. C. 20016

ELECTRONICS COMES ALIVE AS YOU LEARN BY DOING WITH CUSTOM TRAINING EQUIPMENT

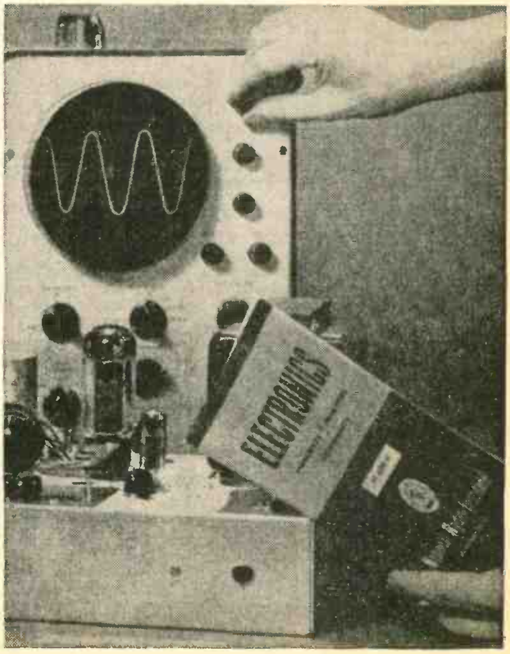
Nothing is as effective as learning by doing. That's why NRI puts so much emphasis on equipment, and why NRI invites comparison with equipment offered by any other school, at any price. NRI pioneered and perfected the use of special training kits to aid learning at home. You get your hands on actual parts like resistors, capacitors, tubes, condensers, wire, transistors and diodes. You build, experiment, explore, discover. You start right out building your own professional vacuum tube voltmeter with which you learn to measure voltage and current. You learn how to mount and solder parts, how to read schematic diagrams. Then, you progress to other experimental equipment until you ultimately build a TV set, an actual transmitter or a functioning computer unit (depending on the course you select). It's the practical, easy way to learn at home—the priceless "third dimension" in NRI's exclusive Electronic TV-Radio training method.

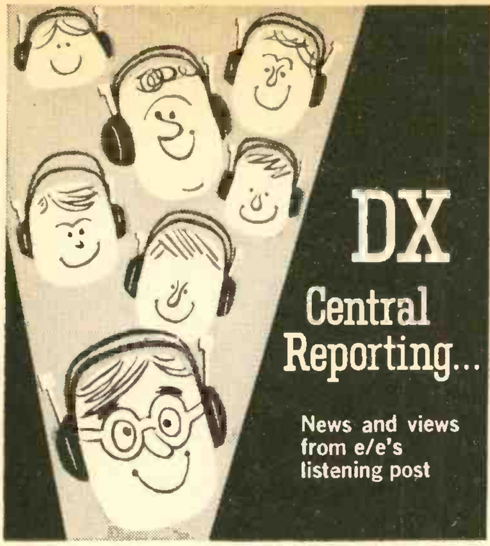
SIMPLIFIED, WELL-ILLUSTRATED "BITE-SIZE" LESSON TEXTS PROGRAM YOUR TRAINING

Lesson texts are a necessary part of training, but only a part. NRI's "bite-size" texts are as simplified, direct and well-illustrated as half a century of teaching experience can make them. The amount of material in each text, the length and design, is precisely right for home-study. NRI texts are programmed with NRI training kits to make things you read come alive. As you learn, you'll experience all the excitement of original discovery. Texts and equipment vary with the course. Choose from major training programs in TV-Radio Servicing, Industrial Electronics and Complete Communications. Or select one of seven special courses to meet specific needs. Check the courses of most interest to you on the postage-free card and mail it today for your free catalog.

Available Under
NEW GI BILL
If you served since January 31, 1955, or are in service, check GI line in postage-free card.

custom training kits "bite-size" texts





A recent addition to the world's DXcasts is now aired by Radio Nederland the third Thursday of each month. It is taped in the U.S. by Glenn Hauser, a professional announcer, top-flight all-band DXer, and Utility Editor for the Canadian DX Club. Glenn, a resident of Albuquerque, N. M., produces this program with the cooperation of the Association of North American Radio Clubs (a federation of all the major radio clubs in the U.S., Canada, and the West Indies). With all this going for it, the program, titled "North American DX Report," promises to be a first-class source of up-to-date short wave news.

SWLs can hear it twice on that third Thursday—at 1615 EST on 11730 and 15425 kHz from transmitters at Hilversum, Netherlands; then at 2045 EST on 9590 from a transmitter at Bonaire, Neth. Antilles (just off the Venezuela coast). This latter facility, incidentally, is leased from Trans World Radio.

North American DX Report will not only cover news of SWBC stations but also aeronautical, marine, and utility DX. And most important of all, the items aired will probably be more accurate than those of many other SW DX programs, some of which are so bad that if you claimed reception from a five-dimensional flying saucer they'd probably believe it.

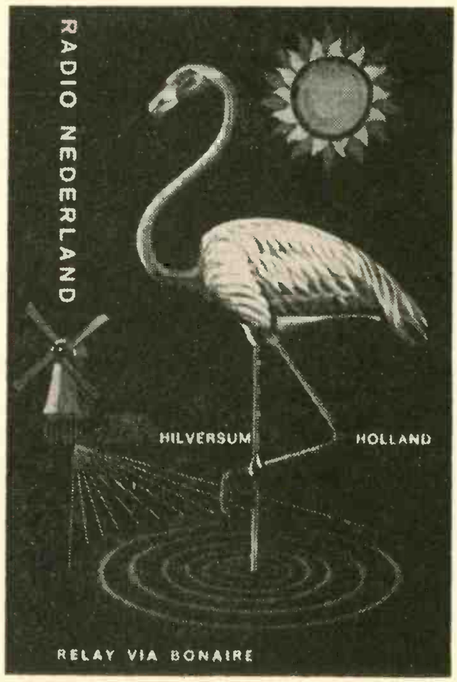
The Numbers Game. A group of clandestine stations that are receiving a great deal of attention by SWL clubs these days are those transmitting what appears to be coded messages (number groups) on a variety of frequencies between 2 and 9 MHz. It is generally believed these are secret messages intended for 007 types. Those transmissions above 4 MHz undoubtedly are legitimate spy stations. But those below 4 MHz are even more interesting, and easier to hear because the frequencies are more or less constant.

The below-4 MHz numbers are usually in Spanish (often read with an American accent), though English is occasionally substituted. One of these stations is on 3200 kHz every Wednesday night starting around 2100 EST with consistently good signals throughout Eastern North America. But contrary to what you might think, this station is not in Southern Florida. Later Wednesday evenings another station shows up on 3385, often transmitting the very same message which has apparently been pre-recorded.

A similar station was also heard for a time on approximately 3100 kHz with very powerful signals in New Hampshire. And on another occasion Spanish numbers were noted on 2300 kHz at 0645 EST by R. Nederland's Glenn Hauser, then listening from Oklahoma. He took DF bearings and found it to be in an East/West direction.

The stations below 4 MHz are obviously in the U.S. and operating with Washington's approval. If they were spy stations, transmissions would, because of the low frequencies involved, have to be intended for CIA operatives in Latin America. But if they were aimed at points south of the border, transmitters would be located either in Southern Florida or the lower part of Texas. However, all of the evidence clearly indicates that most, if not all, of the stations are considerably further north.

Two possible solutions suggest themselves.



QSL card issued by R. Nederland (Box 222, Hilversum, Holland) sports flamingo, windmill, and sun.

Number stations below 4 MHz are decoys. However, this seems unlikely because with those frequencies and locations, Castro's inept monitors probably wouldn't even notice them. Or they could be an experiment in psychological warfare with American SWLs as guinea pigs (just think what a panic these stations would create if they suddenly appeared on the standard BCB). Sound pretty wild? Well, maybe. But if it is an experiment, anyone can take part. Just tune in and use your imagination.

On The Broadcast Band. There are three clear-channel stations which West Coast BCBers had better hurry up and log. They are WMAQ, 670 kHz, Chicago (soon to be blocked by KBOI in Boise, Idaho); WCBS, 880 kHz, New York (KMMJ in Grand Island, Nebraska is switching to this spot); and WBZ, 1030 kHz, Boston (where KTWO in Casper, Wyo., will shortly hold sway). That latter move will make the whole state of Massachusetts difficult to log out West.

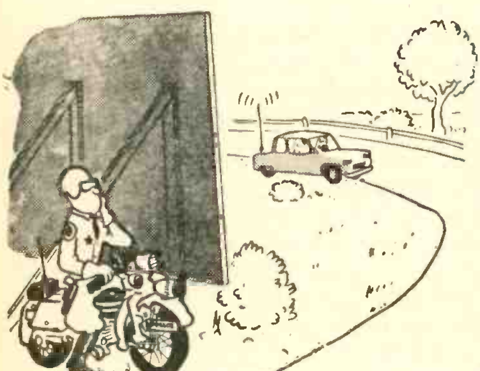
For Easterners, of course, the new powers and frequencies assigned to KBOI and KTWO are good news. The now rarely heard states of Idaho and Wyoming will suddenly become inviting targets Monday between midnight and 0200 EST. Of course, you might say this situation is typical of domestic DXing—one section's QRM always seems to be another's prize catch.

Listening on 670 for either KBOI or WMAQ just might see you run afoul of Castro's powerful new (Czech-built) 150 kW transmitter at Holguin, Eastern Cuba. This one, which relays programs of R. Progreso, will often be heard at night in most parts of the U.S. And that, come to think of it, would make 670 kHz the perfect spot for "psychological warfare" experiments. ■

THE TRAFFIC REPORT

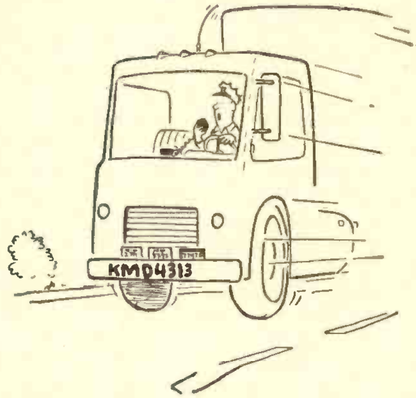
by Jack Schmidt

"Right now I am at the corner of 'One-Way' and 'Stop'!"

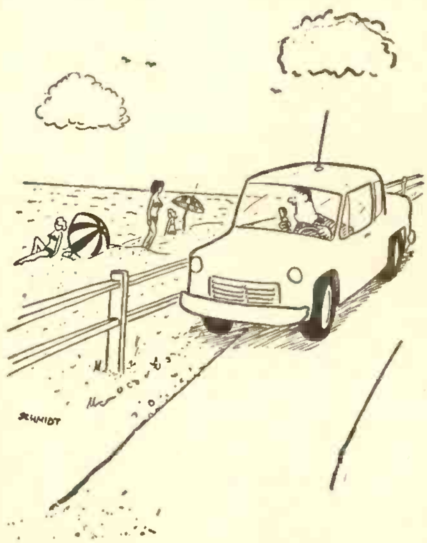


"WA2CQL to all Hams—Slow down to legal limit at North End curve! WA2CQL to all Hams . . ."

"Mayday, Mayday, Mayday!"



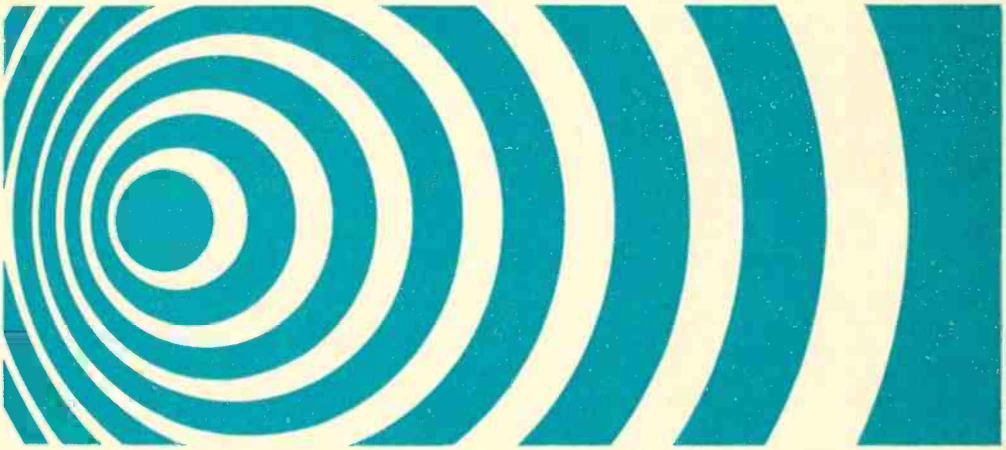
"KMD4313 to little lady in the blue Ford, I'd like to pass . . . please!"



"Surfside Beach at Seventh Street—two blonds, one redhead . . ."

elementary Electronics SEPT/OCT 1967

By K. C. Kirkbride



what's so special about ESP?

Put a frog in a box. Cut an opening in one side so light can pour in. Little friend frog will merrily hop toward the newly opened "window." Close up that side and open a "window" on the opposite side. Pet frog will then jauntily leap toward the new source of light. He sees the light, you say?

Hamper his sight any way that you choose. Blindfold him (some experimenters have used more emphatic methods), and try again. Friend frog will still hop toward the lighted "window," turn around when that "window" closes, and hop to the other side where there is light.

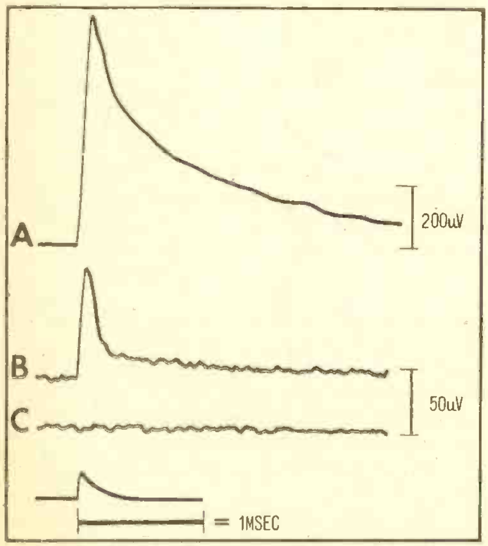
Or watch a prowling tabby stick his handlebar-mustached head into black hole. If his wide whiskers brush a mouse in the dark he will pounce and the mouse will scream to warn his fellows. The thing is, he'll do so with sound no ear can hear—at some 100,000 Hz.

Or observe a honeybee dancing its "directions" to its fellow bees, "telling" them where to find a new source of food. Or listen to the noisy world under the sea. Hydrophones have "listened" as fish cackled, gossiped, groaned, moaned, and whined. Some of their sounds have been compared to those of steaks sizzling, coal rattling down a chute, or the dragging of heavy chains. Yet fish have no ears in the normal concept of the term, so how do they talk and listen through the waters of the sea?

"Five" Senses. Some advanced scientists say man will one day learn to "hear" through his skin, pick up vibration messages through the soles of his feet. For these are but a few of the clues to the extraordinary jigsaw world of the senses, a world never put together until recently. The best man could do before was name the senses. Aristotle named five. Modern anthropologists count perhaps thirteen, some even sixteen. But to explain their functioning was something else again.

Granted, the nervous system is electrical. The waves of the brain can be measured on an electroencephalograph. But the senses themselves defied understanding—until recently, that is. Now, scientists have opened the door wide to a full appreciation of this fabulous world. And they prove what we should have suspected before, that senses deliver messages to an electrical nervous system to transfer to an electrical brain because the senses, too, are electrical.

The Suntan Stuff. Biology Professor Richard Cone, working with a Yale graduate student, H. Becker, in Cone's laboratory at Harvard, was studying the retina of the human eye. When a strong light was flashed, electrical signals seemed to generate from a pigment just behind the retina. Called melanin, this pigment is known for its response to ultraviolet rays.



Curves reveal effects of light flash on skin from black-pigmented guinea pig (A), albino guinea pig (B), and control with white cotton in place of skin (C).

Melanin is the stuff in your skin that reacts to sunlight and gives you a suntan (without Man-tan), or, concentrated in larger quantities, gives some folks' skin a dark hue. Cone reasoned that if melanin in the eye responded electrically to light, it was entirely possible that it did the same thing in skin.

Choosing a variety of "guinea pigs," he sought to test the possibility. With frogs, guinea pigs, rats, and black mollie fish to work with—including some albino specimens, he first anesthetized the creatures, then took a patch of skin from the back of each.

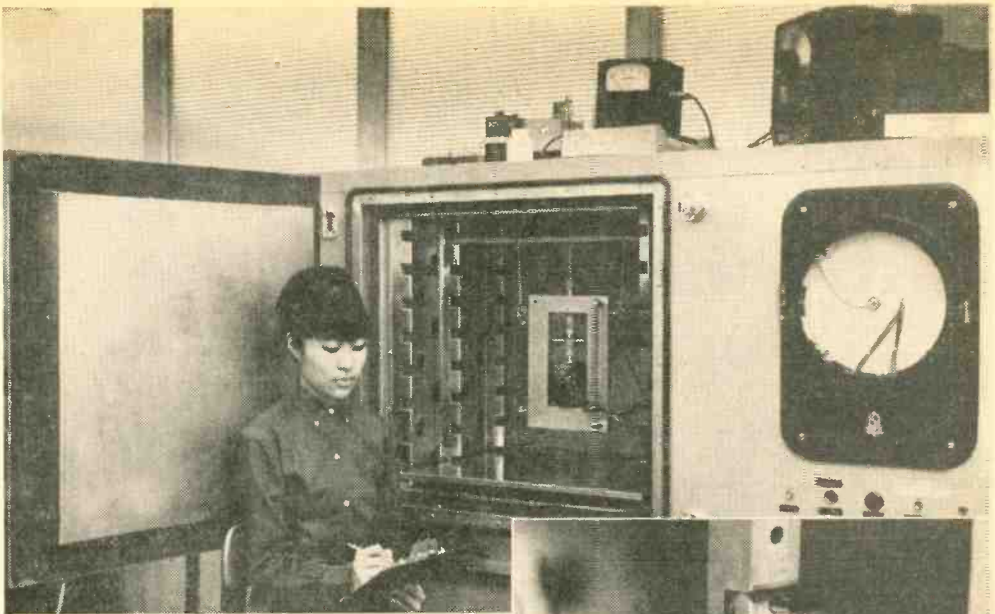
The patches were bathed in a saline solution, and silver-silver chloride electrodes were attached on opposite sides to pick up possible signals that would be amplified and recorded photographically on an oscilloscope. Placing the patches in a copper box to rule out interference waves from a flash lamp, and mounting a condensing lens inside to focus light on the skin, the experimenters next flashed light from a strobe onto the skin patches.

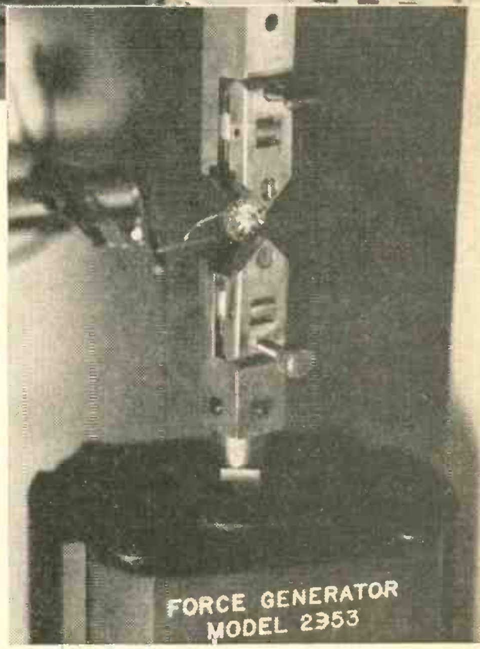
With . . . And Without. Watching results on the oscilloscope, they found the electrodes reported signals not only from melanin-pigmented skin, but from patches of albino skin as well. So melanin with its unique attachment to ultraviolet light didn't have to be the whole answer. Other skin pigments responded to light. Skin itself must respond electrically to light, and this could account for our little friend frog jumping toward the lighted "window." It could explain, too, why the chameleon changes his suit at whim.

The Harvard team had for the first time, linked sight, light, skin, and electricity. But it took two other experimenters, reasoning much as Cone did, to pin down the fact the fundamental senses, such as touch and hearing, are electrical.

As New York University Physics chairman Dr. Morris Shamos puts it, "We knew messages traveling along nerve pathways are electrical in nature, but it was not known precisely how these electrical messages originated."

Piezoelectricity Yet! Only one known phenomenon changes mechanical force or motion—such as the pressure on skin as in touch or vibration of hair cells as in hearing—into electrical impulses. That effect is





Apparatus used by Dr. Shamos to detect skin's piezoelectricity appears above; detail of force generator is shown at right. Box at far right records angle at which tissue is squeezed; greatest output occurs with stress at right angles to collagen fibers.

called piezoelectricity, taken from the Greek word, *piezo,* meaning pressure. Found in crystals, it is popularly described as the process that transfers stress on a needle as it plays a phonograph record into electrical pulses.

Known to exist in wood, silk, and wool, it had never before been thought of as a trait of biological tissue. Yet Shamos, teaming with Dr. Leroy Lavine of Downstate Medical Center, followed a reasoning route similar to Cone's. A common protein molecule, collagen, found in wood and wool, also exists in connective tissue in animal and man. Could collagen be the agent prompting the piezoelectric effect in the inorganic substances? Then it might do the same in animate tissue.

Like Cone and Beck, the two worked out an experiment to test the premise. Thin discs of skin (some of them from humans) were cut, 1.3 cm in diameter, and dried for at least 24 hours. Electrodes were attached, and the entire set-up placed in an oven to govern temperatures and add shielding.

Then an electromagnetic force generator, driven at a 50-Hz frequency by a signal generator, applied stress to the discs. Electrical charges picked up by an AC voltmeter also registered on Shamos' oscilloscope, and he says this proves piezoelectricity can explain much we thought mechanical in the functioning of the senses.

It can explain such physical vibrations as the touch of a finger pressing a table transferring the mechanical/electrical message through the nerves to the brain. It may explain how the honeybee "listens" through its feet, the cat "sees" in the dark, the fishes "hear" gossip of their fish neighborhood without ears.

And may one day pave the way for man to hear through his skin, and, like the honeybee, pick up messages through the soles of his feet. So what's so special about ESP? ■

CB BONANZA

the EASY way to install a COMPLETE CB station

By Herb Friedman, KBI9457

The right way is
the easy way,
and here's the painless
step, by simple step,
to maximum CB joy
with minimum CB heartache

Selecting the right location for the base **1** *station is important. The kitchen is convenient if the rig will be used by the little woman—near the coffee pot, too.*

While the very basis of CB is convenient and simple radiotelephone communications, all too often the operating facility itself approaches the complexity of an old spark-gap transmitter. The result is a multitude of wires, jacks, and controls buried under reams of paper or auxiliary equipment that only a graduate engineer can master.

For maximum effectiveness and convenience, a CB installation should be completely free of clutter. Even more important, it should be arranged so that the minimum

Again, do as the experts did—run your **4** *coax along same route as the telephone cable. After running coax from antenna in through outside wall, seal hole with a calking compound.*

Where coax must be exposed, carefully staple it **5** *to the molding with a round staple gun. Coax and staples can then be painted to match color of the molding.*

It's easy to install the base antenna
2 *by using standard TV antenna hardware. The mast can be attached to the side of the house using mast clamps.*

The telephone company has already found the easiest
3 *way in through the walls of your house, so drill your transmission line hole, using an electrician's bit, next to the phone line.*

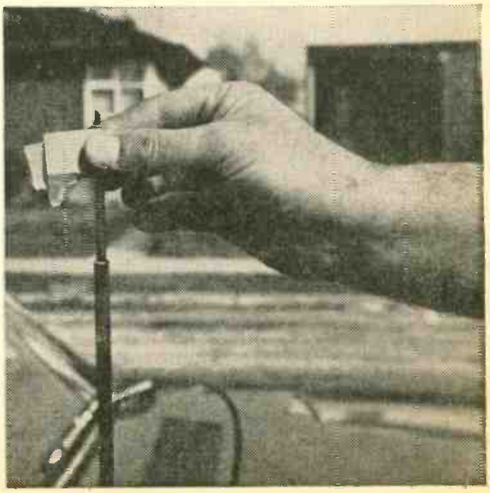
number of motions are required for communications. In addition, the equipment should be placed in a convenient location (burying the rig in the basement when it will be used only by the XYL to talk to the OM returning from the office is almost guaranteeing that the transceiver will not be used at all).

Base Installation. Fortunately, base installations generally create no problems other than selecting the equipment location. After all, about the only thing involved in connecting the tranceiver to the antenna and plugging the rig into the 117-VAC line. Except for a motor-driven directional beam, all CB antennas employ the same mounting technique as a standard TV antenna. You screw a couple of mast brackets to the wall or roof, snap a mast into the bracket, and mount the antenna on top of the mast.

But unlike 300-ohm TV twinlead which can be fed through the window, the coax cable generally must pass through the window frame itself or through the side of the building. Either way, you're not going to be able to drill through with a standard drill bit

Easiest and most convenient to install of the
6 *mobile CB antennas is the CB/AM whip that serves as antenna for both. Unit here is a conversion kit mounting on existing AM antenna.*

The first step in installing the CB/AM conversion
7 *kit is to snip the anti-static ball off the end of the AM antenna. The end is then sanded to remove corrosion and dirt.*



since it's only about 6 in. long. But most hardware stores handle what is called an "electrician's bit," a drill some 15 to 30 in. long and designed to fit into a standard brace. These bits will cut through just about everything but brick—wooden window frames, shingles, asbestos, even aluminum siding.

After you've drilled the hole and fed the coax into the building, fill the hole with calk or putty to prevent rain from running down the transmission line and into the building. And once the transmission line is in the building, the question is what to do with it? Connect it to the transceiver, naturally—but where to place the transceiver? Best answer is to place it in the most convenient location for the primary communications purpose.

For example, suppose the transceiver will be used primarily for the XYL to chat with the OM. What's the most convenient location for the XYL? In nine cases out of ten, the answer is the kitchen, not the den, workroom, or basement. The average XYL spends a good part of her day in or near the kitchen, so CB operations should be as convenient as possible for her. If the rig is to be used by the OM, like for chatting with his buddies in the evening, pick a nice quiet spot away from the kids' TV.

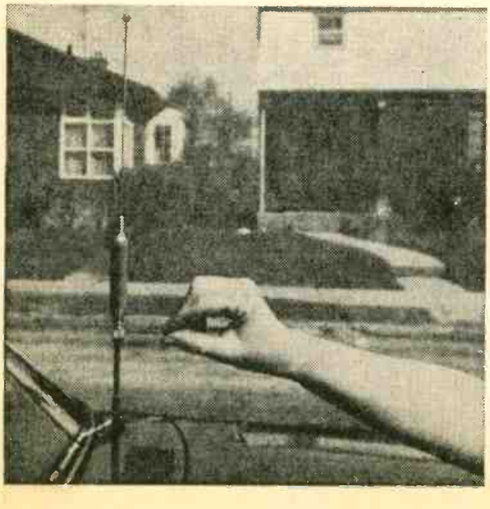
Okay, you picked the tranceiver location and the coax is sticking out of the wall—now to mate the two. If you're the sloppy type, you can drape the coax behind the furniture, over the doorsill, and on to the rig. But if you don't want the coax crushed under the legs of a chair some day, why not install the coax the same as the telephone wiring? Latch onto a staple gun that shoots ¼-in. round staples (the Arrow T25 is a good bet), and staple the coax neatly to the baseboard molding.

Finally, get some kind of ground on the transceiver, either to a cold water pipe (preferred) or the building's electrical ground. While it's true that the transceiver will be grounded through the coax shield if the antenna is properly grounded (as it should be), you need a transceiver ground to allow for times when the antenna is disconnected. Without a ground, a power-supply short-circuit can place the transceiver cabinet the full line voltage above ground; place one hand on the cabinet, the other on a radiator, and *ZAP*!

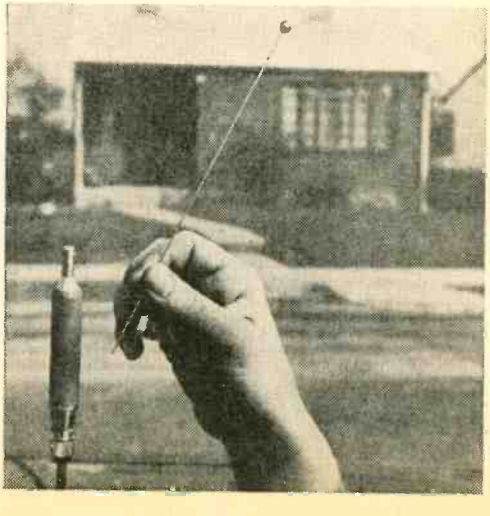
That's all there is to base installations. Just pick the most convenient operating position, connect the coax transmission line between the transceiver and the antenna, and you're ready to go.

Mobile Installation. Depending on your choice of equipment, a mobile installation can take 15 to 30 minutes or several hours. The time-consumers are large, tube-type transceivers requiring extra bracing to pre-

8 *The CB loading coil is screwed down on top of AM antenna. It is then secured by tightening the set screw on the bottom of the loading coil with the tool provided.*



9 *The CB whip mounts on top of the loading coil. When a standing wave ratio (SWR) meter is available, the top whip should be trimmed for lowest SWR on the CB frequencies.*



vent the dashboard from bending, body-mount antennas that demand what is almost a precision drilling job on the car body, and setups that demand excessive "snaking" of the transmission line from the front to back of the car or through the headlining. On the other hand, if you use some of the new solid-state transceivers and insta-mount antennas like those in our photo, the entire installation should take no longer than 30 minutes. Let's go through a typical solid-state installation.

The solid-state rig, to begin with, is small, so it can fit just about anywhere on the dash without interfering with passenger legroom or controls. Select the most convenient location for the operator (so he can work the tuning and volume controls without stretching almost parallel to the seat) and mount the transceiver's mobile bracket to the bottom of the dash.

Since solid-state gear is very light, a couple of #8 sheet metal or machine screws are all it takes to rigidly mount the transceiver. But most cars have the lighting cables running in a channel under the dash, so take care that the drill doesn't slice them off as it goes through.

Next step is to get power to the rig. If the transceiver has *two* power leads, make certain you utilize both of them. A tube transceiver requires a relatively high supply current and should be connected to the power source with the shortest possible length of (usually #12) stranded wire. Do not use solid wire, since it tends to break under severe vibration. A good power source for tube transceivers is the ignition key switch terminals marked *accessory*—generally the same terminal used for the radio's power input.

Solid-state jobs are something else again. The power lead for one of these rigs carries relatively little current (generally about 1.5 amperes), so #16 or #18 stranded wire is quite adequate. Also, it can be cut into any convenient power source such as the power lead to the cigarette lighter (though you'll probably have to connect to the ignition switch's accessory terminal if you want the transceiver's power input to be disabled when the ignition key is removed).

If the transceiver is supplied with a single power lead, make certain the chassis is really grounded, preferably with a separate ground strap. Just a few ohms resistance in a poor ground connection can make the difference between a 3.5- and 1-watt RF output, not to mention poor reception.

One note of warning: A solid-state transmitter should never be keyed (turned on) until the antenna is connected. Keying the transmitter without having the antenna connected can result in the destruction of the RF output transistor.

Mobile Antennas. There are almost as many mobile antennas as there are peas in a pea-patch. As a general rule, however, most mobile antennas give similar performance. For example, while a full-length whip theo-

Lay out the dashboard holes using the mobile rig's mounting bracket as a template. Being careful not to cut any wiring, drill the mounting holes a trifle smaller than self-tapping screws supplied. **10**

Attach mounting bracket to the dashboard using the self-tapping screws furnished with most rigs. Be sure that the bracket is securely fastened—you don't want it falling off. **11**

retically outperforms a loaded antenna in terms of signal strength, the whip favors one particular direction if mounted on a fender or bumper (the usual positions). And while a loaded whip doesn't give equal radiation, it's generally mounted in a more favorable position for omni-directionality (equal radiation in all directions), which balances out the more directional and stronger full-length whip characteristics.

Bumper antennas, though easiest to mount, are subject to damage should the driver "kiss bumpers" when parking. Further, a hole must be drilled in the body for the transmission line and the line must be snaked to the transceiver.

Body-mount antennas with shock springs require three screw holes and a large knockout, and these of course reduce the trade-in value of the car. The performance of the bumper- and body-mounted full-length whips is generally similar.

A small loaded antenna mounted in the center of the roof is generally excellent as far as omni-directivity is concerned because the entire car body acts as a ground plane for the antenna. But again, a hole in the center of the roof might not be appreciated at trade-in time.

Other loaded antenna almost exactly resemble the standard auto-radio antenna, with the addition of a small loading coil to resonate the antenna on 11 meters.

An oddball combination consists of a conversion kit for a standard auto antenna, which allows the same antenna to be used for CB and AM reception—and with no additional holes in the car's body. The kit consists of a loading-coil assembly that converts the AM antenna to a CB/AM antenna, and a two-way converter that splits the signals from the antenna and feeds them to either the CB transceiver or the auto radio. Our photos show a typical antenna converter installation.

To install the kit, you simply cut off the anti-discharge ball at the top of the AM antenna. Next, you screw on the conversion coil and connect the two-way converter *inside* the car. The converter is supplied with all jacks and cables to match the CB and AM gear. Connect the SWR meter between the converter and the transceiver, and you're ready for tune-up. Have someone key the transmitter and observe the SWR meter while you adjust the length of the short top whip (part of the conversion coil) for minimum SWR.

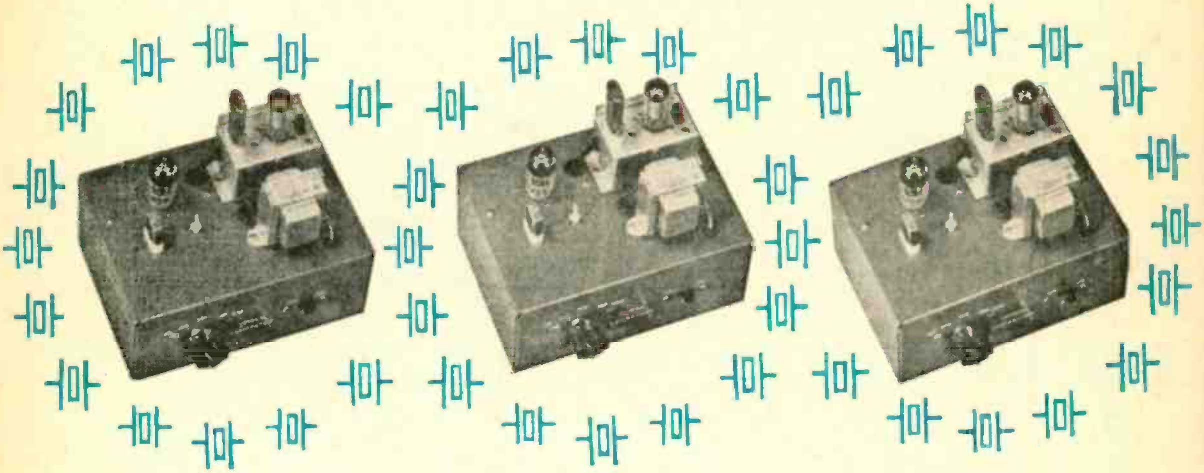
The Lafayette 99C3116 conversion kit shown in our photos is supplied with two different-length top whips to insure minimum SWR. Once the antenna system is resonant, as indicated by the lowest SWR meter reading, tighten the antenna mounting screws, remove the meter, and you're ready to go on the air. ■

12 *Place the mobile rig in the bracket and fasten it down with the supplied screws through the side of the rig; tilt it for the most convenient operating position and snug it down.*

13 *Final step in the mobile installation is to check the SWR and, if necessary, adjust whip length for minimum reading. Button everything up and you're ready to go on the air.*

COVER STORY

X-cal '67



. . . a cool little crystal calibrator that'll give you plenty of pizzaz way up there where you need it most

By Hartland B. Smith, W8VVD

For the serious Ham, SWL, or experimenter, a good crystal calibrator is pretty much a must. Trouble with the ones on the market is that they don't seem to take into account the fact that when you try to use one of them above 6 meters, phhfft—like nothing, man. And the fact is that radiodom is forever going into higher realms.

Crystal calibrators are all pretty much alike—they usually have a crystal controlled oscillator producing a fundamental of 100 kHz. Harmonics are then supposed to provide a usable output every 100 kHz from thereon out. But when you want markers on 6 meters, you're trying to get an output 540 times the fundamental frequency. By that time there's not much poop left.

Futhermore, up around 6 meters, 100 kHz markers get so close together on the average receiver dial, that it becomes rather difficult to identify with certainty the exact check point to which you're tuned. And unless the receiver is so accurate that you don't need a calibrator in the first place, you can easily mistake a 54.1 MHz signal for 54.2 or 54.0 MHz.

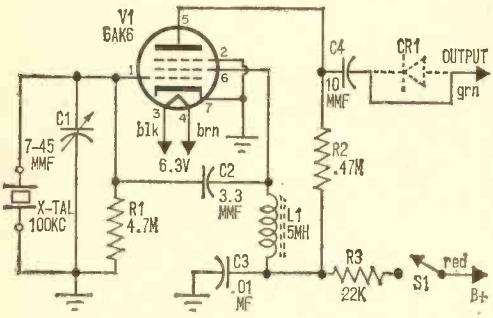
The X-Cal overcomes both of these difficulties. It not only produces strong 100 kHz

e/e X-CAL '67

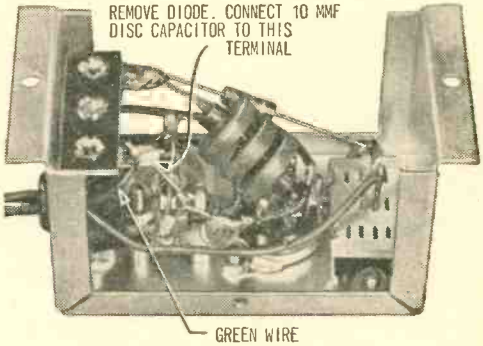
harmonics, even at 54 MHz, but, in addition, it boasts a separate 1000 kHz crystal oscillator. With even a poorly calibrated receiver, you can tell which 1000 kHz marker you're tuned to. Then, starting from this point, you can easily count 100 kHz markers until you reach the exact frequency you're looking for.

Even on the 144 MHz band, where most crystal calibrators refuse to function at all, the X-Cal puts out 100 kHz and 1000 kHz markers of excellent strength. Needless to say, on the lower frequency bands this unit does a superb job too, so if you're looking for a gadget that'll give you accurate check points all the way from 160 to 2 meters, the *X-Cal* is definitely worthy of your construction time and dollars.

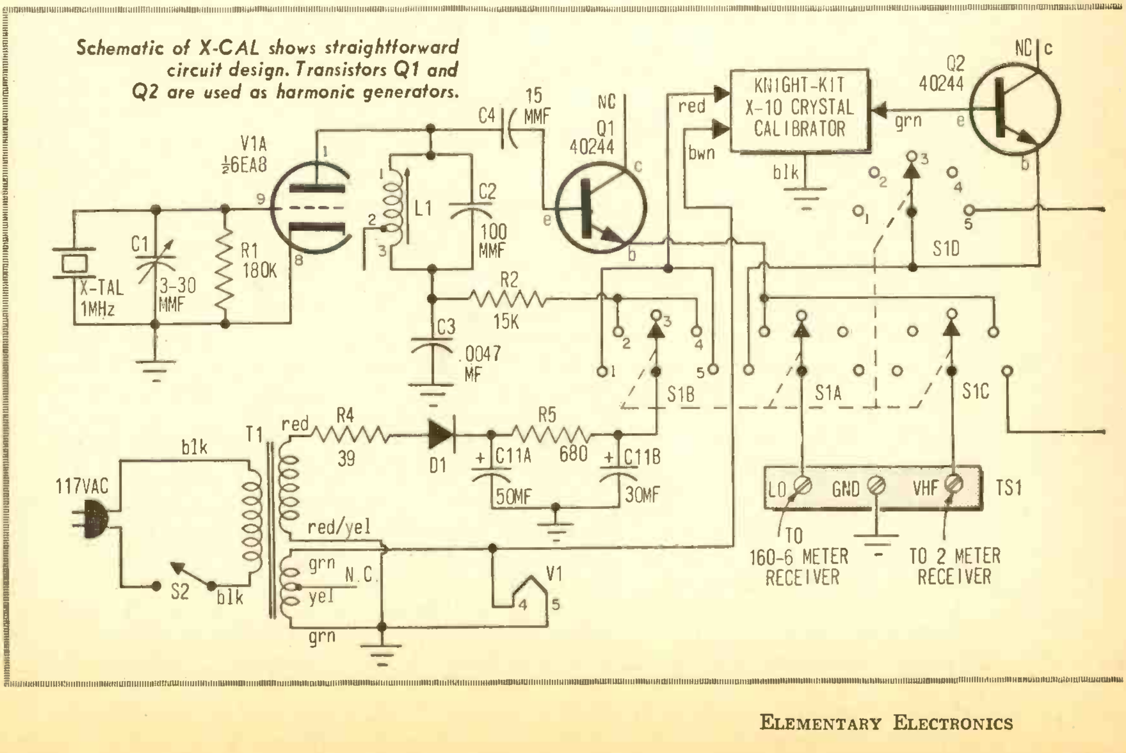
How It Works. The heart of the device is a Knight-kit X-10 Crystal Calibrator. The 100 kHz output from the Knight X-10 is fed to the base-emitter junction of transistor Q2 and then is either switched to the LO frequency terminal of TS1 for 160 through 6 meter use, or to the grid circuit of V1B where the marker harmonics are amplified



Assembling Knight-kit X-10 Crystal Calibrator is first step to X-CAL '67. Output diode CR1 (dotted lines) is removed, as shown at right.



Interior view of completed X-10. If unit comes with diode, remove it, and you're ready to go on to the next step.



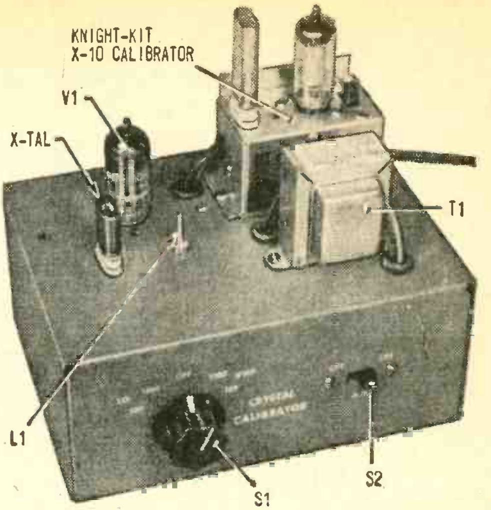
Schematic of X-CAL shows straightforward circuit design. Transistors Q1 and Q2 are used as harmonic generators.

to usable strength for the 2 meter band.

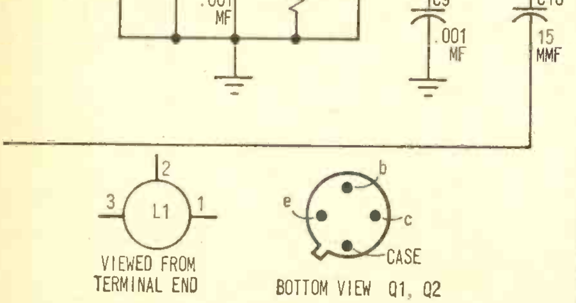
Whenever a radio frequency signal is passed through a non-linear device, such as a silicon diode, numerous harmonics are generated. Some diodes, however, do a better job of producing harmonics than others. Although the diode originally supplied with the X-10 generates usable harmonics above 35 MHz, far better results can be achieved in the VHF range by replacing it with the base-emitter junction of an RCA 40244 transistor. This single change in the Knight X-10 provides markers of excellent strength well above 60 MHz. As a matter of fact, you can even hear them faintly, every 100 kHz, on a sensitive 144 MHz receiver! However, since it's no fun fishing for weak signals when attempting a quick frequency check, V1B has been included in the *X-Cal* to supply the amplification required to bring the 2-meter harmonics up to a very usable level. On the author's 144 MHz receiver, for example, the 100 kHz check points exceed the S-9 level.

V1A is employed as a 1000 kHz crystal oscillator which, in conjunction with Q1, puts out S-9 plus harmonics well into the VHF range.

Power for the *X-Cal* is supplied by a half-wave transformer, a silicon diode and a resistance-capacitance filter. A 4-pole, 5-position switch, S1, connects B-plus voltage to either the 100 kHz or 1000 kHz oscillator when a frequency check is desired. S1 also switches the outputs from the oscillators and the 144 MHz amplifier between the *LO* frequency and the *VHF* terminals of TS1.



Follow photo for layout of major components. Uncluttered arrangement makes for easy construction.



Construction. First, wire up the Knight X-10, adhering strictly to the instructions supplied with the kit. Next, mount the major parts required for the *X-Cal* on a 5 x 7 x 3-in. chassis. Carefully follow the layout shown above. Locate V1's tube socket so that pins 4 and 5 are nearest the rear of the chassis. Using the shortest possible leads, ground the center post of the tube socket to solder lugs placed under both of the nuts on the socket mounting screws. Snip off the antenna wire which is supplied on L1 by the factory. Now, wire the power supply components associated with T1.

Temporarily connect the heater and B-plus leads of the Knight X-10 to the power supply and run the green output lead to the antenna terminal of a ham, short-wave or broadcast receiver. Check the 100 kHz oscillator, as suggested in the kit's instruction manual. When you're satisfied that the X-10 is working, turn off the power supply and remove the temporary hookup.

Disconnect the output diode supplied with the Knight X-10 if your unit comes with one—if not (later models don't use it), go on to the next step. Attach the free end of the 10-mmF disc ceramic capacitor coming from pin 5 of the 6AK6 tube directly to the tie point where the green wire is connected, as shown in X-10 photo. Save the diode. You'll undoubtedly be able to use it in some future project.

Fasten the shield cover to the Knight X-10 and then mount the entire 100 kHz assembly behind the power transformer.

Orient S1, as shown in photo below, so the two screws which support the wafers are at the top and bottom of the switch frame.

Now proceed to wire the balance of the circuit as shown in the schematic. The leads of C6 and C7 should be cut to less than ¼ in. and the capacitors soldered directly between their respective tube socket terminals and the grounded metal ring surrounding the tube socket. Run one terminal of C5 directly to pin 2 of V1B. Solder the other terminal of the capacitor to a ground lug bolted to the chassis. There should be just enough lead length on L2, in addition to the actual winding, so that the coil may be connected across the terminals of C5. One end of L3 goes directly to pin 6 of V1B. The other end has a ⅜ in. lead which runs to an insulated tie point. Capacitor C9 goes from this tie point to the grounded ring on the tube socket. A ⅜ in. piece of wire must be connected to C8 so that it can be fitted between pin 6 and the grounded mounting foot of the tie point that supports L3. Before installing C1, C5 and C8, examine them carefully. Make sure that the capacitor terminals which you ground are the ones connected to the movable plates directly beneath the adjusting screws.

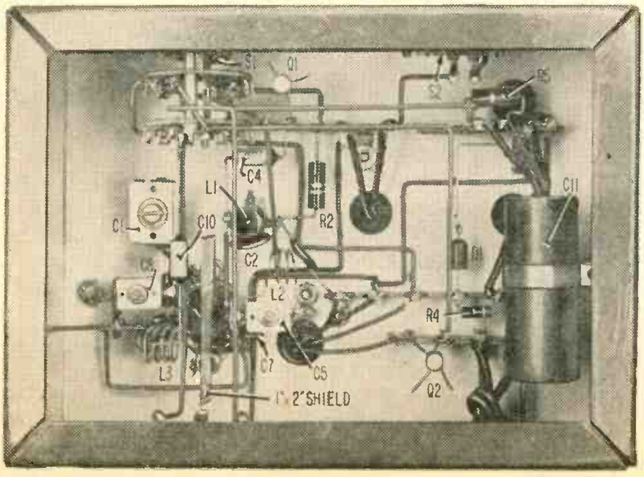
Q1 and Q2 require no sockets. Their base and emitter leads may be soldered to insulated tie points placed at convenient locations on the chassis. During the soldering process, heat sink the transistor leads with long nosed pliers. Bend the collector and case leads out of the way to prevent them from shorting against nearby objects.

The grid and plate circuits of V1B must be well shielded from each other. Suitable material for the job can be obtained from a well tinned vacuum coffee can. Cut a piece of tin 1x2 in. and flatten it. Place it alongside the tube socket center post and run one end of it midway between pins 1 and 9. Cut a ¼ in. slot in the rear half to clear pin 4. Solder the shield, at its mid-point, to the socket center post. Run a short lead from the center terminal of TS1 to the end of the shield nearest the rear of the chassis.

Testing. After you've carefully checked for wiring errors, plug the calibrator into the power line. Attach a wire from the *LO* frequency terminal of TS1, below right, to a radio that tunes somewhere below 30 MHz. Throw on S2 and set S1 at position *2*. Tune the receiver to WWV (any frequency but 2.5 MHz) or to a BC station operating at 1 MHz. Adjust the slug in L1 until the 1000 kHz crystal begins to oscillate. Back out on the slug ½ turn. Now, slowly increase the capacity of C1 until the frequency of the oscillator is zero beat with the incoming station.

Switch S2 to position *1*. Adjust the 100 kHz oscillator to zero beat as described in the Knight X-10 manual.

Run a wire from the VHF terminal of TS1 to the antenna connector of a 144 MHz



Internal arrangement of X-Cal leaves plenty of working space. The only critical parts are in the HF oscillator section—here normal high-frequency wiring practices should be followed.

converter or receiver. Flip S2 to position *4*. As you tune back and forth across the 144 MHz band, you should hear harmonics at 1 MHz intervals. Set the receiver to the 145 MHz harmonic. Throw S2 to position *5*. A faint harmonic of the 100 kHz oscillator should peep through. Adjust C5 and C8 for maximum output, as evidenced by the receiver's S-meter. If either capacitor must be fully open for the strongest signal stretch the turns of its companion coil apart a bit. On the other hand, if best results are obtained at full capacity, squeeze the turns together.

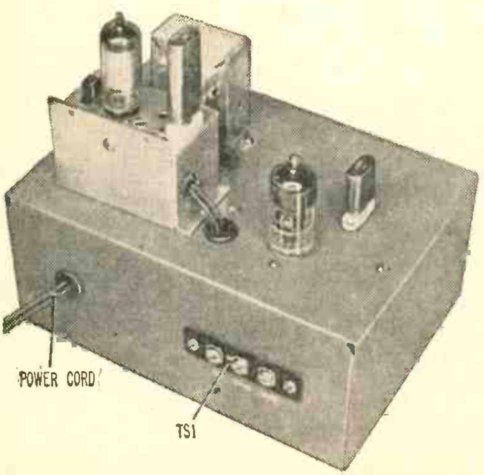
Operation. The X-Cal is now ready for use. Whenever you want to calibrate a receiver dial on the 144 MHz band, switch first to position *4*. Find the desired 1 MHz check point. Then switch to position *5* and start counting 100 kHz markers until you reach the one you are seeking. Always use the 100 kHz checkpoints for precise frequency measurements, because of the superior stability of the 100 kHz oscillator. The 1000 kHz harmonics should be relied on solely for identifying every tenth 100 kHz signal.

Although it won't usually be needed on the average ham-band-only receiver, the 1000 kHz oscillator (with S1 at position 2) will prove very helpful when setting up the bandspread scale on a two-dial, general-coverage shortwave set.

Always switch S1 to the *OFF* (*3*) position when not actually checking calibration. Otherwise, Q1 and Q2 will generate a certain amount of noise which will degrade the reception of weak stations. In addition, some of the more potent signals coming in from the receiving antenna may reach the transistors, be rectified and produce spurious responses that can interfere with desired signals.

Because of the *X-Cal's* low standby power drain, you'll probably want to leave S2 on whenever the receiver's in use. This will allow you to make instant frequency checks, without having to wait for tube warmup.

Anyway, however you use this unit, you'll find it the most useful calibrator going—in fact, it's the last word in its field. ■



Rear view of completed X-CAL, ready to provide bi-Hertz markers clean into UHF land.

X-CAL '67 PARTS LIST

C1—3-30-mmf mica trimmer capacitor
C2—100-mmf disc ceramic capacitor
C3—.0047-mf disc ceramic capacitor
C4, C10—15-mmf tubular or disc ceramic capacitor
C5, C8—0.9-7-mmf mica trimmer capacitor
C6, C7, C9—.001-mf disc ceramic capacitor
C11—50-30-mf, 150 volt, dual electrolytic capacitor
D1—400-P.I.V., 750 ma silicon diode
L1—540-1650 kHz loop antenna (J. W. Miller 2002 or equivalent)
L2—3 turns, No. 20 tinned wire, 3/8 in. i.d., turns spaced 3/32 in. Tap 1 3/4 turns from ground end.
L3—4 turns, No. 20 tinned wire, 3/8 in. i.d., turns spaced 3/32 in. Tap 1 3/4 turns from C9 end.
Q1, Q2—40244 transistor (RCA)
R1—180,000-ohm, 1/2-watt resistor
R2—15,000-ohm, 1-watt resistor
R3—330-ohm, 1/2-watt resistor
R4—39-ohm, 1/2-watt resistor
R5—680-ohm, 1-watt resistor
S1—4-pole, 5-position rotary switch (Centralab PA-1013 or equiv.)
S2—SPST slide switch
T1—Half wave power transformer. Primary: 117 v., Secondary: 150 v. @ 25 ma., 6.3 v. @ .5 amp. (Stancor P-8181 or equiv.)
TS1—3-screw terminal strip
V1—6EA8 tube
Xtal—1000 kHz quartz crystal ($2.50, postpaid. Quaker Electronics, P.O. Box 215, Hunlock Creek, Pa. 18621)
1—Knight-kit X-10 Crystal Calibrator ($10.95, plus postage. Allied Radio Corp., 100 North Western Ave., Chicago, Ill. 60680)
1—Crystal socket
1—9-prong miniature tube socket
1—1-terminal insulated tie strip
2—4-terminal insulated tie strips
2—5-terminal insulated tie strips
1—5x7x3-in. aluminum chassis
Misc.—Solder lugs, wire, solder, 4-40 and 6-32 machine screws and nuts, line cord and plug, rubber grommets, etc.

Estimated cost: $34.00
Estimated construction time: 8 hours

Scientists here are determining capabilities of Gulliver life detection system which may be sent to the nearby planets in a few years.

Gulliver picks up soil samples in effort to detect micro-organisms by shooting out projectiles attached to sticky string.

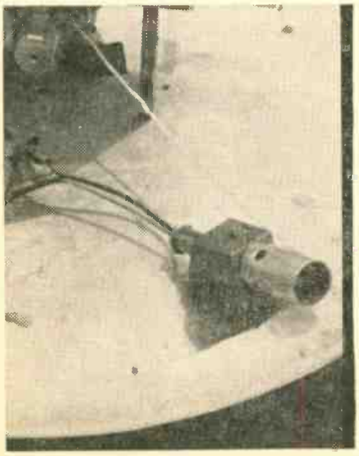
Gulliver's Sticky String

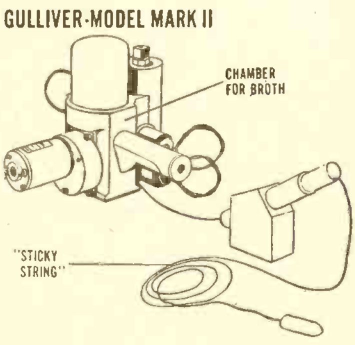
By Joe Craig

Exobiology, the newest of the space sciences, is the study of extraterrestrial life—on the moon, on other planets in our solar system, and in the far reaches of other galaxies. At the moment, there isn't much extraterrestrial life available for study, but exobiologists will soon have their day—sometime this decade in fact, when a life-detection device will be landed on Mars and/or Venus.

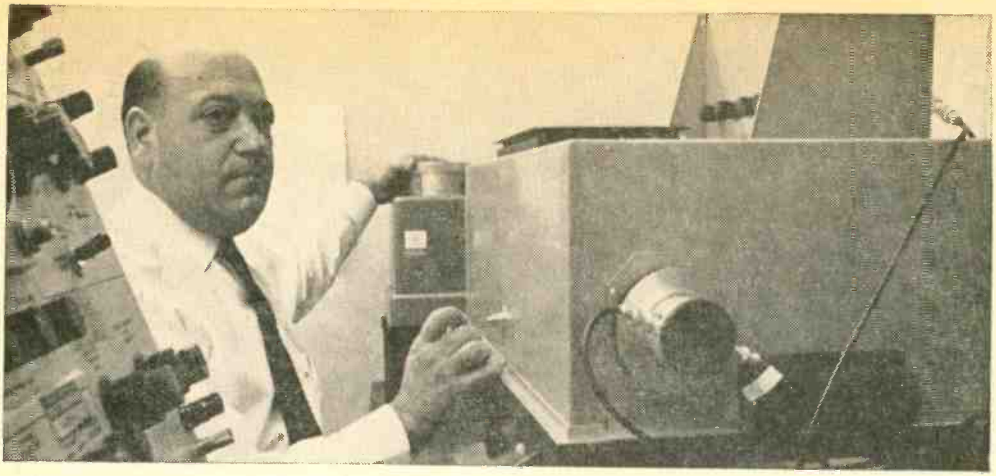
What this device finds may have the most profound influence on man's conception of the Universe since Newton's telescope. For determination of life on another planet will answer age-old questions and give man new insight into the question of the origins of life and the universe.

Sentience? Dr. Carl Sagan of the Harvard Observatory thinks there may be as many as a million planets in our galaxy that bear in-





At left, Gulliver's projectile gun is shown in detail. String is attached to reel in life- detection mechanism (center). Reel recovers string, drawing it into mechanism for analysis. Right, complete unit with cover in place as it will appear in the remote reaches of outer space.



Another approach being studied by NASA scientists employs spectrophotometry to determine composition of other-world soils. Research is aimed at producing a small, rugged unit that will survive the rigorous trip through outer-space and land intact to send data back to Earth.

telligent life, and many millions more in other galaxies. What this life is like has been the subject of centuries of speculation, and anybody's guess is as good as anybody else's right now.

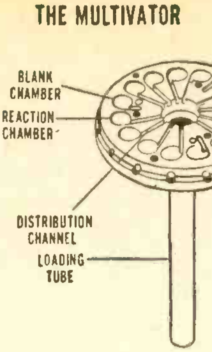
But finding even one unearthly plant cell or bacteria on Mars will be enough to bring this new branch of knowledge to everyone's attention. No serious scientist expects to find human-like creatures on other planets, but all hold the view that certain chemical combinations of elements known or suspected to exist on Mars or Venus, for example, could very well form the basis of some type of living organism.

The recent fly-bys of Mars made by the Mariner spacecraft indicated that the planet has very little atmosphere and no oxygen. But oxygen may not be necessary for life, since there are some bacteria and fungi on earth which live without oxygen. And recent studies have proven that these kinds of life could survive even in the hostile atmosphere of Jupiter, loaded as it is with poisonous gases.

Faraway Life-Detection. Currently, there are several different types of life detection devices being developed and tested by NASA experts and independent laboratories. Some will be operated on the moon, Mars, and Venus by spacemen; others will be rocketed there aboard spacecraft and make their bacteriological investigations by remote control.

Though some of these instruments are

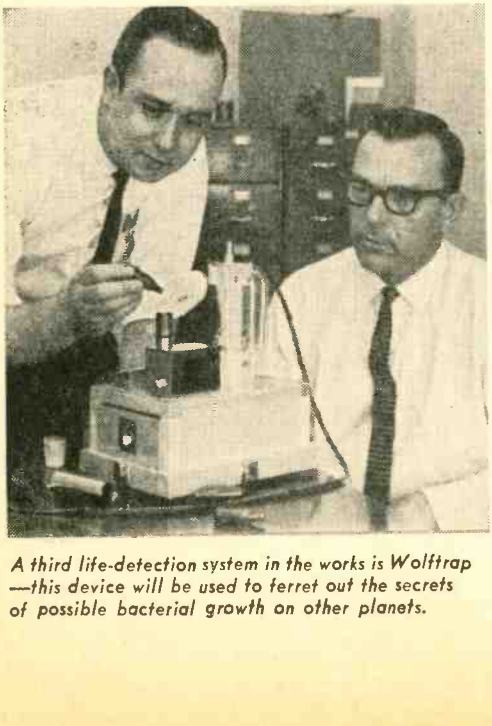
Exobiologists are studying the latest maps of planets accessible to Earthling space ships in order to determine which are the most likely to have life of some form. Results of these studies will decide which way the nose of space ships carrying life-detection systems will point.



Another life-detection system under current study is the Multivator. With this device, dust from an alien planet is drawn up through loading tube (center) into reaction chambers. There, multi-step analysis of constituents is made, the results being radioed back to earth.

extremely sophisticated, scientists fear they may fail to report extraterrestrial life because it might have evolved in some wholly unpredictable form. And though there is but a slight chance of this, exobiologists are nonetheless planning for the broadest possible means of data gathering and interpreting. If life exists on other planets or the moon, scientists want to study it before man actually lands there and faces unknown (and perhaps dangerous) conditions.

Detection Systems. The principal physiological instruments have been nicknamed Gulliver, Wolftrap, and Multivator. Gulliver, the most fully developed, shoots out sticky strings to collect soil or dust from the surface around it. Coated with special nutrients, these strings are pulled back into the instrument, and if bacteria are present, a radioactive carbon dioxide will be released. This will be measured and the amount reported back to earth by radio signal.



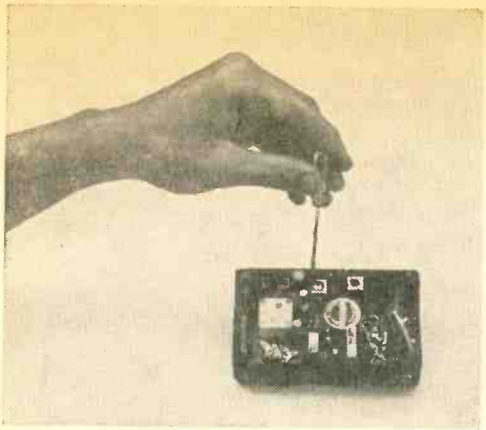
A third life-detection system in the works is Wolftrap —this device will be used to ferret out the secrets of possible bacterial growth on other planets.

Wolftrap, named after its inventor, Dr. Wolf Vishniac of Rochester University, detects bacterial growth. It uses a vacuum tube whose fragile tip will shatter when it hits the surface of another planet. Then the vacuum will suck in dust and test it chemically for bacterial growth.

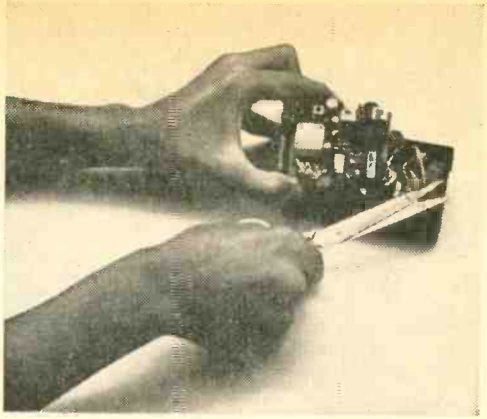
The third device, the Multivator, is a miniature laboratory for conducting a variety of biological and biochemical experiments on the planets and measuring changes caused by the growth of micro-organisms by an acidity detector and a light sensor.

In the Works. Among the chemical life-detecting techniques NASA is working on are a Mass Spectrometer to identify amino acids and peptides (necessary to proteins, which are necessary to life as we know it); Ultraviolet Spectrophotometry, geared to detect peptides; a Gas Chromatrograph to analyze planetary atmospheres for biologically significant gases; and the Firefly, which detects the chemical ATP, another ingredient essential to life.

No one knows what these devices will discover, but Man will soon start getting some of the answers to questions he's asked since the ancients gazed wonderingly into the night sky. ■



Start by removing back of radio and unscrewing circuit board.



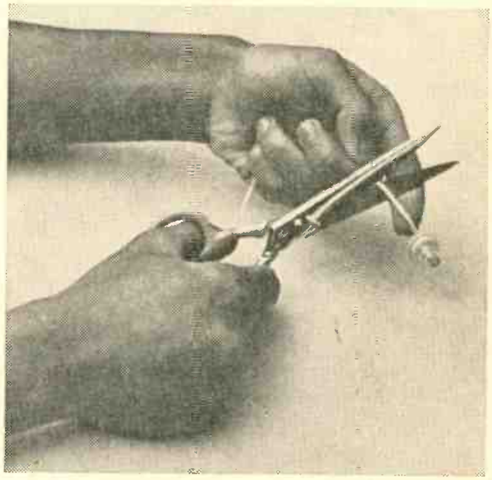
Cut wires and remove circuit board, leaving only speaker and its wires.

MAKE A MINI-MIKE

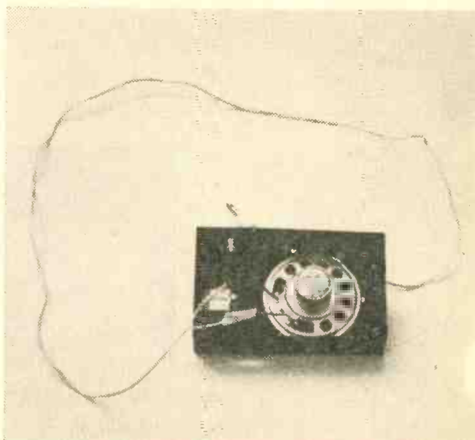
■ If you've an old, broken-down transistor radio just waiting to be thrown away, grab onto it before it's too late. The reason: it can be turned into a great little all-purpose, low-impedance mike. To make your Mini-Mike, just follow our photo sequence.

If the impedance is too low for your purposes, you can try salvaging the audio output transformer. By hooking the speaker to the secondary and using the primary as the output, the output impedance will be increased to approximately 250 ohms.

Miniature transformers with higher impedance ratios are also available from parts houses. —*Ronald Tom* ■



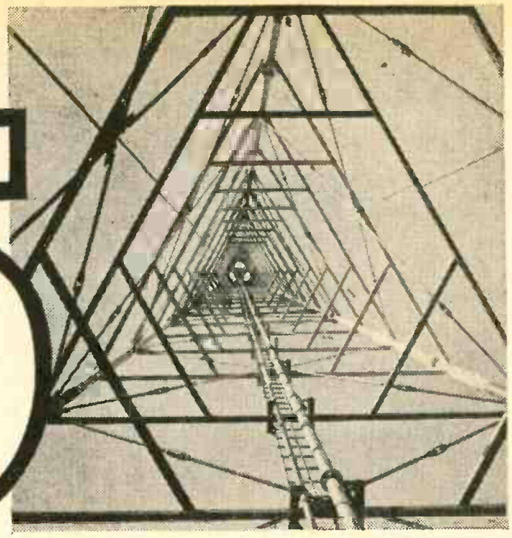
Clip earphone from cord and plug—this plug size is often used in portable tape recorders.



Carefully strip cord wires, solder to speaker wires, then tape. Make a strain loop to prevent pulling speaker wires off.

** Snap back of case on, plug into your recorder, and you're all set to go with this all-purpose Mini-Mike.*

TRY TUNING THE TOP 25



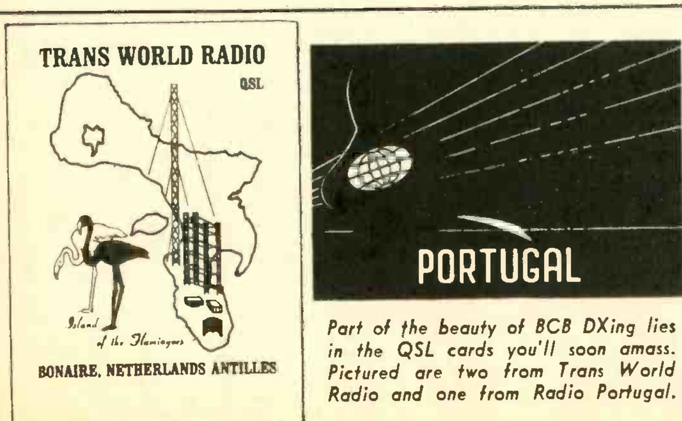
For a New Lease on the Lively World of DXing

By Edward Griffin, Jr.

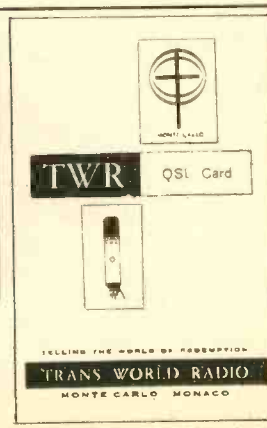
Has shortwave DXing lost its thrill? Do QSLs from the super-power voices of such stations as Radio Moscow, Radio Australia, the BBC and others leave you unexcited? If you can answer "yes" to that question, perhaps you should switch to broadcast band DXing. Unlike the high powered voices on shortwave, most broadcast band stations make little or no attempt to be heard beyond their own general listening area. Often you may hear an SWL DXer brag about a long haul to Australia, but an equally good catch, if not better, is TGW, Guatemala on the broadcast band.

There are three essentials needed to get started on this part of the radio spectrum: a receiver with high selectivity, a good long wire antenna, and a great deal of patience. A novice just breaking into the DXdom should start by trying his hand at some of the clear channel stations in the U.S. such as WJR, Detroit (760 kHz), WCFL, Chicago (1000 kHz), or KSL, Salt Lake City (1160 kHz) in order to get the feel of this band.

Once you become familiar with the broadcast band, it's time to try for a real catch. However, this is easier said than done. The BCB DXer is constantly challenged by receiving conditions, crowding by hundreds of stations, and extensive interference. Prob-



Part of the beauty of BCB DXing lies in the QSL cards you'll soon amass. Pictured are two from Trans World Radio and one from Radio Portugal.



ably the best way for a DXer to overcome interference from local stations is to switch the BFO on and to tune to either side of the desired frequency. Tricks such as this distinguish the true DXer from the ordinary listener.

The BCB presents ripe fields for anyone who wishes to harvest rare rewards. These stations, especially the foreign ones, are happy to verify *accurate* reports that include the date, time (EST), station, program remarks, and return postage.

So warm up the set and try your hand at the top twenty-five BCB catches. And lest you feel that BCB DXing is for pro's only, consider that the author himself has logged every one of the stations in our table, and that he also lays claim to QSLs from 17 out of the 25 stations listed. Operating from his QTH near New York City, he listens on a Hallicrafters S-118 receiver and makes use of two antennas.

One, the rig's built-in loopstick, might pose some problems were it not for the fact that the receiver itself is mounted on a plastic turntable. This way, the receiver can be readily rotated for best possible pickup, while simultaneously serving as a kind of direction finder. Too, the fact that the turntable places the receiver at eye level makes needle-point tuning the rule rather than the exception.

The other antenna, a 30-ft. long-wire, is unfortunately not movable at present, though it doesn't seem to lack in pulling power. A cold-water pipe serves as an A-1 ground.

Now who says you, too, can't try for the Top 25? ■

e/e's GUIDE TO BCB'S TOP 25

Frequency (kHz)	Callsign	Station	Location
570	CFWH		Whitehorse, Y.T., Canada
620		R. Nacional de España	Canary Islands
625	TIRICA	R. Costa Rica	San Jose, Costa Rica
640	TGW	R. Nacional	Guatemala City, Guat.
647	BBC		Daventry, England
650	KORL		Honolulu, Hawaii
660	KFAR		Fairbanks, Alaska
732			Saudi Arabia
764			Senegal, Dakar
782	CSB9	R. Miramar	Miramar, Portugal
800	PJB	Trans World Radio	Bonaire, Neth. Antilles
818			Andorra
850	XEZR		Zaragoza, Mexico
885			Plymouth, Montserrat
1000	XEMO		Mexico City, Mexico
1034		R. City	(Pirate)
1035	4VEH		Cap Haitien, Haiti
1040/1120		VOA	Marathon Key, Fla.
1133		R. London	(Pirate) England
1165		R. Americas	Swan Island, U.S.A.
1178		VOA	Okinawa, Ruykyu Is.
1187/1520		R. Caroline	(Pirate) England
1466	3AM2	R. Monte Carlo	Monte Carlo
1500	PCJ7		Willemstad, Curaco
1529		Vatican Radio	Vatican City

HOME STUDY BLUEBOOK

e/e's Guide to selected Home-Study Courses now being offered by Electronics Schools

One of the *E's* in *Electronics* is for *Education*—wherever you can get it. Fortunately, many of our readers are located near resident schools offering electronics courses suited to their educational needs. A far greater number, however, are less privileged on one, or both, of two counts: resident schools are either located so far away that attendance would be impractical, or personal educational needs have become so esoteric and specialized that resident schools simply can't provide appropriate instruction. And this is where home-study courses from non-resident schools can prove indispensable. For such schools not only fill normal educational needs, they actually forge ahead by offering courses and personalized educational services resident schools can never hope to provide.

Listed below are three courses offered by home study schools. For more information, circle those course numbers that interest you on the coupon below, and fill out both sides of the coupon. ELEMENTARY ELECTRONICS will forward your request to the schools and ask that additional data be sent directly to you.

13. 2-Way Radio. If you don't pass the FCC First Class Radiotelephone license exam after taking *National Radio Institute's* Complete Communications Course, you gets your money back. This beginner-oriented course covers mobile, marine, aircraft, and railroad communications, plus radio-TV transmission, microwave relay, and teletype. Course contains 70 lessons, 13 reference texts, 7 training kits; average completion time, two years. Further details are included in *NRI*'s 72-page, full-color booklet. GI Bill approved.

14. TV Servicing. *RCA Institutes*' Television Servicing Career Program 200 is for the beginner and completely prepares you for a career as a television serviceman. There are 110 pay-as-you-order lessons, starting with basic electricity and electronics, going on into black-and-white television, and concluding with a thorough study of color television. There are 26 kits, two of which are an optional picture tube and cabinet. Details are spelled out and pictured in a free 66-page book called "Your Career in a World of Electronics." GI Bill approved.

15. Sound Info on Sound. *International Correspondence Schools* has a course called "Hi-Fi/Stereo and Sound Systems Servicing" which the average student completes in about 295 hours. With this training under your belt, you'll be qualified as a mono/stereo sound technician and you'll also be able to troubleshoot your own sound equipment. More info is contained in "Electronics," subtitled "The booklet you sent for that can change your life." GI Bill approved.

CUT HERE

ELEMENTARY ELECTRONICS, Dept. HS-4
505 Park Avenue, New York, N. Y. 10022

Yes! I would like to know more about the electronics home study courses described above. I am interested in only the course numbers circled below.

13 14 15

Name ______________________ Age ________

Address ______________________

City ____________ State ____________ Zip ________

(Fill in facts on reverse side)

RAYTHEON RAY-TEL TWR-9
Transceiver/Intercom
CB Communications Center

While the Ray-Tel TWR-9 is basically a 6-channel crystal-controlled CB transceiver, it is also the "heart" of a complete office and home CB communications center. It takes only the addition of a remote speaker to provide a "hands-free" intercom, remote paging, and remote CB monitoring.

Unlike most other transceivers, the TWR-9 is designed for base station operation only, with the full intention that the user utilize all the communications features that are built-in. To this end there is no microphone; the speaker doubles as a mike—just as it does in an intercom. Depress one switch and the TWR-9 functions as a transceiver—you speak and the signal is transmitted. Depress a second switch and the TWR automatically becomes an intercom. A third switch feeds the received CB signal to a remote speaker or through the intercom.

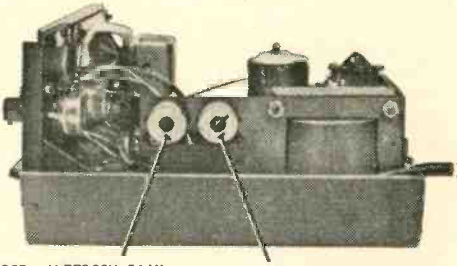
When a "channel switch" is depressed, the intercom facility is automatically disconnected and the TWR-9 instantly reverts to a straight CB transceiver.

The TWR-9 is a hybrid; that is, it utilizes both transistors and tubes. Actually, tubes are used only for the final RF and modulator amplifiers, all the rest is solid-state circuitry.

The Receiver. While the receiver is single conversion, a 455 kHz bandpass filter is used for high adjacent channel rejection. The particular model we tested checked out with 50 dB adjacent channel rejection (very good)—5 dB better than Raytheon's claims. The image rejection also proved better than the specifications, measuring slightly better than 30 dB rejection.

While a 30 dB image rejection is noteworthy for a 455 kHz single conversion receiver, it was also indicative of the excellent front end design of the TWR-9. Many solid-state front ends tend to overload or to even break into oscillation under moderate to strong signal input level; this was not true of the TWR-9. Even the maximum test signal of 100,000 uv. (0.1 v.) failed to "break up" the TWR-9.

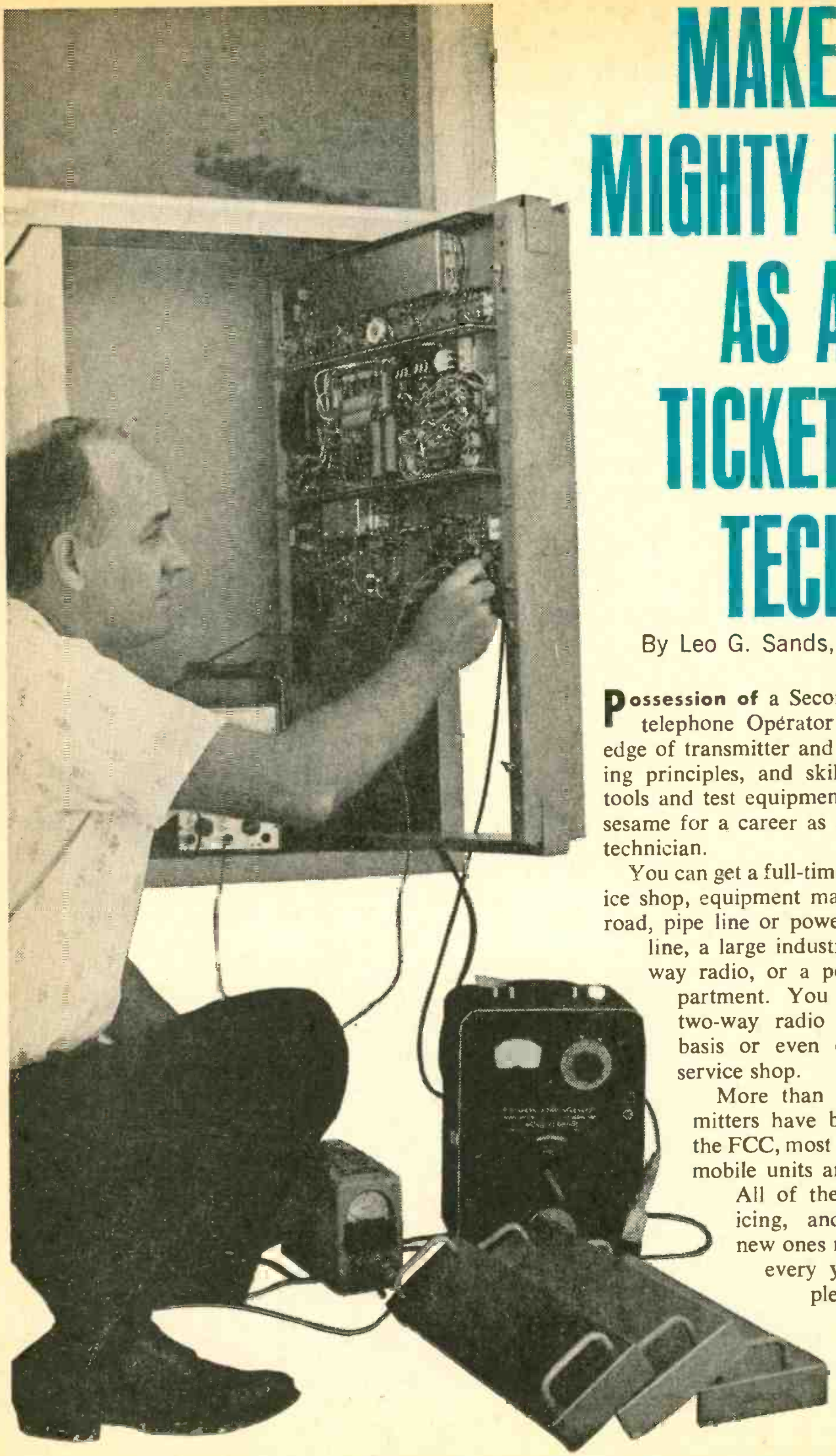
The input sensitivity checked out as 0.7 uv. for 10 dB S+N/N (signal plus noise to noise). Even here the TWR-9 was outstanding (compared to other solid-state units) as the speaker sound was crisp and undistorted even at very low signal levels. The noise limiter performance proved to be about average.



One of the many features of the Ray-Tel TWR-9 is the built-in intercom system with separate set-and-forget gain controls. Other features include push-tab controls like those on tape decks.

The AGC action—the change in speaker output level for a 94 dB change in input level (2 to 100,000 microvolts)—was only 6 dB (very good). In plain terms this means that if the user has the volume cranked wide open to hear a weak signal a strong signal coming on the channel will not blast the speaker.

Both the internal and external speaker impedances are 45 ohms; a "standard" 8 ohm speaker cannot be used for the intercom or remote speaker if the user is to realize the rated (and measured) 2.5 watt audio output. *(Continued on page 118)*



MAKE A MIGHTY BUCK AS A TICKETED TECH

By Leo G. Sands, KOD1939

Possession of a Second Class Radiotelephone Operator license, knowledge of transmitter and receiver operating principles, and skill in the use of tools and test equipment are your open sesame for a career as a two-way radio technician.

You can get a full-time job with a service shop, equipment manufacturer, railroad, pipe line or power company, airline, a large industrial user of two-way radio, or a police or fire department. You can also service two-way radio on a part-time basis or even open your own service shop.

More than 5 million transmitters have been licensed by the FCC, most of them two-way mobile units and base stations. All of them require servicing, and thousands of new ones must be installed every year. There are plenty of job opportunities, and, if you prefer, the chance to go into business for yourself.

What It Takes. First of all, you must be well enough grounded in electronics to pass the examination for a Second Class Radiotelephone Operator license. The written examination covers basic electrical and electronics theory, radiotelephone circuits, FCC rules and radio laws. If you are already familiar with electronics, you can bone up for the exam by getting any of the several radio operator license test question and answer books. Or, if you're starting from scratch, you can take a correspondence course or attend a resident school (see advertisements elsewhere in this issue).

To gain first-hand experience, get a novice ham license (very easy to do), buy a second-hand FM mobile radio unit or base station, and modify it for operation in the two-meter ham band. Also, buy a ham rig kit—preferably an SSB transceiver, because SSB (single sideband) will be in wide use in the future. In short, get plenty of practice building, tuning and using two-way radio and thus get the most mileage from your ham ticket.

Another route you can take is to get a job as an apprentice at a two-way radio service shop. You won't need a license if you work under the supervision of a licensed technician. You'll gain experience making installations, repairing equipment, getting rid of ignition noise, and the like.

Work in repair shop is generally varied enough to offset possible boredom. Technician above is using grid-emission tester to weed out erratic tubes.

Getting A Job. After you've gotten your license and feel confident you can service two-way radio equipment, you can start your own business or look for a job. If you don't want to move to another town, prepare a resume (see our illustration) and mail copies to the two-way radio shops in town, the police and fire departments, and other large local users of two-way radio.

If you don't mind moving to another town, send copies of your resume to the organizations listed in table 1. You might also run a classified advertisement of the "situations wanted" variety in selected magazines covering the electronics field.

Some unique opportunities are available. For example, Kaar Electronics Corporation, a member of the Canadian Marconi group,

Cab companies are excellent job prospects, since radio equipment must be maintained in top working order. Here, mobile unit is removed for repair.

Manufacturing plants generally have well-equipped and well-staffed labs, often with high-precision equipment. This technician is using impedance bridge.

hires two-way radio technicians and gives them intensive training—with salary and living expenses paid while attending school. Graduates are assigned jobs at one of the company's 34 service centers in North America.

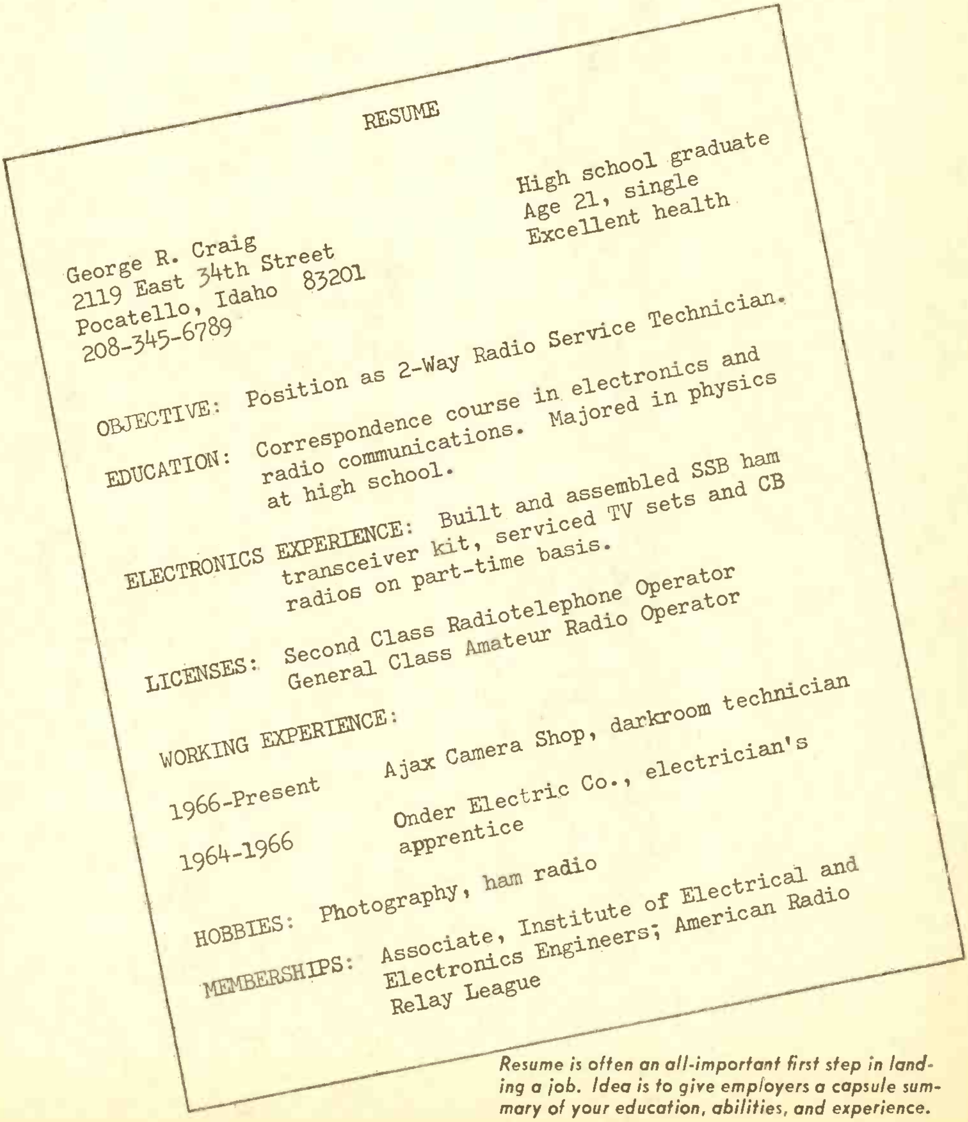
What You Do. A two-way radio technician may be required to perform any or all of the tasks described below.

Working for an independent service shop, you may be required to install and check out mobile units in cars and trucks, hook up and check out base stations, and repair sets on the bench. You may also have to work at eliminating ignition interference generated by radio-equipped cars.

If you work for a railroad, you might be assigned as a bench man at a shop, or you might be required to travel to service base stations and microwave repeaters, or to supervise radio equipment installations at a location other than home base. You'll get free transportation and be reimbursed for living expenses while out of town. Besides, you'll be eligible for a pension.

Working for a pipe-line company would be similar. But, working for a large local user of two-way radio, you probably wouldn't have to travel far enough to be required to spend nights away from home.

Bench Chores. Regardless of whom you work for, you would have to know how to



RESUME

George R. Craig
2119 East 34th Street
Pocatello, Idaho 83201
208-345-6789

High school graduate
Age 21, single
Excellent health

OBJECTIVE: Position as 2-Way Radio Service Technician.

EDUCATION: Correspondence course in electronics and radio communications. Majored in physics at high school.

ELECTRONICS EXPERIENCE: Built and assembled SSB ham transceiver kit, serviced TV sets and CB radios on part-time basis.

LICENSES: Second Class Radiotelephone Operator
General Class Amateur Radio Operator

WORKING EXPERIENCE:

1966-Present — Ajax Camera Shop, darkroom technician

1964-1966 — Onder Electric Co., electrician's apprentice

HOBBIES: Photography, ham radio

MEMBERSHIPS: Associate, Institute of Electrical and Electronics Engineers; American Radio Relay League

Resume is often an all-important first step in landing a job. Idea is to give employers a capsule summary of your education, abilities, and experience.

do the following if assigned as a test bench man.

Measuring transmitter frequencies is a basic chore. You use a frequency meter or an electronic counter to determine that the transmitter operates on frequency, within the specified FCC tolerance. If it's off-frequency, you adjust the crystal trimmer, replace the crystal, or both.

You tune transmitters for optimum performance and measure modulation and power output, using a modulation meter and an RF wattmeter. You measure the sensitivity, selectivity, and image rejection of receivers, using a laboratory-type signal generator and a VTVM. You also align receivers using the same equipment.

You change tubes only if they are weak or otherwise defective (old tubes in good condition are usually more reliable than new ones). You will seldom have to check transistors, since they usually work or don't function at all.

Troubleshooting may take up a lot of your time. You'll probably use a scope, signal generator, VOM, VTVM, and a grid dip meter. When you replace parts, you'll undoubtedly use factory-furnished parts which must be mounted securely to withstand mobile service.

Tuning transmitters into their antenna systems (in a vehicle or at a base station) may be another of your chores. You'll probably use a through-line RF wattmeter (SWR meter). You may also be required to make service calls at base stations.

If your employer is also in the marine field, you'll probably have to repair marine radiotelephones on the bench and check them out on boats.

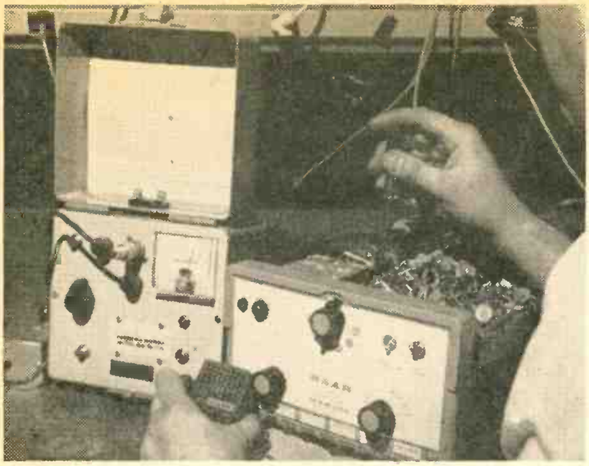
Many technicians find duty calls them for service on the front line, and the one in the photo is no exception. Employed by a firm servicing 2-way marine radios, he checks transmitter output at dockside.

Your Own Shop. If you want to go into business for yourself and don't have a few thousand dollars in reserve or can't get a loan, stick with your job and start on a part-time basis. You'll have to lease or buy much of the equipment listed in table 2. To get customers, write, phone, or call on your local taxicab companies and other users of two-way radio. If you do a good job, your customers will probably refer you to others.

When you're ready to go into the two-way radio service business full-time, find a garage building or vacant store with an enclosed area into which cars can be driven. Set up your bench, get all of the necessary equipment, install adequate lighting, and provide an office for receiving calls for service. Guard your telephone line with an automatic

Table 1. Where to Apply for Jobs

Kaar Electronics Corp. 1203 W. St. Georges St. Linden, N.J. 07036	RCA Service Co. Cherry Hill, N.J. 08034
Communications Co., Inc. 300 Greco Ave. Coral Gables, Fla. 33146	Motorola Communications & Electronics 4501 W. Augusta Blvd. Chicago, Ill. 60651
General Electric Co. Communications Products Dept. Lynchburg, Va. 24500	Mr. Ivan Loucks Association of American Railroads 59 E. Van Buren St. Chicago, Ill. 60605
Radiation Services, Inc. Melbourne, Fla. 32901	Hammarlund Mfg. Co. 73-88 Hammarlund Dr. Mars Hill, N.C. 28754
Director of Communications Police Department Any City, U.S.A.	Canadian Marconi Co. 2442 Trenton Ave. Montreal 16, Que.



Above, technician uses International Crystal C-12N to gauge Kaar marine transmitter. Placing transmitter on frequency requires simple screwdriver adjustment, but years of training and practical experience.

Public transmit, like cab industry, is another heavy user of 2-way radio and thus another prime job prospect. Most such organizations offer excellent working conditions and a variety of fringe benefits.

telephone answering machine or use a telephone-answering service.

To get business, have an announcement printed and mailed to all known two-way radio manufacturers. Some of them may be looking for a shop in your area to serve their users.

To keep up business development, you should keep posted on who's buying two-way radio in your area. Subscribe to Industrial Communications (1327 F St. N.W., Washington, D. C.) which lists all new land mobile licensees. And don't overlook the CB market. About 3 million CB sets are in use and some 40,000 new ones are being sold monthly. You can buy lists of new CB licensees in your area from CB Mailing Lists, Box 60445, Oklahoma City, Okla. 73106.

You might also advertise occasionally in your local papers on the financial pages. By all means, have your business listed in the telephone directory yellow pages under "Radio Communication Equipment & Service."

Selling Equipment. To build your income, you can also sell communications equipment. Actually, most two-way radio manufacturers (RCA and Motorola are two notable exceptions) are seeking dealers. You won't have to invest a lot of money in merchandise, except for demonstration samples. When you make a sale, you order the equipment with the proper crystals installed at the factory. You can get a radio station license for demonstration purposes.

You can also sell antennas, ignition-noise suppression systems, monitor receivers, paging receivers, and even radar (for weather observation). If you're in a boating area, don't overlook marine radio.

(Continued on page 117)

Technicians with radar-endorsed licenses are free to service marine radar on ships and pleasure craft.

Table 2. Test Gear You Will Need

AF signal generator
Dummy load, 50-ohm
Frequency meter, 2-25 MHz, 0.001% tolerance
Frequency meter, 25-470 MHz, 0.001% tolerance
Modulation meter, AM (scope may be used)
Modulation meter, FM (sometimes included in frequency meter)
Oscilloscope, DC to 5 MHz frequency range
Power supply, 0-16 volts, metered
RF signal generator, general purpose
RF signal generator, lab type, to 470 MHz
RF wattmeter, 0-10 and 0-100 watt ranges
Transistor tester, in-circuit type
Tube tester, transconductance or dynamic mutual-conductance type
VOM, 20,000-ohms/volt or better
VTVM, AC and DC with probes for RF

By James A. Fred

4D Power Supply

This neat and nifty little power package is easy to build and will earn its keep day in, day out.

So what's new in power supplies? Not much, but you still need 'em every time you want to diddle, fiddle, or experiment in any way. Catch is, a handy little inexpensive rig for powering transistorized devices is hard to come by. But our 4-D Power Supply will fulfill the requirements of the most avid experimenter—and serve the needs of the solid-state device repairman as well. Here's what our 4-D goodie'll do for you.

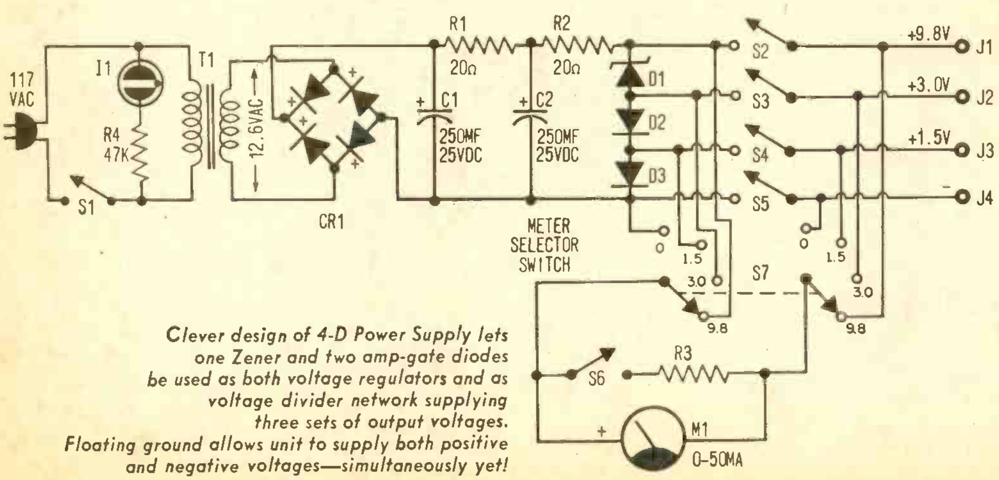
Most transistorized home entertainment equipment—i.e., radios, recorders, and record players—operate on multiples of 1.5-volt zinc/carbon cells or on 1.35-volt mercury cells. There are also some units that require negative voltages of 1.5 or 3 volts in addition to 4.5 or 6 volt positive.

Our 4-D Power Supply will give you voltages of 1.5, 3, 6.8, 8.3, and 9.8 volts—positive *or* negative. These voltages are all Zener-diode regulated and will supply a total of 100 mA regulated output. Each output is metered by the self-contained current meter. The 100 mA supplied is in excess of most requirements in the entertainment field, but that makes the unit useful in just about any eventuality.

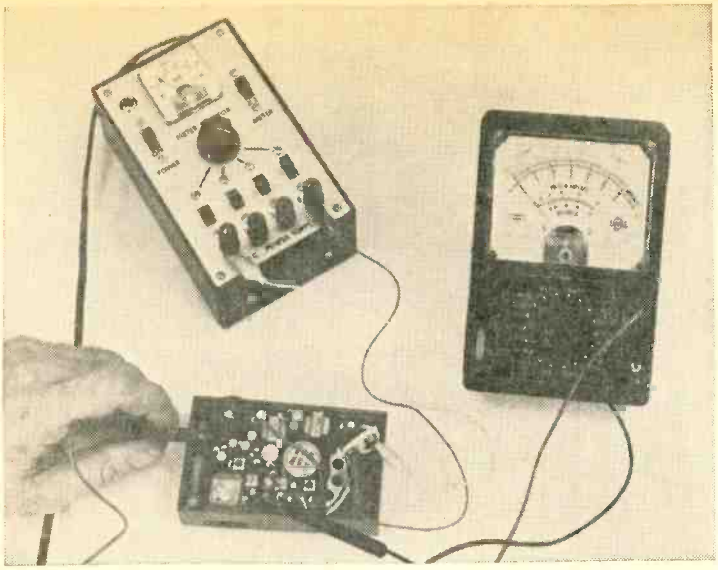
Until recently, there were no diodes capable of regulating as low as 1.5 volts. This power supply makes use of a new device called the amp-gate diode, originally developed for use in preventing overcharge of nickel-cadmium 1.5-volt cells.

How 4-D Ticks. Two amp-gate diodes are connected in series with a 6.8-volt Zener diode and current limiting resistors R1 and R2. There will always be approximately 125 mA current flowing in the circuit. When the load isn't drawing any current, 125 mA will flow through the three diodes in series. When the full 100 mA is drawn by the load, the diode string will draw 25 mA.

The accuracy of the output voltages will depend on the tolerance of the diodes in series. If at all possible, buy a 6.8-volt Zener with a ± 1% tolerance. The amp-gate diodes are nominally rated at 1.5 volts. However, because the power supply has a float-



Clever design of 4-D Power Supply lets one Zener and two amp-gate diodes be used as both voltage regulators and as voltage divider network supplying three sets of output voltages. Floating ground allows unit to supply both positive and negative voltages—simultaneously yet!



Uses of the 4-D Power Supply are unlimited—by virtue of providing a variety of voltages commonly required by transistor equipment, being fully regulated up to 100 mA output, and by allowing accurate monitoring of current consumption. Here unit is being used to service portable transistor radio.

ing ground, it's possible to use any voltage as the zero reference point.

Since one of the drawbacks of many commercial power supplies is the lack of a current meter, you will find one included here. It is a miniature type, 0-50 mA meter calibrated in 50 divisions. A shunt and switch are provided that increase the meter range to 100 mA for the higher current loads. The meter selector switch is in parallel with a slide switch that is in series with each output terminal. When the selector switch is set for a particular circuit and its slide switch is opened, the meter will read the current in that line.

Putting 4-D Together. To build our 4-D Power Supply, it will be necessary to obtain the parts listed. Some substitutions may be made for the manufacturers mentioned, but the values shown should be adhered to as closely as possible.

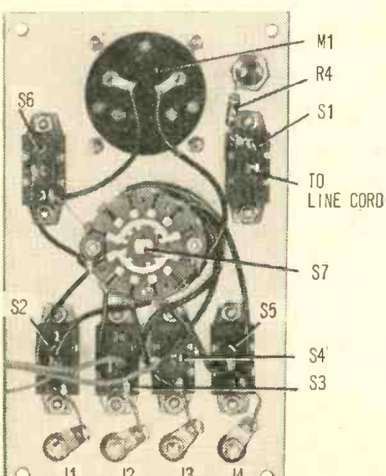


Photo of back of panel shows layout of components and panel wiring of author's prototype.

The power supply proper is mounted in the bakelite box, while the metering and switching circuits are attached to the front panel. The completed unit is very compact, but if you wish, it can be made larger with a corresponding increase in the ease of construction.

To start the project, you should lay out the front panel, following our photo. Make the various size holes by whatever method is simplest.

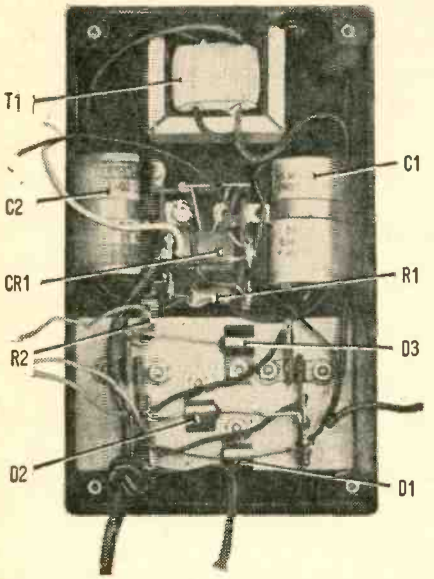
After all the holes are done, etch the aluminum to a satin finish in a mixture of lye and hot water (the lye and water must be mixed in a stoneware crock or an enameled pail). After etching, rinse in cold water and carefully dry with a paper towel. Now spray the panel with a coat of Testors clear spray (available at most drug, variety, and hobby stores). Apply decals or press-on letters to indicate the function of the various switches, binding posts, etc. A second coat of spray will serve to seal and protect the lettering. Carefully mount the needed parts on the front panel.

The power supply guts are secured to the bottom of the box. The layout here is very important because if you're careless, the cover may not go on. The heat sink is made from ⅛-in. aluminum. If you can't find the thick stuff, use several layers of thinner material. If you use 1-watt diodes, you'll have to heat-sink by clamping them to the alum-

4-D POWER SUPPLY

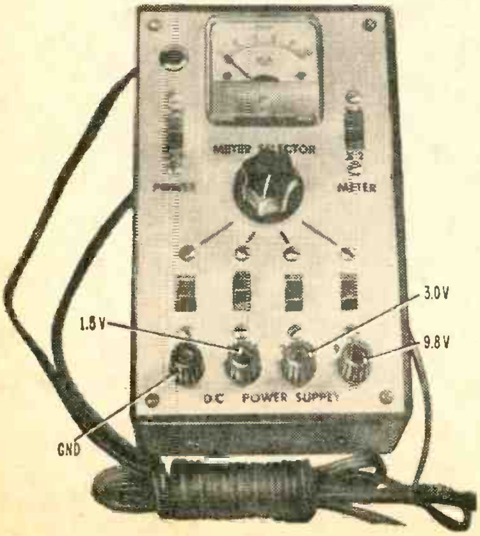
inum with the cable clamps as specified.

The heat sink is located by pushing it as far as it will go into the end of the box. The holes for the transformer and line cord are drilled in the opposite end of the box. Also drill the other holes for terminal strips and capacitor mounting straps—be very careful.



Major components of power supply are mounted in box as shown above. Actual location of parts isn't critical, but make sure there's enough room left to get the front panel on.

Completed 4-D Power Supply below is ready to fire up those transistor projects you've been itching to build.



PARTS LIST

C1, C2—250-uF, 25-WVDC electrolytic capacitors
CR1—Full-wave rectifier bridge, 300 V, 200 mA (Mallory FW50 or equiv.)
D1—6.8 V, 125 mA Zener diode (Mallory ZA68B or equiv.)
D2, D3—1.5 V, 125 mA amp-gate diodes (Mallory AGD or equiv.)
I1—Pilot light assembly (Lafayette 99C6226 or equiv.)
J1, J4—Binding posts, 1 black, 3 red (Lafayette 99C6233 or equiv.)
M1—0-50 mA, 1 3/4-in. square face (Lafayette 99B5054 or equiv.)
R1, R2—20-ohm, 3-watt resistor (Mallory 3AE20 or equiv.)
R3—1-ohm, 3-watt resistor (Mallory 3AE1 or equiv.)
R4—Integral part of I1 assembly
S1, S6—S.p.s.t. slide switches (Lafayette 34C3703 or equiv.)
S7—2-pole, 4-position selector switch (Mallory 4M2215 or equiv.)
T1—Filament transformer: primary, 117 VAC; secondary, 12.6 VAC @ 1A; size max. 1 3/4 x 3x3 in. (Burstein-Applebee 17B392 or equiv.)
1—Bakelite case and panel, 6 1/4 x 3 3/4 x 2 in. (Radio Shack 270-627 or equiv.)
5—2-terminal strips (Allied 24A9088 or equiv.)
2—1-terminal strips (Allied 24A9085 or equiv.)
Misc.—Knob, screws and nuts, wire sleeving, solder, wire clamps, etc.

Estimated Cost: $20.00
Construction time: 6 hours

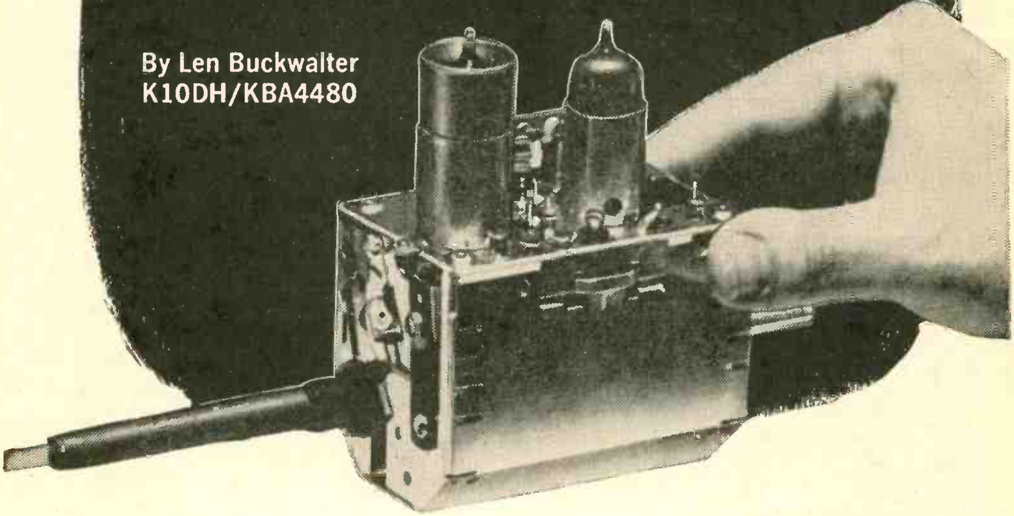
After mounting and wiring the parts, solder two 4-in. long black wires to the minus terminal. Three 4-in. long red wires are soldered to the positive points between the diodes. The transformer primary is brought to the other end of the box to connect to the *on/off* switch. One line cord wire ends at this switch. The other line cord wire goes to a terminal, as do a transformer lead and a 4-in.-long white wire. The other end of the white wire connects to the pilot light on the front panel.

Before connecting the balance of the wires to the front panel, check the voltages at the ends of the red wires. Temporarily connect up the AC leads so you have power. The DC voltages should read + 1.5, + 3.0 and + 9.8 volts.

If the voltages check out, finish the wiring to the front panel and attach it to the box with the four mounting screws. With the 4-D Power Supply finished, you're all set for years to come—whatever your transistor power needs may be. ■

TV's Fussy Front End

By Len Buckwalter
K1ODH/KBA4480



Before you can do, you gotta know how, and that's why what it takes for perfect pix is knowing how your tuner ticks.

Teen-agers twist it with gusto, toddlers tear off its knobs. Servicemen tremble when they look inside, TV setmakers gladly let an outsider produce it. An object of awe and scorn? No, it's your TV tuner. Located inches behind the channel selector, it's a mish-mash of components eerily electronic and magnificently mechanical. In a few thunk-thunks of the dial, it grabs one of 82 channels, trims away interference, whisks off snow, restores the signal's spent vigor, then shunts it onto an intermediate frequency.

Easier said than done. When the job of the TV tuner is closely examined, it sounds like the Twelve Labors of Hercules. First, tuners cover a galloping tuning range. Channels 2 through 83 are really three bands with yawning frequency gaps between. Too, the tuner must operate with remarkable sensitivity and low drift to keep sound, picture, plus a mixed bag of synchronizing signals perfectly centered on the bandpass of following circuits. And all the while it can't succumb to the pulverizing pounding, estimated at 100,000 twists over a decade. Put a tuner on the block and you'll see why they call it television's "front end."

It's Super Yet. The TV tuner is the starting point of a superhet circuit little different in principle from that of an AM or FM radio. Any incoming channel is treated to the superhet's usual 3-step process: selection, amplification and mixing. The end result is the desired channel stepped down to the receiver's intermediate frequency, approximately 44 MHz, in this case. Then a fixed IF amplifier can further boost the signal with high efficiency and selectivity.

How Channel 4 jogs through the tuner is shown by the block diagram in Fig. 1. All channels in the area surge into the antenna, flow down the twinlead and bark at the tuner's doorstep, the RF Amp. Tuned circuits in the amplifier, set up for Channel 4 by the channel selector switch, permit only 69 MHz (Channel 4 center frequency) to ride through to the mixer.

Also aimed at the mixer stage is a signal from the local oscillator. The channel selector has set up tuned circuits in the stage to emit a steady 113 MHz. The mixture of channel and oscillator signals creates the difference frequency—or 44-MHz IF signal. That's a constant value. Switch to Channel 13, for example, on 213 MHz and the tuner responds by tuning to the new frequency. Now the local oscillator steps up to 257 MHz so the difference frequency is still 44 MHz.

This aspect of tuner operation is hardly a challenge. Programming tuned circuits to mix and match frequencies might be done by an engineer with little more than a sharp pencil on the back of an old envelope. It's mostly a matter of figuring the values of coils and capacitors to do the tuning. What might cause him to run off at the mouth is the enormity of the tuning range. Tuned circuits act cantankerous when pushed too far.

Too Many Variables. Most simple radios' tuned circuits have a fixed coil teamed with a variable capacitor to determine the received frequency. As the radio dials higher on the band, capacitor plates open to reduce capacity. But in addition to changing tuning frequency, another effect sneaks in to nibble at the circuit's efficiency. At the high end of the band, the coil becomes relatively large in value compared to the capacitor. This blows up the effect of coil resistance as a circuit element. Like any resistance, it cuts down current flow. This explains why stations on the high end of the band are seemingly weaker than frequencies received at the low end. The resistance also tends to broaden out the circuit so it accepts a wider range of frequencies. If these conditions are reversed—high capacity, low coil inductance—circuit efficiency shoots up. But the circuit bandpass also becomes razor sharp. Thus the circuit designer must play with the tuned circuits until he strikes a working compromise with what's known as "L/C ratios."

In the TV tuner the problem is magnified. Not only would simple circuits slaughter sensitivity due to vast tuning ratios, but ruin selectivity as well. It is rarely practical to

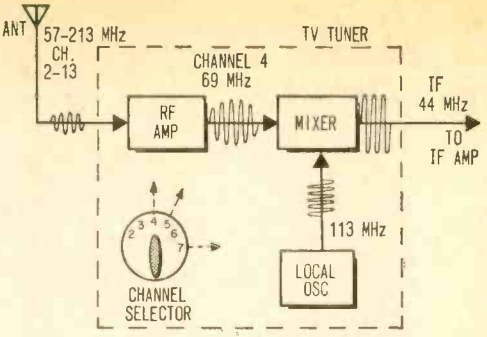


Fig. 1. Channel selector controls both RF tuning and local oscillator frequency by inserting different LC networks into tuner circuit.

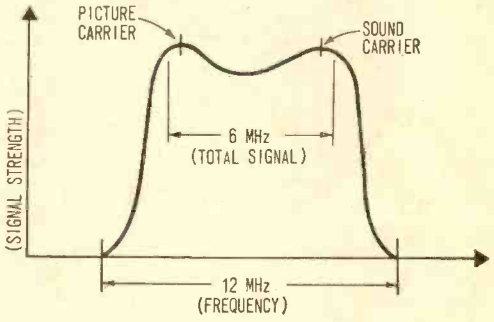


Fig. 2. Tuner's tuned circuits resonate at picture (video) carrier and sound-carrier frequency to provide broadband response necessary to accommodate 6-MHz composite signal bandwidth.

construct a single coil-capacitor combo to cover Channels 2 through 13, a span which runs from 54 to 215 MHz. (And there's a 100-MHz hole between Channels 6 and 7.) Some early TV receivers attempted to solve the problem with the "continuously tunable inductor." As the channel selector turned, a shorting bar moved along a coil and changed its inductance. This kept tuning ratios in check. In another system, the channel selector raised and lowered tuning cores inside coils but it also required a "Hi-Lo" switch to choose between low band (Ch. 2-6) and high band (Ch. 7-13).

Systems in today's television sets handily attack the tuning problem. In each approach, tuning circuits are shaped to each channel. Switch-selection makes tuners easy to operate, as opposed to tedious continuous hand-cranking of earlier days. Since L/C ratios are carefully selected, the tuner's door to an incoming signal opens to a bandwidth

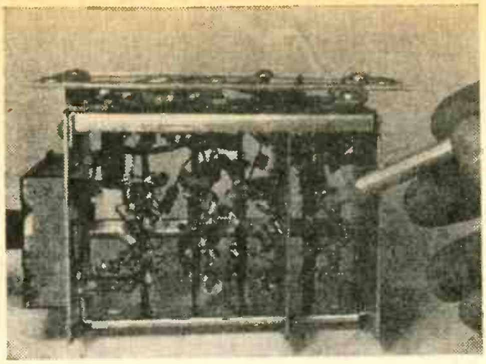


Fig. 3. Typical wafer-switch has coils soldered to switch lugs—movable contacts switch coils in or out of RF and oscillator circuits.

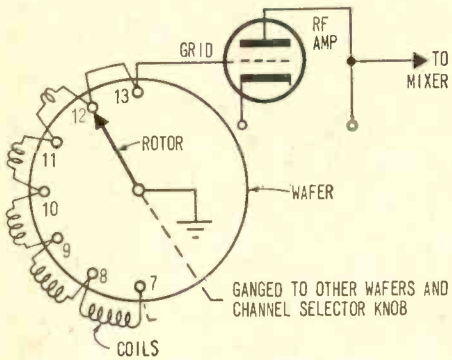


Fig. 4. Schematic representation of RF section in wafer-switch tuner shows series-connected coils that add inductively to select channel. Distributed capacitance allows circuit to resonate.

of approximately 12 MHz. This occurs for any channel so the tuner accords about the same amount of sensitivity and selectivity throughout the bands.

Big Bandwidth. A TV tuner's opening, or bandwidth, presented to a signal is shown in Fig. 2. Something wrong with that curve? You can see the tuner opens to 12 MHz (bottom), but the signal itself is merely 6 MHz wide. That's the slice of spectrum issued by the FCC to each TV station. It takes 6 MHz to accommodate everything from picture and sound carrier, their modulation, plus hip room to prevent adjacent channels from sidling against each other. (Channel 10 is 192-198 MHz, for example.) Nevertheless, the tuner is broadened to 12 MHz for reasons of economy. You'd have to be NASA to afford a circuit that clamps, vise like, exactly over the signal. Besides, tuning would be extremely critical. The 12-MHz figure is a comfortable compromise between high gain and adequate selectivity.

The selectivity curve shown in Fig. 2, incidentally, is not the response of a single tuned circuit. As we'll see, the signal passes through several resonant stages. When the tuner is aligned at the factory, one coil is peaked on the picture carrier, and another is tuned to the sound signal. This system of "stagger tuning" produces a composite response and explains why the two carriers are sitting atop bumps in the curve. The peaks represent individual tuned circuits.

One trick used in low-cost television receivers is aligning circuits so the curve rises higher than shown. This is done to make up for a deficiency in the receiver's sensitivity. But as the curve rises, it also pulls in its sides (becomes more selective) and clips some frequencies at the sides. You can often spot these sets by carefully viewing the picture; it suffers from loss of small detail (like clothing texture). These picture frequencies don't fare well through flinty circuits. Let's inspect several tuners that deliver solid pix and sure sound.

Wafer-Switch Tuner. The photo in Fig. 3 is that of an Admiral tuner with its bottom cover removed. The series of flat plastic wafers with coils mounted around the edges identify it as a *wafer-switch* tuner, one of the three most common types. Each wafer tunes a major section in the tuner (RF amplifier, Mixer and Oscillator). Since all wafers are similar, we can show the operating principle by the action of one; the input of the RF amplifier in Fig. 4.

The coils arrayed around the wafer are actually one long inductor in terms of electrical effect (though they physically appear as separate coils). As the Rotor swings around it grounds, or short-circuits, more coil sections. Thus, when the selector is on Channel 12, as in this example, total coil inductance is that of the small hairpin loop between pin 12, 13 and the tube grid. This is enough inductance for the high frequency of Channel 12 (207 MHz). There is no coil on the wafer for Channel 13. There is enough inductance in the wiring between switch and tube grid to resonate 213 MHz.

Neither are there tuning capacitors for any of the coils. There is ample distributed capacity between coil turns, switch, wiring and tube grid to resonate the inductors to the desired channel frequency. When the tuner is manufactured, a technician adjusts each channel by squeezing or pulling apart coil turns. (*Turn page*)

e/e FUSSY FRONT END

A look at an actual schematic of a wafer-switch tuner reveals some refinements, especially for tuning the local oscillator. In Fig. 5 is an RCA tuner used in one of that company's 19-inch sets. Three wafers and coil assemblies along the bottom provide tuning (from left to right) for input of the RF amplifier, input to the mixer, and frequency control of the local oscillator. If we concentrate on the oscillator wafer at the lower right, we see that each coil contains a tunable core, or slug, identified by an arrow to each coil "L" number. These slugs permit exact tuning of the local oscillator and, in a sense, actually constitute 13 steps to perfect pix. For unlike RF and mixer sections, the oscillator must generate an exact frequency. Otherwise, the emerging IF signal would not be squarely centered on the IF amplifier frequency.

In most TV sets, those oscillator slugs are accessible from the front of the cabinet. The channel selector knob is removed and a screwdriver inserted through the hole into the front wall of the tuner. (See Fig. 6.) The slugs are tuned for best picture and sound on each channel. These adjustments, however, are not final and tend to drift off-frequency within a short time. This is solved by the fine-tuning control operated by the viewer. It enables him to jog the local oscillator a few MHz whenever the set is used. If you refer back to Fig. 5, you'll see the position of the fine-tuning control in the circuit; at top right is a variable coil ("Fine

Fig. 6. Most tuners' oscillator coils are permeability tuned and can be adjusted from front of set for correct center frequency.

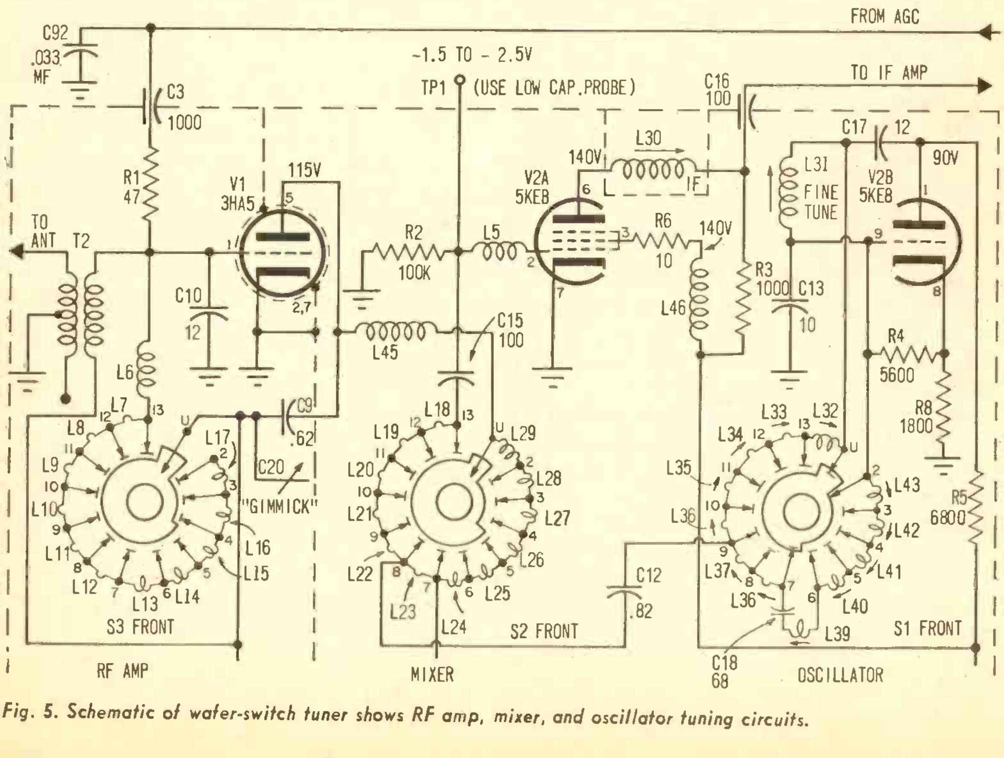


Fig. 5. Schematic of wafer-switch tuner shows RF amp, mixer, and oscillator tuning circuits.

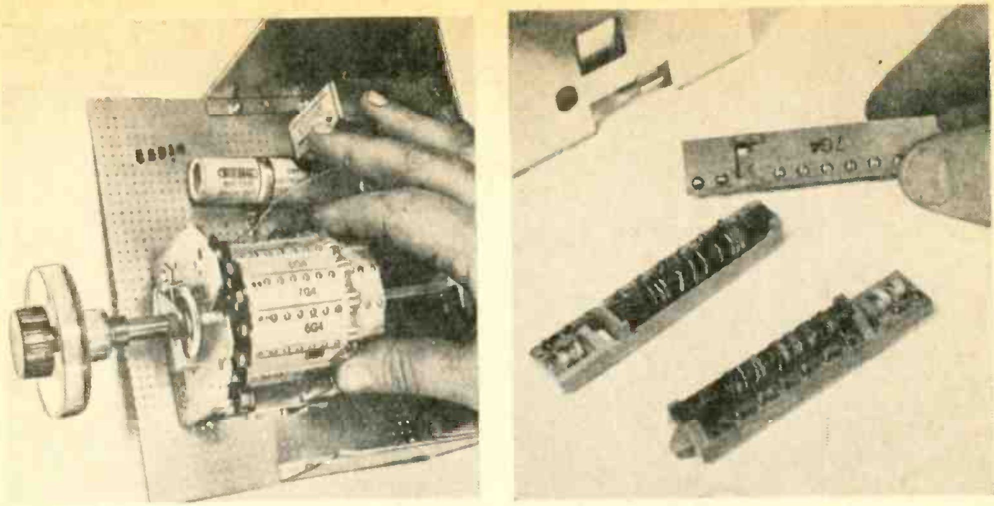


Fig. 7. Popular turret tuner (left) has a separate strip (right) for each channel. Strips snap into place on turret and have permeability tuned coils each connected to a separate set of contacts. Defective strip can easily be replaced with new one.

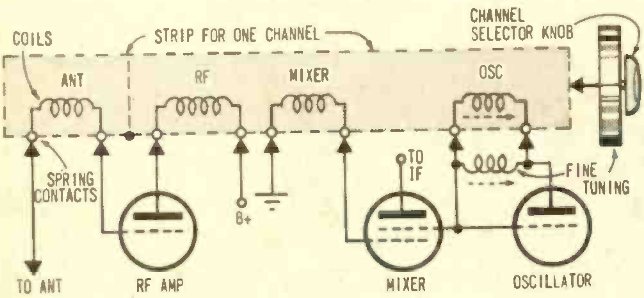


Fig. 8. Coil strips of turret tuner are rotated by selector knob; spring contacts connect strip's coils to tuner circuit as shown in schematic. Note that both RF output and mixer input are tuned by separate coils in turret tuner—wafer switch tuner uses only one set of coils between RF and mixer.

Tune") which manually trims the oscillator frequency. In other tuners, fine-tuning might be a variable capacitor.

Firing from the Turret. Another tuner in the sets of many manufacturers is the *Turret* type. It's easy to spot since the channel selector turns a large drum, or turret, like the one in Fig. 7: Positioned around the drum are plastic "strips"—each containing a set of coils for one channel. (Several strips are shown removed from the drum at right.) As the viewer turns the channel selector, the turret brings strips into contact with the rest of the tuner through spring contacts. Let's examine the schematic of a turret tuner to see how the coils operate.

The model in Fig. 8 is made by Standard-Kollsman, supplier to many major TV-set makers. One strip and its complement of coils may represent all other channel strips. Note that spring contacts connect coils to the various stages. The front, or knob, end of the tuner is on the right in the schematic. This places the oscillator just behind the channel selector knob so it will be easy to tune the slug (Fig. 6) from outside the set. It also places the fine-tuning coil closest to its knob.

Slipped Disks. A more recent entry into the tuner game is the *Disk* tuner. It is really a combination of the types already described; wafer and turret. As our example, we've shown in Fig. 9 the transistorized tuner from a Hitachi 12-inch portable. Electrically, there is little difference; it's the mechanical arrangement that's novel. All coils are mounted on wafers, or disks, but instead of remaining stationary, the complete wafer rotates with the channel selector switch. Spring contacts (as in the turret tuner) make connection between the disk and the rest of the tuner's circuitry. A big advantage of the disk system is that a technician doesn't have to poke deep into the

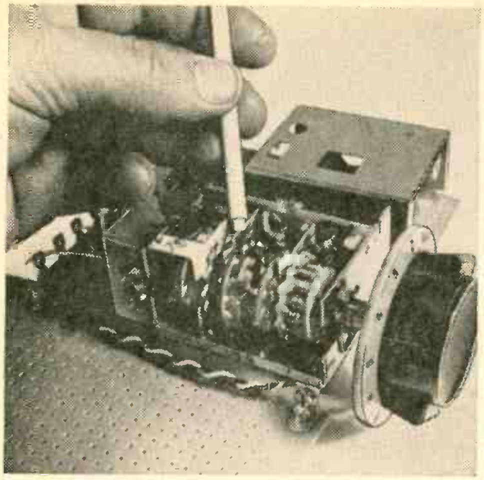


Fig. 9. A new type compact tuner—the disk tuner—has the coils mounted on rotating disks, combining compactness of wafer switch tuner with easy serviceability of turret tuner.

tuner for most repair and alignment. Coils are easily rotated into view—especially important in this teeny tuner.

U-Too. Since 1964, all TV sets by law must be equipped (Fig. 10) for UHF reception (Channels 14 through 83). Since frequencies on this band are so much higher than for VHF, there is a different tuner design approach. As mentioned earlier, it is possible to tune Channel 13 with virtually no discrete coil due to high frequency. Yet, even the lowest UHF channel puts a regular tuned circuit to a severe test. UHF commences at 470 MHz and surfaces at the near-microwave region of 890 MHz. The solution to UHF has been a separate tuning unit and a clever tactic which makes full use of the VHF tuner. Several UHF systems have been developed, but here's the one that's won out in most sets today.

The overall plan is shown in block form in Fig. 10. When the viewer wishes to tune a UHF channel, he first turns the regular channel selector to the "U" position. (This is equivalent to switching to a

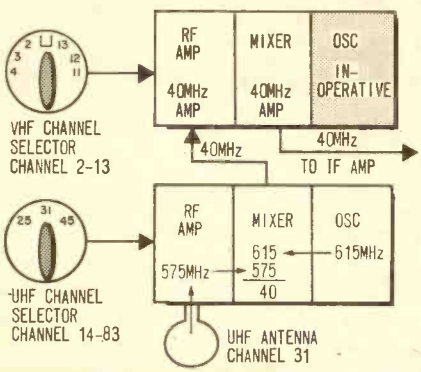
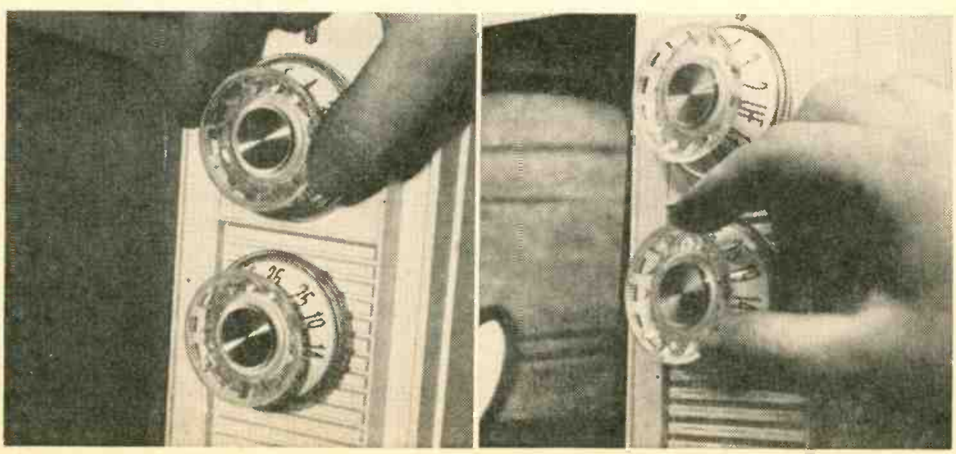


Fig. 10. TV sets tuning UHF range usually employ converter to reduce UHF frequency of 470 to 890 MHz to 40-MHz signal. VHF tuner section is used for additional gain. Process of frequency conversion is shown in block form at left. Tuning of UHF channels (below) is accomplished by setting VHF channel selector to U, then adjusting continuous-tuning UHF selector to area of desired channel. Fine tuning is usually done with same control and is set for best picture.



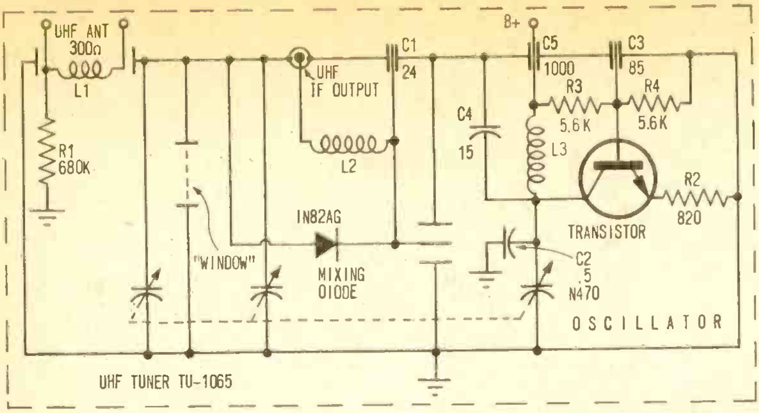


Fig. 11. In typical transistorized UHF tuner, only the oscillator is active. RF and mixer sections are passive, providing tuning function but no gain. Needed additional amplification of signal is provided by associated VHF tuner RF and mixer stages employed as IF stages.

fictitious Channel 1.) Inside the VHF tuner, coils don't set up the various stages exactly as before. As you may recall, the coils tuned the RF amplifier and mixer to the channel frequency, and determined the oscillator frequency. But when the tuner is in the U position, the RF and mixer stages are tuned to 40 MHz. Now they function as straight 40-MHz amplifiers. Also, the local oscillator stage is completely disabled by suitable contacts on the wafer switch (or strip if it's a turret tuner).

Now to follow the action of the UHF tuner. Note that it has the same stages used in the VHF tuner; RF, mixer and oscillator. What's more, they seemingly perform an identical electrical function. Incoming UHF signals enter the RF stage where the desired signal is tuned and sent on to the mixer. For example, channel 31 on 575 MHz is being mixed with the oscillator frequency of 615 MHz. The result is the IF on 40 MHz. This is amplified by the VHF tuner and sent along to the regular amplifier. Yet there is much that is different about the UHF tuner. For one, it contains no amplification. This can be seen by the actual UHF tuner shown in Fig. 11, used in a recent Setchell-Carlson TV receiver. Only the transistor oscillator at the extreme right is active. The RF tuning and mixer sections are "dry"—or passive. Here's how they work.

The heavy vertical bars in the tuner are short rods or spirals which are equivalent to coils at UHF frequencies. Below the three bars are sections of a variable tuning capacitor, controlled by the channel selector. When an incoming UHF channel arrives from the antenna, it enters the circuit at the top left. A small matching coil here (L1) couples the signal to the first rod. This is equivalent to an RF stage—the desired signal is tuned. Next the identical tuning action is repeated. The signal is coupled, through the "window," to the next tuning rod and capacitor. (The window is actually a small opening in a compartment of the tuner.) The second tuning section simply imparts additional selectivity and helps reject interference.

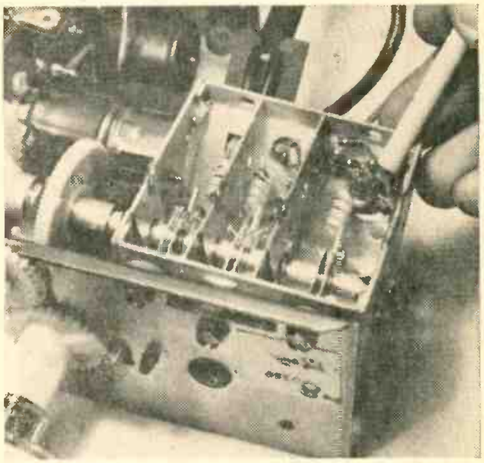


Fig. 12. RF, mixer, and oscillator sections of typical UHF tuner occupy separate shielded compartments. Heavy metal spirals take the place of coils at temperamental UHF frequencies.

Now the signal is ready for mixing. The mixer stage is simply a diode that receives channel and oscillator frequencies and produces the difference signal, or IF. From the left, the diode picks up the channel frequency via a short rod positioned next to the window. The oscillator signal is received from the right through a short pickup link poking into the oscillator compartment. Just above the diode is a tuned circuit on 40 MHz (L2) which taps off the IF or difference signal and sends it to the VHF tuner.

The UHF tuner is a simple device from

e/e FUSSY FRONT END

an electrical standpoint, but mechanically, it's a very sophisticated piece of plumbing. Its operating frequencies are very high and intricate mechanics take the place of conventional components in lower-frequency circuitry. And since it exploits the amplifying power in the VHF tuner, the VHF remains remarkably simple, rugged and effective. (See Fig. 12.)

In most UHF tuners (as in VHF) there are both main and fine-tuning controls. But in UHF, fine tuning is done mechanically through gearing-down between the two knobs (Fig. 13.) Continuous, (smooth)

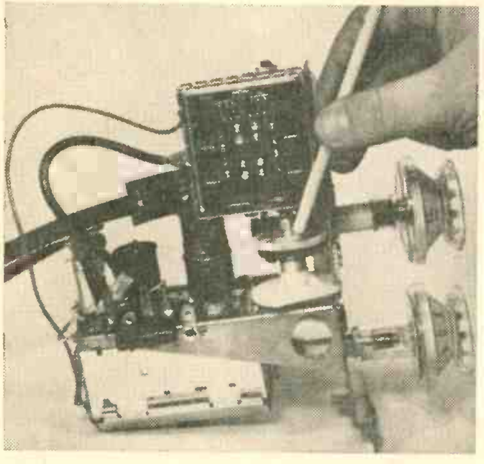
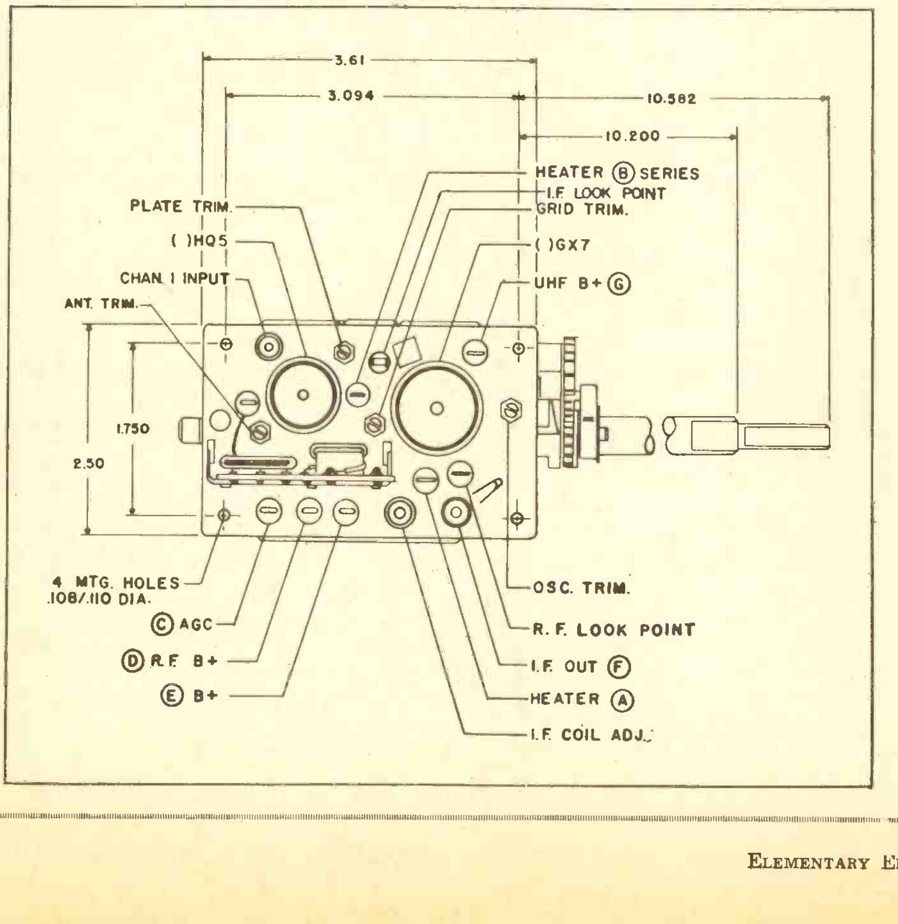


Fig. 13. Tool points to mechanical coupling of main tuning and fine tuning of typical UHF tuner. Gearing-down of fine tuning knob gives simple and direct control.

Fig. 14. Typical modern, high-performance tuner layout is shown below. New designs offer cascode front end for tremendous sensitivity and memory fine tuning that prevents having to adjust fine tuning each time channel selector is rotated.



tuning on UHF is no problem since stations on the band are few and far apart. Rapid tuning is possible with the main selector.

Tuning in Tomorrow. Circuits in VHF tuners have experienced steady progress in electrical performance. (A recent model is seen in Fig. 14). Designers have improved RF stages in a persistent quest for hotter front-end performance. Greater sensitivity permits tuning weaker stations with less snow or noise. What began as a simple pentode tube has evolved into the efficient "cascode" circuit found in higher-priced models. But the big change in tuners today, is surprisingly, in tuning. That's primarily due to the success of color TV.

Tuning a color program is far more touchy than for black-and-white. The reason is the color sub-carrier, a signal which must drop into the narrow-band IF amplifier with precision. This is accomplished by the viewer through careful adjustment of the fine-tuning control. He must repeat this for each channel. In tuners of most new sets, however, the manufacturer adds a new feature to ease the burden. It's called "memory" or "pre-set" tuning.

As mentioned earlier, fine-tuning in a VHF tuner is accomplished by manually adjusting a small coil in the oscillator. Problem is there's only one coil for all channels. This means an adjustment on one channel is rarely correct for another, so fine-tuning must be repeated every time the channel selector is moved. In the memory-type tuner, each channel has an independent fine-tuning adjustment. But this is not as revolutionary as it might seem.

If you recheck Fig. 6, you'll see that slugs in each oscillator coil are adjusted by a screwdriver inserted through the front of the set. What the memory tuner does is present these same adjustments to the viewer whenever he turns the fine-tuning control. The tuner-maker adds a small gear wheel to each oscillator slug, as shown in Fig. 15. When the viewer grasps the fine-tuning, it automatically bites into that channel's gear wheel, permitting him to make adjustments. This automatically disengages when the viewer releases the knob. Let's say he turns to a new channel. Its gear wheel pops behind the fine-tuning knob and the viewer may repeat the process for the new channel. The important feature is that adjusting one channel doesn't upset all the others. It eliminates the need for frequent touch-up of the knob.

AFC Here Too. Even this mechanical convenience is showing signs of giving way to a better system. It's AFC, or automatic frequency control, used for years in FM radios. Now TV makers are grabbing it for color sets. After the viewer adjusts fine-tuning one time for each channel, an electronic hand takes over from there. This system, as it appears in some current models, is

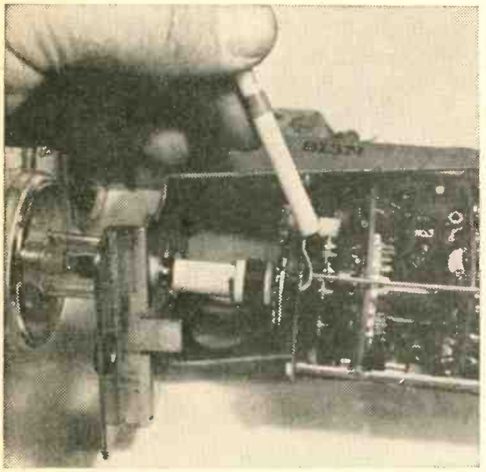


Fig. 15. Tool points to gear on slug of oscillator coil used for memory fine tuning.

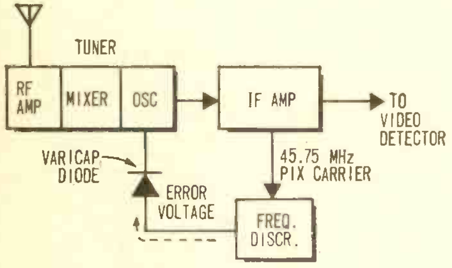


Fig. 16. Block diagram shows how AFC is employed in new tuners for automatic fine tuning.

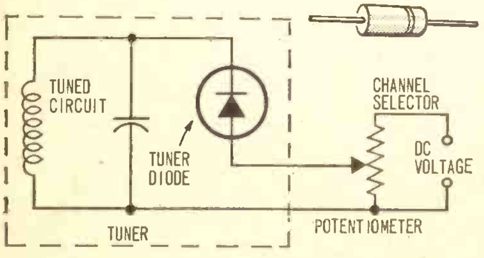


Fig. 17. New tuner diode may allow electronic tuner to replace current mechanical jobs.

shown in Fig. 16. It's based on the fact that a perfectly tuned channel ultimately has a picture carrier on 45.75 MHz as it travels through the receiver's IF amplifier. A small sampling of the signal is tapped from the IF and applied to a frequency discriminator. This is little more than a sharply tuned circuit on 45.75 MHz with a couple of diodes for converting the signal to DC. If tuning is perfect, output of the discriminator is zero volts—the diodes exactly balance each other. But let the carrier shift off frequency, and voltage will go positive or negative, depending on the direction of drift. This is the error voltage, fed to a Varicap diode. The semiconductor has the ability to change capacity with applied voltage. Since it is tied into the tuner's local oscillator, it exerts a variable capacity effect to kick the oscillator back on frequency. This electronic fine-tuning circuit operates so long as the set is on and counters the effects of heating, component aging and anything else that nudges the oscillator off-frequency.

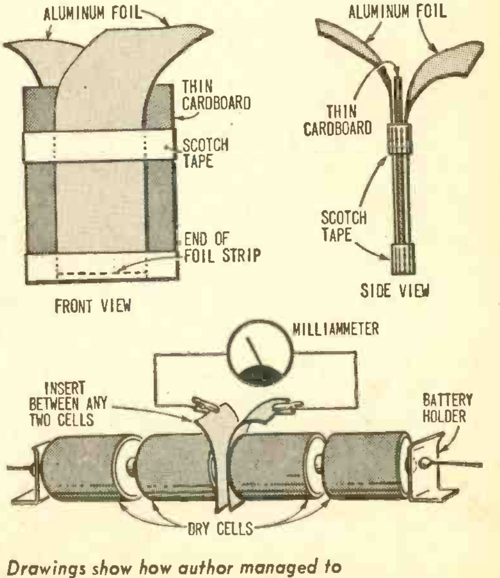
Non-Mechanical Tuning. A very recent development might upset the classic construction of today's TV tuner. It is an announcement by ITT that could convert a tuner into a switchless and coil-less wonder. The company has developed a semiconductor similar to the Varicap just described for automatic frequency control. The difference, though, is that the new diode won't simply adjust fine-tuning. It will electronically tune every major section of the tuner through the VHF and UHF bands. By using the diode as a variable capacitor several advantages are stated. A spokesman for the company told us that the 52 odd tuner coils will shrink to a mere 8. The mechanical wafer switch or turret will be eliminated since the diode can be controlled by a potentiometer to vary the applied voltage. No circuits are available yet, but the diagram in Fig. 17 illustrates the concept.

Capacity-variable diodes have been around for some time, but ITT's breakthrough is in tuning range. Older diodes offered a tuning ratio of about 3-to-1, not quite enough for the big frequency changes in the TV band. The new unit, however, is specified at a ratio of 4.2-to-1 (a capacity of 2.2 pF to 12 pF). Not only does it promise to simplify the tuner, but permit the channel selector to be positioned away from the tuner proper, even outside the set if desired. Only a DC control voltage, rather than delicate high frequencies, flow through connecting wires. And the new diodes aren't very expensive at all—a piddling 36 cents each. (Oops! . . . unfortunately that's for a minimum quantity of 100,000.) ■

To A Smoker, It's A Cinch!

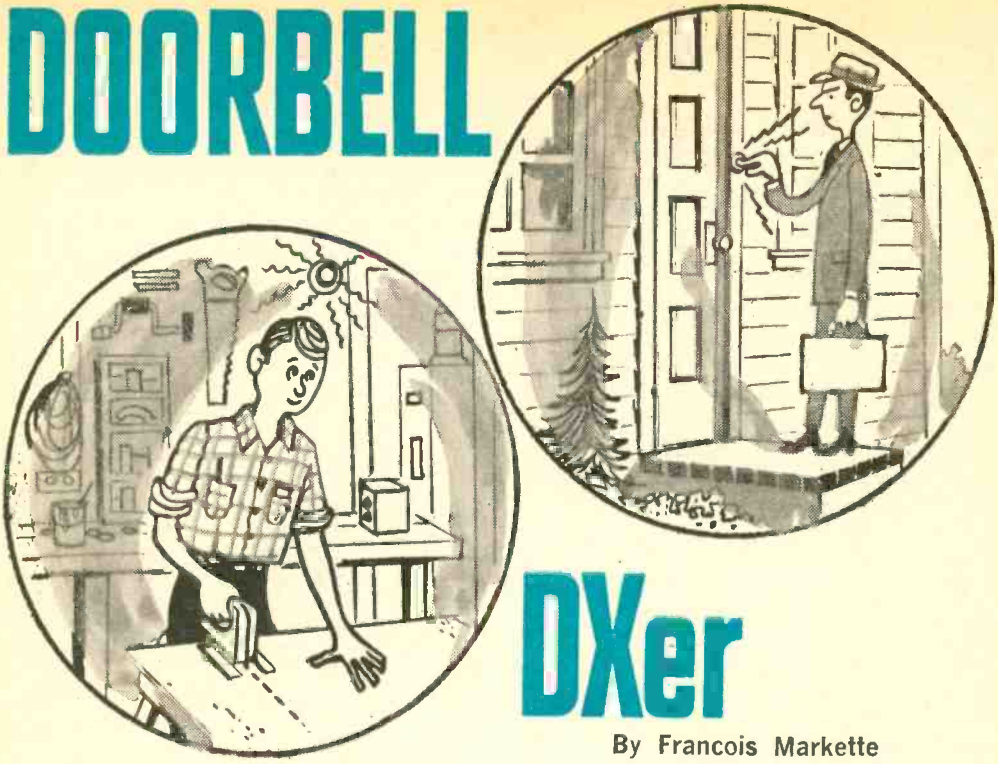
Talk of necessity being somebody's mammy, it happened to me one night when I wanted to read total current of a portable radio and had my VOM with me but no tools of any kind. I solved the problem with a matchbook cover, cigarette foil wrapper paper, and Scotch tape.

You simply tear the match cover at the fold, then grab your pack of smokes and sacrifice to the cause by divesting it of its integral piece of foil (you can put your remaining smokes back in the outside cover). Trim the foil into two strips just slightly narrower than the cardboard. Scotch-tape both strips to opposite sides of the cardboard with the foil side out, and *voila!* Slip the gizmo between the cells, attach a meter to the loose foil ends, and you're all set to count electrons. —*Fred H. Horan* ■



Drawings show how author managed to measure current with makeshift probes made from matchbook and foil.

DOORBELL DXer



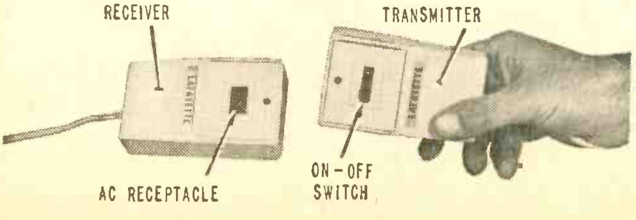
By Francois Markette

At least once a month nearly everyone stays within hearing range of the doorbell, waiting for a mail package delivery, or just a visitor you don't want to miss. And let's not forget REA (Railway Express Agency), for if you don't answer the door they tack on another charge when they come back for re-delivery.

But why kill hours, or even a day, waiting for the doorbell to go *boing*? Just add the *Doorbell DXer* to your home's bell circuit and you can go about your normal business, never fearing you'll fail to hear the doorbell. Want to work in the basement? The *DXer* will page you there. Cleaning the car in the garage? The *DXer* will call you in. Even if you've got a blast going in the back yard you won't miss the *Doorbell DXer's* boing, for wherever there's an AC outlet, you can have an extension of your doorbell with you.

The heart of the device is Lafayette Radio's Wireless Remote Control, a two-unit system that transmits and responds to low frequency (about 80 kHz) RF pulses fed through the building's AC power lines. The wireless control consists of two separate solid-state units—a transmitter and a receiver. The transmitter plugs into the AC receptacle and has only an *on/off* switch; when the switch is set to *on*, an RF signal is fed into the power line. When the switch is set to *off*, the RF signal is interrupted.

Uncontrolled Reception. The receiver has no controls, just a 117 VAC power receptacle. When the receiver—which is always on—receives the RF signal from the transmitter, 117 VAC is applied to the built-in power receptacle. When the RF signal is in-



Heart of the Doorbell DXer is this wireless remote control duo made by Lafayette Radio. AC receptacle on receiver (left) is energized when transmitter sends out signal via the house power lines.

terrupted, the AC is removed from the receptacle. Either a light, buzzer or appliance can be controlled through the transmitter and receiver. By using something other than a finger—such as a doorbell circuit—to turn the transmitter on and off, the wireless remote control becomes part of a complete unattended remote signaling device.

How The DXer Works. The schematic diagram shows how the *Doorbell DXer* works. When the doorbell is activated, the AC voltage used to operate the doorbell or chimes also keys relay K1, which in turn applies power to the transmitter unit which already is set with the *on/off* switch to *on*. As soon as K1 closes the transmitter broadcasts its signal.

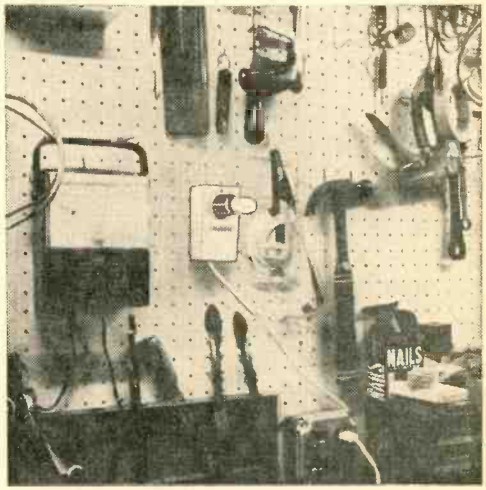
Any receiver unit plugged into the house wiring is activated by the transmitted signal, and if a lamp is plugged into the receiver it will glow each time the doorbell is pressed. If a 117 VAC buzzer or bell is plugged into the receiver it will similarly *sound off* each time the doorbell is activated.

When not being used the entire system can be turned off by simply setting the transmitter's power switch to *off*.

No Modifications To The Receiver. The receiver is used "as is," unless you want to hang it on a wall as shown in the photographs. The lamp or buzzer can be plugged directly into the receiver's power outlet, making a complete portable "pager".

If you want to hang the receiver semi-permanently on the wall, it will be necessary to drill a mounting hole in the bottom section of the cabinet. To remove the cover, insert a small set-screw size screwdriver under the front panel nameplate and gently pry the plate off the cover—you can snap it back into position when finished. Remove the two screws under the plate and the cover will come away. Two inside screws hold the printed circuit board to the bottom section. Drill whatever size hole is needed to mount the receiver on a screw and reassemble the unit.

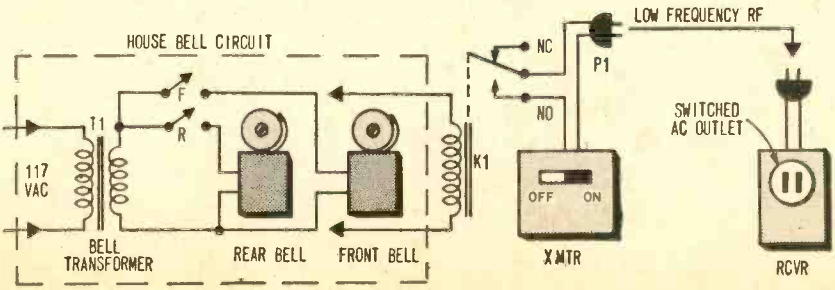
The Transmitter. The control relay is mounted on the main section of an aluminum chassis box approximately 5 x 3 x 2 in. Disassemble the transmitter the same way as for the receiver (above) and drill two holes in the bottom cabinet section. Drill two



The receiving unit can be mounted anywhere there's an AC outlet. Unit can be used to turn on a light or to ring a bell.

PARTS LIST

K1—S.p.s.t., 12-VAC relay (Potter & Brumfield type KAYAY-12AC or equiv.)
1—Wireless remote control, transmitter and receiver (Lafayette 99C9118)
1—Aluminum chassis box, 5¼x3x2⅛" (Premier AMC1006, Radio Shack 77-0674 or equiv.)
Misc.—Wire, hardware, grommets, solder, etc.
Estimated cost: $18.00
Construction time: 3 hours



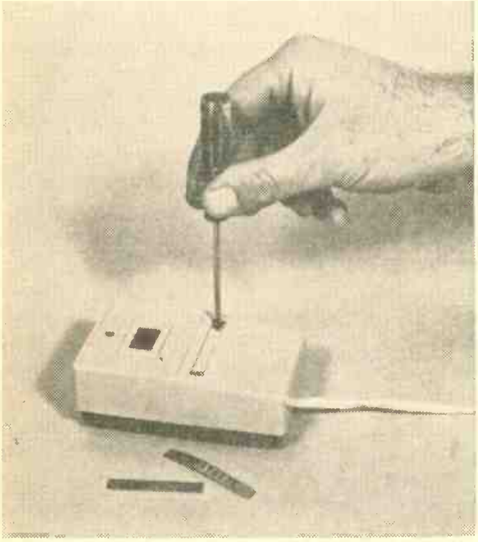
matching holes in the main section of the cabinet—then set the transmitter aside.

Mount relay K1 in the center of the main chassis box section. If you use the relay specified, you must file down the mounting screw flush with the mounting nut to provide clearance when the transmitter is mounted.

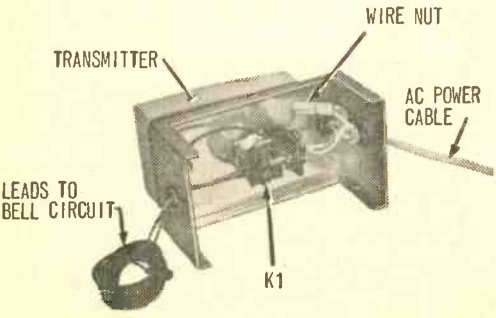
Now install the transmitter on the aluminum chassis box and reassemble the transmitter. Cut into the transmitter's power cord and connect to K1 as shown in the schematic diagram; make certain you connect to the normally-open relay contacts. The power cord wire that does not pass through the relay contacts can be spliced together with a wire nut, or you can twist-solder-tape.

Select a location—generally in the basement—near an AC receptacle and the bell wires. Connect the two wires from relay K1 across the bell wires going to the front (or rear) doorbell; whenever power is applied to the bell, power will also be applied to operate K1. Connect P1, the transmitter's power plug to the nearest AC receptacle.

Install bottom of base box in convenient location close to bell wires and AC outlet. Attach transmitter half of box; then just set it and forget it—you'll always hear the bell.



Screws through back cover of receiver are the simplest way to mount unit on a wall for permanent installation. To get back cover off to drill mounting holes, remove nameplote and screws underneath.



Addition of relay in metal base box is all that's needed to complete transmitter—running leads to bell circuit and plugging unit in finishes job.

Set the transmitter's power switch to the *on* position, so that a signal is "broadcast" whenever the doorbell is activated.

Getting The Message. Connect any 117 VAC signal device to the receiver's AC receptacle and plug the receiver into any AC receptacle on your home's power circuit—it probably won't work as far as your next door neighbor, but you can try; it might work if you're both on the same power line.

Anytime the doorbell is pressed, your receiver will sound off, or light up if you've plugged in a lamp.

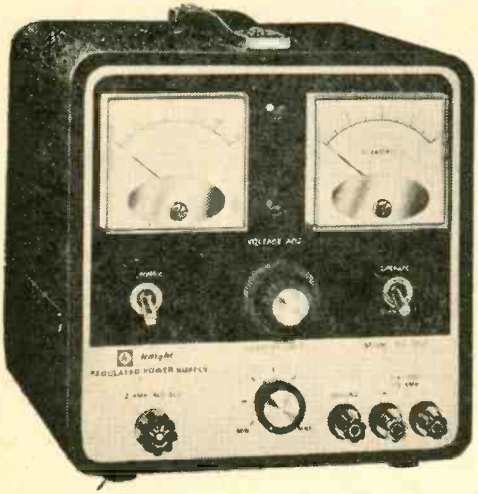
While the transmitter can be left permanently in the *on* position—even when the receiver isn't used—it can be disabled by simply setting its power switch to the *off* position; the relay will still operate but no signal will be "broadcast." It is not necessary to disable the relay.

The relay specified in the Parts List will accommodate a bell circuit voltage range of 11 to 16 VAC. If you have one of those rare old 6-volt bell circuits, substitute the 6-VAC model of the specified relay.

If you're against toting the receiver around the house with you, extra units can be had for about ten bucks each. Happy *boinging!* ■

e/e TEST GEAR

KNIGHT KG-663 Regulated DC Power Supply



■ Not too long ago, the average experimenter and service shop could easily handle solid-state projects and equipment by simply using a battery as the power supply. But today, most solid-state gear is relatively high-powered, and a development or test power supply must deliver a lot more current than the few mils available from a battery. In addition, you need some way to limit the maximum current since solid-state devices get *zapped* faster than it takes a meter pointer to get pinned.

There are other tight specifications for a power supply suitable for solid-state research and service work, and you'll find all the needed features in the Knight KG-663 Regulated DC Power Supply.

The KG-663—available in kit or wired form—provides a fully adjustable output voltage from 0-40 VDC at currents up to 1.5 amperes. A separate meter is provided for both voltage and current monitoring. The output voltage is available from two 5-way binding posts, with a third post providing the ground connection. Either polarity output terminal can be connected to ground.

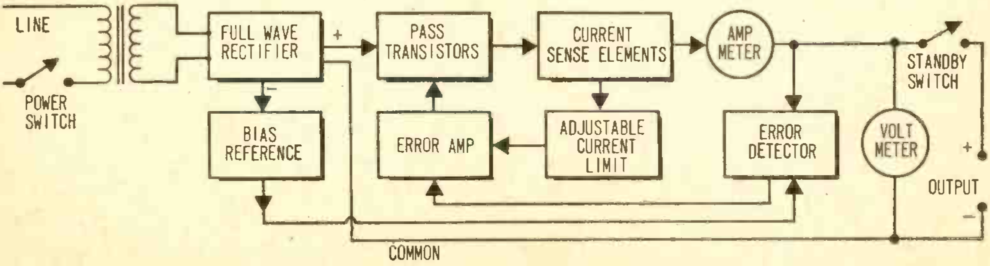
A front panel current-limit control allows the power supply to be set to a maximum current limit to provide absolute protection against short circuits and excessively high current surges.

Both a power switch and a standby switch are provided, as are lights indicating when the switches are in *on* position. The power switch turns on the supply, allowing the desired voltage to be set as indicated on the voltage meter; however, no voltage is applied to the output terminals until the standby switch is activated. To insure that equipment is not unknowingly connected to fully charged filter capacitors, the power switch automatically discharges the KG-663's filter capacitors when set to the *off* position.

How Much Protection? The big feature of this supply is the current limiting capability, so it was the first thing we tested. The current limit control sets the maximum current the supply can deliver, up to the maximum of 1.5 amps. Here's how it's used.

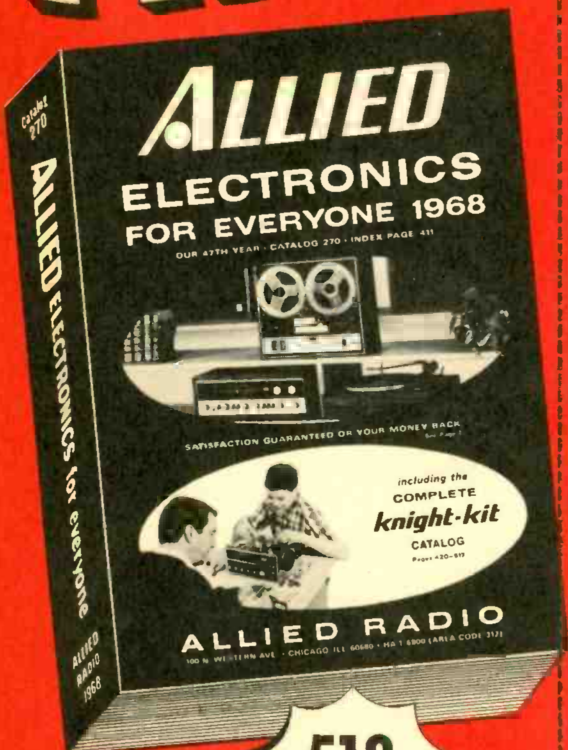
Assume you are working on a transistor amplifier normally rated for a maximum current drain of 1 amp, and you suspect there might be a short which will "blow" a few

(Continued on page 116)



Block diagram of sophisticated Knight KG-663 shows elements of circuit design that makes unit ideal for the serious solid-state experimenter, laboratory researcher, or equipment repairman. High stability, accurate voltage regulation, and current limiting are features of this unit.

FREE



518 pages

New 1968 Allied Catalog

Here it is! The brand-new 1968 edition of the world's most famous catalog of electronic equipment.

518 pages, including the complete Knight-Kit Catalog – picturing, describing and pricing thousands of items—the most complete inventory ever assembled of hi-fi, radios, tape recorders, CB, electronic equipment, parts, and tools, all at money-saving prices.

You'll want your own personal copy of the Allied Catalog. *It's free.* So tear off, fill out, and mail a card. Do it now!

NO MONEY DOWN—24 MONTHS TO PAY!
Low Monthly Payments to fit your budget.

DO A FRIEND A FAVOR—give him this card to send for his FREE ALLIED CATALOG

NAME—PLEASE PRINT

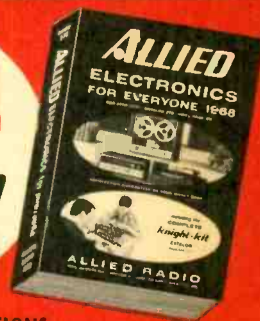
ADDRESS

CITY

STATE 51J ZIP

FILL THIS CARD OUT—MAIL IT NOW!

FREE
ALLIED
1968 CATALOG



WORLD'S LARGEST SELECTIONS
SATISFACTION GUARANTEED OR YOUR MONEY BACK

NAME—PLEASE PRINT

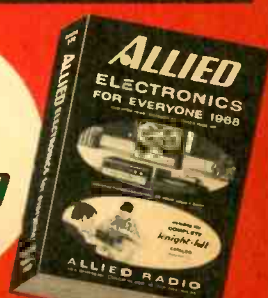
ADDRESS

CITY

STATE 51J ZIP

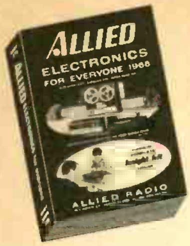
FILL THIS CARD OUT—MAIL IT NOW!

FREE
ALLIED
1968 CATALOG



WORLD'S LARGEST SELECTIONS
SATISFACTION GUARANTEED OR YOUR MONEY BACK

RUSH THIS CARD TODAY!



for your

FREE

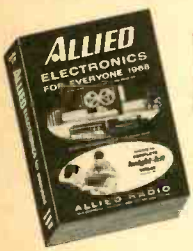
1968 ALLIED CATALOG

TO:

ALLIED RADIO
P.O. BOX 4398
CHICAGO, ILLINOIS 60680

PLACE STAMP HERE

RUSH THIS CARD TODAY!



for your

FREE

1968 ALLIED CATALOG

TO:

ALLIED RADIO
P.O. BOX 4398
CHICAGO, ILLINOIS 60680

PLACE STAMP HERE

Why Buy by Mail from ALLIED?

Each year Allied fills more than a million orders by mail. Only the complete facilities of the world's largest electronics supply house can satisfy all the needs of hi-fi enthusiasts, CB users, engineers, "Hams" and experimenters.

WORLD'S LARGEST SELECTIONS
Imagine shopping for hi-fi where you can select from every model of 15 major manufacturers of receivers, tuners and amplifiers, 14 brands of tape recorders, 7 makes of turntables, nearly 100 speakers from a dozen manufacturers. Plus similar choices in every area of electronics—CB, Ham, test equipment, kits (including Knight-Kits), parts, supplies . . . almost anything you want.

MANY PRODUCTS NOT AVAILABLE ANYWHERE ELSE
As the world's largest supplier of electronics, Allied can afford to stock thousands of items not available elsewhere. In addition, many products are specially-built to our specifications.

YOUR SATISFACTION GUARANTEED OR YOUR MONEY BACK!

FIRST WITH THE LATEST FOR 47 YEARS
We have always been the first to offer the latest developments in electronics, as you will see when you get our new free catalog.

WE QUALITY-TEST WHAT WE SELL
Among all electronics supply houses, only Allied has a continuous program of quality-testing to assure you that everything you buy meets the highest standards.

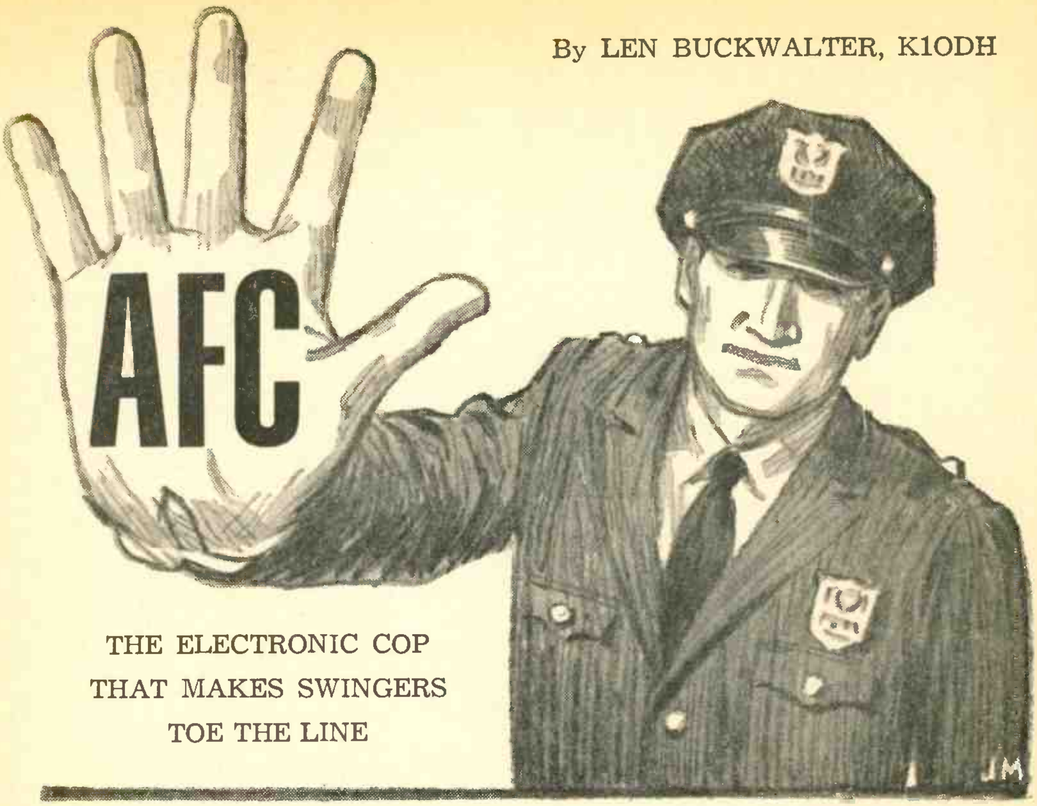
COUNT YOUR SAVINGS AT ALLIED
You always get the lowest prices at Allied. Check Allied prices and compare. Look for special values—available only in the Allied catalog.

IMMEDIATE SHIPMENT
There's no delay when you deal with the world's largest electronics supply house. Orders are filled promptly—usually the day they're received.

NO MONEY DOWN — UP TO TWO YEARS TO PAY
You don't need cash at Allied. Up to 2 years to pay. Make "add-on" purchases – even though you are already paying for something else. It's easy to be a credit customer at Allied.

SATISFACTION GUARANTEED OR YOUR MONEY BACK
Buy with confidence from Allied. We guarantee satisfaction or money back.

ENJOY "EASY-CHAIR" SHOPPING
Shopping's easy at Allied. More accurate, too! You always know *exactly* what you get. And *what a choice!* A selection of merchandise so vast no store could ever assemble and stock it all.



By LEN BUCKWALTER, K1ODH

THE ELECTRONIC COP THAT MAKES SWINGERS TOE THE LINE

Unappreciated it may be, but AFC—short for automatic frequency control—is one of electronics' most devoted slaves. It lets you loaf when you're taking your pleasure from the ether, and it can prove indispensable for those who jockey jets. In fact, AFC in one form or another comes into play in a multitude of nefarious activities involving electronics.

For example, it keeps your Bach sweet and pure if you are an audiophile listening to FM. It prevents pips from being bouncy, blurry blips if your abiding interest is watching radar scopes. And it keeps Jackie Gleason as near vertical as can be by holding his horizontal lock. Here is how this unprepossessing device works.

AFC grips an oscillator until it wrings out the right number of cycles come heat or high water. It's an electronic bird dog that sniffs out frequency error, tracks it to the source, then applies the right correction. Best-known example of AFC occurs in FM tuners where it prevents ear-nagging distortion caused by a drifting local oscillator. AFC keeps a receiver locked to the desired station from warmup to sundown.

AFC is secretly at work behind many another front panel, but it goes unnoticed since it's automatic and needs no attention. Your TV set has an AFC circuit in the horizontal section. Without it you'd have to ride the horizontal-hold control with the precision of a helicopter pilot to keep pictures from sliding sideways.

If the set is color, another AFC circuit nudges a crystal oscillator into vibrating down to the last digit of 3579.545 kHz (a small error here introduces the Jolly *Red* Giant). Late-model TV sets also boast AFC in the tuner so that the fine-tuning is less touchy to operate. Though AFC is used in diverse applications, its operating principle is about as common as a 3-penny nail.

Manual Frequency Control. Whenever you tune a radio that has a signal strength (VU) meter, you illustrate the dynamic concepts of AFC. In fact, the radio designer depends on you as the missing link in a human servo system. It works this way: Your eye senses an error by viewing the meter. That error might be that a desired station is poorly tuned. This information is processed by your brain and the result is a control message directed to the arm.

The hand rocks the tuning knob until

the eye sees the needle rise on the desired station. Then you'll probably hunt back and forth across the station to find the highest point. Similarly, AFC must sense a tuning error, its degree, and follow up with the right amount of correction. The action, however, is purely electronic and happens even if you drop off during the commercial.

AFC Blocks. Hidden in most AFC circuits are the two building blocks shown in Fig. 1. Note that they form a closed loop with the oscillator stage to be controlled. Within the loop the oscillator's frequency is sensed in two ways. Not only must AFC decide if frequency is running high or low, but how far it's drifted. Both are determined by the frequency detector, or discriminator.

The detector can produce a control voltage that bears all the needed information. For example, if the oscillator operates precisely on frequency, the detector may produce zero control volts. But an upward or downward shift generates a corresponding positive or negative voltage. The *amount* of voltage will tell how many cycles off frequency the oscillator has drifted.

Output of the detector, called a "DC control voltage," is then applied to a variable reactance. This component, as we'll see, may behave like a coil or capacitor and its usefulness lies in the fact that a DC control voltage can vary its capacity or inductance. (This is equivalent to adjusting the receiver's tuning knob.) If, for example, the oscillator drifts up in frequency, the DC control voltage might signal the reactance to add more capacity to the oscillator circuit. This would lower the frequency to correct the error.

That's an AFC circuit's basic action. It may be tied to a variable (local) oscillator of an FM receiver, a crystal-controlled oscillator of an FM transmitter or color TV

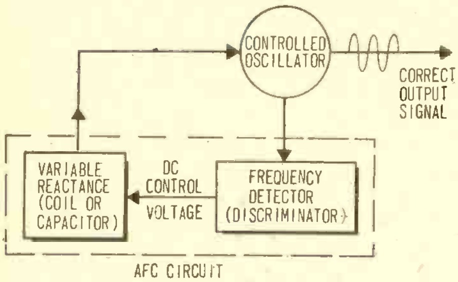


Fig. 1. The functional blocks at left summarize the AFC story. Most AFC circuits are basically the same and will contain the three sections shown by the blocks. If the Controlled Oscillator changes frequency, the Frequency Detector "blows the whistle" and directs the Variable Reactance to shove the oscillator back on frequency.

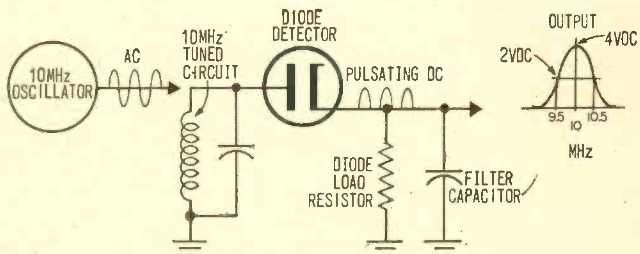


Fig. 2. Circuit at right produces a DC output voltage dependent on frequency of AC input as shown by OUTPUT curve. Comparing DC output with AC input tells difference between oscillator frequency and tuned circuit resonant frequency, but not whether oscillator is high or low.

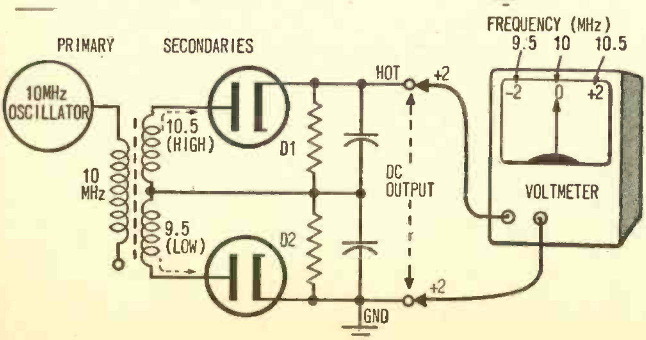


Fig. 3. To tell the oscillator whether its frequency is high or low, two tuned input circuits are used. As above, DC output level indicates degree of oscillator frequency shift, but now polarity says which way it went—up or down.

receiver. (Crystals are generally considered fixed in frequency, but AFC can still shift them enough for correction.) AFC may have other names, like "phase lock" or "synchronous detection." But the fundamental sensing, feedback, and control loop is virtually the same. Here's how each building block performs its task.

AC To DC. A circuit to convert part of an oscillator signal to an equivalent DC control voltage is the diode detector, shown in Fig. 2. The oscillator generates an AC signal on 10 MHz and this is applied to a tuned circuit (also on 10 MHz). The signal is next applied to the plate of the diode tube where it is rectified; only the positive portion is conducted through the tube. There is now a pulsating DC signal, subsequently smoothed to pure DC by the diode's load resistor and filter capacitor.

Notice the shape of the curve (in Fig. 2) marked "Output." It is indicating highest voltage (4 VDC) when *centered* on a 10-MHz signal. The reason is the tuned circuit; it passes most oscillator energy only when that signal falls exactly on 10 MHz. If the frequency moves slightly above or below the 10-MHz resonant center frequency the DC output voltage falls.

Thus, the detector circuit not only creates DC from AC but also senses how far off center frequency the AC signal is. One defect, though, is that a simple detector cannot tell in which direction the signal departs from 10 MHz. This is cured by adding another section, as shown in Fig. 3.

Now the circuit contains three tuned circuits. The first one, centered on 10 MHz, merely serves as the primary of a transformer that couples the oscillator to two secondary windings. Those secondary windings, however, are not tuned to the 10-MHz center frequency. The top one is adjusted to a higher frequency—10.5 MHz—while the lower winding is tuned to 9.5 MHz. Each secondary winding, therefore, is slightly off frequency.

A 10-MHz signal entering the out-of-

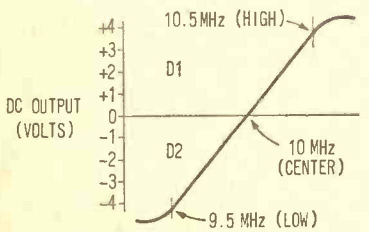


Fig. 4. Within operating range, the discriminator gives an almost linear DC output voltage in direct relationship to the input frequency. A graphic summation of the discriminator input frequency to DC output is shown above.

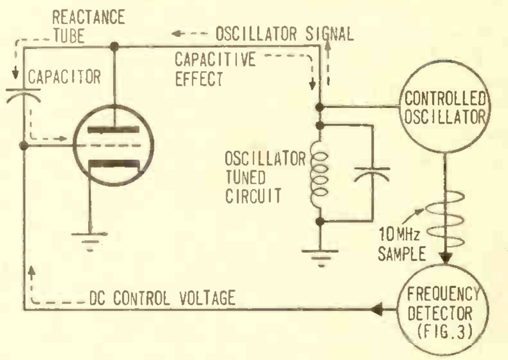


Fig. 5. In the circuit above, varying reactance-tube grid voltage varies the plate to cathode capacitance, effectively giving you a voltage-controlled variable tuning capacitor which is used to control oscillator frequency.

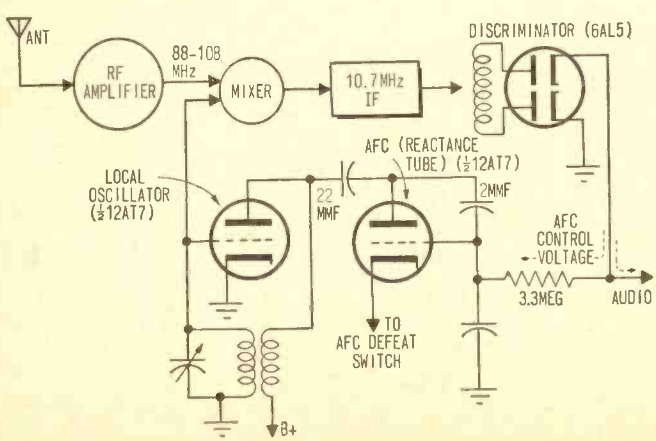


Fig. 6. Left, typical application of the three AFC blocks. Shown is AFC in front end of FM tuner.

tune secondaries might produce, say, only 2 VDC at each diode output. Further, note how each diode presents its 2 VDC across the "hot" and ground output sides of the circuit. The voltmeter connected to these points measures zero volts, since no potential difference exists between +2 and +2. This is precisely the desired action: when the oscillator is operating on frequency, there is no error and correct frequency is represented by zero output volts.

But assume the oscillator starts to drift higher in frequency. (An oscillator coil, for example, could be warmed by a nearby tube and its turns might expand, or line voltage could vary.) As oscillator frequency rises, the signal finds an increasingly better path to diode D1. This is because the tuned circuit at this point was previously adjusted to a higher frequency (10.5 MHz).

Voltage output of D1 now rises to +3 as the signal increases frequency. Meanwhile, a proportionately lower voltage develops in the lower D2 circuit section. Since the tuned circuit here is adjusted to the low-frequency side of the oscillator, D2's output might rise to a mere +1 volt. The voltmeter across hot and ground sides of the output circuit indicates +2 volts—the potential difference between the two points.

Assume now the oscillator is drifting in the opposite direction; that is, below its 10-MHz center frequency. Since the lower tuned circuit favors a lower frequency, it causes diode D2 to conduct more heavily. Circuit conditions are exactly reversed; there is +3 volts output from D2, which appears at the ground point. Only +1 volt is contributed by the top diode.

Now the voltmeter across hot and ground sides of the output indicates −2 volts. Though the two output voltages are positive, the meter is reading the *difference* of potential between them. A positive ground point makes the hot point appear relatively negative.

The action of the circuit is graphically summed up by the curve in Fig. 4. Note that at any frequency between 9.5 and 10.5 MHz there is a given DC control voltage. It contains the requisite information; voltage *polarity* tells whether drift is in the high direction (+) or toward the low end (−). And the *amount* of voltage encodes the degree of frequency drift. Beyond the limits of the curve voltage falls off sharply since the signal falls outside the discriminator's tuned circuits, or bandpass. This is not likely to happen as the next major AFC circuit section is activated to correct drift before it gets out of hand.

Varying Reactance. A common triode tube can be connected in a fashion which fools an oscillator into believing it's a variable capacitor. How the system operates appears in Fig. 5. We begin with the oscillator to be controlled (at bottom left). Tied to it is a tuned circuit which determines the oscillator's normal frequency output. A portion of that signal is tapped off and applied to the reactance tube through a small capacitor.

Notice that another capacitor appears across the plate and grid of the reactance tube. If the tube is considered to be conducting current, that capacitor is effectively connected between plate and ground. This also would place the capacitor across the oscillator's tuned circuit, and cause a drop in oscillator frequency.

But remember that the capacitor returns to ground through the reactance tube. By controlling the current through the tube, it is possible to regulate signal current through the capacitor. This is electrically the same as varying its capacity. If the capacitor has a high-resistance path to ground, for example, it behaves as if its capacity is reduced.

As shown in Fig. 5, the flow of current is governed by the DC control voltage applied to the grid of the reactance tube. When DC voltage increases in the positive direction, tube current increases. As this occurs, the grid-to-plate capacitor increases capacity across the oscillator tuned circuit and frequency is lowered. Thus the DC control voltage can continuously alter oscillator frequency.

Circuits described to this point are widely applied in FM transmitters and receivers. How AFC is used in a commercial FM tuner is shown in Fig. 6. The major stages of the tuner are shown at the top; signals enter the RF amplifier and are applied to the mixer where they convert down to the tuner's 10.7-MHz intermediate frequency. The FM signal becomes an audio voltage in the discriminator (or detector) stage.

A big advantage in an FM tuner is that its discriminator (or ratio detector) not only provides an audio signal, but an AFC control voltage as well. These circuits produce DC output which contains all the information of the diode stages described earlier.

Note that the stage marked "AFC" is the reactance tube (12AT7); it shares the same tube envelope as the tuner's local oscillator. The cathode of the AFC tube is returned to ground through an AFC defeat switch. This enables the operator to easily tune the receiver to a weak station. If AFC remained on it would tend to lock onto stronger signals. When AFC is in operation it keeps the local oscillator on frequency and the incoming signal centered in the tuner's IF frequency.

It's Solid, Too. With FM receivers abandoning tubes for transistors, a new component is supplanting the reactance tube. It's the semi-conductor variable capacitor known under such trade names as *Varicap* and *Semicap*. Fig. 7 illustrates its operation.

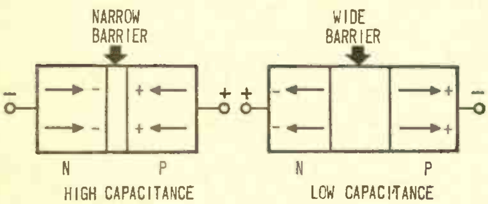


Fig. 7. With the advent of semiconductors, naturally someone would come up with a solid-state, voltage-controlled variable capacitance. Above, voltage magnitude and polarity controls capacity of Varicap.

The device is a diode consisting of two pieces of semiconductor material joined as shown. One section is N-type, rich in electrons; the other is P-type, rich in positive charges (holes).

When an external voltage is applied to the diode, the charges respond by varying the width of the barrier region. When the barrier narrows, internal capacity of the diode increases—equivalent to raising capacitance of a conventional capacitor by reducing the spacing between plates. When charges are attracted away from the barrier by an external voltage, capacity decreases. This property of the diode, to change capacity under changing voltage, makes it a useful component for an AFC circuit.

One recent use of the device is for AFC in color TV receivers. A black-and-white set can tolerate some mistuning, but color signals quickly deteriorate unless fine-tuning is on the nose. Also, the receiver's local oscillator shouldn't drift or the viewer might have to retune several times after the set is turned on.

How Magnavox adds AFC to its color receiver is shown by the simplified diagram in Fig. 8. Object of the circuit is to keep the incoming picture carrier exactly on a frequency of 45.75 MHz as it travels through the set's IF strip. Let's trace circuit action, as given in Fig. 8.

A sample of the picture carrier from the IF strip (see top right) is sent down to the AFC discriminator. As in earlier circuits, a pair of diodes develops a DC control voltage when the signal departs from the desired frequency (45.75 MHz). The DC control voltage is applied to the Varicap mounted near the set's local oscillator. Capacity variations in the diode drive the oscillator back to the correct frequency.

If, for example, the oscillator is running too high, the AFC discriminator develops a positive DC control voltage. Applied to the Varicap, it causes an increase in capacity, which lowers oscillator frequency. Note that the top side of the Varicap is connected to a source of B+ voltage. This establishes necessary bias for the correct operating range of the diode.

The circuit is also equipped with an AFC defeat switch. It's automatically turned on whenever the viewer handles the fine-tuning control. This prevents AFC from fighting back during channel adjustment. When channel tuning is approximately correct, the viewer releases the fine-tuning and AFC switches back in to take over further control.

Puckered Pix. Color TV and its need for accurate tuning is bringing AFC back into vogue for television. But nearly every TV ever made contains AFC in its horizontal section. You may have sensed it while turning a horizontal hold control. When the knob is far out of adjustment, the picture is torn into slanting lines. As the knob reaches the proper setting the picture is not only solid, but attempts to remain stable even as the hold knob is turned slightly off position. The unseen hand holding the picture is an AFC circuit.

The need for AFC became apparent in early TV sets. In the original system, the TV station sent out horizontal synchronizing pulses to lock the home receiver precisely on 15,750 Hz. That's the number of times per second the picture tube's scanning beam flies across the screen. The receiver contained an internal oscillator operating on approximately 15,750 Hz and TV station pulses purportedly kept it accurate.

That system works extremely well for the receiver's vertical section. The vertical oscillator moves the scanning beam downward at 60 times per second and it easily locks to vertical sync pulses transmitted by the station. However, the higher frequency of the horizontal oscillator makes it far more susceptible to error, due to incoming noise being mixed with the sync pulses.

The slow speed of the vertical section permits it to elude the effects of noise, which tends to occur in short bursts. Not so for the horizontal. Early TV receivers produced jittery, unstable pictures as noise competed with sync pulses in the effort to control the horizontal oscillator. Another defect of the system: each scanning line of the picture could begin at a slightly different time. This produced ragged edges on the outline of objects in the scene. So an AFC circuit was introduced to vastly improve the horizontal oscillator system.

One of the most popular TV receiver circuits now in use is *Synchroguide*. In several ways it resembles the AFC systems described earlier: it develops an error-correcting signal to control an oscillator. In the TV receiver, however, error isn't detected in a tuned circuit. Since extraordinary accuracy is needed to keep picture elements in place, the TV station transmits the horizontal sync pulses previously mentioned. They are always accurate since they originate from horizontal signals simultaneously used at the TV station to operate the cameras. How those sync pulses lock the receiver is shown in the *Synchroguide* schematic of Fig. 9.

Consider the role of the horizontal oscillator (bottom tube in the diagram). It is a *free-running* oscillator. (This simply refers to its ability to be easily controlled by an external signal applied to its grid.) Note that it generates a *sawtooth* wave which is ultimately applied to the picture tube.

This waveform is specially shaped so the beam scans at a relatively slow rate from left to right, but returns very quickly to begin a new line. A sample of the sawtooth, at approximately 15,750 Hz, is applied up

(Continued on page 114)

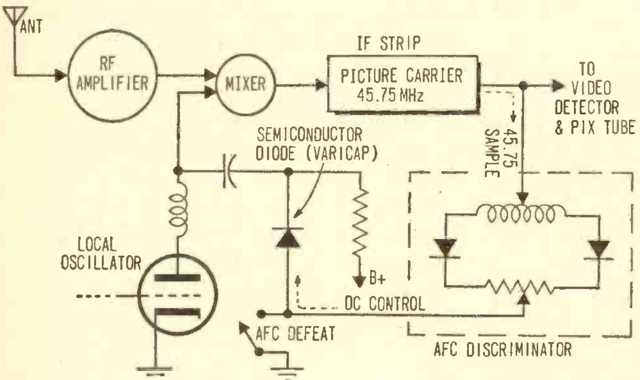


Fig. 8. Variable capacity diode at left keeps local oscillator right on the button; in color television this is necessary to keep color compatable. AFC defeat switch operates in conjunction with fine tuning control so AFC doesn't fight back when you are adjusting fine tuning.

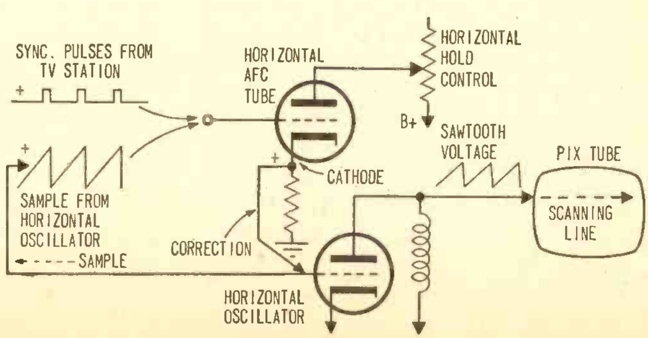
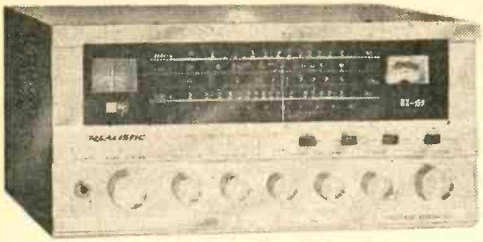


Fig. 9. At right, another type of sophisticated AFC is used for extremely accurate control of TV horizontal oscillator so that elements of picture stay aligned coherently. In effect, circuit keeps an electronic hand on horizontal control so you don't have to.



RADIO SHACK MODEL DX-150
Solid-State, All-Band Communications Receiver

We test so much equipment that we rarely get excited about anything until all the test results are in. But from the moment we unpacked Radio Shack's Realistic DX-150 Solid-State Communications Receiver we knew we had something different and exciting, for though the DX-150 is priced at only $119.95, it had the appearance and "control feel" of a receiver in the $200 to $300 class.

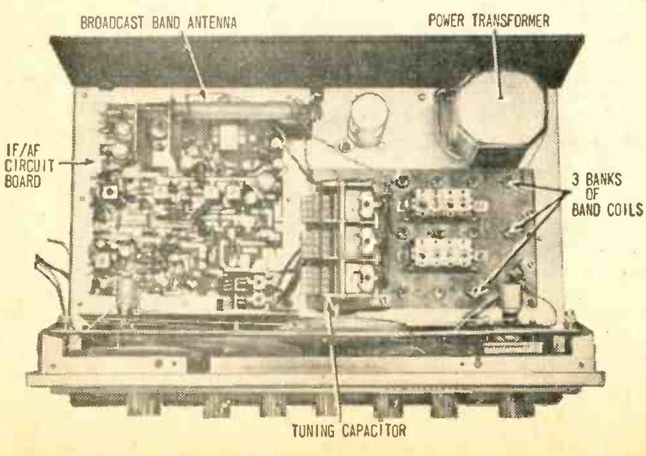
The DX-150 is all solid-state, covering the frequency range from 535 kHz to 30 MHz. Calibrated bandspread is provided for the 80 through 10-meter ham bands and the Citizen's Band. Unlike other budget receivers, the DX-150 is actually designed for both AM and sideband reception, having a product detector and selectable slow and fast AVC (automatic volume control).

An effective noise limiter is provided in addition to an S-meter, RF gain control, antenna trimmer, and variable BFO.

While the receiver has a 117 VAC power supply, provision is made for operation from several sources of 12 VDC power. An optional DC power supply kit provides all the "hardware" needed to power the DX-150 from a battery pack, DC supply, or an auto's 12 volt battery through the cigar lighter.

At first glance, the DX-150 appeared to utilize more-or-less standard receiver circuitry: An RF amplifier, oscillator, mixer, and single conversion 455 kHz IF amplification; the only unusual feature appeared to be the product detector for SSB. Closer inspection, however, revealed several *isolation amplifiers*, whose purpose appeared to be to give the DX-150 the stability common to communications receivers priced considerably higher than $119.95. As examples, to reduce front end overload, oscillator pulling caused by strong signals, and instability on the high frequency band, an isolation amplifier is connected between both the RF amplifier and the mixer, and the oscillator and the mixer. To avoid the common problem of the S-meter drifting off the zero-set when the RF gain is reduced, the DX-150 utilizes a separate full-time zero-set S-meter amplifier that keeps the S-meter on zero regardless of the setting of the RF gain control.

Test Results. Since so much attention was given to stability, our first test was to determine how the DX-150 would respond to



Internal view of the Realistic DX-150 communications receiver reveals a unit surprisingly professional in its construction. RF and oscillator coils as well as tuning capacitor are mounted on heavy copper plate at right; IF and AF printed-circuit board is at left. For another view of the DX-150, in full color, take a peek at our front cover.

e/e REALISTIC DX-150

high-band (14-30 MHz) SSB signals. We chose the high band as a starting point as it is usually the frequency range on which ordinary receivers literally fall to pieces, with severe drift and growling CW and SSB reception. The DX-150 passed this test with flying colors, having but a very slight drift even at 28 MHz; enough to raise the pitch of the voice on an SSB signal, but not enough to lose intelligence or produce monkey chatter. The SSB product detector worked just fine with no apparent distortion caused by very weak or very strong signals.

Front-end stability proved very good for a solid-state rig. Up to 20,000 microvolts signal input, the front-end was rock steady, with no tendency to break into oscillation or block-up. Above 20,000 microvolts there was considerable break-up and cross-modulation. But when one considers that 20,000 microvolts is equivalent to a station located down the block, this is good performance. The built-in loopstick for the AM band is specially equalized to prevent excess signals overloading the front end, so there's no problem on that score.

Sensitivity, Selectivity, and Images. The overall sensitivity for a 10 dB S+N/N (signal-plus-noise to noise) ratio was outstanding, even for a much higher priced receiver. As shown in the chart, the nominal sensitivity was 1.5 microvolts, even at 30 MHz. (This is strictly top quality performance.) The reduced sensitivity of 2.8 *uv*. (still superb for a low-cost receiver) at 14 MHz was caused by a not-too-careful alignment job on the low end of the high band.

DX-150 SENSITIVITY CHECKS

Frequency (MHz)	Sensitivity— for 10 dB S+S/N (*u*V)	Minimum Sensitivity for CW (*u*V)
30	1.55	0.2
21	1.4	0.2
14	2.8	0.3
10	1.3	0.1
5	1.0	0.1
3.5	1.6	0.1

An unusual characteristic (which we have previously noted in some solid-state receivers) was that input signals were 100% readable when the input signal was below the usual 10 dB S+N/N test. Frankly, we don't know why this is so, but we were able to obtain 100% readability on signals equivalent to a 6 dB S+N/N test level (nominally 1 *uv*.)

The minimum usable input signal level for 80% copy of CW signals is also noted in the chart. While these signal levels were well into the noise level, the signals were still usable.

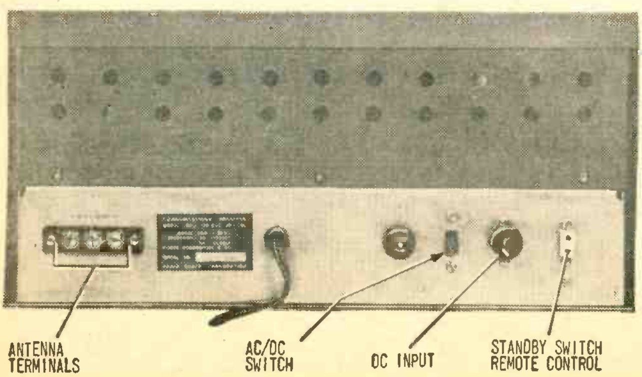
Selectivity through the front-end at 27 MHz (the worst possible test conditions) checked out 32dB down for 20 kHz bandwidth—the equal of 32dB adjacent channel rejection on the Citizen's Band. This is 7 dB over Radio Shack's specifications.

Image rejection on the high band was essentially nil, improving to 46 dB at 3.5 MHz.

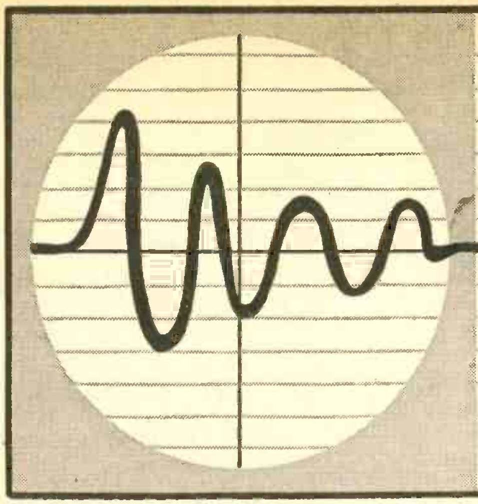
AVC Action. The change in speaker volume vs. an 80 dB variation in input signal (1 to 10,000 microvolts), was 12 dB; about average for a tube receiver and a little below average for a solid-state job.

The noise limiter action is very hard, cutting deeply into the noise spikes. Unfortunately, heavy clipping also means that some of the audio must be clipped, with resultant distortion. While the noise limiter

(Continued on page 114)



Rear apron of DX-150 contains antenna terminals, standby/remote-control facility, AC/DC power selector switch, and DC input plug. Available as an optional accessory, DC power kit contains case to house batteries and assortment of cords so receiver can be powered from several DC supplies.



FCC Q&A

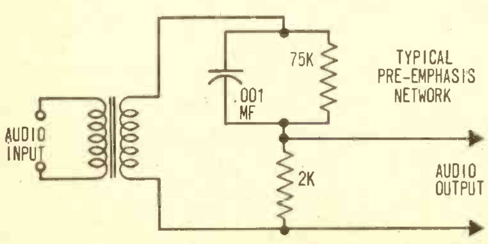
By Carl L. Henry

There's more to FM than meets the eye, so study up on these oft-asked Q's and the boys over at the FCC won't catch you with your A's down.

Don't congratulate yourself yet on learning FM radio. The questions in the last column were the easiest to be found on the FCC tests concerning FM. This column will take up the more difficult questions. If you plan to work in radio communications, FM radio will probably be the principal type of equipment you will work on. A good basic understanding of FM principles will be very valuable to you. Study these often-asked questions and answers thoroughly.

Q. *What is meant by pre-emphasis in an FM broadcast transmitter?*

A. Pre-emphasis is the process of giving more amplification to the higher audio modulating frequencies. By increasing the high frequency audio modulation level, compared to the lower frequency audio, de-emphasis at the receiver overrides any high frequency noise picked up in route to the receiver. Pre-emphasis on the order of 17 to 20 dB is normally used. The network is much like a high-pass filter. See diagram for a typical network.



Typical pre-emphasis network employs R/C time constant to provide relatively greater signal strength of AF high frequencies.

Pre-emphasis networks cannot be used on phase modulation (PM). The major difference between FM (frequency modulation) and PM (phase modulation) is that in true FM, the deviation of the carrier is proportional to the amplitude of the modulating signal, and not to its frequency. In PM, the deviation of the carrier is proportional to the amplitude and to the frequency of the modulating signal. Usually, in a typical two-way PM radio, a clipper and integrator circuit precedes the modulator, and no pre-emphasis is used.

Q. *Explain why high gain antennas are used at FM broadcast stations.*

A. At the frequencies used for FM broadcast (88 to 108 MHz), the sky wave is lost through the ionosphere and the ground wave suffers much more attenuation than it would at lower frequencies. For this reason, it is necessary to radiate a stronger signal than would be necessary at lower frequencies to cover the same area. Fortunately, at these frequencies, the short wavelength makes it possible to build multiple element directional antennas. These antennas have no vertical radiation and concentrate power in the horizontal plane, giving a good power gain. For this reason, FM broadcast stations have two power specifications. The first is the normal power input to the final amplifier stage, or power output. The second is the Effective Radiated Power (ERP) of the antenna. Since the antenna has a gain factor, it is possible in some cases to supply 10 kilowatts of power to the antenna, and to have an Effective Radiated Power of 100 kilowatts from the antenna.

Q. *An FM transmitter operates on 150 MHz and uses a crystal oscillator tuned to 4637.5 kHz. If the deviation of the FM carrier is 15 kHz each side of center frequency when modulated by a 1000 Hz audio tone, how much does the reactance-tube modulator vary the crystal frequency?*

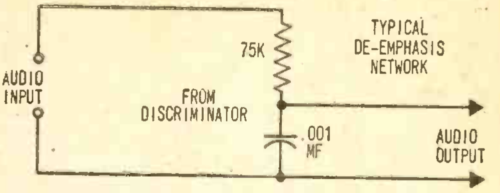
A. The audio frequency is not important. We first determine the frequency multiplication of the transmitter by dividing 150 MHz by 4687.5 kHz. This tells us that the frequency multiplication of transmitter is 32 times. If the deviation at the carrier frequency is 15 kHz, the deviation at the oscillator must be 15 times 32, or 469 Hz each side of center frequency.

Q. *What is the purpose of a discriminator in an FM broadcast receiver?*

A. A discriminator in an FM receiver is similar in purpose to a demodulator in an AM receiver. That is, its function is to change carrier variations, in this case variations in frequency, into an audio signal. The discriminator puts out a DC voltage whose value varies in step with variations in carrier frequency. The Foster-Seeley discriminator will not reject AM, and must be preceded with one or more limiter stages. The ratio detector does reject AM, and thus does not need limiter stages.

Q. *What is the purpose of a de-emphasis circuit in an FM broadcast receiver?*

A. The de-emphasis circuit compensates for the pre-emphasis circuit used in the transmitter. Any high audio frequency noise



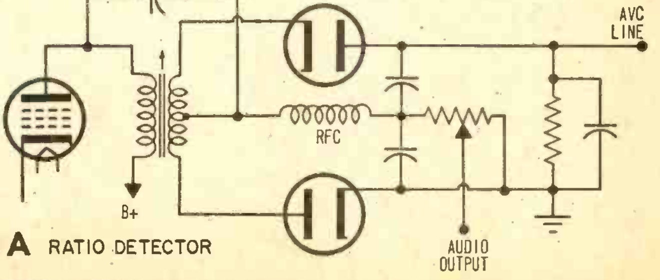
Typical de-emphasis network restores proper relative strength of transmitted highs; this reduces strength of predominantly high frequency noise.

that is picked up is also de-emphasized, greatly increasing the signal-to-noise ratio at the receiver output. The diagram illustrates a typical de-emphasis circuit. Usually these two circuits are designed to have exactly equal and opposite response curves. Sometimes the transmitter manufacturer uses this pre-emphasis to simplify the modulator design, but it is not possible to do this at the receiver since the low rather than the high audio frequencies must be favored here.

Q. *How wide a band of frequencies must an IF stage in a FM broadcast receiver pass for full signal reproduction?*

A. Since a broadcast FM transmitter is allowed a maximum deviation plus a minus 75 kHz, the total bandwidth of the signal would be 150 kHz. In practice, for economic reasons, the bandpass of a typical FM receiver IF amplifier is not made this wide. Usually the bandpass is down 6 dB at each extreme. This allows more gain in the IF amplifiers, and causes little noticeable distortion.

Discriminator (right) requires preceding limiter stage. More popular ratio detector needs no limiting, isn't AM sensitive.

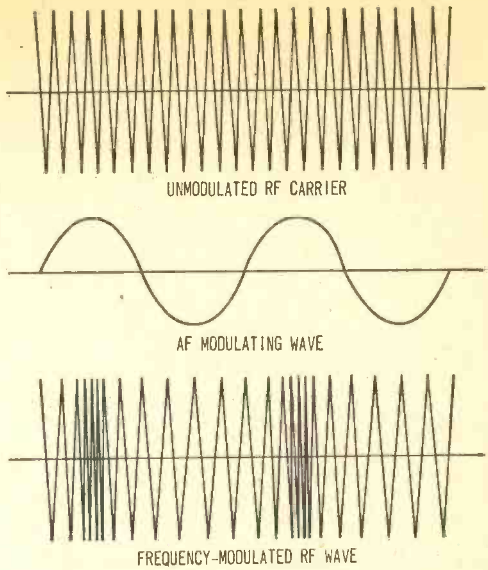


Q. *What characteristic of an audio tone determines the percentage modulation of an FM broadcast transmitter?, and—*

Q. *What determines the rate of deviation of an FM broadcast transmitter?*

A. In any AM system, the amplitude of the modulation is determined by the amplitude of the audio modulating signal. The frequency of the modulating signal determines how far the sidebands, which carry the transmitted intelligence, will be from the carrier. Thus, we can limit the bandpass of the AM receiver to receive any sort of the AM signal, based on the frequency of the modulating audio. In FM this will not work. The deviation of an FM transmitter is proportional to the amplitude of the audio modulating signal. For this reason, the receiver must have a bandwidth adequate to pass the entire frequency deviation range of the transmitted signal. The rate at which the carrier of the FM signal is changed or deviated is determined by the frequency of the modulating audio signal. Thus, an audio modulating signal of 1000 Hz will cause the FM transmitter carrier to deviate at a 1000 Hz rate. How far (in KHz) the carrier deviates from its normal rest or center frequency is determined by how much audio signal is supplied to the modulator.

Q. *An FM broadcast transmitter has a final plate voltage of 2000 volts, and a final plate current of 1.2 amperes. The manufacturer specifies the final amplifier to have an efficiency of 65%. If the antenna has a field gain of 10 dB and the transmission line losses are negligible, what is the Effective Radiated Power of the transmitter?*

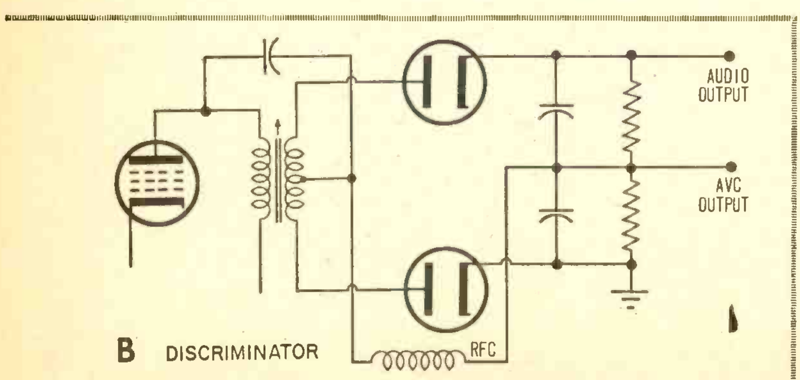


Rate of FM carrier shift is determined by AF frequency—amount of carrier shift is dependent on AF amplitude.

A. The power of the final stage is stated to be 2000 x 1.2 x 65%, which equals 1560 watts. The transmission line delivers this power to the antenna with no losses. The antenna has a power gain of 10 DB. From the formula $DB = 10 \log \frac{P1}{P2}$, we know that this is a positive ratio of 10. The ERP of the transmitter is therefore 1560 x 10 or 15.6 kilowatts.

Q. *What is the tolerance of operating power of FM broadcast stations?*

A. The operating power tolerance is plus 5% or minus 10% of the license rated power.



Q. *An FM broadcast transmitter is modulated 35% by a 1000 Hz test signal. If the percentage modulation is doubled, what is the transmitter deviation?*

A. For 100% modulation, a deviation of 75 kHz is allowed. Therefore, doubling 35% gives 70%, so 0.70 x 75 is equal to 52.5 kHz deviation each side of the center frequency.

(Continued on page 115)

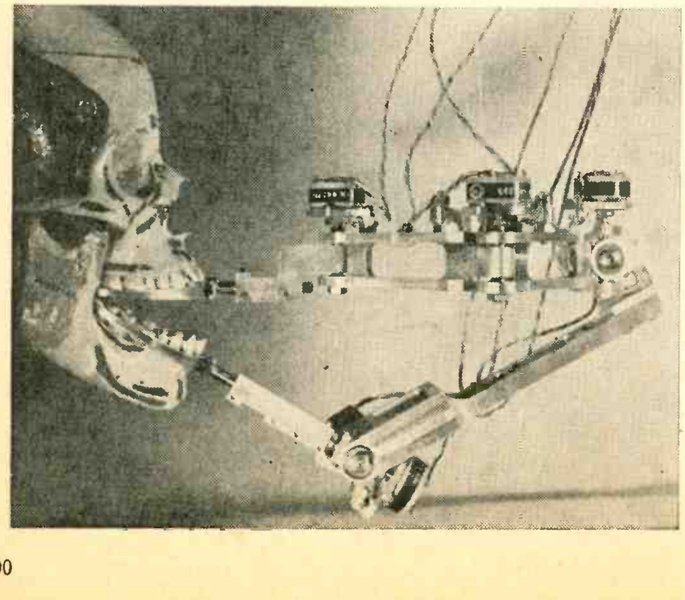
Charlie Chomps Chewing Gum Cheerfully —*Or Does He?*

Chomping on gum, chewing food, and talking are acts we seldom give even casual thought to, yet all involve the jaw and all entail some extremely complex movements. Now, a new device promises to guide dental researchers to a clearer understanding of the complicated actions of man's jaw.

Developed by the General Electric Research and Development Center in Schenectady, N.Y., the gizmo can measure and record minute jaw motions—even those below the level of human consciousness. It can be used to study the movements of the human jaw during chewing, talking, and swallowing and will first see service as a research tool at Marquette University's School of Dentistry in Milwaukee, Wis.

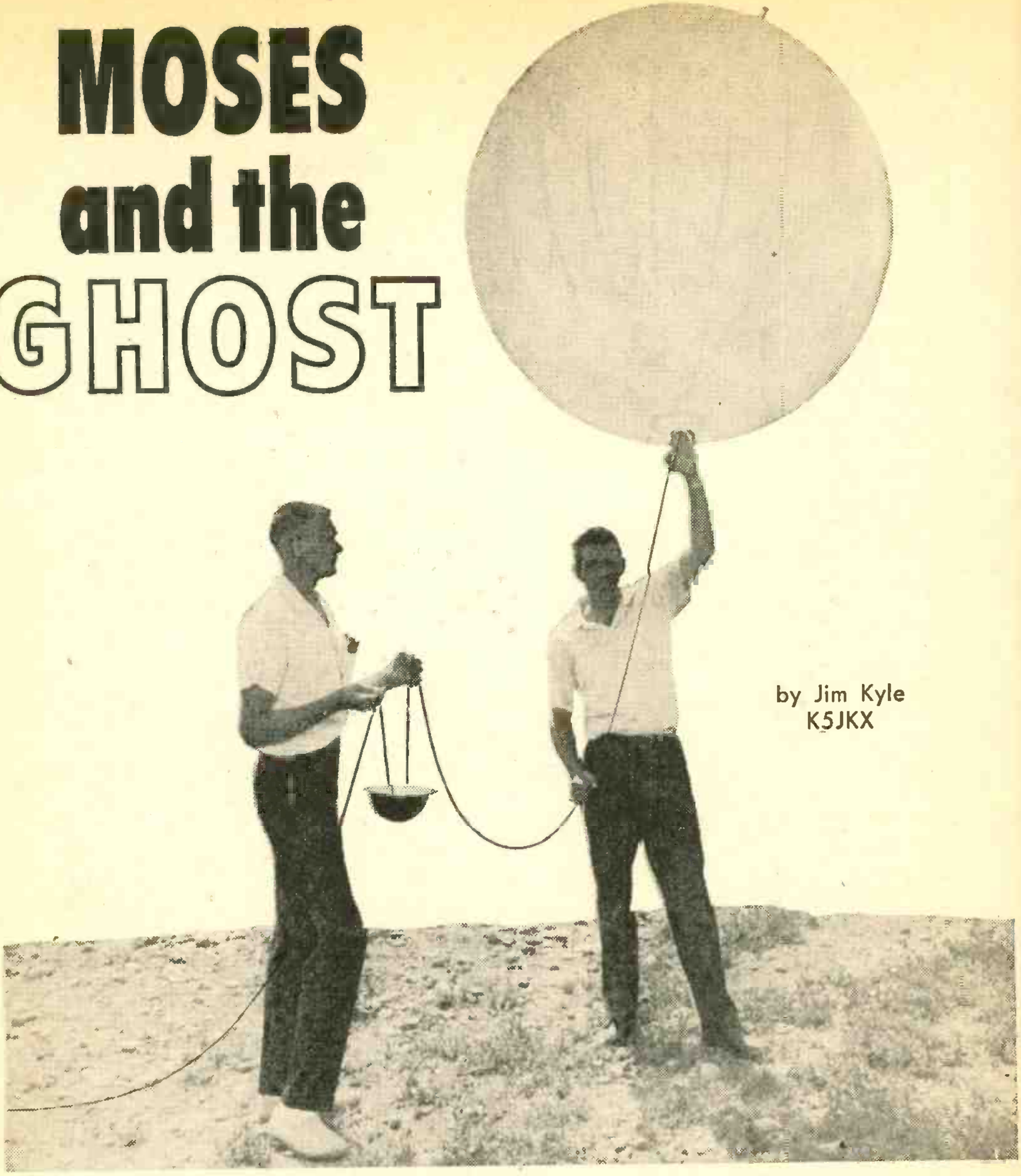
Constructed of aluminum and weighing only 20 oz., the device measures the six angles of jaw movement in inches and degrees of rotation. The gadget is attached to the teeth by a dental "clutch"; electrical signals produced by the device can be fed directly into an analog computer for analysis.

Though the jaw-motion measurement instrument made for Marquette University is a prototype, it's entirely possible that similar units will find their way into dentists' offices and thus help keep Charlie's gum-chomping on the cheerful side. —*C. Hansen* ■



Jaw-motion measurement device developed for Marquette University's School of Dentistry will first be used to study retrusion (backward) motion of jaw during swallowing, since knowledge of this movement is important for fitting dentures. Instrument weighs only 20 oz., provides signals that can be fed direct to analog computer.

MOSES and the GHOST



by Jim Kyle
K5JKX

Modern instrumentation acquires strange names to do even stranger jobs—all to help man to find out what goes on.

THE TIME WAS just 10 days after April Fool's Day, 1966. *Moses* was transmitting from New Zealand to Australia, while at an altitude of approximately 40,000 feet a *Ghost* was fulfilling still another Jules Verne prophecy.

And though the names might lead you to believe that this was all the product of a 10-day-late practical joker's imagination, the fact is that the accomplishment of *Moses* and the *Ghost* bid fair to make possible the long-anticipated control of the weather.

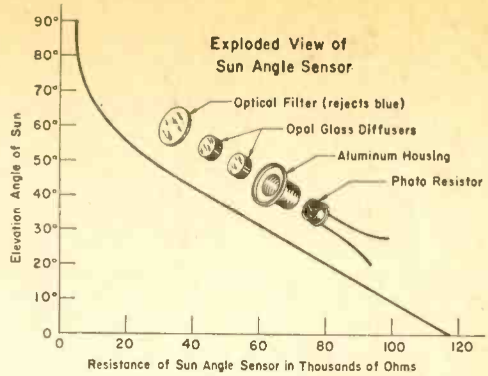
For *Ghost* is the name of a project called in its longer form *G*lobal *Ho*rizontal *S*ounding *T*echnique, and *Moses* is a part of this project—the *M*eteorological *O*bserving *S*tation, *E*xtremely *S*imple.

The *Ghost* which fulfilled the Jules Verne prophecy on April 10, 1966, was a 7-foot-diameter balloon trailing radio telemetry equipment underneath. On that date, it completed the first nonstop round-the-world flight ever made by a balloon. The Verne prophecy, of course, was Phineas Fogg's famous trip *Around the World in 80 Days*. The speedier *Ghost* took only 10 days for the trip, from New Zealand all the way around.

What's more, that same *Ghost* balloon made five more trips around in the following 64 days before project trackers lost radio contact with it. While it was the first, it was by no means the longest-lived. That honor goes to a later *Ghost* which went around 17 times. Several have remained aloft more than six months.

Data, Then Control. The purpose of the project is to develop a way of obtaining weather data from the 90 percent of the earth's atmosphere not now accessible to weather observers. When such data can be gathered, then scientists believe it will be possible to not only forecast weather accurately, but to actually control it on a major scale.

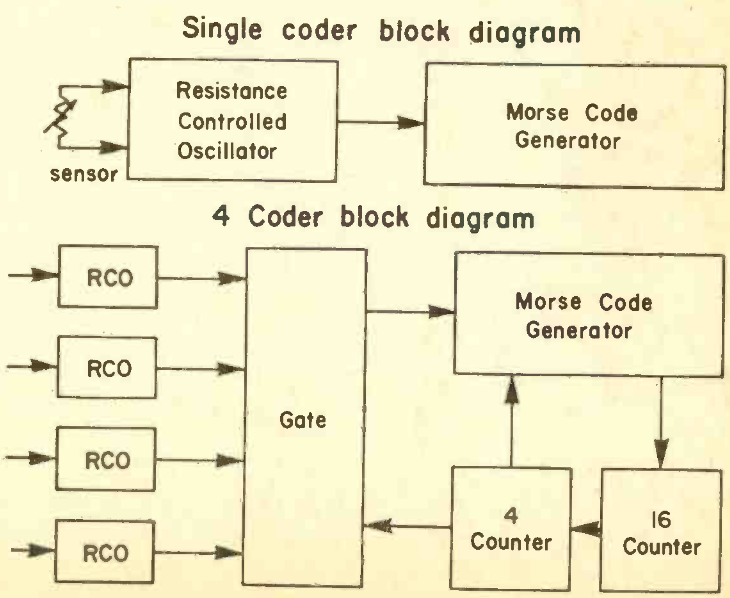
Such a plan is many years away from being operational—but *Ghost* is being tested now. The idea behind *Ghost* is to launch a huge fleet of long-lived balloons which float at various heights in the atmosphere (all above 15,000 feet, however, to minimize aircraft danger) and gather atmospheric data. Each of the more than 10,000 balloons in the fleet would relay its data to orbiting satellites, and the satellites in turn would send the data to ground stations for processing.



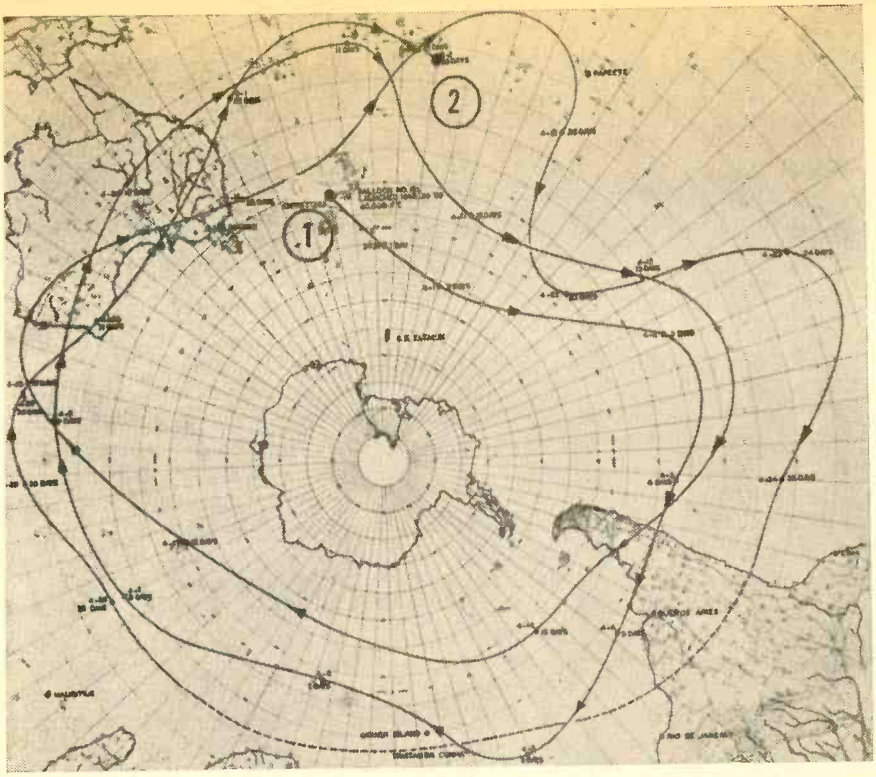
The sun-angle sensor consists of photoresistive cell, opal-glass diffusers and filter to reject scattered blue light. High sun angle lowers sensor resistance.

Balloon Life. So far, only about 50 *Ghost* balloons have been launched from the Christchurch, New Zealand, test facility. At present, the object of the program is to develop long-lived balloons which will remain aloft for an average of at least six months; the longer, the better.

When the life problem is solved, scientists of the National Center for Atmospheric Research, Environmental Science Services Administration, and the New Zealand Weather Service intend to proceed to the next step—interrogation of the balloons by satellites. This step is expected sometime during 1968 or 1969. At present, signals from the *Ghosts*



Sensor resistance controls frequency of ujt oscillator, which, in turn, controls keying rate of Morse Code Generator. Low resistance values produce higher code speeds. Four sensors can be connected to transmitter.



This map, centered on the South Pole, shows the track of balloon number 18, launched from Christchurch (1) at 2200 GMT on March 30, 1966. Only the first 33 days of the 74-day flight are shown. Flight ended June 12 (2).

are tracked by ground-based stations in New Zealand, Mauritius Island, Australia, South America, and Africa.

While the project is still considered to be experimental, it is already providing valuable weather data. Each *Ghost* balloon remains at an altitude determined by atmospheric pressure but which is essentially constant and known. Simply tracking the course of each balloon indicates the wind velocity and direction at the balloon's altitude—and this is information not available from any other source.

The Radio System. The voice of each *Ghost* is a tiny transistorized transmitter which ranges in power output from 1 watt at noon to only 50 milliwatts just before sunset (it is powered by solar cells). Despite the microscopic power level, these rigs have been tracked at a range of 4,000 miles regularly.

Each *Ghost* transmitter operates at a frequency near 15.025 MHz., and is identified by a CW code letter. The telemetry data varies the transmission speed of the CW character, and a different character is used for each channel of telemetry. Present flights use four channels, so each *Ghost* transmits four different characters. Transmission frequencies may vary slightly from 15.025 MHz.

Each of the characters transmitted is sent 16 times before the next channel of telemetry is chosen and the character changed. On many flights only a single channel is used, so that the character never changes. These flights are measuring sun angle.

To determine the telemetry results of the single-channel flights for yourself, be sure your clock is set exactly to WWV Time. Then time how long the *Ghost* takes to transmit 10 consecutive code characters, and write down both the time of day to the nearest second and the time required for 10 characters.

Present Tests. *Ghost* transmitters used in the present tests contain a single-transistor crystal oscillator and a single-transistor power amplifier, together with an 18-transistor-per-channel telemetry modulator system. All power is obtained from a bank of 26 solar cells which produces 12 volts. The entire transmitter is assembled on a printed-circuit board approximately five inches in diameter. Total weight of the radio system carried aloft is only about 4 ounces.

To keep everything operating in the 90-below-zero temperatures encountered at 40,000-foot-altitudes, the entire system is enclosed in a black plastic cover which absorbs heat from the sun. This cover worked too well at first, getting the transmitter too hot at 20,000-foot-altitudes. A small ventilation hole solved that problem, and now the radio system remains at about normal room temperature despite the sub-zero cold surrounding it.

In the fully operational *Ghost* system, the plan is to have the entire transmitter built with integrated-circuit techniques, directly upon the skin of the balloon. Then nothing need dangle beneath, and there will be no chance of an aircraft hazard since the balloon itself will collapse with any impact against a hard surface.

What About Moses? Where does *Moses* come into the picture? *Moses,* a modification of the *Ghost* radio system, is intended for ground-based use. Like the *Ghost, Moses* handles four channels of telemetry. However, *Moses*' power supply is larger—it contains 90 solar cells (instead of 26) and a rechargeable nickel-cadmium battery to boot. Thus *Moses* can operate for seven days without sunlight, and can keep going indefinitely if it gets 3 hours of sunlight daily. *Moses* is housed in a section of 6-inch pipe which is mounted on a 12-foot pole. The antenna is a simple ground-plane composed of the pole's guy wires.

To conserve power, *Moses* transmits at a slower speed than does a *Ghost*. Also, each character from *Moses* is repeated only four times rather than 16.

Range of *Moses* is somewhat greater than that of *Ghost*. The present model has been heard from 6,000 kilometers (almost 4,000 miles) distance. Installed at Christchurch, the present version transmits to a receiver at Melbourne, Australia. Three channels of telemetry transmit air temperature, package temperature, battery voltage, and the fourth is a reference chanel.

In an operational version different sensors would be used to transmit data other than air temperature. Cost is expected to remain less than $1,000 per unit. Such weather stations could be installed at many remote locations, and any number monitored by a single receiving station within range.

The Future. Even when both *Moses* and *Ghost* are fully operational—which in itself is an event not likely to occur during the next 3 to 5 years—scientists will have only a data-collection network. Why go to such lengths to collect data?

Since the 1920's, when British scientist L. F. Richardson first proposed the idea, weathermen have been attempting to develop a *mathematical model* of the earth's atmosphere. Such a *mathematical model* is a system of equations which completely describe all the effects of all observable variables in the weather. Models of this sort have been developed for many processes, including those of management and of manufacturing, but no workable mathematical model of the atmosphere has yet been perfected.

About 10 years ago, John von Neumann (the father of the electronic digital computer and the inventor of game theory, among other notable accomplishments) and his co-workers at Princeton's Institute for Advanced Study produced a model which they were able to test with a computer, but it was too simple to be practical. Today, the scientists are still stumped in developing their model. The reason, largely, is lack of sufficient data.

That is one of the major purposes of the *Ghost* project. Hopefully, the project will provide enough data to enable formulation of an accurate mathematical model of the weather. Then additional data collected by *Moses* and the *Ghost* can be "plugged into" the mathematical model to produce reliable forecasts for up to two-week periods—with at least the accuracy now obtained in election-night vote forecasts.

Outlook. When the mathematical model is perfected, weathermen will have the most accurate forecasting tool yet developed, but more than that it will be a means of testing all their theories about weather control. As Walter O. Roberts, NCAR director, puts it, the scientists can "paint the Mojave Desert black, by means of a numerical model, and use computers many times the speed of nature's computer, the atmosphere" to determine what the results of such action would be. After many such simulations, they will be able to determine what experiments should be attempted in the actual atmosphere, to achieve man's long-time goal—planet-wide weather control. ■

There's many a slip twixt 'tenna and TV, and it's usually the lead-in that's to blame. To learn why, join with us as the experts take us . . .

On twin-lead's twisty trail

By the Engineering Staff of the Belden Manufacturing Company

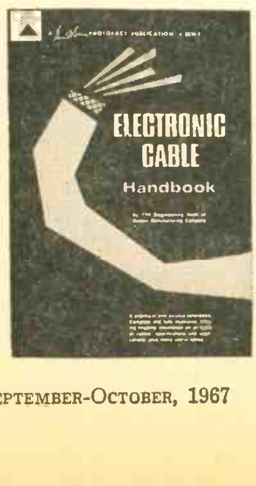
There's one thing about a TV installation we all invariably take for granted—and the result is all too often less than optimum performance from the receiver. Some people will shop around for the best TV on the market, and buy an expensive, high-gain antenna engineered to snap up the maximum TV signal from the ether. But they'll still end up with mediocre performance simply because the least expensive part of the installation, the lead-in cable, is either the wrong type or is incorrectly installed.

If your TV suffers from ghosts, fuzzy detail, or poor color, odds are that the condition or type of lead-in you're using—and not paying much attention to—is the stick in the mud. And the same holds true if your FM-stereo sounds better mono. The fact is that spending a few minutes correcting some of the common mistakes—like rerouting the lead-in, taking the kinks or sharp bends out of it, or maybe replacing it with the correct type—will make that picture come out as good as the old Orpheum's down the street, or the FM sound like the ghost of Toscanini is there in person.

The antenna lead-in cable accounts for only a fraction of the cost of a television receiving system, but its physical and electrical characteristics can make the difference between good and bad reception. Selecting the optimum transmission line is just as important as installing a suitable antenna.

What's With It Anyway

The primary requirement for a power transmission line is low conductor resistance. But with an RF transmission line, such as television lead-in, the capacitance between the conductors and the



This article is based on material contained in the Electronic Cable Handbook, by Belden Manufacturing Co., published by Howard W. Sams and Co. Inc., Indianapolis, Ind. This Handbook covers all phases of wiring and cabling and is available from the publisher. Only the section of special interest to our TV readers is covered here and comes from Chapter Five of the Handbook.

inductance of the conductors have a great deal of effect on power transmission.

Since each foot of RF line has the same physical dimensions, each given length will have identical inductance (L) and capacitance (C). When the transmission line is terminated in an impedance equal to the square root of L/C (known as "characteristic impedance"), energy will travel along the line to the termination where it will be absorbed. When the line is terminated in an impedance other than the square root of L/C, some of the energy is "reflected back" from the termination, causing a power loss (known as "mismatch loss"). However, in actual practice, since the source (antenna) and load (FM or TV receiver) impedances vary considerably, it is more important to have a transmission line with impedance uniform throughout its length to avoid multiple internal reflections which cause picture deterioration. Correct lead-in impedance is maintained by careful control of conductor size and spacing as the cable is being manufactured.

There are three other kinds of signal losses in lead-in; remember that these losses increase with signal frequency.

Conductor loss occurs as signal current in the lead-in conductors dissipates energy in the form of heat. As frequency increases, this loss rises rapidly, because the current is increasingly nearer the surface of the conductor (skin effect), thus reducing the effective cross-sectional area of the conductor.

Copper-clad steel core lead-in is most often preferred since it has about 150 percent greater breaking strength and about 250 percent greater flex life than lead-in made of similar size, all-copper conductors. High-frequency conductivity is approximately the same with either type conductor, since the signal occupies only the thin outer layer of copper on the conductors.

Dielectric losses are caused by the insulating material heating when a voltage difference exists between the lead-in conductors. Air, cellular polyethylene, solid polyethylene, and some other dielectric materials exhibit relatively low losses. This is one reason why polyethylene is used on lead-in. Cellular polyethylene is even better because it combines polyethylene with dry air dielectric (which has the lowest loss).

Radiation and induction losses result from electrostatic and electromagnetic fields surrounding the conductors. When the field around the conductors is disturbed by a metallic object less than six inches away, current is induced in the metal, resulting in power loss. Additional loss occurs because some of the energy radiates into space.

Transmission Line Types

Transmission lines for TV and FM receivers include flat lead, open wire line, tubular lines (cellular core and hollow), flat lines encapsulated in cellular polyethylene, as well as shielded and coaxial lines. Three of these are shown in the illustration.

Open line has two parallel conductors kept uniformly apart by insulating spacers. These open lines have a very low dielectric constant but losses increase as the amount of moisture in the air increases. The unwieldy physical structure and packaging of open lines discourage their use except in installations requiring minimum line losses, especially when the antenna must be located a considerable distance from the receiver.

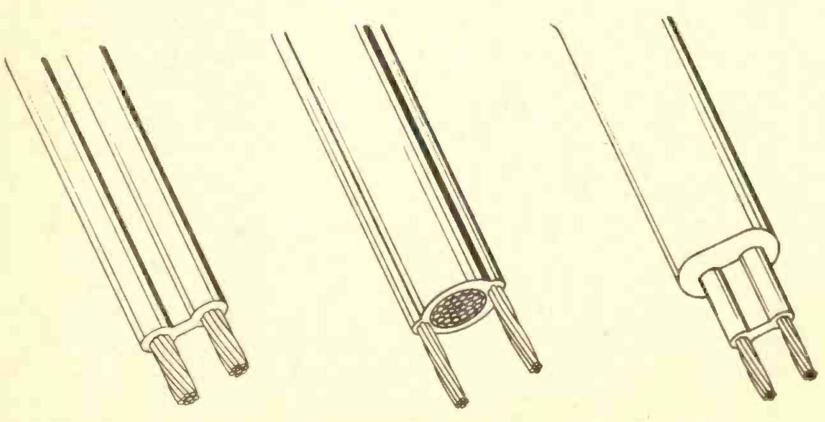
Selecting the Correct Lead-In

Many installation technicians have used the flat ribbon lead-in almost exclusively in the past. Though these installers can cite many examples of satisfactory reception using this type of line, flat line was designed for indoor use only.

Today's lead-in cables must carry both UHF and VHF signals, including critical color signals. Any installations requiring outside antennas should use a lead-in which is specifically designed for outdoor operation. When moisture accumulates on the surface of a flat line, or when the flat line is routed near metallic or conductive objects, part of the electromagnetic field surrounding the lead-in is induced into these objects, increasing attenuation losses. These conditions also result in losses due to impedance changes and signal reflections. This problem is not eliminated by increasing the thickness of the insulation web; flat twin-lead with 0.08 in. or 0.1 in. web thickness has essentially the same electrical limitations as twin-lead with a thinner web.

The color of the polyethylene insulation used on outside lead-in cable is quite critical, odd as it may seem at first. Polyethylene in its natural state (translucent milky color) or in any light color is very susceptible to stress-cracking from the effect of ultraviolet light, which is a strong component of sunlight. Such cracks collect moisture and dirt and cause leakage paths which distort and greatly weaken the signal through losses. A dark-pigmented color, such as the brown commonly used on lead-in, screens out this ultraviolet light and eliminates stress-cracking. Black would be even better, but black pigments contain carbon, which is conductive and would therefore impair the dielectric strength of the polyethylene insulation.

The choice of transmission line for outdoor installation should be made between cellular core and encapsulated lines as shown below. Cellular core lines are designed for transmission of VHF



FLAT RIBBON LEAD IN — CELLUAR CORE LEAD-IN — ENCAPSULATED LEAD-IN

Drawings show three types of lead-in commonly found in home installations.

signals from the antenna to the TV set, while encapsulated lead-in is designed for all-weather transmissions of both VHF and UHF signals, including color signals.

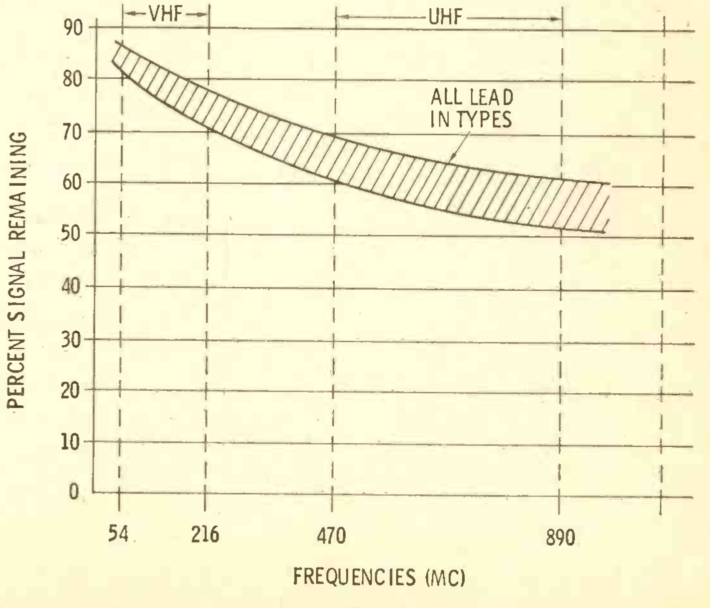
Cellular core lead-in is designed to reduce wet weather effects and normal dielectric losses by lengthening the conducting path between conductors and by providing a low dielectric constant material between the conductors. Hollow tubular lines, however, accumulate considerable moisture inside the hollow core through condensation caused by temperature changes, which lowers the dielectric strength of the air in the core and results in signal losses.

Cellular core lead-in results in a more rigid line; this semi-rigidity reduces line flutter in heavy winds and, when a rotor is used in the antenna installation, the lead-in holds a firm position around the rotor. The cellular core eliminates the need for end-sealing the lead-in after installation, and also eliminates moisture condensation.

The requirements for transmission lines conveying UHF and/or color TV signals are even more critical. Ultrahigh frequencies require a uniform-impedance line which can only be achieved when two conditions are met: first, the proper conductor spacing must be maintained, and second, the electromagnetic field surrounding the conductors must travel through a low-loss insulation.

The old style flat and tubular lead-ins perform well at UHF frequencies *only* when they are free from all trace of surface deposits. As soon as these lines encounter rain, snow, smog, fog, industrial deposits, etc., the impedance drops abruptly causing attenuation losses to soar, and reflections in the line, which cause multiple images or ghosts.

Encapsulated lead-in contains properly spaced conductors completely sheathed in a low-loss protective jacket. The cellular polyethylene outer jacket keeps all surface deposits out of the critical signal area regardless of weather conditions, assuring that signal



Curve indicates signal getting through lead-in under optimum conditions.

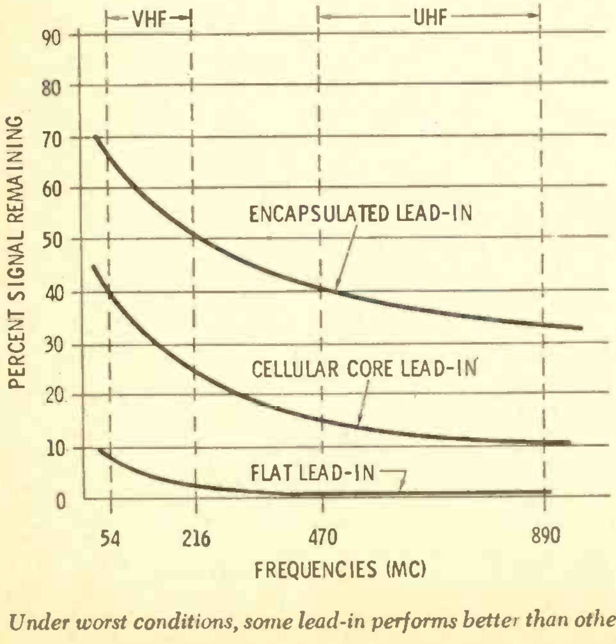
transmission is maintained at a level close to that of a laboratory environment. This impedance protection means that the encapsulated lead-in is correctly matched to both the antenna and the receiver under all environmental conditions, so that the strongest possible signal reaches the TV set.

Attenuation, or Signal Loss

A comparison of lead-in signal-loss characteristics must include bad weather performance data to be meaningful. Laboratory, or good weather, TV lead-in performance is charted below, left; the attenuation losses are so similar that any line could be chosen and no difference in receiver performance would be noted, assuming good installation practices were followed.

The graph below shows the problem from a more realistic point of view. It is evident that TV lines which have performed satisfactorily for black-and-white VHF reception cannot be used for color or UHF channels. The signal losses become intolerable using these lines in bad weather while the encapsulated lead-in continues to deliver a strong signal.

The term dB (decibel) is used in attenuation measurements to express the ratio of signal in to signal out. Any signal passing through a given length of cable will lose a certain amount of signal; this loss is expressed in dB. The engineering term dB may be converted into a percent loss figure. As an example, assume a cable with 5.0 dB loss over 100 ft. A quick reference to the table (see next page) indicates that 56 percent of the original signal would be available at the end of the 100 ft. Note that this is not a linear relationship; because 44 percent of the signal was lost in the first 100 ft., it does not mean that 88 percent would be lost in 200 ft., or 132 percent lost in 300 ft., etc.! Rather this means that if 44 percent of the



Under worst conditions, some lead-in performs better than others, as graph shows.

signal is lost in the first 100 ft., then 44 percent of the signal presented to the second 100 ft. would be lost at the end of 20 ft., and so on.

Coaxial Lead-In

Coaxial cable has concentric conductors separated by solid or cellular polyethylene insulation. It is used for special applications. RG-11/U and RG-59/U coaxial cable types, with line amplifiers, have been used for hotel, motel, hospital, apartment house, and similar master antenna system installations, or in other commercial situations where high ambient noise levels exist, caused by such sources as elevators, automotive ignition systems, industry, and medical equipment. In addition, long horizontal runs of unshielded flat type lead-in would pick up unwanted signals.

Shielded Twin-Lead

A new development in shielded twin-lead incorporates a total shield (a wrap of thin aluminum foil) and a jacket of weather-proof polyethylene (see illustration). This lead-in eliminates the need for stand-off insulators and does not require twisting or careful routing of the lead-in to minimize reflections. The design of this shielded twin-lead allows it to be taped directly to the mast or tower, routed through metal conduit, buried underground or even installed in rain filled gutters, if need be. This feature also makes shielded twin-lead a logical choice for applications which require installing lead-in within building walls.

Unlike coaxial cable, shielded twin-lead does not require a copper wire braided shield for current carrying purposes. An aluminum foil shield may be used to enclose this twin conductor lead-in because the shield of a balanced, two-conductor cable doesn't carry signal current.

The primary advantage offered by a shielded twin-lead is the elimination of pick-up of man-made electrical noise, such as automobile ignition noise and 60-Hz powerline interference, as well as the elimination of out-of-phase TV signals created by the transmission line acting as an antenna.

Signal Reduction Due to Lead-in Losses

Attenuation (DB)	Signal Remaining (Percent)	Signal Remaining* (Microvolts)
1	89	450
5	56	280
10	32	160
15	18	90
20	10	50
25	5.6	28
30	3.2	16
35	1.8	9
40	1.0	5
45	0.6	3

*A 500 microvolt antenna signal is presumed.

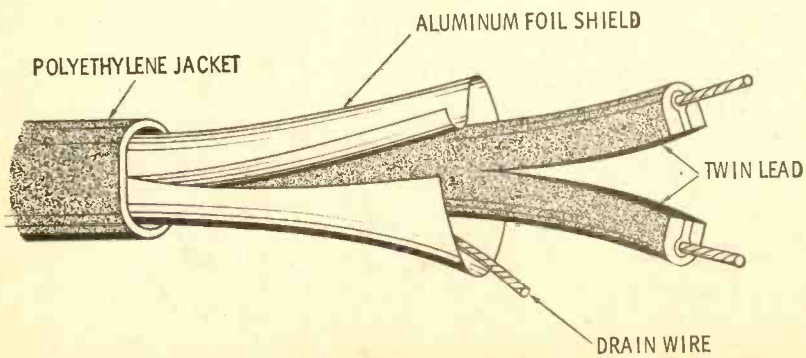
Though coaxial cable can also be used to minimize pick-up of unwanted electrical interference, this benefit is generally offset by attenuation losses which are intolerable in many VHF and most UHF receiving systems. In addition, coaxial cable introduces new problems by requiring two additional components. These components (two matching transformers) are required in coaxial systems to convert the unbalanced 75-ohm cable to a balanced 300-ohm impedance. Laboratory tests indicate that a pair of these matching transformers typically adds a 2-dB attenuation loss over the frequency band for which they are designed to operate. Matching transformers designed for only VHF seriously limit their use, since many areas have both UHF and VHF telecasts. A 100-ft. run of coaxial cable delivers 15 to 25 percent of the UHF antenna signal to the receiver when used with matching transfomers designed for these frequencies. This does not compare favorably with a 100 ft. run of shielded twin-lead, which delivers approximately 50 percent of the UHF antenna signal to the TV set.

Helpful Tips

Regular flat and cellular core unshielded lead-ins should be routed away from gutters, conduit, water pipes, metal baseboards, and similar obstructions. Insulated stand-offs should be used every four to six feet. Stand-offs which do not encircle the lead-in with metal are required for UHF. Unshielded lead-in should be twisted (conductors transposed) about once every 18 in. to minimize effects of external objects on electrical fields. When the installation requires more than one lead-in (FM, UHF or VHF), individual lines should be spaced a minimum of six in.

Use a knife to prepare unshielded twin-lead ends for termination. Cut the insulation along the outside of the conductors and spread the conductors to the side. This leaves the center intact for attaching to the boom or mast, providing physical support for the lead-in at the antenna terminals.

The newer shielded twin lead-in requires a somewhat different approach in preparation and installation. At the antenna, the jacket is removed, and the exposed shield is covered with electrician's tape or heat shrinkable tubing, to seal out moisture. For best results, try grounding the shield at the receiver through a .001 uF capacitor. If performance isn't improved, just leave it unconnected. ■



Cutaway view of new shielded lead-in that outperforms other types.

LITERATURE

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

LIBRARY

CB—AMATEUR RADIO—SHORTWAVE RADIO

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.

107. Get with the mobile set with *Tram's* XL'100. The new Titan CB base station, another *Tram* great, is worth knowing about.

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.

★93. *Heath Co.* has a new 23-channel all-transistor 5-watt CB rig at the lowest cost on the market, plus a full line of CB gear. See their new 10-band AM/FM/Shortwave portable and line of shortwave radios.

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.

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

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

45. CBers, get *World Radio Labs* CB catalog—a big first for *WRL*. If you need anything for base or mobile use, WRL has it. Best catalog buy there is and 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.

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 "SSS." Also, CB accessories that add versatility to their 5-watters.

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

KITS

★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. *EICO's* new 48-page 2-color pocket-size short form catalog is just off the press. Over 250 products: Ham radio, CB, hi-fi—in kit and wired form—are illustrated. Also, discover *EICO's* new experimenter kit line.

ELECTRONIC PRODUCTS

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

108. Get the facts on *Mercury's* line of test equipment kits—designed to make troubleshooting easier, faster and more profitable.

67. "Get the most measurement value per dollar," says *Electronics Measurements Corp.* Send for their catalog and find out how!

92. How about installing a transistorized electronic ignition system in your current car? *AEC Laboratories* will mail their brochure giving you specifications, schematics.

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.

ELECTRONIC PARTS

★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 latest *Allied Radio* catalog? The surprising thing is that it's free!

★2. The new 1967 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.

★3. Bargains galore! Parts, tools, test equipment, radios and many more specials at ultra-low prices. *Progressive Edu-Kits* will send latest catalog.

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 1967 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's 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 100's 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.

12. VHF listeners will want the latest catalog from *Kuhn Electronics*. All types and forms of complete receivers and converters.

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.

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

SCHOOLS AND EDUCATIONAL

★61. *ICS (International Correspondence Schools)* offers 236 courses including many in the fields of radio, TV, and electronics. Send for free booklet "It's Your Future."

★74. Join the *troubleshooters!* Let *CIE (Cleveland Institute of Electronics)* train you to keep our electronics world running.

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.

HI-FI/AUDIO

26. Always a leader, *H. H. Scott* introduces a new concept in stereo console catalogs. "At Home With Stereo" offers decorating ideas, a complete explanation of the more technical aspects of stereo consoles.

85. Need a tuner? Preamp? Amp? Tape deck? Then inspect *Dynaco* for kits or wired units. It's worthwhile looking at test reports *Dynaco* sends your way.

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!

15. *Acoustic Research* would like to send you a copy of their fact-packed "Stylus Force" booklet—must reading for hi-fi bugs.

16. Discover why Lab 80 by *Garrard* offers top dollar value. 32-page *Garrard* Comparator Guide will make you a wiser buyer.

17. *Electro-Voice* has two new, pocket-size, four-color product guides for you. One covers speakers and components; the other, microphones and accessories.

19. *Empire* has made exceptional advances in speaker cabinet design you should read about. Also, *Empire's* successes in the turntable and cartridge fields are worth discovering.

24. Need a hi-fi or PA mike? *University Sound* has an interesting microphone booklet audio fans should read before making a purchase.

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 *Acoustech's* solid-state amplifiers are the rage of the experts. Colorful brochure answers all your questions.

TAPE RECORDERS AND TAPE

113. Get a packet full of facts and tape data from *Scotch-3M* and learn all about your tape recorder and the tape it needs.

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.

33. Become the first to learn about *Norelco's* complete Carry-Corder 150 portable tape recorder outfit. Four-color booklet describes this new cartridge-tape unit.

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 new *Viking of Minneapolis* line—they carry both reel and cartridge recorders you should know about.

HI-FI ACCESSORIES

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

98. Swinging to hi-fi stereo headsets? Then get your copy of *Superex Electronics'* 16-page catalog featuring a large selection of quality 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."

TOOLS

★78. Need a compact screwdriver kit? *Xcelite's* 99PV-4 and 99PV-6 consists of handle, 3 and 5 blades, respectively, in "see-thru" zipper case. Get *Xcelite's* catalog 166.

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.

TELEVISION

★70. Need a new TV set? Then assemble a *Heath* TV kit. *Heath* has all sizes, B&W and color, portable and fixed. Build the next TV you watch.

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

ELEMENTARY ELECTRONICS
Dept. 967
505 Park Avenue,
New York, N. Y. 10022

Please arrange to have the literature whose numbers I have circled sent to me as soon as possible. I am enclosing 25¢ for 1 to 10 items; 50¢ for 11 to 20 items to cover handling (no stamps, please). Maximum number of items—20.

11-20 items

1-10 items

CHECK ONE

maximum number of items = 20

☐ Indicate total number of booklets requested

1	2	3	4	5	6	7	8	10	11
12	15	16	17	19	23	24	26	27	31
32	33	34	35	42	44	45	46	48	50
54	59	61	66	67	70	74	78	85	92
93	95	96	97	98	99	100	101	103	104
105	106	107	108	109	111	112	113	114	115
116	117	118	119	120	121	122			

NAME (Print clearly)____________________

ADDRESS____________________

CITY____________________

STATE____________ZIP____________

Radio Shack DX-150

Continued from page 96

could not be used for music reception such as on the broadcast band, the hard noise limiting on the SW frequencies was more than worth the increased audio distortion.

The speaker, which is built-in, is automatically disconnected when a plug is inserted in the headphone/remote speaker jack. We strongly suggest the use of the optional type 20-1500 ($7.95) voice-frequency speaker. We don't know how it was done, but this speaker is sharply peaked at the voice frequencies (sharp low frequency attenuation) and the extra intelligibility obtained on speech and CW reception is well worth the extra cost.

The S-meter proved as hot as a firecracker. Virtually any signal that can be received with 100% intelligence indicates S9—and anything stronger than a flea's sneeze is indicated as "over S9".

The power supply is 117 VAC, though 12 VDC can be used with the optional type 20-1501 Power Set ($7.95). The heart of the power set is a somewhat unusual battery case that provides sleeves for 8 D cells as well as an extra set of sleeves for a spare set of batteries. If you were using the DX-150 on a field day, or at camp, and the main batteries ran dry, it would take but a few seconds to interchange the active and spare battery sleeves (they snap-in between two springs). The power set comes with three power cords that connect to the 12 volt plug on the back of the receiver. One cord is for connection of the battery pack to the receiver, another cord matches the receiver to an auto's cigar lighter, and the third cord we haven't quite figured out—it appears to mate with the remote battery input jacks used on battery powered tape recorders. (This power set might be "universal".)

All In All. As you can see, our initial impression of quality was more than confirmed by the performance checks. While budget priced, the performance easily equals or surpasses receivers priced considerably higher. Even the construction is first rate. The RF circuits are on a heavy, well shielded (no spurious signals) chassis, and the PC boards have the "wiring" (road map) printed on top so the user can easily follow each component from point to point in case of difficulty.

For additional information on this great little rig, write to Radio Shack, Dept. CL, 730 Commonwealth Ave., Boston, Mass. 02215. ■

The Electronic Cop

Continued from page 94

to the horizontal AFC tube which is adjusted, or biased, so that it cannot conduct current when the sawtooth sample alone is applied to its grid. The sawtooth sample cannot grow sufficiently positive to start the tube conducting.

Notice that sync pulses from the TV station are also applied to the grid. Sawtooth and sync combined add up to enough positive voltage to cause a current flow in the AFC tube. That combination, however, happens only when sync and sawtooth occur at the same time. Any left or right change in the sawtooth position (due to drifting frequency) lets the tube drop back into its cutoff region. Next we'll trace how the system keeps the horizontal oscillator on frequency. Up to this point, AFC has merely compared signals.

If you observe the cathode of the AFC tube, you'll note that it's marked +. This represents a pulse of voltage developed at the cathode when the tube draws current (as sync and sawtooth coincide). This becomes the correction voltage fed back to the horizontal oscillator.

Since the oscillator can be easily controlled by external signals, it is pulled in by the pulses developed by the AFC tube. Any tendency of the oscillator to drift will change the length of the AFC correction pulse. This, in turn, will speed up or slow down the oscillator.

The horizontal hold control permits a coarse adjustment of the overall AFC system. As you watch the screen and turn the hold control you are setting the current-conducting range of the AFC tube by varying B+ voltage. Since this also affects the length of the correction pulse, the horizontal oscillator frequency will change, too. Once you see a locked-in picture, you can let go of the hold control—AFC will automatically take it from there. No one we know would welcome having to keep tabs on a horizontal oscillator by hand, so it's fortunate AFC is willing to do it for us. ■

FCC Q & A

Continued from page 99

Q. *What is the frequency deviation of an FM transmitter when modulated to 60%?*

A. An FM broadcast transmitter is allowed a deviation of 75 kHz. This would be considered to be 100% modulation. A 60% deviation would therefore be 75 x 0.60, or 45 kHz deviation. If we were discussing business band FM transmitters, which are limited to 15 kHz deviation, the answer would be 15 x 0.60, or 9.0 kHz deviation.

Q. *If an FM transmitter employs one tripler, one doubler, and one double-driver, what is the carrier deviation if the reactance-tube modulator swings the oscillator exactly 1 kHz each side of its center frequency?*

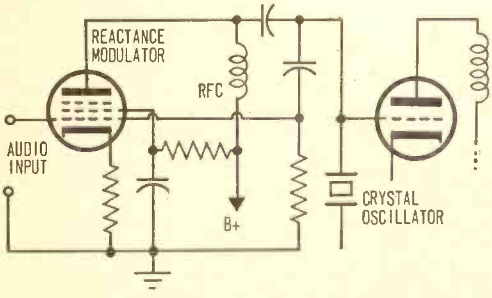
A. There is a total frequency multiplication here of 12. The deviation from center frequency of the carrier will therefore be 12 x 1 kHz or 12 kHz.

Q. *What is a ratio detector?*

A. A form of FM demodulator or discriminator whose output is proportional only to the ratio of the input IF voltages, and not to their amplitude. For this reason it is not sensitive to AM signals, and does not require preceding limiter stages.

Q. *Draw a diagram of a means of modulating an FM transmitter.*

A. A typical device for modulating an FM transmitter is a reactance-tube modulator. See diagram below.



Reactance modulator tube acts as variable capacitor controlling oscillator frequency.

Q. *How does the amount of power required to 100% plate modulate a 1000 watt AM transmitter compare with the amount of power required to 100% modulate a 1000 watt FM transmitter?*

A. Much more power is needed to modulate the AM transmitter. In practice, 1 milliwatt will easily modulate an FM transmitter to 100% modulation.

Q. *If the transmission line current of an FM broadcast transmitter is 10 amperes without modulation, what will the transmission line current be with 90% modulation?*

A. (A) 10A, (B) 9A, (C) 90A
Since the FCC exams are of the multiple-choice type, these answers would confront you on the exam. Which would you pick? If you guess you will probably be wrong. Don't confuse FM with AM. The transmission line current will not change between modulated and unmodulated condition on an FM signal, since the power does not change, only the frequency deviation.

Q. *How wide is an FM broadcast channel?*

A. Each FM broadcast channel is 200 kHz wide. Of this 150 kHz is for actual transmission of signal, and a 25 kHz guard band is used on either side of the 150 kHz.

Q. *How is the operating power of an FM broadcast transmitter determined?*

A. The operating power of an FM broadcast transmitter equals E (the final plate voltage) times I (the final plate current) times F, where F is an efficiency factor determined by the manufacturer of the transmitter, usually on the order of 60 to 65%. The method of determining operating power is called the indirect method.

Q. *Explain how an FM multiplex system operates.*

A. One audio channel modulates the carrier directly, through a reactance modulator, as in a conventional FM transmitter. A second audio channel amplitude modulates a subcarrier oscillator. The modulated signal from the subcarrier oscillator then frequency modulates the carrier oscillator through the same reactance modulator. The fact that the subcarrier modulation is AM allows it to be separated from the other audio signal at the receiver by injecting the subcarrier frequency from a local oscillator, then demodulating it. ■

Knight KG-663 Power Supply

Continued from page 86

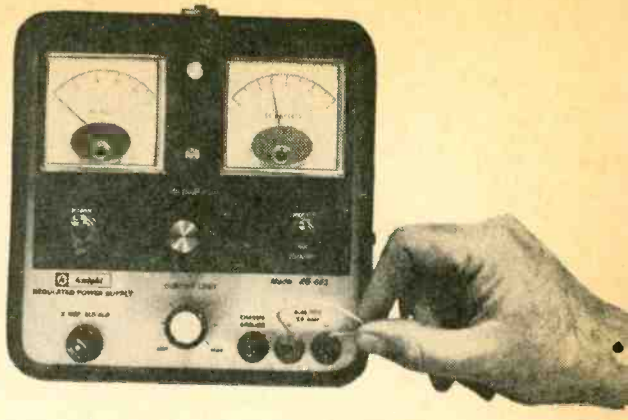
transistors when power is applied. So first, you connect a short piece of wire across the power supply's output terminals, set the output voltage to *any voltage reading,* close the standby switch and slowly advance the current-limit control to 1 A. Once the current limit is set, the supply cannot deliver more than 1 A. regardless of the voltage delivered to the amplifier. Similarly, if the current limit was set to a short-circuit limit of 100 ma. the supply wouldn't deliver more than 100 ma.

If the device connected to the supply's output terminals attempts to draw more current than the limit set, the power supply's output voltage is automatically reduced to maintain the established current limit.

In short, when the current limit is correctly used (and it's almost impossible to use it incorrectly), both the power supply, and the equipment to which it is connected, are protected against burn-out.

Features. To insure maximum convenience and accuracy, the KG-663 is provided with a fine-voltage-adjust control, concentric with the main voltage-adjust control. From one end to the other, the fine-adjust provides an output voltage variation from 1 to 2 volts, the exact range depending on the exact output voltage.

Additional terminals on the rear apron provide an extra set of output terminals, as well as remote voltage sensing to automatically compensate for voltage drop on long power supply leads carrying relatively high current, and the terminals allow remote control of the supply's output voltage.

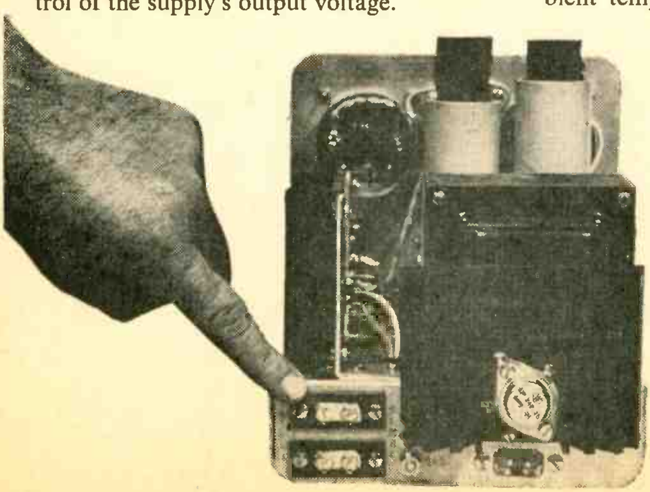


Current limiting circuit is set up by shorting output terminals and then adjusting front-panel controls for current and voltage required.

The KG-663 is a regulated supply, meaning it is supposed to maintain the set voltage output over a relatively wide range of both output current and line voltage variations. The unit we tested far exceeded Knight's claims. While Knight claims less than a 60 millivolts change in output voltage from no load to full load (0 to 1.5 amps), we were unable to measure any variations with quality service-grade instruments. And while Knight claimed less than a 0.3 volt variation at any load over an applied line voltage range of 110-130 VAC, our test unit held within this rating from 100 to 140 volts.

Warm Up. Though the KG-663 checked out well, there was one negative aspect we should call to your attention: the supply requires at least 15 minutes warm-up to obtain the full 40 volt output. From a cold start, the maximum output voltage varies from about 34 to 38 volts, depending on the ambient temperature. After warm-up, the full 40 volts is obtained. A user adjustment allows the maximum output voltage to be compensated for component aging.

The KG-663 is a pleasant departure from the usual kit styling; in fact, it's hard to tell



Finger points to rear panel terminal strips that provide auxiliary output terminals, and remote control of output voltages or remote sensing to compensate for voltage drops.

at first glance that it is a kit. The cabinet is a heavy black wrinkle-finish steel; the transistor heat sinks are heavy duty black anodized aluminum, rather than the usual cheap metal fin. The under-chassis components are wired on the parallel terminal strip arrangement common to laboratory instruments.

How It Works. The block diagram shows how the supply works. Q5 and Q6, the *pass* transistors, perform as controllable "resistors." Q2 compares the established output voltage against a fixed voltage from the bias reference. If the output voltage attempts to change in any way, either up or down, Q2 detects the error and varies the "resistance" of Q5 and Q6 to re-establish the set voltage output.

The current limit is controlled by transistor Q1, which "senses" a change in output current as a change in voltage developed by the output current across a very small resistor.

In conclusion, while we're used to thinking of instrument kits in terms of "service grade," the KG-663 regulated power supply can be associated with "laboratory grade" equipment, for in both performance and quality, it is suited for research and development work. While its price is relatively high for the experimenter or service shop ($99.95 in kit form and $149.00 wired), modern, sophisticated, solid-state equipment servicing often requires the high stability and ripple (hum) free characteristics of the KG-663.

For additional information write to Allied Radio Corp., Dept. 20, 100 N. Western Ave., Chicago, Ill. 60680. ■

"Boy! My signal must be going clear around the world—the ham down the block says he can hardly hear it!"

Ticketed Tech

Continued from page 69

Selling CB radios can also build your income. You not only make a profit on each sale, but you can also charge $25 for installation of each set and get another steady service customer. Since CB sets use standard crystals, you should have quite a few sets on hand and have a stock of crystals. You'll find CB equipment manufacturers listed in the 1967 edition of CB BUYERS' GUIDE.

Working For A Manufacturer. There's still another area of opportunity for the two-way radio technician. Equipment manufacturers are looking for good technicians to check out equipment at the end of the production line, repairing defective sets returned by customers, building prototype equipment in a lab, and supervising installations.

Many men who started out as technicians for manufacturers have risen to executive jobs. From technician duties they have turned to engineering or sales. The communications sales manager of one of the big manufacturers started out with another company as a field service technician. One of his former associates is now the owner of one of the largest mobile radio service shops in the metropolitan New York area.

To get a job with a manufacturer, run a classified ad in Electronics News (7 E. 12th St., New York, N. Y. 10003), Communications (Box 63992, Oklahoma City, Okla. 73106), CEM (14 Vanderventer Ave., Port Washington, N. Y. 11050), and/or Communications Market Report (Box 3095, New York, N.Y. 10017).

Booming Field. Only a little more than two decades ago, Fred M. Link got the two-way radio industry going in a big way when he founded Link Radio Corporation. Today, it is almost a $200 million per year business, and it's growing 10 per cent every year.

You can get into this booming field if you study and get a Second Class Radiotelephone Operator license. As a part-time, on-your-own two-way radio technician, you can command $10 an hour or more for your time. Working for someone else, you can get $100-175 a week at the start and in time earn as much as $250 a week doing service work. If you switch over to sales, you might eventually earn as much as $50,000 per year in salary and commissions. Some are doing it right now. ■

RAY-TEL TWR-9

Continued from page 64

The Transmitter. Utilizing a pi-net output circuit, the transmitter delivered 3.5 watts into a 50 ohm load. A so-called "antenna" indicator—actually a front panel lamp—glows when the transmitter is activated. But in fact, the lamp only indicates that power is being applied to the transmitter; it does not indicate RF output as it will glow even if the transceiver is switched to a blank crystal position.

The intercom switching deserves some extended discussion because of somewhat unique circuitry that allows a single remote speaker connected to the speaker jack on the transceiver's rear apron to serve three different functions. To illustrate, let us assume the remote speaker is placed in the shop while the transceiver is located in the kitchen.

If the front panel *remote switch* is depressed the output of the transceiver is fed to both the transceiver's speaker and the remote speaker, allowing the CB channel to be monitored both in the shop and kitchen. To disable the remote monitoring, it is only necessary to depress the remote switch a second time; it is not necessary to disconnect the speaker to eliminate the remote monitoring.

When the *intercom switch* is depressed, the TWR-9 is converted to an intercom with a hands-free remote station, that is, it provides full-time monitoring of the remote speaker. In our example, the kitchen would always monitor the shop. By depressing the *talk* button, the "kitchen operator" could talk back to the shop. To restore the transceiver to CB operation, the user simply depresses the desired channel switch, automatically disconnecting the intercom circuit.

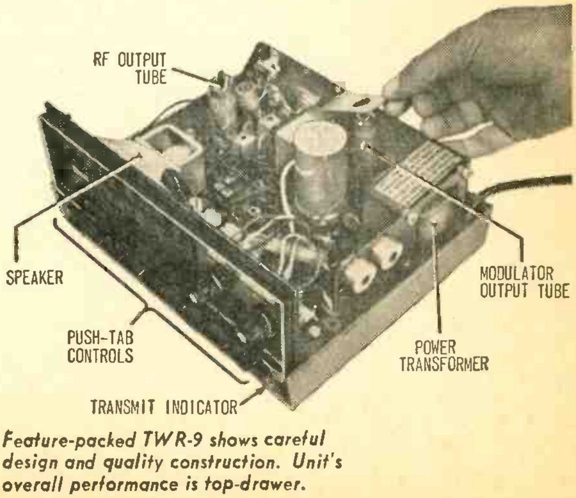
Separate Volume Controls. The front panel volume control determines only the volume of the received radio signal; it has no effect on the intercom. The intercom volume controls, which can be user adjusted, are located inside the cabinet. One control sets the level at the transceiver (the level from the remote speaker); a second control establishes the sound level at the remote speaker (intercom). Note that both volume controls affect only the intercom service; when the remote speaker is used for remote monitoring of received CB signals the normal transceiver volume control determines the sound level from both the transceiver and remote speakers.

The TWR-9's overall quality is a notch or two above the usual CB construction. The first unusual bit is a three prong power plug that insures the transceiver is at least connected to the electrical ground. Secondly, the printed circuit board is fiberglass, with extra heavy printed circuit wiring. All components are very rigidly mounted, right down to a swivel-bar to secure the modulator tube. In addition, the two tubes are placed "in the open" so their heat will have little or no effect on adjacent components. Finally, instead of the more common solder-terminals used for crystal sockets, each channel has its own set of crystal terminals in a solid plastic block.

Summing Up. Based only on our checks, the TWR-9 was as good or better than Raytheon's claims. From the operating viewpoint, the transceiver was as easy to operate and handle as the ordinary office intercom, the only difference being that the user selects a CB channel rather than a particular intercom sub-station. And as we said, construction quality was first rate. All in all, the TWR-9 is an unusual but highly effective CB radiophone/intercom system.

The basic transceiver is priced at $99.95. The remote speaker/intercom (with cabinet to match the transceiver) complete with 50 feet of connecting cable (with plug and terminals pre-wired) is $119.85.

For additional information write to Raytheon Co., Ray-Tel Products, 213 E. Grand Ave., So. San Francisco, Calif. 94080. ■



Feature-packed TWR-9 shows careful design and quality construction. Unit's overall performance is top-drawer.

CLASSIFIED

Market Place

FOR BIGGER PROFITS! NEW CAREER OPPORTUNITIES!
READ AND REPLY TO THESE CLASSIFIED ADS

Classified Ads 55¢ per word, each insertion, minimum 10 words, payable in advance. To be included in the next available issue of ELEMENTARY ELECTRONICS, copy must be in our New York Office by Sept. 10th. Address orders to C. D. Wilson, Manager, Classified Advertising, ELEMENTARY ELECTRONICS, 505 Park Ave., New York, N. Y. 10022.

How to get into

One of the hottest money-making fields in electronics today–servicing two-way radios!

HE'S FLYING HIGH. Before he got his CIE training and FCC License, Ed Dulaney's only professional skill was as a commercial pilot engaged in crop dusting. Today he has his own two-way radio company, with seven full-time employees. "I am much better off financially, and really enjoy my work," he says. Read here how you can break into this profitable field.

More than 5 million two-way transmitters have skyrocketed the demand for service men and field, system, and R&D engineers. Topnotch licensed experts can earn $12,000 a year or more. You can be your own boss, build your own company. And you don't need a college education to break in.

HOW WOULD YOU LIKE to start collecting your share of the big money being made in electronics today? To start earning $5 to $7 an hour... $200 to $300 a week... $10,000 to $15,000 a year?

Your best bet today, especially if you don't have a college education, is probably in the field of two-way radio.

Two-way radio is booming. Today there are more than *five million* two-way transmitters for police cars, fire department vehicles, taxis, trucks, boats, planes, etc. and Citizen's Band uses—and the number is still growing at the rate of 80,000 new transmitters per month.

This wildfire boom presents a solid gold opportunity for trained two-way radio service experts. Many of them are earning $5,000 to $10,000 a year *more* than the average radio-TV repair man.

Why You'll Earn Top Pay

One reason is that the United States Government doesn't permit anyone to service two-way radio systems unless he is *licensed* by the Federal Communications Commission. And there simply aren't enough licensed electronics experts to go around.

Another reason two-way radio men earn so much more than radio-TV service men is that they are needed more often and more desperately. A home radio or television set may need repair only once every year or two, and there's no real emergency when it does. But a two-way radio user must keep those transmitters operating at all times, and *must* have their frequency modulation and plate power input checked at regular intervals by licensed personnel to meet FCC requirements.

This means that the available licensed experts can "write their own ticket" when it comes to earnings. Some work by the hour and usually charge at least $5.00 per hour, $7.50 on evenings and Sundays, plus travel expenses. A more common arrangement is to be paid a monthly retainer fee by each customer. Although rates vary widely, this fixed charge might be $20 a month for the base station and $7.50 for each mobile station. A survey showed that one man can easily maintain at least 100 stations, averaging 15 base stations and 85 mobiles. This would add up to at least $12,000 a year.

THIS COULD BE YOUR "TICKET" TO A GOOD LIVING. You must have a Commercial FCC License to service two-way radios. Two out of three men who take the FCC exam flunk it . . . but nine out of ten CIE graduates pass it the first time they try!

Be Your Own Boss

There are other advantages too. You can become your own boss—work entirely by yourself or gradually build your own fully staffed service company. Instead of being chained to a workbench, machine, or desk all day, you'll move around, see lots of action, rub shoulders with important police and fire officials and business executives who depend on two-way radio for their daily operations. You may even be tapped for a big job working for one of the two-way radio manufacturers in field service, factory quality control, or laboratory research and development.

How To Get Started

How do you break into the ranks of the big-money earners in two-way radio? This is probably the best way:

1. Without quitting your present job, learn enough about electronics fundamentals to pass the Government FCC Exam and get your Commercial FCC License.
2. Then get a job in a two-way radio service shop and "learn the ropes" of the business.
3. As soon as you've earned a reputation as an expert, there are several ways you can go. You can move *out* and start signing up and servicing your own customers. You might become a franchised service representative of a big manufacturer and then start getting into two-way radio sales, where one sales contract might net you $5,000. Or you may even be invited to move *up* into a high-prestige salaried job with one of the major manufacturers either in the plant or out in the field.

The first step—mastering the fundamentals of Electronics in your spare time and getting your FCC License—can be easier than you think.

Cleveland Institute of Electronics has been successfully teaching electronics by mail for over thirty years. Right at home, in your spare time, you learn electronics step by step. Our AUTO-PROGRAMMED™ lessons and coaching by expert instructors make everything clear and easy, even for men who thought they were "poor learners." You'll learn not only the fundamentals that apply to all electronics design and servicing, but also the specific procedures for installing, troubleshooting, and maintaining two-way mobile equipment.

Get Your FCC License . . . or Your Money Back!

By the time you've finished your CIE course, you'll be able to pass the FCC License Exam with ease. Better than nine out of ten CIE-trained men pass the FCC Exam the first time they try, even though two out of three non-CIE men fail. This startling record of achievement makes possible the famous CIE warranty: you'll pass the FCC Exam upon completion of your course or your tuition will be refunded in full.

Ed Dulaney is an outstanding example of the success possible through CIE training. Before he studied with CIE, Dulaney was a crop duster. Today he owns the Dulaney Communications Service, with seven people working for him repairing and manufacturing two-way equipment. Says Dulaney: "I found the CIE training thorough and the lessons easy to understand. No question about it—the CIE course was the best investment I ever made."

Find out more about how to get ahead in all fields of electronics, including two-way radio. Mail the bound-in postpaid reply card for two FREE books, "How To Get A Commercial FCC License" and "How To Succeed In Electronics." If card has been removed, just send us your name and address on a postcard.

ENROLL UNDER NEW G.I. BILL

All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, OR are in service now, check box on reply card for G.I. Bill information.

CIE Cleveland Institute of Electronics
1776 E. 17th St., Dept. EL-4, Cleveland, Ohio 44114

A Leader in Electronics Training . . . Since 1934 • Accredited Member National Home Study Council