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JUNE 1970

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Match your TV antenna to receiver

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DEPARTMENTS

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INDEX TO VOLUME 32 (JAN.-JUNE 1970)

This month's cover photo by
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Shakespeare MAKES THE BEST ANTENNAS

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Tape Recorder Servicing Guide
Explains in detail the principles of magnetic recorder circuitry. Describes components and systems and provides comprehensive instructions for preventative maintenance, adjustments, and repair. Order 20748, only $3.95

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CIRCLE NO. 28 ON READER SERVICE PAGE
Midland goes mobile in SSB/AM
To offer a complete, compatible 3-way system

Now! Base, mobile, hand-held...a complete system of SSB/AM transceivers. A new 23-channel mobile unit packs all the power and performance of the famous 13-880 base station. Add the 3-channel hand-held unit for a complete, fully compatible system with an unlimited range of applications. All use separate transmitters for AM and SSB (upper and lower) which assures superior performance on both. Dual-conversion receivers all have crystal lattice filter, full squelch, noise blanker and AGC. It adds up to three of your best buys in SSB!

New 23-Channel 5-Watt AM, 10-Watt SSB Mobile Transceiver
Mobile companion to the 13-880. Fully equipped to operate independently on upper and lower side band, all AM channels. Compatible with all other CB units. F.E.T. front end, RF/"S" meter, clarifier control, PA switch. Model 13-873 $359.95

3-Channel AM/SSB
Operates independently on upper, lower SSB and 3 AM channels. Combination SSB clarifier, AM delta tuning. Squelch, built-in battery meter, center-loaded telescoping antenna, earphone, batteries, strap. Model 13-778 $219.95

23-Channel AM/SSB Base-Mobile
All deluxe features plus these extras: AC-DC operation, built-in SWR system, on/off/transmit lights, built-in digital clock. Mike, headphone, PA jacks. With all accessories. Model 13-880 $369.95

For free color brochure, write: Dept. 1406
P.O. Box 1903, Kansas City, Mo. 64141

Prices shown are suggested retail.

CIRCLE NO. 20 ON READER SERVICE PAGE
have you any idea how many ways you can use this handle?

as a screwdriver...
for slotted, Allen hex, Phillips, Frearson, Bristol, Clutch Head, Scrulox® screws

as a nutdriver...for hex nuts, screws, and bolts

as an awl/scriber and reamer

It accommodates 49 interchangeable blades of various types and sizes.
Its patented spring device permits quick blade insertion and removal.
It's shockproof, breakproof (UL) plastic. Comes in three sizes — regular, junior, stubby — also Tee type.
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CIRCLE NO. 33 ON READER SERVICE PAGE

HIGH SCHOOL ELECTRONICS

There is an error in your monthly department, "Opportunity Mirror," (March, 1970) where it is intimated that electronics is not taught in high schools.

Here at the Greater Lawrence Regional Vocational Technical High School, Andover, Mass., a curriculum involving a vocational major is combined with academic courses. These meet regular high school requirements and give the student the benefit of a high school diploma and a vocational or technical certificate for his major subject.

Being a member of the graduating class this year I look forward to the vast number of opportunities available to me as a result of being a student in the electronics program of this school. I will also have the opportunity to continue employment under the terms of our high school's cooperative work programs. It is also possible to continue on in our high school through its post graduate and institute programs, or advance into another popular area of electronics, Computer Programming.

PHILIP MARCELLO
Methuen, Massachusetts

BINGO FOR THE BAMBOO BROADCASTER

Thank you for printing the article, "Bamboo Missionary Broadcaster" (February, 1970, p 61).

R. L. FULLER
San Mateo, Ca.

Congratulations on the foresight and character to print the excellent article on the "Bamboo Missionary Broadcaster." These people have been ignored and neglected too long. How about an article on TransWorld Radio?

R. G. THOMPSON
Milwaukee, Wis.

I enjoyed reading the wonderful story by John Kimberley on the Far East Broadcasting Company. Don't forget some of the other missionary broadcasters such as HCJB and 4VEH.

R. J. ENGELKIRK
Princeton, Iowa

CB LICENSE PLATE

On behalf of the Twin Ports CB Radio Club (Duluth, Minn./Superior, Wisc.), we

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Your future, your decision...choose ARMY.

June, 1970
feel that CB'ers may be able to obtain license plates in the state of Minnesota and have petitioned our legislative representative in this district. We appreciate that there may be an additional cost for this service, but we are confident that most CB'ers will be willing to pay this extra fee.

We would like to have other known and established CB clubs in the state of Minnesota support our efforts in this endeavor.

J. C. MAUSOLF
Twin Ports Citizen's Band Radio Club
2717 East 5th Street
Duluth, Minn. 55812

LOUD, BUT NOT TOO LOUD

To escalate a treble boost for guitar (letter from J. R. Guthrie, March, 1970, page 13) into the urban noise pollution problem is downright silly. Does this mean that POPULAR ELECTRONICS should stop printing speaker designs or hi-fi amplifiers with more than 1 or 2 watts output?

The treble boost can add a whole new world of harmonic content to low and middle register instruments. If Mr. Guthrie is concerned about noise pollution, he should participate in some of the ecological and environmental organizations now springing up to combat this serious problem. Writing to POPULAR ELECTRONICS about the fabled sins of an innocuous device does nothing to lift the cloud of noise and dirt that has settled over us.

CRAIG ANDERTON

TAPE RECORDING, MORE LITERATURE

Your reader, R. Stoddard (April 1970, p 8), should find Skip Athey's book, Magnetic Tape Recording, published by NASA in 1966 a valuable addition to his library. I believe it is still available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. It was selling for $1.25. This is a general book, not one devoted to hobbyists, or even sound recording, but a study of it would benefit any tape recorder user.

W. L. SMITH, W3QKP
Spencerville, Md.

OUT OF TUNE

Various gremlins got into the works in our April issue. In the "Micro'Lign Generator" article on page 49, the leads on the transistor case outline for Q1-Q3, should be E, C, and B, left to right. On page 40, "Digital Logic Microlab," the figure number should be 8. Parts I, J, and K were omitted due to lack of space. On page 57, "100-kHz Standard," the prices in the parts should be $2.15 for the board, $9.85 for the kit.
The New COBRA 24... Wild, but never Primitive!
Watch for It! The New 23-Channel Radio that brings order to the CB Jungle!

The COBRA 24 lurks no longer. It has struck with deadly effectiveness to prey on the weaknesses of others. With more power, more intelligence, more beauty than any other radio in its class.

- 5-watts input, maximum talk power with DYNABOOST speech compression, a Dynascan exclusive
- Selective, dual-conversion, superhet receiver with ceramic filter to give outstanding selectivity and gain
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- 23 crystal-controlled channels—no extra crystals needed
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- PA/CB switch with adjustable volume
- Illuminated channel selector and "S" meter for night transmission
- Includes push-to-talk microphone
- Meets FCC requirements—operates on 12 volts DC

There are other reasons for COBRA superiority. Get all the facts from DYNASCAN. Better yet, visit the COBRA dealer near you. He will show you through the CB jungle!

Cobra 24: Net $169.95
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CIRCLE NO. 11 ON READER SERVICE PAGE
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on Police and Fire Conversations
and Weather Reports

6 high band frequencies (150 MHz to 175 MHz) and 6 low
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unit let you tune-in wherever the action is. This handsome
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design, integrated circuits.
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3 crystal controlled channels plus regu-
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ELECTRONICS
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by J. B. Murdoch
Classroom tested, this book can be considered
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on steady-state linear networks and the latter
part on free and forced behavior of such net-
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Published by McGraw-Hill Book Co., 330
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are written in a programmed-text format.
The text is well written and profusely illus-
trated to show and explain every item dis-
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4500 West 68 St., Indianapolis, IN 46268. Hard
covers. 640 pages Book 1, 704 pages Book 2.
$9.95 each book.

WAVE GENERATION AND SHAPING
Second Edition
by Leonard Strauss
In the decade since the first edition of this
book appeared, solid-state technology has
revolutionized active circuit design, and IC's
have replaced discrete components. Written
primarily as a textbook, the objective is to
present a logical unified approach to the
analysis of those circuits in which the non-
linearity of the active device is the significant
factor. A developmental treatment is fol-
lowed as focus is placed on the essential fea-
tures of practical wave generating, shaping,
and logic circuits. The book is divided into

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Be it Bach, Beethoven, Folk, Soul,
Rock and Roll
Add a new sensation to your favorite listening pleasure. A panoramic display of sound to multi-color light patterns.

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Dual Channel Color Organ Model GF-2F
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A pair of bookshelf size, 3 sided prismatic glass enclosure with walnut finish top and bottom. Each unit is a dual channel color organ. Lights respond with sound amplitude (volume) and with different sound frequencies.

3 Channel Color Organ, Model CVA-3F — $49.95 each
User Net.
3 channel color organ. Each channel of lights have their own sensitivity control. Lights respond with sound amplitude (volume) and with different sound frequencies.

3 Channel Color Organ Model LGF-3F — $47.95 each
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Stereo (dual channel) Color Organ Model CVA-6F, $69.95 each
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A stereo (dual channel) system complete in one walnut finish bookshelf cabinet. Each channel is independent and uses 2 individual sensitivity controls per channel.

Color Centers

3 Channel Frequency Divided Color Control Center Model PCC-3LF $34.95 User Net.
Any sound from a Hi-Fi, phono, radio, etc., may be fed into this unit. Each channel is independent and uses 3 individual sensitivity controls per channel. Lights respond with sound amplitude (volume) and with different sound frequencies.

Single Channel Color Control Center, Model PCC-10F — $16.95 User Net.
Any sound from a Hi-Fi, phono, radio, etc., may be fed into this unit. Converts sound to light variations. Will handle up to 600 watts of plugged in lamps.

Stereo Color Control Center Model PCS-5LF — $34.95 User Net.
2 separate inputs and outputs for true stereo sound to light conversion. Separate sensitivity controls for each stereo channel. Each channel handles up to 500 watts of controlled lights.

Strobe Lights

Model ST-2F $34.95 wired, $24.95 kit, User Net.
Walnut wood case. High intensity strobe. Easy to use and build. Built in strobe speed control.

Model STCC-3F, Strobe 3-channel Color Organ Combination
$79.95 wired, $49.95 kit, User Net.
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CIRCLE NO. 7 ON READER SERVICE PAGE
Musi-Cube the “switched on” speaker

Musi-Cube has revolutionized the idea of what a speaker should be. Four “switched on” color designs make them fun—even when they’re quiet. And because Musi-Cubes measure just 7¾” on a side, you can put them almost anywhere. 50 to 16,000 Hz response and full 12-watt music power rating produces a sound so big, you have to hear it to believe it. Write for free full color literature.

Lasers and Holography

by Winston E. Kock

Holography, like ordinary photography, is a way of recording a scene on film. But while the photograph displays the scene in only two planes (it has no depth), the hologram is a three-dimensional display of the scene; it actually has depth that changes perspective with the changing angle of view. In this book, the reader is introduced to the holography technique by a careful review of the underlying wave concepts, including coherence, diffraction, and interference. The atomic process by which lasers generate their special coherent light is explained. Also shown is how the unique properties of holography will make the laser a valuable instrument in the future of photography.


1-2-3-4 Servicing Automobile Stereo

by Forest H. Bell & Associates

Anyone who services electronic equipment faces the dilemma of speed versus thoroughness. A simple procedure that gets the job done correctly is the best approach. And that is just what is involved in this book; getting the job done the easy way and the right way. The 1-2-3-4 method of finding troubles, coupled with the Easy-Read format of writing and editing, make even the most complicated discussions easy to understand. The topics are carefully organized and thorough explanations, supported by clear illustrations are provided. Whether you are a student, practicing technician, or curious layman, you will understand automobile stereo systems when you have finished reading this book.

Published by Howard W. Sam's & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 192 pages. $3.95.
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NEW Heathkit "Spectre" 3/8 Scale R/C Car
Join The Most Exciting New Hobby In America...

building and racing radio-controlled Grand Prix cars up to scale speeds of 200 mph. The Heathkit "Spectre" R/C car reaches that speed and has already proven itself a winner. And no wonder; its design is unique. It has a chrome plated steel chassis, adjustable caster and toe-in, specially formulated rubber tires that lock onto the cast nylon wheels, independent front suspension for excellent cornering and a 5.5:1 gear ratio for maximum torque at all speeds. The snap on, 3/4 scale car body (length: 19\%8") is of high impact plastic—almost indestructible. Suspension is by real coil springs. The radio equipment compartment is dirt and oil proof. The Heathkit "Spectre" is the only complete car kit available. You get the body, chassis, wheels & tires, 4 oz. fuel tank & tubing, equipment case & protective foam, centrifugal clutch & gears, axles, servo linkages & mounting tape, all hardware, decals, numbers and a comprehensive manual. The "Spectre" accepts any .15 to .23 cubic inch R/C engine and any proportional R/C electronics system. It requires only two servos to operate the steering, brake and throttle. Get in on all the thrills of R/C car racing at the lowest possible price . . . order a Heathkit "Spectre".

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

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For Planes, Gliders, Cars And Boats

Ideal for use with the new Heathkit "Spectre" R/C car to give you total control over your car. Here's what the Heathkit GD-57/R/C system includes: Transmitter with assembled, factory aligned RF circuitry; new 2 oz. miniature receiver that needs no IF alignment, in a tough nylon case; you also get two servos; all plugs; connectors; cables; charging cord; flat pack rechargeable nickel-cadmium transmitter and receiver batteries . . . and a special soldering iron. You can have your choice of five operating frequencies in each of three bands . . . 27, 52 or 72 MHz. This is the most value ever offered in a 3-channel rig.

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

NEW Heathkit Siren/PA
For Licensed Emergency Vehicle Only

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

Kit GD-18, Siren/PA Amplifier, 7 lbs................................$49.95*
Assembled GDA-18-1, Exterior Horn, 9 lbs........................$49.95*
Assembled GDA-18-2, Concealed Horn, 4\% x 4\% x 13", 9 lbs........$49.95*
System GD-18A, (includes GD-18 plus exterior horn), 16 lbs......$99.95*
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NEW Heathkit Solid-State Portable Fish Spotter


Kit MI-29, 9 lbs..........................................................$84.95*
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The new Heathkit SB-102... proud successor to the famous "100" & "101". You can expect top performance and value from this rig... and you get it. An all solid-state Linear Master Oscillator delivers faster warmup, greater stability and better tracking... new receiver circuitry gives better than 0.35 uV sensitivity for real performance under bad band conditions. Plus all the features that made the SB-101 the world's most famous, most popular transceiver... 180 watts PEP SSB input... 170 watts CW input... 80 through 10 meter coverage... USB, LSB or CW modes... built-in VOX or PTT operation... built-in CW sidetone... built-in 100 kHz crystal calibrator... Triple Action Level Control for reduced clipping & distortion... fast, easy bandswitching and tune-up... rugged, inexpensive 6146 finals... separate headphone level control & front panel jack... simple assembly with circuit board-wiring harness construction... sharp Heathkit SB-Series styling plus many more features. Order yours now.

Kit SB-102, 23 lbs. $380.00*
Kit SBA-100-1, mobile mt, 6 lbs. $14.95*

NEW Heathkit 60-Watt AM-FM-FM Stereo Receiver

Superb stereo performance at budget price, that's the new Heathkit AR-19. A giant, electronically regulated power supply provides 60 watts HF music power (full for all modular and high efficiency speaker systems)... frequency response is -1 dB from 6 Hz to 35,000 Hz... and Harmonic & IM distortion are less than 0.25% at any output. This advanced performance assures you of crisp, clean highs without ringing or break-up... solid, clean-cut lows without distortion—just pure, uncolored sound reproduction at all frequencies and power levels. The FM Stereo circuitry is unequalled by any receiver in this price class... a factory assembled & aligned FET FM tuners... superb overload characteristics & 2.0 uV sensitivity... a factory assembled & aligned FM IF circuit board with 4 IC's for superior AM rejection, hard limiting, greater stability and 35 dB selectivity... a precision ball-bearing indexed tuning wheel for smooth, precise tuning... two front panel tuning meters for exact station selection. Other features include modular snap-out circuit boards, built-in self-servicing capability, hi-fi AM reception and much more. Make the AR-19 the heart of your stereo system now.

Kit AR-19, 29 lbs. $225.00*
Assembled AE-19, oiled pecan cabinet, 10 lbs. $19.95*

Heathkit Solid-State Metal Locator

Here's versatile, professional performance in a metal locator at lowest cost. The all solid-state GD-48 uses a unique induction balance detection system that doesn't produce a tone until metal enters the search field... eliminates having to listen for a change in tone. The built-in Sensitivity control allows adjustment to detect varying size objects down to 6 feet. A built-in speaker audibly signals presence of metal... for higher sensitivity use the accurate front-panel meter. And the front-panel headphone jack lets you use headphones to screen out annoying background noise. Look no further for an excellent metal locator... order the GD-48 now.

Kit GD-48, 4 lbs. $59.95*
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CIRCLE NO. 17 ON READER SERVICE PAGE
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COMMUNICATIONS RECEIVER KIT

Armchair adventuring is more fun than ever when you tune in on the world with a receiver you've built yourself. This is the idea behind the new Knight-Kit Model R-195 budget-priced communications receiver kit. The kit features a "modular concept" in which most parts are already soldered to printed circuit boards and all critical adjustments have been made at the factory so that the builder merely interconnects the boards. The assembled R-195 tunes the international and domestic short-wave stations in three bands (1.8-4.8, 4.8-12, and 12-30 MHz), marine weather and navigational beacon stations on long wave (200-420 kHz), and standard AM broadcast band.

A specially designed r.f. section features 2 µV sensitivity for 10 dB S+N/N. Selectivity is 4.5 kHz bandwidth at 6 dB. Other features include automatic noise limiting, a.v.c., EFO for CW and SSB reception, remote receiver muting, 4" speaker, and a headphone jack.

Circle No. 78 on Reader Service Page 15 or 95

STEREO CASSETTE DECK

The Lumistor Products Model LP-1 stereo record/playback deck is unique in that it is designed to allow for conversion to play four-track "quadrasonic sound" cassettes. The deck was designed to provide the features and operation convenience of quality reel-to-reel decks while retaining the convenience of cassette handling. Featured are interlocking controls, a four-pole synchronous motor, three-digit counter, dual VU meters with separate input level controls, and all interconnecting cables. Present plans are for the four-track converter pack to be made available to those who wish to convert to quadrasonic sound capabilities as soon as prerecorded cassettes for the new sound become available.

Circle No. 79 on Reader Service Page 15 or 95

7-IN-1 BIAS SUPPLY FOR COLOR TV

A new bias supply for color TV alignment has been introduced by Sencore. The Model BE166 meets the demands of the TV receiver manufacturers by providing three separate 25-volt supplies that can be switched positive or negative as indicated by alignment instructions provided by the TV receiver manufacturers.

Tube operated receivers require negative voltages, while most solid-state receivers use positive voltages. A seventh range of 0-75 volts has been provided to meet the specifications of the manufacturers who use 67.5 volts to bias the chroma amplifiers during alignment. All three supplies are well filtered at 0.1% ripple and have little or no interaction between them.

Circle No. 80 on Reader Service Page 15 or 95

AUTO-REVERSE STEREO TAPE RECORDER

The Sony Model 780 automated tape recorder, available from Superscope, is designed for the connoisseur who wants and can afford the best. It features a three-motor drive system that is completely independent of the 60-Hz line power frequency to provide precise speed control. Any external altering circumstance is automatically and instantaneously compensated for by a sophisticated regulating system. Automatic reversing is accomplished through an electronic sensory system; no metal foil or subsonic tones are required to activate the auto-reverse. The 780 is equipped with the Sony Noise Reduction System that provides noise-free playback of all recorded tapes by automatically reducing the gain of the playback amplifier during quiet passages. The Model 780 includes vari-speed tuning, front panel bias switch, and feather touch control buttons. Another new feature is the ferrite Roto-Bilateral Head that allows recording and playback in both directions with simultaneous tape monitoring.

Circle No. 81 on Reader Service Page 15 or 95

REGULATED LOW-VOLTAGE SUPPLY

The new Heathkit Model IP-28 current-limiting regulated lowvoltage supply, available from the Heath Company, incorporates a number of features that will make it attractive to servicemen, experimenters, and anyone interested in solid-state circuitry. It is capable of delivering from 1 to 30 volts at 1 ampere maximum load with less than 50-mV variation. For critical circuits where the voltage drop across the supply leads is critical, the
Now it costs less to own the best VOM you need.

The best you need is the new solid-state RCA WV-510A Master VoltOhmyst®. The most functional VOM we've ever produced, the 510A has all the features you'll ever need no matter what your requirements may be.

And we've added some extra features you won't find in any competitive VOM, at any price...features designed to make your work easier, help you get the job done faster.

For example: RCA WV-510A operates from batteries or AC. Remove the detachable AC line cord while you're taking a measurement and the batteries take over immediately without a flicker of the pointer. And you'll get maximum life from the batteries because they're always on trickle charge during AC operation. Stability? Switch from range to range and watch a whole series of measurements without constantly zero-adjusting the meter.

Some statistics:
Current:
0.01 milliampere to 1.5 amperes in 8 ranges.

Resistance:
0.02 ohm to 1000 megohms in 7 ranges.

DC Volts:
0.01 volt to 500 volts in 8 ranges.

AC Volts:
0.2 to 1500 rms AC volts in 7 ranges plus peak-to-peak voltages of complex waveforms.
21 megohm resistance on all DC ranges.

And it's only $128,† complete with DC/AC ohms probe and flexible shielded input cable with BNC connector, and removable AC line cord.

Some statistics! For complete details, contact your local RCA Distributor.

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CIRCLE NO. 27 ON READER SERVICE PAGE
IP-28 is equipped with a remote sensing feature that reduces the voltage variation to less than 20 mV. A front panel rocker switch selects range of either 1-10 volts d.c. or 1-30 volts d.c., and the output on both is continuously variable. Variable current limiting in two switch-selected ranges from 10-100 mA or 10 mA-1 amperes is also included to protect the load. A 3½” meter can be switched to indicate either voltage or current.

Circle No. 82 on Reader Service Page 15 or 95

MOBILE POWER INVERTER

The new "Quad-Continental" inverter available from Terado Corp. converts 12-volt d.c. to 117 volts a.c. at 60 Hz while maintaining the a.c. frequency within 0.25 Hz, regardless of input voltage or load. The Model 50-110 inverter can handle up to 1200 watts of output loading. Hence, it is ideal for powering small-to-medium compressor type refrigerators. The Quad is completely filtered for operation of sound equipment. It comes with a control harness and features solid-state circuitry and forced air cooling.

Circle No. 83 on Reader Service Page 15 or 95

STEREO FM RECEIVER FOR CARS

Stereo Magic recently announced a stereo FM receiver as an add-on accessory to fit all cars. With the Model DFM-888 receiver, any car owner can enjoy stereo FM broadcasts while on the road. The DFM-888 is all solid state in construction, employing 21 transistors, 11 diodes, and 4 thermistors.

The result is a powerful circuit with 101 dB sensitivity (signal-to-noise ratio of 30 dB); 5 watts r.m.s. of audio output power, and only 3% distortion at 1 watt. The receiver features a.c.f. with a holding range of 600 kHz and a frequency range of 50-10,000 Hz. The DFM-888 operates on 12 volts d.c., negative ground, and fits easily under the dash in most cars.

Circle No. 84 on Reader Service Page 15 or 95

PORTABLE CASSETTE RECORDER

A portable cassette recorder with random function controls and door loading has been made available by the Ampex Corp. Designated the "Micro 9," the recorder has position controls that allow random switching from one function to another without using the stop control. The door loading feature allows rapid and easy insertion and removal of cassettes. The Micro 9 operates on a built-in battery supply or from 117 volts a.c.; and with an optional adapter, it can even operate from a 12-volt source. Automatic record control, transistor regulated motor, and earphone monitoring during recording are among the extra features of the new recorder.

Circle No. 85 on Reader Service Page 15 or 95

HI/LO BAND MONITOR RECEIVER

A new Hi/Lo Band VHF-FM monitor receiver, Model CQP-50HL, from Courier Communications, has a built-in 117-volt a.c. power supply for home or office use; yet, it can be operated as a mobile receiver from 12-volt d.c. sources. It has six high-band frequencies between 150 and 175 MHz and six low-band frequencies between 25 and 50 MHz. Other features include exclusive crystal control on all channels (crystals not included) to assure on-frequency monitoring; solid-state design incorporating IC's exclusive r.f. peaking control for obtaining maximum sensitivity; adjustable squelch; and tone control switch for emphasizing highs or lows.

Circle No. 86 on Reader Service Page 15 or 95

PROFESSIONAL VTVM

The Mercury Electronics Corp. Model 1700C is an advanced design vacuum-tube voltmeter that will meet the demands of the technician's most rigid requirements. It has a large 6" wide-view meter featuring double jewelng at the pivot (with individual side and tail weights), anti-parallax mirrored scale, and easy-to-read scale markings. The highest quality components are said to be used throughout. Wide frequency response is featured in the a.c. voltage mode for compatibility with color TV receiver servicing, FM multiplex troubleshooting, and general industrial applications. Also available in kit form.

Circle No. 87 on Reader Service Page 15 or 95

AM/STEREO FM RECEIVER

Olson Electronics' 85-watt solid-state AM/stereo FM receiver, Model RA-194, has a brushed aluminum front panel with a three-dimensional effect that contrasts strikingly with its oiled walnut enclosure. Contemporary styling is enhanced by an illuminated slide rule dial, FM stereo indicator lamp, and precise tuning meter. Technical specifications: 2-µV FM sensitivity; greater than 30 dB multiplex separation; 20-20,000 Hz audio range; 4-16-ohm output impedance; 22-transistor, 13-diode, 2-IC, and one-PET complement; circuit breaker overload protection; headphone jack; tape output.

Circle No. 88 on Reader Service Page 15 or 95
The Tiger 23. The new untamable radio from Pearce-Simpson, a Division of Gladding Corporation.

The Tiger 23. A radio you'll have to reckon with. Because no other CB in the world can offer all these features at the same price. Only $149.95.


And more. 23 channels plus PA, modulation light, external speaker jack, plug-in dynamic microphone, and large illuminated combination RF-S meter.


And inside, the latest in solid state circuitry including ceramic filter to bring in sharp clear signals, Integrated Circuit, and Field Effect Transistor.

Put it all together and you've got a radio that won't quit. A radio from Pearce-Simpson, the finest name in Marine radios. CB's, antennas, and electronic communication equipment. And backed by Gladding Corporation, first in outdoor recreation since 1816.

The Tiger 23. If you can handle it.
Assemble these new RCA IC Experimenter's Kits quickly and easily. All the active and passive components, the pre-drilled printed circuit boards, and full clear instructions are included. (Add your own preference of alarm indicator to kits KC4005 and KC4006.)

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**KC4002: Audio Oscillator IC Kit** — for testing audio, hi-fi equipment, and amateur radio transmitters—also for code practice.

**KC4003: Amplifier/Oscillator IC Kit** — a 500 mW audio amplifier or a variable tone audio oscillator.

**KC4004: 9-V Regulated Power Supply IC Kit** — supplies 9 volts DC output with voltage regulation of 3% at a maximum current of 250 mA.

**KC4005: Intruder Alarm IC Kit** — a circuit that develops a “whooping” signal for a security system.

**KC4006: Fire Alarm IC Kit** — a low-melting-point solder sets off this circuit for a warning device.

**KC4500: IC Kit Enclosure and Hardware Pack** — optional for KC4000, KC4001, and KC4002 — a handsome, sturdy, prepunched case with input and output jacks, switch, and other hardware.

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(STARTING AT UNDER $5.00*)

* Optional distributor resale price
MATCH YOUR TV ANTENNA TO RECEIVER
FOR BEST POSSIBLE PICTURE

BY GEORGE MONSER

GOOD TV RECEPTION is not obtained by accident; it is carefully sought for and designed into your antenna system. You can get the best antenna and lead-in cable money can buy, but if the antenna is not impedance-matched to the cable and/or the cable is not matched to the TV receiver, you might just as well be using outdated “rabbit ears.” This is especially true for color TV reception—and not just in the “fringe” reception areas.

Everything in your TV receiving system must be just perfect, and the only way you can make sure that it is is to do the job right—the first time. But do not think that you have to be a TV antenna/transmission line expert to set up a receiving system. With the help of the information provided in this article, you can set up the best possible antenna system.

The Loss Factor. Nothing is perfect. No matter whether it is an automobile engine or an electronic circuit, every system suffers from some type of loss which reduces its efficiency. While you cannot completely eliminate receiving system losses (known as signal attenuation), you can limit them to an acceptable level.

To demonstrate how loss becomes a critical design factor, consider a 300-ohm folded dipole antenna (tuned or cut to any TV channel) connected to a length of 300-ohm twin-lead cable. Very little loss would occur between the antenna and cable for the channel to which the antenna is tuned. But for all other channels in the TV band, the loss might be as high as 3-4 dB; and over the complete band, an average loss of 2 dB would be typical, enough to cancel the characteristic 2-dB gain of the folded dipole (favorably oriented) antenna.

Now, consider a resonant 300-ohm folded dipole, reflector, and several director array (representative of most commercial TV receiving antennas). An estimated 2-dB loss would occur at the
antenna/cable connection due to the lowering of the dipole's impedance. (The effect of placing a reflector and directors in close proximity to the folded dipole is to lower the 300-ohm characteristic impedance of the dipole to about 70-100 ohms.) But since this antenna array provides 6-10 dB of gain, a 2-dB loss, severe in our first case, can usually be acceptable, particularly in good reception areas.

For both cases cited above, the cable lead-in loss, assuming about 40' of twin-lead at VHF, amounts to between 0.6 and 1 dB. Hence, the total loss in antenna signal strength is 3 dB. This means that only 50% of the antenna signal power would be delivered to the TV receiver.

Reducing the Losses. The choice of improving the antenna-to-transmission line match basically involves inserting an impedance-matching transformer between antenna and line. The drawing in Fig. 1 illustrates the makeup of one type of transformer you can use. It is easy to fabricate and consists of two lengths of 300-ohm twin-lead cable.

The decision of whether to fabricate your own transformer as opposed to buying one that is commercially made should depend on the end results. Tests made with both types show that at the 70-MHz frequency of channel 4, the commercial ferrite-core balun lowers the signal level by about 2 dB, while the quarter-wave, twin-lead homebrew transformer improves the signal level by 1.5 dB.

Lead-in attenuation, the other loss (amounting to less than 1 dB) can be slightly reduced, but not without considerable effort. Here, two possibilities exist: transition from the antenna to a homebrew 600-ohm open-wire lead-in and back to 300 ohms at the TV receiver; or transition from the antenna to homebrew 1"-diameter, 77-ohm coaxial line and back to 300 ohms at the receiver. Neither of these alternatives will yield a line loss less than 0.3-0.5 dB, which hardly seems worthwhile by itself. However, if a choice were to be made, it would probably be easier to stay with a balanced line and use 600-ohm open line. (Fig. 2 illustrates how this can be accomplished with #16 wire and a wire separation of 4" to yield a line loss of about 0.25 dB/100' at 88 MHz, or less than 0.15 dB for a typical 40' run.)

You may be wondering when and where it is advantageous to use these methods for improving signal transfer. As a general rule, they should be employed in "fringe" reception areas to improve weak TV channel reception. When making your own transformer or transformers, refer to the Table for the proper quarter-wave transformer lengths to use for each TV channel in the VHF spectrum. The lengths listed were computed assuming standard 300-ohm twin-lead cable with a phase factor of 0.84, which is typical for polyethylene-jacketed twin-lead.

Now, take three practical examples to show how to improve TV reception. In the first example, suppose you have a good quality commercial antenna array and wish to improve reception on Channel 4 by inserting a transformer section between the antenna and a 300-ohm twin-lead line. Select the transformer length section from the Table; in this case, 36" is indicated. Cut two pieces of twin-lead cable to exactly 36" (plus about ½" extra at each end). Strip away ½" of insulation from each end of both cables. Then, connect the lengths of twin-lead in parallel with each other (see Fig. 1).
Insert the transformer section between the antenna and twin-lead lead-in cable. This should yield an improvement of 1.5 dB in signal strength and a noticeable improvement in Channel 4 fringe-area reception.

For our second example, suppose you use the same antenna and want the best possible reception. Rather than running 300-ohm twin-lead cable, try using lower loss 600-ohm open line. This can be done fairly easily by following the instructions detailed in Fig. 2. At both the antenna and TV receiver, the line must be tapered gradually to the 600-ohm spacing of the open line. When completed, the installation should yield about a 2-dB improvement in signal reception, slightly better than in the first example.

As a final example, assume you are planning to erect the Pyramidal TV/FM Antenna ("Build the 'Pyramidal' TV/FM Antenna," POPULAR ELECTRONICS, July 1969). This antenna's impedance is about 150 ohms, which means that 300-ohm twin-lead cable is reasonably ideal to use. However, for the ultimate match, you should insert a tapered section of line between the antenna connecting terminals and the 300-ohm twin-lead lead-in cable as shown in Fig. 3 to improve reception by about 0.5 dB.

The added complication of tapering the line in the last example might not be justified, considering that this antenna has a nearly flat gain characteristic of 10 dB for all VHF TV channels.

Finally, suppose that even 10 dB of gain is not enough to provide quality fringe-area reception. You could stack two Pyramidal antennas as shown in Fig. 4 to obtain 13 dB overall gain. Here, the individual antenna connecting point impedances can be tapered to 600 ohms and then paralleled, providing an ideal match to the 300-ohm twin-lead cable line to the receiver. In the illustration, the center-to-center spacing between the antennas is 5'. Of course, the antennas could just as easily be placed side by side to yield the same resultant gain; but erection on a single mast is usually easier to implement.

Now that you have been apprised of good receiving system basics, you can start designing your own system. And with the warm weather here, what better time is there to tackle the job?  

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**Table:**

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<tr>
<th>VHF Channel</th>
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**Fig. 3.** Gradual taper matches 300-ohm twin-lead cable to 150-ohm impedance of Pyramidal Antenna.

**Fig. 4.** Open line matches two Pyramidal Antennas to 300-ohm cable. Note half twist in 600-ohm line.

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June 1970
VECTOR-CIRCUIT MATCHING QUIZ

BY ROBERT P. BALIN

Vector diagrams are widely used to show the magnitude and phase relationships between voltages and currents in an a.c. circuit. A knowledge of vectors is a must for understanding the theory behind frequency modulation and detection, color TV and feedback circuits.

Ten circuits (1-10) are shown below; vector diagrams (A-J) representing the voltages and currents in the circuits are also shown. To test your knowledge of vectors, match the diagrams to the circuits. Note that this is a simple matching quiz—obviously special cases might exist if the effects of resonance were considered. It is also assumed that all elements are pure (that is, capacitors have only capacitance, inductors only inductance, and resistors only resistance).

Standard counterclockwise vector rotation is used to indicate angles of lead and lag. A white arrowhead represents a voltage vector; a black arrowhead is a current vector. In all cases, the reference is the line along the horizontal, extending to the right. Relative vectors are shown for all voltages and currents in each circuit.

(Answers on page 96)
HAVE YOU EVER painted a very special piece of equipment, only to have it ruined by dust or bugs while drying? Or have you ever had a delicate biological or chemical experiment spoiled by strange gases and smoke in the air? If you have either of these, or any other, needs for a source of truly clean air, the "Transcipitor" is for you.

This clean-air device uses a high-voltage charge in an enclosed column of moving air to remove dust, smoke, and other particulate matter. The column enclosure can be made from a stack of discarded coffee cans (with the ends removed) or from a length of sheet-metal downspout, topped with a small blower. The electronic "heart" of the Transcipitor is a 10-kV d.c. power supply. Power for the device can be obtained either from a 12-volt battery or a transformer/rectifier combination operated from the 117-volt a.c. line.

How It Works. A single isolated conductor, connected to the high-voltage source, is run up through the center of the metal column—the latter being grounded. When air moves through the column all particulates receive a charge from the static field within the column. They immediately fly to the grounded column and cling there where they are joined by millions of other particles until there is actually a visible coat of dust on the inside of the column. When the power is turned off, the dust particles fall slowly to the bottom of the column and can be removed easily.

This system is essentially a miniature version of the type used in factory chimneys to remove residue from the smoke.
If you are going to use coffee cans for the column cut the bottoms out of five of them, but leave the bottom in the sixth for mounting the fan. Stack five cans together, align them as closely as possible and spot solder them together. Wrap tape around the seams to make them airtight.

The fan is mounted on the sixth (top) can. The fan can be salvaged from an old automobile heater or an evaporative cooler, or you can buy one at a surplus supply house. A small 12-volt type is best, but a fan with a 117-volt motor can be used. The fan and motor assembly should be smaller than the top of the coffee can on which it is to be mounted.

Cut a hole in the bottom of the sixth can to fit the fan intake and mount the fan as shown in Fig. 2. Temporarily set this can (and fan) aside.

Stand the 5-can stack up. In the bottom can, drill a series of 3/16" holes about 1/8" apart around the can about 1/2" from the bottom. (Most cans have an indentation ring around the can at about

Cabinet Construction. Dimensions of the case for the Transcripitor are not critical. A layout of the author's prototype is shown in Fig. 1. Any kind of wood (such as pine) can be used for the sides, top and bottom but the front and back panels are of thin hardwood. A 5" shelf, located 10 3/4" from the bottom of the cabinet is attached to the side and rear, with another screw inserted through the front panel when it is put into place.

Four 3/8" ventilation holes are drilled in the top, while the front panel is cut 6" or 7" short to allow air to enter at the bottom. The height of the column (in this case six 1-lb coffee cans, plus the fan) dictates the height of the cabinet. It is best to assemble the column first and then build the cabinet.
Fig. 3. The circuit is a simple power oscillator driving a voltage-doubler circuit. The two high-voltage capacitors and the flyback transformer can be salvaged from old television sets.

that point which you can use as a guide.) Deburr the holes. About 1\frac{1}{2}" from the top of the can (or in the top indentation ring if it has one), drill four holes 90° apart around the can. Use a thin bit (\#43) for these holes. Drill four similar holes in the fifth or top can.

Thread a \#6 nylon string through the four holes in the bottom can so that a "crosshair" is created. Make the string tight and apply a little glue on the outside knots to make sure that they hold. Do the same thing on the fifth can. These crosshairs will be used to support and insulate the high-voltage wire in the center of the column. Do not attach permanently the can with the fan at this time.

Place a plastic lid over the open end of the bottom can and stand the stack in the cabinet.

If you use sheet-metal downspout for the column, make the column as high as six coffee cans and drill all holes in approximately the same places. You will have to mount the fan on a piece of metal and secure this to the column later.

June, 1970
Power Supply. The circuit for the high-voltage power supply is shown in Fig. 3. For safety, the device is enclosed in a grounded metal container and the high-voltage output is taken through a feed-through insulator.

The supply is a simple transistor oscillator using extra windings on a conventional TV high-voltage horizontal output transformer. Two of these extra coils, a primary and a tickler feedback (L1 and L2 in Fig. 3), in conjunction with the transistor, form a regenerative feedback network similar to that used in receivers. When the power is turned on, current flows through L1 and the transistor. The magnetic field set up by this current generates a voltage in L2 that increases the forward bias on the emitter of Q1. The collector current through L1 then increases. Eventually, the core of the transformer saturates and the magnetic field around L2 stops building so that the emitter return to ground potential. The cycle then repeats. The oscillator frequency is near the upper end of the audible range.

The oscillator frequency is near the upper end of the audible range.

The transistor is biased by R1, which is bypassed by C1. Capacitors C2 and C3 protect the transistor from static discharges.

The current through L1 varies from zero to about 5 amperes. Because of the turns ratio between L1 and L3, about 5000 volts a.c. is developed across L3. A voltage-doubler/rectifier combination (V1 and V2 with C4 and C5) raises the voltage to about 10,000 volts d.c.

Caution. Although the current is low, voltages at the 10-kV level can be very dangerous. Do not, under any circumstances, turn on this high-voltage generator unless the case is completely closed and the high-voltage feedthrough is well in the clear. When the system is turned off for any reason, always discharge the high-voltage terminal using an insulated cable, with one end secured to cutoff. When no current flows through L1, there is no voltage across L2 and the emitter returns to ground potential. The cycle then repeats.
to ground and the other end held at the end of an insulated rod to touch the terminal.

**Power Supply Construction.** Remove the insulated filament winding from the flyback transformer. If there is a sponge-rubber pad between the core and the mounting bracket, remove it. Caution: the core is made of a brittle ferrite material in an epoxy binder. Therefore, do not force or twist it in any way. Gently remove the rectifier plate connector lead from the coil. Make sure that you can identify the high-voltage winding terminals.

Solder a two-lug terminal strip to each side of the mounting bracket as shown in Fig. 4. Wrap a layer of insulating tape on the bare horizontal ferrite core, feeding the tape between the core and the mounting bracket. Wind 12 turns of #18 stranded hookup wire in a close layer around the core. This forms L1. Solder the ends to the bottom insulated tie points of the terminal strips. If the winding does not pack tightly, remove it, and rewind with a slightly larger wire.

Wind a five-turn coil, using the same gauge wire, on top of L1. This forms L2. Solder the two ends to the top lugs on the terminal strips. Wind L2 in the same direction as L1 with the windings spaced evenly across L1.

Using the same type of wire originally used for the filament winding (removed in an earlier step), wind the two one-turn coils between the turns of L2. These form L4 and L5 and will be connected to the filaments of the rectifier tubes. Locate one end of the high-voltage winding and connect it to the nearest ground—the transformer mounting bracket will do.

Obtain a metal box, large enough to accommodate the transformer and the rectifier tubes, yet small enough to fit between the metal column and the side of the cabinet. It should be less than 10" high (including the insulator for the high-voltage feedthrough) so that the entire assembly will fit below the shelf in the cabinet.

The transistor is mounted on a heat sink using appropriate hardware and insulating material. Coat both sides of the transistor insulator with silicone heat-conducting grease. The heat sink assembly is mounted at the outside lower end of the rear panel to keep it away from corona discharges set up in the high-voltage section (see Fig. 5). Appropriate holes must be drilled in the rear panel to mount the heat sink and to provide access to the transistor terminals.

The flyback transformer is mounted at one side of the power supply enclosure (see Fig. 6) so that the high-voltage and filament leads face the two rectifier tubes. The tube sockets (of the anti-corona type) for the rectifiers are mounted on ceramic insulators, one on the top and the other on the bottom of the enclosure. Mount the other components as shown in Fig. 6 and wire them, point-to-point, as shown in Fig. 3. Take care to make neat, smooth joints and avoid sharp edges to prevent corona discharges. Resistor R2 connects from the rectifiers to the feedthrough insulator.

**Checkout.** Connect a 2- to 3-volt d.c. source to the battery input terminals,

---

*Fig. 5. The transistor is electrically insulated from its heat sink, and the heat sink is attached to the rear of the metal chassis. Make sure that no metal can contact the case (collector) of Q1.*

June, 1970
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June, 1970
with positive to ground. A pair of flashlight D cells will do. The circuit will oscillate with this low supply but voltage levels will be down. Try to draw an r.f. arc from the transformer high-voltage terminal using a well-insulated screwdriver. If there is no arc, even a small one, reverse the connections to L2. In some cases, it may be necessary to add or remove turns from L1 to obtain the proper core saturation.

Once you know the oscillator is working, connect 12 volts d.c. to the circuit and, being extremely careful, measure the voltage at the filaments of the rectifiers. It should be between 1.2 and 1.5 volts a.c. Make sure that no part of the voltmeter or your body touches ground when making this measurement! Once filament voltage has been confirmed, shut down the power supply, discharge the high-voltage feedthrough, and assemble the metal enclosure, making sure that it is completely sealed.

As a final check, connect the circuit to a heavy-duty 2- to 12-volt power supply (such as a battery charger) capable of handling 5 amperes. Connect an ammeter in the input lead. With a 2-volt input, the ammeter should indicate about 0.5 ampere. With 12 volts input, current should be about 2 amperes. The reading could go as high as 5 amperes if the circuit is loaded with a high-voltage experiment.

DANGER! There is at least 10,000 volts present on the top of the feedthrough insulator! Treat it with the greatest respect. Don’t try to draw arcs with a pencil, and don’t short this terminal to ground when the supply is energized. Also, don’t touch the transistor case while the supply is operating.

Shut down the power supply, discharge the high-voltage feedthrough, and place the power supply in the cabinet as shown in Fig. 7, with the battery terminals and pilot light facing front.

Mark the point on the metal column that is directly opposite the top of the high-voltage feedthrough. Drill a ¼” hole at this point and deburr it. Obtain a length of high-voltage plastic tubing long enough to go from the top of the feedthrough to the center of the column. For still better insulation, insert another piece of ⅛” tubing inside the first one. Feed a length of #22 or smaller wire through this insulator leaving enough at one end to make a connection to the feedthrough and a small loop at the other (column) end, at the center of the crosshairs.

Attach a length of fine nichrome wire (obtained by dismantling an old wirewound resistor) to the loop of wire at the bottom crosshair (wind the copper wire around the nichrome) and to the crosshair itself for support. Pass the nichrome
wire up through the column and attach the top end to the upper nylon crosshair, making sure that the wire is reasonably straight and does not come near the sides of the metal column. Cut off any loose end.

(Nichrome wire is used here because the high voltage produces a tiny corona which would ruin copper wire but does not harm the nichrome. Steel wire can be used, but it will eventually rust and disintegrate.)

Do not use any mechanical device to connect the nichrome wire to the high-voltage lead since this joint will have to be disassembled occasionally so that the column can be removed for cleaning. Replace the plastic cover on the bottom of the column. Place the blower container on top of the column, making sure that the exhaust is toward the front of the cabinet. Secure this can in place by wrapping tape around the seam. Make a wire connection between the metal column and the metal chassis of the power supply by soldering at both ends.

The appearance of the stack can be improved by spraying it with paint, but don't get paint in the blower mechanism or on the high voltage leads.

Line Operation. The Transcipitor can be operated from a conventional low-voltage d.c. power supply such as that shown in Fig. 8. Mount the transformer on the small shelf in the cabinet and the filter capacitor on a clamp secured to the cabinet wall. A TV power socket is mounted on a small piece of metal and located on the cabinet wall so that power can be applied to the system only when the front panel is in place. A TV "cheater" supplies power to the socket and is mounted on the front panel aligned with its receptacle. The two rectifier diodes are mounted on a heat sink on the rear wall. Wire the power supply point-to-point as shown in Fig. 8.

If the fan motor is of the 12-volt variety, wire it to the power supply, observing proper polarity. If the motor is 117 volts a.c., connect it in parallel with the input to the power transformer.

Final Assembly. The finished project should now look like the one in Fig. 7. The column, with the fan at the top should just fit snugly within the cabinet.

It may have to be wedged if too loose; or the cabinet top may have to be hollowed out slightly if the fit is too tight. Recheck all wiring, making sure that the metal column is connected to the positive battery input (at ground) on the supply. Make sure that the high-voltage feed is in the clear and that all parts attached to the cabinet walls are on tightly.

Obtain a length of flexible vacuum cleaner hose. The hose should be covered with plastic rather than cloth to make cleaning easier. Wash the hose thoroughly, inside and out, with a good detergent and then rinse thoroughly. Cut a hole in the front of the cabinet so that the end of the hose and the exhaust on the fan can be mated. It may be necessary to make up some type of size-matching device if the two are greatly different in size. Check all dimensions, and then mount the front panel on the cabinet using a few screws to secure it.

Fig. 7. Coffee-can stack was painted before installation to make a more pleasing appearance. The four top vents provide cooling for power supply.
Operation. With the front panel in place and the a.c. supply connected, the blower should start up and moving air should be felt at the outlet. Hold a lighted cigarette or other source of smoke near the ring of holes at the bottom of the column. If everything is working properly, smoke will enter the column, but the air coming out will be clean with no trace of smoke.

For conducting delicate experiments or for drying paint on small items, another cabinet such as that shown in Fig. 9 can be constructed. The vacuum-cleaner hose is coupled to this cabinet; and a small vent in one wall permits the air to escape from the interior. The front door can be constructed with a glass insert and a light bulb can be installed within the cabinet for viewing experiments.

When it comes to removing pollen, dust, etc. from an area as large as a room, the Transcipitor will work—to an extent. It does not have the capacity to handle a very large room; but, in a small room, with windows and doors closed, its effect is quite noticeable.

Every so often, inspect the metal column for dust accumulation. Remove the column from the cabinet, hold it over a paper sack and remove the bottom plastic cover. Shake the column gently to remove dust particles stuck to the sides. Clean the inside walls before reinstalling the column in the cabinet. The stack can be inspected from the outside by shining a flashlight through the bottom array of holes and looking into the other holes. If you can see the dirt, empty the column.

Fig. 8. This power supply operates both the air purifier and fan and is mounted on the case wall above the h.v. supply. Use a heat sink for the two rectifiers.

Fig. 9. The front door does not come down to the bottom of the cabinet to allow for air intake and observation of the indicator lamp. To prevent operation when the door is open, a TV "cheater" system is door operated.
THE SIGNAL INJECTION technique, most electronics technicians agree, is the quickest way to troubleshoot radio receivers and audio equipment. Using a signal injector, he can check an entire unit with only one hookup—no matter how complex the receiver or amplifier. Time-consuming voltage or ohmmeter checks are required only when the faulty stage is located.

Whether you plan to use it on the job or at home to keep your own equipment in working order, you will find many uses for the “IC Signal Injector” described here. This Injector is basically a battery-powered 1000-Hz multivibrator that generates square waves. The amplitude of the output square waves is continuously variable and is great enough, with the amplitude control wide open, to drive or test a loudspeaker. The Injector also provides a wide band-width r.f. signal which is extremely useful in testing AM receivers.

**Construction.** As you can see from the schematic diagram in Fig. 1, the circuit of the IC Signal Injector is very simple. However, since it does employ an integrated circuit with closely spaced pin leads, it is essential to use a printed circuit board. You can obtain a prepunched and etched board from the source listed in the Parts List, or you can make your own with the aid of the etching guide provided in Fig. 2.

Install the components on the board as shown in the photo in Fig. 3, paying particular attention to the orientation of the indexing groove on IC1. Use a low-wattage, fine-pointed tool when soldering component leads to the foil pattern on the board.
the PC board, and apply heat only long enough to allow the solder to flow.

Next, mount R3, C3, S1, and J1 and J2 on the front panel. Use %”-long spacers and #6 machine hardware to fasten the circuit board to the front panel in the position shown, and interconnect with hookup wire all components and the circuit board.

Battery B1, two 1.5-volt D cells connected in series, can be mounted to the rear panel of the enclosure with a dual-cell holder. However, if you plan to use another type of d.c. supply (see sidebar), make the hookup wires connected to S1 and ground on the circuit board as long as necessary.

How To Use. To test the IC Signal Injector, close S1 and connect a small 3.2- or 8-ohm loudspeaker to the AUDIO jack on the front panel. Rotate LEVEL control fully clockwise; you should hear a 1000-Hz tone coming from the speaker. An

HOW IT WORKS

Integrated circuit IC1 in Fig. 1 is a dual inverting buffer. Each input has two outputs, one low- and the other high-level. The low-level outputs are cross-coupled to each buffer input through capacitors C1 and C2 and charging resistors R1 and R2 to form an astable multivibrator.

One high-level output is fed to level control R3 and AUDIO jack J1 as a 1000-Hz signal. Internal isolation between low- and high-level outputs prevents heavy loads—or even short circuits—from stalling or radically shifting the operating frequency of the multivibrator.

Capacitor C3 couples only the high-frequency energy (derived from the harmonic-rich leading edges of the square waves generated by the multivibrator) of the audio waveform to RF jack J2. At J2, there is available a series of impulses that can be used for signal injection and other AM radio receiver work.

Fig. 2. Actual size circuit board etching guide is designed to accommodate components not mounted on front panel of the project. Isolated dots locate mounting holes.
IC EXPERIMENTER’S POWER SUPPLY

The low-voltage power supply whose schematic is shown here can be used with any and all of the “IC Experimenters’ Corner” projects presented in this series. Note that the supply has full-wave rectification and very good filtering to supply a stable d.c. voltage source for the IC projects. Output voltage from the supply is approximately 6.3 volts d.c.

The power supply can be assembled by any conventional method, including point-to-point wiring. Very few components are used and they are relatively small in size. Hence, the supply can be fit inside any of the enclosures suggested for the various projects.

**PARTS LIST**

C1—0.1-µF disc capacitor
C2,C3—4000-µF, 15-volt electrolytic capacitor
D1,D2—25 PCV, 1.5-ampere silicon diode
S1—S.p.s.t. slide or toggle switch
T1—6.3-volt, center-tapped filament transformer
      (Stancor No. P-6134 or similar)
1—Line cord with plug
Misc.—Hardware, hookup wire, solder, etc.

*Note—A kit of parts for the power supply is available at $4.50 postpaid from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78210.*

Alternate test method would be to connect the audio output of the injector to an audio system, setting the LEVEL control as needed, and listen for the tone.

The output from the RF jack on the injector is rich in harmonics to allow the checkout of the front ends in most receivers, including those that operate in the standard AM broadcast spectrum.

For example, assume you want to troubleshoot a faulty AM transistor radio receiver. First check the receiver’s battery under load with a voltmeter. If it checks out good, proceed to your signal injection tests:

First inject the audio signal into the speaker, directly across the speaker terminals. If you hear the tone, the speaker is in operating order. Then, stage by stage, work back toward the front end of the receiver until the signal ceases to be heard from the receiver, at which time you will have located the faulty stage. (Note: when injecting into the audio circuits, use the audio output; for the i.f. and r.f. stages, use the r.f. output.) You should end up at the antenna input if the receiver is in perfect operating order.

If you wish to change the audio frequency of the tone, you can change the values of C1 and C2. Higher capacitance values decrease the signal frequency, and vice versa.

Current drain for the IC Signal Injector is on the order of 80 mA at 3 volts d.c., assuring long life from a battery supply, especially if you use heavy-duty alkaline cells. If you prefer a built-in power supply, however, you can build your own by referring to the schematic diagram shown in box above. Or, you can use any good bench supply capable of delivering 1.6 to 6 volts d.c. at about 100 mA for full-load operation.

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**Fig. 3. Pay particular attention to location of notch on IC1 during assembly of project. Mount C3 between J1 and J2.**

June, 1970
THE MOST EFFECTIVE teaching aids and the most interesting science fair projects are working models of mechanical, electrical, or electromechanical devices. The photocell motor control demonstrator described here falls into this category. Unlike most such projects, however, it offers audience participation. Passersby are invited to turn on and off a motor themselves simply by shining a beam of light on a photocell.

By spreading out the circuit on a large 15 1/4" x 24" piece of 1/2"-thick plywood and running the wires on the front surface of the board a twofold objective is achieved. First, the project has eye appeal (an important consideration at science fair judgings). Second, since there is no hidden circuitry on the rear of the board, it is more convenient to explain how the system operates.

How It Works. Photocell PC1 (see Fig. 1) is connected across the emitter/base junction of transistor Q1. Then when light strikes PC1, a slight voltage is generated which causes Q1 to conduct. This, in turn, causes relay K1 to be energized and power is applied to the motor. Simultaneously, K3 is energized and latched in since its circuit is completed through the contacts of K2. (If the light beam is removed from PC1, relay K1 will drop out.) The entire sequence takes place in just a few milliseconds, so just a quick flash of light on PC1 is enough to operate the circuit.

To turn off the motor, a beam of light must be directed at PC2, which generates a voltage that causes Q2 to go into conduction. Now, K2 is energized, opening its normally closed contacts and de-energizing K3. When K3 drops out, the motor circuit is opened, and the motor stops operating. Again, the action is almost instantaneous.

Construction. Begin by selecting a 1/2"-thick piece of clear plywood measuring 15 1/4" x 24" (or substitute a close-grained piece of particle board, cut to the same dimensions). If you use plywood, make sure the top lamination is birch so that there will be less of a tendency for the wood to crack after it has been painted. Sand the wood to obtain a smooth, flat finish, remove all wood dust, and apply a thin coat of sealer.

When the sealer has thoroughly dried, sand and clean once more. Now paint the board with thin coats of white or light gray enamel, using as many coats as nec-
each necessary from the ed side the 2, through this mounting dimensioned

connected are in place. Appropriate nuts. Next, board, through mounting hole exits are 1½" piece of ¼" birch plywood or close-grained particle board. 1—3-volt d.c. hobby motor. Misc.—6-32 brass machine hardware; crimp-on solder lugs; #14 plastic-jacketed solid hook-up wire; sandpaper; sealer; white or light gray paint; battery connectors (2) for B1; etc.

Fig. 1. Relays, operated by photocell-driven amplifiers, apply and remove power from the motor.

PARTS LIST
B1,B2—1.5-volt D cells (see text)
B3—9- or 12-volt power source (see text)
K1—1000-ohm, ½-watt s.p.s.t. relay (Sigma Type 11F-1000-G/SIL)
PC1,PC2—Solar cell (International Rectifier Corp., SIM, or similar)
Q1,Q2—2N404, 2N1191, or SK3006 transistor

Pass a 6-32 × 1" brass machine screw through each hole from the rear of the board, and fasten in place with machine nuts. Next, mount the motor in its proper location by any convenient method, and epoxy cement PC1 and PC2 in place. The size D flashlight batteries are soldered to ±14 solid wire and connected to the appropriate screws with solder lugs, making a neat and sufficiently strong arrangement.

The potentiometers should be made self-supporting by soldering their contacts to solder lugs (see Fig. 3) and fastening them to the screws. The leads of transistors Q1 and Q2 are simply connected to the screws directly or via solder lugs.

Wiring is best accomplished by cutting the leads to the appropriate sizes and attaching to each end a solder lug, after which the leads are simply bolted into place with machine nuts. Use #14 solid, plastic insulated wire to obtain the neatest layout and so it can be seen for a considerable distance. Remember, the bold appearance of the wire adds to the success of your project.

The power source for the transistors consists of two 9-volt batteries in parallel. No switch is provided, since the battery connector easily snaps on and off the batteries. (When the demonstrator is to be used for long periods, such as at Science Fairs, two heavy-duty 6-volt lantern batteries can be connected in series and hooked up to the circuit in place of the 9-volt batteries.) Mount the 9-volt batteries as shown, and route their wires behind the board. The dashed lines in Fig. 3 show where the battery leads terminate in the circuit.

No switch is provided in the motor power supply since the D cells supply no

necessary to give a hard reflective finish. Remember to sand and clean between each coat and allow sufficient time to dry.

Note that the board is painted before the holes are drilled. The reason for this is to prevent the screws from picking up paint when they are pushed through the holes.

Using the information provided in Fig. 2, drill ½" holes for parts mounting on the board. Drill through from the painted side so that as the drill point exits from the wood, any flaking or chipping will be on the unseen side of the board. (Note that holes for the relays are not dimensioned into the drawing since different types of relays require different mounting hole centers.)

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power when the circuit is in standby. The D cells are in a series-parallel configuration to provide long life.

Adjustment and Use. After making a complete check of your wiring, cover PC1 and PC2, and set R1 and R3 to their mid-range positions. Connect the 9- or 12-volt power source to the circuit, but do not install B1 and B2 yet.

Uncover PC1 and from about 5’ away, direct a light beam onto it and adjust R1 so that K1 is energized when the light strikes PC1. Move the beam away from PC1; K1 should be immediately deenergized. Listen for the clicks.

Now, with PC1 covered and PC2 exposed, again from about 5’ away direct a beam of light onto PC2. Adjust R2 so that when the beam strikes PC2, K2 is energized. Then, when the beam is moved away from PC2, K2 should immediately drop out.

Uncover both photocells. Now direct the flashlight beam onto PC1, and adjust R3 until K3 pulls in when the light strikes PC1. Check that K3 remains locked in and is deenergized only when the light beam is directed at PC2.

Now install B1 and B2 and recheck the operation of the circuit.

Potentiometers R1 and R2 are sensitivity controls that can be adjusted for optimum circuit operation under whatever ambient light conditions exist in the vicinity of the demonstration setup.
MANY FM BROADCAST stations transmit a secondary frequency-modulated subcarrier that is offset from the regular carrier frequency by 67.5 kHz. This sub-carrier channel (called SCA for Subsidiary Communications Authorization) provides the listener with continuous music programming that is uninterrupted by commercials, news, weather, or other reports. The SCA should not be confused with the 38-kHz subcarrier normally used to carry the complementary channel in normal stereo FM broadcasts; it is a separate system which no home entertainment receiver is designed to receive.

Perhaps you are already familiar with the SCA broadcasts. You hear them in such places as restaurants, supermarkets, and other commercial establishments as “background” music. If you would like to receive the SCA subcarrier with your present receiver, all you need is a simple multiplex adapter that can extract the program material without interference from the “normal” program channel transmissions from the FM station.

Adding the SCA Adapter (described in this article) to your FM receiver will in no way interfere with the receiver's normal operation. If anything, it will add to the receiver's versatility by providing an extra source of entertaining music.

How It Works. Referring to Fig. 1, the frequency-modulated SCA subcarrier is introduced into the adapter through input jack J1 where it encounters a 67.5-kHz parallel-tuned circuit consisting of radio frequency choke RFC1 and capacitor C3. Then it is passed through a high-pass filter made up of C2, C4, and RFC2. From here, the frequency-modulated subcarrier is amplified and limited by Q1 and Q2, respectively. At this point, the frequency modulation will have been converted to a series of pulses whose frequency is the same as that of the original frequency modulation.

Once amplified and limited, the signal is coupled to monostable multivibrator stage Q3-Q4. Here, Q3 is normally conducting, while Q4 is held in cutoff. Po-
tentiometer $R_{12}$ acts as a "threshold" control, allowing only the higher amplitude 67.5-kHz subcarrier signals to trigger the multivibrator. Each time the multivibrator fires, a negative pulse is generated at the collector of $Q_4$.

Since the width of the generated pulse is essentially independent of the triggering rate, the average voltage level appearing at the collector of $Q_4$ will be directly proportional to the triggering frequency (the 67.5-kHz modulation) up
to the point where $Q_4$ is cut off completely all the time. This point is slightly above the audio spectrum; therefore, the multivibrator will deliver an output for the full subcarrier modulation range.

Power for the SCA adapter is derived from any 6.3-volt, 60-Hz, source. A built-in half-wave rectifier/filtering circuit, consisting of $D1$ and $C15$, $C16$ and $R19$, provide the d.c. voltage required for proper operation of the adapter.

Although the SCA Adapter so far described makes use of five commonly available n-p-n silicon transistors, germanium or p-n-p transistors can be substituted. Merely change the polarities or values of a few components. The changes that must be made for transistor substitutions are given in the table on the next page.

**Construction.** The circuit of the SCA Adapter is really very simple, lending itself to just about any type of chassis construction you prefer. While the photos show the original prototype assembled on a double-row solder-terminal tag strip, which is essentially point-to-point wiring, a printed circuit board layout would have been just as appropriate for assembly.

The circuit can be assembled in any enclosure you choose. A 5" × 2½" × 2½" aluminum utility box was used for the prototype, with $J1$ and $J2$ mounted at opposite ends of the top surface. Threshold control $R12$ was also mounted to the top, while to one side is located a screw-type barrier block for bringing in the 6.3 volts a.c. for the power supply circuit.

**Installation and Use.** To operate properly, the SCA adapter must be electrically connected to your receiver. This is a simple process that can be performed in a couple of minutes.

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**A NOTE ABOUT THE LAW**

There is no FCC Regulation that prohibits the reception of Subsidiary Communications Authorization broadcasts for private home entertainment purposes. However, there are regulations that do prohibit the use of SCA programs to promote business (or any other reason) by commercial establishments unless such businesses are authorized subscribers and use only the SCA channel to which they subscribe.

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Transistors can be installed in sockets or soldered directly to lugs. Locate a.c. filter capacitors on underside of terminal board and the barrier block at end of box.

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Before digging into your receiver (or tuner), carefully study its schematic diagram to locate the detector stage and resistor/capacitor de-emphasis network. Then, study the receiver layout to locate the point indicated in Fig. 2. You will notice that the SCA Adapter's input must be connected to a point between the detector output and the de-emphasis network. If the connection is made after the de-emphasis network, no SCA signal will pass through!

The filter (SCA Adapter) was designed to operate most efficiently with a 3000-ohm load. So, it may be necessary to couple the adapter to the receiver circuit via an isolation resistor with a value of a few thousand ohms, depending on your particular receiver.

Now, connect a twisted-pair cable between the 6.3-volt a.c. winding on your receiver's power transformer and the screw-type barrier block on the adapter. If 6.3 volts a.c. is not available from your receiver, use a separate 6.3-volt filament transformer. Then connect a shielded audio cable from the adapter's output jack to the auxiliary (AUX) input jack on the rear apron of your receiver.

Turn on and tune the receiver to a local FM station known to be broadcasting SCA program material. Set the receiver's source switch to AUX and function switch to MONO, and adjust threshold for the clearest audio. (Note: in some receivers, when the source switch is moved out of the TUNER or FM position, the power is disconnected from the tuner. In this case, connecting the output of the adapter to the receiver's AUX input will not work—a separate amplifier will be required unless you can figure a way of restoring power to the tuner when the source switch is in the AUX position.

Tuning across the dial, you may find that several SCA programs are available. This is true especially in the large cities where different types of background music are required by the subscribers. So much the better for your choice of programs.

Although a printed circuit board or multi-lug terminal strips could be used, wiring is just as simple with a parallel-row terminal board having 13 solder lugs per row as shown here.

**TRANSISTOR SUBSTITUTION TABLE**

<table>
<thead>
<tr>
<th>Transistor Type</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>PNP silicon</td>
<td>Invert polarities of D1, C12-C16</td>
</tr>
<tr>
<td>NPN germanium</td>
<td>Change R2,R6,R16 to 6800 ohms</td>
</tr>
<tr>
<td>PNP germanium</td>
<td>Combine both of the above changes</td>
</tr>
</tbody>
</table>

52 POPULAR ELECTRONICS
EVERY MUSICAL instrument owes its unique sound to a certain combination of inherent characteristics. For instance, the number of harmonics produced, combined with their magnitudes and phase relationships, play an important role in creating the instrument’s distinctive sound.

Another important characteristic is attack time—the speed with which sound is built up after a tone is initiated. Reed instruments such as the clarinet produce sounds which can be described as “soft” because they have a relatively slow attack caused by the time it takes for the reed to build up to its maximum vibration. On the other hand, instruments such as the guitar have a very rapid attack because maximum amplitude vibration is started as soon as the string is plucked or struck.

By changing an instrument’s attack, we can make it sound different and, at the same time, not like any other instrument. That is what the “Attack Delay Unit” (ADU) does for the guitar. By slowing down the guitar’s attack, a brand new sound can be obtained. The effect can also be produced by recording a guitar passage on tape and then running the tape backwards through the player. Instead of sharp, clean tones, a hard-to-describe “whoop” is heard for each note played. Although the note is on pitch, it doesn’t sound like it belongs to any known musical instrument.

Using the ADU, attack can be delayed for a very short period so that only the sound of the pick hitting the string is eliminated or it can be delayed so that the music builds up over the length of a run. A foot control switch makes it easy to delay particular notes selectively.

Construction. The circuit of the ADU, shown in Fig. 1, is fabricated on a printed circuit board whose foil pattern is shown in Fig. 2. Once the board has been made (or purchased), install the components as shown in Fig. 2. Be sure to install the semiconductors and electrolytic capacitors correctly. Use a heat sink (such as long nose pliers) on the transistor and diode leads while soldering to avoid possible thermal damage. Also, use a low-power (35 watts) soldering iron.

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53
"Get more education or get out of electronics... that's my advice."
Ask any man who really knows the electronics industry. Opportunities are few for men without advanced technical education. If you stay on that level, you'll never make much money. And you'll be among the first to go in a layoff.

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Fig. 1. The circuit is essentially a two-transistor, high-gain audio amplifier with negative feedback controlled by a FET. The remainder of the circuit generates the feedback control signal which is determined by a switch-selected capacitor.

PARTS LIST

C1,C12 - 100 µF, 6-volt electrolytic capacitor
C2,C4,C5 - 0.1-µF disc capacitor
C3 - 30-µF, 6-volt electrolytic capacitor
C6,C7,C10 - 5-µF, 6-volt electrolytic capacitor
C8 - 10-µF, 6-volt electrolytic capacitor
C9 - 2-µF, 6-volt electrolytic capacitor
C11,C13 - 0.005-µF, disc capacitor
C14 - 0.01-µF, disc capacitor
C15 - 100-µF, 15-volt electrolytic capacitor
C16 - 1000-µF, 10-volt electrolytic capacitor
D1,D2 - 1N4001 diode
J1-J3 - Open-circuit phone jack
Q1-Q6 - Transistor, pnp (National 2N5139 or similar)
Q7 - Field-effect transistor (Motorola MPF102)

R1,R3 - 33,000-ohm
R2,R19 - 100,000-ohm
R4,R11,R16,R17 - 4700-ohm
R5,R6,R9,R14 - 1000-ohm
R7 - 47-ohm
R8 - 10,000-ohm
R10 - 2.2-megohm
R12 - 220,000-ohm
R13 - 470-ohm
R15 - 100-ohm
R18,R22 - 680-ohm
R20 - 47,000-ohm
R21 - 50,000-ohm trimmer potentiometer (PC type)

S1-S4 - S.p.s.t. toggle switch (see text)
T1 - Power transformer, secondary, 12.6 volts at 300 mA
Misc. - Chassis, line cord, rubber grommet, 7-" terminal strip, 1/2" insulated spacers (4), rubber feet (4), wire, solder, etc.

Note - The following are available from PAIA Electronics, P.O. Box 14339, Oklahoma City, OK 73114: etched and drilled PC board, $3.00, postpaid continental U.S.A.; complete kit of parts including PC board and case, $19.25, plus postage for 3 lb. Oklahoma residents add 3% sales tax.
Connect sufficiently long leads to the various external connection pads before mounting the board in the chassis.

Almost any type of metal chassis may be used as long as it will hold the PC board, the power transformer, and the associated rectifier and will permit the installation of four switches on the front and three phone jacks on the back.

The choice of switches for S2, S3, and S4 should be made carefully. During use, it may be necessary to manipulate these switches rapidly in various combinations so they should have large paddle-type handles and operate with a light pressure. Any type of s.p.s.t. switch may be used for power switch S1.

Mount the power transformer (T1) and a seven-lug terminal strip at one end of the chassis and drill a hole in the wall for the line cord. Put a grommet in this hole. Build up the power supply and attach the positive lead to S1. Do not ground either side of the a.c. to the chas-

Fig. 2. The actual size foil pattern is shown at the left, while component installation is illustrated below. The PC board is mounted on four spacers, and the power supply is mounted elsewhere in the cabinet. Alternatively, the ADU can be built in an existing amplifier console, with the control switches readily accessible to user.
sis. Mount the three capacitor-selector switches (S2, S3, and S4) on the front wall and three phone jacks (J1, input; J2, foot control; and J3, output) on the rear wall.

Mount the PC board on four \( \frac{1}{4} \)" insulated spacers so that R21 will be accessible from the side. Wire the complete circuit as shown in Fig. 1. Put four rubber feet on the chassis bottom to keep it from slipping around when in use.

Setup. Prepare the unit for operation by running a short length of cable from the output of the ADU to your amplifier input and plugging the instrument output into the ADU input. For the time being, do not use the foot control switch. Turn the ADU on and set the delay to 4.

Since a certain minimum signal is required to operate the delay unit, the instrument's gain should be turned up almost all the way and the volume adjusted by using the amplifier's control.

The only thing that needs adjustment in the ADU is potentiometer R21. At one

With no signal input, transistor Q6 is turned on and acts as a short circuit around the switch-selected capacitors C3, C9, and C10. The gate bias of FET Q7, in this case, is such that the FET is turned on and its low source-to-drain resistance results in a large amount of feedback for the linear amplifier formed by Q1 and Q2. Since this amplifier is designed for unity gain with no feedback, for all practical purposes, no input signal passes through it.

When there is an input signal, it is amplified by high-gain amplifier Q3 and Q4 and then rectified by peak detector DJ. The resulting d.c. voltage appearing across C7 turns on Q5, which then turns off Q6 and allows the selected capacitor to charge. As the capacitor charges, the bias on Q7's gate changes to increase its source-to-drain resistance. The increase in resistance around the linear amplifier loop decreases the feedback and causes the gain to go from nearly zero to approximately unity. The time required for this to take place depends on the capacitance value selected. Trimmer potentiometer R21 acts as a threshold control and sets the bias on the gate of Q7 when Q6 is on.

When the foot control switch is closed, the base of Q6 is shorted to ground, allowing the selected capacitor to remain charged. This holds the linear amplifier at unity gain and defeats the attack delay.

The power supply is built up on a seven-lug terminal strip which also carries the input a.c. line cord. The arrangement is not critical, but make sure that neither side of the power line makes electrical contact with the chassis.
When obtaining switches for the delay selection, remember that they may be operated a considerable number of times, in various orders, and possibly in a hurry. Pick switches with long handles and smooth operation.

end of this pot's rotation, there is little or no delay in the instrument attack; with the opposite setting, there is no sound for an instant and then the volume will come up full. Between these two extremes, are a variety of settings which can be selected strictly as a matter of personal taste. Ideally there should be very little or no sound when the note is first struck, followed immediately by a noticeable increase in volume with a smooth glide to maximum.

Operation. The three delay switches on the ADU can be used singly or in combinations to yield up to seven different delays. The numbers above the switches represent some arbitrary unit of delay (which varies with the setting of R21) and may be added together to get the longer delays. For instance, if the "2" and "4" switches are down, the attack delay is 6 times longer than if only the "1" switch is down.

Since the ADU requires a short, no-signal dead time for the circuits to reset, all strings on a guitar must be silenced before the next chord or note is struck. If single notes are being played, just lifting the finger from the fingerboard will ordinarily accomplish the deadening, but for chords with open strings, it is necessary to deaden the strings with the palm of the strumming hand. The resetting time is actually very short (on the order of a tenth of a second) so very rapid runs can be played with the delay still occuring on each note.

The foot control switch is a single-pole, single-throw type and can be housed in a sturdy case of metal or a block of wood. The switch can be a push-on/push-off type but experience has shown that a spring-loaded, normally closed switch works best. With this arrangement, selective delay can be accomplished by pressing the switch when delay is desired and releasing it to sustain a note.
Buck Up Bass Response With a Super Woofer

By Eric Pavlak

One of the best methods of getting good bass response from your stereo system is to use a super-powerful woofer in addition to your regular speaker systems. Since the very lowest bass notes, those under 100 Hz, are non-directional, a single super woofer setup will serve both stereo channels. Consequently, your regular speaker systems can have less than full bass response and still be quite satisfactory.

A super woofer, for best results, should be powered by a separate amplifier. This provides several distinct advantages over systems connected by an LC crossover network. For one thing, the independent bass amplifier (actually, it can be any amplifier with very good bass response) can be adjusted without interfering with the main amplifier. So, the volume level of the super woofer can be set in relationship to the rest of the system without introducing resistance in series with any of the speakers—a resistance that would prevent good speaker damping.

Also, a separate amplifier allows the lowest bass to be increased without upsetting the balance of the rest of the system. And it permits the use of steep-sloped filters of 18-dB/octave that would otherwise be impractical. One further advantage of using a single super woofer is that no phasing problems exist.

The amplifier for the super woofer should be coupled to both the right and left channel outputs of your regular amplifier. For this, you will need a circuit like that shown in the schematic diagram. This circuit is simpler than an electronic crossover network with active elements and it introduces less distortion than a passive filter which uses both capacitive and inductive elements.

Crosstalk introduced by this adapter circuit is minimal. Signal level is adjusted by control R6. When assembling the circuit, mount it inside a shielded box. Parts placement is not critical, but be sure to use shielded cable between the circuit output and the input of your super woofer amplifier.

The super woofer itself can be as big as your listening room will allow and as expensive as your budget can take. Several 12” or 15” woofers can also be used; or, better yet, you can use one of the horn-type woofers available from Altec or Klipsch.

The best place in a room to set the super woofer is in a corner. And since only the lowest frequency sounds are to be radiated, it matters little if furniture or thin draperies are located between the super woofer and listener. But be wary of standing waves which can result when large, flat surfaces are directly opposite the speaker.

A super woofer is just the thing to improve weak bass systems. Adding one is relatively simple and inexpensive yet it can provide really thunderous lows without mid-bass thumping or booming.
KOOL-KEEPING KWIZ

BY CARL KOHLER

How well do you cope with life’s bruises and abrasions?

It’s a philosophical fact that into every existence a little pain must crawl. The question is, “How well do you withstand the pain?” To find out, take the following pseudological test, consisting of several theoretical life situations no electronics enthusiast is likely to encounter. The test does not purport to increase your self-knowledge, but it may add to your confusion. A dubious scoring system, found at the conclusion of the test, is based on whichever of the multiple-choice reactions you instinctively and neurotically selected. No cheating now—and good luck!

Supermouth

While attending a social gathering, you hear a loud-mouthed type bragging that his CB antenna has broken the height regulations for years, and you realize that he is unaware that another guest is the FCC Field Engineer. What would you do?

A. Whisper a warning.
B. Feel embarrassed for him.
C. Belch nervously.
D. Listen carefully as he prattles on.
E. Ask the lout to repeat his brag to the FCC employee.

Hurry—I’m Double Parked

A neighbor with more gall than most borrows your constant-current ohmmeter. Within an hour he brings it back, asking you to repair it so he can get on with his testing. What would you do?

A. Graciously comply with his request.
B. Coldly refuse.
C. Feel stunned.
D. Talk real dirty.
E. Brandish a soldering iron at him.

It Is Nobler to Receive

Quite accidentally you learn that your wife is planning to give you a costly set of living-room furniture and drapes for a wedding anniversary present. What would you do?

A. Feel pleased.
B. Try to talk her out of it.
C. Give her a bound file of Popular Electronics project schematics.
D. Surprise her with a collection of every other Heathkit item on the market.
E. Sulk.

I’ve Gathered You Here

Having generously agreed to share your vast knowledge of solid-state theory with an electronics club, your lecture is off to an impressive start when your mind goes blank on the whole subject. What would you do?

A. Admit you can’t remember a thing.
B. Ask for help in getting restarted.
C. Smoothly divert their interest to a faked-out history of electronics.
D. Sing and dance.
E. Sprint for the nearest exit.
I Gave at the Office

* Having worked long and hard to build your own specially modified Universal Frequency Counter, you find your wife has given it to a shut-in to take apart for the therapeutic fun of having something to do. What would you do?

A. Consult your attorney about institutionalizing her.
B. Report her to the Westinghouse people.
C. Stamp your foot.
D. Offer the shut-in some tools.
E. Proceed with the next project—from the safety of another country.

Part 95 Violation

* You're a bachelor and you've finally succeeded in becoming chummy enough with the curvy little blonde who moved into the next-door apartment to be invited over for a friendly drink. Once there, you discover that the delectable creature is blithely operating a CB rig with a 250-watt linear. What would you do?

A. Reprimand her sternly.
B. Report her to the FCC.
C. Decide to meet another girl.
D. Drink your drink and say nothing.
E. Teach her how to work skip on channels 24A and 24B.

But I Learned That in School

* By sheer accident your cable TV has gone berserk and channel 13 is showing "educational" stag films. What would you do?

A. Tune to another channel.
B. Have the cable TV send a repairman.
C. Keep the information to yourself.
D. Call the neighbors in for a party.
E. Write a protesting letter to FCC Commissioner Johnson.

Wanted: One Anechoic Chamber

* After laboring diligently for weeks you've scratch-built a magnificent hi-fi stereo system with speakers and a beautiful cabinet of your own design. Just as you're ready to try it out, your mother-in-law, who is visiting you and your wife, becomes ill, and the doctor prescribes quietude—bordering on complete silence—for her recovery. What would you do?

A. Wait with clenched teeth.
B. Have the doctor's credentials checked out.
C. Go on an aspirin diet.
D. Buy her a matched set of earplugs.
E. Write a complaining letter to "Dear Abbey".

You'll Never Get It off the Ground

* A slight acquaintance lets you talk him into installing your multi-proportional R/C system in his newly built, highly expensive model airplane—and it crashes into splinters. What would you do?

A. Offer to replace the airplane.
B. Buy him a cup of consolation coffee.
C. Deride his flight dexterity.
D. Yawn.
E. Bill him for your ruined system.

Of Course They Could

* While casually tuning your short-wave receiver, you overhear two stations discussing a plot to kidnap the Statue of Liberty and hold it for ransom. What would you do?

A. Call President Nixon direct.
B. Mail an anonymous letter to the FBI.
C. Jam their radio frequency.
D. Fly United to Bedloe's Island to see it happen.
E. Offer to sell a statue of Sophia Loren to the Government as a replacement.

CHECK YOUR SCORE HERE

All right, now that you've checked the various reactions to these dismal Life Situations, it's analysis time. If you have mostly A reactions, it could indicate that you are Mr. Straight Arrow. Mostly E reactions might mean that you're a flexible individual. Mostly C reactions clearly indicate a warm, human will to survive. Mostly D reactions show that you tend to have an enviable Kool indeed. If you have mostly E reactions, it's a sad hint that you are an accomplished loser. Of course, if you actually bothered to check any choices at all, you're putting us on more than we did you with this screwy thing.
MAYBE it's hard to believe that a kit which goes together as readily as does Heath's new GR-78 can look so attractive and also perform so well—but it's true. With its low-profile styling, handsome two-tone gray cabinet and polished aluminum bezel, this 190-kHz to 30-MHz solid-state portable receiver matches in appearance what it can do as a top-notch performer.

Within just a little more than 24 hours after its assembly and calibration—and using only the receiver's built-in 39" whip antenna—this reviewer's GR-78 had logged stations on all six continents!

Let's take a look at what makes such performance possible in a receiver costing only $130. The two factors most important in determining the value of any general-coverage receiver are its selectivity and its useful sensitivity. The term "useful sensitivity" is significant, because the ability of a receiver to bring in weak stations is determined, not by gain alone, but by gain in the presence of a low receiver-noise level. Unless a signal can make it through the hiss or "shot noise" generated in the front end of every receiver, the signal cannot be heard, no matter how high the gain of the stages which follow.

The Important Front End. The tuner in the GR-78 uses the latest in MOSFET's to maximum advantage, providing high gain, minimum crosstalk, and a low inherent noise level (typically 3.5 dB at 200 MHz for these transistors). It is especially well shielded and, most important of all to the average kit builder, it has short leads for minimum stray capacitance. It is by far the easiest tuner to assemble that we have ever seen.

Each of the tuner's four stages is wired as an assembly on a separate PC board and then plugged into its own shielded compartment. The result is a neat, factory-made appearance and high gain with high stability. Six ferrite-core pretuned coils are used in each stage since the receiver covers 190 kHz to 30 MHz in six settings of the band switch instead of the usual four or five.

The GR-78 can be aligned without instruments if necessary, but to peak it for top performance and sensitivity all you need is a calibrated signal generator and the receiver's own built-in S-meter. It isn't mentioned in the Assembly Manual, but you can zero the calibration in very close to the dial legends by zero-beating the built-in 500-kHz crystal calibrator against WWV, then zero-beating your signal generator against the calibrator. We aligned our GR-78 by this method and have found, so far, that calibration has been satisfyingly stable for a receiver in this price range. There is some slight drift for the first few minutes as the receiver "warms up," but even this would not be noticeable were it not for the GR-78's outstanding selectivity.

Latest in I.F. Amplifiers. Sensitivity is of little value without selectivity—especially on

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MOSFET's are including handling, voltages induced because of that, with quality preferred. Calibrated reduction tuning and noise detector, BFO, and there used highly stable for the second setting 455 kHz wide at 6 dB down for about eight hours at a reasonable listening level before recharging is needed. A transformer-type 120/240-volt a.c. charger is built into the receiver, and there's a separate circuit for charging from a 12- to 15-volt source—such as the electrical system of a car or boat.

The GR-78 went together more easily than many a kit-type broadcast-band receiver this reviewer has assembled. You don't need the dexterity of a circus performer to build it—there are no hard-to-reach places for either the screwdriver or the soldering iron. Assembly instructions are clear, easily understood, and thoroughly detailed with illustrations. Heath supplies a 120-page Assembly Manual with the kit.

However, take care in soldering the trimmers to the PC boards in the tuner. There is plenty of room to accommodate the solder tabs on the trimmers, but assembly without careful attention to the positioning of the tabs can result in a short circuit to adjacent soldered connections. Look all around the tab for clearance before applying the iron.

The S-meter is attached to the front subpanel with only one screw. The meter mounting tabs are thick, so probably single-screw mounting is sufficient; but, if you'll feel better about it, you can secure the meter's other mounting tab to the subpanel with a couple of spots of plastic household cement.

The GR-78 is a lot of good receiver for the money. Conservatively designed and ruggedly built, it is a fine performer at home or on the go. (Front-view photo and ceramic-filter i.f. response curve courtesy Heath Co. MOSFET data courtesy RCA.)

Circle No. 89 on Reader Service Page 15 or 95
For maximum stability, band switch decks are mounted in chassis with metal shields isolating them from each other. Then shaft is installed.

REGENCY MONITORADIO SCANNER  
(Model TMR-4)

The Day of the blinking red light is upon us. Garage and gasoline service stations, volunteer firemen, newspaper reporters, and hundreds of just plain listeners are buying VHF monitor receivers. The latest innovation is the VHF radio receiver that automatically tunes (or "scans") a certain number of fixed-frequency channels. Usually these channels are set for the local police and fire departments, certain business radio services, the weather broadcaster on 162.55 MHz, etc. The scanning is fully automatic and stops to listen in on the first occupied channel. As soon as that transmission is finished, scanning resumes until another signal is picked up.

Your reviewer recently had the opportunity to set up the new Regency Monitoradio Scanner Model TMR-4. This is a modest-cost version ($129; crystals are available at $4.95 each) of the larger 8-channel model with the
same general characteristics. The four frequencies selected included the 3 police services in the surrounding northern New Jersey area, plus the weather broadcaster KWO-35. The police frequencies were 240 kHz apart and the receiver had been "peaked" around 155-156 MHz.

Using the fully extended built-in antenna, we had no difficulty receiving all 3 base stations and all of the mobile units within 5 to 6 miles of our location. Using an outdoor antenna (cut for 155 MHz), all mobile units could be heard, as well as a variety of miscellaneous police services sharing the same frequencies—though some were 50 miles away.

Squelch action is positive and there is no "hang-on" after the received carrier goes off the air. Scanning action in the TMR-4 is rapid and the four channels are scanned about twice a second. Of course, this can be speeded up by locking out the weather station (scanning 3 channels) so that the scanning action is not immobilized by the constant carrier of KWO-35.

Besides the excellent sensitivity, there was no indication of any problems that might arise from inadequate or poor selectivity. Other channels known to be occupied and only 40 kHz away from one of the preset channels could not be heard (splatter or cross-modulation).

The TMR-4 is usable in the home or office operating from a 117-volt power line and can be installed in a mobile vehicle with a 12-volt negative-ground system.

The front panel of the TMR-4 has two rotary controls (volume and squelch) and 6 pushbuttons. As the face plate indicates, the upper left button places the TMR-4 in either the fully automatic scanning mode of operation or permits the user to select any one of the 4 channels manually. In manual operation, the selector button is repeatedly depressed until the proper channel (indicated by the light) has been tuned in. The four channel pushbutton permits the user to by-pass an undesired signal or channel. When any one of the 4 pushbuttons is depressed, scanning is started; releasing the pushbutton deactivated the channel.

Crystals are plugged into the TMR-4 by removing top cover. Miniature HC-18/u crystals are used with plug-in type pin leads. Crystals are easily obtained by mail order from Shepherd Industries, Overland Park, Kansas, at a price of $4.95 each.
VA-Approved Schools

I am fully qualified for educational benefits under the GI Bill. I like the new electronics school in my home town, but found that it isn't approved for VA training. The school tells me that they can't get VA approval until they have been in operation for two years. Is this true or just a phony excuse?

- It is, indeed, true that a school must be in business at least two years before it can qualify for VA approval. The VA people have told us that even the old, well-established schools are not automatically granted approval for a new branch school until it has been set up and has been in operation for at least two years.

- If the school is working toward obtaining VA approval, it would certainly indicate that the courses will meet some of the stiff standards that have been set up by your State Board of Education.

- As far as the business end of the school is concerned, you can always check with your local Better Business Bureau. If the BBB has received any complaints about the school and its business operation, they'll tell you to read your contract carefully.

To Relocate, or Not to Relocate

I have just received my diploma in electronics technology from a well-known home study school. I live in a very small town, and there is only one electronics company within five miles of my home. My friends advise me to move to a large city (about 100 miles away), although I am quite reluctant to leave home. Is it true that I can earn a lot more money and will have greater job opportunities in the larger city, opposed to working only a few miles from my present home?

- There can only be a general answer to this question. It is certainly true that salaries are higher in and around the larger cities than in a small town. However, this in itself is misleading, because the cost of living is also much higher. I suggest that you visit the city, interview for several jobs and compare salaries. Find out where you might live and approximately how much it would cost you each month. In terms of dollar income, you will undoubtedly find it more economical to take a job in the smaller local electronics company.

- The notion that people can earn more money by working in a major city does have one real advantage. Electronics firms tend to have a large turnover of employees. This means that you may have more chance to upgrade your career than working for the local manufacturer. If you are in a big hurry to advance your career and salary you should move to the city where you can probably change jobs several times in just as many years. If you are a good technician, you will be able to offset quickly the higher cost of city living by making the appropriate job changes.

- If on the other hand you want to wait for opportunities to come your way, perhaps you should stay at home and build up a sound reputation and security with the one local company. Although the opportunities to advance may not come along as often, you will certainly encounter less competition when they do.

Electronics Consulting

For the past 10 years I have been employed in a highly responsible position as an electronics engineering technician. Although I don't have a college E.E. degree, I think that I have enough engineering experience to start my own consulting business. Are there any special pitfalls that I should avoid?

- There certainly are! First, you will find it necessary to clarify the exact nature of
your "consulting" business. It is impossible to call yourself an "engineer" without being duly certified as a Professional Engineer by your state government.

There are different kinds of consulting businesses that you can enter, as long as you do not pretend to be a bona fide Professional Engineer. You could, for example, open a sound system consulting firm. Such consulting firms plan music and intercom systems for homes and offices. Another consulting business might deal with computer programming. In practically every state it is not necessary to be a certified P.E. to write and sell computer programs. However, it is expected that within the near future, an examination program will be established to certify qualified computer programmers. This is being developed by the Council of the Processing Management Association. The first examinations are expected to be given in late 1970.

The problem is in drawing the fine line between "consulting" and engineering. If you want to do real engineering design, you can probably be certified as a Professional Engineer by passing the pertinent examinations in your state.

Throughout most of the country, the P.E. exams take two days to complete. The first day covers general engineering principles while the second deals exclusively with electrical engineering. You can usually take the exams as many times as necessary should you fail one part the first time—although there is a waiting time required between each examination.

Besides passing the state examination, all of your college-level education and work experience must add up to at least eight years. Many engineers take their state examinations right after graduation from a four- or five-year engineering college. Even though they pass the exams, they can not qualify for certification until they have the necessary three or four years of work experience. Your 10 years of electronics technical experience should more than fulfill this part of the P.E. requirement.

We have discussed your problem with a representative from the National Society of Professional Engineers. It is agreed that anyone thinking about stepping into any kind of consulting business should first spend several years in someone else's consulting firm. Like any other profession, there are certain techniques and business problems, plus many unwritten rules of the game, that are not taught in engineering colleges and business schools. The most practical idea is to let someone else pay your salary while you learn the business end.

You can get more information on the consulting business by writing for the free pamphlet, "So You Want to Start a Consulting Firm" from the National Society of Professional Engineers, 2029 K Street, N.W., Washington, DC 20006.

**Engineering-Level Home Study**

I noticed in the article "Engineering Opportunities For You" (POPULAR ELECTRONICS, Feb. 1970) that only four schools are listed as offering engineering electronics courses through home study. Are there any other schools you can add to this list?

- Aside from the four schools mentioned in this article, five more offer engineering-level courses in electronics through home study. These are: Bell & Howell Schools and DeVry Institute of Technology, both of which are based at 4114 W. Belmont Ave., Chicago, IL 60641; Commercial Trades Institute, 1400 W. Greenleaf Ave., Chicago, IL 60626; International Correspondence Schools, Scranton, PA 18515; and National Radio Institute, 3939 Wisconsin Ave., N.W., Washington, DC 20016. The excellence of the material offered by these schools is the same as that of the schools listed in the "Engineering Opportunities For You" article.

**Sleep Learning—Real or Hoax?**

A friend tells me that "sleep learning" would solve my problems concerning the memorization of formulas used in electronics. I have only read one advertisement about sleep learning and wonder if it isn't a big hoax.

- About 10 years ago, sleep learning was in vogue and a dozen or so "schools" sold tape or disc recordings that repeated certain phrases while the student was asleep. Some people said that sleep learning was very effective—others ridiculed the idea.

Recently two professors of psychiatry at Duke University have established that, although the brain is alert (a mother will awake at her baby's cry), it is in a state of internal communications. Memory and thinking do continue during sleep, but unless the (Continued on page 85)
Build a Low-Cost Time Delay Relay

An inexpensive, semi-variable time delay relay is a handy item to have around if you do a lot of experimenting. While solid-state timers give excellent results, they are often more precise than required and prohibitively expensive for simple experimenting and occasional use. However, commonly available and inexpensive thermostatic delay relays can be arranged in a circuit to provide the time delay or delays you would normally require.

Keeping in the low price range, it was found that a maximum of only three minutes could be obtained from any given thermal relay. However, with two thermal relays, as in the schematic diagram, you can obtain anywhere from four seconds to six minutes of delay time.

Circuit operation is easy to follow. When pushbutton switch S1 is momentarily depressed, electromagnetic relay K3 energizes, simultaneously delivering power to the heating element of thermal relay K3 and the a.c. outlet. The indicator lamp lights up whenever the a.c. receptacle is "live."

After some specified time, depending on the characteristics of K2, the thermal relay's contacts close and supply power to the heater of K1. Then, when K1's time delay has elapsed, its contacts open and break the circuit that latches K3 closed. Relay K3 deenergizes, and the delay cycle ends. The variable feature is not built in; it is actually a function of a combination of delay times selected for K1 and K2.

Since the circuit is so simple, it can be laid out as desired during construction. The prototype shown here was built on a 51/4" x 3" x 2" metal utility box to conserve space. Although the a.c. outlet is shown mounted to the rear of the box, it could just as easily have been located at the end of any desired length of twin-conductor power cable.

In use, the delay relay's power cord is plugged into an a.c. outlet, and the appliance to be operated connected via the a.c. receptacle. The delay relay is capable of handling up to 1000 watts; so a fairly high load can be safely controlled.

Thermal relays K1 and K2 are selected to give desired delay time. Depending on the relays, delay can be between 4 seconds and 6 minutes.

PARTS LIST

K1—S.p.s.t. normally closed 117-volt thermostatic relay
K2—S.p.s.t. normally open 117-volt thermostatic relay
K3—D.p.d.t. 117-volt electromagnetic relay with 10-ampere contacts
S1—S.p.s.t. normally open momentary-action push button switch
Misc.—X-ray lamp assembly with built-in current-limiting resistor; chassis- or line-cord-mounting a.c. receptacle; sockets for K1 and K2; chassis; line cord and plug; hardware; wire; solder; etc.
Join "THE TROUBLESHOOTERS"

They get paid top salaries for keeping today's electronic world running

Suddenly the whole world is going electronic! And behind the microwave towers, push-button phones, computers, mobile radio, television equipment, guided missiles, etc., stand THE TROUBLESHOOTERS—the men needed to inspect, install, and service these modern miracles. They enjoy their work, and get well paid for it. Here's how you can join their privileged ranks—without having to quit your job or go to college in order to get the necessary training.
The Troubleshooters
June, 1970
studying before.
make learning
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means
called upon
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In radio or TV, they're
Xerox
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Think With Your Head, Not Your Hands
The service technician, you see, "thinks with his hands." He learns his trade by taking apart and putting together, and often can only fix things he's already familiar with.
But as one of The Troubleshooters, you may be called upon to service complicated equipment that you've never seen before or can't take apart. This means you have to be able to take things apart "in your head." You have to know enough electronics to understand the engineering specs, read the wiring diagrams, and calculate how a circuit should test at any given point.
Now learning all this can be much simpler than you think. In fact, you can master it without setting foot in a classroom and without giving up your job!
AUTO-PROGRAMMED Lessons Show You How
For over 30 years, the Cleveland Institute of Electronics has specialized in teaching electronics at home. We've developed special techniques that make learning easy, even if you've had trouble studying before.
For one thing, our auto-programmed lessons build your knowledge as you'd build a brick wall—one brick at a time. Each piece rests securely on the one that came before it.
In addition, our instruction is personal. When your teacher goes over your assignment, no one else competes for his attention. You are the only person in his class. He not only grades your work, he analyzes it to make sure you are thinking correctly. And he returns it the day it's received so that you can read his comments and corrections while everything is fresh in your mind.
Always Up-To-Date
To keep up with the latest developments, our courses are constantly being revised. This year CIE students are getting new lessons in Laser Theory and Application, Microminiaturization, Single Sideband Techniques, Pulse Theory and Application, and Boolean Algebra.
In addition, there is complete material on the latest troubleshooting techniques including Tandem System, Localizing through Bracketing, Equal Likelihood and Half-Split Division, and In-circuit Transistor Checking. There are special lessons on servicing two-way mobile equipment, a lucrative field in which many of our students have set up their own businesses.
Your FCC License—or Your Money Back!
Two-way mobile work and many other types of troubleshooting call for a Government FCC License, and our training is designed to get it for you. But even if your work doesn't require a license, it's a good idea to get one. Your FCC License will be accepted anywhere as proof of good electronics training.
And no wonder. The licensing exam is so tough that two out of three non-CIE men who take it fail. But CIE training is so effective that 9 out of 10 of our graduates pass. That's why we can offer this warranty with confidence: If you complete one of our license preparation courses, you'll get your license—or your money back.
Mail Card for 2 Free Books
Want to know more? Mail the postage-paid reply card bound here. We'll send our 40-page catalog describing our courses and the latest opportunities in Electronics. We'll also send a special book on how to get a Commercial FCC License. Both are free. If the card is missing, just send us your name and address.

ENROLL UNDER NEW G.I. BILL
All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now, check box on reply card for G.I. Bill information.

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Accredited Member National Home Study Council
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CIRCLE NO. 10 ON READER SERVICE PAGE

June, 1970
REPORTING to DX stations via tape recordings is a subject that has been discussed at considerable length in various club publications. Tom Meljer of Radio Nederland, who took over the duties of Master of Ceremonies for the "Happy Station Program" has listed certain conditions that must be met by the individual reporter who is applying for a QSL.

Foremost is that all tapes submitted must be single-track with a speed of seven and one-half inches per second. (Many reporters send double-track tapes at 3 1/2 in./sec.)

Tom also reminds listeners that the tape must contain such fundamental items as date, time, frequency, and enough program information in order to qualify for a QSL. In the event that any of the items cannot be included on the tape (date and time, for example) this information should be included in a separate letter enclosed with the tape.

"Happy Station" shows are presently being recorded up to seven days in advance of actual broadcast time. SWL's should not be alarmed at the belated mention of certain requests; simply send your requests earlier than you normally would have in the past.

Guide to Broadcasting Stations. A brand-new edition of this favorite British listing of long-wave, medium, and short-wave stations has just been published. Increased to 224 pages, this station/frequency listing is prepared from information collected by the BBC monitoring facilities. It is a remarkably accurate book—better than the World Radio TV Handbook—and includes a special notation showing the seasonal schedule changes of all short-wave broadcasters. Obviously, the schedule information is based on past history, but at least it gives the user a "fighting" chance of knowing whether or not a particular broadcaster has ever used a certain frequency and when (seasonally) he is likely to be back in operation. The new edition is being sold by Gilfer Associates, Inc., Park Ridge, NJ 07656 for $2.50.

CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports were as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used.

Albania—R. Tirana has been found on 11,866 kHz with s/on in Portuguese at 2130, and on 7265 kHz from 0700-0726 with English news and commentary.

Angola—CRGPF, R. Clube de Benguela, 5043 kHz, has been s/on at 0545 with the schedule for the day, then pop tunes non-stop at 0600.

Antilles—Word is out that Trans World Radio, Bonaire, will increase the power of their 800-kHz transmitter from the present 500 kW to a whopping 2 MW. (That's two million watts!). No target date for the new power has been released.

Austria—R. Österreich, Vienna, is now on a new frequency of 11,325 kHz as noted at 2130-2157 in German to northern Europe. Also still well heard is 9770 kHz at 0030-0045 in English.

Belgium—Brussels presents "Belgium Speaking" in English at 2305-2315 on 11,790, 5550 and 9740 kHz and at 0550-0610 on 11,790, 6125 and 9740 kHz.

Bolivia—CP105, R. Pinturas, continues to
To be eligible for one of the new DX All-Zone Awards designed for WPE Monitor Certificate holders, you must have verified stations in 10, 20, 30, or 40 of the radio zones of the world. The following recently qualified for and have received awards.

10 ZONES VERIFIED

Dimitur Alipiev (WPE2QXL), Syracuse, N. Y.
Ronald Siewert (WPE3HJO), Owings Mills, Md.
Mitchell Kassoff (WPE2QTK), Little Neck, N. Y.
Kurt Leonhardt (WPE2QAF), San Francisco, Calif.
Ivan Waukle (WPE2QVD), St. Johnsville, N. Y.
Arthur Bolduc (WPE1H1Q), Biddeford, Maine
Robert Brown (WPE6HKR), Yuccaipa, Calif.
Wayne Gentry (WPE6HMR), Foster City, Calif.
James Sanders (WPE6HMF), Glendale, Calif.
Steve Nack (WPE3HTU), Jim Townsend (WPE8KJL), Pennsylvania, Ohio
Philip Thibodaux (WPE5FEV), Morgan City, La.
Peter Veir (WPE2QKE), Anchorage, Alaska
Robert Cummins (WPE4KHF), Waterbury, Conn.
Tommy Buchanan (WPE4KGA), Darlington, S. C.
James Murray (WPE2RFY), Troy, N. Y.
Carroll Patterson (WPE4KHW), Demorest, Ga.
Gary Hubbard (WPE6HQA), Northridge, Calif.
Robert Galka (WPE8BWS), Tallahassee, Fla.
James Haberman (WPE9JWS), Indianapolis, Ind.
Donald Jones (WPE8KLY), Pima, Ariz.
Tony D'Astogino (VE3PE25D), Hamilton, Ont.
Marvin Van Sickie (WPE6FDP), Dubuque, Iowa
Joseph Ulrich (WPE6HQA), Los Angeles, Calif.
Henry Seldner (WPE2REP), Pearl River, N. Y.
Bradley Krohn (WPE2REA), Amherst, N. Y.
Robert Hassen (WPE4KHTB), Englewood, Fla.
Wayne Randall (WPE1HFA), Danbury, Conn.
Daniel Lindley (WPE4KEA), Florence, S. C.

20 ZONES VERIFIED

Mitchell Stern (WPE2QJA), Brooklyn, N. Y.
Martin Miron (WPE8JTN), Warren, Mich.
Stefan Lai (VS6PE1H), Causeway Bay, Hong Kong
Thomas Alleman (WPE2QFR), Rochester, N. Y.
Loren Davis (WPE6HMA), Hayward, Calif.
Robert Potter (WPE2QDA), Seattle, Wash.
James Ziegler (WPE9JMW), Milwaukee, Wisc.
Joseph Breton (WPE1HKW), Methuen, Mass.
Michael Dospoin (WPE4KCF), Enterprise, Ala.
Brian Heller (WPE2QVP), Lawrenceville, N. J.
Gary Kromer (WPE2PH1), Auburn, N. Y.
Lawrence Plin (WPE1HPL), Billings, Mont.
Peter Macinta (WPE2ROB), Kearny, N. J.
J. H. Mac Neill (WPE6GWX), Redwood City, Calif.
Dean Frey (WVE6PHN), Fort Saskatchewan, Alta.
Daniel Polansky (WPE2QF), Rochester, N. Y.
Michael Lynch (WPE2QEA), Auburn, N. Y.
Lance Kimmel (WPE2QOY), Monroeville, Pa.
Robert Hagerman (WPE8INH), Hemlock, Mich.
Charles Loisif (WPE4KF), Landrum, S. C.
Everett Shu (WPE2QRC), Los Angeles, Calif.
Steve Sox (WPE4KEU), Asheboro, N. C.
Charles Clay (WPE2QWE), Clenax, N. Y.
Robert Scott (WPE4HMX), Kingsport, Tenn.
Nick Chinn (WPE6KHB), San Leandro, Calif.
John Adams (WPE3HXT), Beltsville, Md.
Mrs. Mildred Marshall (WPE8FR), Devils Lake, N. D.
Donald Appling (WPE7CNQ), Spokane, Wash.
Steven D'Aldo (KX6PE1B), APO (Marshall Islands)
Delbert Fant (WPE6HM), San Luis Obispo, Calif.
Tom Uhrman (WPE3HMA), Monroe, Pa.
Frank Swanson III (WPE3VJD), Doltion, Ill.
Paul Metro (WPE2QZM), Colorado, Colo.
G. W. Fisher (WPE7CX2), Longview, Wash.
Robert Fleck (WPE3DXZ), Schiller Park, Ill.
Ken Piper (WPE6GB), Stockton, Calif.
Douglas Stark (VE3PE2OY), London, Ont.
Carroll Patterson (WPE4KHW), Decatur, Ga.
Bruce McCoy (WPE3HMY), La Porte, Ind.
Bill Portotti (WPE2QYH), Ithaca, N. Y.
Jack Dasher (WPE4KJC), Camden, Tenn.
Marvin Robbins (WPE6MW), Omaha, Neb.
Gregory Kelley (WPE4JGI), Staunton, Va.
Kurt Leonardt (WPE9FLI), Blue Island, Ill.

30 ZONES VERIFIED

Everett MacLeod, II (WPE1HTG), Gloucester, Mass.
Mark Connelly (WPE1HG), Arlington, Mass.
Jeff Wilson (VE3PE2NL), Sarnia, Ont.
Tom Christian (WPE7CXG), Seattle, Wash.
Thomas Creery (WPE2PH2), Conklin, N. Y.
Vincent Gerash (WPE1HMR), Shilo Con., Conn.
Richard Shawyer (WPE6CFL), San Francisco, Calif.
John Sgrulletta (WPE2MFX), Bedford Hills, N. Y.
Steve Kamps (WPE5EU7), Irving, Texas
Marvin Robbins (WPE80W), Omaha, Neb.
Clifford McKinstry (WPE6GCS), Hamilton, Va.
be heard on 4958 kHz at fair level until s/off at 0200 in all Spanish programming.

Brazil—ZYWS, Radio Dufusora Jatai, Jatai (Goiânia) on 5930 kHz and verified after five reports; no schedule or power was stated. It's audible at times around 2300 in Portuguese but does not seem to be on any definite schedule. . . . ZYWS3, R. Vitoria, Vitoria, has settled down on 5693 kHz and is heard daily in Portuguese from 1400 to 2200 between 0200-0230. . . . R. Braganca, Braganca Paulista (Sao Paulo), is on 2480 kHz but with a strong harmonic at times on 4960 kHz; it's been logged there after 0200. Vitoria, in Portuguese.

Chile—R. Sociedad Nacional de Minería is noted daily on 9750 kHz from 0100 with many talks and ID's in Spanish.

Columbia—Reports are being received on a superpower operating in the 5600-5900 kHz, medium wave. Heard evenings (local time) causing heavy QRM to WGY. Schenectady, N.Y., we have not as yet obtained a definite ID. Listed for the channel is R. Sintetenza, Bogota; the power is said to be 250 kW. This is undoubtedly strong competition to the Antilles station on 800 kHz.

Czechoslovakia—R. Prague is on 5930 kHz with IS and time ticks at 0358-0810 and opens with this schedule: to US and Canada at 0100 and 0400 on 5590, 7345, 9540, 9630 and 10100 kHz re-broadcast to Europe at 0700 on 6055 and 9565 kHz; to Australia and New Zealand at 0700 on 9575, 11800, 15310, 21485 and 27170 kHz; Sundays to N.A. at 1400 and 2145 kHz.

Dominican Republic—HIBC, Voz de Papagayo, La Romana, 5020 kHz, has a most elaborate s/off at 0400 with a sad-voiced announcer, playing 'Tapes', then a stirring march, A station that we've been hearing on 2500-0800 is thought in some quarters to be a second harmonic of HIBC, La Voz del Progreso, 1250 kHz.

Ecuador—HCB, Quito, is good on 11,740 kHz with a DX Party Line opening at 0900 and the program heard at 0935 and 0140: "DX Party Line" was logged at 0230-0300. . . . R. Vision, Manta, long inactive, is again on the air on 6141 kHz and heard from 0400-0430 with music, commercials and time checks in Spanish, . . . HCAR2, Cadena Radiofusora Escutianora, Guayaquil, was heard from 2355-0105 on 4655 kHz with L.A. music and radio drama.

Egypt—Cairo is testing numerous channels in the 31-meter band. English news is heard on 9565 kHz at 2200; Arabic with chanting can be heard at 0000-0040 on 9860 kHz. The 9475 kHz channel is still heard well at 0230-0245 with English news and music as it's 9470 kHz at 1830-2300 in Italian, French, German and Russian. Reports go to P.O. Box 566, Cairo, United Arab Republic.

El Salvador—YSS, San Salvador, 5980 kHz, is reported planning more extensive English and French programs to be aired Monday to Saturday from 0300-0330 and Sunday at 0600-0100. This will be on 5955 kHz.

Ethiopia—ETLF, Addis Ababa, opens at 0330 in Swahili to E. Africa on 9725 kHz, a new frequency. Condemned (East)—R. Berlihe International is on 15,145 kHz in English to Africa until 1900 closing and requesting reports.

Gibraltar and Ellice Islands—VSZ1, Betio, Tarawa, 6445 kHz, was on to be under 10 kW as indicated by increasingly better signals on the West Coast at 0600.

Guantanamo Bay—If you need this country for DX Awards, look for KG4AA in the 20-meter ham radio band. He contacts around 0800-1000 weekdays on single sideband.

Guatemala—Possibly a new frequency for R. Nacional-La Voz de Quezaltenango is 9680 kHz as noted from 0930 with marining music.

Guiana (French)—Cayenne. 3385 kHz has French from 0915 s/on; news is given at 0930. This one often fades out by about 1000.

International Waters—A good catch was that of the Navy Supply Ship, 'Lacquer', callsign ZMUC. On 8236 kHz with 250 watts, it was

noted at 0911 in contact with ZLW, Wellington. It verified in nine days by letter and by signing a prepared card.

Italy—Rome was heard in Italian to N.A. at 2300-0000 on 6010 and 9710 kHz, both unlisted channels, then shortly afterward, on 5990 and 9575 kHz, in a dual frequency move.

Mexico—XSVJ, Chilpancingo, a 250-watt station, has been heard on 2160 kHz at 1347 in Spanish, . . . R. Mexico is on a new frequency of 9745 kHz, dual to 11,715 kHz at 0500 but with heavy QRM on the lower channel.

Mongolia—The English test transmissions to Great Britain over R. Andorrana on 701 kHz have been moved to R. Monte Carlo on 1466 kHz and are aired at 2300-0100 every Saturday-Sunday night under the name of Radio 205. Reports go to Geoff Reed, 1 Harleston Street, London, W.1, England.

Nigeria—Voice of Nigeria, Lagos, was heard at 2310-2330 and at 0450-0525 with mostly English programs of music, news, commercials and time checks on 9988 kHz. Some African chattering was noted around 0450-0455.

Norway—"Norway This Week" in English is aired on Sundays to East Coast N.A. at 2000-2030 on 21,655 kHz and 2200-2230 on 11,860 kHz, at 1600-1650 to East Coast on 25,900 kHz and to West Coast on 21,730 kHz, and on Mondays to West Coast on 11,860 and on 0230-0230 on 9610 kHz and at 0400-0430 on 9610 and 11,735 kHz.

Paraguay—An overseas source reports that this country is planning an international service with a transmitter of 100 kW. Further details as they become available.

Peru—OBX10, R. Atlantica, Chulucanias, 4990 kHz, once occasionally logged under severe QRM from a Venezuelan on the same channel from 0600 with the usual L.A. format.

Portugal—A new frequency for Lisbon is 15,340 kHz as noted in Portuguese from 0445 s/on. Other frequencies reported recently include 11,570 kHz to N.A. at 0200 with English around 0245-0305, and 11,935 kHz at 0020 with "Radio Safari" using the facilities on the second Monday in each month.

Seychelles—R. Seychelles, Victoria, was logged on 15,265 kHz from 1538-1630 s/off with light music at 1550, "Back to the Bible" at 1600, ID, frequency, and time, in an all-English mix.

South Africa—R. RSA, Johannesburg, is now operating to N.A. at 2330-0020, 0300-0120, 0130-0220 and 0230-0300 on 9695, 9705, 11,875 and 15,220 kHz, and to Africa in English and Afrikaans at 1100-1110 on 25,790 kHz. Two other new frequencies noted include 15,249 kHz at 1800 with English news, and 15,320 kHz at 0150 with an interview-type program, also in English.

Sweden—R. Omland broadcasts at 0700-0900 and 1600-1900 on 4994 and 11,835 kHz with English usually at 1715-1800.

Switzerland—New frequencies in use by Berne include 6055 kHz in French with s/off at 2245, and 11,720 kHz at 2310-0600 s/off in Portuguese.

USAF—Two of the time stations listed last month, RID and RKM, are being noted by Your Editor. RID is usually audible around 2300-0200 and RKM around 1100-1300, both on 15,004 kHz. ID's are given every 10 minutes by Morse, alternating with "VVCQ CQ CQ" and sounds like it is being heard- sent. So far we have not yet located RTA on 14,966 kHz. . . . Vladivostok, 5015 kHz, was noted in the clear at 1045 in Russian with two bars of organ music and an ID at 1100, then music and woman alternating in Russian news . . . A report to R. Moscow for reception of Kalinin, listed in this column last October on 15,470 kHz, brought a fast reply repair to one of our 'readers that the Soviet Union has no xmt'r's on that frequency.'

Vatican City—A new frequency in use by R. Vaticano is 6135 kHz as noted at 2358-0015 in Spanish to L.A. dual to 11,845 kHz and a third channel which we could not contact. English news is given (Continued on page 91)
NEW PROCESS MAY REDUCE IC COSTS

INTEGRATED CIRCUITS may be less costly in the future as a result of a new manufacturing process developed by the Bell Telephone Laboratories (BTL). Requiring fewer production steps than previous methods, the new IC fabrication technique can produce reliable, high-quality devices which are smaller than a grain of sugar.

Conventional bipolar integrated circuits require from five to seven photolithographic masking steps before the contacts to the silicon are formed. In contrast, the new circuit configuration needs only three such steps and, appropriately, is called a “Tri-Mask” (TRIM) structure. In both techniques, of course, additional processing is required to make contacts to other circuits and to protect the device from the environment.

As illustrated in Fig. 1, the new TRIM structure is based on the use of lateral transistors—devices in which injected carriers flow parallel to the surface rather than perpendicular to it. The collectors and emitters are diffused simultaneously and, therefore, need only one masking operation. Thus, all of the important transistor properties are determined by this one step.

The TRIM process starts with a silicon substrate lightly doped with boron to provide general p-type characteristics. A shallow p-plus base layer is diffused into the substrate. Next, silicon oxide is grown over the entire surface, then etched away selectively using the first photolithographic mask to establish the emitter and collector areas. Phosphorous-doped emitter and collector regions (n-type) are diffused through the p-type base and then all of the exposed silicon oxide is removed. Another silicon oxide layer is now grown on the surface with a second mask defining the emitter, collector, base, and surface contact holes. Metal is

Fig. 1. TRIM structure, based on use of lateral transistors, has collectors and emitters diffused simultaneously. It requires only one masking operation. One step determines all of transistor properties.
evaporated over the entire surface and etched away except where the third mask defines the metal conductor paths. The final contacts to external circuits are provided through beam leads, with a layer of silicon nitride providing environmental protection.

Thus far, the TRIM method has been used primarily for the fabrication of integrated circuit logic gates of the type used in computers and telephone switching system; but, conceivably, it could be used in linear devices as well. A transistor in such circuits occupies less than one millionth of a square inch.

**Reader's Circuit.** In developing a Science Fair project, reader Paul Serafin, WN4OEG (707 Cathy Ct., Murfreesboro, TN 37130) first selected a reader's circuit described here in March 1969. Encountering minor difficulties, he modified the design using a circuit we described in February 1966. Additional modifications and adaptations resulted in the multi-purpose project whose schematic is shown in Fig. 2. Operating, variously, as an electronic organ, a metronome (and thermometer), code practice oscillator, or siren.

Essentially a wide-range relaxation oscillator, Paul's circuit features a two-stage, direct-coupled complementary amplifier using pnp (Q1) and nnp (Q2) transistors to drive a PM loudspeaker. The circuit's operational mode and basic repetition rate (frequency range) are determined by the feedback arrangement chosen by function switch S10, while its exact operating frequency can be adjusted by bias control R2, in series with current limiting resistor R3. Switches S2 through S9 serve as the organ "keys," while S1 serves as the siren switch. Circuit power is furnished by BI, controlled by a familiar handkey or switch.

Standard, readily available, parts are used in the project. Transistor Q1 is a general purpose pnp transistor, such as RCA's SK3020. Capacitors C1 through C8 and C10 are low-voltage ceramic or tubular paper types; C9 is a metallized paper or electrolytic unit; and switches S1 through S9 are s.p.s.t. normally open momentary pushbuttons. Almost any PM loudspeaker may be used; but better results generally will be obtained with units having high-impedance voice coils (8, 16, or 45 ohms).

Neither layout nor lead dress is critical and the circuit can be assembled using any preferred construction technique. Paul assembled his display model on a three-section poster, with the schematic diagram and actual circuit in the center and an explanation of the project operation on the sides.

The circuit's performance as an electronic organ, metronome or CPO is fairly straightforward. In its "siren" mode, however, R1 must be adjusted for optimum signal with S1 closed. Finally, the circuit may be used as an electronic thermometer" by switching to the metronome mode and physically varying Q1's temperature. The output beat rate will change as Q1 is heated or cooled.

**Manufacturer's Circuit.** With a variety of potential applications in experimental projects as well as in commercial and industrial systems, RCA's TA371B is a unique integrated circuit which combines light-sensitive elements and an amplifier in a single device. Two typical circuits using this unit are shown in Fig. 3. Both were abstracted from the engineering bulletin/specification brochure published by RCA describing the new device.

(Continued on page 88)
FIELD DAY, 1970

MOST IMPARTIAL observers agree that amateur radio's ability and willingness to supply emergency communications are two of its most valuable functions. This was demonstrated dramatically when Hurricane Camille struck the Gulf Coast in the fall of 1969 and in other less publicized disasters.

On the fourth weekend of each June, "Field Day," sponsored by the American Radio Relay League, Inc., gives amateurs a chance to show and test their abilities at supplying communications under emergency conditions. Between 1900 GMT, Saturday, June 27, and 2200 GMT, Sunday, June 28, amateurs all over the United States and Canada will set up temporary, self-powered stations in forest preserves, parking lots, athletic stadiums, etc., to contact other amateurs. Each contact made on each code or phone sub-band earns a number of points determined by the power source and the amount of transmitter power used.

Large groups may operate 20 or more transmitters simultaneously during the event; although the greatest number of entries is usually in the one-, two-, three-, four-, and five-transmitter groups. And of course there are always a few "iron-man" entries in which a single operator attempts to keep his field day station in operation during the entire period. Undoubtedly, however, the most enjoyable and valuable Field Day operations are the co-operative ven-

Jim Rafferty, WA9UCE, 529 Buckingham, Libertyville, IL 60048, became a Novice in 1967 and was a General in three more months. His Collins KWM-1 SSB/CW transceiver is older than he, but its 175 watts fed into a Mosley TA-33-Jr., tri-band beam, 30 ft high, has worked all states and 97 countries. Jim attends Western Illinois U., where he is president of the radio club, W9YOL, and lives at the fire station, where he signs WB9AZW. We are sending WA9UCE a 1-year free subscription to POPULAR ELECTRONICS for sending this month's Amateur Station Photo. You can enter by sending a clear (black and white preferably) photo of yourself at the controls of your stations and some details about your amateur career to Herb S. Brier, W9EGQ, P.O. Box 678, Gary, IN 46401.
tures in which amateurs from the newest Novice to the hoariest old timer (and their families) work to make Field Day a success.

Collecting equipment, erecting antennas, installing the equipment, and keeping a number of transmitters going around the clock under conditions that simulate an actual emergency present real challenges to any amateur club. So, starting Saturday afternoon, June 27, you can expect many bosky glens and other likely (and unlikely) spots to echo with the call “CQ Field Day” from approximately 12,000 throats and keys until the affair ends Sunday evening. Drop a request (with a stamped, business size envelope) to Communications Dept., ARRL, 225 Main St., Newington, Conn., 06111, for full Field Day rules and score sheets.

FCC and Related News. Amateur license fees are going up! In an attempt to obtain its entire budget from fees charged for license processing, the FCC proposes in Docket 18,802 to increase basic amateur license fees from $4.00 to $9.00 and for applications for special call signs from $20.00 to $25.00. The CB fee will jump from $8.00 to $19.00.

While April 20, the date set by the Commission for filing original comments on the docket, will have passed before you read this, we assume that the Commissioners will consider any well-reasoned “late” comments from interested parties. Most comments that we have heard claim that the increases are inflationary. We strongly suspect that the protests will not prevent the increases, but enough protests might delay the effective date.

The Commission also issued its proposals to formalize the regulations governing ama-


teur repeater operation on the frequencies above 50 MHz. Such repeaters receive signals on one frequency and simultaneously retransmit them on another frequency. The most important part of the new proposals limits the repeaters to 200-kHz segments in the 50-, 144-, 220-, and 430-MHz bands and also specifies the frequencies to be used to transmit to the repeater. The rest of the proposal clarifies and consolidates the informal rules that have been put into effect since repeaters became so popular.

In a recent speech, Everett G. Henry, W3BG, Chief, Amateur and Citizens Radio Division, FCC, stated that surveys of the Advanced and Extra class segments of the amateur bands show that they are not the deserted wastelands that some opponents of incentive licensing claim. Rather, they are well occupied during the popular operating hours. Some of them are rather sparsely occupied at other times, but the other parts of the bands are not overly crowded then, either.

W3BG also stated that 85% of the applicants for the Advanced license who must take the code test (Novices, Technicians, Conditional, and brand new applicants) pass it. Also, 81% of all who take the Advanced class written exam pass it. Similarly, 80% of the applicants pass the Extra class code test; and 77% of those that get by the code also get by the Extra class written examination.

Thoughts on Silver Plating. It is common practice to silver plate UHF/VHF coils, cavities, etc., to reduce “skin effect,” which increases the r.f. resistance of conductors above their d.c. values. But many UHF/VHF workers say that the results do not justify the effort.

R. S. Stone, VK5PB, reports in Amateur (Continued on page 86)
ENGLISH LANGUAGE NEWS BROADCASTS FOR THE MONTH OF JUNE
Prepared by ROGER LEGGE

<table>
<thead>
<tr>
<th>TIME-EDT</th>
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<th>FREQUENCIES (MHz)</th>
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<td>Melbourne, Australia</td>
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<td>Peking, China</td>
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<td>9.70, 11.87, 15.15</td>
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13 SUPERB SELECTIONS


BEETHOVEN: Wellington’s Victory (Battle Symphony) (excerpt from the first movement) Westminster Records.


KHAN: Raga Chandranandan (excerpt) Connoisseur Society.

RODRIGO: Concierto-Cancion for Harp and Orchestra (excerpt) from the first movement) DGG.

MANITAS DE PLATA: Gypsy Rhumba (complete) Conn. Soc.


PRAETORIUS: Terpsichore: La Bourrée XXXII (complete) DGG Archive.

BERG: Wozzeck (excerpt from Act III) DGG.

BARTÓK: Sonata for two pianos and Percussion (excerpt from the first movement) Cambridge Records.

BEETHOVEN: Wellington’s Victory (Battle Symphony) (excerpt from the last movement) Westminster.

Note: The Stereo Demonstration Record only is available in your choice of 33 1/3 RPM or 45 RPM.

Both the Model SR12 Stereo Test Record and Stereo Demonstration Record are processed and pressed on a newly developed, improved vinyl. It is permanently anti-static, resists dust and dirt and promotes longer stylus wear. The use of this material is conductive to low surface noise and contributes to the production of full dynamics and frequency range. The record continually looks new, sounds new and wears longer.
subject under study was in danger or might be rewarded (the mother example again), it is not possible to impress "new" material or learn while sleeping.

Jobs for "First Phone" Holders

I have a First-Class Radiotelephone license, but my interest is not in commercial AM or FM broadcasting. What other kinds of jobs can I get to take advantage of my First-Class FCC license?

- The non-broadcasting jobs that you can get will depend upon the amount of training that you have above and beyond what is required to get the First-Class license. If your training covered only the material necessary to pass the examination, you can only get a job that involves operating, maintaining and troubleshooting communications gear. There are a lot of governmental jobs of this kind currently available. Law enforcement agencies ranging from the local police to the FBI all report a shortage of qualified radio operators and troubleshooters. And, all branches of the Armed Forces also hire "first phone" men for their civilian repair facilities.

There are some private business openings and I would suggest trying taxicab companies, the local telephone company, and any other outfit that uses a lot of mobile radio gear. Put an application in with a reputable, nationwide employment agency. Many jobs for men with a "first phone" license are fee-paid.

The best jobs go to the men who have both a "first-phone" license and a solid background in general electronics technology. Almost every electronics company that designs and builds communication gear is looking for men who have an FCC license and at the same time can design solid-state logic and control circuits.

Keep your eye on the classified employment ads in your local newspaper. Visit any major airport and you'll probably find a cluster of small companies that specialize in airborne radio communications equipment. However, you'll find that the engineering electronics technician job is a lot more exciting than the plain and simple "first phone" maintenance and operation job. If you don't have the training to let you design communications and control circuits, I suggest you enroll in a home study course in electronics.

June, 1970
Radio, Melbourne, Australia, that work done by Alan Fowler of the Australian Post Office Research Department, indicates that these "doubting Thomases" may be right. He says that, unless that silver plating is nearly 100% pure, its resistance becomes excessively high. Furthermore, not only is it difficult to keep the plating solution clean; commercial platers usually add contaminants called "silver brites" to obtain a bright finish. Compounding the difficulty, many silver-plated electronic components are also gold plated to inhibit corrosion. Gold brighteners also increase the resistance of gold plating sharply—and its resistance is greater than copper or silver.

VK5PB (who is a professional plater) recommends skipping silver plating entirely. Instead, buff the material to a smooth, shiny surface; electroplate it with copper (even if the material is copper to begin with); polish again; and lightly flash with pure gold to inhibit corrosion.

Gary Kent, WN0SZY, Eddyville, IA, 52553, is waiting for his General license. His Heathkit DX-60B, Drake 2B, Hy-Gain 18-AVQ have worked 34 states.

$1,000,000 TVI Suit—Final Report. As we reported previously, the $1,000,000 TVI suit against "Grid" Gridley, W4GJO, has been withdrawn. Legal costs were $6,500, of which $5,200 were covered by contributions. Further contributions may be sent to the Sarasota Amateur Radio Association, P.O. Box 3323, Sarasota, Fla. (Tnx Florida Skip)

NEWS AND VIEWS

Ron Del Buono, WA2JUI, 415 41 St., Union City, NJ 07087, collected over 450 QSL cards as a Novice! His best Novice DX was Spain, but he is most proud of his card from WAGUIL at the San Diego Naval Base. Ron used a Hallicrafters S-120 receiver and a Heathkit DX-20 as a Novice. He is
now using a Heathkit Sixer on 6 meters. Ken Sobel, WN3MQL, 1560 E 102 St., Apt 3-G, Brooklyn, NY 11236, worked 22 states his first three weeks on the air and expected to pass the General exam during Easter vacation. He uses a DPZ "Vacationer" window-mounted antenna in conjunction with a Heathkit DX-805 transmitter and HR-10B receiver on 15 meters. The antenna is 4½ feet long and 30 feet high. Across coast, Dave Weetherbee, WN6OTE, uses an Ameco AC-1 transmitter and R-5A receiver in conjunction with a Goham V-80 vertical antenna. Dave has three states confirmed after a few days on the air and is studying hard for his General ticket.

The Medical Amateur Radio Council, Ltd., will hold its 4th Annual meeting in Chicago at the Sheraton-Blackstone Hotel on June 25 at the time of the American Medical Association Meeting. Reservations at $7.50 can be obtained from Joseph J. Boris, P.O. Box 229, Manchester, CT 06040. The MARCO nets meet on 14,280 kHz at 0200 GMT and on 7290 kHz at 0100 GMT. Last September, the MARCO net, with help from the International Missionary Radio Net, obtained 10 amoules of Di-lantin needed for a 3-year-old ill with encephalitis in Lima, Peru, and put them on a plane in Miami. The drugs arrived in time, and the child was re-learning how to use her muscles in February.

Roy Ilich, WN8FZM, 446 Alameda Ave., Youngstown, OH 44504, was so excited when his license arrived that he fell down the stairs getting to his shack. Picking himself up, it took him a month to work 16 states and Canada on 40 meters. Don Babcock, WB4KUZ, Titusville, FL 32780, likes to rag chew and he is also a member of the local Radio Amateur Civil Emergency Service (RACES).

A Heathkit HW-16 transceiver drives Ray's 50-meter vertical antenna, and he has plans for a 15-meter beam. R. H. Mottoz, W9ADT/MM, SS Green Bay (6457 Hatch Lane, West Palm Beach, FL 33406, when he's home) has been a ham for over 38 years. He has also been a disc jockey and engineer for AM and FM stations, member of the National Institute of Engineering, seaman. The shipboard equipment includes a Heathkit SB-300 receiver, SB-400 transmitter driving an SB-200 linear amplifier to 1000 watts input into a Hy-Gain 14-AVQ vertical antenna. On shore, Bob signs WB41PP Get him to tell you how he was blown 100 miles out to sea on his honeymoon, spending 35 hours hosed to the tiller of the 34-ft ketch. By the way, the captain of the Green Bay is WASTKY, the General manager.

Faris Howat, WN2GJM, 115 Ocean Ave., Brooklyn, NY 11225, alternates between a home brew 10 watt and a Heathkit DX-60V transmitter. His antenna is a Hy-Gain 14-AVQ vertical, and his receiver is a Drake SC. It all adds up to 41 states and 10 countries. When Faris gets his code speed built up a little more, he will go for his Advanced ticket. As he already holds 2nd class Commercial Radiophone license with Federal endorsement, he isn't too worried about the theory. Being in the U.S. Navy may explain the radar endorsement...

C. D. Andodenseger, UV2AI/W2, Box 253, Manassas, VA 20110, first got on the air in Mainland India, using a 25-watt, homebrew transmitter to feed a folded dipole antenna. He received on a BC-342 and worked over 80 countries. Anand is in the United States for electronics training and has been operating under the Indian/USA reciprocal operating agreement through the cooperation of Charles, W2A1W. The best time to catch Anand is on weekends on 20 meters. James W. Andrews, WN8FRQ, 4240 Otis Dr., Dayton, OH 45416, feeds his 49-meter dipole with a Drake 2-NT transmitter and receives on a Drake 2C. Jim has worked 11 states and is president of the Miami Valley SWL Association. Daniel Roy, WN1MJC, 19 Standard Ave., West Warwick, RI 02893, has separate dipoles for the 80-, 40-, and 15-meter Novice bands. He operates them in conjunction with a Heathkit DX-60B transmitter and a Realistic DX-150 receiver. Dan wants to start an amateur radio club at his high school and would appreciate advice from officials or members of established clubs.

Jim Lobo, WA5ZVI, 1704 Mosher Dr., Enid, OK 73701, was KH6FKB in Hawaii for six months before becoming WA5ZVI. He was thrilled at working 45 Novices in 12 states on 15 meters. His big frustration was being unable to convince many of them that his call was KH6FKB, not KG6FKB. Jim uses an SBE-34 transmitter on 15 meters, but he is now a VHF man with homebrew or kit gear for 50, 144, 280, and 146 MHz.

Good luck on Field Day. Keep your "News and Views," pictures, and club bulletins coming to P.O. Box 678, Gary, Ind. 46101. 73, Herb, W8EQQ
Fill in coupon for a FREE One Year Subscription to OLSON ELECTRONICS’ Fantastic Value Packed Catalog — Unheard of LOW, LOW PRICES on Brand Name Speakers, Changers, Tubes, Tools, Stereo Amps, Tuners, CB, and other Values. Credit plan available.

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CIRCLE NO. 23 ON READER SERVICE PAGE

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219 (PE) W. Rhapsody
San Antonio, Texas 78216

CIRCLE NO. 31 ON READER SERVICE PAGE

SOLID STATE
(Continued from page 80)

The TA5371B is a developmental IC consisting of a photosensitive section and a power amplifier on a single monolithic silicon chip assembled in a modified TO-5 package fitted with a transparent window. The light-detector portion includes two photosensitive Darlington pairs connected in parallel, while the amplifier is a direct-coupled multi-stage circuit using seven npn transistors, four diodes, and ten fixed resistors.

Depending on external connections, the TA5371B can be used either as an amplifier providing a linear output signal or as a sensitive light-actuated switch with two outputs. One output (terminal 6) supplies power to the load when the photosensitive elements are illuminated, while the other (terminal 2) furnishes current in the absence of light. The block diagrams (A) and (B) illustrate these configurations.

Fig. 3. New RCA TA5371B IC is shown in circuit (A) connected as light-actuated on/off switch. In circuit (B), same IC is used as a linear amplifier.
of light. Designed for operation on a 7.5-volt d.c. power source, the device can furnish up to 100 mA output. Its peak sensitivity is to infrared light at 7250 Angstroms, but it responds to visible light as well.

An on/off switching action is provided by the circuit shown in Fig. 3A. In operation, the load is energized when light strikes the sensitive elements located between pins 9 and 12. A reverse action—load energization in the absence of light—can be obtained by connecting the load to pin 2 with 6 open. A gallium-arsenide light-emitter diode (LED). RCA type 40598A, may be used as the controlling infrared source, and will provide greater sensitivity than an incandescent source. The linear amplifier arrangement (Fig. 3B) may be used in test equipment or communications applications. In practice, the output signal developed across load resistor R2 can be coupled to a high-impedance voltmeter, to an output amplifier and speaker system, to an oscilloscope, or to other instrumentation, depending on system requirements.

In both circuits, all resistors are half-watt types and the capacitors low-voltage ceramic or tubular paper units. The switching circuit's load can be a tone source, such as a Mallory Sonalert, or a moderately sensitive 6-volt electromagnetic relay. If a relay is used, however, a small diode should be connected across its coil to absorb the transient pulse voltages generated during switching (anode to pin 6).

While conventional construction and wiring techniques may be used for assembling either of the two circuits, reasonable care in regard to layout and lead dress is necessary to prevent feedback and instability due to the amplifier's inherently high gain. Signal leads must be kept short and direct. RCA, in fact, suggests that the external components (R1, R2, C1, C2, etc.) be connected directly to the appropriate IC terminals.

Device News. Motorola Semiconductor Products Inc. (P.O. Box 10912, Phoenix, AZ 85036) has announced the production of an integrated circuit UFH duplexer. Identified as type MCH5890, the unit is essentially a solid-state s.p.d.t. switch designed to operate at frequencies between 400 and 500 MHz with inputs of up to 40 watts. Although primarily a transmit/receive switch, the new device also can be used as a monitor network in a transmitter, as a sampling unit in an a.f.c. or a.g.c. circuit, or in similar communications applications. With a typical 0.1-dB transmit-mode insertion loss and 25-dB transmit-mode isolation figure, the MCH5890 is supplied in a

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thin plastic-ceramic package measuring 1/2" by 1" overall.

An interesting solid-state "relay" has been developed by Ebeko of Urolffen, West Germany. Featuring an integral four-transistor direct-coupled amplifier, the unit employs a conventional electromagnetic input coil. Instead of operating a mechanical armature, however, the coil acts to control the resistance of a Hall-effect indium-antimonide element. The Hall-effect resistor, in turn, adjusts the amplifier's bias to provide output switching, with one driver transistor used as the normally off and another as the normally on contact. Suitable for use in d.c. as well as pulsed a.c. circuits, the new relay has the advantages of virtually unlimited life, fast, bounceless, arcless operation, and excellent input/output isolation.

Field-effect transistors capable of handling 10 to 12 watts at 2 GHz have been developed by Siliconix, Inc. (1140 W. Evelyn Ave., Sunnyvale, CA 94086) as the first products in a planned line of microwave semiconductor devices. Future products will include additional special purpose FET's and bipolar devices as well as both multiplier and tuning varactors.

A line of "Magnistors" at prices within the reach of the serious experimenter is being offered by the Hudson Corp. (Box 867, Manchester, NH 03105). A Magnistor is a silicon planar transistor which has two collectors and a single emitter, with its construction so arranged that an external magnetic field gives a lateral motion to the charge flow from the emitter, causing a differential change in the relative collector currents. Used as magnetic sensors, these devices can be employed in test and control applications. Unit prices range from

$3.50 for the HM 111 B to $5.00 for the HM 111 G, although there is a minimum order requirement of $30.

Transitips. Engineer Bob Botos of Motorola Semiconductor Products Inc., has passed along some very worthwhile tips for anyone concerned with minimizing feedback and oscillation problems when working with linear integrated circuits. He points out that linear monolithic IC's, even if specified for audio applications, are potential r.f. amplifiers and, therefore, must be treated with respect and care.

Good r.f. breadboard techniques must be observed, with both signal carrying and power supply leads kept short and direct to minimize distributed inductances and feedback capacities. In addition, bypass and frequency compensation capacitors, where used, should be connected directly to the device's leads (or socket terminals). Naturally, ground loops must be avoided.

According to Bob, improper breadboard techniques can result not only in frustration but in a tendency to blame the IC's manufacturer for producing poor-quality merchandise.

—Lou

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SHORT-WAVE LISTENING
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Richard Pendleton (WPEHIMV), E. Braintree, Mass.
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Gary Lovegren (WPE8BFP), St. Paul, Minn.
Art Burke (WPE8POF), Topika, Kan.
Carl Larson (WPE80GA), Mount Ayr, Iowa
Jack Perlo (WPE8PEC), Sao Paulo, Brazil
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Capt. P. Lefevre, Caracas, Portugal
Case Lawurt, Holmde, N.
Gary Munch, Tewksbury, Mass.
Jim Silt, Kansas City, Mo.
Robert Toman, Jermyn, Pa.
Dan Tchopp, Hunhle, Texas

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short-wave listening
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on 9645 kHz at 2055-2105 and around 0655 on 6175 and 11,725 kHz. Numerous reports received within the last few days also list 9615, 9686 and 15,285 kHz as having English church news during that 0650 xmn.

Vietnam (North)—V. of Vietnam, Hanoi, now runs an English time slot on 10,042 kHz at 2300-2330 for American Forces in South Vietnam with usual slanted propaganda, some old American pop records and the voice of “Hanoi Hattie.”

Clandestine—Radio Nordsee International is being reported on 6210 kHz at 2120-2300 with rock music and amn’t’s in English and German.

dx country awards presented
To be eligible for one of the DX Country Awards designed for WPE Monitor Certificate holders, you must have verified stations in 25, 50, 75, 100, 125, or 150 different countries. (“Letters of Certification’’ will be issued to those who have over 150 countries verified in steps of 10.) The following DX’ers recently received their awards for 25 countries.

25 COUNTRIES VERIFIED
Howard Rosenberg (WPE2PQE), Queens Village, N. Y.
Lewis West, Jr. (WPE4JYL), Charlotte, N. C.
David Perry (WPE2QFK), Pleasant Valley, N. Y.
Dennis Davenport (WPE9JLT), Edwardsville, III.
Edward Sue (WPE1HMA), Brookline, Mass.
John Ward (WPE1HJD), Springfield, Mass.
Horace Steinhaeuser (VE1P32JO), Kenora, Ont.
Jack Dashper (WPE4KJC), Camden, Tenn.
E. F. P. Lloyd (VE7PE1ED), N. Vancouver, B. C.
David Galletly (WPE2QHG), Scud Bay, N. Y.
T. R. Wiener (WPE2QVT), Summit, N. J.
Richard Moore (VE3PE2NZ), London, Ont.
Michael Dopson (WPE4KCF), Enterprise, Ala.
Steve Swift (WPE7CVV), Olympia, Wash.
Barry Lavine (WPE2QHM), Elmina, N. Y.
James Ziegler (WPE5JOW), Milwaukee, Wisc.
Robert Olszewski (WPE8KFW), Toledo, Ohio.
Loren Davis (WPE6HMA), Hayward, Calif.
Fred Parkinson (WPE2QTW), Hewlett, N. Y.
Charles Lofthus (WPE4KFL), Landrum, S. C.
John Burda, Jr. (WPE8KA), Willard, Ohio.
Joseph Cooper (WPE5JRT), Milwaukee, Wisc.
David Yoder (WPE0EZU), Denton, Kansas.
Everett Slosman (WPE2QZB), Endicott, N. Y.
Craig Seufert (WPE1HNS), Newtown, Conn.
Gregory Walter (WPE8KFL), Wyoming, Mich.
Robert Robinson (WPE2RRAK), Bellmawr, N. J.
Daniel Laurier (WPE2QHP), Walton, N. Y.
Glenn Tamsai (VE7PE1EDY), Vernon, B. C.
Ron Taylor (WPE9JSJ), Benton, Ill.
Richard Lewis (WPE5BST), Blackfoot, Idaho.
David Lubar (WPE9JF9), Elwood, Ill.
Donald Asp (WPE6HGY), Tustin, Calif.
Willie Martin (WPE5FBY), Blithely Air Force Base, Ark.
Thomas Gongaware (WPE5HWH), Latrobe, Pa.
Joel Bahl (WPE9JFY), Worth, Ill.
Charles Albertson (WPE7C6W), Spokane, Wash.
Clayton Ruth (WPE9JGY), Munster, Ind.
Michael Schackner (WPE1HJS), Pawcatuck, Conn.

John Limbach (WPE4KCV), Fayetteville, N. C.
David Winfrey (WPE4KBA), Jupiter, Fla.
Curtis Phillips (WPE3HNS), Hellertown, Pa.
James Maker (WPE4H8), Tampa, Fla.
David Weisinger (WPE3HVY), Philadelphia, Pa.
Mrs. Mildred Marshall (WPE0FIR), Devils Lake, N. D.
Robert Byers (VE3PE2PX), Gannanoque, Ont.
Ronald Richmond (WPE9JLJ), Alexandria, Ind.
Alan Macnaughton (VE3PE2PP), Kitchener, Ont.
Warren Flack (WPE4KJU), Atlanta, Ga.
Stanley Starks (WPE8KDE), Midland, Mich.
Thomas Blossom (WPE9FHQ), Fort Wayne, Ind.
Kim Stenson (WPE1HPU), Wilmington, Vt.
John Adams (WPE3HXT), Beltville, Md.
Dennis Sheppard (WPE4JTH), Stone Mountain, Ga.
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June, 1970
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 and model number of the unit. If you don’t know both the maker’s name and the model number, give 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. Do not send an individual postcard for each request; list all requests on one postcard. 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.

Crosley Model 51 Receiver. Schematic and tubes needed. (John Von Dollen, 820 Ambrone Dr., Salinas, CA 93901)
MusicCraft Model MS 30-30 stereo basic amplifier. Schematic needed. (Wm. Jachlin, 6338 Baker Ave., Chicago, IL 60617)
RCX Model RC-6108 AM-FM radio. circa '34. Schematic and operation manual needed. (Eric Urscher, 620 10th Ave., Huntington, WV 25701)
Triumph Model 841 oscillograph. Instruction book and schematic needed. (Leo Belilts, 1920 State St., Everett, WA 98201)

Norelco Model EL 3241/54B tape recorder. Instruction manual needed. (Donald Rubin, 3619 Bancroft Rd., Baltimore, MD 21215)
Motorola Model L03-F3 FM receiver. Manual needed. (R. Bell, 20146 Beachcliff, Rocky River, OH 44116)
RealTone Model VT-2466 TV. Operating manual and schematic needed. (Bruce Friedman, 21 Stuyvesant Oval, New York, NY 10009)
Atwater Kent Model 60. Speaker needed. Philco radio chassis type 89 (or 19 series). Schematic needed. (Delmar Pond, 11 Stevens Court, Exeter, NH 03833)
Precision Apparatus Model 920 tube and set meter. Instruction manual and schematics needed. (Mike Morrow, 506 Manchester Dr., Chattanooga, TN 37415)
Lyso Model 600 CW transmitter. Schematic and parts list needed. (Stephen Smith, 2011 Broad St., New Castle, IN 47362)
Revere Model T-110 tape recorder. Schematic needed. (George Dewey, 512 N. Shore Dr., Crystal Lake, IL 60014)
Precise Model 300 oscilloscope. Schematic needed. (R. Arguin, 6055 Blvd. L. Basque, Laval, P.Q. Canada)
Motorola Model KM 2023C vibrasonic. Schematic needed. (Cris Holmes, 1723 Orchard, Fresno, CA 93703)
Kadette Model 36 by International Radio Corp. Schematic needed. (Terry Shotts, 18009 Marden Ln., Sandy Sprng, MD 20660)
Brunswick Model 5KR. Schematic and 1-UX71A, 2-UX226 tubes needed. (Larry Fahn, 1103 Hampton Circle, Elmira, NY 14904)
Zenith Model 55110 shortwave receiver. Source for parts needed. (Bob Patton, 2500 Elm, Parsons, KS 67357)
Globe Scout Model 650 transmitter. Schematic and instruction manual needed. (Ken Countess, 110 Sycamore Circle, Stony Brook, NY 11790)
Hallaclrafters Model S-76. Alignment data and operating manual needed. (John Davis, 2607 Colgate Ln., Lake Worth, FL 33460)
E. H. Scott Model 600 5761 console receiver. Schematic and operating manual needed. (S. Petrie, 1925 Newell Ave., Walnut Creek, CA 94596)
RCA Model T4-8 receiver. Schematic, manual and source of tubes needed. (Gary Lueck, 692 4th Ave., Newport, MN 55056)
Satellite FM receiver (channel A) to match FM-107 transmitter. Schematic needed. (Bruce Welin, Box 691, 5115 Margaret Morrison St., Pittsburgh, PA 15213)
Temco Model RA-150 amateur transmitter. Schematic, operating manual, and source for plug in coil needed. (Stephen Pankaly, 2833 S. St. Louis Ave., Chicago, IL 60623)

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VECTOR-CIRCUIT QUIZ ANSWERS

(Quiz appears on page 30)

1-B In a series circuit containing only resistance, the current is in phase with the applied voltage.

2-F In a parallel circuit, there are three currents and a single voltage, which is used as the reference vector (directed horizonta1ly to the right). The current in an inductor lags the voltage across the inductor by 90 degrees. The current into a capacitor leads the voltage across the capacitor by 90 degrees. The total circuit current is the difference between the branch currents.

3-J The current is used as the reference vector. The voltage drops across the capacitor and resistor add vectorially to equal the applied voltage.

4-H The applied voltage is the reference vector. The current in the circuit lags the voltage by 90 degrees.

5-G The applied voltage is the reference vector. The two branch currents add vectorially to equal the circuit current.

6-A The current is used as the reference vector. The voltage drops across the resistor and inductor add vectorially to equal the applied voltage.

7-I The current is the reference vector. The voltage drops across the inductor and capacitor are 180 degrees out of phase, and the difference between them is equal to the applied voltage.

8-E The applied voltage is the reference. The leading currents in each branch are in phase and add to equal total circuit current.

9-D The applied voltage is the reference. The two branch currents add vectorially to equal total circuit current.

10-C The applied voltage is the reference. The current in the inductor leads the applied voltage by 90 degrees.
A new leaflet, Form No. 7260, recently issued by Nortronics Co., Inc., is written to show the owner of a tape recorder how to determine whether or not his tape head is worn enough to warrant replacement. The leaflet describes the company's "Look-Touch-Listen" test, which gives the visible, aural, and tactile indicators on tape head wear. Worn heads, or heads where the gap has widened, tend to lose their effectiveness in reproducing high frequency sound clarity; worst of all, the deterioration takes place so gradually that the listener is usually unconscious of the change. In view of this, the leaflet recommends periodic head examination even if there is no active dissatisfaction with the performance of the tape recorder.

Circle No. 75 on Reader Service Page 15 or 95

A new company, Antenna Corporation of America, is offering to distributors a complete line of TV and FM receiving antennas that are suitable for color and monochrome TV. The antenna line will be marketed under the name "Citation." The VHF-UHF-FM antennas include a number of features, such as tetrapole collector elements, dual-action director/reflectors, screen, and die-cut impedance collimators. Also being offered are electronic accessories, including set couplers, solid-state preamplifiers, booster couplers, and matching transformers. A complete-line brochure is available from ACA.

Circle No. 76 on Reader Service Page 15 or 95

An easy-reference brochure featuring the company's entire line of home entertainment products is available from Koss Electronics, Inc., manufacturer of stereo headphones and accessories. The catalog, P/N11-1351, lists and describes Koss' exclusive electrostatic line of three stereo headphones and six dynamic models. Included also is a listing of accessories, encompassing remote control stations, connector box, monitoring adapter, extension cables and cords, and a high-impact plastic stereophone carrying case with sponge liner.

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- **Super Flash (Couch)** .......................................... 48 May
- **TC Switch—For Remote Control (Bechtold)** .................. 52 Apr.
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- **Letters From our Readers**
  - 8 Jan., 8 Feb., 8 Mar., 8 Apr., 8 May, 8 June
- **New Literature**
  - 12 Jan., 16 Mar., 16 Apr., 14 May, 97 June
- **New Products**
  - 22 Jan., 22 Feb., 22 Mar., 22 Apr., 22 May, 22 June
- **Operation Assist**
  - 100 Jan., 103 Mar., 104 Apr., 87 May, 94 June
- **Out of Tune**
  - Psychedelia I (Sept., 1969, p. 27) ............................ 13 Feb.
  - The Touch-A-Tone (Mar., 1970, p. 66) ........................ 88 May
  - Numitron Readout (Mar., 1970, p. 73) ........................ 88 May
  - One-Step Motion Detector (Mar., 1970, p. 57) ................. 88 May
  - Build Security I (Mar., 1970, p. 27) ........................ 88 May
- **Tips And Techniques**
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  - 79 Mar., 93 Apr., 77 May, 69 June

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- **Bamboo Missionary Broadcaster (Kimberley)** ................. 61 Feb.
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- **Electronics Geography Quiz (Haskell)** ........................ 42 Apr.
- **Experiment- Level Opportunities for You (Burawa)** .......... 76 Feb.
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- **Laser Holography, Do It Yourself (Knowles)** ............... 27 Jan.
- **Loaded Dice, A Pair of (Weems)** .............................. 40 Jan.
- **Metronome Timer, One Second (Mangieri)** .................... 58 Feb.
- **Micro/Lign Generator (Robbins)** .............................. 48 Apr.
- **Micro-Sensitive Schmitt Trigger (Tooker)** .................... 64 Jan.
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- **No-Bounce Pushbutton, Build the (Lancaster)** .............. 51 Mar.
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- **Photographic Wash Tester, Build a (Brosnan)** .............. 65 May
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- **Security I, Build (Pina)** ..................................... 27 Mar.
- **Shift Register, Build a (Lancaster)** ........................ 43 May
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- **Standard, Build the 100-kHz (Lancaster)** .................... 56 Apr.
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- **TC Switch—For Remote Control (Bechtold)** .................. 52 Apr.
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- **Time Out, Build the (Stayton)** ................................ 52 Jan.
- **Transcipient, Build a (Boyd)** ................................ 31 June
- **Voxor, Build the (Hirschfeld)** ................................ 81 Feb.
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June, 1970

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