TRANSISTOR IGNITION FOR VW

POPULAR ELECTRONICS

OCTOBER 1965

35 CENTS

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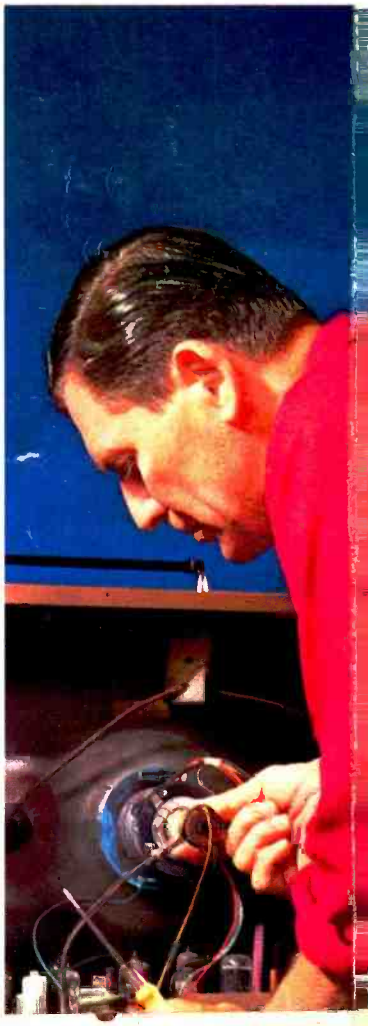
Guide To TV Pic Tube Testers

Build Bantam Hi-Fi Speaker

Fail-Safe Power Supply



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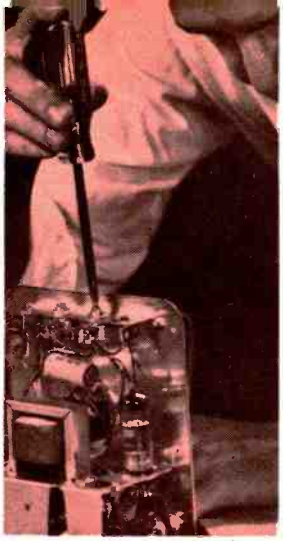

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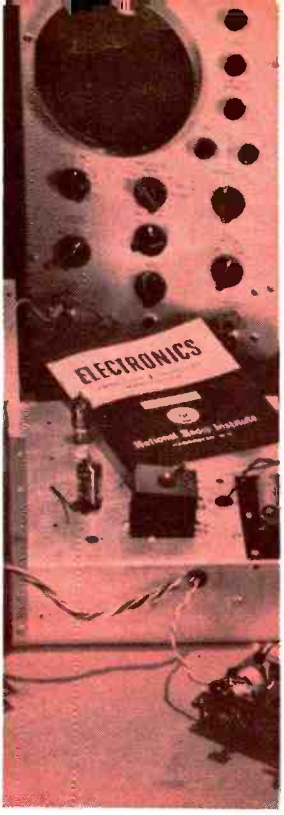

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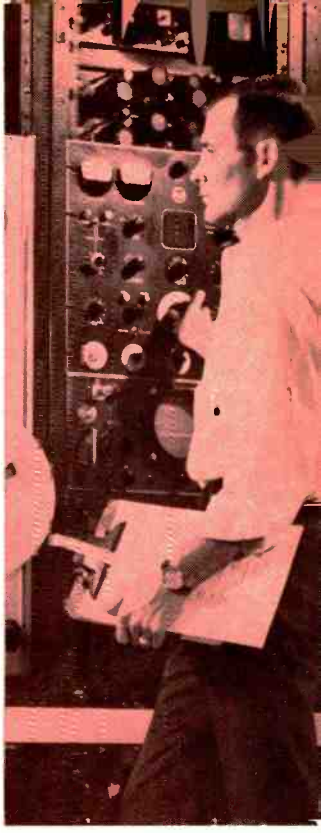

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POPULAR ELECTRONICS

ZIFF-DAVIS PUBLISHING COMPANY

POPULAR ELECTRONICS is indexed in the Readers' Guide to Periodical Literature
This month's cover photo by Bruce Pendleton

VOLUME 23 OCTOBER, 1965 NUMBER 4

Special TV Section

Electronic Construction Projects

Communications

Electronic Features and New Developments

Departments

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POPULAR ELECTRONICS

World's Largest-Selling Electronics Magazine

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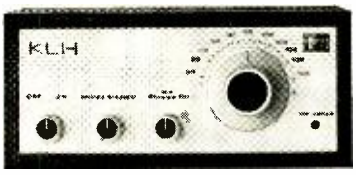


300 Years ago they'd have burned us as witches. We make little things perform miracles.

Like the KLH Model Eighteen.

It's a solid state FM stereo tuner.

Sopping wet, in its handsome oiled walnut enclosure, it weighs less than four pounds. And it measures just 9" wide x 4¼" high x 5⅜" deep.

Can something like that perform miracles?

We have witnesses.

"The design philosophy of the Model Eighteen is definitely rooted in the KLH tradition of making as much as they can themselves to insure quality . . . In the case of the Model Eighteen they have gone to the trouble of making their own i.f. transformers . . . the payoff is in performance . . . the most remarkable specification of the KLH is its price $116.95. At that price and with the performance it provides, the KLH is a remarkable tuner buy." AUDIO MAGAZINE.

"The Eighteen is engineered to produce maximum performance with minimum complexity . . . (It) is an exceptional value, and is, in fact, one of the better FM tuners I have seen regardless of price." JULIAN HIRSCH, HI FI/STEREO REVIEW.

"Its clear open sound and sensitivity to stations all the way up and down the dial qualify it unquestionably for use as a tuner in the finest of playback systems." HIGH FIDELITY.

"The audio purist who spends his entire life looking for better sound would find no fault with the Model Eighteen." RADIO-TV EXPERIMENTER MAGAZINE.

"The KLH Model Eighteen in normal use should never need realignment or servicing for the life of the unit."

Who said that? We did.

Is that witchcraft?

Not really. We did it all with our own hands, our own parts, our own imagination. The way we do everything. The KLH way. It guarantees miracles.

And those rumors of ladies in pointed hats prowling the moonscapes of Cambridge, Mass., are completely unfounded.

We'll bet our broomstick on it.

For more complete information on all our miracles, write The KLH People, 30 Cross Street, Cambridge, Mass., Dept. 103.

KLH

30 Cross Street, Cambridge, Mass.

CIRCLE NO. 24 ON READER SERVICE PAGE

LETTERS
FROM OUR READERS

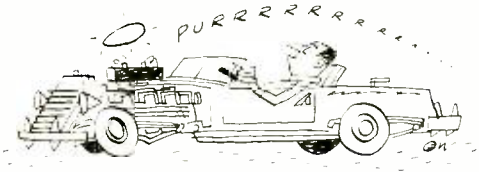
Address correspondence for this department to: Letters Editor, POPULAR ELECTRONICS, One Park Avenue, New York, N. Y. 10016

CD IGNITION SYSTEM A SUCCESS

After reading "Transistorized Capacitor Discharge Ignition System" (June, 1965), I purchased a kit from SYDMUR to install in my 1964 Chrysler "Newport." I found it easy to put together, and it worked the first time I tried it. I was getting 13 miles per gallon and now I am getting 16 miles per gallon. The engine starts faster and doesn't stall as often during the first few minutes of warm-up.

RALPH C. NEWELL
W. Boylston, Mass.

My compliments on a fine article. I bought the SYDMUR kit and installed it in my Olds "Starfire." After three weeks of use and 1900 miles of driving, I find that the engine is "greasy" smooth at all speeds, mileage has



improved from 11 to 12½ miles per gallon, and acceleration is positive. I'm 100% satisfied with the way the system operates.

JOHN BARNA
Buffalo, N.Y.

It's worth the money. Engine performance is smooth, ignition interference-free, and gas consumption is less. Most of all, I like the effortless starting.

HERMAN S. KRUZEL, K9SNF
Chicago Heights, Ill.

Much interest has been shown in the CD ignition system. For answers to some pertinent questions, and instructions as to how to convert the system for operation with positive ground ignition as well as for the 6-volt foreign jobs, see page 69.

ELECTRONIC COIN TOSSER

In the "Electronic Coin Tosser" (April, 1965), please note that the bistable multivibrator or flip-flop resistors *R9* and *R10* are 820 ohms but should be 8200 ohms. Using 820 ohms, the forward bias on the transistor, which is in the off condition, is too great and the square-wave signal is lost; I confirmed

LETTERS

(*Continued from page 7*)

this on a Tektronics scope #543. I would also recommend placing a 25-pf. capacitor across these resistors. Since I modified the Tosser, it works very well.

ART KRACIKAS
Winnipeg, Manitoba, Can.

We can't argue with success, Art, but it is not unusual for different batches of the same transistor types to require different values for related components. The original model worked fine with the 820-ohm resistors.

THE PROJECT WORKS

I have noted that editors and readers alike are particularly pleased with letters that say, "It works." As I enjoy your magazine and its articles on construction projects, I am sending you this letter to say, "It works."

RUSSELL JONES
Toronto, Canada

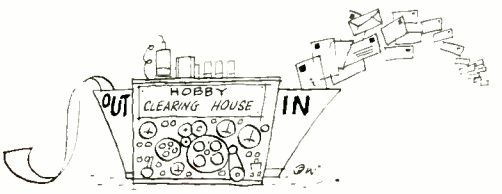
Russell, what works?

HAMS WITH OTHER HOBBIES RESPOND

I think Art Taylor's idea of a clearing house for hams (*Letters*, August, 1965), is excellent. In addition to ham radio, I am also interested in astronomy, photography, and amateur rocketry. I operate on six and two meters (50.166 and 145.8 mc.) AM and CW almost every evening. I would like to join a net or discussion group.

KENNETH J. BURGESS, WA8RER
Allen Park, Mich.

Kenneth, your letter in response to Art's idea was the first of many to arrive here. Hobby interests varied from flying to water



sports, from stamp collecting to camping, from archery to reading, from hi-fi to building electronic projects, etc. Starting in the November issue, we will publish calls, bands, and interests of those who write in. A post card will do. Tell us your favorite "second" or "third" hobby, what bands you operate, what mode, when you are on the air, and when you would be willing to join a net or discussion group.

BOWS AND ARROWS

I fail to see any sense in Rep. Frank T. Bow's bill—House Resolution 377, (*Letters*, August, 1965). To take our 10-meter ham band and give it to a group of "lids" is not right . . . The solution to this whole CB

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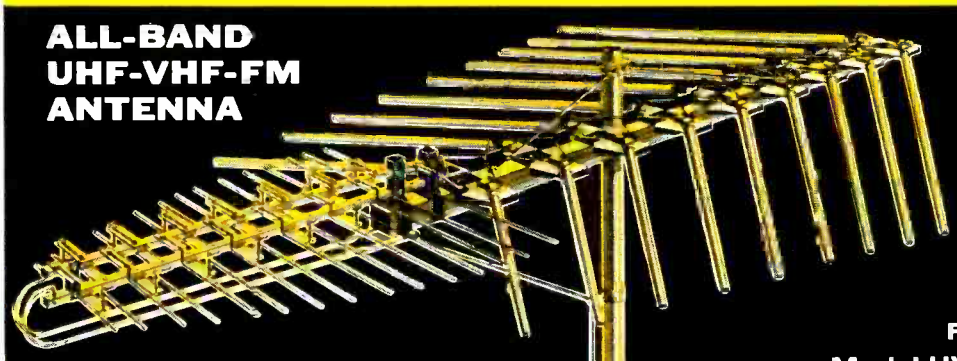
FOR UHF, VHF, FM RECEPTION

ALL-BAND UHF-VHF-FM ANTENNA



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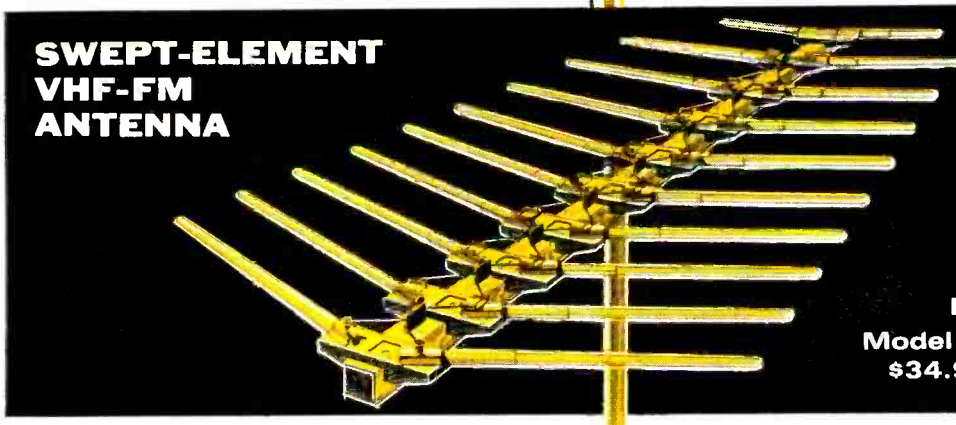

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CIRCLE NO. 15 ON READER SERVICE PAGE

LETTERS

(*Continued from page 8*)

dilemma is to examine every CB licensee for valid need of the Citizens Radio Service. If there is none, revocation of the license should follow.

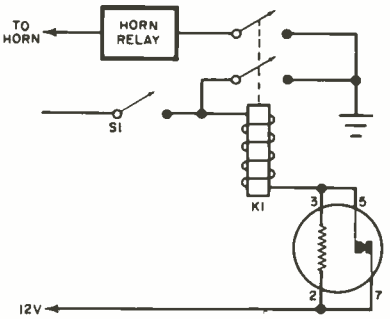
JOHN C. BRY, III, WN2QLG
Cherry Hill, N.J.

I agree with Rep. Frank T. Bow. I'm asking my representative, Joe Skubitz, to give House Resolution 377 all the help he can.

RALPH B. BILSON
Eureka, Kan.

TAMPER ALARM GOES "PERIODIC"

The "Simple Self-Resetting Tamper Alarm" (July, 1965), stays on all the time the hood or door is open. There is less chance of running the battery down if the horn is made to go on and off periodically. A minor wiring



change as shown in the schematic will cause the alarm to go on and off until either the master switch is opened, or the hood and all the doors are closed.

ARTHUR C. LANGUIRAND
Newport, R.I.

RESONANCE ENGINE PULLS FIRST PRIZE

I constructed the "60-Cycle Repulsion Coil-Resonance Engine" (March, 1964) and entered it in my school's science fair. I also wrote an explanation of the principle of resonance, and used the engine to demonstrate it. I received first prize.

GARY CHIRLIN
Buffalo, N.Y.

H.E.L.P.

I agree 100% with Ron Haney, KHC3840, who wrote in opposing the H.E.L.P. system (May, 1965). Why not use a channel which has *not* been allocated for CB use? The units on the highways would then only need one channel and could not be used for any other purpose. This would simplify things for the motorist and save CB from destruction.

GREG IPPEN, KNJ6323
Rockford, Ill.

H.E.L.P. is just the thing for an emergency. We should have more people using CB for

Zip through Scott's new solid state FM stereo tuner kit in one afternoon

Four to six hours! That's all you need to zip through Scott's new LT-112 FM stereo tuner kit. Start after lunch—enjoy superb stereo at dinner.

Scott solid state circuitry is the key to the LT-112's superior performance. Costly silicon transistors give performance unapproached by any other kit on the market. The LT-112 is kit-brother to Scott's best-selling 312 solid state stereo tuner, of which *Audio* said, ". . . one of the finest tuners anywhere."

Your LT-112 arrives with all critical circuitry pre-wired, pre-tested, pre-aligned, and mounted on heavy-duty printed circuit boards. Scott's exclusive life-size, full-color construction book details every step . . . makes perfect wiring almost automatic.

You'd never believe a kit so easy to build could be so packed with features. Built into the LT-112 is a new Scott invention . . . the Trimodulation meter, used for a Signal Strength Indicator, Zero Center Indicator, and Alignment Meter.

See your Scott dealer today, and pick up an LT-112 tuner kit . . . $179.95 plus one enjoyable afternoon will net you a lifetime of listening pleasure.

For complete information on Scott's kits & components write: Dept. 520-10, H. H. Scott, Inc., 111 Powdermill Road, Maynard, Mass.
Export: Scott International, Maynard, Mass. Cable HIFI. Prices slightly higher west of Rockies.
Prices and specifications subject to change without notice.

CIRCLE NO. 43 ON READER SERVICE PAGE

LETTERS (*Continued from page 10*)

practical purposes, particularly to aid motorists.

JOE & CHARLIE BERRIOS, KMD1261
New York, N.Y.

POPULAR ELECTRONICS IS TWO WORDS

Doing the puzzle "Find the Components" (July, 1965) was an exciting experience. I managed to get all but one, #23. When I looked at the solution and found that "POPULAR ELECTRONICS" was the answer, I was disappointed. POPULAR ELECTRONICS is *not* a component.

KEN WEINSTEIN
New York, N.Y.

You caused me some anxiety with the "Find the Components" puzzle. Item 23 was an unlisted item of 18 letters and I tried to think of a component that had 18 letters for about a week. Had I known it wasn't a component and was two words, I might have been able to complete the puzzle with the words POPULAR ELECTRONICS. I enjoy working the puzzles and quizzes and find your articles informative and interesting.

BRUCE A. FEEZEL
Ledyard, Conn.

Ken and Bruce, you're right. POPULAR ELECTRONICS *is not a component, for no component we know has so many applications.*

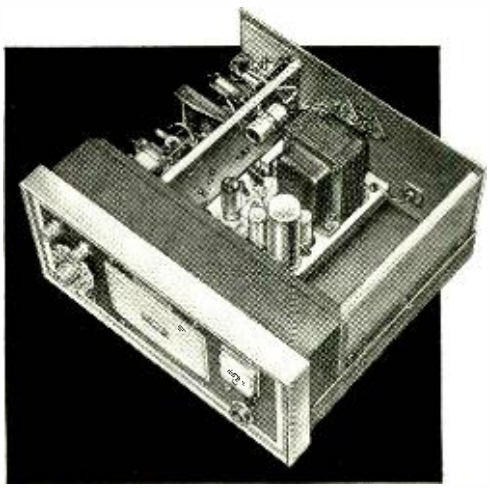
SOME WIRELESS MICROPHONES ARE TABOO

I would like to increase the signal strength and range of the "FM Wireless Microphone" (May, 1965). Can I use a longer antenna, or make a power source change? I don't want to modify the circuit.

D. B. TOBIN
New York, N.Y.

Sorry, D.B., the FCC has some other ideas about this project. Their Part 15 does provide for operation of wireless microphones in the 88 to 108 mc. band without a license, but only with type-approved equipment. Type approval is not available for a home-constructed wireless microphone operating in the 88- to 108-mc. band. Home constructors are encouraged to use frequencies below 1600 kc., or the 26.96- to 27.27-mc. band. —30—

NEW
FROM INTERNATIONAL



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- Ten Tubes
- Five Silicon Transistors
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- Eleven Silicon Diodes

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CIRCLE NO. 20 ON READER SERVICE PAGE

NEW

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CIRCLE NO. 51 ON READER SERVICE PAGE

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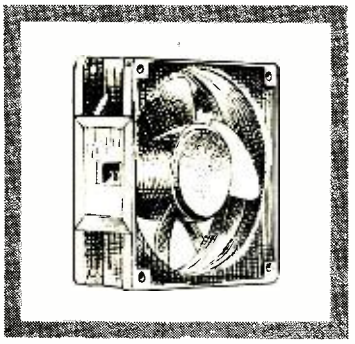

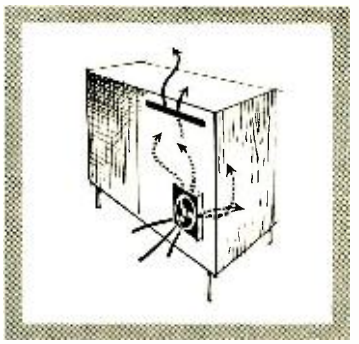

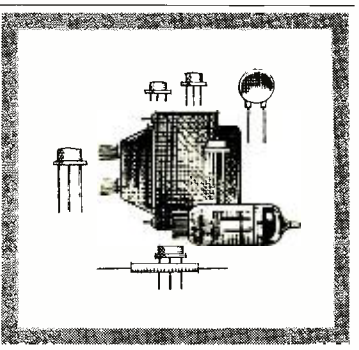

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A QUICKLY AND EASILY INSTALLED WHISPER FAN KIT COOLING YOUR HI-FI EQUIPMENT...

BREATHES 65 CUBIC FEET OF COOL AIR PER MINUTE THROUGHOUT THE ENCLOSURE...

THOSE HEAT GENERATING TRANSISTORS, TUBES AND COMPONENTS FOR ADDED LIFE...

Whisper Fan® KIT

the WHISPER FAN beats the heat that wrecks the set. Engineers have found that up to 40% or more life can be added to computer systems when components are properly cooled. And the life of your hi-fi, TV or ham equipment will be shortened unless you provide for the dissipation of the heat generated by transistors, tubes, transformers and other components. In addition, the Whisper Fan improves equipment performance by minimizing component drift due to heat and eliminates hot spots due to eddies.

Measuring only 4 11/16" square and 1½" deep, it can be set in a corner or mounted on the rear panel in just minutes. The Whisper Fan requires only 7 watts, just pennies a week to operate. Whisper Fan Kit comes complete with mounting hardware, plug and cord for electrical connections and installation instructions. Cost only $14.85 ☐ Write for descriptive literature and name of nearest dealer.

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CIRCLE NO. 54 ON READER SERVICE PAGE

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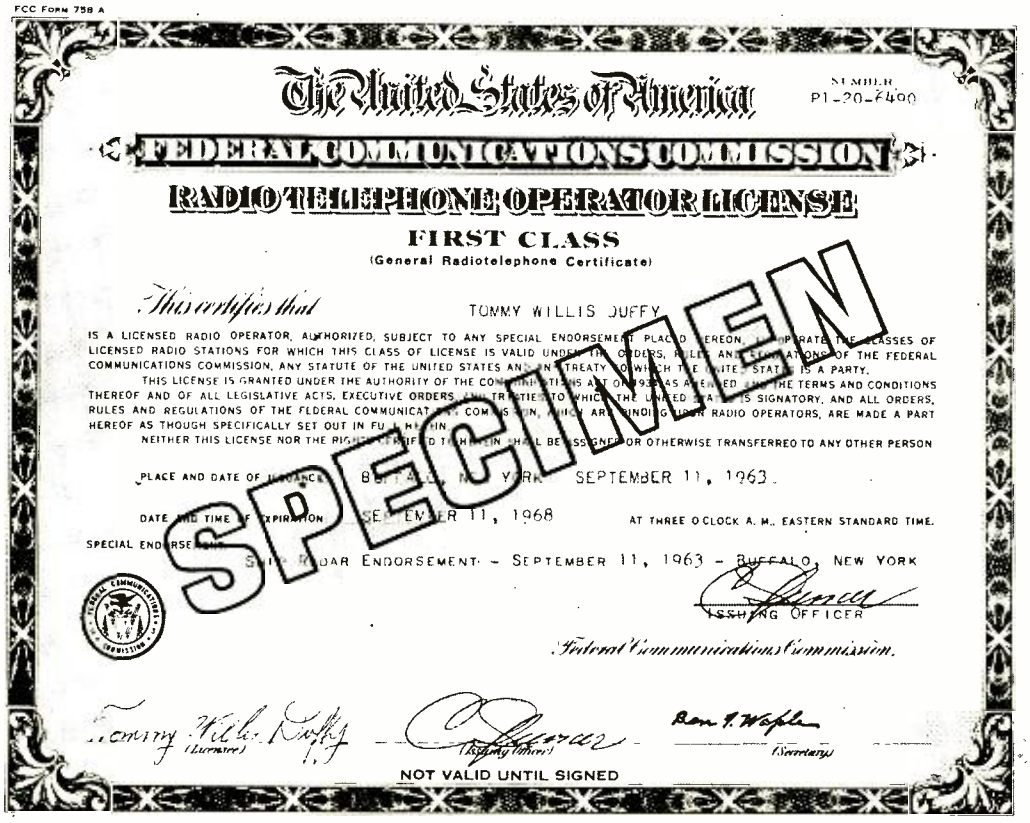

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FEDERAL COMMUNICATIONS COMMISSION

RADIO TELEPHONE OPERATOR LICENSE

FIRST CLASS

(General Radiotelephone Certificate)

This certifies that TOMMY WILLIS DUFFY

IS A LICENSED RADIO OPERATOR, AUTHORIZED, SUBJECT TO ANY SPECIAL ENDORSEMENT PLACED HEREON, TO OPERATE THE CLASSES OF LICENSED RADIO STATIONS FOR WHICH THIS CLASS OF LICENSE IS VALID UNDER THE ORDERS, RULES AND REGULATIONS OF THE FEDERAL COMMUNICATIONS COMMISSION, ANY STATUTE OF THE UNITED STATES AND ANY TREATY TO WHICH THE UNITED STATES IS A PARTY.

THIS LICENSE IS GRANTED UNDER THE AUTHORITY OF THE COMMUNICATIONS ACT OF 1934, AS AMENDED, AND THE TERMS AND CONDITIONS THEREOF AND OF ALL LEGISLATIVE ACTS, EXECUTIVE ORDERS, TREATIES TO WHICH THE UNITED STATES IS SIGNATORY, AND ALL ORDERS, RULES AND REGULATIONS OF THE FEDERAL COMMUNICATIONS COMMISSION, WHICH ARE BINDING UPON RADIO OPERATORS, ARE MADE A PART HEREOF AS THOUGH SPECIFICALLY SET OUT IN FULL HEREIN.

NEITHER THIS LICENSE NOR THE RIGHTS PRIVILEGED THEREIN SHALL BE ASSIGNED OR OTHERWISE TRANSFERRED TO ANY OTHER PERSON

PLACE AND DATE OF ISSUANCE BUFFALO, NEW YORK SEPTEMBER 11, 1963

DATE AND TIME OF EXPIRATION SEPTEMBER 11, 1968 AT THREE O'CLOCK A. M., EASTERN STANDARD TIME.

SPECIAL ENDORSEMENTS SHIPBOARD RADAR ENDORSEMENT - SEPTEMBER 11, 1963 - BUFFALO, NEW YORK

ISSUING OFFICER

Federal Communications Commission.

Tommy Willis Duffy (Licensee)

(Deputy Officer)

Ben F. Waple (Secretary)

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SPECIMEN

Employers are paying good money for men holding FCC tickets. Read how to get yours:

When you hold a Commercial License issued by the FCC (Federal Communications Commission) you have written proof that you know and understand basic electronic theory and fundamentals. It's worth plenty . . . particularly to companies on the lookout for qualified electronics technicians. Here's how one of the country's leading office machine manufacturers rates men with FCC Licenses:

> "An FCC License is an asset to any man looking to enhance his career in the field of electronics. At our Company, a licensed man is well-rewarded because an FCC License attests to his knowledge of electronics theory . . ."

Thousands of employers will tell you the same thing. Licensed men get the good jobs. They make more money . . . move ahead faster . . . enjoy exciting, challenging work. What's more, they're needed badly in every field of electronics. Industrial electronics. Radio-TV Broadcasting. Aerospace. Electronics Servicing . . . including mobile and marine radio *plus* CB.

Yes . . . your opportunities are unlimited once you're carrying that FCC Commercial Ticket. AND CLEVELAND INSTITUTE OF ELECTRONICS CAN GET ONE FOR *YOU!* On the facing page, read how four ambitious men just like you have cashed in on CIE's sure-fire FCC Licensing Program. Read about CIE's exclusive money-back offer. And then send in the postage paid reply card. CIE will quickly send you complete FREE information. You will soon be on *your* way to a Commercial FCC License and the many rewards that go with it!

These CIE men have good jobs
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Matt Stuczynski, Senior Transmitter Operator, Radio Station WBOE. "I give Cleveland Institute credit for my First Class Commercial FCC License. Even though I had only 6 weeks of high school algebra, CIE's AUTO-PROGRAMMING teaching method makes electronics theory and fundamentals easy. After completing the CIE course, I took and passed the 1st Class Exam. I now have a good job in studio operation, transmitting, proof of performance, equipment servicing. Believe me, CIE lives up to its promises!"

Ted Barger, Electronic Technician, Smith Electronics Co. "I've been interested in electronics ever since I started operating my own Ham rig (K8ANF). But now I've turned a hobby into a real interesting career. Cleveland Institute of Electronics prepared me for my Commercial FCC License exam . . . and I passed it on the first try. I'm now designing, building and testing all kinds of electronic equipment . . . do a lot of traveling, too. It's a great job . . . and thanks to CIE and my FCC License, I'm on my way up."

Chuck Hawkins, Chief Radio Technician, Division 12, Ohio Dept. of Highways. "Cleveland Institute Training enabled me to pass *both* the 2nd and 1st Class License Exams on my *first* attempt . . . even though I'd had no other electronics training. (Many of the others who took the exam with me were trying to pass for the eighth or ninth time!) I'm now in charge of Division Communications and we service 119 mobile units and six base stations. It's an interesting, challenging and extremely rewarding job. And incidentally, I got it through CIE's Job Placement Service . . . a free lifetime service for CIE graduates."

Glenn Horning, Local Equipment Supervisor, Western Reserve Telephone Company (subsidiary of Mid-Continent Telephone Company). "There's no doubt about it. I owe my 2nd Class FCC License to Cleveland Institute. Their FCC License Program really teaches you theory and fundamentals and is particularly strong on transistors, mobile radio, troubleshooting and math. Do I use this knowledge? You bet. We're installing more sophisticated electronic gear all the time and what I learned from CIE sure helps. Our Company has 10 other men enrolled with CIE and take my word for it, it's going to help every one of them just like it helped me."

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ELECTRONICS LIBRARY

TRANSISTOR IGNITION SYSTEMS

by Marvin Tepper

This is the second paperback on transistorized ignition to appear in the past two years. The first one—written by Brice Ward—was reviewed in our May, 1964, issue. Unfortunately, comparison of the two books is inevitable, and Tepper's contribution comes out on the short end. Although this author's discussion of original equipment ignition systems, engine performance, and transistor theory is more thorough, sound, and better written, the section of the book dealing with transistor ignition systems is far too limited. Tepper has ignored many of the systems that have been developed and has depended heavily on magazine articles (mostly from ELECTRONICS WORLD, when he should also have read POPULAR ELECTRONICS), press releases, and the advice of a single manufacturer.

Published by John F. Rider, Publisher, Inc., 850 Third Ave., New York 22, N.Y. 128 pages. $2.95.

THE RADIO AMATEUR'S V.H.F. MANUAL

by Edward P. Tilton

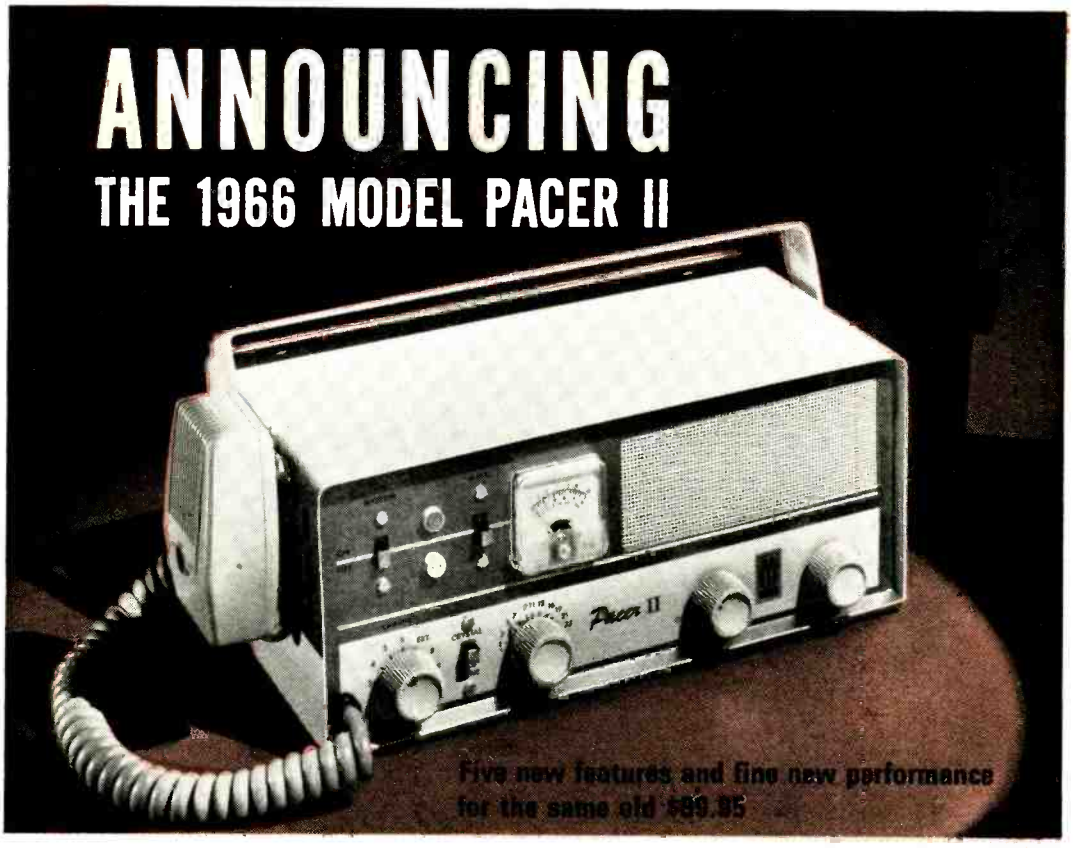
A textbook both for the beginner and the experienced ham, this manual of amateur radio communication on the frequencies above 50 megacycles includes a history of amateur radio followed by chapters on propagation, receivers, converters, transmitters, antenna and feed systems, test equipment, etc. Constructional information on up-to-date gear for the VHF/UHF operator is provided.

Published by the American Radio Relay League, Inc., Newington 11, Conn. 360 pages. Soft cover. $2.00 in U.S.; $2.25 elsewhere.

FREE LITERATURE

You'll find the latest in electronics and high fidelity in the 1966 Lafayette catalog. Equipment of all major manufacturers is represented, plus Lafayette's own components. Consisting of 512 pages, Catalog No. 660 is available from Lafayette Radio Electronics Corp., P. O. Box 10, Dept. PR, Syosset, L.I., N.Y. 11791.

ANNOUNCING
THE 1966 MODEL PACER II



Our original Pacer is a fine CB transceiver.

But our new Pacer II is even finer!

Pacer II not only gives you all the features that made our original Pacer such a bargain (23-channel tunable superhet receiver, positive squelch control, quick-change external crystal socket), it now offers new, smaller case, plus a built-in, solid-state, 12-volt power supply, plus 11 (not just eight) crystal-controlled channels, plus an ANL switch and a big, easier-to-read "S" meter.

Best of all, you get all of these goodies at the same old low price.

You'd think that for $99.95, this is all that you'd get.

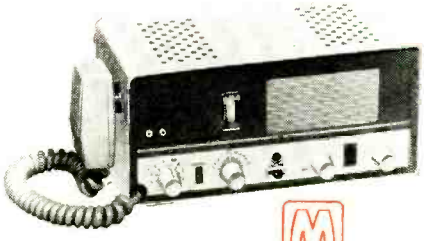
Guess again.

When you buy Pacer II, you also get a set that has been environmental tested *before* you buy. And a set that features both American parts *and* workmanship.

Better look into a new 1966 model Pacer II today.

Complete with channel 11 crystal, PTT mike, mobile mounting bracket, carrying handle, AC and 12V DC power supply cords $99.95

ALSO NEW MUSTANG II



Get on the air for just $79.95 and get these new Mustang II features: eight crystal-controlled (not just six) channels, quick-change external crystal socket, "S" meter, spotting switch, 23-channel tunable receiver, plus PTT mike, positive squelch control.

Complete with channel 11 crystal $79.95

METROTEK ELECTRONICS, INC.
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CIRCLE NO. 55 ON READER SERVICE PAGE

NEW PRODUCTS

Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15.

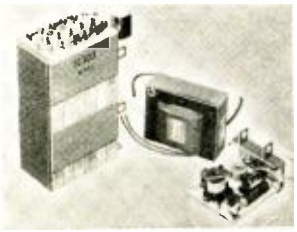
D.C. PORTABLE LABORATORY STANDARDS

Triplett Electrical Instrument Co. has announced a new line of d.c. portable laboratory standards, known as Model 825. Three multi-range units are available: a voltmeter, a milliamp/ammeter, and a micro/milliammeter. They all feature the Triplett "BARRING" suspension movement (no pivots, no bearings, no hairsprings, and thus no rolling friction). Other features are a long 6.84" mirror scale, a knife-edge pointer, and a fully open meter front with top and side natural lighting for easy and accurate reading. Accuracy is ± ½ of 1%.

Circle No. 75 on Reader Service Page 15

VERSATILE NICKEL-CADMIUM BATTERY

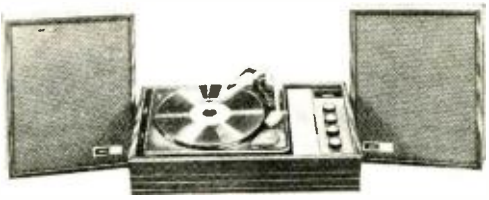
Would you be interested in a battery that weighs only two pounds, can be disassembled and its individual cells used separately, that recharges in only an hour, won't wear out, and operates just as well at freezing temperatures as at room temperature? Available from *Edmund Scientific Co.*, the basic 7.2-volt battery consists of six 1.2-volt nickel-cadmium cells hooked up in series and housed in a stainless steel, strap-type casing. Stud-type terminals, with polarity clearly identified, are located on the top of each cell. Single-cell and multiple-cell hookups can provide a wide variety of voltages. Recharging is done via a 12-volt transformer and a charger circuit board, rectifier and automatic transistorized regulator which come as a kit.



Circle No. 76 on Reader Service Page 15

SOLID-STATE STEREO MUSIC SYSTEM

Lafayette's "Pro 50" is a matched component stereo phono system for shelf or table top mounting. It consists of a 20-watt solid-state amplifier plus a deluxe Garrard 4-speed automatic record changer and a pair of matched



high-performance speakers—all packaged in walnut cabinets with an oiled walnut finish. The amplifier features four controls—loudness, balance, bass and treble—plus FM tuner input jacks and selector switch, and two external speaker jacks. The matched speaker enclosures each contain an 8" woofer with 9-oz. ceramic magnet and a 3½" tweeter.

Circle No. 77 on Reader Service Page 15

CHUCK ADAPTER FOR SPIRAL RATCHET DRIVERS

A chuck adapter has been developed by *Xcelite Incorporated* to permit the use of its Series "99" interchangeable, single-end blades with Stanley, Greenlea, Millers Falls, and similar spiral ratchet drivers. Since the Series "99" blades are available with a wide range of hex socket ends and a variety of screwdriver and other tips, the adapter greatly extends the usefulness of spiral drivers. It comes in three shank-diameter sizes.

Circle No. 78 on Reader Service Page 15

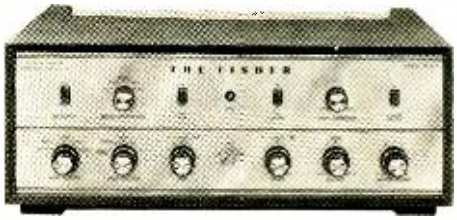
MOBILE ENCODER/DECODER

Easily mounted under the dash near the two-way radio control head, *Reach Electronics'* 1PT1 provides selective calling of vehicle operators plus single-tone encoding from the mobile transmitter. The decoder circuitry can be used to shut out all unwanted calls from other two-way radio users on the frequency, allowing only calls from one's own system to be heard. When an encoded call comes in, the 1PT1 alerts the vehicle operator by turning on the speaker or by honking the horn. At the same time, a light on the 1PT1 panel turns on, and stays on, to show that the vehicle has been called.

Circle No. 79 on Reader Service Page 15

THE "LIVING CARTRIDGE"

Dubbed the "Living Cartridge" because of its extreme frequency response, the *Empire* 888P can reproduce a note as low as 8.15 cy-



If Fisher amplifiers are so special, how come anybody can build one?

Because Fisher's method of kit construction is rather special, too. With the exclusive Fisher StrataKit method, anybody, including your wife, can build an authentic Fisher stereo component that will be fully equal in performance and reliability to its laboratory-wired prototype.

No experience is necessary. Assembly takes place by simple, *errorproof* stages (Strata). Each stage corresponds to a *separate* fold-out page in the uniquely detailed instruction manual. Each stage is built from a *separate* packet of parts (StrataPack). Major parts come already mounted on the extra-heavy-gauge steel chassis. Wires are *pre*cut for every stage—which means every page. All work can be checked stage-by-stage and page-by-page, before proceeding to the next page.

The end result is one of the world's finest high-fidelity instruments. Like this Fisher KX-200 stereo control-amplifier. Its 80 watts (IHF) stereo power amplifier section will drive the least efficient speakers at extremely low distortion. Its preamplifier section provides a virtually unlimited range of input and control facilities. It even incorporates features like a laboratory-type d'Arsonval bias/balance meter and a power-derived third-speaker output with separate volume control.

If bought already assembled, an amplifier like this is easily worth $250. But it is all yours in the Fisher KX-200 StrataKit for $169.50*. And that price is rather special, too. *WALNUT CABINET, $24.95

FREE! $1.50 VALUE! Send for The New Kit Builder's Manual, an illustrated guide to high fidelity kit construction, complete with detailed specifications of all Fisher StrataKits.

Fisher Radio Corporation
21-40 44th Drive
Long Island City, N. Y. 11101

Name _____

Address _____

City _____ State _____

1010

OVERSEAS RESIDENTS PLEASE WRITE TO FISHER RADIO INTERNATIONAL, INC., LONG ISLAND CITY, N.Y. 11101.
CANADIAN RESIDENTS WRITE TO TRI-TEL ASSOCIATES, LTD., 55 BRISBANE ROAD, DOWNSVIEW, ONTARIO.

The Fisher KX-200

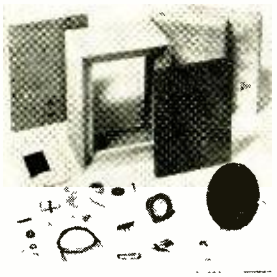
PRODUCTS (*Continued from page 22*)

cles or as high as 40,000 cycles. A sharp-attack square wave with virtually straight rising time, very slight overshoot, and near perfect clamping (less than 1 cycle of ringing) testifies to its low distortion even while tracking at ½ gram. Signal-to-noise ratio is 80 db, compliance 15 x 10^{-6} cm/dyne. The 888P provides more than 30 db stereo separation over a frequency spectrum of 10 octaves.

Circle No. 80 on Reader Service Page 15

COMPACT SPEAKER SYSTEM KIT

Want to put together your own compact high-compliance, acoustic-suspension speaker system? *Sonotone*'s new Sonomaster ^{T} Model RM-1K kit is supplied with the same quality parts used to produce its RM-1 factory-made system. The kit contains a linear high-compliance woofer and a high-frequency tweeter, crossover, coil, capacitor, high-frequency level control, wires, screws, etc. Measuring 14½" x 10½" x 7¼", the cabinet is made of unfinished birch veneer, ready for any finish or color you wish. A 16-page construction booklet illustrates all parts and includes exploded diagrams for easy-to-follow assembly. The RM-1K will handle 40 watts of average program material (80 watts peak) and its response is 45 to 20,000 cycles.



Circle No. 81 on Reader Service Page 15

FIVE-BAND ANTENNA SYSTEM

The *Delta Electronics* Type VDX-5 antenna system consists of a desk-top control unit, a coupling unit, and a 100′ control cable. It's designed to match and deliver maximum power (1000 watts on CW or AM, 2000 watts PEP on SSB) into a 35′ vertical radiator. The coupling unit consists of five separate matching networks, each designed for optimum performance on one of the five amateur bands between 3.5 and 29.7 mc. The appropriate network is remotely selected by a switch on the control unit.

Circle No. 82 on Reader Service Page 15

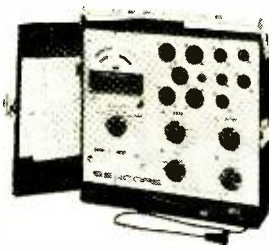
"LARYNX MIKE"

A microphone that you can wear under your shirt collar instead of in your shirt pocket—the "Larynx Mike AC-77"—has been introduced by *Telephone Dynamics Corp.* An electromagnetic contact microphone, it is energized directly through the vibrations of the vocal cords. It is said to shut out all outside interference, resulting in extreme clarity of reproduction. The AC-77 is available with 50 to 5000 ohms impedance, and comes equipped with a lightweight plug-in cord. It has a frequency response of 200 to 3000 cycles.

Circle No. 83 on Reader Service Page 15

NEW "MIGHTY MITE" TUBE CHECKER

Many more tubes can be checked with *Sencore's* new model of its "Mighty Mite" portable tube checker. Designated the "Mighty Mite IV," it has a plastic holder in the cover to hold open the pages of the set-up booklet —which now lists over 3000 tubes— for faster testing. Also, a specially designed hinge has been used on the cover so that the cover can be left on the tester or removed and held in the easy-grip steel handle. And a new socket has been provided to test the Amperex and Mullard 10-pin tubes used in many of the 1965 color receivers.



Circle No. 84 on Reader Service Page 15

HI-FI TAPE DECKS

Rheem Califone has introduced five new tape decks for professional, studio, or home use. Prices range from $69.95 to $599.95. Model 3170, shown in the photo, records and plays back stereo or mono programs, has three heads, three motors, and is fully automatic. It features sound-over-sound, sound-on-sound, remote control, and horizontal or vertical operation. The Model 3170 plays in both directions, and automatically shuts off after playing a complete tape.

Circle No. 85 on Reader Service Page 15

"MULTI-CUBE" AUDIO FURNITURE

From one to eight handsome "Multi-Cube" storage units can be used in innumerable floor-standing, stacked, and wall-hung combinations. Announced by *Toujay Designs, Inc.*, the basic unit is 24" wide by 15" high by 24" deep, with unrestricted air circulation on all sides. "Multi-Cubes" are available in walnut, teak, and rosewood, with fittings for speakers, turntable, electronic equipment, tape recorder, and record storage. The speaker units have optional rotating bases.

Circle No. 86 on Reader Service Page 15

CIRCLE NO. 39 ON READER SERVICE PAGE →

New from RCA!

ALL SOLID-STATE CB 2-WAY RADIO WITH ALL SILICON TRANSISTORS

New RCA Mark 10 Transistorized CB Radio

only $189.95*

Here's the latest, and the finest, in a long line of exceptional 2-way radios from RCA. The new all transistor RCA MARK 10 with the operating features you have been asking for...engineered to provide the most dependable communications possible. Check this partial list of RCA MARK 10 advantages:

- All silicon transistors assure dependable communications at temperatures ranging from −23° to +130°F.
- 12 crystal-controlled transmit and receive channels with illuminated channel selector
- Combination "S" meter and relative RF output meter
- Operates from 12-volts DC power source (positive or negative ground)
- 3-watt public address system with volume level fully controllable by receiver volume control
- Provision for tunable receive, AC operation, and external speaker (optional)
- Crystal-controlled double conversion, superheterodyne receiver provides frequency accuracies greater than 0.004%
- Separate AGC amplifier eliminates blasting and overloading, minimizes fading
- Six-stage IF bandpass filter for maximum selectivity without ringing
- Low distortion, series type noise limiter with automatic threshold adjustment
- Receiver power regulated for maximum stability
- Acoustically designed cabinet with audio characteristics shaped for maximum intelligibility
- External speaker jack (de-activates internal speaker)
- Compact, lightweight. Only 3⅜" high, 5¾" deep, 8½" wide, weighs less than 4½ pounds

See it at your Authorized RCA Citizens' Band Radio Distributor. To find him, look for stores displaying this symbol. It's your assurance of top-quality RCA CB equipment.

*Optional distributor resale price

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N. J.

The Most Trusted Name in Electronics

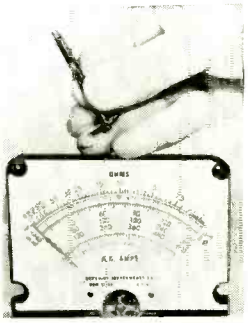
PARTS METHODS IDEAS GADGETS DEVICES TIPS & TECHNIQUES

SMALL RADIO DOUBLES AS BFO

A small AM broadcast band tube or transistor radio can be placed near a short-wave receiver and made to serve as a BFO, enabling you to receive CW transmissions. Loosely couple the two radios, either by wrapping several turns of wire around the small radio to form a loop and connecting the wire to the antenna terminals of the short-wave receiver, or by placing the small radio on top of the short-wave set. In the latter case, you may have to hunt for a "sensitive" spot on the receiver at which to locate the small radio. Tune in the CW station on the receiver and slowly tune the small radio until the desired tone is obtained. If the BFO signal is too strong and overloads the short-wave receiver, loosen the coupling by reducing the number of turns of wire around the small radio, or increase the distance between the sets. Coupling can also be varied by rotating the small radio on top of the receiver, or within the loop.

—*Robert Wilson*

FILM SPOOL MAKES SAFE METER ADJUSTMENT TOOL



When it is necessary to straighten indicating meter pointers or to make slight adjustments of meter springs, a delicate tool and a delicate touch are required to avoid damage to moving parts. An empty camera film spool, with one flange removed and the tips which held the flange filed down, will do the job; the slot in the spool shaft fits over the meter pointer. A second spool can be used to hold the pointer near the coil or at any other suitable location.

—*H. Leeper*

ISOLATED LINE VOLTAGE FROM FILAMENT TRANSFORMERS

Experimenters are well aware of the dangers of a hot chassis, such as the a.c./d.c. radios

(*Continued on page 28*)

Some plain talk from Kodak about tape:

Noisemanship...modulation noise... and how to get extra dbs. of silence

Starting at the beginning

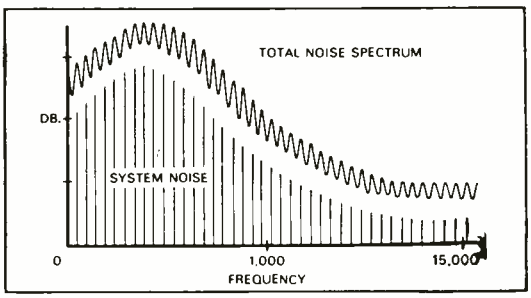
Kodak tape is mighty quiet when it leaves the factory. Because of special milling techniques and our now-famous "R-type" binder, the gamma ferric oxide particles are more uniform in size and shape and more uniformly dispersed than was ever before possible. Result: a superior degree of magnetic randomness, and thus, built-in quietness. To make sure that the roll of Kodak tape you purchase is as "quiet" as possible, we also bulk erase each roll. By "randomizing" the particles' polarity in *all* dimensions, foreign signals picked up during manufacture are eliminated.

This fairly pristine state doesn't last long. Once the tape has been subjected to the erase field and record bias from your recorder, a certain degree of randomness is lost. So-called zero-signal noise results because a recorder's erase system is not as efficient as a bulk eraser. Whereas bulk erasers cause 3-dimensional decay of the remnant signal, an erase head causes decay in one dimension only—along the length of the tape. This explains why zero-signal noise is always higher than bulk-erase noise.

Blue plate special—noisewise

Noise in the presence of a recorded signal—modulation noise—is the real meat and potatoes of tape performance. Testing for modulation noise is a bit tricky, however, because ac program and noise get mixed up in the amplifier. And if we are to determine the amount of noise in a system, it's imperative that we distinguish between one and the other. One way to do this is to use what our scientists refer to as a dc equivalent in r.m.s. milliamps of an ac signal.

Simply explained, we select the ac signal level that represents the practical limit for linear recording —2% third harmonic distortion. Then we apply a dc signal to the record head and increase the record current until it reaches the same level as that of the above ac signal. On the tape we have recorded a "zero frequency" program plus the modulation noise contributed by both equipment and tape. Since the reproduce amplifier filters out dc signals, only the modulation noise comes through, and this can be measured by an output meter.



Strike up the band pass

Final proof-of-the-pudding is to examine the total noise spectrum through band pass filters. Fun! One could, for example, measure the noise that comes through a 1-cycle band pass filter —even get a signal-to-noise ratio of about 115 db. But this really tells nothing about the tape's practical performance. For as the graph shows, there is much more noise in the lower frequencies than in the higher. For more meaningful evaluation, we specify two signal-to-noise ratios...one for the average low frequencies (20-1000 cycles at 15 ips) and one for the high frequencies (1000-15,000 cycles at 15 ips). We are happy to report that Type 31A (Kodak's general-purpose/low-print tape) rates as much as 6.5 dbs better in the low frequencies and 1.5 dbs better in the high frequencies. At Kodak, "shhh" is the word.

KODAK Sound Recording Tapes are available at most electronic, camera and department stores.

New, 24-page, comprehensive "Plain Talk" booklet covers all the important aspects of tape performance, and is free on request. Write: Department 8, Eastman Kodak Company, Rochester, N.Y. 14650.

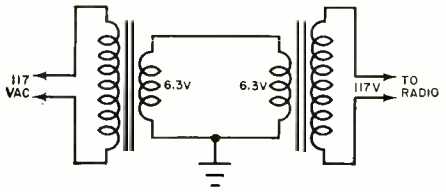
EASTMAN KODAK COMPANY, Rochester, N. Y.

CIRCLE NO. 13 ON READER SERVICE PAGE

TIPS

(*Continued from page 26*)

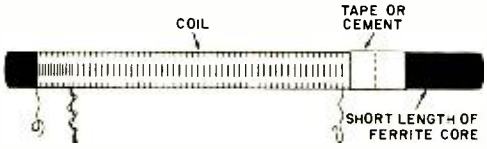
and the transformerless TV sets. Besides shock hazard, test equipment can be damaged when you're working on a hot chassis that isn't isolated. Two 6.3-volt transformers can be connected back-to-back to do the work of a 1 to 1 isolation-type transformer, as shown in the diagram. A certain amount of noise



filtering is also realized from this type of hookup. But don't drive any equipment which requires more wattage than the lowest watt-rated winding. The transformer case and one side of the low-voltage windings can be grounded; however, the hookup will work satisfactorily without the ground connection. —*Robert B. Kuehn*

USE FERRITE CORE RODS TO BOLSTER INDUCTANCE

Say you've just wound a coil, soldered it into a circuit, and find you need more inductance. What do you do? Just insert a short length of ferrite core into the coil form. Then adjust it for the correct inductance and cement it in place. The same technique can be used if you need a few extra turns of wire on a



ferrite core. Simply tape or cement a short length of ferrite core to the coil end as shown; this will have the same effect as adding more turns to the coil. —*Art Trauffer*

LARGE METAL BLOCK PREVENTS SOLDERING IRON PITTING

To prevent your soldering iron from pitting when it is turned on but is not in actual use, drill a hole in the side of a 5-lb. block of plumber's caulking lead to make a loose fit for the tip of the iron. Besides being a convenient holder for your iron, it keeps the tip of any small to medium iron well below the temperature point where pitting is troublesome. When the iron is removed from the holder, the temperature of the tip rises rapidly to maximum and the iron is soon ready for use. For heavy-duty irons, use a larger block of metal other than lead and cut slots along its edges to provide for better cooling. —*James E. Pugh, Jr.*

Be super-critical.

Whether you're looking for the fun and economy of building quality kits or you want ready-to-use factory-wired equipment — before you buy, examine carefully. Compare EICO with anybody else — feature for feature, chassis for chassis, part for part. The more critical you are, the more you'll see for yourself that your best buy is EICO.

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Model 667 Tube/Transistor Tester. Dynamic conductance tube tester. 14 combinations of 3 plate and 3 screen voltages and 3 ranges of grid voltage. Interelement leakage readings in ohms. Checks all new tube types. Two step transistor test. **$79.95 kit, $129.95 wired.**

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Model 1064 DC Power Supply. For bench testing auto radios, CB, mobile and tone equipment. Voltmeter and ammeter. Low ripple for transistor equipment. 0-8V/0-16V outputs. **$45.95 kit, $54.95 wired.**

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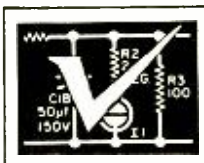
1945-1965: TWENTY YEARS OF LEADERSHIP IN CREATIVE ELECTRONICS

CIRCLE NO. 56 ON READER SERVICE PAGE



OPERATION ASSIST

Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other *P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information,* write him directly—*he'll appreciate it. If* you *need help, send a postcard to Operation Assist,* POPULAR ELECTRONICS, *One Park Avenue, New York, N.Y. 10016. Give maker's name, model number, year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Because we get so many inquiries, none of them can be acknowledged.* POPULAR ELECTRONICS *reserves the right to publish only those items not available from normal sources.*

SCHEMATIC DIAGRAMS

Coronado Model 43-8312 receiver. Tunes BC. Has 6 tubes. (Frank E. Prussa, Atkinson, Nebr. 68713)

Clarion receiver, circa 1930. Tunes 550-1700 kc., 5.0-19.0 mc., and 1.7-5.2 mc. Has 7 tubes and 6G5 tuning eye. (W. R. Sphar, 1200 Atlantic Ave., Monaca, Pa. 15061)

EICO Model 450 oscilloscope, made for Signal Corps, circa 1940. (Joseph G. Koppel, 35-60 74 St., Jackson Heights, N.Y. 11372)

BC-669C surplus transmitter. (J. E. Ballenger, Duke Power Co., Cliffside, N.C.)

Radiomarine Corp. of America Model AR-8506-B receiver. Tunes 85-550 kc. and 1.9-25 mc. (Bill Young, Box 163, Yarnell, Ariz.)

Rauland Model 42 amplifier, ser. 25082. Has 6 tubes. (J. D. Calhoun, 14112 Colesville Rd., Silver Spring, Md. 20904)

Hickok Model 19XD signal generator. Tunes 90 kc.-144 mc. (B. J. White, 29-8 Garden Circle, Waltham, Mass. 02154)

RCA Model 86T2 receiver, circa 1935. Tunes 550 kc.-to 22 mc. Has 6 tubes. (Robert Ward, 3406 Avent Ferry Rd., Raleigh, N.C.)

American-Bosch Model 515 receiver, ser. 546117. Tunes 540-3300 kc. Has 5 tubes. (Ray Vander Bok, 1634 Philadelphia, Grand Rapids, Mich.)

Dumont Model 274A C-R oscillograph, ser. 447. (Henry S. Tannenbaum, 26 Cranberry Lane, Plainview, N.Y. 11803)

RCA Model TMV-132-A universal a.c. bridge, ser 1201. (Fred Pfiester, 2808 Cortelyou Pl., Cincinnati 13, Ohio)

"Rayscope" Model 27-T metal detector (R. E. Ogren, 825 Evergreen, Burbank, Calif.)

Freed-Eisemann Model 30 receiver, type CH-100, ser. 9537. Tunes AM and FM. (Richard B. Price, 102 Bennington Court, Richmond, Ky. 40475)

Sylvania Model 131 oscilloscope, circa 1950. (Lindsay M. Neely, 1968 Howell Mill Rd., N.W., Atlanta, Ga. 30318)

Zenith Model 5S08 receiver, circa 1940. Tunes BC and s.w. Has 8 tubes plus magic eye. (Richard Buchhop, 2112 Rivard Rd., Toledo, Ohio 43615)

Browning Laboratories Model OL-15B oscillosynchroscope. (Lance Lee, 605 12 Ave. N.E., Aberdeen, S.D. 57401)

(*Continued on page* 32)

ASSIST (*Continued from page 30*)

Philco Model 52-542-122 receiver, circa 1952. Has 5 tubes. (Joseph Rotello, Jr., 1341 S. Edlin Ave., Tucson, Arizona 85711)

Fada Model 637 receiver, chassis 594A, circa 1946. Has 6 tubes. **Automatic** Model R54 car receiver, ser. Y372090, circa 1959. (Paul H. Espersen, 29 Croft Lane, Smithtown, N. Y. 11787)

Superior Instruments Model 670-A vacuum-tube voltmeter. (William Houck, 45-41 40th St., Long Island City, New York, N. Y. 11104)

Airline Model 14WG-739A receiver, chassis 7A61-726837, circa 1941. Tunes AM and s.w. Has 7 tubes. (Michael Strong, 1343 Morningside Dr., Charleston, W. Va. 25314)

Federal Telephone and Radio Model TS-XA-49 oscilloscope and PP-XA-21 power pack, ser. 4. (Arnold Cohen, 1324 Ryland Ave., Cincinnati, Ohio 45237)

SPECIAL DATA OR PARTS

Telvar/Audar Model T60-2 transmitter, circa 1948. Oscillator and final r.f. coils and all available data wanted. (William H. Cook, 515 S. Hidalgo, Alhambra, Calif. 91801)

GE Model H-637 receiver. Ballast tube needed. (Ross Webb, R.#2, Box 63, Fancy Gap, Va.)

Westinghouse Model 541A receiver; tunes BC and s.w. (6-18 mc.) on 2 bands; has 5 tubes. Battery hookup data and schematic needed. (Robin Good, R.R.#1, Lakefield, P.Q., Canada)

Zenith "Trans-Oceanic" receiver, circa 1940; tunes BC and s.w.; has 8 tubes. Tube source and schematic needed. (Stanley Jones, Box 488, Hollandale, Miss. 38748)

Tinker and Rasor Model S-5 oscilloscope. Schematic and other data needed. (Harold G. Coxon, 82 Withrow Ave., Ottawa 5, Ontario, Canada)

Hickok Model 155 signal tracer. Operating instructions needed. (Vincent M. Cinanni, 64 Harmony Lane, Rochester, N. Y. 14622)

Fada Model 480A neutrodyne receiver, circa 1926. Escutcheon and other parts needed. (Frank Pagano, 1835 W. 7th St., Brooklyn, N. Y. 11223)

Howard Radio Model 437-A receiver, ser. A-437983, circa 1947; has 9 tubes; tunes .55 mc. to 44 mc. on 4 bands. Schematic, parts source, and alignment data needed. (Frank Frazier, Box 224, Carrizo Springs, Texas 78834)

Espey Mfg. 1-122-B signal generator, ser. 219; tunes 15 to 25 mc., and 95 to 135 mc. Schematic and technical data needed. (R. C. Poirier, 12 rue Lagille, Paris 18e, France)

BC-654 receiver. Schematic, operating manual, and terminal strip layout needed. (Tom Adams, 6612 Aberdeen St., Chicago, Ill.)

Western Auto Truetone D-723 receiver, circa 1940; tunes 550 kc. to 16 mc. on 3 bands. Schematic diagram and parts data needed. (David Branch, 2432 Regentview Dr. N.E., Canton, Ohio 44705)

Zenith Model 4-T-26 receiver, circa 1935. Schematic or instruction manual and 6P7G tube needed. (Ray Carifio, 7855 S.W. 17 St., Miami 55, Fla.)

Silvertone Model 4763 receiver. 6B6G tube needed. (Gregory Ickes, Box 23, Fairview, Pa. 16415)

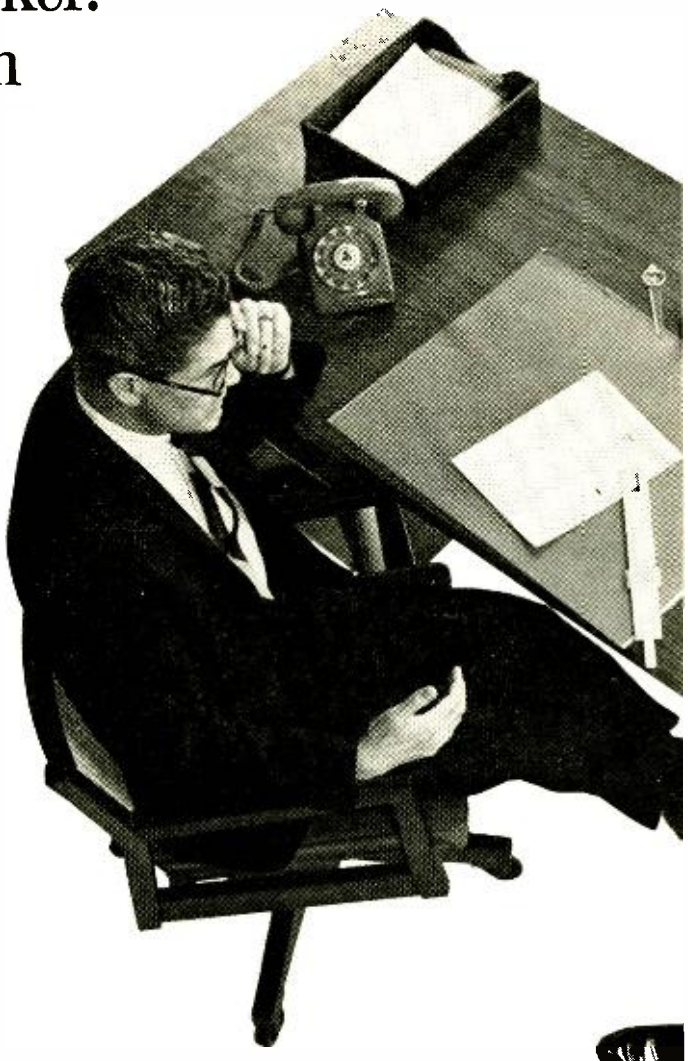
CBS 27" television set. Transformer 1027 needed. (William Brown, 41 Laurelton Ave., Jackson, N. J. 08527)

Silvertone Model 8074 tape recorder, ser. 528-58022, chassis 528-59051. Servicing manual and parts list needed. (E. M. McDaniel, 202 Odessa Ave., Gwinhurst, Wilmington, Del. 19809)

Belmont Radio Model 04BR-907A receiver, circa 1940; tunes BC and s.w. on 4 bands. Tuning dial scale, pointer, and two plastic push-buttons needed. (Garnet W. Frank, Route 1, Potsdam, N. Y. 13676)

Sanyo Electric Model 8SP14 receiver; has 8 transistors. Schematic and tuning meter needed. (E. Metz, 4620 N. Kenneth, Chicago, Ill. 60630) —30—

"He's a good worker. I'd promote him right now if he had more education in electronics."



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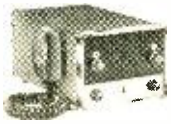

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CIRCLE NO. 22 ON READER SERVICE PAGE

COVER STORY

HOW TO GET MORE LIFE OUT OF YOUR TV PICTURE TUBE

By ROBERT CORNELL

R Early life—*treat gently; avoid sun, vibration, and excess voltage*
Old age—*rejuvenate, boost, open shorts, and weld opens*

HOW MUCH life you can get out of a picture tube depends upon the treatment it receives from the day of manufacture—the way the tube was built and the quality of the materials used. The life of a tube also depends upon its environment, how you adjust the set, and other operating conditions. Even when it becomes apparent that a replacement is needed, steps can usually be taken to extend the life of a tube.

Environment. The picture you see on your tube cannot be any better than the signal it receives. Your TV set and antenna should be in good working order.

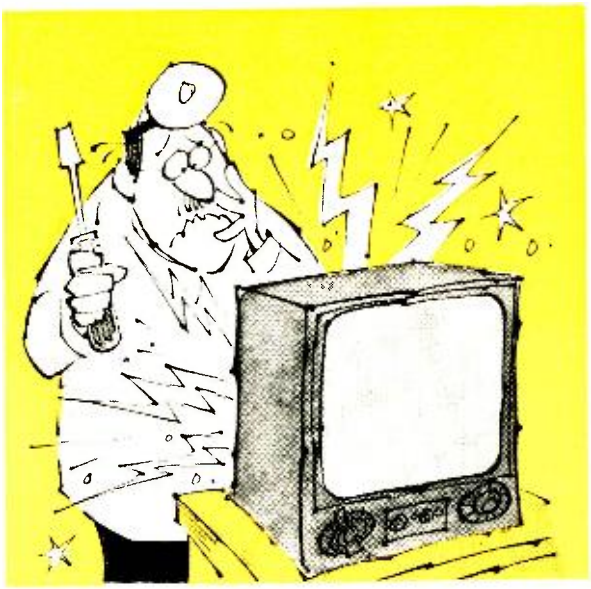
Your set should be positioned in such a way as to keep the light from the tube from competing with direct light or strong reflections from lighting fixtures and the sun. The sun can dissipate the phosphors on the face of the tube. The brighter the light in the room, the harder you have to drive the tube in order to get a usable picture.

It pays to judiciously adjust brightness and contrast controls to obtain the best picture with minimum settings. The brighter the picture, the more you have to crank up the contrast to make the blacks seem black. Instead of pushing contrast, try backing down on the brightness control; you'll be "burning" up fewer millions of electrons and the phosphors will last longer.

Too much heat can shorten picture tube life. Keep the set away from radiators and hot air registers. Don't box up your TV set in a closet or wall enclosure where the air cannot circulate freely. If you must locate your set in confined quarters, a small ventilating fan should be installed. Give your set a chance to dissipate the heat.

Vibration. An often overlooked source of trouble is vibration. The picture tube is pretty rugged and is already shock-mounted to some extent, but if you live near a street or highway with lots of truck traffic, or if some other heavy machinery is in operation in the vicinity of the TV set, it's a good bet that the big picture tube is taking a beating. It's easy to tell if you have a problem—if the balls of your feet ripple when a truck goes by, chances are the tube and some of its components are trembling in sympathetic vibration. If this is the case, place the entire set on a slab of foam rubber, if it's a table model. If you have a footed cabinet, you can place a small foam rubber pad under each leg.

Not all vibration problems stem from heavy machinery. Watch out for those big speakers in a custom installation. You may not run into acoustic feedback or other microphonic problems but there is a possibility that the picture tube is doing a jig in step with some of the music. Use suitable acoustic insulation between the speaker and the TV set. Better yet, get the speaker into a different housing.



Line Voltage. Fluctuations in line voltage, particularly on the up side, can do much to overheat the picture tube from both the inside and the outside—excessive filament and B-plus voltage can cause excessive heat and expansion of various parts of the electron gun in the picture tube. Shorts, opens and possibly the release of gas could be the unhappy result. However, the picture tube is usually gifted with a rugged gun structure which can withstand "normal" voltage surges.

If you have reason to believe that your 100-watt or 60-watt lamp on the ceiling doesn't last as long as you think it should, you may find it desirable to install a constant voltage transformer between your TV set and the 117-volt line. A constant voltage source also pays dividends by keeping the picture from shrinking or fading out in the event of a low-line voltage condition.

Use Caution. Before you attempt any action that exposes either the front or the back of picture tube, *know what you are doing and proceed carefully, or you will do more harm than good.* A big picture tube properly installed and not abused is perfectly safe. In the hands of an inexperienced person, it can be quite dangerous. The larger the tube, the more careful you should be.

Fortunately, most of the things you

can do to get more life out of a picture tube do not involve removal of the tube, or a need to get into the high-voltage part of the set. Once you remove the back of the set, the neck of the picture tube is vulnerable. The neck is fragile and can be inadvertently guillotined. Clear the top of the set of all objects, even your tools and test equipment. An extra tug on the test leads or a child's toy bumping into the set can cause an embarrassing moment.

When removing or replacing the socket on the picture tube, be careful not to loosen or break the base, or distort the pins. Quite often, a tube that has been in use for some time will have a loose base. This in itself is not a problem, but careless twisting could break the leads from the tube to the pins in the base. Rough handling of a loose base could break the glass-tipped vacuum seal.

Ion Trap. If your tube is equipped with an ion trap, it should be checked from time to time, and the trap should be adjusted for maximum brightness. This adjustment can best be made in a darkened room and with the brightness control turned down until there is almost no light from the picture tube screen. You rotate the ion trap slowly and slide it back and forth on the neck of the tube until you are satisfied that you have found a position of maximum brightness. Should you find two such positions, use the position closest to the base of the tube.

Do not use the ion trap to eliminate neck shadows, if any. The yoke and positioning magnets should be used for this type of correction. And it's a good idea to recheck the ion trap if the yoke or positioning magnets have been moved.

Tube Base Repairs. Loose tube bases should be cemented back in place. Chipped bases can also be cemented, if you have the chips. If the base is beyond repair, obtain a new one. Do not attempt to replace a base unless you absolutely have to. It can be quite tricky and leads can break flush with the glass.

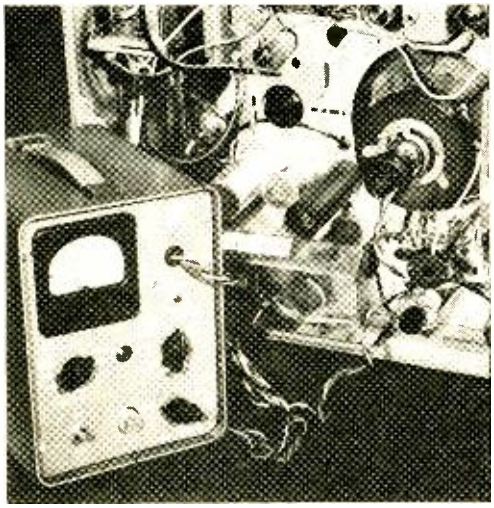
To replace a socket, first remove the old cement and clean the glass, then clean and pre-tin all the leads. Line up the leads so that they coincide or line up with the proper base pins and slip the base into position. This is easier said than done. It might be helpful to spot-solder a length of thin wire to each lead to serve as a flexible guide.

Once the base is in place and all the pins are soldered, the guide wires can be clipped. Almost any heat-resistant cement that will adhere to glass and Bakelite can be worked around the edge of the base in contact with the glass.

Heater Repairs. The absence of light in the neck of the tube could be due to an open heater. First check to see that heater voltage is present at the tube socket. In a series string set, this could be a problem and sometimes quite misleading. A normal voltmeter reading could be 117 volts, even though only 6.3 volts are required at this point. If the only break in the string is the open heater in the picture tube, no current will flow in the string—no current flow, no voltage drop; if there is no voltage drop, the meter sees the full line voltage.

A quick way to check the string is to complete the circuit with a jumper across the picture tube's heater connections. If the string lights up in a normal manner, it is safe to assume that heater voltage is present. Of course, the set has to be on and plugged into a wall

(*Continued on page* 113)



BUILD A TV PICTURE TUB

DOES YOUR TV set "smear" when you try to turn up the brightness to a comfortable viewing level? Do the whites seem to become silvery? Is your picture so dim that you have to pull the shades or wait for nightfall to watch a program? Does it take a long time for the brightness level to come up? Is it impossible to vary the brightness level? Does the picture tube seem to go on and off? If the answer is yes to any or all of these questions, you probably have a "sick" picture tube.

While there are many different types of tests performed by the picture tube manufacturer, three types are usually made in the field: open-short, emission, and grid control tests. You can make all of these tests reliably and quickly, and also "rejuvenate" a "tired" picture tube with this easy-to-build TV Picture Tube Tester and Rejuvenator. The parts are inexpensive and readily available.

HOW IT WORKS

Opens and Shorts. The open-short test is shown in the simplified diagram in Fig. 1. In this test a.c. voltage is applied to the cathode, and to each element in the tube, one at a time, through a neon lamp. Each of the elements acts like an anode with respect to the cathode, as in an ordinary diode. Since half the a.c. voltage waveform is passed by the diode so formed, only one half of the neon lamp will glow.

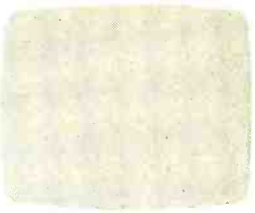
Should the element be shorted to the cathode, current will flow in both directions and both halves of the lamp will glow. Should the element be open, no current will flow and the lamp will not glow.

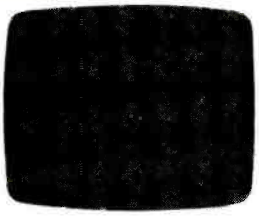
In the heater-cathode check, however, the lamp will not glow even on one side when conditions are normal. The inside of the cathode cylinder is not coated with the activated emitting material and very little current will flow. A shorted condition will be indicated as in the other tests . . . both halves of the neon lamp will glow.

Emission. The emission check is shown in the simplified diagram in Fig. 2. The control grid is tied to the cathode and an a.c. voltage is applied to G_2 through a d.c. ammeter and series resistor. The amount of current that flows (during each positive half cycle) is a relative indication of the electron emission capability of the cathode.

Grid Control. The grid control test is similar to the emission test except that instead of having a zero grid bias as used in the emission test, a negative voltage is applied to the control grid as shown in Fig. 3. As the control grid voltage is made more negative, less G_2 current flows. When the control grid (G_1) voltage is made sufficiently negative, no current will flow and the tube will be cut off.

The amount of negative voltage required to achieve cutoff indicates the relative contrast range of the picture





It's easier to plug in a tester than it is to change a picture tube

By JEFF H. TAYLOR

E TESTER AND REJUVENATOR

SIMPLIFIED CIRCUITS

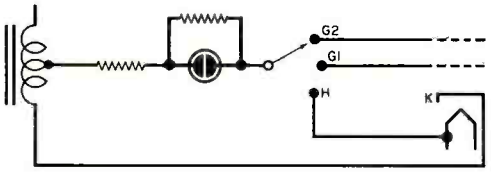


Fig. 1. Neon lamp indicator shows leakage, shorts, and opens between each element and the cathode.

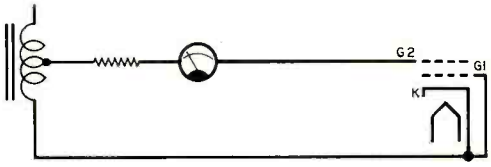


Fig. 2. Meter reads relative emission. Tests made at 1-minute intervals show warm-up characteristics.

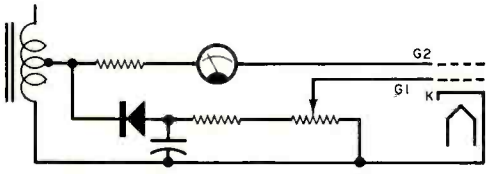


Fig. 3. Grid control is determined by the amount of negative voltage needed on G1 to obtain cutoff.

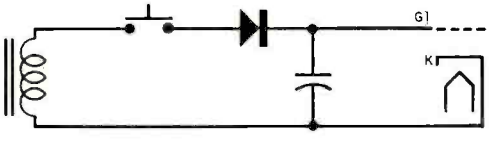


Fig. 4. Momentary application of a high d.c. potential across the cathode and G1 can boost emission.

tube. A tube that will cut off with a small voltage will produce a more contrasty picture than one that requires a larger voltage. In a 3-gun color tube, it is possible to determine if all the guns will cut off at the same potential, or the degree of imbalance, if any.

Rejuvenation. The cathode of a picture tube is a small metal cylinder with an external coating of emitting material. The heater is essentially a coiled wire and is placed inside the cathode cylinder. As the picture tube is used, the outermost activated material on the cathode becomes deactivated and its ability to emit is reduced accordingly. The process of rejuvenating the picture tube removes some of the deactivated coating from the cathode and allows the unused material beneath this "scab" to once again emit a good electron beam. This is accomplished by causing a heavy current to flow from the cathode to G_1— by placing a relatively high potential across the control grid and the cathode, for a very short period of time, as shown in Fig. 4.

If the tube is very weak, sufficient current may not flow to rejuvenate the cathode. Increase the filament voltage one step and try again. When the *REJUVENATE* button is depressed, you may see sparks fly inside the picture tube in the vicinity of the cathode. This is caused by the "dead" material being "stripped" off the cathode.

In a 3-gun color CRT, each gun in

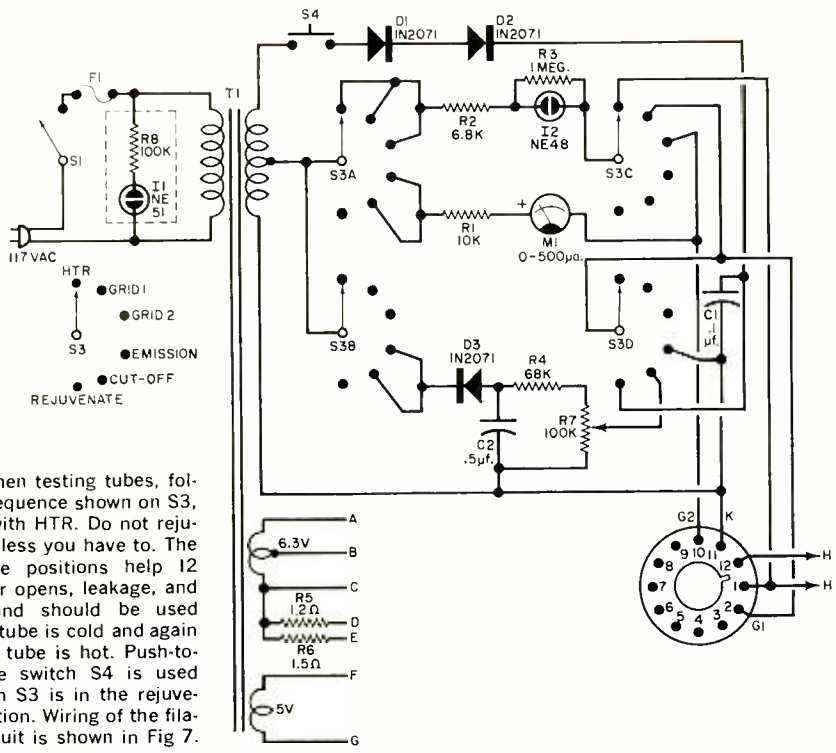


Fig. 5. When testing tubes, follow the sequence shown on S3, starting with HTR. Do not rejuvenate unless you have to. The first three positions help I2 "look" for opens, leakage, and shorts, and should be used when the tube is cold and again when the tube is hot. Push-to-rejuvenate switch S4 is used only when S3 is in the rejuvenate position. Wiring of the filament circuit is shown in Fig 7.

PARTS LIST

C1—0.1-μf., 1000-volt paper capacitor (two 0.2-μf., 600-volt capacitors in series or two 0.05-μf., 1600-volt capacitors in parallel)
C2—0.5-μf., 600-volt paper capacitor
D1, D2, D3—IN2071 silicon rectifier
F1—1½-ampere fuse
I1—NE-51 neon lamp
I2—NE-48 neon lamp
M1—0-500 microampere meter (Simpson Model 27 or equivalent)
R1—10,000-ohm, ½-watt resistor
R2—6800-ohm, ½-watt resistor
R3—1000-ohm, ½-watt resistor
R4—68,000-ohm, ½-watt resistor
R5—1.2-ohm, 2-watt resistor
R6—1.5-ohm, 2-watt resistor
R7—100,000-ohm potentiometer
S1—S.p.s.t. toggle switch
S2—4-pole, 9-position rotary switch (Centralab PA 2013 or equivalent)
S3—4-pole, 6-position rotary switch (Centralab PA 2011 or equivalent)
S4—Normally-open push-button switch (Grayhill 23-1 or equivalent)
T1—Power transformer: primary, 117 volts; secondaries, 470 volts CT @ 40 ma.; 5 volts @ 2 amp.; and 6.3 volts CT @ 2 amp. (Stancor PC 8401 or equivalent)
1—Cabinet (Bud WA1540 or equivalent)
1—2" x 5" x 7" chassis
Misc.—CRT sockets and adapters, fuse holder, line cord, knobs, etc.

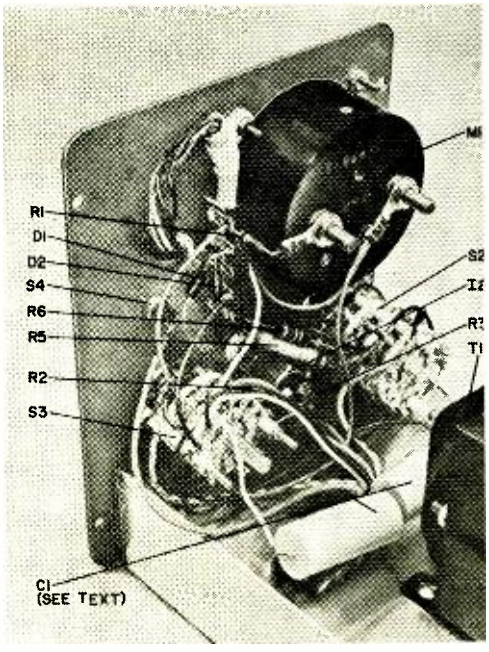


Fig. 6. Nothing is critical here, except for meter polarity. Most of the components are panel-mounted.

turn can be treated in this manner. Appropriate adapters and switching arrangements to accommodate multi-gun tubes, or any tube having a different base or basing arrangement, can be added to the tester. If you are careful, and if you don't have an appropriate socket, you can use clip leads or patch cords to make connections to the CRT pins.

CONSTRUCTION

Any convenient layout of parts can be used in building the tester/rejuvenator. The wiring is straightforward, except for the filament wiring. The phase of the transformer's filament windings must be determined before the filament switch can be wired.

To determine the phase, first tape the leads from the high-voltage secondary winding to avoid accidental contact, and do the following:

(1) Connect one of the 6.3-volt leads (not the C.T.) to one of the 5-volt leads.

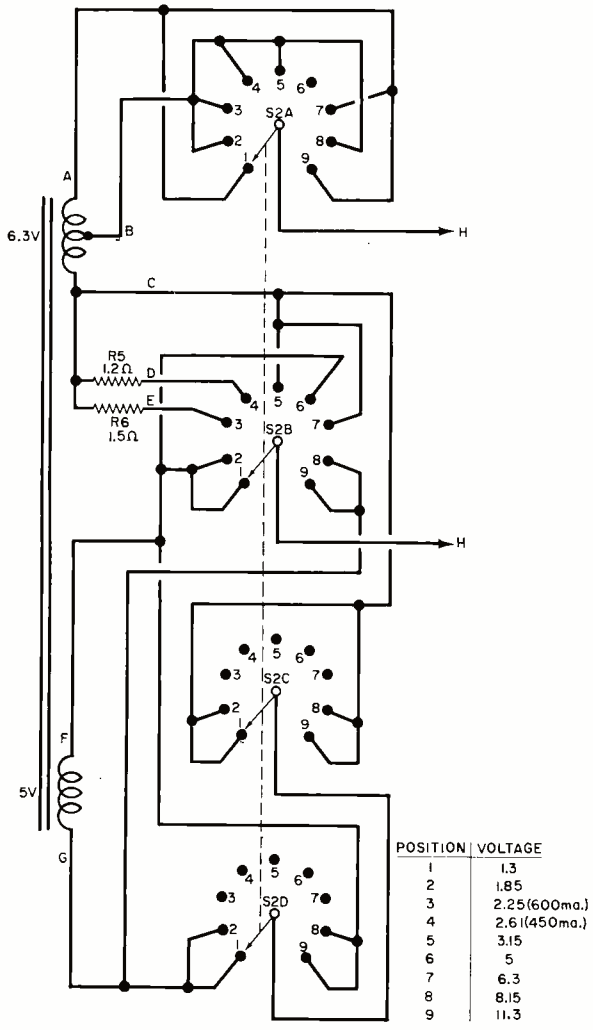
(2) Connect the primary to 117 volts. (Be sure that the other transformer leads are not touching each other.)

(3) If an a.c. voltmeter is available, measure the voltage between the two unconnected (not the C.T.) filament leads. If this voltage measures about 11 or 12 volts, label the 6.3-volt lead to which the meter is attached "A"; label the 5-volt lead to which the meter is attached "G"; label the other 6.3-volt lead "C", and the other 5-volt lead "F". If the meter voltage measures 1 or 2 volts, label the 6.3-volt lead to which the meter is attached "A"; label the 5-volt lead to which the meter is attached "F"; label the other 6.3-volt lead "C", and the other 5-volt lead "G".

In the absence of a voltmeter, a 12-volt panel lamp can be used as a voltage indicator. The bulb will glow brightly when the winding phase produces 11 volts, and will glow almost inperceptively—if at all—when the winding phase produces 1 volt.

Wiring is considerably easier if the switches are wired before installation.

(*Continued on page 90*)



POSITION	VOLTAGE
1	1.3
2	1.85
3	2.25(600ma.)
4	2.6 (450ma.)
5	3.15
6	5
7	6.3
8	8.15
9	11.3

Fig. 7. Windings are made to aid or oppose each other to obtain six more filament voltage levels.

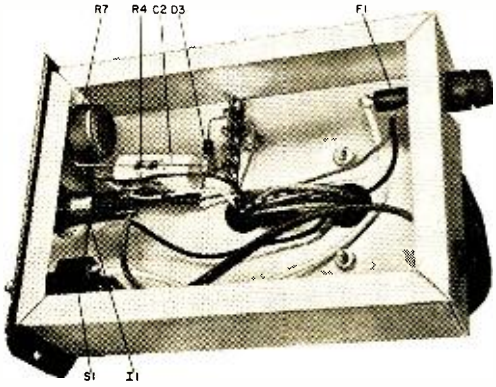
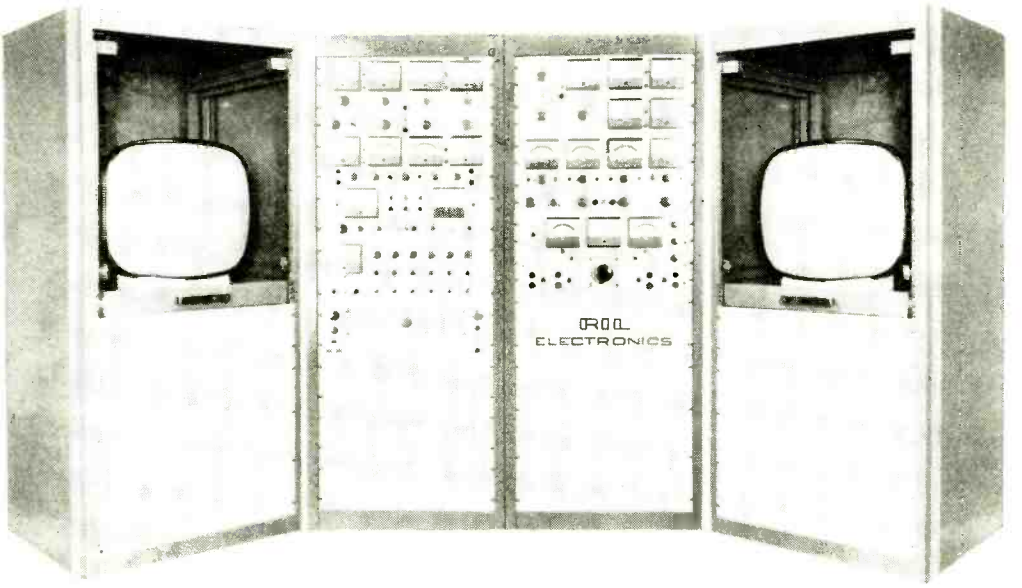


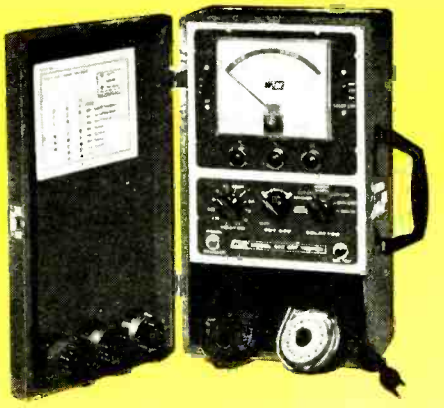
Fig. 8. Observe polarity of D3 or you'll put a positive voltage on G1 and possibly ruin your meter.



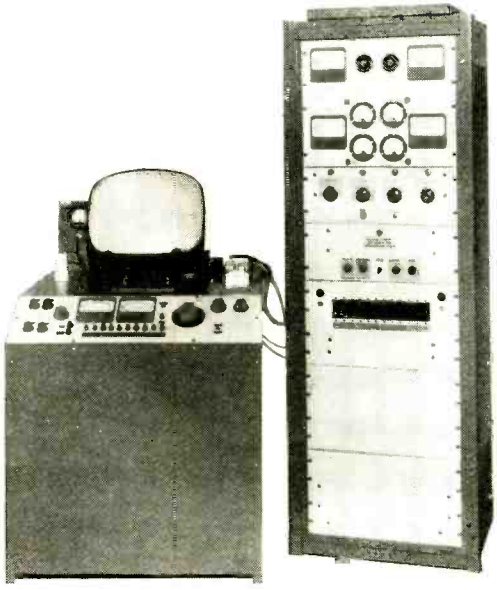
GUIDE TO PICTURE TUBE TESTERS

Prevent premature replacement and extend your picture

Amphenol CRT Commander tests and rejuvenates each electron gun separately. Tests for gas, relative emission, and cut-off can be made. Unit has variable G2 voltage. Built-in voltmeter circuit permits voltage measurements in a TV set. $89.95.



B&K Model 445 Cathode Rejuvenator Tester features: an easy-to-read chart to help interpret neon lamp indications of opens and shorts; separate gun tests and repairs; high- and low-G2 voltage; and a low, medium, and high rejuvenation circuit. $74.95.



Equipment for automatic production testing and quality control of TV picture tubes were the forerunners of service type checkers and rejuvenators that sell for as little as $49.95 and as much as $89.95. The small job at left sells for $6,900, and the big unit on page 46 goes for $15,000; both of these models are products of RIL Electronics.

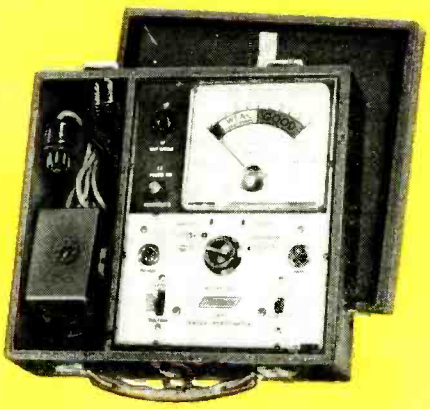
AND REJUVENATORS

tube's life

By GARY WAYNE

MOST REGULAR emission-type tube testers, with appropriate adapters, can test picture tubes for shorts, opens, emission, and a certain amount of inter-electrode leakage. The dynamic types can also test for gas, predict contrast range, and even check gun balance in multi-gun tubes. Naturally, the better the tube checker and the more you know how to put it to use, the more valuable it will be to you. But you will usually find that you can make more significant tests of picture tubes in less time, and with a lot less fuss by using a tester built specifically for the purpose. In addition, just about all of the picture tube testers available have built-in circuitry to rejuvenate the picture tube, and some have

EICO Model 632 CRT Tester and Rejuvenator has push-button selectors for individual testing of each element for opens, shorts, beam current, and gas. Variable meter-measured filament voltage permits exact settings. Kit, $54.95; wired, $79.95.



Mercury Model 801 CRT Tester-Reactivator tests for opens, shorts, emission. Reactivation process can be observed and continued as long as desired. Opens and shorts are repaired. Gun selector switch is located on multi-head cable. $49.95.

RCA Type WT-115A Color Picture Tube Tester is especially designed to test color tubes only. Each gun is tested separately for emission quality, inter-electrode leakage and shorted elements. Meter is used to establish proper cutoff point. $89.50.

Model CR-128, not shown, looks like CR-133, but has 3-position G2 switch and single harness with plug-in adapters. $69.95.

Sencore Model CR-133 Picture Tube Tester features: high-sensitivity shorts and leakage tests; d.c. emission tests; calibrated grid bias control to determine cut-off voltage; variable G2 voltage; and timed rejuvenation and repairs. $89.95.

an ability to remove internal interelectrode shorts and to weld opens.

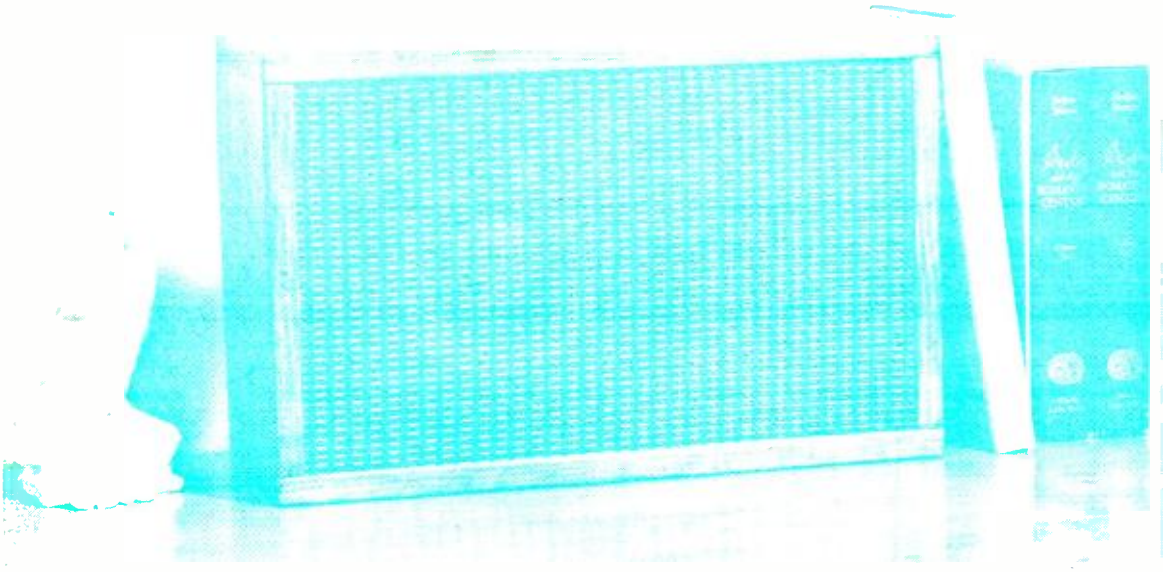
Because of the many tests that have to be made quickly (emission is a function of time and heat, among other things) switching arrangements should be simple, and indicators should be easy to interpret. A picture tube tester should also be able to apply varying amounts of voltage on the different tube elements to simulate operating conditions.

Models, features, and prices are subject to change. You should consult your dealer and manufacturers' literature to track down additional features for the different models, and to help you decide which tester will best serve you.

Tube testers, like most test equipment, can be separated into two very broad categories: (1) testers designed for tube manufacturers and their laboratories, and (2) testers that are sold to servicemen, do-it-yourselfers, experimenters, and others. Generally the lab instruments are elaborate affairs and are priced at about $5,000 and up. These lab testers are multi-meter instruments capable of establishing, varying, and measuring several parameters at the same time. They can establish a raster on the screen; measure spot size and brightness; determine electron beam centering; and make a host of other tests. They are often called upon to perform certain functions required in the tube manufacturing process.

Fortunately, it isn't necessary to have such lab type equipment in your home. The service-type instruments do a commendable job, and are lightweight, portable and inexpensive. The cost of the instrument is quickly offset by the amount of money you save when you extend the life of a picture tube, or avoid premature replacement because of a wrong diagnosis. There are many troubles inside a TV set, other than in the picture tube, that resemble one or more picture tube defects. Of course, you could substitute a known good tube to determine if the trouble is in the tube or in the set. However, it is much easier and much safer to just plug in a tube tester. -30-

Build The "CINDERELLA"



By DAVID B. WEEMS

Half-cubic foot sealed enclosure costs under $10

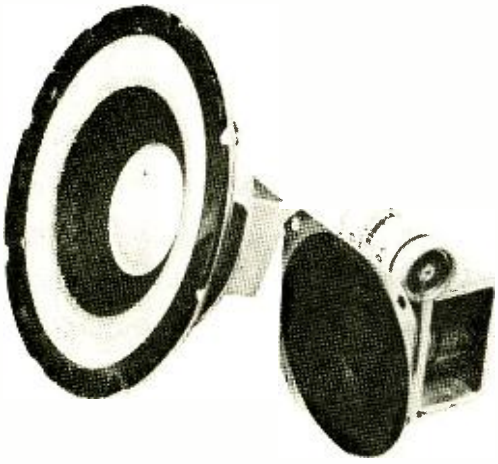
IF YOU'RE thinking of putting down $30 or more for one of those department store "no name" speakers in a box, wait. Here is a little hi-fi speaker system that can save you money and will probably sound better. At least you will know what went into the box! And you won't find a similarly well-constructed enclosure with a good-quality small speaker system on the market for anything like this price. If your idea of what $10 will buy in speaker systems is based on what was available just a few years ago, the *Cinderella* system will amaze you.

The secret of the *Cinderella* is in the design and construction of its XS-5052 woofer. This woofer's distinctive qualities are noticeable in two ways. The first is the obvious visual differences between it and a normal 6-inch speaker. Second, and more important, there is a distinct aural difference, which can be made apparent by a frequency test run.

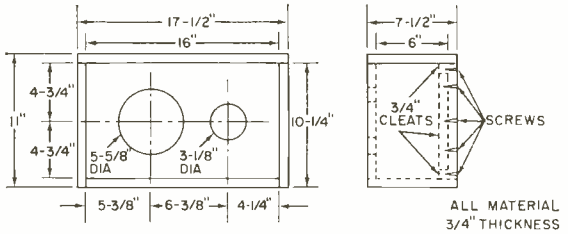
Test Results. I set one of these woofers on my workbench and hooked it up for the usual bass resonance frequency test, starting downward from 200 cycles. Although most 6-inch speakers resonate at about 120 to 150 cycles, a few "hi-fi" 6-inchers have a bass resonance of around 70 cycles, and, frankly, that is where I expected this woofer to fall. Low resonance is the crucial characteristic for woofers to be used in small sealed enclosures; the restricted air volume in such systems will raise the point of resonance.

My eyes were glued to the oscilloscope screen as the audio generator dial passed 70 cycles, then 60. Not until 48-49 cycles did the voltage across the speaker reach a peak, indicating resonance. A remarkably low frequency for a $4 speaker.

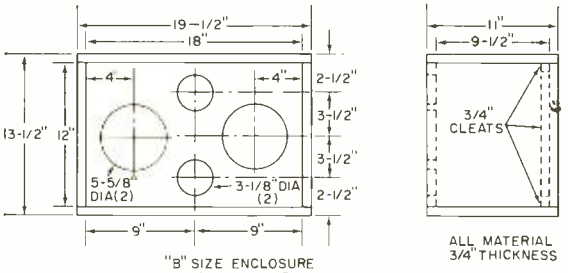
The remainder of the system consists of a small cone tweeter with its self-contained capacitor which acts as a high-pass filter, and an enclosure that occupies



Six-inch woofer costs only $3.95 but has surprising low end response. Tweeter is not sold separately.

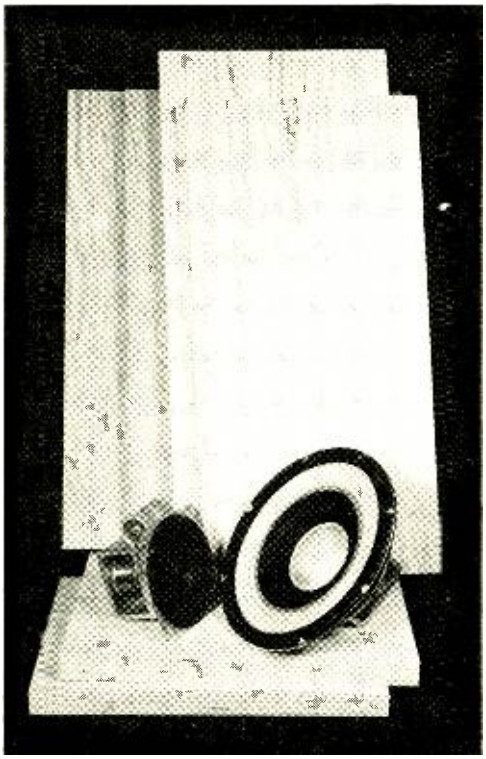


"A" SIZE ENCLOSURE
FOR ONE WOOFER-TWEETER PAIR



"B" SIZE ENCLOSURE
FOR DUAL WOOFER TWEETER COMBINATION

Most builders may be satisfied with single woofer-tweeter combination, but dual system sounds better.



The Cinderella enclosure is caulked and sealed, requiring use of sturdy front, top, back, and side panels. The author was satisfied with ¾-inch pine.

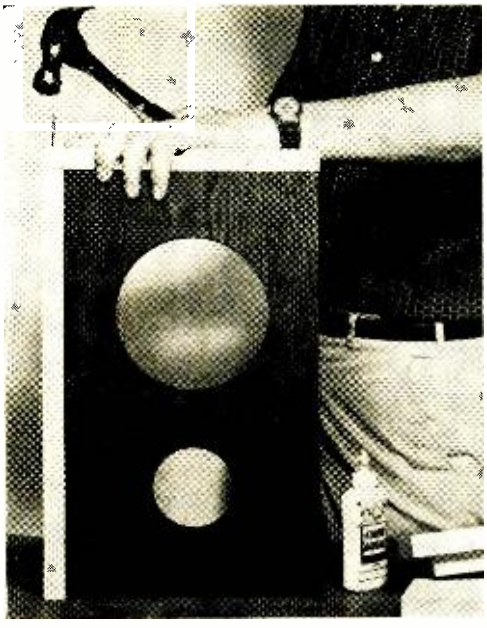
BILL OF MATERIALS

"A" System Total cost, $10

1—Woofer-tweeter combination (Stock No. XS-TS-63, McGee Radio Co., 1901 McGee St., Kansas City 8, Mo.; woofer available separately as XS-5052 for $3.95)
2—9½" x 16" pieces of ¾" fir plywood for front and back
1 7½" x 17½" piece of ¾" clear pine for top (1 x 8)
1 7½" x 16" piece of ¾" clear pine for bottom (1 x 8)
2—7½" x 10¼" pieces of ¾" clear pine for sides (1 x 8)
2 ¾" x 9½" pieces of ¾" pine (side cleats for back)
2—¾" x 14½" pieces of ¾" pine (top and bottom cleats for back)
12—#8 x 1¼" wood screws for back
8—#6 x ½" sheet metal screws for speakers
1—1" x 24" x 30" sheet of fiberglass
Misc. #6 finishing nails (¼ lb.), caulking material, glue, and grille cloth

"B" System Total cost, $18

2—Woofer-tweeter combinations (Stock No. XS-TS-63, McGee Radio)
2 12" x 18" pieces of ¾" fir plywood for front and back
2 11" x 19½" pieces of ¾" fir plywood for top and bottom
2 11" x 12" pieces of ¾" fir plywood for sides
2—¾" x 12" pieces of ¾" pine (side cleats for back)
2 —¾" x 16½" pieces of ¾" pine (top and bottom cleats for back)
14—#8 x 1¼" wood screws for back
16—#6 x ½" sheet metal screws for speaker mounting
1—1" x 24" x 60" sheet of fiberglass
Misc.—#6 finishing nails (½ lb.), caulking material, glue, and grille cloth



Nail side to bottom and front of the enclosure. Good fit and a liberal use of glue are important.

only ¾ sq. ft. of shelf space. The system is called the *Cinderella* because, while it bears no apparent pedigree, it does show inborn quality. For example, even in the small enclosure, the *system* resonance is a little over 70 cycles. The transient response is surprisingly good for a low-cost system. As in all small sealed enclosure systems, efficiency is lower than in a large system, but a 7-watt amplifier supplied all the sound you would want in a very large but very live room. The *Cinderella* is rated at 12 watts.

Budgeting Your Money. The enclosure is sturdy, contains sufficient damping material, and is thoroughly sealed. Any one of these features may be missing from a department store box. For the skeptic, here is a rundown of how to budget your money to build the *Cinderella* "A" system for only $10.

Speakers	$6.90
Plywood for front and back	.55
Pine for top, bottom and sides	.75
Screws	.26
Glue	.25
Fiberglass	.66
Caulking material	.20
Nails	.06
Total	$9.63

That leaves 37 cents to squander on grille cloth and trim. You can use screen molding for trim (as I did—15 cents for a cabinet) and decorator burlap will serve as grille cloth at 49 cents a yard (17 cents). If anyone mentions finishing the wood, you will find that 5 cents is still available, and that is just about the amount of shoe polish I used to stain and "oil finish" the model shown. For very little more, you can use a veneer plastic, such as Contact. Or choose a hardwood if you want fine cabinetry.

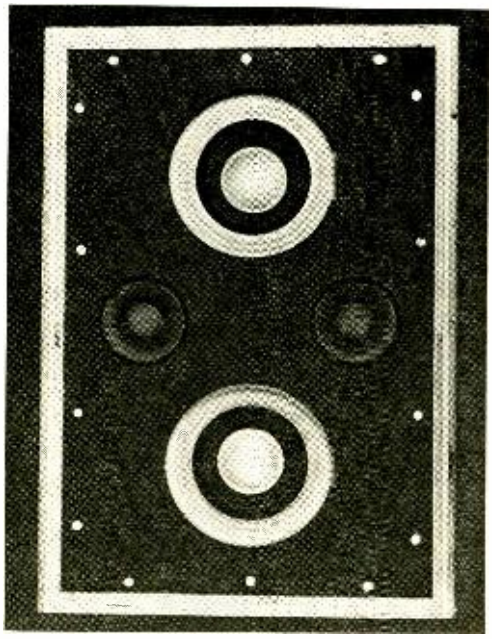
The sound can be improved by putting two sets of the woofer-tweeter combination ($12.95) in one "B" size cabinet (see page 52) at a cost of about $18. Used in multiples, these little speakers sound even better. There is more solidarity in the bass and somewhat smoother sound throughout the whole spectrum. Also, the impedance curve tends to flatten out when two woofers are hooked in parallel.

In buying material, note that the ¾″ x 7½″ pine shown in the drawing is, of course, what lumber yards sell as "1 x 8". When you have cut all parts to the specifications shown, set them up as in the finished enclosure. At this time you can trim any of them that do not fit satisfactorily. One of the economies in this system, in time as well as money, is the avoidance of many cleats which would require the use of extra screws, nails, and glue. The nailing system shown in the diagram is quite adequate for such a small enclosure, but a good fit is necessary.

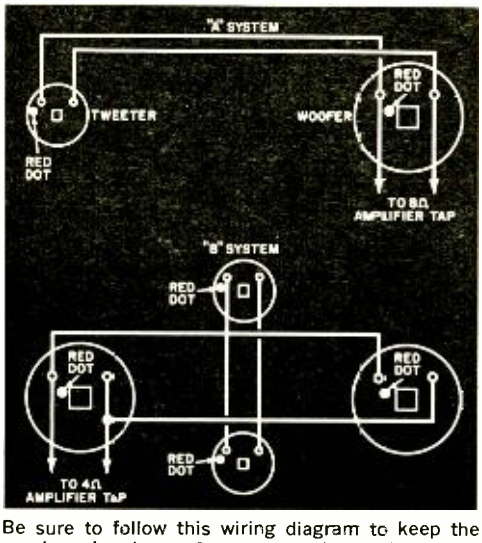
Construction. Begin construction by nailing the bottom to the front, using plenty of glue between these two parts. Next, nail one end to the bottom and front. Continue with the other end, and finally nail down the top to the sides and front.

The cleats for the back can now be attached, using glue and nails as with the exterior parts; but if you use the same kind of nails, they must be cut just short enough so they will not penetrate the outer surface of the sides and top. A somewhat easier method is to use a different nail, such as sheet rock nails which have a large head and are the correct length.

The joints should be caulked even



Front view of an experimental "B" system built by the author to test front and side panel vibration. This enclosure was built using cleats and screws, unlike the plans on page 50. Fir plywood was also used and the enclosure covered with a plastic veneer. It was determined that gluing and nailing of the panels would be adequate if care was exercised in fitting the panels together. A grille cloth was later installed to protect the speakers. Wiring of the "B" speaker arrangement is shown below. Try the 8-ohm tap instead of the 4-ohm output of your amplifier if the bass response seems a little thin.



Be sure to follow this wiring diagram to keep the speakers in phase. Once the enclosure is sealed, you may find it fairly difficult to change the wires.

though they seem to be thoroughly sealed by glue. The caulking material can be purchased in a cylinder for use with a gun, or in a squeeze tube. Most building supply stores have guns to loan, but some rent them. Force the caulking material along the joint and wipe away excess with a rag so it won't flow onto the speakers.

The speakers are mounted and wired as shown in the diagram. The back should be drilled to allow speaker connections to pass through. The wires can be brought out through a small hole which is later filled with caulking material or sawdust and glue, but a better method is to use small bolts as connectors through the back.

Padding is extremely important in a small sealed enclosure. Tests indicated that the *Cinderella*'s resonance could be lowered 10 cycles or more and the bass range greatly extended by the use of proper padding. The whole interior of the model shown is lined with a 1-inch layer of fiberglass. You can get fiberglass from most electronics stores; a common size measures 1″ x 24″ x 60″, enough for two cabinets. Cut the fiberglass to fit all interior surfaces, except the front baffle, and secure it in place with tacks or glue. Then fold the remainder of your sheet of fiberglass so that it will fit into the enclosure loosely. This should fill the enclosure.

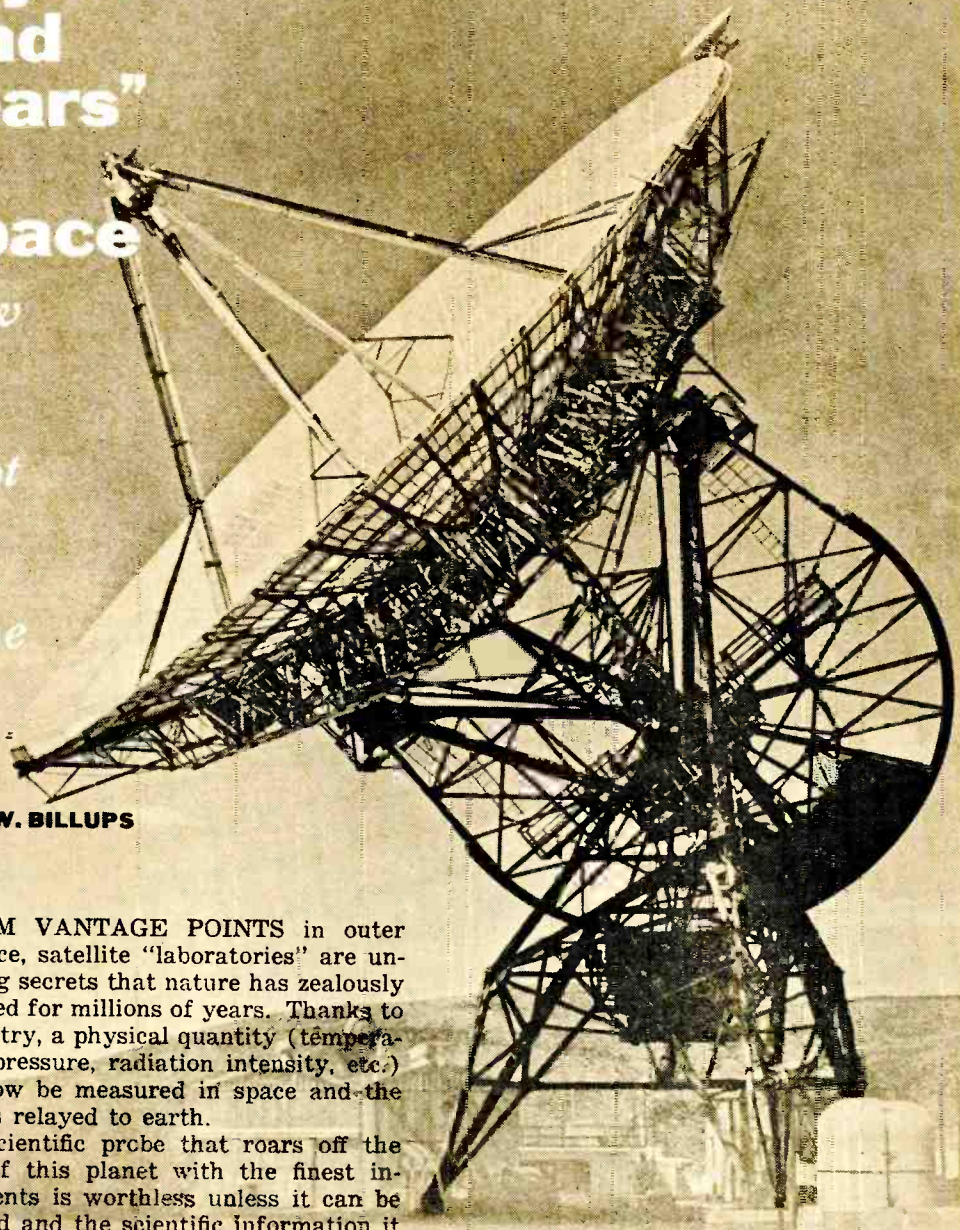
Now fasten the back in place with the screws specified, hook the *Cinderella* up to your amplifier, and try on the "glass slipper." That, naturally, is a suitable wide range program source. When you do, you'll be glad you didn't settle for a pig in a poke. —30—

After filling cavity behind speakers with padding, cleats should be caulked and back-nailed into place. The usual household caulk works out just right.

telemetry our "eyes" and "ears" in space

how to say a lot in no time at all

by J. W. BILLUPS



This type of tracking and data acquisition antenna is used by Deep Space Network, Goldstone, California, in support of the NASA Lunar Interplanatory Programs.

FROM VANTAGE POINTS in outer space, satellite "laboratories" are unlocking secrets that nature has zealously guarded for millions of years. Thanks to telemetry, a physical quantity (temperature, pressure, radiation intensity, etc.) can now be measured in space and the figures relayed to earth.

A scientific probe that roars off the face of this planet with the finest instruments is worthless unless it can be tracked and the scientific information it is collecting recorded at ground stations. Scientists *must* know what is going on inside the satellite as well as the proper-

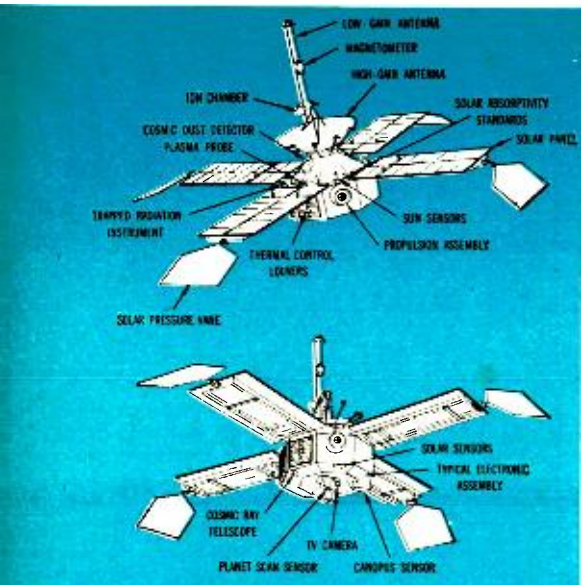


Fig. 1. Artist's drawing of the Mariner Mars spacecraft that sent back the first close-up pictures of the planet Mars. Note location of TV camera on the underside of the spacecraft (lower illustration). Mission objectives also included collection of a wide range of data on the operation of a spacecraft during a long-duration flight away from the sun, and recording of scientific measurements in interplanetary space between the orbits of Earth and Mars, and in the vicinity of Mars. (Drawing courtesy of NASA)

ties of the outer space environments.

Since our probes are not recoverable, the data gathered by the satellite's sensors and recorders must be transmitted back to earth while the vehicle is still in flight. This is done by establishing a radio telemetry link with the ground stations. (Instructions sent *to* a satellite from the earth are command-control functions, and should not be confused with the telemetering system.)

Telemetry in Space Research. Figure 1 shows the *Mariner* Mars spacecraft with its data-collection instrumentation. The data gathered by the various sensors are encoded and stored for radio relaying to earth when the satellite is commanded to do so by a ground station. The discovery of the Van Allen radiation belts is an example of the kind of information that is gathered by the satellite sensors and telemetered to earth via FM radio.

A single observatory satellite like OGO (Orbiting Geophysical Observatory) is designed to collect information on *solar cosmic rays, gamma ray spectrum, interplanetary dust particles, VLF noise,* and so on. The mass of measurements sent back by such a satellite is so voluminous that it would take 500,000 years to decode and graphically present this information manually. A high-speed computer can process an equal amount of data in about nine months.

To cope with the ever-increasing flow of data from outer and deep space, scientists have had to devise ever-swifter means of reading and analyzing space telemetry. Without the ability to quickly reduce acquired information from their experiments into meaningful engineering terms, launching of the spacecraft would be an adventure in futility.

For even though the space age is still in its infancy, already the Goddart Space Flight Center (Greenbelt, Maryland) now receives from 40 to 50 miles of magnetic tape data every day. In the year 1964 alone, satellites and other flight projects of the National Aeronautics and Space Administration sent back more than 57 million bits of data per day from space. This is ten times more than in all previous years.

Telemetry in Industry. Telemetry has been credited with saving the lives of aircraft test pilots by detecting structural weaknesses in time for the pilot to take corrective action. Not so long ago, an experimental helicopter was being tested at a U. S. Navy flight-test center. During one of the flights, the ground station telemetry readout indicated the existence of a serious structural failure. The pilot was told by radio to bail out, thereby narrowly escaping injury. The recorded telemetered information was later used to isolate the weakness, and this condition was corrected in later designs.

But telemetry is not restricted to space exploration, or to the aircraft industry alone. The modern railroad dispatcher now uses it to "see" distant trains, and to follow their movements in his district. Pipelines that are hundreds of miles long can also be cited as another example of how much telemetry is used today. As a matter of history, the pipelines were among the first to automate through extensive use of telemetry. Mil-

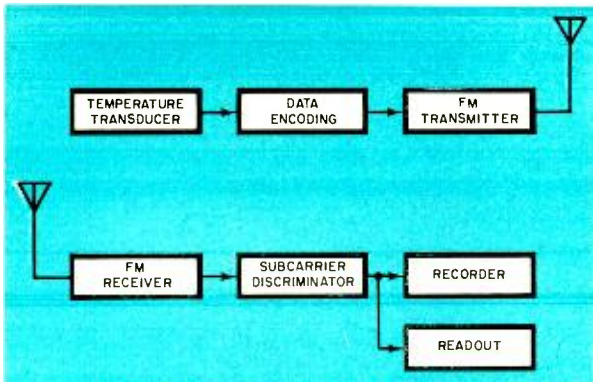


Fig. 2. Simplified block diagram of a basic telemetering system. Coded data from the collection equipment are transmitted to a receiving station over FM radio for readout and interpretation.

lions of gallons of oil and other fluids are now pumped daily through pipelines strewn across the country.

For operating safety and economy, the status of the entire flow—volume, viscosity, pressures and delivery rate—of the liquid being pumped through the pipelines must be definitely known and closely controlled from a central point. Any flow changes desired must be coordinated simultaneously at many points. All of the pumping and compressor stations along the route can be monitored through the "eyes" of telemetry, and supervisory personnel can then alter the flow and pressures at unmanned booster pump stations at will.

Weather forecasters also use telemetry extensively. Pictures of cloud formations taken by cameras aboard the Tiros and Nimbus satellites are relayed to ground stations. When a series of pictures is received, it is recorded on magnetic tape for permanent storage, and the signals are simultaneously sent through demodulators to a kinescope camera which immediately converts the electrical signals to film. The film is used in long-range weather predictions.

How Telemetry Works. Suppose it is necessary to measure the air temperature 200 miles above the earth. We know we must have a means of measuring the temperature and a means of getting the information back down to earth. A simple block diagram of such a telemetering system is shown in Fig. 2.

The indication can be obtained from a temperature sensor installed in the missile. The indication must be in the form of electrical impulses which can modulate a radio transmitter in the missile. On the ground there must be the necessary data receiving, recording, and decoding equipment to translate the received data into real units of measurement (degrees). The device used to translate the temperature reading into corresponding electrical signals is called a *transducer*.

The Transducer. The transducer is used to convert mechanical or physical variations into corresponding electrical variations, and vice versa. Generally, transducers fall into one of two categories: (1) *modulating* type and (2) *generating* type. Examples of the modulating transducers are the variable inductance, variable capacitance, and variable resistance types. Variable resistance transducers include potentiometers, resistance strain gauges, thermistors, and electron tubes. Generating types of transducers include photoelectric cells, and thermoelectric and piezoelectric devices.

Figure 3 shows a simplified diagram of a transducer suitable for temperature sensing. The thermistor element is in series with a 6-volt battery and a gating circuit. Since the thermistor is a temperature-sensitive device, any increase in ambient temperature decreases its resistance, producing a smaller voltage drop across it. This causes a higher voltage to appear across the gating unit. A reduction in ambient temperature has the opposite effect.

Getting back to our original problem, assume that the range of the tempera-

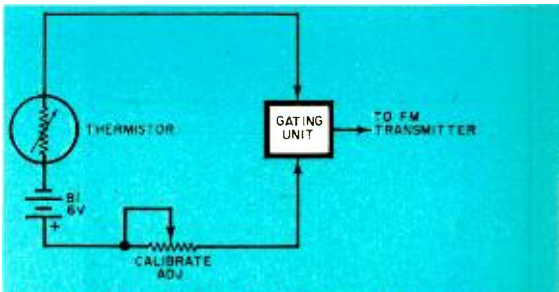


Fig. 3. Circuit of a basic transducer that can be used for temperature sensing. As the temperature changes, the resistance of the thermistor changes, as does the current to the gating unit.

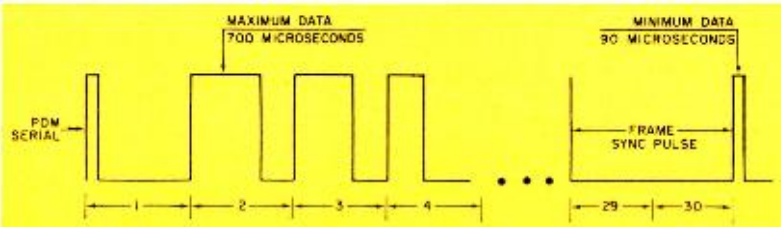


Fig. 4. PDM serial used to modulate an FM transmitter. Pulse duration varies in direct proportion to data intensity.

ture to be measured 200 miles up is between 0° and 100°. We could calibrate the sensing and readout devices for indication in the range of, say, 0-5 volts. Therefore, zero indication would be obtained at 0°, and a 5-volt indication would be obtained at 100°. A temperature of 50° would give a readout of 2½ volts if our equipment is linear.

Having established a representative voltage at the output of the transducer, the next step is to modulate the radio transmitter with this voltage.

Modulation Methods. We can modulate the transmitter in a number of ways. But there are some proven acceptable methods we can choose from. These include: (1) pulse duration modulation (PDM); (2) pulse amplitude modulation (PAM); (3) frequency modulated/frequency modulation (FM/FM); and (4) pulse code modulation (PCM).

In selecting the best method of modulation for a particular application, we must consider the following: (1) the type and quantity of data to be transmitted; (2) the maximum allowable size and weight of the telemetering equipment; (3) the frequency response or resolution required to faithfully reproduce the data to be gathered; and (4) the time and expense involved in converting the received data into original units such as pressure, acceleration, temperature, direction of travel, etc. If necessary, the data-handling capacity of a telemetering system can be increased substantially by combining, for example, PDM with FM/FM, and so on.

To understand the fundamentals of a practical telemetry system, assume in the following discussion that the transmitter is modulated by the output of more than one transducer.

Pulse Duration Modulation (PDM). As the term implies, PDM carries the data in a series of pulses whose width varies directly as the magnitude of the sampled data. In a system with a capacity of 28 separate pieces of data, say, each piece is represented by an assigned pulse whose width is made to vary with the magnitude of the pressure, temperature, acceleration, or whatever data are assigned to the particular pulse.

Figure 4 shows a series of pulses, referred to as the PDM serial, which modulates the transmitter directly. This group of pulses, 30 in all, is defined as one frame. Of the 30 pulses, two are required to form a frame-synchronizing pulse, which identifies the beginning of each group of pulses. Starting at the end of a frame and reading from left to right, each data pulse is identified consecutively as 1 through 28. The frame is made up of pulses 29 and 30.

Based on standards established by the IRIG (Inter-Range Instrumentation Group—a group of scientists and engineers whose purpose is to generate standards and procedures for range instrumentation), we can choose from four data capacities: 30, 45, 60, and 90 pulses. In each case, we have a repetition rate of 900 pulses per second. Therefore, if a capacity of 30 pulses were selected, the system would produce 30 frames ($30 \times 30 = 900$); and if 90 pulses are selected, we would have but 10 frames ($90 \times 10 = 900$).

As shown in Fig. 4, each data pulse has a minimum and maximum width. At minimum pulse width (90 μsec.), the data contents would be zero; and at maximum pulse width (700 μsec.), the data would be maximum.

To illustrate, assume we are measuring the acceleration of a missile. While the missile is on the launching pad in a vertical position, the acceleration would be one g, or close to minimum pulse width. As acceleration increases during the thrust phase of the flight, the assigned

data pulse would widen toward maximum width. If the pulse modulating equipment were calibrated so that 20 g's represented full-scale data, and if—during the missile flight—the data pulse width amounted to only one-half its maximum width, we would know that the missile acceleration was only 10 g's. Here again we assume that the equipment is linear.

Now that we have an understanding of the data pulse structure, we can see how the airborne PDM telemetry system works. In Fig. 5, the data input from each transducer (accelerometer, pressure gauge, temperature probe, etc.) is assigned a contact on a rotary switch (called a commutator switch). As pressure, temperature, or acceleration is sensed, the transducer output voltage is applied to its respective switch contact. As the wiper arm moves around, sequentially wiping each data contact, the voltage appearing on each contact is picked off and applied to the input of a keyer. The keyer converts these varying amplitude pulses (PAM) to varying width pulses, known as the PDM serial.

Observe that two commutator switches are required for PDM telemetry. The second switch (keying voltage) is arranged to lag slightly behind the data switch to allow any contact bounce on the data pulse to pass before a so-called "ramp" generator, which forms part of the keyer, is triggered. The amplitude of the data pulse is compared with the ramp voltage; if the two are equal, the pulse-width generator is automatically shut off. This results in the pulse width being proportional to the data amplitude.

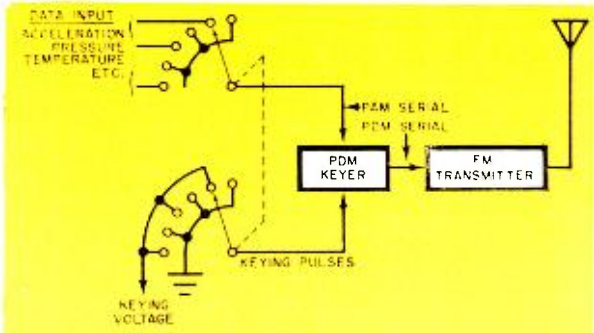


Fig. 5. The data input from each transducer is assigned a contact on the commutator switch. As the acceleration, pressure, or temperature is sensed, the wiping arm picks off the voltage on the switch contact and applies it to the input of the keyer. The keyer then converts the varying amplitude pulses to varying width pulses which can frequency-modulate the transmitter.

The series of pulses at the output of the PDM keyer modulates an FM transmitter directly. At the ground station telemetering receiver, the pulses are then applied to a PDM limiter-amplifier, or slicer, which reconstructs the pulses in their original form. They are then applied to the input of a bar graph for a "real time" display of each data bit, or to the input of a computer which converts the data pulses into the engineering units appearing at the input of the transmitting transducers.

In practice, all telemetering information is recorded on tape as received, and the tapes may be sent to a data center for processing.

The PDM technique is a simple one, and its accuracy is not seriously affected by noise appearing on the data pulses. This technique *does* have one drawback, however, in that it has relatively poor frequency response. This is an important consideration in the selection of any telemetering system. Good frequency response is essential for faithful reproduction of a signal whose amplitude or frequency is constantly changing.

For example, if we compare PAM, PCM, and FM/FM with the 15-cycle PDM frequency response capability, we see that their relative frequency responses are 70, 180 and 2000 cycles, respectively. These numbers are not absolute and involve many influencing factors that are beyond the scope of this discussion.

Pulse Amplitude Modulation (PAM). In some respects, PAM is similar to PDM. Each system uses a commutator switch, and each transmits data in the form of a series of pulses. One major difference is the fact that a keyer is not required in PAM since there is no need for conversion from pulse amplitude to pulse duration. Therefore, the PAM output from the commutator is used to modulate the transmitter directly.

A solid-state type commutator switch is generally used to achieve higher data rates as well as higher data capacities.

(*Continued on page* 93)

SOLID STATE

By **LOU GARNER,** Semiconductor Editor

NOW THAT MANUFACTURERS have brought down the prices on a number of their silicon transistors, hobbyists can indulge in the luxury of including them in their experiments. At least three manufacturers are offering a variety of silicon units at less than $1 apiece in single lots.

Silicon transistors are generally superior in performance to their germanium counterparts. In fact, silicon transistors are used almost exclusively in military equipment as well as in critical industrial applications because of their low d.c. leakage and their ability to withstand higher operating temperatures. They are less susceptible to thermal "runaway" and circuit drift. And they are ideally suited for use in direct-coupled audio amplifiers, and in the amplifiers used in meter circuits of sensitive test instruments.

Among the currently available low-cost silicon transistors are GE's 2N2923, Motorola's MPS 706 and MPS 834, and Texas Instrument's TI-416. These are all plastic encapsulated *pnp* types featuring "in-line" terminals.

Reader's Circuit. The relatively simple pulse generator circuit shown in Fig. 1 was submitted by reader Michael Ross (795 Pelham Parkway North, Bronx, N.Y. 10467). Mike writes that he has been using this circuit as a nerve stimulator for experiments in biophysics.

Transistor *Q1* together with transformer *T2* and associated components comprise a blocking oscillator circuit in a modified Hartley configuration. Transformer *T2* starts and sustains oscillation by providing the necessary feedback loop. The oscillator frequency or repetition rate is determined by the characteristics of *Q1* and *T2*, as well as by the values chosen for the base biasing components (*R2* and *C2*) and the setting of *R1*.

Capacitor *C3* tunes the secondary winding of *T2* to the oscillator frequency, and the neon lamp (NE-51) functions both as an indicator and as a peak limiter. The unit derives its power from a 117-volt a.c. line. Transformer *T1* steps down the voltage, and *C1* rectifies and filters it.

Standard components are used throughout. Transistor *Q1* is a 2N255, *T1* is a 6.3-volt filament transformer, and *T2* is a "universal" audio output transformer. Diodes *D1* and *D2* are general-purpose silicon rectifiers. Resistor *R1* is a familiar 1000-ohm potentiometer and *R2* a 33,000-ohm half-watt resistor. Capacitors *C1* and *C2* are both 10- to 15-volt electrolytics and *C3* is a ceramic or molded paper type. Power switch *S1* is a s.p.s.t. unit that can be a toggle, slide, or rotary type, as preferred. The output con-

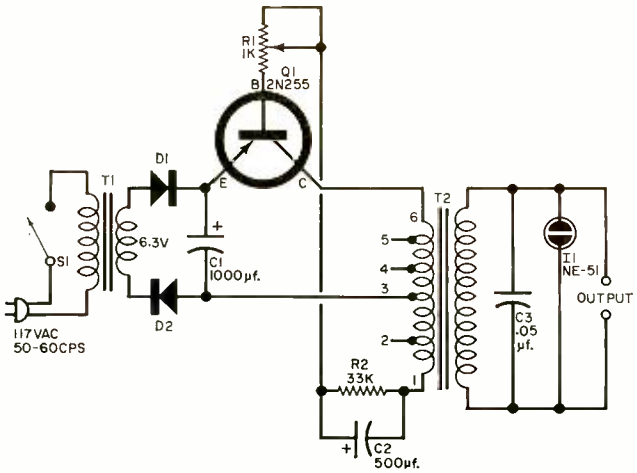


Fig. 1. Schematic diagram of pulse generator used experimentally as a nerve stimulator in biophysics. Submitted by reader Michael Ross, the circuit is essentially a blocking oscillator using standard parts.

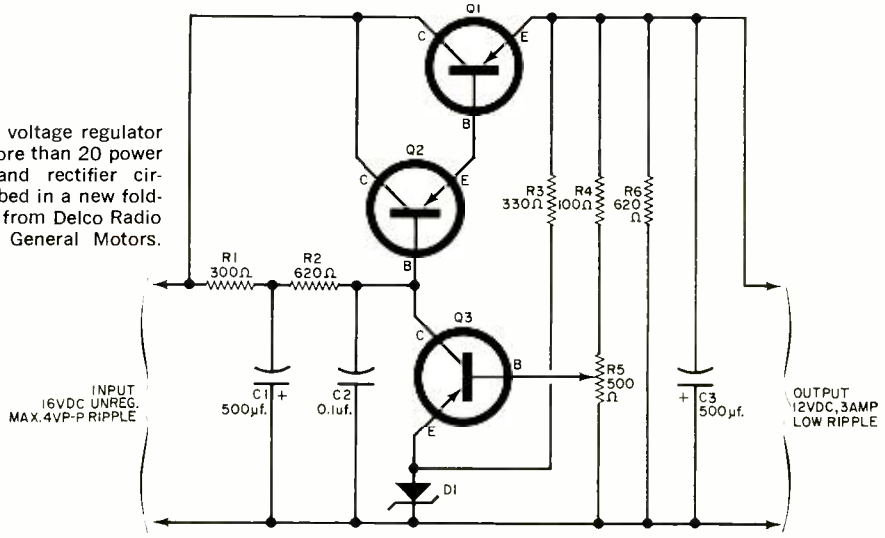


Fig. 2. This voltage regulator is one of more than 20 power transistor and rectifier circuits described in a new folder available from Delco Radio Division of General Motors.

nectors can be conventional binding posts, banana jacks, or screw-type terminals.

From a construction viewpoint, neither the layout nor the wiring is critical. The circuit could be assembled on a perforated phenolic board, but you may prefer chassis-type construction to provide an adequate base for *T1* and *T2*. A medium-size utility box or a small sloping front "meter" cabinet is suitable for housing the instrument.

Manufacturer's Circuit. Suitable for use either as an integral part of a power supply design or as a separate accessory item, the voltage regulator circuit in Fig. 2 is one of more than 20 power transistor and rectifier circuits described in a folder recently published by the Delco Radio Division of General Motors Corporation. Entitled "Application/Versatility in Power Semiconductors," the folder is available both through Delco's regional offices and its main sales office at 700 East Firmin St., Kokomo, Ind. 46901.

Designed to accept an input of 16 volts, d.c. unregulated, with up to 4 volts peak-to-peak ripple, the circuit will deliver up to 3 amperes at 12 volts regulated, and with low ripple content. Power transistors *Q1* and *Q2* are connected in a Darlington arrangement effectively in series with the load. Darlington base bias is supplied by a network consisting of *R1, R2, C1, C2, Q3, R3* and *D1*, with the instantaneous bias depending on the load and *Q3*'s collector-to-ground impedance. Transistor *Q3*'s impedance, in turn, depends on the relationship between the base bias obtained from *R4, R5* and *D1*'s fixed voltage drop. Capacitors *C1, C2* and *C3* serve as ripple filters. Resistor *R3* permits minimum operating current through *D1* and tends to forward-bias the zener diode. Resistor *R6* is a bleeder unit.

In operation, the voltage drop across *Q1* and *Q2* depends upon the emitter collector impedance of *R6*. The emitter-collector impedance depends on the base bias which, in turn, depends upon *Q3*'s collector-to-ground impedance. If the output voltage tends to drop, as may happen with an increased load, *Q3*'s forward base bias also drops. This increases *Q3*'s effective impedance which, in turn, reduces the voltage drop across *R1* and *R2*, and increases the forward base bias on *Q1* and *Q2*. This lowers *Q1* and *Q2*'s effective impedance and reduces the voltage drop across the pair until the output voltage is restored to the preset value determined by *R5*'s setting. The opposite action takes place if the output voltage increases.

Standard parts are used in the circuit. Except for *R5*, all resistors are half-watt types. Capacitors *C1* and *C3* are 25-volt electrolytics and *C2* is a low-voltage ceramic or paper type. Since neither component layout nor lead dress is critical, you can follow your own inclinations when assembling this voltage regulator circuit. Either a circuit board or chassis-type construction can be employed. An insulated heat sink should be provided for *Q1* and *Q2*, and all the d.c. polarities must be observed.

Transitips. Our discussion on distortion in the June column apparently "rang a bell" with many readers. A number of requests to expand our original treatment have been received. One reader, in fact, was prompted to develop a new circuit. Tom Mastrangelo (514 Windley Rd., Wilmington, Del.) wrote in part ". . . When I connected my guitar to my 12-watt amplifier, I was disappointed

(*Continued on page* 101)

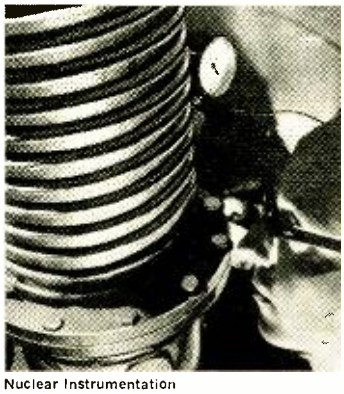
696,000 TECHNICIANS NEEDED BY 1970!

Government Report* Points Out Rapidly Growing Job Opportunities: Need for Trained Electronics Technicians An Important Factor

By Bill Gordon, RCA Institutes, Inc.

President Johnson Emphasizes Need. In his 1964 annual manpower report, President Johnson indicated that the demands for manpower are expanding most in, among other fields, service and technical (including technician) occupations. This expansion is the result of a handful of causes underlying today's big changes in the occupational picture: (1) increasing complexity of modern technology, (2) trend toward automation of industrial processes, (3) growth of new areas of work, such as in the field of atomic energy, earth satellites and other space programs, and (4) data systems analysis and data processing. Indicative also of the growing importance of the use of technicians is a recent revision of the "List of Critical Occupations" published by the U.S. Department of Labor in which technicians are listed for the first time by the U.S. Government.

Salary Levels for Trained Technicians Rising Fast. Beginning salaries for graduates of top level technician education programs have continued to go up during the past five years, at a faster rate than salaries of similar types of jobs. In fact, a U.S. Labor Department projection based on the figures shows that by 1970, technician salaries will average an all-time high.



Nuclear Instrumentation

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Of the total 696,000 technicians needed by 1970, it can be estimated that electronics technicians at all levels will form a vital core in today's major job picture.

*"Scientists, Engineers, and Technicians in the 1960's" U.S. Department of Labor, Bureau of Labor Statistics.

Nuclear Instrumentation

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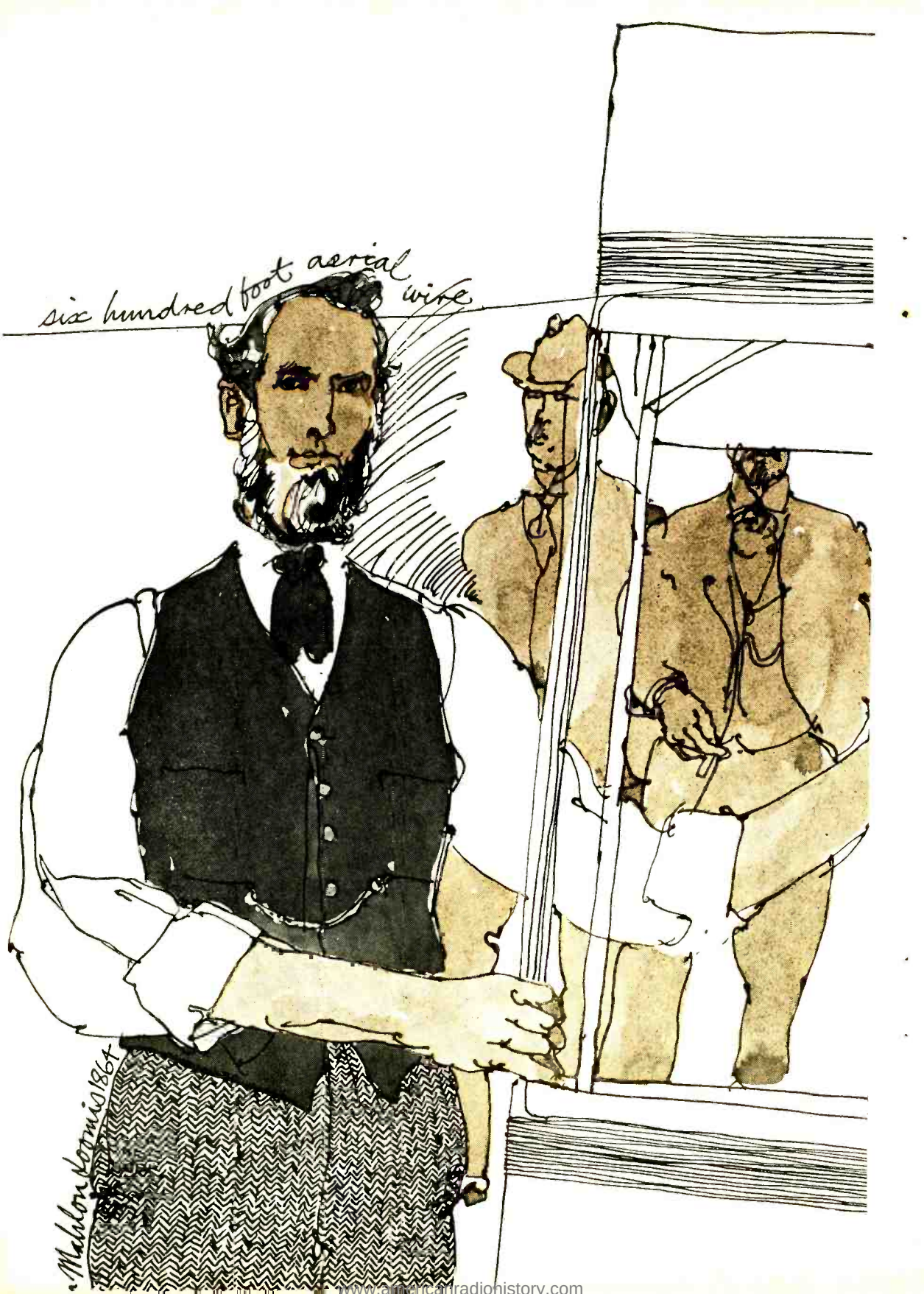
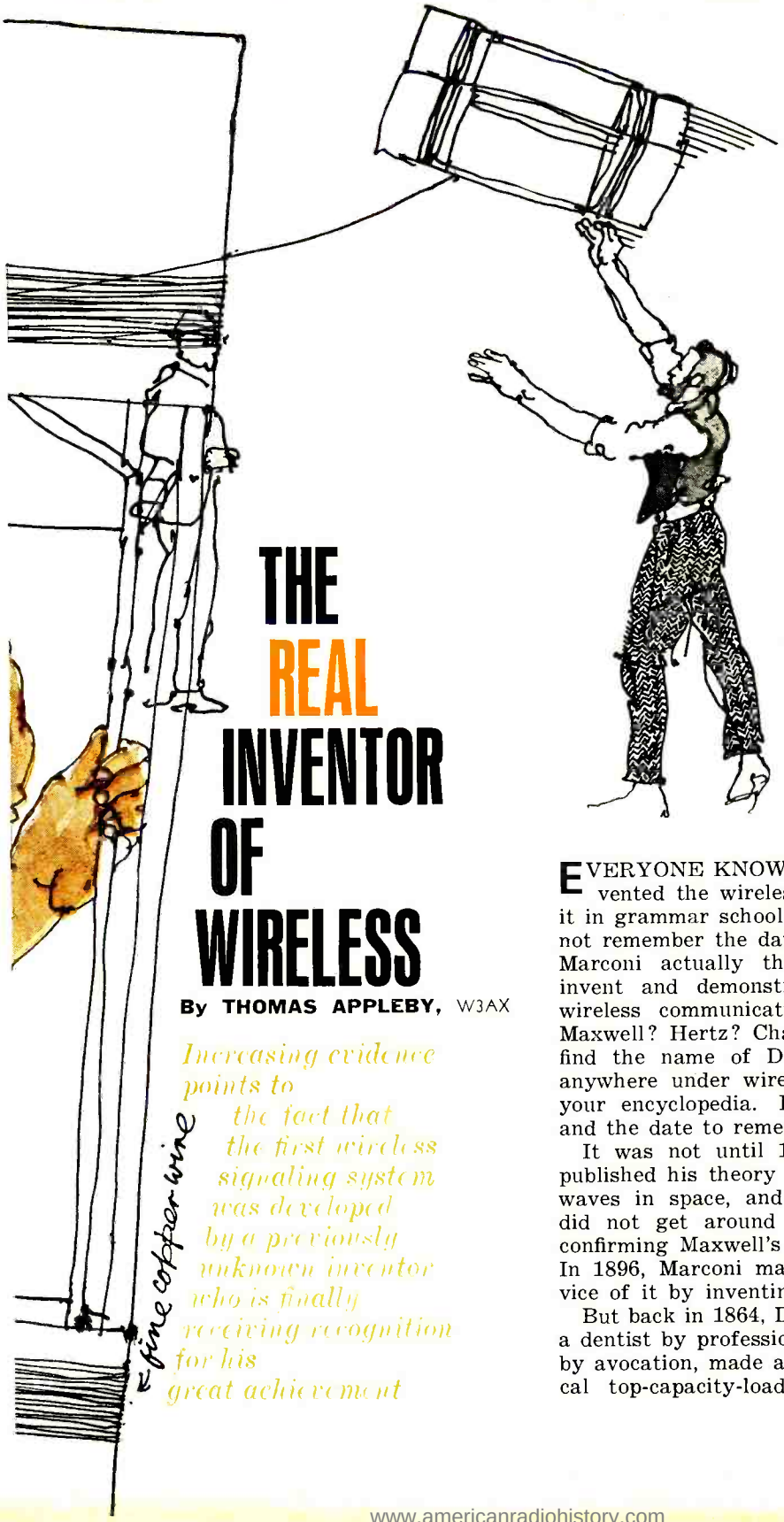




THE REAL INVENTOR OF WIRELESS

By THOMAS APPLEBY, W3AX

Increasing evidence points to the fact that the first wireless signaling system was developed by a previously unknown inventor who is finally receiving recognition for his great achievement

EVERYONE KNOWS that Marconi invented the wireless. We are taught it in grammar school, although we may not remember the date—1896. But was Marconi actually the first person to invent and demonstrate a system of wireless communication? Who, then? Maxwell? Hertz? Chances are you won't find the name of Dr. Mahlon Loomis anywhere under wireless telegraphy in your encyclopedia. It belongs there—and the date to remember is 1864.

It was not until 1865 that Maxwell published his theory of electromagnetic waves in space, and Hertz apparently did not get around to experimentally confirming Maxwell's theory until 1887. In 1896, Marconi made a practical device of it by inventing the antenna.

But back in 1864, Dr. Mahlon Loomis, a dentist by profession and an inventor by avocation, made a sketch of a vertical top-capacity-loaded aerial with a

keying device and an indicator, all in series to ground. He also wrote a brief description of how the system would operate to "remit shocks (to the atmosphere) affecting a distant reciprocating apparatus."

At that time, Loomis had absolutely nothing relating to electromagnetic radiation that he could refer to for inspiration. He came up with a complete system of wireless communication before the natural phenomenon was known or understood. This is attested to by Dr. Loomis's own notebooks and other sketches, as well as old newspaper clippings.

On *July 30, 1872*, a patent (No. 129,971) was granted Loomis on his system by the United States Government.

The First Transmission. In 1866 Dr. Loomis went out to Bear's Den in the Blue Ridge mountains near Bluemont, Virginia, where he elevated a 600-foot aerial wire by means of a kite. He partially covered the kite with fine copper wire mesh connected to the aerial wire for top-loading purposes. This was the first instance of top-loading capacity being used with an aerial.

Between his aerial wire and ground connection, Loomis connected a keying device, which doubled as a spark-gap, and an indicating device. The aerial became charged from the overhead clouds and a "spark" occurred at the key points whenever the key was operated. Oscillations raced up and down the aerial wire, radiating electromagnetic waves into space.

An assistant of Dr. Loomis went to a spur of the Catoctin mountains 18 miles away, also in Virginia, just across a bridge over the Potomac at Point of Rocks, Maryland. There, an exact duplicate of the first station was set up. Both aerials were of exactly the same length and characteristics. While Loomis apparently did not understand high frequency currents—he may not even have known that they existed—he had a notion that both systems should be identical.

Starting at a given moment, and for a predetermined period of time, Dr. Loomis sent a series of impulses from Bear's Den by tapping the end of his aerial wire to the binding post of his grounded indicating device. His associate 18 miles away had been instructed to disconnect the aerial wire from the duplicate instrument after the original "transmitting" period was over, and to tap back the exact number of impulses that had been received. At the same time, Loomis connected his aerial wire to his indicating device.

Dr. Loomis states in one of his notebooks that the exact number of impulses were received back from the distant station, and further that the series of transmissions was repeated a number of times for positive verification.

He also noted that when dark clouds gathered above his 600-foot aerial, too much electricity was collected from the atmosphere. There was so much electricity, in fact, that he had to shut down operations until the clouds moved away and weather conditions became more favorable.

The Time In Between. There are a few more dates for the encyclopedias and the history books. Numerous other similar experiments were conducted over a period of years, and in 1869 Dr. Loomis petitioned Congress for a grant of $50,000 with which to commercialize his wireless system. This petition was shuttled from committee to committee for over a year, and then indefinitely postponed.

In 1873, the year after he received his patent, Dr. Loomis was incorporated by Congress as the Loomis Aerial Telegraph Company, with an authorized capital stock of $200,000 and the privilege of increasing it to $2,000,000 if the interest of the company should require it. The Bill was signed by President Ulysses S. Grant.

Dr. Loomis tried in vain to sell sufficient stock to put his invention to practical commercial use. His inability to do so was undoubtedly due to two national financial panics (so-called "Black Friday's") and the Great Chicago Fire which wiped out the fortunes of bankers in New York, Boston, and Chicago, who were about to finance him.

Nor would most people believe in him. He was so far ahead of his time that

(*Continued on page* 92)

"WATCHDOG" MOBILE MONITOR

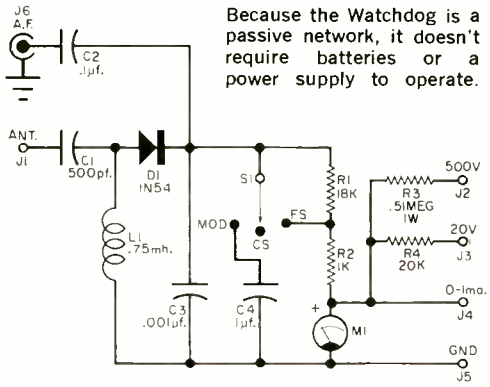
A real watchdog, this miniscule tester functions as a field strength meter, carrier-shift indicator, and modulation checker. The perfect companion piece for your mobile rig, it also measures voltages and current.

By HOWARD BURGESS

THE "WATCHDOG" is a self-contained, unpowered monitor to help you squeeze the last legal milliwatt out of your transmitter. The circuit was designed to enable measurement of relative field strength, determine if carrier shift is taking place, and give an audio check of modulation quality. As a bonus feature, the watchdog can serve as an emergency d.c. voltmeter. If you rush out and buy all new parts, you might be set back about $9, but many—if not most—of the necessary parts are probably right in your junk box.

Construction. Because the greatest value of the *Watchdog* is in mobile operation, the circuit has been squeezed into a 2⅛" x 1⅝" x 4" aluminum box (Premier PMC-1002). A bigger—or even a smaller—aluminum box could be used, depending on the size of the 0-1 ma. meter. A 1¾" square face meter of the imported variety was used. These meters are commonly available and you should have no difficulty in duplicating the exact layout of the parts shown in the accompanying photographs.

Only two parts in the circuit need spe-



Because the Watchdog is a passive network, it doesn't require batteries or a power supply to operate.

PARTS LIST

C1—500-pf. mica capacitor
C2—0.1-μf., 200-volt capacitor
C3—0.001-μf. ceramic disc capacitor
C4—1-μf. low-voltage capacitor
D1—1N54 diode
J1, J2, J3, J4, J5—Phono tip jack
J6—Miniature phone jack
L1—0.75-mh. r.f. choke
M1—0-1 ma. d.c. meter (1¾" square)
R1—18,000-ohm, ½-watt resistor
R2—1000-ohm, ½-watt resistor
R3—0.51-megohm, 1-watt resistor
R4—20,000-ohm, ½-watt resistor
S1—Single-pole, 3-position switch
1—1⅝" x 2⅛" x 4" aluminum box
Misc.—Insulated tie point, wire, solder, etc.

cial attention. One of these is silicon diode *D1*, which must be suitable for detector operation up through 30 mc. Capacitor *C3* must be of the low-leakage variety (Mylar-type) and must have a capacity of at least 1.0 μf. The voltage rating of *C3* is not important.

The components built into the circuit for voltage measurements are not an absolute necessity and may be left out if you wish. No effort was made to alter the meter scale; instead, a conversion table was pasted on the back of the box.

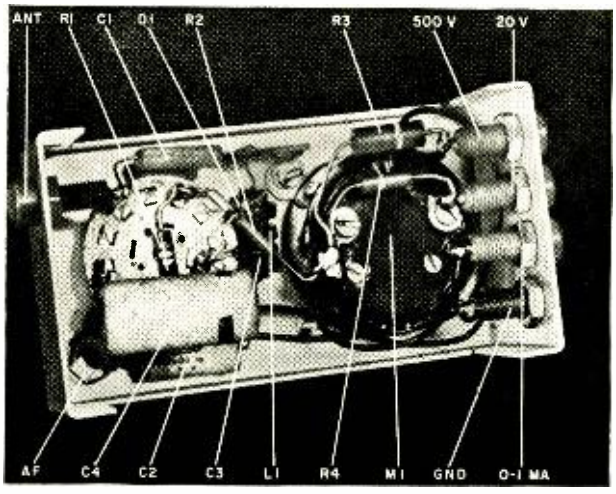
One final construction suggestion: after the case has been drilled and the meter hole cut out—but before the parts are mounted—spray-paint the box to match the interior colors of your car. Spray enamel paints are readily available at all automotive supply stores.

Operation. The *Watchdog* has three operating positions. With switch *S1* in the *FS* position, the watchdog becomes a field strength meter and will indicate the relative carrier level output of your transmitter. A short piece of wire plugged into the antenna jack, *J1*, is more than ample to drive the meter off-scale with even a 5-watt input CB rig. The *Watchdog* requires no tuning and will work on any of the ham bands up through 10 meters. With *S1* in the *FS* position, the *Watchdog* can be used to peak up the pi-network of your transmitter or tune your antenna for maximum efficiency.

When *S1* is in the *CS* position, the "talk power" of your transmitter is being measured, and the circuit has become a linear detector. It will be necessary to close-couple the output of the transmitter to the *Watchdog* by bringing a lead from *J1* close to the transmitter. If the transmitter is well shielded, or very low powered, it may be necessary to place the end of the lead inside the case of the transmitter. The coupling between the *Watchdog* and the transmitter should be arranged so that the meter reads about 0.8 ma. The exact reading is not important—just be sure that the coupling is not too tight to damage the meter.

If the transmitter is properly modulated, the meter should have a slight upward kick for normal voice transmission. The movement of the meter needle should not be more than 10% of the unmodulated (about 0.8 ma.) value. A larger than 10% upward kick indicates overmodulation, and a downward shift says that the transmitter has insufficient drive to the final amplifier.

(*Continued on page* 84)



Parts placement depends on size of meter used. With a very small meter, lay out components as shown.

NOW! A UNIVERSAL CD IGNITION SYSTEM

By MURRAY GELLMAN

Modified unit fits 12- or 6-volt cars, including positive ground ignition

Because of the excellent response to the article on a "Transistorized Capacitor Discharge Ignition System" by Murray Gellman (POPULAR ELECTRONICS, June, 1965), the author has provided construction details to modify the basic 12-volt negative ground circuit for operation with 6- or 12-volt positive, or 6-volt negative ground ignition system. On page 71 you'll find some representative excerpts from our reader mailbag, with the appropriate answers.

THE EDITORS

WHETHER YOU ARE the owner of a foreign car with a 6-volt ignition system, or an American car with a 12-volt positive or negative ground ignition, you can now enjoy the advantages of increased gas mileage, quicker starting even in cold weather, longer life for breaker points and spark plugs, and more power at high speeds with a transistorized capacitor discharge ignition system. You can build the system from scratch for the car you presently own, and modify it later, if you wish, to fit any other car you might buy. The 12-volt negative ground system (and how to build it) was described in the June, 1965, POPULAR ELECTRONICS. The following instructions tell you how to modify the basic design to fit your car.

Six-Volt Negative Ground Ignition. The basic 12-volt transistorized capacitor discharge ignition system can be modi-

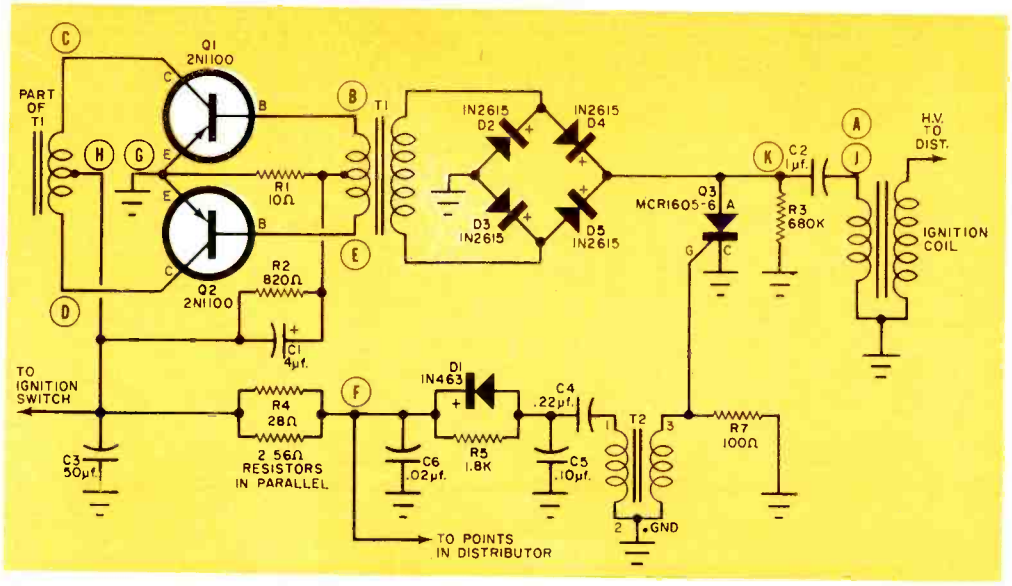
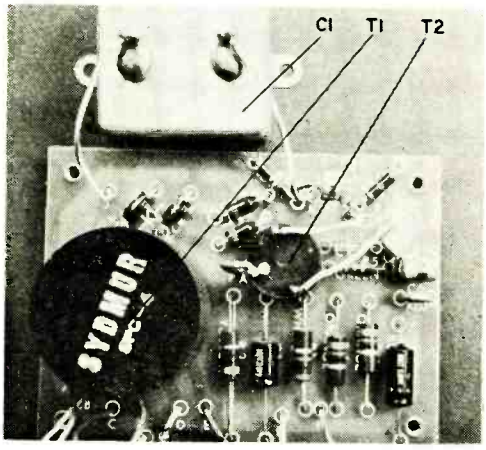


Fig. 1. In this positive ground ignition system, the d.c. resistance of pulse transformer T2 replaces resistor R6 in negative ground circuit. Also, positions of R1 and R2 are reversed, as is polarity of diode D1.



Component side of positive ground circuit board showing parts location and orientation. All components are color-coded, and the appropriate colors marked on the circuit board to facilitate assembly.

fied to operate on six volts by making the following changes: (1) add another 10-ohm resistor in parallel with *R1*; (2) add another 820-ohm resistor in parallel with *R2*; (3) short out *R6* (27 ohms) by connecting a heavy jumper wire across it; and (4) replace the SPC-4 transformer (*T1*) with six-volt transformer SPC-4A (available from SYDMUR, P. O. Box 25A, Midwood Station, Brooklyn, N.Y. for $14.95).

Positive Ground Ignition. To convert the 6- or 12-volt negative ground system to positive ground (see Fig. 1) using the same printed circuit board, the collector center tap must be removed from ground. This can be done by cutting the copper strip above and below the letter *G* with a single-edge razor blade. Hold a clean soldering iron—one having no solder on the tip—on the copper strip next to the letter *G*. Remove the strip using the razor blade. Drill a hole (using a #52

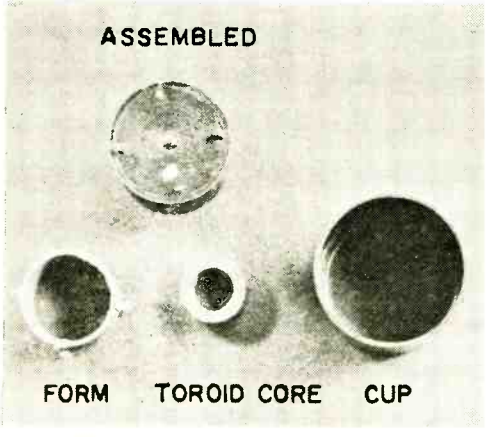


Fig. 2. Fabrication details of positive ground pulse transformer. Shown are a completely assembled unit, the ferrite toroid core, and coil assembly forms.

MORE ABOUT CAPACITOR DISCHARGE IGNITION SYSTEMS

Q Can I substitute a new ignition coil with a 250:1 turns ratio for my 100:1 coil now in the car?

A Yes, but you wouldn't gain enough to merit the extra cost. Your present coil used with a CD system will produce adequate voltage at all engine speeds.

Q Must the "condenser" across the breaker points be removed?

A No. It does no harm—leave it there.

Q I want to wind my own toroid transformer. How about revealing the winding details?

A Sorry, but this transformer is something special and a patent has been "applied for" to cover its construction.

Q What temperatures will the CD system withstand?

A It has been tested at 60 degrees below zero (F) and 200 degrees-plus under the hood.

Q Why no heat sinks on the transistors?

A The transistors are rated to operate above the ambient temperature under the hood, and, besides, the metal box acts as a heat sink.

Q Must I replace the distributor cap and ignition wiring harness?

A You might find it advisable to clean out the cap and check the harness for breaks or worn spots. Replacement is not a prerequisite.

Q Do I change the engine timing?

A No. Just be sure it meets the manufacturer's specs. The CD system will not upset the timing.

Q Must I use a printed circuit board?

A Why not? What have you got against space-age engineering?

Q I used your transformer in another CD circuit that I saw published this year. The transistors gave up the ghost. What happened?

A The toroid in this CD system was designed to match the transistors. Substitution could lead to a lot of headaches.

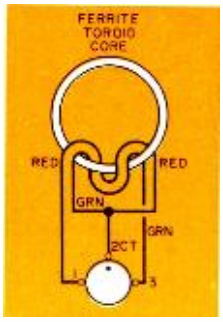


Fig. 3. Pulse transformer is wound on ferrite toroid core with 300 turns of bifilar-wound #40 Polyurethane insulated wire. Wire terminals are soldered to lugs on coil form.

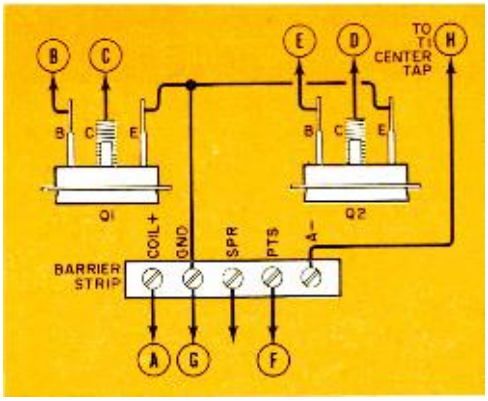


Fig. 4. Wiring details of transistors and barrier strip connections for positive ground ignition system. Terminal marked **A**— connects to ignition switch.

bit) in the copper strip ¼-inch away from the end that was cut, and another hole near the letter *Y* in the ground strip. Then, using a #42 bit, drill a hole above the letter *U* on top of the printed circuit board; this hole is used to mount the pulse transformer (*T2*).

The pulse transformer is made by winding 300 turns of bifilar-wound #40 Polyurethane insulated wire on a ½-inch ferrite toroid core. (See Fig. 2.) After the wire is wound, it should be placed in a form and the leads connected to the lugs (see Fig. 3). The wire leads can be wrapped around the lugs without removing the insulation (the heat melts away the insulation), and then soldered. After this is done, the form is placed in a small cup form and filled with epoxy cement. (SYDMUR will supply the toroid, form, and cup form for $2.50, or the completed pulse transformer for $4.50.)

The pulse transformer reverses the polarity of the incoming negative pulse to the positive pulse that is required at the gate to make the SCR conduct. No attempt should be made to drop the B+ from the power supply in order to supply a positive pulse to the gate. This would

(*Continued on page* 96)

PARTS PROFILES

By DON LANCASTER

COMPONENTS OF THE MONTH

This is the second installment of our new "Parts Profiles" column which is intended to provide you with exciting information about unusual or little known electronic components and devices that are inexpensive, interesting, and useful. These products will usually enable you to build more interesting projects at less cost, in less time, and with improved performance. All items covered are available nationally or from at least one reliable source of supply.

THE EDITORS

PORTABLE 12-VOLT LEAD ACID BATTERY

A sealed, lightweight, completely rechargeable lead acid battery that never requires refilling with either water or electrolyte is now available. You can turn the Exide MF2 upside down and shake it—it won't leak. Weighing eight pounds, this 4″ x 5″ x 6″ six-ampere-hour, 12-volt battery is ideal for camp lights, mine lanterns, portable power tools, and television sets. Combining the light weight and high power normally found only in nickel cadmium cells costing twice as much, the MF2 features an entirely new design that overcomes the problem of *hydrogen formation* inherent in lead acid cells.

Of special significance is a new controlled charging concept. Since most of the hydrogen formed in the ordinary lead acid cell is due to the rapid charging, and consequent heating, of the battery, a special charger designed for the MF2 has overcome this problem by using a power transistor regulator to limit the maximum charging current to less than 0.5 ampere. The regulator automatically adjusts the energy applied to the battery to just the right amount required for the proper charge. To avoid violent destruction, both the charge and discharge rate should not exceed the manufacturer's specifications. For those *aficionados* who would rather build than buy the charger, free data sheets are available from the manufacturer. The cost of the charger is about the same, whether you build or buy—$8.80.

Also available is a smaller battery, the MF1. It is rated at 6 volts and sells for about $5 less than the MF2. However, if you are designing anything that requires more power than dry cells can provide, you will probably be better off with a 12-volt system which is generally preferable because of its compatibility with most automobile batteries and trickle chargers.

The MF2 battery is available from Exide Industrial Marketing Division, The Electric Storage Battery Co., Philadelphia 20, Pa., for $22.30. The companion charger, Model MFC2, Catalog No. 95327, is available from the same source for $8.80.

200-WATT SCR RUNS WITHOUT HEAT SINK

Here's a new low-cost SCR that looks like an oversized TO-5 transistor, mounts either on a printed board or on a special socket, and needs no heat sink. True, SCR's have been around for quite some time, but the new low price and unusually small size of this 1.3-ampere, 200-volt 2N3528 RCA unit

"on" and light the indicator lamp if the SCR being tested is good. The SCR is reset by depressing switch *S2*. If, during a test, the indicator lamp goes on immediately, before *S1* is pressed, the SCR is shorted or is rated at well below 200 PIV. If the indicator fails to go on, the SCR is open. *A word of caution:* Observe proper connections and polarity when connecting the SCR. The SCR case is usually the anode—just the opposite of zeners and power diodes. If an "R" appears at the end of the part number, the case is the cathode.

If you've used SCR's before, you may want to try your hand with the dimmer circuit of Fig. 2. This is a full-range symmetrical dimmer with which you can operate a number of a.c.-d.c. loads not requiring more than 200 watts continuous or 250 watts intermittent operation. The dimmer handles regular incandescent bulbs as well as fluorescent lamps—provided that the fluorescent lamp is always started in the maxi-

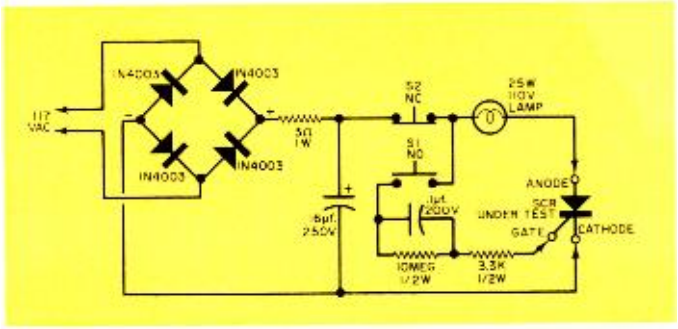


Fig. 1. Circuit of SCR demonstrator/tester suitable for observing operation of SCR's, and for SCR testing. The 117-volt, 25-watt lamp indicates the conduction of SCR under test when S1 is depressed. Switch S2 resets SCR.

makes it ideally suited for the experimenter. If you've never "played" around with SCR's before, start with the simple demonstrator/tester with which you can learn some basic principles of SCR operation, and which can double as an SCR tester. The schematic of this unit is shown in Fig. 1.

When the circuit is used as an SCR tester, depressing *S1* produces a momentary gate pulse that causes the SCR to latch

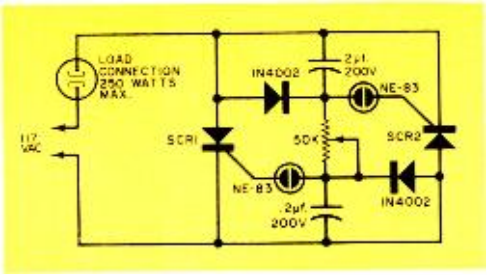


Fig. 2. Full-wave control can vary the speed of most small brush-equipped motors, and dim incandescent and fluorescent lamps not exceeding 200 watts.

mum position of the control, and the control is never varied to its lowest point. You can also use the dimmer to provide precise temperature control of a soldering gun or iron, so long as the maximum power rating of the SCR is not exceeded. The speed of small brush-equipped motors can be controlled with the dimmer, but it cannot be used with induction motors or loads specifically requiring a.c. only.

If you need more power, the RCA 2N3228 is the same SCR but in a bigger package. With a heat sink, you can run up to 5 amperes or 600 watts at 120 volts. The 2N3228 costs a penny less than the 2N3528. (See article entitled "Low-Cost SCR Motor Speed Control," in the December, 1964, issue of POPULAR ELECTRONICS.)

The 2N3528 SCR's are available at RCA semiconductor distributors for $1.63. Also available, free, is RCA Data Sheet 2N3528 8-64 from an RCA distributor or from Radio Corporation of America, Electronic Components and Devices, Harrison, N.J.

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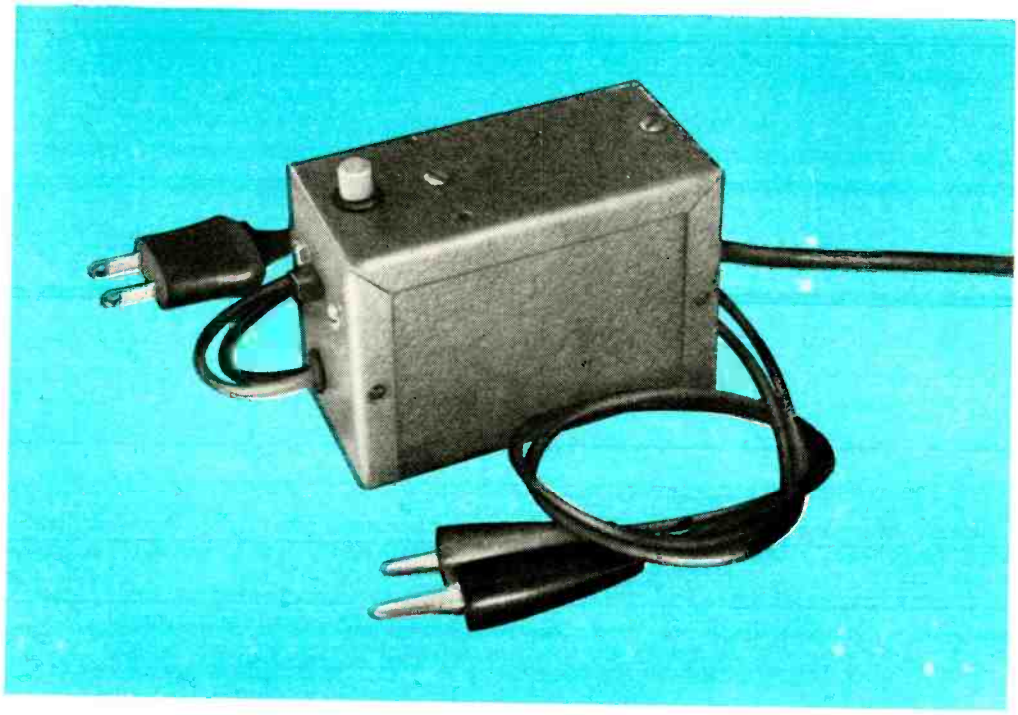


BUILD A FAIL-SAFE TRANSISTOR POWER SUPPLY

By EDWARD NAWRACAJ and FRED FORMAN

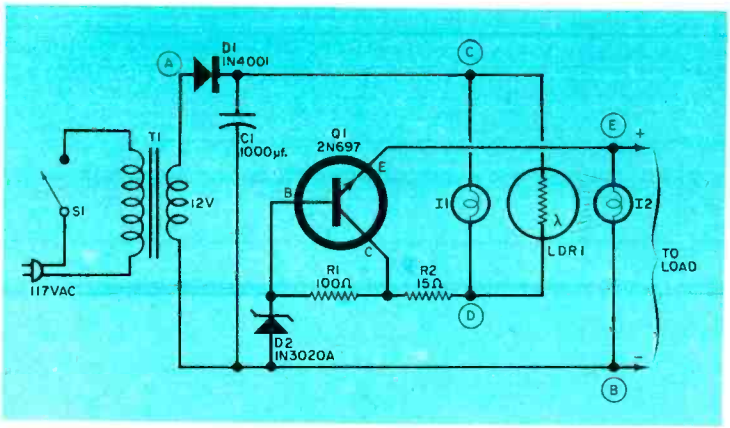
It halts runaway transistors . . . eliminates batteries . . . restores itself instantly . . . and dead shorts can't kill it

BY COMBINING a transistorized series-regulated power supply with a light-dependent resistor (*LDR1*), it is possible to obtain a fail-safe power supply that is regulated, short-proof, and self-restoring. There are no fuses to replace or circuit breakers to reset. Even a dead short across the load line cannot damage this power supply.

Before you say, "So what?" . . . keep in mind that short-circuited, series-regulated power supplies generally cause the base-emitter junction of the series transistor to rupture, and end further use of the supply until the transistor is replaced. This does not happen with the fail-safe supply.

The components selected enable this supply to provide you with a 9-volt output at 0 to 100 milliamperes. It is ideal for transistor projects, radios and other 9-volt battery-operated devices whose current requirements do not exceed 100 ma.

In addition to the fail-safe feature, the supply tends to protect the devices being powered. Suppose you had a defect which could cause a runaway condition in one of your transistor projects . . . chances are that with a battery supply your transistors would draw destructive currents. With the fail-safe supply, maximum current is 100 ma. And, of course, a big advantage is that the power supply serves as a battery eliminator: it works off the 117-volt line.

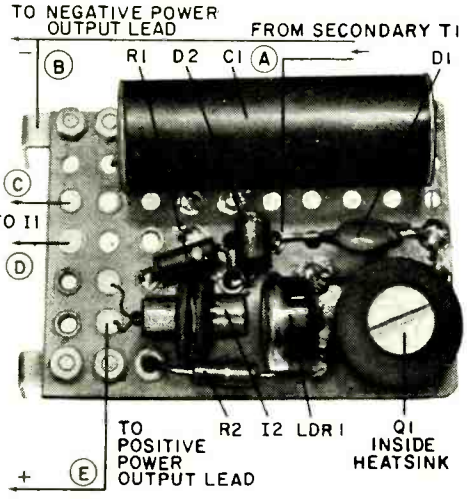


An overload brightens I1 and darkens I2. You see I1 and LDR1 "sees" I2. If you don't remove the overload, the LDR biases Q1 to cut down the output current. Removal of overload darkens I2 and output voltage jumps back to normal.

An overload indicator quickly alerts you to operating conditions. Here's what happens. Under normal load conditions the indicator light *I1*, protruding through the top of the cabinet, is off and the output voltage is correct. Under excessive load conditions, *I1* glows and the output voltage is down sharply. When you remove the excess load, *I1* will stop glowing and the output voltage will come up to normal almost instantly.

How It Works. Diode *D1* rectifies, and *C1* filters the 12-volt a.c. output from *T1*. The main current path can be traced from the bottom of the secondary winding of *T1* through the parallel path of *I2* and the load, through the emitter-collector circuit of *Q1* through *R2*, through the parallel paths of *I1* and *LDR1*, through *D1*, and finally back to *T1*.

A small secondary current path through *R1* and zener diode *D2*, which is dependent upon the total effective resistance of all the other components and the load, establishes and varies *Q1*'s base bias, which in turn varies *Q1*'s dynamic resistance, the main current flow, the respective voltage drops across the various components in the circuit, and the load. Output voltage variations due to larger or smaller loads are compensated for by these changes in bias, so long as



Press-fit I2 into a grommet and position the assembly close to and "facing" LDR1. A wire loop holds the grommet in place. Observe polarity of diodes.

PARTS LIST

C1—1000-μf., 25-volt electrolytic capacitor
D1—50-PIV, 300-ma. diode (1N2482, 1N4001, or 1N2610)
D2—10-volt, 1-watt, 10% zener diode (1N3020A)
I1—18-volt miniature lamp (Sylvania 18ES or equivalent)
I2—10-volt miniature lamp (Sylvania 10ES or equivalent)
LDR1—Light-dependent resistor, 100 footcandle-100 ohms, (Sigma 4H6 or equivalent, available from Newark Electronics Corp.)
Q1—2N697, 2N1420, or 2N1613 transistor
R1—100-ohm, ½-watt resistor
R2—15-ohm, 2-watt resistor
S1—S.p.s.t. slide switch
T1—Filament transformer: primary, 117 volts; secondary, 12 volts, 1 amp. or greater (Stancor P8130 or equivalent)
1—4" x 2¾" x 2" aluminum box
1—1¾" x 2½" perforated circuit board
Misc.—Transistor heat sink for TO-5 transistor housing (Thermalloy 2211 or equivalent), grommets (3), right-angle brackets (2), color cap for I1, line cord, output leads, wire, screws, etc.

the load does not demand more than the maximum 100 ma. of current.

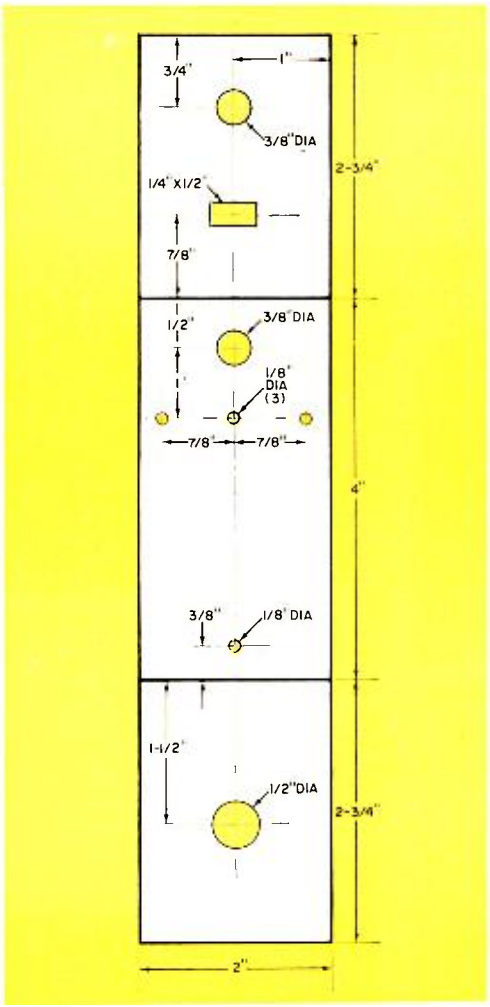
Excessive loads reduce *Q1*'s forward bias to a very low value and sharply limit the amount of main current flow. The resulting drop in voltage across the load extinguishes *I2*. The loss of light on *LDR1* increases its resistance and further limits the main current flow. The voltage drop across *LDR1* is now sufficient to light *I1* and alert you to the overloaded condition.

When the excessive load is removed, current flow through *I2* will increase sufficiently to once again illuminate *LDR1*, reduce *LDR1*'s resistance, and increase *Q1*'s forward bias. This servo-like action has a regenerative characteristic and quickly responds to almost instantaneous load variations.

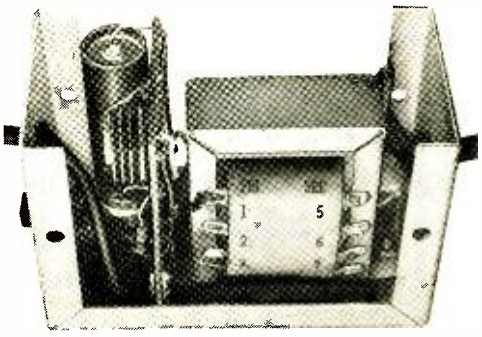
Construction. Prepare a 2″ x 2¾″ x 4″ aluminum box as shown and install the three grommets, switch, transformer and *I1*. Preassemble all the other components on a 1¾″ x 2½″ perforated phenolic or other suitable circuit board. Transistor *Q1* should be enclosed in its heat sink before you mount it on the board.

Pressure-fit *I2* into a grommet and position it close to and "facing" the sensitive side of *LDR1*. Stand the grommet upright on the board and tie it into place with a small length of bare wire.

Now attach two small right-angle brackets to the edge of the board as shown. Because some of the negative leads are connected to one bracket and some to the other, this circuit is completed when the board is fastened to the box. Therefore, you should avoid contact between the box and the positive lead or the load.



Drill holes in the outer portion of the aluminum box as shown. The size of the rectangular opening can be modified to accommodate any s.p.s.t. switch.


Preassemble the circuit board and install after S1, I1, and T1 (in that order) are mounted. Connect all leads and check the circuit before closing box.

Install the subassembly in the box, and hook up the transformer, line cord, and output leads. Double-check to see that all wire and components are properly arranged so that there are no unwanted short circuits.

You can now plug in the unit and check its operation. Touch the output leads together and watch the action. Do the same with the leads apart. If you followed instructions, the action will be as described. —30—

ON THE CITIZENS BAND

By **MATT SPINELLO,** KHC2060, CB Editor

A TORNADO accompanied by heavy rain and hail slashed into the mountains of Colorado last June. As rivers began to rise and a dam broke along the Arkansas River, portions of Southeastern Colorado were alerted to expect high winds and flooding. There was flooding also from the Fountain River, and since both rivers meet in Pueblo, Colorado, the inhabitants of that city were presented with a highly dangerous situation.

COLORADO CB'ERS REACT

At 3:30 p.m., on June 17, the Pueblo Citizens Band Radio Club was called upon to put its REACT team into action. Their first assignment was to warn the families of Pueblo to evacuate and head for the shelters that had been prepared for them. The REACT team quickly set up a chain of communications relaying warnings to La Junta and Lamar, Colorado (100 miles from Pueblo), and an additional link to Fountain, Colorado, where the flood waters had started their race to Pueblo. This enabled CB'ers from Fountain to initiate an "early warning system" on the crest waters to come.

The REACT CB'ers also established a communications system at Red Cross headquarters and stationed CB mobiles at all of the city's bridges in order to warn motorists. Some of the bridges had cracked under the strain of high waters; others were being flooded. CB'ers standing by at each point relayed information to other monitoring units, enabling all to advise motorists which routes not to use and which were passable.

The crest of the flood reached Pueblo just before 11 p.m., destroying several homes and leaving hundreds homeless. Near midnight the CB'ers rushed a boat to pick up children who had been cut off by the flood; and rescues and emergency assists continued throughout the night. Additional communications were set up to back up amateur radio systems; and on the morning of the 18th the Civil Defense director of Pueblo County contacted CB control asking for assistance due to a loss of communications. The REACT'ers quickly created a relay link from Pueblo to Colorado Springs (40 miles north) to pass on information and inquiries regarding missing persons.

The emergency extended into the afternoon hours of the 18th, by which time many

As the aftermath of a tornado in the mountainous regions of Colorado, southern cities like Pueblo were plagued by flooding, high winds, and heavy rain. Hundreds were left homeless, dams and bridges were broken, and debris was scattered for miles.

The Pueblo CB Radio Club's REACT team provided several vital communications links during the flood, as well as assisting in clean-up operations. Club president Hank Rail shook hands with the vice president, Al Phelps, after the emergency was over.

of the CB'ers had racked up some 25 volunteer hours without sleep or a break. On the morning of the 19th, the same CB'ers were involved with the clean-up process. They also assisted in relocating families and reporting on damage caused by the flood.

Congratulations to the Pueblo Citizens Band Radio Club and its REACT team.

Majority Equals "Nine." Several qualified sources of information have given strong indication that the long-disputed National Calling Channel situation has now come to rest where POPULAR ELECTRONICS first proposed it might in 1961. One of the obvious drawbacks to some in switching to channel 9 was that CB'ers had grown used to placing their calls on channels that became popular in their own areas before word spread across-country that there should be a National Calling/Monitoring/Emergency Channel. Moreover, some areas were so crowded with traffic on channels 7, 9, 11 and 15 that many CB'ers were reluctant to give up their quiet, cozy corner on channels 2 or 22, for instance.

While acceptance of channel 9 was nearly seven years in coming, the idea never really got lost in the shuffle. But it did have its growing pains! The first promoters of channel 9 date back as far as 1959, most of them organized CB clubs whose single-sheet bulletins of yesteryear have grown into the leading CB newspapers passed around the country today. The monthly pleas by these publications for members to accept channel 9, or at least come to an agreement on which channel should be adopted, have now mostly subsided. For nearly a year reports have substantially verified the switch to 9, some of them prompted by an order issued to more than 600 REACT teams last September, advising that channel 9 would be a required 24-hour-a-day National Emergency Channel as of January 1, 1965.

REACT Captain Jack Forbing of 11-Meter Communications Squad, Inc., is shown monitoring channel 9.

And, finally, the introduction of a Highway Emergency Locating Plan (HELP) by the Automobile Manufacturers Association appears to have cinched the majority nod to channel 9 for a National Calling and Emergency Channel. In its proposal to blanket the country's highways with emergency communications monitoring, primarily to aid motorists, the AMA accepted channel 9 for such purposes. The latest word received indicates that a steady stream of individuals and service-minded CB clubs have requested information on joining HELP, with additional hundreds already assigned to the operation.

Club News. The ultra-neat, well-equipped shack shown on this page is commanded by REACT Captain Jack Forbing (CB'er, KHC2683; Amateur, K9LSB; and Short-Wave Listener, WPE9AMH). Jack heads the 11-Meter Communications Squad, Inc., Fort Wayne, Ind., and monitors channel 9 on a 24-hour basis. Other officers of the squad include Dee Northcutt, KLJ2814, first lieutenant; Carl Snyder, KHD7314, second lieutenant; and Denver Druesedow, KLJ1176, treasurer.

The Citizens Communications Club of Savannah, Ga., is promoting a new slogan: "The Big 'M' is here!" Their reference is to the "Savannah Monitor," a monitoring center intended to handle emergency communications within 100 miles of Savannah. Located on the 14th floor of the Drayton Towers, the center is licensed under the assigned call KKN2913. In addition to monitoring for tourists in need, it will operate in conjunction with fire and police departments and will tie in with Civil Defense when and where needed. The Monitor's christening ceremony was covered by newspaper, radio, and television.

The Carrier Breakers, Livonia, Mich., are now geared to have up to 100 radio-equipped cars on emergency assignments over a 135-square-mile area within six minutes after notification. According to Jack D. Keehn, president, such short notice is possible because the 150 members are all serious, public-spirited users of Citizens Band radio. William Gourieux, chairman of the emergency committee, explains that all search or rescue operations can be controlled from his base, covering the areas of Livonia, Redford Township, Inkster, Garden City, Dearborn Heights, and portions of Southfield and Detroit. This spread has been divided into four areas with teams of four vehicles assigned to square-mile areas. The club also has a CB radio-equipped airplane for use in search operations.

The Queen City 5-Watters Radio Club, in

(*Continued on page* 100)

SHORT-WAVE LISTENING

By **HANK BENNETT,** W2PNA/WPE2FT
Short-Wave Editor

WRUL SCORES A RADIO "FIRST"

STATION WRUL, *Radio New York Worldwide*'s international outlet, scored a "first" recently when it was invited to beam broadcasts to Germany and France via the *Early Bird* satellite by RCA Communications, Inc. It became the first radio station in America to participate in an international broadcast experiment.

The WRUL program to Germany used the facilities of *Hessischer Rundfunk* whose headquarters are in Frankfurt. As part of the experiment, the Frankfurt network returned the identical broadcast, also via the *Early Bird,* to the receiver station in Andover, Maine, for WRUL. A comparison is being made of the technical quality of the broadcast transmitted against the technical quality of the broadcast received. The WRUL program to Paris, arranged with the cooperation of *Radiodiffusion Francaise,* was handled in the same way.

The experiment also illustrated the receivability of diversified content. There was a live organ recital on the famed Mormon Tabernacle organ in Salt Lake City by Alexander Schreiner, and the Mormon Tabernacle Choir which performed in the first *Telstar* broadcast was heard. In the French broadcast, a portion of the U.N. Security Council debate on the Dominican Republic featured an address by Roger Seydoux, French Ambassador to the United Nations.

"Hanoi Hannah." During World War II, many American servicemen fighting in Europe and the South Pacific were well acquainted with the sugar-and-honey voices of "Axis Sally" and "Tokyo Rose." During the Korean conflict, another girl decided to make herself known to the lonesome GI's via the air waves as "Seoul City Sue." The two latest are "Hanoi Hannah" and "Hanoi Hattie," who are trying in vain to convince American forces to go home—from Viet Nam. Evidently they are young North Vietnamese girls. Has anyone actually heard them on the air?

Australian Time Station. In the April issue we listed a new Australian time station with the call VMG. The correct call-sign is VNG. Also, we have since learned that the station operates from Lyndhurst in Victoria on 5425 and 7515 kc. at 0715-1700 and on 7515 and 12,005 kc. at 1715-0700.

Mike Byers, WPE4IKW, Shelby, N.C., (left), has an impressive total of stations logged—8212. His primary receiver is a Lafayette KT-135, but he covers 10 meters with a GI-025 Command receiver.

Glenn Wyant of St. Catharines, Ontario, Canada, has a record of 31 countries verified out of 86 heard—to date. Featured in Glenn's listening post is a Hallicrafters SW-500 and a R1155A war surplus receiver, plus lots and lots of QSL cards.

English-Language Newscasts to North America

All of the stations below specifically beam English-language newcasts to the U.S.A. The times may vary a few minutes from day to day.

COUNTRY	STATION	FREQUENCY *(kc.)*	TIMES *(EST)*
Argentina	Buenos Aires	11,780, 9690, 6090	2200, 0100 (Mon.-Fri.)
Australia	Melbourne	17,840, 15,220	2030, 2130, 2230
		9580	0745
Bulgaria	Sofia	9700	1900, 2300
Canada	Montreal	15, 190, 11,725, 9625	1800 (E. Coast)
		9625, 5970	0230 (W. Coast)
Congo (East)	Leopoldville	11,755	1630
Congo (West)	Brazzaville	15,370, 11,930	1430
Czechoslovakia	Prague	11,990, 9795, 7345, 7120, 5930	2000, 2230
Denmark	Copenhagen	15,165	0730
		9520	2100
West Germany	Cologne	11,925, 11,795, 9735	1010
		9640, 6075	2040
		9735, 6145	0000
Hungary	Budapest	9833, 7215, 6234	1930, 2030, 2200, 2330
Italy	Rome	11,905, 9630	1930, 2205
Japan	Tokyo	15,135, 11,780	1900
Jordan	Amman	9560	2000
Lebanon	Beirut	9710	2130
Netherlands	Hilversum	15,425, 11,730	1100 (Tues., Fri.)
		9715, 6085	1535 (Tues., Fri.)
Netherlands Antilles	Bonaire	9590	2030
Portugal	Lisbon	6185, 6025	2100, 2245
Romania	Bucharest	11,940, 11,810, 9590, 9510, 6190, 6150	2330, 2200, 2030
Spain	Madrid	11,715, 9615, 6140	2200, 2100, 2000
Sweden	Stockholm	15,195	0900
		11,805	2215, 2045
Switzerland	Berne	9665, 9535, 6120	2015
		9665, 9535	2315
Turkey	Ankara	15,165	1700
United Kingdom	London	15,300, 11,860	1100
		9610, 6195	1700, 1800, 1900, 2100
U.S.S.R.	Moscow	15,180, 15,140, 9730, 9660, 9640, 9630, 9570, 9540, 7360, 7330, 7320, 7310, 7290, 7250, 7240, 7230, 7200, 7150, 7130, 6070 (all channels not in use at any one time)	1730, 1900, 2000, 2100, 2300, 0045
Vatican City	Vatican City	9645, 7250, 5985	1950

The signals are a series of pips sent out at one-second intervals, with the minutes marked by the elimination of the 59th pip. A recorded voice identifies the station during the first minute of each hour. The equipment is housed in the Post Office Department's speaking clock installation at the City West Telephone Exchange in Melbourne and is connected to Lyndhurst by landline. Scattered reports from various points indicate that this station is being heard in North America.

KYW Returns to Philadelphia. The transfer of KYW, Cleveland, Ohio (1100 kc.) back to Philadelphia, Pa. (1060 kc.) caught numerous medium-wave DX'ers without a verification from the Ohio location. Your Short-Wave Editor, too, was surprised while vacationing in Michigan to hear the "home town" station (WRCV) sign as KYW. Although we knew the move was coming, we had forgotten the actual transfer date.

Station KYW, which originally opened in Chicago, Ill., is now one of the East Coast's 50,000-watt stations. The Cleveland, Ohio, area is currently being served by WKYC, reportedly the most similar call-sign available.

(*Continued on page* 110)

AMATEUR RADIO

By **HERB S. BRIER,** W9EGQ
Amateur Radio Editor

ADDING AUDIO PUNCH TO PHONE TRANSMITTERS

ANYONE who has observed the signal from a conventional AM or SSB transmitter on an oscilloscope knows that if the microphone gain control is adjusted so that the highest modulation peaks just reach 100% modulation on AM, or are just below the flat-topping point on SSB, the average modulation level is quite low. Unfortunately, the weaker voice sounds contain much of the spoken intelligence, but if the gain control is turned up to make them stronger, the stronger peaks overdrive the transmitter audio system. This, in turn, generates bad distortion and a broad signal that causes severe interference to stations operating on adjacent frequencies. Even worse, cranking up the gain control doesn't really improve the readability of the transmitted signal.

What is needed is an amplifier that will amplify the weaker speech components more than the strong ones without introducing objectionable distortion in the signal. One way of attacking the problem is with an audio compression amplifier. Such units amplify weak signals below a certain threshold level fully; signals above this level actuate a fast-acting automatic gain control system to reduce their peak amplitudes drastically.

In theory, a well-designed compression amplifier can boost the weaker speech components as much as 30 db more than the stronger peaks before the distortion becomes objectionable. But how well does theory translate into practice? Testing it out with a Galaxy audio compression amplifier, we obtained the following results.

When the compression amplifier was connected between the microphone and the microphone input jack of an SSB transmitter like the Hallicrafters HT-37 or the Heathkit "Apache"/SB-10 combination (neither of which contain built-in compression circuits), turning on the amplifier had about the same effect on signal reports as turning on a high-power linear amplifier. Both local and DX stations invariably reported that the signal sounded one to one-and-a-half "S" units stronger with the compressor amplifier turned on. (In all checks, the output of the transmitter was monitored with a cathode-ray oscilloscope to insure that the peak output levels were exactly the same with the

AMATEUR STATION OF THE MONTH

Jim Peterson, WNØLVM, and his daughter, Heide, WNØLVN, of Aurora, Colo., are graduates of the Denver Radio Club Novice Class. Between them they have worked 19 states and Canada on the 80-, 40- and 15-meter Novice bands using a Johnson "Viking II" transmitter and a home-built one, and two receivers—a Gonset "Sixty-Three" and a Hallicrafters S-77. Jim and Heide will receive a one-year subscription for submitting this winner in our Amateur Station of the Month contest. If you would like to enter the contest, send us a clear picture of your station, preferably with you at the controls, accompanied by some details on your ham career and on the equipment you use. Even if your photo doesn't win, we will publish it if space permits. Entries go to the Amateur Photo Contest, c/o Herb S. Brier, W9EGQ, Amateur Radio Editor, Box 678, Gary, Ind. 46401.

Dr. Morris Rosenberg, WB2MOJ, Mt. Vernon, N.Y., took 41 years to become a ham. His son, WN2NOW, who uses the Heathkit DX-60 on the right, required a similar number of days. See "News and Views."

Mike Kersenbrock, WH6FON, of Kaneohe, Hawaii, (below), hasn't found being over 2000 miles from the next state much of a handicap. He made over 150 contacts in his first few months on the air.

compressor amplifier in or out of the circuit.)

When the compressor amplifier was used with an SSB transmitter containing a built-in a.l.c. circuit—as all currently available SSB transmitters and transceivers do—the results were less spectacular: the average listener reported about half an "S" unit improvement, and about one in four could hear no improvement at all.

The compressor amplifier works equally well on conventional AM transmitters if their audio systems are capable of handling the increased average power contained in a compressed signal. In simplest terms, if the transmitter is capable of 100% modulation without strain and it does not contain a built-in speech compressor, a good external compression amplifier will add audio punch to its signal. But if the audio system is skimpy to begin with, the compression amplifier simply makes the audio sound as if you had a hot potato in your mouth.

The Galaxy audio compression amplifier would probably be classified as a "deluxe" unit, because it contains five transistors and six diodes in a fairly elaborate circuit and has a $24.95 price tag, less the internal 9-volt battery and the optional a.c. power supply. The unit is available from Galaxy Electronics, 10 S. 35th St., Council Bluffs, Iowa 51504, and from many amateur radio distributors.

A number of manufacturers offer simpler compression amplifiers usually containing a pair of transistors and a couple of diodes and selling in the $15 price bracket. These simpler units, such as the WRL CA-27, also improve the effective power of phone signals but not as dramatically as the more elaborate unit.

Getting Help in Code and Theory. Every now and then, we receive a complaint that old-timers refuse to help newcomers. In fact, I have a letter before me now from a brand-new General, who claims that none of the local hams would help him; so he got his Novice and General licenses in less than a year on his own. Obviously, the writer didn't need personal help. But the help *was available* to him for the asking, because his local amateur radio club conducts a number of amateur code and theory classes a year. Of course, not all hams are willing to spend the time to help newcomers for a number of reasons, but it is very seldom that a prospective ham who needs help cannot get it by asking for it courteously.

The first step is to check the list of ham clubs offering help to prospective amateurs in the current issue of POPULAR ELECTRONICS' *Communications Handbook*. If there isn't any club near you, visit the local radio and electronics emporiums, etc., until you get the name of a nearby ham. Then call him on the telephone at a reasonable hour of the day, introduce yourself, and ask if you can make an appointment to meet him, see his station, and talk over your problems. If the first ham you contact can't help you, he will undoubtedly be able to refer you to someone who *can* give you a hand.

When you get an appointment, be there on time, and be neatly dressed—not looking as if you had just finished greasing a locomotive. And don't bring a bunch of uninvited friends with you. Remember you are visiting a man in his home, and the impression you make on him (and his wife if he is married) will probably determine whether you are ever invited back. And when you get in the ham shack, keep your hands off the dials until you are invited to tune the re-

(*Continued on page* 102)

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CIRCLE NO. 40 ON READER SERVICE PAGE

MOBILE MONITOR

(*Continued from page* 68)

The last switch position is for a modulation check (*MOD*). The *Watchdog* circuit has now become an r.f. voltmeter with a time constant long enough to show audio modulation peaks. The coupling between the *Watchdog* and the transmitter must be adjusted to give a meter reading of about 0.5 ma. (unmodulated carrier). On high level modulation peaks, the meter reading may almost double; and on positive modulation, the peaks should reach the 100% (1.0-ma. point).

The operator can check his own modulation quality by plugging a headset into the *A.F.* jack on the front panel of the *Watchdog*. Turn *S1* to the *CS* position, and what you will hear in the headset will be a perfect reproduction of the signal being transmitted. At your home station, the output of this jack can be used to feed an oscilloscope to look for residual a.c. hum, parasitics, or distortion.

Emergency Voltmeter. In an emergency, the *Watchdog* may be used as a voltmeter by connecting test leads to the tip jacks mounted in one end of the box. In series with the tip jacks are resistors *R3* and *R4*, providing a 1000 ohms-per-volt range at two different voltage scales. With the test leads connected to tip jacks *J3* and *J5*, the meter scale can be converted into a range of 0-20 volts. With the leads between tip jacks *J4* and *J5*, the meter scale can be converted to a range of 0-500 volts. In addition, tip jacks *J6* and *J5* can be used to connect the 0-1 ma. meter to any transmitter that has built-in current multipliers and provisions for tuning up with a low-range milliamp meter. —30—

VOLTAGE CONVERSION TABLE

Meter Reading (ma.)	20-Volt Scale (volts)	500-Volt Scale (volts)
0.2	4	100
0.4	8	200
0.6	12	300
0.8	16	400
1.0	20	500

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CIRCLE NO. 18 ON READER SERVICE PAGE

Look What's

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(Assembled GWW-14, $124.95)

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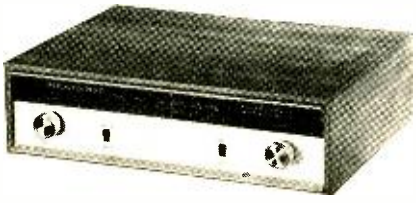

Kit AJ-14
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(less cabinet)

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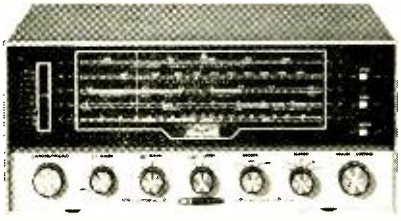
New Deluxe Shortwave Radio



Kit GR-54
$84.95

Compare it to sets costing $150 and more! 5 bands cover 200-400 kc, AM, and 2-30 mc. Tuned RF stage, crystal filter for greater selectivity, 2 detectors for AM and SSB, tuning meter, bandspread tuning, code practice monitor, automatic noise limiter, automatic volume control, antenna trimmer, built-in 4" x 6" speaker, headphone jack, gray metal cabinet, and free SWL antenna. Assemble in 15 hours. 25 lbs.

New 6-Meter SSB Ham Transceiver

Kit SB-110
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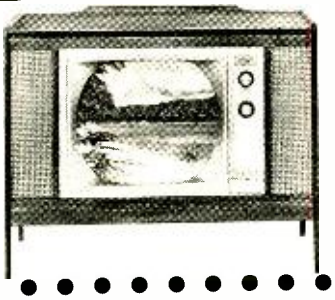

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CIRCLE NO. 18 ON READER SERVICE PAGE

TESTER / REJUVENATOR

(*Continued from page* 45)

The neon lamp is supported by its terminals.

The on-off switch, panel lamp, and grid-bias potentiometer are mounted through the front panel and the chassis, and serve to hold the panel and chassis together. The filament and function switch are mounted on the front panel and are held securely in place with lock washers.

OPERATING INSTRUCTIONS

Open and Short Tests

(1) Select proper filament voltage.

(2) Connect the socket to the CRT.

(3) Turn the power switch to *ON* and allow approximately 30 seconds for the tube to warm up.

(4) Turn the selector switch to *HTR*. If the heater is not shorted to the cathode, the neon lamp (*I2*) in the center of the tester will not glow. If it is shorted, both sides of the lamp will glow.

(5) Turn the selector switch to *GRID 1*. If grid 1 is not shorted to the cathode,

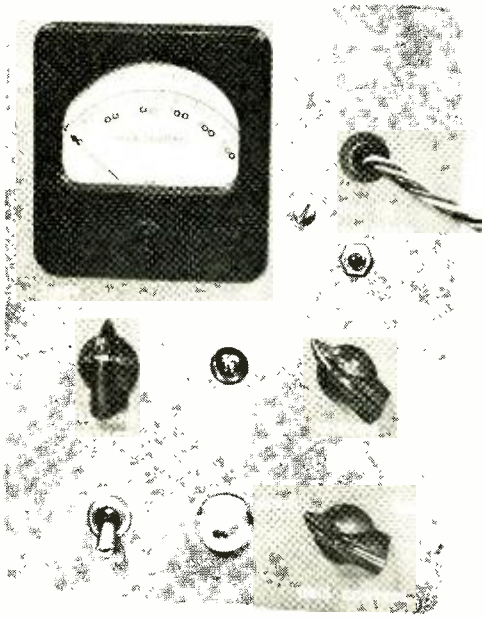

Fig. 9. Test cable can be fed through the panel, or plugged into a front-mounted octal socket. Picture tube socket adapters can be added as needed.

one side of the neon bulb will glow. If it is shorted, both sides of the lamp will glow. If it is open, or if cathode emission is extremely low, the lamp will not glow.

(6) Turn the selector switch to *GRID 2*. If grid 2 is normal, one side of the neon lamp will glow. If this grid is shorted to the cathode, both sides of the lamp will glow. If grid 2 is open, or if cathode emission is too low, the lamp will not glow.

Emission Test

(7) Turn the selector switch to *EMISSION*. The meter should indicate approximately 300 microamperes or more for a good tube; however, a tube that conducts 100 microamperes or more will probably produce an acceptable picture. (Some of the newer type picture tubes designed to use higher G_2 voltages may indicate "weak" when they actually are not.)

Grid Control Test

(8) Turn the selector to *CUT-OFF*. With the *GRID CONTROL* knob turned fully counterclockwise, the meter should indicate the same value as it did on the emission check. Now advance the control clockwise until the meter registers no current (or an extremely small current). If the potentiometer has not advanced beyond the vertical mark, the tube cutoff characteristic is acceptable. In most cases, the tube will cut off well below this mark.

Rejuvenation

(9) If the emission check indicated a weak tube, turn the selector switch to *REJ*. Depress the *REJUVENATE* button for approximately ½ second and release, then turn the *SELECTOR* switch to *EMISSION*. If the tube now appears normal, remove the tester. If the tube still appears weak, increase the filament voltage to the next higher voltage and rejuvenate again. Reduce the filament voltage to its normal value, wait about a minute, and retest. If it does not now appear usable, increase the filament voltage one step higher and rejuvenate again. If this all-out try doesn't help, check emission with a higher than normal filament voltage. If this works, but rejuvenation doesn't, install a picture tube brightener. —30—

INVENTOR OF WIRELESS

(*Continued from page 66*)

even his wife called him crazy, because he neglected his profession as a dentist and spent his money on wireless experiments. He died in 1886 at the age of 60.

Recognition. Efforts are now under way to see that Dr. Loomis receives official recognition for his work in the field of wireless telegraphy. A joint resolution was introduced in the 88th Congress by Congressman Smith of Virginia, but not passed. It is hoped that by the time this article is in print, the resolution will have been reintroduced in the present Congress.

88TH CONGRESS
2D SESSION

H. J. RES. 1181

IN THE HOUSE OF REPRESENTATIVES

SEPTEMBER 21, 1964

Mr. SMITH of Virginia introduced the following joint resolution; which was referred to the Committee on the Judiciary

JOINT RESOLUTION

Memorializing Doctor Mahlon Loomis.

Whereas Doctor Mahlon Loomis, an American dentist and inventor, in 1864 invented the first wireless telegraph communication system and subsequently demonstrated it in Bluemont, Virginia, in 1866; and

Whereas Dr. Loomis obtained a United States patent on his wireless system in 1872, the first patent ever issued on a system of wireless signaling; and

Whereas Doctor Loomis' invention and demonstration of wireless communication preceded by several years the developmental work of others in the field of radio; and

Whereas, during his lifetime, Doctor Loomis did not receive credit for and recognition of his outstanding achievement which was the forerunner of radio communication as it is known today; Now, therefore, be it

Resolved by the House of Representatives (the Senate concurring), That the Congress hereby recognizes, on behalf of the American people, the foresight, ingenuity, and outstanding achievement of Doctor Mahlon Loomis in being the first person to invent and demonstrate a system of wireless communication.

The author has done considerable research on the life and work of Dr. Loomis, and has co-authored a book entitled "Mahlon Loomis, Birth of Wireless" with George M. Applegate. This book is as yet unpublished. All readers who would be interested in obtaining a copy of it are requested to write to: Thomas Appleby, Cdr. USNR. Retired, 5415 Connecticut Ave., N.W., Washington 15, D.C. -30-

TELEMETRY

(*Continued from page 57*)

Also, because a keyer is not required, the second keying switch is not required in PAM. When greater data capacity and switching rates are required, PAM is to be preferred over PDM.

Frequency Modulated/Frequency Modulation (FM/FM). FM/FM is one of the most popular modulation techniques in use today. As the name implies, an FM subcarrier is used to modulate an FM carrier.

For example, suppose we have an FM transmitter whose operating frequency is 250 mc. Using FM/FM telemetering, we are allowed by IRIG to deviate the transmitter carrier ± 125 kc. from the operating or center frequency. This gives a total deviation or bandpass of 250 kc. When the modulating signal is applied to the transmitter's modulator, it shifts the transmitter carrier frequency above and below the center frequency by a maximum of 125 kc. Therefore, the ground station receiver must have a bandwidth of 250 kc. or greater.

With the preceding explanation in mind, let us see how a 3-kc. audio carrier is used to modulate the 250-mc. carrier. To avoid confusion, we will refer to the 250-mc. carrier as the r.f. carrier, and to the audio carrier as the subcarrier.

Of the many types of subcarrier oscillators that are commercially available, the most popular is the voltage-controlled oscillator, commonly called VCO. In the VCO oscillator, any change in voltage, resistance, or inductance shifts the oscillator frequency proportionally above and below its center frequency.

This, in effect, is the FM principle. Thus, using a subcarrier whose frequency varies with the modulating data voltage and an r.f. carrier whose frequency also varies with the modulating subcarrier voltage produces the FM/FM method.

Pulse Code Modulation (PCM). PCM is relatively new to telemetry. This system of data transmission uses digital techniques to represent the quantity being measured. For example, a pulse referred to as a "bit" is used to represent a digit. The number of bits required to form a "word" (data) is usually determined by the accuracy requirements of the measurements to be taken.

For example, if we assign the numbers (bits) 8—4—2—1, in that order, to form

This compact tape recorder, produced by the Raymond Engineering Laboratory, Inc. (Middletown, Conn.), records and reproduces FM and digital telemetry data through all phases of rocket flight including ignition, powered boost, stage separation, and re-entry. The unit also provides time displacement of data for playback in flight during optimum telemetry periods, as well as for readback in the laboratory and on launch pad for final checkout.

a four-bit word (8+4+2+1), a combination of 15 can be derived. If no bits appear within a word, the quantity being measured is zero. The accuracy of a four-bit system can be determined by reducing the fraction 1/15 to a percentage. Thus, 1/15 = 0.066 or 6.6%. By increasing the bit number from four to

ten, the number of possible combinations will be increased to 1023. By reduction, this gives an accuracy of $1/1023 = 0.1\%$. From these examples, it can be seen that there is a definite advantage in using a higher number of bits per word. Actually, PCM is approximately ten times more accurate than all other systems discussed.

PCM, like PAM, also has its frame pulse. The structure of the PCM differs from that of PAM in that the PCM frame pulse is a specially coded word. The number of data words per frame is governed by several factors: the maximum bit-rate of the system, as determined by the r.f. bandwidth of the receiver in the ground station (receiver bandwidths of more than three times the bit rate are required to faithfully reproduce the PCM serial); the accuracy requirements of the measurements taken; the information capacity or number of different measurements required; and other factors.

Due to its digital nature, the PCM serial can be fed directly to an electronic computer for automatic data reduction. Where computers are not immediately available, the magnetic tape from the ground station tape recorder can be taken later to a computer center for data reduction.

What Lies Ahead for Telemetry? We have discussed some of the most popular telemetry systems that are in use today. There are still other systems—some outdated, while still others are in experimental stages of development at this time.

We can safely say that at some time in the not-too-distant future someone, somewhere, will develop a means of transmitting vital data from unmanned exploratory submarines that will be investigating a part of our earth we know as little about as we know of outer space. Through undersea explorations we may someday determine whether or not the earth rotated around a different axis in prehistoric times.

There are many other research fields that need persuing, and a great deal of information is desperately needed in order to improve our way of life. Whatever the future research projects may be, it is certain that telemetry will play a vital part in them. —30—

IGNITION SYSTEM

(*Continued from page 71*)

result in regeneration of the SCR due to large current feedback.

Wiring the P-C Board. With the pulse transformer completed, proceed with the wiring of the printed circuit board. The only changes that are made to the negative ground circuit are as follows. In order for the transistors (*Q1* and *Q2*) to be properly forward-biased, it is necessary for resistors *R1* (10 ohms) and *R2* (820 ohms) to shift positions; *R1* replaces *R2* and *R2* replaces *R1*. Capacitors *C1* (4 μf.) and *C3* (50 μf.) are reversed in polarity so that the plus (+) side of the capacitors are grounded. Diode *D1* (1N463) is reversed so that the anode goes to the plus (+) mark on the printed circuit board. The 27-ohm gate current limiting resistor (*R6*) is not required since the d.c. resistance of *T2* takes its place.

Cut two 1½" long pieces of heavy wire. Insert the end of one wire in the hole vacated by *R6*, and the end of the other wire in the remaining hole. Now, connect the free ends of the wires respectively to terminals 1 and 3 of transformer *T2*. The center lug (white dot) on the pulse transformer goes to the hole in the ground strip (near the letter *Y*).

Installation. The wired printed circuit board and capacitor *C2* (1 μf.) are placed in the cabinet. Wires from *G* as well as from the emitters go to ground on the barrier strip. The wires coming from *H* and the collector center tap go to *A*— on the barrier strip, the *A* wire to coil plus (+) and *F* wire to *PTS* on the barrier strip. The wires coming from *B*, *C*, *D*, *E* and the transistors are connected as shown in Fig. 4.

Other items available from SYDMUR are a complete kit for negative ground ignition, including a specially made cabinet ($44.50), and a completely wired system ($60.00). A kit for positive ground ignition can be obtained for $47.50. —30—

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CIRCLE NO. 28 ON READER SERVICE PAGE

PARTS PROFILES

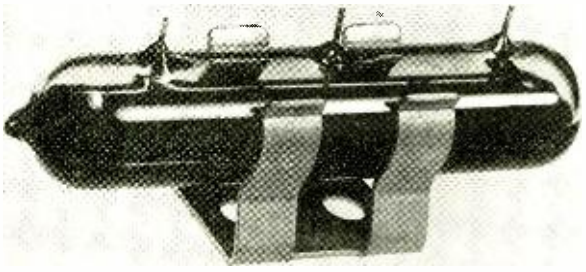
(*Continued from page* 73)

ELECTRONIC LEVEL INDICATOR

Here's an electronic component that's always on the level. If it isn't, it promptly "tells" you so. This new and unusual device, measuring a little over two inches, is the Hamlin EP-10 gravity sensing electronic potentiometer that can be used in electronic levels, percent-of-grade meters, inclinometers, accelerometers, and other balancing devices.

A typical circuit application is shown in Fig. 3. The EP-10 consists of a glass tube half-filled with a conducting liquid. In the tube are three electrodes as shown. When the tube is level, the resistance between either end electrode and the middle electrode is the same. If the tube tilts, more liquid makes contact with one of the end electrodes, and less contact with the other. This results in an electrical imbalance in the circuit. Unlike a mercury switch, the EP-10 is not an *on-off* device but rather a *linear* resistor whose ratio changes over a range of 10 degrees inclination.

For a.c. operation, a *stable* 10-12 volt input is required. For d.c. operation, a transistor audio frequency oscillator output of



approximately 150 milliwatts is required. In either case, the source voltage *must* be stable. The circuit unbalance is detected by the germanium diodes in the bridge, and the d.c. error output is then monitored by one of the metering configurations shown. A 0-1 d.c. milliammeter can be used for most experimental applications although a significant circuit loading will be evidenced.

Before calibrating the circuit, add a mechanical zero-set to adjust the electrical

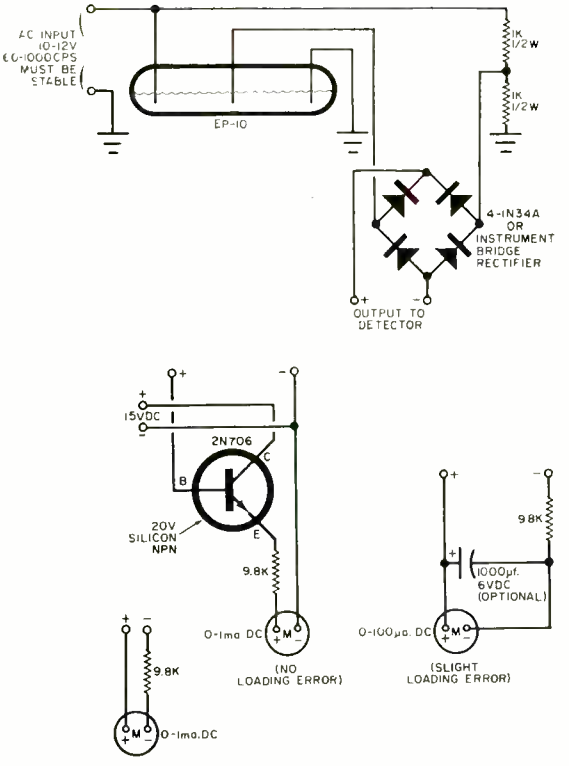


Fig. 3. Schematic of level indicator circuit using Hamlin EP-10 gravity sensing tube. When tube is level, resistance between either end electrode and middle electrode is the same. Any of the three meter circuits shown, or another similar configuration, can serve as level readout. Meter accuracy and circuit loading determine overall instrument efficiency.

output to precisely zero when the EP-10 is level. Then place the circuit on a 10″-long board and zero mechanically with an accurate level.

From a trig table, the *sine* of one degree is 0.0175. Multiplying this by 10, we get 0.175, the amount in inches by which the board is raised at one end. Meter output corresponds to one degree of tilt in either direction. You can mark the meter face directly. Continue in this manner to determine the meter output for 2, 3, 4, 5 . . . etc. degrees, always finding the *sine*, multiplying it by 10, and then jacking up the end of the board by the amount, in inches, computed. Use whatever increment best suits your needs.

You can buy the PE-10 for $15, plus 25 cents for a mounting clip from: Hamlin, Inc., Lake and Grove Streets, Lake Mills, Wisconsin. Complete data and applications sheet also available upon request. —30—

stage and one of the earlier stages feeds back a part of the output signal in such a way as to reduce overall gain and a resulting loss of the weaker harmonic signals introduced by the amplifier.

Product News. A new slide rule calculator for SCR's is being offered by the International Rectifier Corp. (233 Kansas St., El Segundo, Calif.). Selling for $1, the calculator contains a cross-reference of JEDEC and IR type numbers and design constants for one-through-twelve-phase rectifier circuits. It can also be used to determine output voltage as a function of firing pulse angle, and for designing test circuits.

From Japan comes news that Sony is developing a series of transistorized TV receivers designed to sell for less than corresponding tube-operated sets. According to early reports, these new sets will be intended for a.c. line operation, will have a 12-inch screen, and will weigh less than eight pounds.

A major step towards the use of molecular and thin-film circuits in consumer products has been taken by Westinghouse with the development of a subminiature CB receiver and transmitter. Although still in the laboratory stage, it demonstrates that such units *can* be manufactured.

Have you planned any projects you'd like to assemble during those long winter nights? If not, now is a good time to start warming up your transistors. We'll be back next month with more news. . . .

—Lou

AMATEUR RADIO

Continued from page 82)

ceiver. Finally, don't wear out your welcome by staying and staying until you are virtually thrown out.

After you find someone to help you, he will probably arrange a regular schedule of lessons. Make sure to be there on time for every lesson, or, if you are unable to get there, let him know ahead of time; otherwise, you will quickly lose your teacher. The rest is up to you. If you are not willing to study and practice, the best teacher in the world won't be able to help you get a license—what's more, he won't waste much time trying. But, with determination on your part, you can get your ticket, with or without a teacher—although a good teacher will help you over the humps.

New FCC Rule Interpretation. After many years of the tradition that amateur call

letters "belong" to the station and not to the operator, the FCC now interprets its regulations differently. According to the new interpretation, when you operate another amateur's station, you must use your own call letters as a portable station and only to the extent permitted by your license. For example, if you are WN9ABC and operate W9EGQ's station, you must sign WN9ABC (portable), and operate in the Novice bands, with crystal control and with a transmitter power not exceeding 75 watts. In addition, you will have to keep your own log.

The key to the new interpretation is "control." The operator of a station must be capable of suspending operations immediately if there is any observed deviation from legal operation. If the owner of the station isn't present and monitoring operations, he obviously cannot exercise such control; therefore, the amateur in actual control should identify himself by using his own call letters.

An exception has been made for club stations. The trustee to whom the club call letters are assigned does not have to be present whenever the club's call letters are being used. The FCC considers the club member operating the station as the trustee's agent; this permits the club call letters to be used.

This new interpretation apparently will prevent several amateurs from combining to keep a single station on the air continuously under one call-sign during a contest, unless the licensee keeps his hand on the main switch the entire time or the group organizes beforehand as a club and obtains a club call-sign.

News and Views

Chuck Lempke, WN2PAS, 5336 S. Freeman Rd., Orchard Park, N.Y. describes his station as "small but efficient." Using a Knight-Kit T-60 transmitter and a Knight-Kit "Star Roamer" receiver with a 40-meter dipole, Chuck has 31 states logged. If all goes as planned, he should own a General Class ticket by this time . . . **Augusto Battistoni, I11074,** an Italian SWL studying in Switzerland, compliments the U.S. for authorizing reciprocal amateur operation in the U.S. and cooperating countries and hopes that Italy will soon do the same. In the meantime, Aug promises to send us lists of low-power "W's" he hears . . . **Davie Williams, WPE3DLI/WN3CRE,** 2627 Carter Drive, Erie, Pa., took 90 days to work 28 states and Canada on 80 meters. His tools are a Navy surplus RAL-7 receiver, a Heathkit DX-40 transmitter, and an 80-meter vertical antenna.

Bob Wood, VE3GBW, Box 67, 6 McLeod St., Tilbury, Ontario, Canada, runs 20 watts to a war-surplus transmitter, with an AMECO AC-1 as a standby unit. Bob's antenna is a 132' "Windom," and he receives on a Hallicrafters S-77A; you'll find him near the U.S. 80-meter Novice band—usually on 3.68 mc . . . **John, WA4RIJ,** Apartment 27, 5450 N. Ocean Blvd., Fort Lauderdale, Fla., had to start all over when he moved from Jacksonville, Fla., but he already has 40 states and 40 countries worked. A Hallicrafters HT-40/SX-40 combina-

(*Continued on page* 108)

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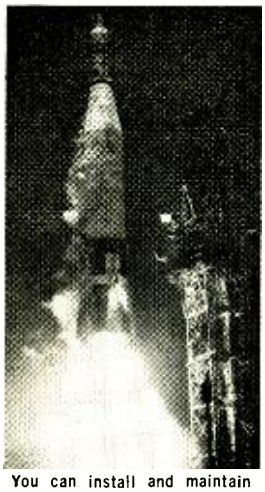

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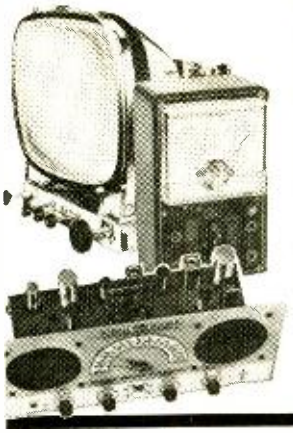

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tion and a Heathkit HW-32 feeding a non-rotating Mosley TA-31 Jr., tri-bander managed to do the trick. There are 120 apartments in John's apartment complex, but installing a low-pass filter in the coaxial feedline and grounding his equipment to a water pipe eliminated all TVI, even on his own TV receiver. Living 150 feet from the ocean, John manages to get in his share of skin and scuba diving; and, in the proper season, he is kept quite busy running phone patches for visitors to the beach . . . **Keith Kumm, K7UHE,** 5102 E. Butler Drive, Scottsdale, Ariz., jockeys the power input to his 813 transmitter between 50 and 200 watts on 40 and 20 meters. Aided by a vertical antenna and a Heathkit "Mohican" receiver, K7UHE has worked 48 states and 10 countries; the missing states are Rhode Island and Vermont. Keith's best DX is Moscow.

Doris L. Taylor, VE3FRN, 121 Combermere Drive, Apt. 404, Don Mills, Ont., Canada, reports on the first YL club in Canada, "The Ontario Trillums," which has the club call letters of VE3TOT. Officers are: Jeanine, VE3BII, president; Jean, VE3DGG, vice president; Doris, VE3BBO, treasurer; Ivy, VE3EZI, secretary; and Doris, VE3FRN, publicity. Their net meets on 3650 kc. each Saturday at 1800 GMT . . . **Bob Pace, WB6NBU,** 7421 Westlawn Ave., Los Angeles, Calif., has been keeping his Swan 350 transceiver and Hy-Gain 14AVQ vertical antenna on 40 and 15 meters, where he has worked 43 states and 9 countries. Although Bob usually prefers to rag-chew instead of chasing DX, he rates getting a 599 report from Jamaica as a real thrill. He also likes to work Novices and is interested in contests and in message handling . . . **Mike Calvert, WN2QOE,** 343 S. Webber Dr., Chittenango, N.Y., is an operator and a builder. In five months, he made 300 contacts in 31 states with a 50-watt, home-brew transmitter and a BC-455 receiver. He is now working on a new 300-watt transmitter for use when his General license arrives. A dipole up 25 feet does the radiating everywhere, except into the seventh call area.

Mike Kersenbrock, WH6FON, 45-645 Pua Alowato, Kaneohe, Hawaii, divides his time equally between 40 and 15 meters. A Hallicrafters HT-40 transmitter feeding either a 40-meter dipole or a "trap" vertical antenna, and a Hallicrafters SX-140 receiver have worked 10 states and 4 countries—not bad when the nearest state is over 2000 miles away. Mike has a VFO ready to plug into the transmitter as soon as he gets his General ticket . . . **Alec A. Hugh, 6Y5AH,** 38 Brentford Rd., Kingston, Jamaica, is to be found on 15- or 20-meter phone most weekends. His Heathkit DX-35, driven by an external VFO, runs 40 watts input to feed a Mosley TA-33 Jr. tri-band beam, and he receives on a Heathkit RX-1 "Mohawk." Alec has worked 60 countries and 42 states, is a member of the Rag Chewers' Club, and is an avid certificate chaser; so far he has earned 30 different operating certificates. Alec is willing to make skeds with any stations needing a Jamaican contact . . . **Dr. Morris Rosenberg, WB2MOJ,** 319 Summit Ave., Mt. Vernon, N.Y., started studying for his amateur license in 1923 and made the grade 41 years later. Moe finally got his Novice and Technician licenses in January and his General in June, 1964. He started out with a Heathkit DX-60 transmitter and a National NC-303 receiver, and gradually added gear here and there. He now has a Collins "S" line to feed a 3-element tri-band beam, a 5-band dipole, or a vertical antenna. Also part of the shack is his son, WN2NOW, who keeps the DX-60 hot bringing in QSL cards.

Until we meet in the same spot next month, keep your "News and Views," pictures, and club bulletins coming to: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P.O. Box 678, Gary, Indiana 46401.

73, Herb, W9EGQ

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CIRCLE NO. 32 ON READER SERVICE PAGE

SHORT-WAVE LISTENING

(*Continued from page 80*)

Current Station Reports

The following is a resume of current reports. At time of compilation all reports are as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Eastern Standard and the 24-hour system is used. Reports should be sent to SHORT-WAVE LISTENING, P.O. Box 333, Cherry Hill, N.J., 08034, in time to reach your Short-Wave Editor by the fifth of each month; be sure to include your WPE Monitor Registration and the make and model number of your receiver.

Algeria—*Radio & Television of the Democratic Algerian Republic*, Algiers, 15,230 kc., is noted in Eng. until 1730; from 1730 in Spanish, and around 1924/closing time in French. Since the station announces as operating on 6060 kc., this may be a parallel channel.

Argentina—*R. Splendid*, Buenos Aires, is now on a new frequency of 5995 kc. where it has been noted in Spanish at 1948. There are infrequent ID's but a four-tone chime is heard often. Programming consists mostly of talks, a little music, and evidently no commercials.

Australia—*R. Australia* is being widely reported on 15,220 and 15,240 kc. at the same time but with different programs. The schedule lists 15,220 and 17,840 kc. to N.A. at 1955-2245 and 15,240 kc. to Mid Pacific Islands at 1929-0145. The station is now issuing a silver-colored QSL card commemorating its 25th anniversary.

Austria—*Osterreichischer Rundfunk*, Vienna, broadcasts to Eastern N.A. daily at 1800-2300 on 9770 and 6155 kc. (from 1700 on 9770 kc., and to 2330 on 6155 kc.), and on Saturdays, Sundays and Mondays at 1700-1800 on 6155 kc.; to Eastern S.A. daily at 1900-2100 on 11,905 kc., daily at 2100-0000 on 9525 kc., and on Mondays, Wednesdays and Fridays at 1200-1400 on 15,240 kc.; to the Far East daily at 0100-0400 on 15,410 kc., daily at 0600-0900 on 11,785 kc., and Saturdays, Sundays and Mondays at 1200-1400 on 9610 kc.; to India and Indonesia on Mondays, Wednesdays and Fridays at 0000-0200 on 17,805 kc. and at 0800-1000 on 17,800 kc.; to Australia and New Zealand on Mondays, Wednesdays and Fridays at 0400-0600 on 17,810 kc.; to Japan on Mondays, Wednesdays and Fridays at 0600-0800 on 11,725 kc.; to S. Africa on Mondays, Wednesdays and Fridays at 0200-0400 and 1000-1200 on 17,750 kc.

Bolivia—A new station is *R. Viloco*, Viloco (Departamento de la Paz), 3340 kc., operated by *Sindicato Mixto de Trabajadores Mineros de Viloco*. This station frequently relays other stations such as *R. Nacional de Huanuni* (5862 kc.), *R. San Jose* (5872 kc.), and *La Voz de Minero* (5852 kc.), and was noted recently with many political talks in Spanish. S/off is at 2100.

Station CP77, *R. Sararenda*, Camiri, has moved to 4886 kc. from 4712 kc. and is heard with lengthy periods of pop tunes. S/off may be as late as 0030.

La Voz del Minero, 5852 kc., Llallagua, now uses a "cuckoo" signal with their ID. S/off is at 2302.

Brunei—*R. Brunei* transmits on 4865 kc. with 10 kw. daily at 0300-0400 and 0800-0920 in Eng., at 0400-0515 in Chinese, and at 0515-0800 in Malay. They use a collinear, half-wave, folded bi-directional dipole antenna. Reports (no IRC's required) should go to Department of Broadcasting & Information, Brunei.

Canada—The Department of Lands & Forests, Toronto, can be heard mornings on 4775 kc. A letter verification stated that they have no QSL cards. Reports may be sent to Radio Division, Forest Protection Branch, Department of Lands & Forests, Queens Park, Toronto 5, Ontario. Other information: there are 167 "Lands & Forest" stations ranging from 30 to 500 watts and operating between 3000 and 10,000 kc., as well as an extensive VHF network on 12 channels between 46 and 49 mc. They also operate 43 radio-equipped aircraft.

Station CBNX, St. Johns, 6160 kc., is now signing their new call, CKZN.

Ceylon—Listeners who want a QSL from the Commercial Service of *R. Ceylon* should send their reports to Radio Advertising Services, Cecil Court, Lansdowne Rd., Apollo Bunder, Bombay 1, India (or to P. O. Bag 10013, Bombay 1, India). They verify promptly.

China—*R. Peking* operates to N.A. as follows: to East Coast at 2000-2100 and 2100-2200 on 7035, 7450, 9480, and 11,945 kc.; to West Coast at 2200-2300 and 2300-0000 on 7080, 9457, 11,820, and 15,115 kc. Other xmsns logged include Spanish to Latin America at 2020-2050 and 2120-2150 on 15,060 kc. and Eng. on the same channel at 0815-0900. The 9457-kc. outlet is good at times around 2000. The 11,690-kc. outlet signs on in Turkish at 1230 with the ID *Burasai Pekin Radyosu*.

Congo (West)—According to the latest schedule received from Paris, the following is the complete Brazzaville schedule: to West, East, and Middle Africa and Madagascar in French at 0000-0230 (Eng. news at 0015) on 4795 5970, 9730, 11,725, and 15,445 kc.; to West, East and Middle Africa in Eng. at 0600-0645 and in Portuguese at 0645-0700 on 11,970 and 15,445 kc., and in French at 0600-0755 on 7105, 11,710, 15,190, and 21,500 kc.; to Far East areas in Eng. at 0800-0830 and in French at 0830-0900 on 17,720 and 21,500 kc.; to West, East, and Middle Africa in French and Portuguese at 1230-1600 (Eng. news at 1415) on 5970, 7105, 9730, and 15,190 kc., and on 11,725 kc. until 1400, then on 11,930 kc. to 1600.

Dominican Republic—Broadcasting in this country is still very unstable. Being heard currently is *R. Santo Domingo TV* on 3225 kc. around 2000, on 3325 kc. with music and some talks to 2301 s/off, on 3385 kc. at 0115-0130 (this outlet may ID as *R. Caribal*), and on 3460, 3490 and 7575 kc. during the 1830-2130 time period. The 9505-kc. outlet is not being heard. Overseas sources report that an Air Force station at San Isidro with the call HIFA is still operating on 645 kc., mostly in Spanish but with some English; no regular programming is being noted, however.

Ecuador—Station HCJB, Quito, is using 15,120 kc. to 1530 and 15,105 kc. at 1530-1700. The normal frequency, 15,115 kc., is used after 1700. In the 16-meter band, the station uses 17,850 kc. to 1700, then moves up to 17,890 kc.

Egypt—Cairo now uses 15,100 kc. and is heard at 1130-1700 with chanting and talks, dual to 7050, 9495, and 11,745 kc. The European beam is on 9475 kc. from 1630 to 1730 in Eng. and to 1830 in Arabic.

Germany (West)—*Deutsche Welle*, Cologne, is noted on 11,710 kc. from 2325 s/on in Arabic.

Ghana—Two new frequencies for *R. Ghana*, Accra, are 6110 kc., observed with Eng. news till 2245 and reportedly beamed to N.A., and 9760 kc. at 0005 with native music.

Haiti—Station 4VEH, Cap Haitien, is presently scheduled daily at 0530-0630 in Spanish and to 1000 in Eng.; on Sundays they also operate at 1200-1400 in French and Creole and at 1400-2030 in Eng.; and on weekdays at 1200-1600 and 1800-2030 in French and Creole, and at 1600-1800 in Spanish. Frequencies used are 11,835, 9770, 6120, 2450, and 1035 kc.

Iran—*R. Iran* has moved from 11,750 kc. to 11,700 kc. and is heard in Russian to 1230, in Arabic to 1330, in French at 1445, and in Eng. from 1500.

Israel—*Kol Zion*, Jerusalem, has Yiddish at 1100 and 1300, Rumanian at 1250, Hungarian at 1305,

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Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

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1186 Broadway, Dept. 648D, Hewlett, N. Y. 11557

CIRCLE NO. 38 ON READER SERVICE PAGE

Hebrew at 1400 (also at 1631 on Sundays), French at 1515 and Eng. at 1545 on 9009, 9625, and 9725 kc. Tests have been made recently on 11,750, 11,755, 11,760, 11,905, 11,910, and 11,915 kc. between 0300 and 0500.

Nepal—*R. Nepal* broadcasts at 2120-2320, 0220-0420, and 0820-1020 on 4600 and 7105 kc. The 5-kw. power will soon be increased to 100 kw. Reports go to Superintending Engineer, Department of Broadcasting, Singha Durvar, Kathmandu, Nepal.

Netherlands—The Sunday "Happy Station Program" at 1030-1150 to Africa and Europe is now on 21,570 kc. instead of 17,830 kc.

Netherlands Antilles—*Trans World Radio*, Bonaire, 11,855 kc., operates at 1935-2005 in Eng. and to 2020 in French although it may move up to 11,880 kc. at times. Another new xmsn is on 9710 kc. to 0600 in Spanish.

Nigeria—*Voice of Nigeria* is scheduled at 0300-1100 and 1200-1700 on 11,900 kc., and at 1100-1700 on 15,255 kc. Reports go to Mr. Theodore A. Faneye, Director of External Broadcasting, Ikoyi, Lagos.

Peru—*R. Union*, Lima, 6115 kc., is a new station being heard from 1800 to 0100/close with Spanish and Latin American pop tunes. Seldom heard is OAX8W, *R. Sideral*, 9750 kc., around 2200/close; you'll really have to dig deep for this one. About the strongest Peruvian currently is *R. Nacional del Peru*, OAX4Z, Lima, 6082 kc., heard from local sunset to 0000 s/off with news and many musical features; verification took six months.

Somali Republic—*R. Mogadiscio*, 7160 kc., verified promptly with a photographic card. S/on is at 2226, Arabic to 2245, Eng. to 2300, then Somali. The 4970-kc. channel was also listed as being in use.

South Africa—The Africa Service is aired at 2200-2300 on 6150 kc.; at 0500-0955 on 11,900 kc.; at 0955-1125 on 9525 and 11,900 kc.; at 1125-1225 on 9525 and 7270 kc.; and from 1125 to close on 6150 and 7270 kc. The Commercial Service in Eng. and Afrikaans is noted in Eastern areas at 2213-2246 on 2376 kc.

Swan Island—*R. Americas* is being reported on 18,000 kc. around 0000 in Spanish. This is the third harmonic from 6000 kc.

Sweden—Stockholm is using 11,805 kc. for its half hour programs in Eng. to Eastern N.A. at 2045 and to Western N.A. at 2215. A recent xmsn in Eng. to S. E. Asia from 0945 s/on was monitored on 15.315 kc.

Switzerland—Berne is using a new frequency of 11,775 kc. (HEI6). S/on is at 1800 in French.

U.S.S.R.—*R. Kiev* can be heard well with an IS and ID at 1730 and news commentary in Russian on 11,955 kc. *R. Vilnius*, Lithuanian SSR, 7310 kc., is heard in Eng. on Sundays only from 1800 to 1830, at which time reports and suggestions are requested; operation is dual to 7110 and 7185 kc. Vladivostok is noted with Russian programming consisting of semi-classical music and talks at 1000-1100 on 5015 kc.; at 1050 there is a clear ID for *Radiostantsi Unik*.

Viet Nam (North)—*V. of Viet Nam*, Hanoi, 11,760 kc., is noted at 0800 with an Oriental march IS, at 0820 with a talk, and s/off at 0827. Broadcasts are Eng. and beamed to American servicemen in South Viet Nam. The programs are largely news, commentary, talks and a bit of Vietnamese music.

Viet Nam (South)—Station VTVN, Saigon, 9620 kc., was logged from 0700 with a stringed instrument IS and until 0820 tune-out with Vietnamese talks, news, and music. This is Network A of the Vietnamese Home Service.

Windward Islands—Grenada is heard on 15,100-15,105 kc. from 1700 to as late as 1900 with its usual programs of news, commentary, request music, and special anmts.

Utility—A new time signal station has been noted on 15,000 kc. in Eastern areas during evenings. The station, using single sideband, gives a CW call each ten minutes as "RID." Can anyone identify it?

—30—

GET MORE LIFE

(*Continued from page* 41)

outlet to test the filament string in this manner. Jumping the picture tube heater to make this test can do no harm. In a transformer-equipped set where the tube filaments are wired in parallel, it is a simple matter to read the proper voltage directly on an a.c. voltmeter. Do not jump a parallel heater connection.

A common heater-type trouble, particularly when the heater seems to be blinking on and off over short or long periods of time, is in the base pin connection. A special crimping tool is commercially available to obtain a tight physical connection between the pins and the heater leads coming from the neck of the tube. Sometimes you can reheat and resolder the pins to cure this trouble.

If the heater is broken inside the tube, the end has probably come. Even so, you can try tapping or vibrating the neck of the tube while applying a charged electrolytic capacitor to the heater pins. You don't want to break the neck of the tube, so go easy. If the break inside the tube should momentarily close, the resulting surge of current could weld the loose ends. (A 40-μf. capacitor charged to about 300 volts will do. It could also give you quite a kick, so don't let your fingers cross the capacitor.)

Slow Warm-Up. If it takes an unusually long time for the picture tube to brighten up, or if it doesn't get bright enough, particularly so far as old tubes are concerned, chances are that the emission is low. If a fairly new tube acts up in this way, look for trouble in the set, since this is a typical symptom of old age.

You can get some extra life out of your old tube for perhaps six months to a year by giving it a "hot shot." A combination picture tube tester and rejuvenator is a handy instrument for this purpose, but if one is not available, you can try using one or more boosters. The idea is to raise the heater temperature enough to "boil" away the uppermost material or coating on the cathode and

POPULAR ELECTRONICS
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expose some fresh electron emitting material.

The rejuvenator can do this with the set off, but it is necessary to connect the boosters between the picture tube and its socket, and turn the set on. Allow the set to stay on long enough for the brightness level to come back to what appears to be normal, and perhaps a few minutes longer. Shut off the set, remove the brighteners, and replace the tube socket. Allow the tube to cool down before turning on the set to see if the tube has responded. If it did, fine; if not, you can try again. If the tube still doesn't come up to your expectations, you could install one booster and leave it in the set.

You should use only those boosters that are specifically designed for your type of set. There are boosters for both series-string and parallel-wired sets which offer varying degrees of boosted heater voltage. It is a good practice to start with the least amount of boost possible. You can always add more. There's nothing wrong with adding a booster to a booster.

Shorted Elements. Loss of brightness, loss of picture, a picture or screen whose brightness cannot be varied, or a large dark horizontal bar across the screen (60 cycle hum) are typical manifestations of a shorted element. Sometimes shorts can be cleared by tapping the neck of the tube. If the short is due to debris between the elements, there is always a possibility that your tapping will cause the short to clear, to move to another location, or to become more firmly entrenched where it is. So at the risk of looking foolish, try spreading a blanket in front of the set and lay the set face down on the blanket. Now tap the tube's neck and hope that the foreign matter clears the gun.

Should this fail, you can try burning out the short by applying about 300 volts a.c. across the shorted elements. There's a gadget on the market that plugs into the rectifier tube socket on one end and the picture tube on the other. A flip of the switch momentarily puts the power transformer's high-voltage winding across the selected elements.

However, do not attempt to clear a

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cathode-to-heater short in this manner—odds are that the heater will be ruined forever. The solution in this case is to use an isolation transformer.

Open Cathode. Don't throw away a tube you think has an open cathode, at least not until you've tried to jump the break. The trick here is how to determine if the cathode is really open. Of course, a tube checker will help you peg this defect, but what do you do without one?

You can check and eliminate all the other causes for no brightness and then assume that the cathode is open. If the cathode does have a break, and if the break happens to be in the right place, you can make a permanent repair by connecting the cathode pin to one of the heater pins and using an isolation transformer. You can also try to repair the break with a charged capacitor.

If you are among the most fortunate, you will never have to replace a picture tube, at least not for ten years. Three to five years of life is not unusual. If you get less than that, you didn't read this article. —30—

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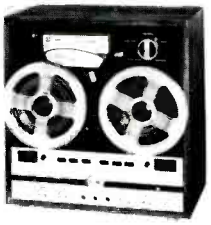

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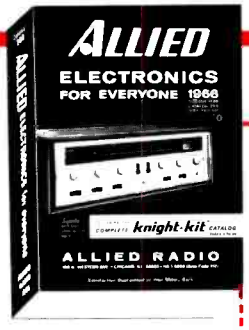

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