Electronics World

NOVEMBER, 1962
50 CENTS

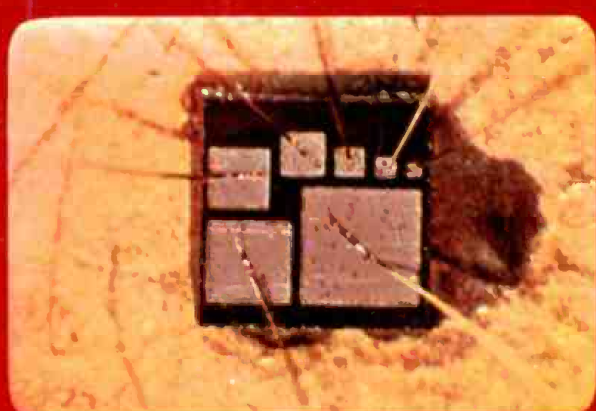
DESIGN FOR AN ALL-PURPOSE TV-FM ANTENNA

WHITE NOISE—*Its Nature, Generation, and Applications*

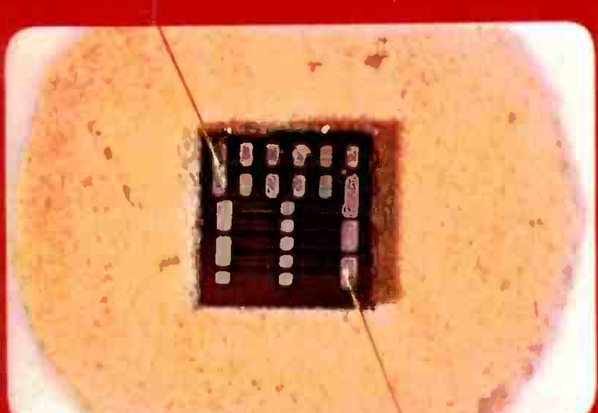
EVOLUTION OF THE COMMUNICATIONS RECEIVER

Build an —FM BOOSTER
VIBRATO SIMULATOR
3-TRANSISTOR CB TRANSCEIVER

INDUCTOR



CAPACITORS



RESISTORS

INTEGRATED CIRCUITRY

Entire circuits can now be made on tiny bits of material and placed inside transistor-sized cases. This new technique makes ... reliable, ... pensive.

A ZIFF-DAVIS PUBLICATION

to provide the biggest sound in slim-lines!

New Electro-Voice REGINA 200

Now! Enjoy a slim-line system that sounds as good as it looks! The new E-V Regina 200 with component-quality speakers expressly designed to meet the challenge of ultra-thin cabinetry!

In the woofer, for example, where some thin-speaker systems use light-weight "radio set" speakers, the new E-V Regina 200 employs a true 10-inch high fidelity speaker... with powerful 1 lb. 6 oz. ceramic magnet, precision edgewise-wound voice coil and specially-tailored low-resonance suspension. This combination guarantees solid response to 50 cps, plus minimum distortion and optimum efficiency — with even the lowest-powered stereo amplifiers!

Now, examine the tweeter! It has the look and sound of fine laboratory equipment! The heavy die-cast frame and jewel-like machining insures a lifetime of uniform response. And note the polyurethane suspension system that's years ahead of the rest! It's the secret of the remarkably smooth response to 15,000 cps! Note the handy level control on the back of the Regina 200 for exact personal control of tonal balance.

Measuring only 5-5/8 inches deep, 24-3/8 inches high, 16-3/8 inches wide, the new E-V Regina is a beautifully easy answer to your stereo speaker placement problems. And it's easy on the pocketbook, too . . . just $89.50 net with oiled walnut finish.

Hear the biggest sound in slim-lines... the new Electro-Voice Regina 200 at your E-V dealer's today!

ELECTRO-VOICE, INC.
Commercial Products Division
Dept. 1124N, Buchanan, Michigan

Electro-Voice®

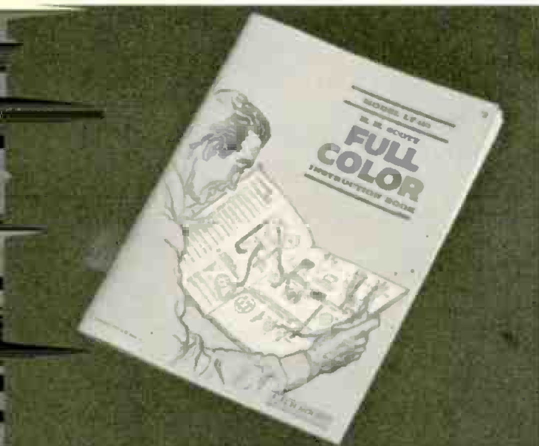
INSTITUTE OF HIGH FIDELITY

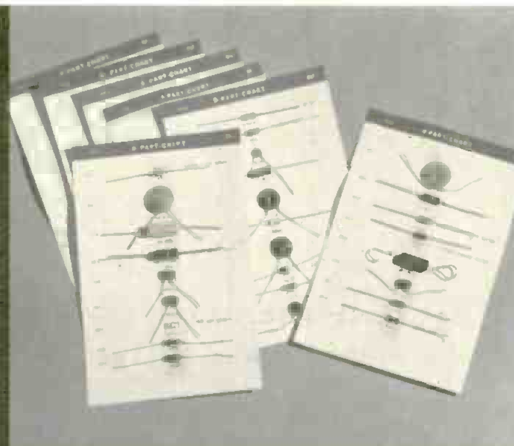
CIRCLE NO. 116 ON READER SERVICE CARD

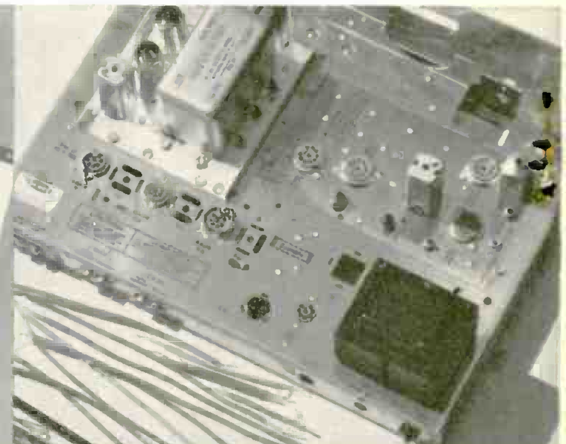
ELECTRONICS WORLD is published monthly by Ziff-Davis Publishing Company at 434 South Wabash Avenue, Chicago 5, Illinois. Subscription rates: one year United States and possessions $5.00; Canada and Pan American Union countries $5.50; all other foreign countries $6.00. Second Class postage paid at Chicago, Illinois and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada and for payment of postage in cash. November, 1962; Vol. 68, No. 5.

Here's why Audio Magazine says Scott® Kits are

"Simplest to build..." and have "Engineering of the highest calibre" *



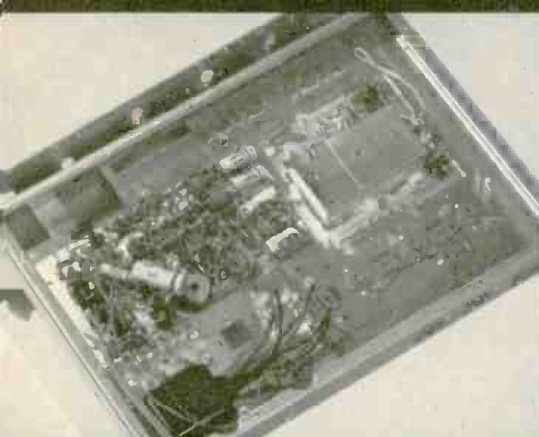


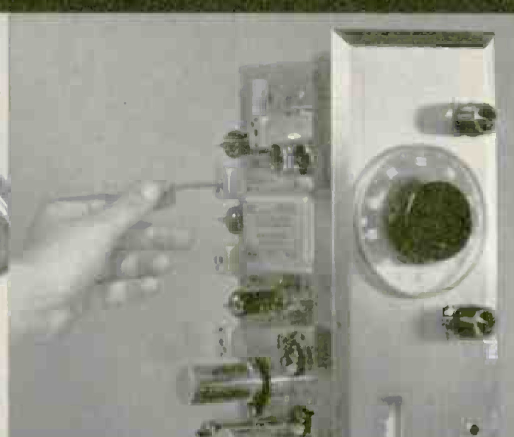


The exclusive Scott full color instruction book shows every part and every wire in natural color and in proper position. To make the instruction book even clearer, each of the full color illustrations shows only a few assembly steps. There are no oversized sheets to confuse you.

Each full color illustration is accompanied by its own Part Chart . . . another Scott exclusive. The actual parts described in the illustration are placed in the exact sequence in which they are used. You can't possibly make a mistake.

Much of the uninteresting mechanical assembly is completed when you open your Scott Kit-Pak. All the terminal strips and tube sockets are already permanently riveted to the chassis. To insure accuracy all wires are pre-cut and pre-stripped to proper length.





There are certain areas in every professional high fidelity component where wiring is critical and difficult. FM front ends and multiplex sections are an example. In Scott Kits these sections are wired at the factory, and thoroughly tested by Scott experts, assuring you a completed kit meeting stringent factory standards.

Tuners are aligned with the unique Scott Ez-A-Line method using the meter on the tuner itself. This assures perfect alignment without expensive signal generators. Amplifier kits require no laboratory instruments for perfect balancing.

The new Scott Warrantee Performance Plan guarantees that your kit will work perfectly when completed. If you have followed all recommended procedures and your kit fails to work Scott guarantees to put your kit in working order at the factory at minimum cost.

When you finish your kit you'll be delighted by its handsome good looks. And when you turn your Scott Kit system on you'll know for yourself why the expert editors of leading high fidelity magazines like Audio say . . . "only the most sophisticated engineering thinking could design a kit as simple and foolproof as this . . ." *

*Audio — February 1961, Pages 54-56

SCOTT®

H. H. Scott, Inc., 111 Powdermill Road, Dept. 160-11, Maynard, Mass.

FREE STEREO RECORD

demonstrating new FM Multiplex Stereo and explaining all important technical specifications.

SEND ME FREE STEREO record plus 20 page 1963 "Guide to Custom Stereo", new Scott kit brochure.

Name ______________________

Address ______________________

City ______________ State ________

Include names and addresses of any interested friends.
Export: Morhan Exporting Corp., 458 Broadway, N. Y. C.
Canada: Atlas Radio Corp., 50 Wingold Ave., Toronto

CIRCLE NO. 153 ON READER SERVICE PAGE

NOVEMBER 1962 / VOL. 68 NO. 5 **Electronics World**

CONTENTS

ZIFF-DAVIS PUBLISHING COMPANY
Editorial and Executive Offices
One Park Avenue
New York 16, New York
ORegon 9-7200

MIDWESTERN and CIRCULATION OFFICE
434 South Wabash Avenue
Chicago 5, Illinois
WAbash 2-4911
Midwestern Advertising Manager
Gilbert J. Jorgenson

WESTERN OFFICE
9025 Wilshire Boulevard
Beverly Hills, California
CRestview 4-0265
Western Advertising Manager
Bud Dean

FOREIGN ADVERTISING REPRESENTATIVE
D. A. Goodall Ltd., London, England

COMING NEXT MONTH

Special Feature

Lasers and Their Uses—A new source of intense coherent light that can be used as a carrier for space communications systems or as the heart of an ultra-precise radar. This versatile electronic tool is also used as a delicate scalpel for eye surgery or as a cutting torch for tough metals ... a progress report on the art.

HIGH-ACCURACY SATELLITE TRACKING SYSTEM

After launching, a space vehicle is located and its speed is measured by a radar-like technique which is described by James E. Kirch, the Program Manager of the Goddard Range & Range Rate System of Motorola's Military Electronics Division in Phoenix.

THE ACOUSTICAL LENS

How this widely used device performs its job of dispersing and shaping the sound energy from a horn-type loudspeaker driver. From its earliest beginnings the author traces the evolution of the lens to its present, highly developed state.

THE BUSINESS RADIO SERVICE

George W. Pettengill of RCA's Mobile Communications Equipment Dept. gives the facts and figures to support his contention that almost any business can profit from the use of two-way mobile radio. He claims increased efficiencies will more than offset the cost of such a mobile installation.

PULSE-HEIGHT ANALYZERS

All radioactive substances—and many others that can be stimulated to radiate—emit at characteristic energy levels. From these levels, positive identification can be made quickly and easily. Unlike indiscriminate radiation detectors, pulse-height analyzers respond to radiation amplitude. For this reason they have numerous applications in medicine, agriculture, and industry.

DIGITAL READOUTS

These units, which convert electrical signals into readable data, are widely used in counters, digital voltmeters, stock market quotation boards, airline flight reservation boards, computers, and data-processing equipment. Because they are such popular devices, the author describes the operation and maintenance procedures for 15 different electro-mechanical, optical, and mechanical-optical types.

1962 ELECTRONICS WORLD INDEX

A concise and handy listing of all the feature articles which have appeared in the magazine during 1962. The articles are classified by subject matter.

All these and many more interesting and informative articles will be yours in the December issue of ELECTRONICS WORLD ... on sale November 22nd

ZIFF-DAVIS PUBLISHING COMPANY

William B. Ziff
Chairman of the Board (1946-1953)

William Ziff
President

W. Bradford Briggs
Executive Vice President

Hershel B. Sarbin
Vice President and General Manager

M. T. Birmingham, Jr.
Vice President and Treasurer

Robert P. Breeding
Circulation Director

Charles Housman
Financial Vice President

Stanley R. Greenfield
Vice President

Member Audit Bureau of Circulations

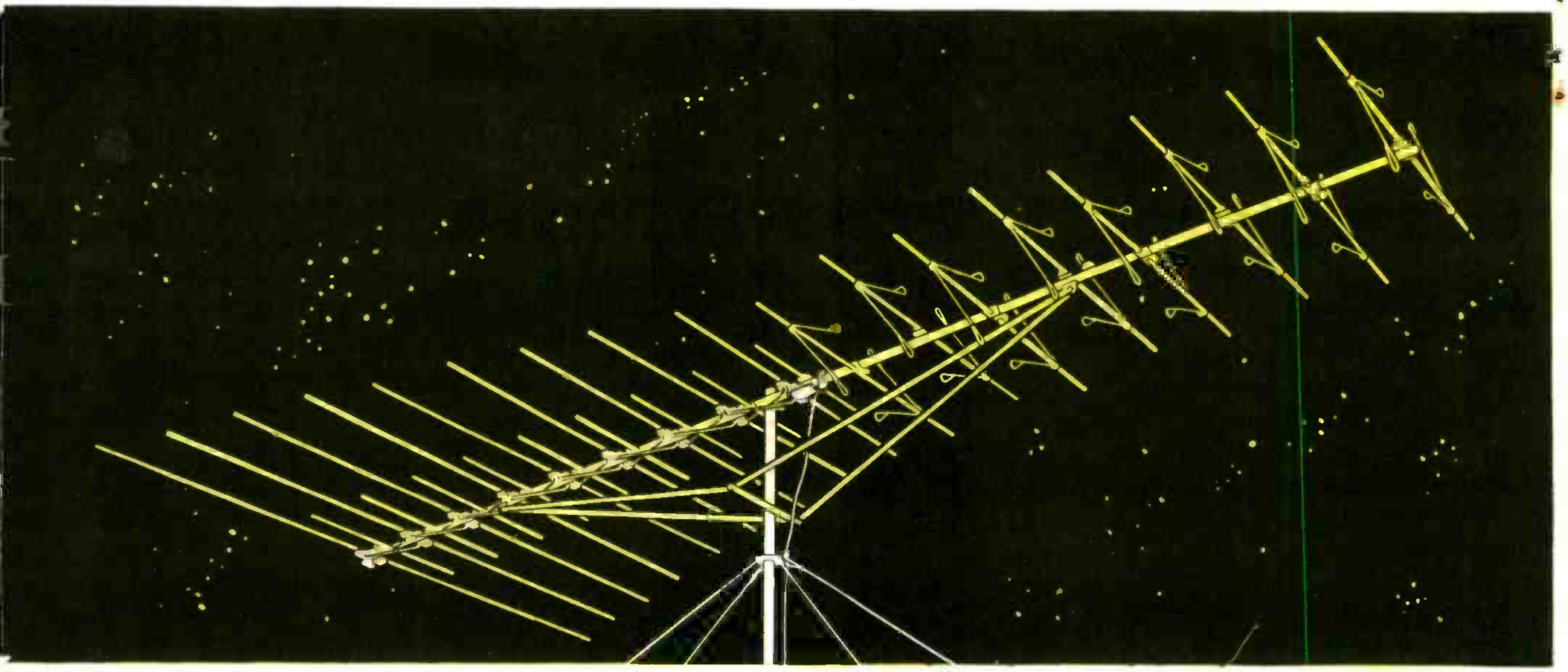
Radio & TV News • Radio News • Radio-Electronic Engineering Trademarks Reg. U.S. Pat. Off.

SUBSCRIPTION SERVICE: All subscription correspondence should be addressed to Electronics World, Circulation Department, 434 South Wabash Avenue, Chicago 5, Illinois. Please allow at least six weeks for change of address. Include your old address, as well as new—enclosing if possible an address label from a recent issue.

EDITORIAL CONTRIBUTIONS must be accompanied by return postage and will be handled with reasonable care; however publisher assumes no responsibility for return or safety of art work, photographs, or manuscripts.

6 NEW SPACE-

BY CHANNEL MASTER



All new Telstar Crossfire

Electronic Antenna combines unequalled performance of new Super-Crossfire Antenna with new built-in Telstar Booster

World's most powerful antenna features exclusive, advanced, new, TRI-BAND Director System for low band, high band, and FM. Gives lots more gain—plus tremendous added gain of Telstar Booster.

In the Crossfire Antenna, Channel Master gave you Proportional Energy Absorption—the most effective principle yet for achieving top picture power in picture-poor areas. Now, in the **Telstar Crossfire**, we've teamed this principle with two new exclusive developments—to make this far and away the most powerful antenna in the world.

Basically, the Telstar consists of our brand new Super-Crossfire—an antenna with a brand-new Director system. The TRI-BAND Director System—exclusive with Channel Master—enables each Director to receive low and high bands, and FM . . . on a single element. Thanks to a unique Phase Controller, each director—on the high band —functions as 2 half-wave co-linear elements with in-phase current distribution. In effect, **simplifed** directors make it possible to use more directors—for increased effectiveness. Result?

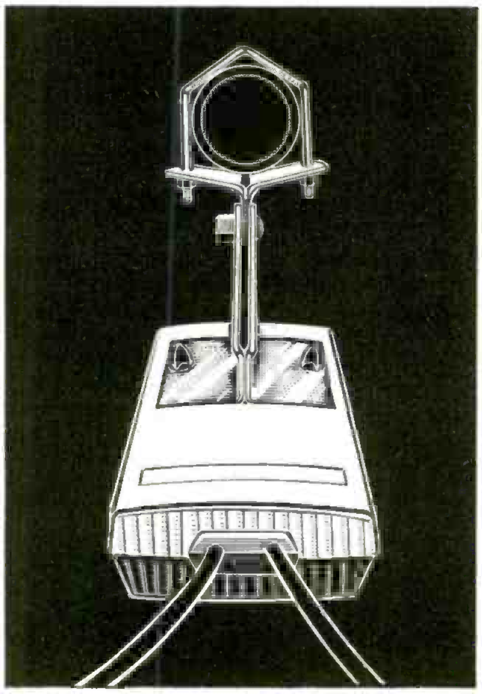
. . . **In the Super-Crossfire Antenna** (Model 3607 . . . available separately) . . . you get up to 42% more gain than the 28-element Crossfire, plus the same high front-to-back ratios.

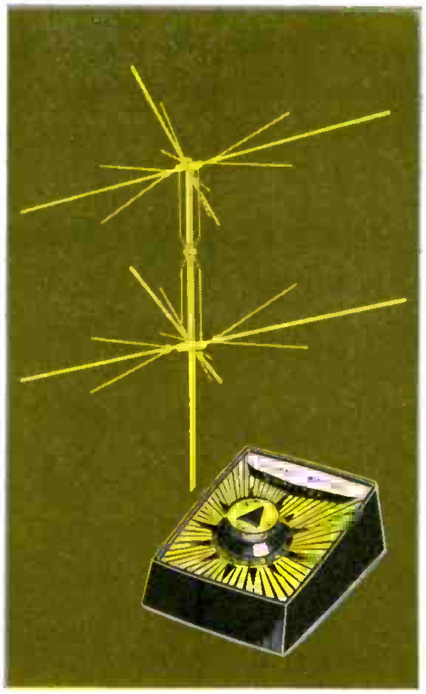
. . . **In the Telstar Crossfire Antenna** (Model 3606) . . . you get all the outstanding features of the Super-Crossfire . . . **plus** the extra-powerful gain and low noise-figure of the brand new Telstar Booster (see right). No other antenna even comes close.

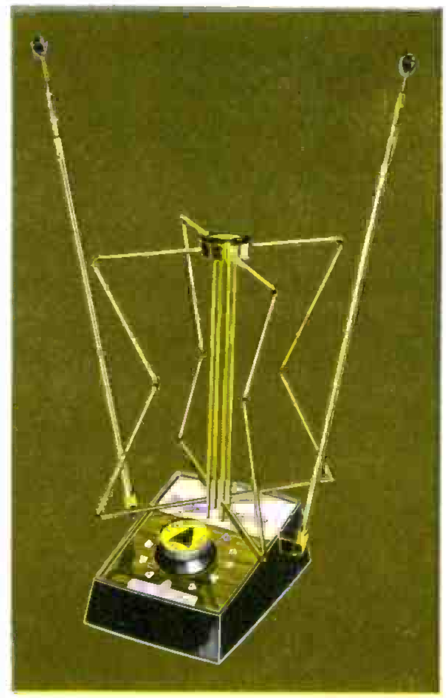
- **Exclusive New!** Both Telstar and Super-Crossfire feature still another Channel Master first: New 2-way boom bracing . . . stops cross-arm bounce and horizontal wind-whip.
- **Exclusive!** All Channel Master outdoor antennas are fully protected against corrosion by E.P.C. "Golden Overcoat."

AGE TRIUMPHS

BEST-PERFORMING OF ALL ANTENNAS AND BOOSTERS! AND MOST PROFITABLE FOR YOU! BEST FOR BLACK-AND-WHITE AND COLOR TV. FM STEREO, TOO!







NEW Telstar BOOSTER-COUPLER

features peak-power plus lightning-resistant circuit!

TV and FM Stereo get the biggest performance boost yet with a booster that is miles ahead of the "second best" booster. The Telstar Booster is especially engineered to pour more **usable** power than any other booster to 1, 2, 3, or 4 sets! The latest circuitry and advanced low-noise transistor result in highest gain and highest signal-to-noise ratios yet.

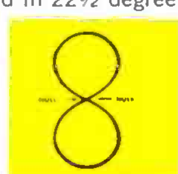
Lightning-resistant, too—because circuit utilizes the lightning rod principle to prevent **transistor burnout** caused by induced atmospheric lightning. Laboratory-tested by 250,000 lightning volts! Beautifully styled in blue-and-white. **Model 0023**

New OMNI-RAY TV/FM STEREO ANTENNA

GHOST-KILLER EXTRAORDINARY!

A brand-new outdoor antenna with directivity electronically controlled by an indoor switch. (No rotator needed) • Stops ghosts and interference in metropolitan, suburban, and near-fringe areas. For Color TV, Black-and-White, and FM Stereo.

1. Perfect figure-8 reception pattern, electronically rotated in 22½ degree steps.
2. Deep side nulls. 10:1 rejection ratio.
3. "Aim the beams" for top power; "aim the nulls" for top ghost and interference rejection.
4. Special "Duo-Twin" Transmission lead prevents mutual coupling.



Your choice of: • Supersembled stacked antenna only • Complete kit, single bay • Complete kit, stacked

Handsome New CANAVERAL

FIRST INDOOR DIPOLE ANTENNA WITH TRUE ELECTRONIC CIRCUITRY.

Unique " Pix-Power " switch and impedance-compensating circuit give you these exclusive advantages:

1. On low band—resonates on all channels (even 2 and 3) by electronically lengthening or shortening elements—**without need for manual dipole adjustment.**

2. On high band—Greatly increases gain by functioning as 2 co-linear half-wave dipoles — **without manual adjustment.**

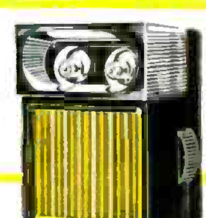
3. Has balanced system with 300-ohm impedance-matched output to eliminate standing waves.

Has the longest elements anywhere (96" tip to tip) for greater pull-in power.

Smartly-styled, with tremendous merchandising possibilities. **Model 3720**

NEW! Rechargeable BRIGHT-MITE.

The revolutionary tiny miracle light that outshines big flashlights. Powered by the Permanent Energy Cells that power the Satellites. Ask about our terrific Display Pack deal.



See your Channel Master distributor for literature on all these products.

...for the Record

By **W. A. STOCKLIN**
Editor

A Tribute To Our Scientists

"TELSTAR," launched on July 10, has received more public attention than any other unmanned satellite to date. Even after three months of operation, radio, television, and the press were still acclaiming this outstanding technical achievement.

We have already seen some samples of transatlantic TV programs and we have been able to make transatlantic telephone calls. Just the other day, for example, one of our editors was flying about 5½ miles above eastern Pennsylvania on a new jet. He was able to sit in on a telephone call made from the plane, to the ground, then up to "Telstar" several thousand miles away, then down to Goonhilly Downs, England, and, finally, to an office in London. The London operator came in loud and clear.

Although the scientists, engineers, and technicians who planned the design and helped to carry it out were obviously confident of success, many unforeseeable circumstances could have marred their efforts. On the other hand, to be able to plan, design, and predict performance, as the engineers and scientists have in this experiment, would make it seem that luck played only a minor role.

"Telstar's" performance after several hundred orbits remained exactly as planned. The tracking equipment is so accurate that the satellite's position can be predicted to within .1 degree. And this is possible even though the satellite is a mere yard in diameter and is radiating a signal which, when picked up at the Andover, Maine, receiving station, averages only about 7.5 micromicrowatts (.0000000000075) of power. Yet voice communications and television transmissions continue to be just as expected.

These are only a few of the facts, but they do point out a major achievement and advancement in the field of communications in a few short years.

Although the success of "Telstar" is still being acclaimed, the performance of our new Venus-bound spacecraft, "Mariner II," is additional evidence of the "know-how" of our scientists, engineers, and technicians. Extremely difficult space maneuvers, at a great distance from the earth, were accomplished on September 4, when this spacecraft's direction was changed.

Original plans were to have "Mariner II," a 12-foot, 450-lb. space vehicle, pass within 10,000 miles of the planet Venus. Unfortunately, during lift-off, the "flying laboratory" was projected in such a course that it would have crossed the orbit of Venus some 233,000 miles ahead of the planet. At this distance few useful observations could have been made. But nine days after launching, and after the spacecraft had traveled approximately 1.5 million miles, scientists at California Institute of Technology's Goldstone tracking station in California's Mojave Desert decided to attempt to correct its course. By ground radio command, the spacecraft was made to roll on its axis and pitch forward so that it was in the proper position for rocket firing. Next, the rocket fired, slowing down the vehicle and altering its course. Finally, the long-range precision antenna was reoriented toward earth and the panels of solar cells were pointed toward the sun. Predictions now are that "Mariner II" will pass within 9000 miles of Venus.

On the day after this complex maneuver was successfully completed, scientists were still getting "loud and clear" signals from the spacecraft's 3-watt transmitter when it was nearly 2 million miles from earth. They expect to be able to track it even beyond the planet Venus.

It is hoped that a Venus pass will provide us with details on the planet's temperature and type of atmosphere, along with details on magnetic and radiation fields. Obviously, all of these facts will help us determine whether life, as we know it, can exist on the distant planet.

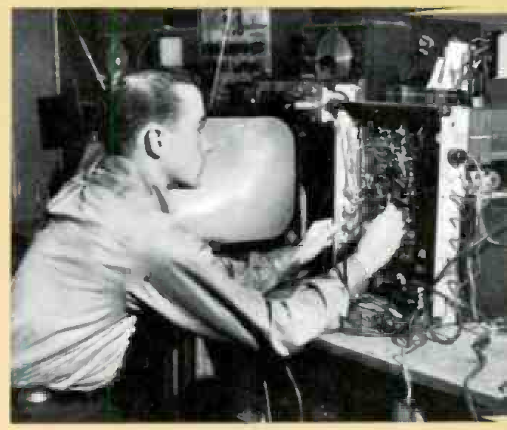
Considering that Venus will be about 36 million miles from earth at the time "Mariner II" is due to pass it around noon (EST) on December 14 there should be no doubt in anyone's mind that the entire project is an outstanding scientific achievement. Honors are due not only to the brilliant scientists who conceived these systems, but also to the many engineers and technicians who carried out the designs. ▲

← CIRCLE NO. 125 ON READER SERVICE PAGE

PICK THE CAREER YOU WANT
IN THE WONDERFUL FIELD OF ELECTRONICS
TRAIN AT HOME WITH THE LEADER

Higher earnings and rapid advancement plus a growing need for trained technicians . . . these are the reasons why so many men are training for careers in Electronics with NRI. Right now, four-to-seven technicians are needed for every graduate engineer—but you must be *trained* to qualify. So to assure advancement, or to turn your hobby into a new and profitable career, investigate the Electronics courses offered by NRI, the oldest and largest home-study school of its kind. NRI training is the time-proved way to get into the fast-growing industry of the 1960's.

TELEVISION-RADIO SERVICING
(INCLUDES COLOR TV)



NRI's time-tested course in Servicing not only trains you to fix radios, stereo hi-fi, black & white TV, etc., but also prepares you for profit opportunities in the growing field of Color TV. NRI training shows how to earn spare-time money starting soon after you enroll. Prepare for a spare-time or full-time business or a good job as a Service Technician. Special training equipment included.

INDUSTRIAL ELECTRONICS

Prepare for a career as an Electronic Technician in industry, business, government, the military, with this NRI course in Electronics — Principles, Practices, Maintenance. Computers, telemetry, automation, missiles, rockets all employ the same basic principles . . . and that is what this NRI course stresses with illustrated lessons, special training equipment.

TV-RADIO COMMUNICATIONS

Get actual experience as NRI prepares you for your choice of Communications fields and an FCC License. Commercial methods and techniques of Radio and TV Broadcasting; teletype; facsimile; microwave; radar; mobile and marine radio; navigation devices; FM stereo multiplexing are some of the subjects covered. You work with special training equipment NRI furnishes.

FCC COMMERCIAL LICENSE

This course is for men with Radio-TV experience who want to operate or service transmitting equipment used in broadcasting, aviation, marine, microwave, facsimile or mobile communications. A Service Technician is *required by law* to have an FCC License to work on C-Band and other transmitting equipment. This new NRI course trains you quickly for your Government exams.

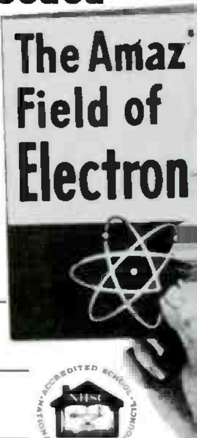
Job Counsellors Recommend—TURN PAGE ▶

Mail Postage-Free Card ▶

Cut Out and Mail—No Stamp Needed

NRI

NATIONAL RADIO INSTITUTE
WASHINGTON 16, D. C. EA



Please send me your Electronic, Radio-TV catalog without cost or obligation. I am interested in the course checked below. (No salesman will call. PLEASE PRINT.)

☐ INDUSTRIAL ELECTRONICS ☐ FCC LICENSE
☐ RADIO-TV SERVICING ☐ COMMUNICATIONS

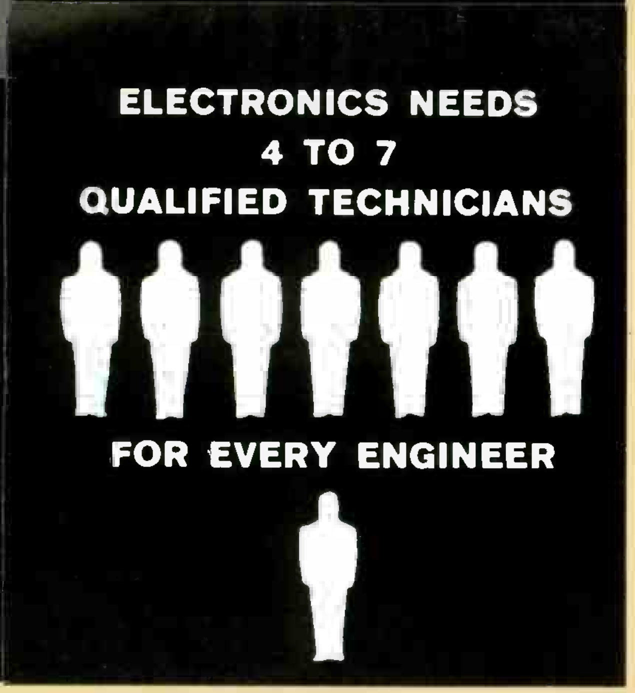
Name____________________________ Age______

Address________________________________

City____________________ Zone____ State________

ACCREDITED MEMBER NATIONAL HOME STUDY COUNCIL

Approved for Veteran's under Korean GI Bill



Join The Thousands Who Trained For Advancement With NRI

Thousands of NRI graduates throughout the U. S. and Canada are proof that it is practical to train at home. NRI graduates are in every kind of Electronics work: inspectors, maintenance men, lab technicians, testers, broadcasting and mobile communications operators, Radio-TV service technicians, or in essential military and government posts. Catalog tells more about what NRI graduates do and earn. Mail postage-free card.

"Learn-by-Doing" with Special NRI Training Equipment

As part of your training (in all but the FCC License Course) NRI sends you specially-developed training kits that give actual practice, make NRI training come to life in an exciting, practical, easy-to-understand manner. You perform dozens of "home lab" experiments with high-quality, scientifically designed electronic components, like those used in commercially-made instruments. You keep all the equipment you get. It is yours *at no extra cost* . . . to use in your new career. See and read about this special training equipment, as well as other course details, information about the growing Electronics field, data on amazing new developments, job opportunities and the NRI trial plan in FREE 64-page Catalog. No obligation. No salesman will call on you. Just mail postage-free card below.

SEE OTHER SIDE

"THE FINEST JOB I EVER HAD" is what Thomas Bilak, Jr., Cayuga, N. Y., says of his position with the G. E. Advanced Electronic Center at Cornell University. He writes, "Thanks to NRI, I have a job which I enjoy and which also pays well."

BUILDING ELECTRONIC CIRCUITS on specially-designed plug-in type chassis, is the work of Robert H. Laurens, Hammonton, N. J. He is an Electronic-Technician working on the "Univac" computer. Laurens says, "My NRI training helped me to pass the test to obtain this position."

"I OWE MY SUCCESS TO NRI" says Cecil E. Wallace, Dallas, Texas. He holds a First Class FCC Radio-telephone License and works as a Recording Engineer with KRLD-TV.

MARINE RADIO OPERATOR is the job of E. P. Searcy, Jr. of New Orleans, La. He works for Alcoa Steamship Company, has also worked as a TV transmitter engineer. He says, "I can recommend NRI training very highly."

FROM FACTORY LABORER TO HIS OWN BUSINESS that rang up sales of $158,000 in one year. That's the success William F. Kline of Cincinnati, Ohio, has had since taking NRI training. "The course got me started on the road," he says.

FIRST CLASS
PERMIT
NO. 20-R
(Sec. 34.9, P.L.&R.)
Washington, D.C.

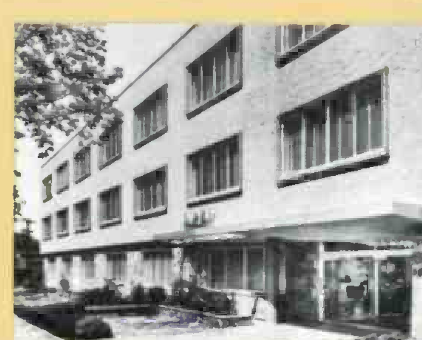
BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY

NRI National Radio Institute
3939 Wisconsin Ave.
Washington 16, D.C.

NRI IS OLDEST, LARGEST SCHOOL OF ITS KIND

Helping men to succeed through Home Study training has been NRI's only business for nearly half a century. Thousands of NRI graduates from coast to coast are proof that NRI home study methods lead to profitable, respected careers. *Act Now.*



MAIL POSTAGE-FREE CARD NOW!

NOW with

INTERNATIONAL MODEL 100 A EXECUTIVE TRANSCEIVER

International's new Model 100 A is the latest in the outstanding line of Executive transceivers. The advanced design Executive features a *transistor power supply, new perforated metal cabinet,* and a *new rugged microphone* . . . all of which contribute to a more reliable mobile operation.

The Model 100 A . . . the finest of its kind, also features:

• Crystal filter for improved receiving • Twelve crystal controlled transmit positions • Two crystal controlled receive positions • Dual conversion superheterodyne receiver tuning 23 channels • Built-in calibration circuit • N R squelch • Provision for connecting external speaker and s/meter • Push-to-talk operation • Transistor power supply operates from 6/12 vdc or 115 vac

Model 100 A, complete with 1 transmit crystal, 1 receive crystal, and microphone.......$199.50

External Speaker and S/Meter

The perfect companion for the International Executive Model 100. Utilizes a high impedance vacuum tube volt meter circuit. Connects to socket on rear of transceiver. S/meter reads in three ranges. Brown cabinet, brown and silver panel matches Executive transceiver.

Complete with interconnecting cable.......$49.50

Executive Speech Clipper/Filter Amplifier

A microphone amplifier designed to increase average modulation . . . limits modulations peaks . . . filters audio frequencies above 2500 cycles. Permits arms-length microphone operation. Power requirements: 12 vac or 12 vdc.

Complete with interconnecting cable.......$36.50

12.6 VAC, 2 Ampere Power Unit

Base station power unit for Speech Clipper/Amplifier. Operates from 115 vac. Provides 12.6 vac at 2 amperes.

Complete with mounting chassis, power cord, fuse, switch.......$12.50

Citizens Band licensees with International equipped stations know the unquestioned superiority and advantages of Executive transceivers and their system engineered accessories.

See your authorized International dealer today.

INTERNATIONAL
CRYSTAL MANUFACTURING CO., INC.
18 NORTH LEE • OKLAHOMA CITY, OKLA.

LETTERS FROM OUR READERS

TRANSISTORIZED IGNITION SYSTEM

To the Editors:

I was interested in the article in your August issue entitled "Transistorized Ignition System." It is easy to see that the claims of the author about improved point life must certainly be justified. However, it is very difficult to see how his system could achieve the improved engine performance he claims for it.

Take the matter of secondary voltage: Under the immutable laws of physics the secondary voltage of a perfect transformer cannot possibly exceed the primary voltage multiplied by the turns ratio. But in Mr. Saatjian's circuit the primary voltage is limited to an absolute maximum of 48 volts under collapsing field conditions. (This value is the difference between the zener drop and the opposing battery voltage.) Multiplying by the turns ratio gives 12,000 volts for the secondary, not a very high voltage.

By comparison, the corresponding maximum primary voltage in the conventional ignition system, according to the figures given in the article, would be 288 volts. Multiplying by the turns ratio of 100 gives a secondary voltage of 28,800 volts, which represents a big difference in favor of the old system.

Then, take the matter of energy delivered in the spark on the occasion of each firing. That energy cannot possibly exceed the energy stored in the primary in the periods between firing. With 1 mhy. in the transistorized primary and 3 mhy. in the conventional primary, along with 7 amps maximum in either case, the stored energy must be .0245 joule in the one case and .0735 joule in the other.

So, I'm not doubting the author's word. I'd just like to know how he can cut secondary voltage by more than half, and cut spark energy by two-thirds, and still obtain *improved* starting and overall performance.

Now, if he is only talking about high-speed performance, he might have something. But if it were considered desirable to sacrifice performance at low and medium rpm in favor of the performance at high rpm, this could have been achieved long ago without the benefit of transistors, zeners, etc.

ROBERT LYNN
Beverly Hills, Calif.

Here is a portion of Author Saatjian's reply to the above letter.—Editors.

Dear Mr. Lynn:

After I received your letter, I ran a test on my car, using the "Allen-Tronic" ignition analyzer console. As I have not removed the regular ignition from my car, I could switch from transistorized ignition to regular ignition very easily.

The following high-voltage readings were obtained on the "Allen" scope:

Transistorized System	
575 rpm (idle)	24,000 volts
2000 rpm	22,000 volts
4500 rpm	20,000 volts
Regular System	
575 rpm (idle)	29,000 volts
2000 rpm	15,000 volts
4500 rpm	6000 volts

Next, an exhaust analyzer was used to measure combustion efficiency. After several readings, the average was 9% higher efficiency in favor of the transistorized system.

The article claims higher efficiencies at highway speeds, and this is proven correct by the above tests.

BOGHOS N. SAATJIAN
Los Angeles, Calif.

Incidentally, a good many readers have asked us what changes must be made in the circuit for positive-ground ignition systems and for 6-volt systems. Author Saatjian is working on a brief follow-up story covering these modifications. We intend to run this additional information in an early issue.—Editors.

° ° °

THE ELECTROMETER

To the Editors:

The article entitled "The Electrometer" which starts on page 33 of the July issue, is quite interesting. However, I think that the artist who drew the arrows had his directions reversed. I believe that the lines of electrostatic force should be shown with arrows pointing from plus to minus, rather than from minus to plus as you have shown.

PAUL PETER FINCH
Detroit, Michigan

Whether or not the drawing shown is correct depends upon which convention you use. In many texts, the direction of the electric lines of force is determined by the movement of a positive charge of electricity. In this case, the lines would point from plus to minus. On the other hand, there are other texts, particularly those dealing with electron optics and cathode-ray

NOW *EVERYONE* CAN QUICKLY

Set up and Service Color TV

1 PATTERN DISPLAY STANDARD
Shows correct pattern and color in window viewer for visual guide

2 PATTERN SELECTOR
Produces each pattern individually for quick, easy convergence

3 AUTOMATIC DECONVERGENCE
Simplifies static and dynamic convergence. No digging into set

4 COLOR SELECTOR
Produces each color one at a time for accurate color set-up

5 COLOR GUN KILLER
Automatically enables the technician to actuate any combination of the 3 guns

6 DEMODULATOR ALIGNMENT
Makes alignment extremely simple, without going into the color set

New! B&K Model 850 COLOR GENERATOR

Most Complete, Most Versatile, Portable Instrument for Use in the Home and in the Shop Makes Color TV Set-up and Service Easier, Faster than ever!

Now every service technician can be ready to set-up and service color TV with amazing new ease and speed! New advanced design simplifies the entire operation, saves time and work in every installation. Eliminates difficult steps in digging into the color TV set. Gives you new confidence in handling color.

Produces Patterns, Burst, and Colors Individually—Provides dot pattern, crosshatch, vertical lines, horizontal lines, burst signal, and individual colors—one at a time—on the instrument panel as well as on the TV color set—for fastest, easiest check. Unique window-viewer on front of the instrument panel shows you each pattern and color as it should be—gives you an exclusive display standard to use as a sure guide for quick, visual comparison.

Provides Accurate, Individual Color Display—Produces Green, Cyan, Blue, B—Y, Q, Magenta, R—Y, Red, I, Yellow, and Burst—one at a time. All colors are crystal-controlled and are produced by a precision delay-line for maximum accuracy. Each color is individually switch-selected—no chance of error.

Provides Accurate NTSC-Type Signal—Color phase angles are maintained in accordance with NTSC specifications.

Makes Convergence and Linearity Adjustments Easy—Highly stable crystal-controlled system with vertical and horizontal sync pulses, assures the ultimate in line and dot stability.

Simplifies Demodulator Alignment—The type of color display produced by this instrument provides the ultimate in simplicity for precise demodulator alignment.

Provides Automatic Deconvergence—Eliminates the necessity for continual static convergence adjustments. The instrument automatically deconverges a white into a color dot trio without digging into the color set to mis-adjust the convergence magnets. It also deconverges a white horizontal or vertical line into red, green and blue parallel lines. This greatly simplifies dynamic convergence adjustments.

Provides Exclusive Color Gun Killer—Front-panel switch control makes it easy to disable any combination of the three color guns. Eliminates continuous adjustment of the background or screen controls, or connection of a shorting clip inside the receiver. The switch also selects the individual grids of the color tube and connects to a front-panel jack to simplify demodulator alignment.

Provides Switch-Selected R.F. Signals—Factory-tuned, for channels 3, 4, and 5—for open channel use in your area.

Model 850 also includes other features that make it invaluable for home and shop use. Net, **$199.95**

See Your B&K Distributor or Write for Catalog AP20-N

B&K MANUFACTURING CO.
Division of DYNASCAN CORPORATION
1801 W. BELLE PLAINE AVE. • CHICAGO 13, ILL.
Canada: Atlas Radio Corp., 50 Wingold, Toronto 19, Ont.
Export: Empire Exporters, 277 Broadway, New York 7, U.S.A.

tubes, in which the opposite convention is used. In this case the direction of the lines would indicate the paths taken by a moving negative charge or an electron. Under these conditions, the direction would be as we have shown. We prefer this latter convention since it indicates how a beam of electrons would move when under the influence of a given electrostatic field.—Editors.

° ° °

POOR MAN'S STEREO

To the Editors:

In my article "Poor Man's Stereo,'" which appears on page 62 of the August issue, switch S_2 should be a double-pole rather than a single-pole switch as shown. The additional switch contacts should be used to connect the two ground sides of jacks J_1 and J_2.

JAMES E. PUGH, Jr.
Menominee, Michigan

If the switches and jacks used in Author Pugh's system are mounted in a metal case and the jacks are connected to the common ground, then the single-pole switch originally shown would be okay. Otherwise, a double-pole switch would have to be used to put the two outputs in parallel.

° ° °

RATTLING TRANSISTORS

To the Editors:

For some time I have been curious as to why some power transistors exhibit audible rattle when shaken. This occurs in many power transistors of different makes and types. According to a letter I received from *Bendix*, the rattle is simply due to the inclusion of a desiccant pellet within the transistor case. Hence, there is no cause for concern and there is no reason to secure the desiccant so that it can't move.

PAUL GALLUZZI
Itek Laboratories
Lexington, Mass.

Thanks to Reader Galluzzi for this bit of information. We have often wondered about the noise ourselves and thought perhaps that something was loose.—Editors.

° ° °

NCB TEST TAPE

To the Editors:

I have noticed in some of the *Hirsch-Houck* laboratory tests on tape recorders reference is made to the use of a *NCB* test tape. Is this a misprint for *NBC* or *NAB?*

CHARLES F. REINHOLD
Terrytown, New York

NCB is not a misprint. Actually, several years ago the N. C. Brunner Laboratories in Ithaca, New York, produced a number of accurately recorded tapes for test purposes. These tapes not only were useful for alignment purposes, but they also had recorded on them the complete frequency run which was equalized according to the NAB standard. This is the test tape employed in our laboratory measurements. Incidentally, the manufacture and sale of these tapes has been discontinued.—Editors.

° ° °

COLOR TV GENERATOR

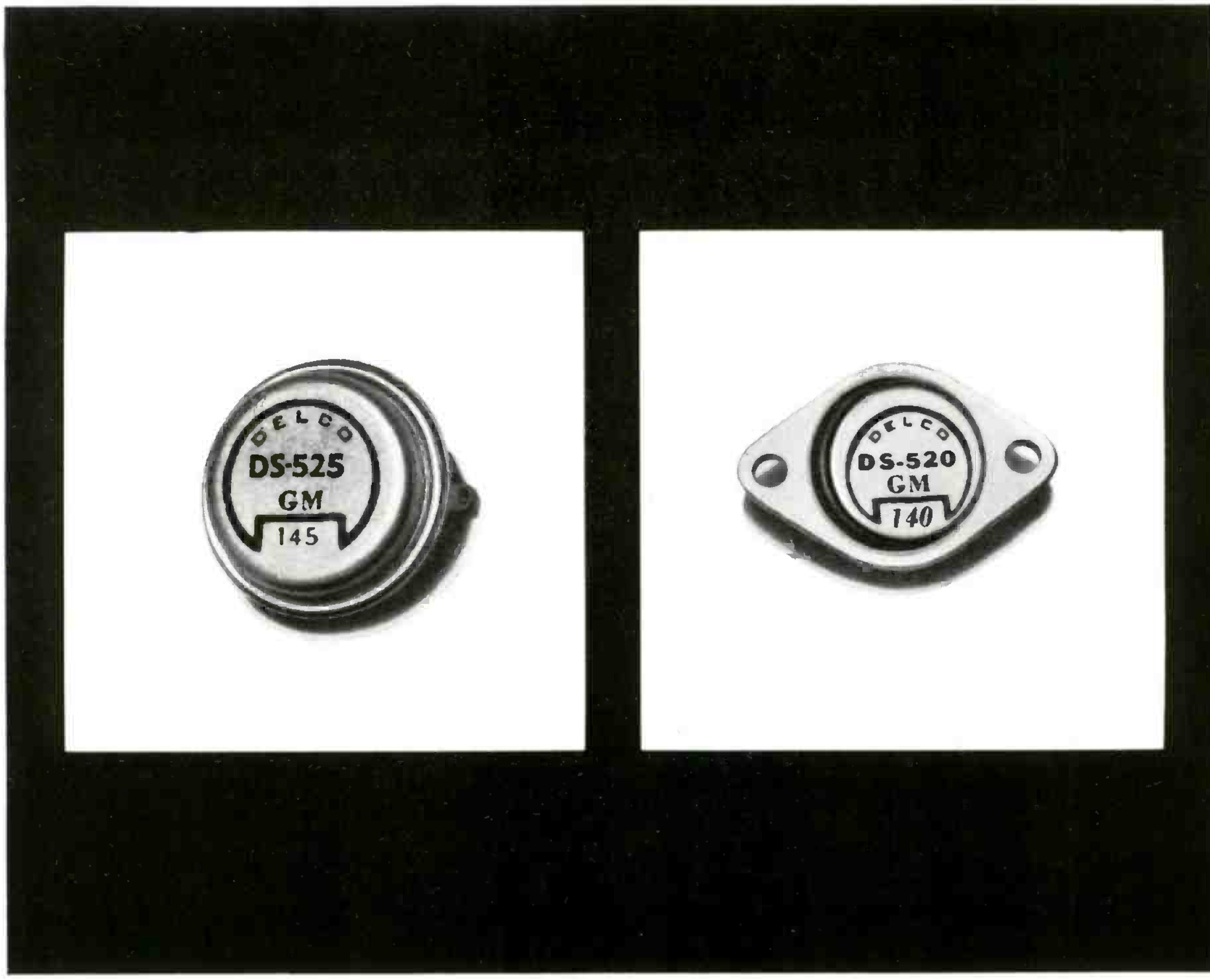
To the Editors:

In the August issue of ELECTRONICS WORLD under your directory of color-TV generators on page 51, you list the *B&K* Model 1076 as bearing the price of $199.95. This price is incorrect and it should have been given as $299.95.

BERNARD J. GOLBUS, Sales Mgr.
B&K Manufacturing
Division of Dynascan Corp.
Chicago, Illinois

Sorry for the typographical error on the Model 1076. The price of the B&K Model 850 is correct as shown at $199.95.—Editors. ▲

CIRCLE NO. 123 ON READER SERVICE PAGE



HOW TO CUT THE COST OF POWER TRANSISTORS—WITHOUT CUTTING CORNERS:

simply say Delco

Now you can offer your customers inexpensive replacements for their Delco audio output transistor needs. The DS 520 and our new DS 525 can be used in place of the Delco DS 503 and DS 501 where low cost is a factor. Each of these low-priced transistors can produce 4 watts of output with top Delco reliability. They're ideal for the servicing of older car radios or for the experimenter or ham operator. The DS 520 and the new DS 525 will be a profitable addition to your basic line of Delco transistors: the DS 501 and DS 503—to restore full power audio output in all Delco Radios; the DS 25 and DS 26 to cover small signal needs in Delco and just about every other auto radio or small portable on the market. How's that for a complete line of transistors? Oh, you need application and cross reference charts too? Look in the package. They come with all Delco transistors. All are available now through your United Delco electronics parts distributor.

Delco Radio automotive radio service parts and electro-mechanical devices are distributed nationally through **United Delco.**

DELCO RADIO, Division of General Motors, Kokomo, Indiana

United Delco

CIRCLE NO. 113 ON READER SERVICE PAGE

READER SERVICE PAGE

Please use the coupon at the bottom of this page to obtain more information about products advertised in this issue.
Simply circle the number on the coupon that corresponds to the number at the bottom of the advertisement in which you are interested.

Additional information on items mentioned in **"New Products & Literature"** can also be obtained by following this same procedure.

PRINT your name and address on the coupon and mail it to:

ELECTRONICS WORLD
P.O. BOX 7842
PHILADELPHIA 1, PA.

ELECTRONICS WORLD
P.O. BOX 7842
PHILADELPHIA 1, PA.

TOTAL NUMBER OF REQUESTS [ ]

Void After Nov. 30, 1962 **11**

Please send me additional information concerning the products of the advertisers whose code numbers I have circled.

100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179

NEW PRODUCTS & LITERATURE

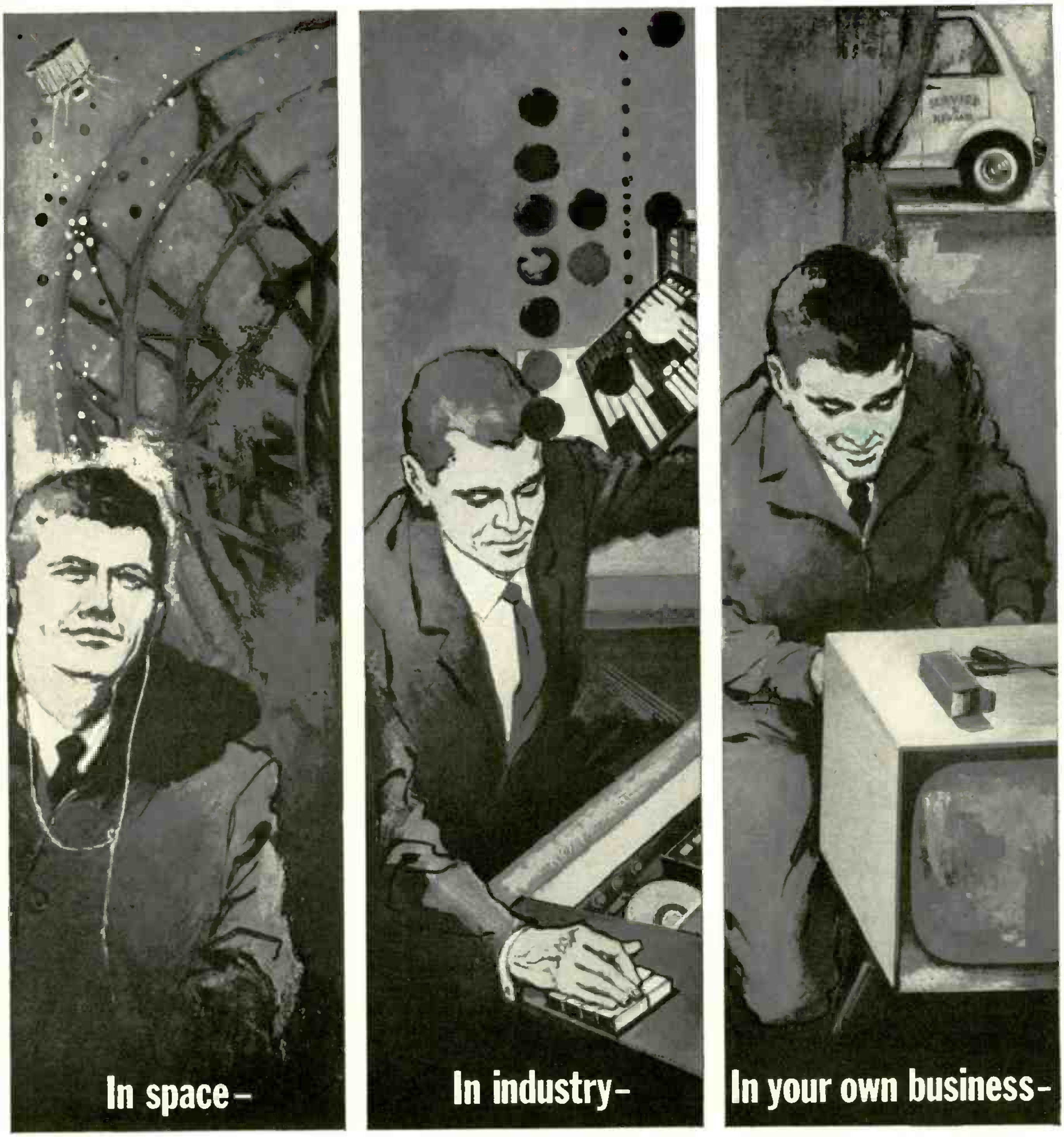
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60

(Key numbers for advertised products also appear in Advertisers Index)

NAME____________________________

ADDRESS____________________________

CITY______________ZONE______STATE__________



You Have a Future in Electronics

Build a successful career now with RCA Training

Home Study or Classroom Training. Now, RCA and RCA Institutes, Inc. offer you 22 authoritative courses in electronics to choose from—the widest range of courses in their history! You can start to build a profitable career in electronics right in your home, or, at any of five convenient locations across the country! Never before has superior RCA electronics training been within such easy reach!

Complete Selection of Courses. Whether you are a beginner or an advanced student, RCA gives you the kind of technical instruction you want, tailored to your needs. And, the very name "RCA" means dependability, integrity, and scientific advance. It is recognized throughout the world. RCA training, right now, can be the smartest investment you ever make!

RCA Institutes Home Training is Complete

Choose from a comprehensive selection of up-to-date courses.

- Electronic Fundamentals
- Television Servicing
- Color Television
- Transistors
- Automation Electronics
- Communications Electronics
- Computer Programming
- Electronic Drafting

RCA Institutes Training lets you set your own pace in keeping with your ability, finances, and time. Lesson assignments are individually graded by technically trained personnel, and you receive personal guidance and instruction if you need it. RCA Institutes Home Training Courses are complete, and include theory, experiment, and service practice, beginning with the very first lesson. All your courses are clearly written, easy to understand, well illustrated.

Kits Are Included

You get prime quality equipment in all kits furnished to you. They are complete in every respect and all parts are top grade. You keep all the equipment furnished to you for actual use on the job . . . and you never have to take apart one piece to build another. Most important, all kits used in the Electronic Fundamentals course are furnished without extra charge.

Voluntary Tuition Plan

RCA Institutes Home Training is available to you under a Voluntary Tuition Plan. This plan gives you the most economical method possible of home training. You pay for lessons only as you order them—one study group at a time. If, for any reason, you should wish to interrupt your training, you can do so, and you will not owe one penny until you resume the course. There are no other obligations! No installment payments required. RCA Institutes Home Training alone offers you this unique Voluntary Tuition Plan.

Classroom Training in 5 Convenient Locations

No previous technical training required for admission.
You are eligible even if you haven't completed High School.

New York City • Los Angeles • Chicago • Cherry Hill (near Camden, N. J.) • Philadelphia

RCA also offers you classroom training of the highest caliber if you prefer to build your electronics career at one of the five convenient locations throughout the country. At RCA Institutes, Inc. resident schools in New York City and Los Angeles, and at RCA Technical Institute Schools in Chicago, Philadelphia, and Cherry Hill near Camden, you can prepare for a rewarding position in the exciting field of electronics.

If you did not complete High School, RCA will prepare you for such training with courses specially designed to provide the basic math and physics required.

Coeducational Day and Evening Courses are available. You can prepare for a profitable career in electronics while continuing with your normal full-time or part-time employment. Classes start at regular intervals throughout the year.

Free Placement Service

RCA graduates may take advantage of the free placement service offered to them. This service has established and continued to maintain a high percentage of successful placements in important electronics companies and military installations.

Simply check "Classroom Training" and information will be rushed to you.

SEND ATTACHED PRE-PAID POSTCARD FOR FREE ILLUSTRATED BOOK TODAY! SPECIFY HOME TRAINING OR CLASSROOM TRAINING!

RCA INSTITUTES, INC., Dept. EW-N2 A Service of the Radio Corporation of America
350 West 4th St., New York 14, N. Y. • Pacific Electric Bldg., 610 S. Main St., Los Angeles 14, Calif.

RCA ® THE MOST TRUSTED NAME IN ELECTRONICS

EW Lab Tested

AUDIO PRODUCTS TESTED BY HIRSCH-HOUCK LABS

H. H. Scott LT-110 FM Stereo Tuner

For copy of manufacturer's brochure, circle No. 57 *on coupon (page* 17).

THE LT-110 FM multiplex tuner is one of the family of *H. H. Scott* high-fidelity component kits. These kits are designed for construction by hobbyists without specialized electronic training. To this end, the assembly of the LT-110 is broken down into 13 sections, or assembly groups. For each group, the parts are separately packaged, with pre-cut and tinned hook-up wire. The instruction manual (which includes a very good explanation of the theory of operation of the tuner) covers each group individually, with a full-size colored pictorial diagram of that section. In this way, resistor color codes can be checked against the assembly drawing, and the chances of incorrect lead dress are greatly reduced.

The kit is supplied in a sturdy cardboard container, or "Kit-pack," which serves as a work surface and allows the builder to put away the partially assembled kit after an evening's work without having to clean up loose parts and wires. The chassis comes with the tube sockets, power transformer, and pre-aligned front-end mounted. The multiplex circuits are on a pre-wired and aligned sub-chassis. The i.f. transformers are also pre-aligned, and final "touch-up" alignment of the tuner is done using the built-in tuning meter and a received signal. Construction time for the unit we tested was 6½ hours, without alignment.

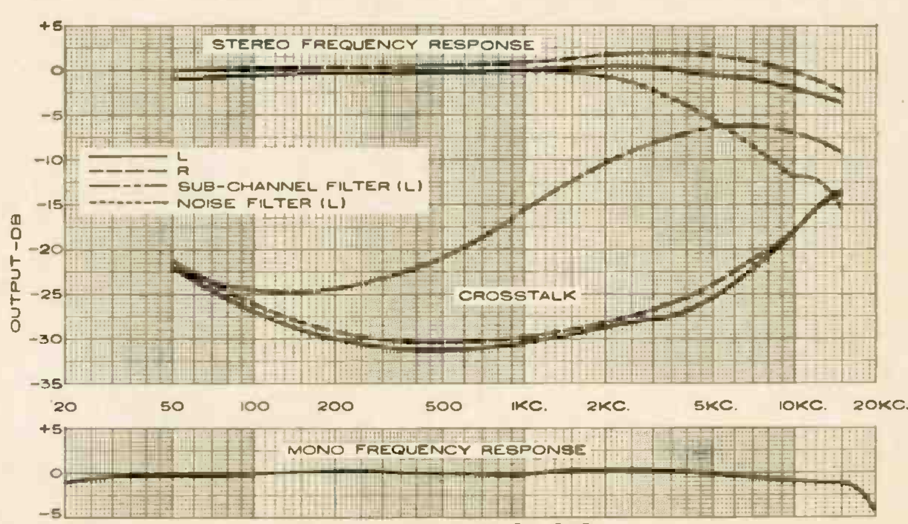
Like all *Scott* tuners, it has a shielded, silver-plated front-end with a 6BQ7A cascode r.f. amplifier and a 6U8 mixer/oscillator. Two 6AU6 i.f. amplifier stages are followed by a 6AU6 limiter and a diode wide-band ratio detector.

The multiplex demodulator uses switching circuitry. A 6BL8 amplifies the composite detected signal and separates the 19-kc. pilot carrier which synchronizes the push-pull 12AU7 oscillator at 38 kc. The entire signal, with frequencies above 53 kc. attenuated to reduce SCA interference, is applied to two four-diode switches. These are alternately gated on by the 38-kc. oscillator. Their outputs, corresponding to left- and right-channel signals, are amplified, de-emphasized, and passed through a ganged level control to a pair of feedback output amplifiers.

The mode selector switch on the panel of the tuner (which also controls the a.c. power) has positions for mono, stereo, and stereo with sub-channel filtering. The latter permits reduction of noise in weak signal reception without loss of frequency response, although channel separation is reduced. There is a separate switch which reduces high-frequency response for both mono and stereo reception, in the event of excessive background noise. A third switch in the a.g.c. circuit increases the r.f. amplifier gain somewhat for better stereo reception.

On the rear of the tuner are two paralleled outputs for each channel, so that a tape recorder may be driven simultaneously with the main amplifier. For those who wish to connect a portable tape recorder, there is a three-circuit phone jack on the front panel, carrying both channel outputs.

In our lab measurements, the tuner had an IHFM usable sensitivity rating of 2.5 μv., essentially the same as the rated 2.2 μv. The harmonic distortion at 100% modulation varied with signal strength, from 0.7% to 1.3%, over a range of input signals from 4 μv. to 100,000 μv. The capture ratio was 8 db (rated 6 db). The internal hum, from incidental FM modulation of the oscillator, was -51.5 db referred to a 100% modulated signal. The



from ALLIED

NEW! POWERFUL knight-kit®

1-WATT WALKIE-TALKIE!

KG-4000 All-Transistor CB Kit

FULL 1-WATT RF INPUT!

10 times the power of most walkie-talkies ... reliable 2-way communication up to 5 miles

EASY TO BUILD! GREAT TO OWN!

WITH THESE ADVANCED FEATURES:

ONLY **$59.95**

only $5 per month on Allied's Credit Fund Plan

- 9-Transistor, 3 Diode Circuit—Powerful 1-Watt RF Input
- Professional Quality Truly Portable 2-Way Radio With a 5-Mile Range
- Crystal-Controlled Transmit and Receive Channels
- Superhet Receiver with RF Stage, 2 IF's, Squelch, AVC, Noise Limiter, Push-Pull Audio Output

THERE'S NO OTHER KIT LIKE IT!

Knight-Kit is the leader again with this professional-quality transceiver kit ... with 10 times the power of most walkie-talkies ... with full *1-watt* RF input for reliable 2-way communication up to a 5-mile range! Superhet receiver has automatic noise limiter and variable squelch to reduce background noise and maintain speaker silence between calls. Distance-Local switch and AVC eliminate receiver distortion caused by nearby units. Includes: handy press-to-talk button; relative RF output indicator for maximum power adjustment; plug-in crystal sockets; 52" whip antenna; external-antenna jack; jack for earphone or external speaker; weather-protected built-in mike and speaker; uses 9 transistors, 3 diodes. Weighs only 32 ounces. Complete with tan high-impact Styrene case and carrying strap; wire, solder; easy instructions; FCC-permit application form. Less batteries and crystals (requires 1 transmit, 1 receive, listed below). 10⅜ x 3⅝ x 4 11/32". Shpg. wt., 2½ lbs.

83 YX 803DA. KG-4000 Walkie-Talkie Kit. Only........... **$59.95**

83 Y 012. "C" Batteries for above (8 required), each ...... 14¢

83 Y 011. Rechargeable Battery/Charger/AC Power Supply Kit. Replaces the 8 "C" cells; may be recharged many times; charger unit permits the KG-4000 to be operated from 115 VAC while charging battery. Shpg. wt., 1 lb. Only........... **$19.95**

83 Y 047. Adapter for 12-v. Use. Plugs into cigarette lighter of auto. With cable. Only.................................. **$1.00**

20 YX 473-2. 1-Receive and 1-Transmit Crystal; specify Channel 1-22.. **$5.00**

THE SPECIFICATIONS PROVE THE QUALITY AND VALUE!

Receiver: Crystal-controlled superheterodyne. Sensitivity better than 1 μv for 10 db s/n ratio. Selectivity, 6 db at 6½ kc. Image Rejection, 12 db adjacent channel, 30 db down. Audio Output, 750 μv class B push-pull.

Transmitter: Crystal-controlled (any CB Channel, 1-22) RF Input, 1 watt. RF Output, 0.5 watt.

Power Supply: Operates up to 50 hours on 8 size "C" flashlight cells, or on rechargeable nickel cadmium cell (optional); has provision for operation from external 12 VDC source.

Typical of the quality and value of over 100 other great KNIGHT-KITS

Satisfaction guaranteed or your money back

manufactured by
KNIGHT ELECTRONICS CORP.
A DIVISION OF
ALLIED RADIO

NO MONEY DOWN: Now! More Buying Power with your Allied Credit Fund Plan

ORDER TODAY

ALLIED RADIO
100 N. Western Ave., Chicago 80, Ill.
Ship me the following:

☐ **KG-4000 All-Transistor CB Walkie-Talkie Kit 83 YX 803DA**
☐ "C" Batteries 83 Y 012 (quant.....).
☐ Adapter for 12-v. use 83 Y 047
☐ Rechargeable Battery/Charger/AC Supply Kit 83 Y 011
☐ Receive & Transmit Crystals; Specify Channel 1-22 20 YX 473-2
☐ Ship No Money Down on Allied's Credit Fund Plan

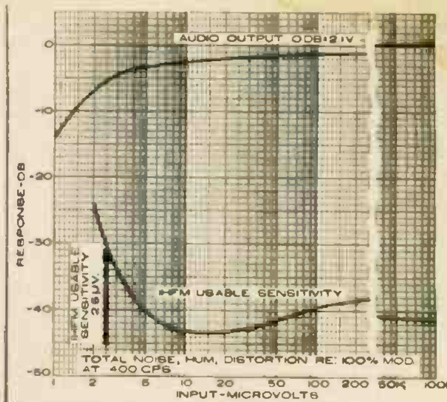
New Credit Customers Only: Send name and address present employer, how long employed, position, monthly salary; rent or own home, how long at present address; give age (21 minimum for credit account).

☐ $........enclosed (check) (money order)

Name________________________________
PLEASE PRINT

Address______________________________

City____________________Zone______State__________



low output impedance of the tuner allows the use of long cables without loss of high-frequency response.

In its mono position, the frequency response of the LT-110 was excellent, ± 1 db from 20 to 16,000 cps. In stereo, there was a slight loss of highs, about 2.5 db at 15,000 cps. Channel separation was 30 db at mid-frequencies and held up very well at higher frequencies (17 db at 10 kc., 11 db at 15 kc.). The sub-carrier filter drastically reduced high-frequency separation, although the audible stereo effect was slight. Like all *Scott* tuners, the LT-110 is extremely stable, drifting only 2 or 3 kc. from a cold start.

In listening tests, the tuner showed its high usable sensitivity to good advantage. Using an indoor antenna which produced marginal signal-to-noise ratios on most other tuners, we were able to get noise-free, undistorted stereo reception. It is quite non-critical to tune, hardly requiring the use of its tuning meter. Our most serious criticism of the design is the omission of a stereo-transmission indicator; one must depend on prior knowledge or station announcements. The kit sells for $159.95.

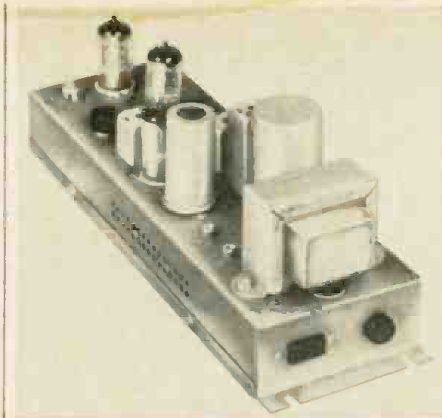
(Editor's Note: Recognizing the value of an indicator, the manufacturer has advised us that all current LT-110's are available with an automatic light indicating stereo transmission. There is available a small modification kit for owners of older LT-110 tuners which don't include this automatic indicator.) ▲

Fisher MPX-200 Multiplex Adapter

For copy of manufacturer's brochure, circle No. 58 *on coupon* (*page* 17).

THE *Fisher* MPX-200 stereo multiplex adapter is basically similar to the MPX-100 covered in detail in last month's issue, but without certain of its refinements and automatic features. It has no front panel and no operating controls, allowing it to be placed out of sight in any convenient location within three feet of the tuner.

The MPX-200 has high-level and low-level inputs, individual channel-level controls, and a separation control. It is self-powered, but has no power switch, and is normally plugged into a switched

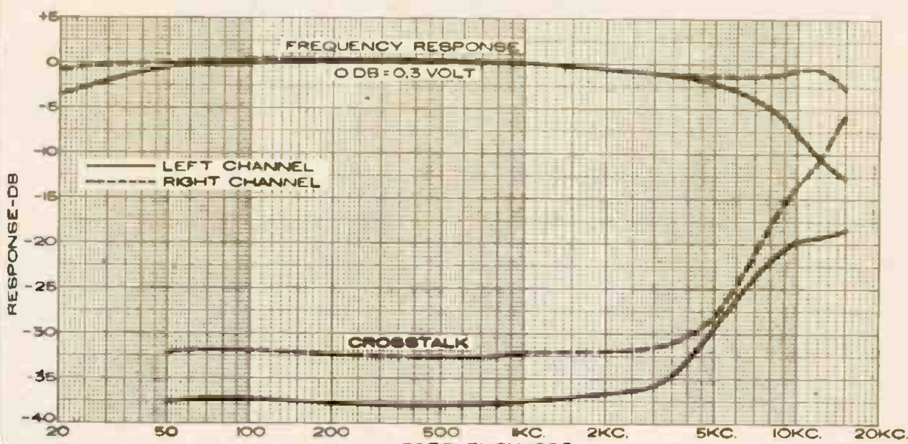


a.c. outlet on the associated tuner or preamplifier. There is a mono-stereo switch on the chassis, which may be used to disable the 38-kc. oscillator if, for example, signals are too weak for satisfactory stereo reception. In some installations, access to this switch might not be convenient, and it is intended that the adapter normally operate in its stereo mode.

Our measurements showed the maximum gain of the adapter to be 18 db. It would lock in with pilot carriers as weak as 12.5 mv. and had low distortion for outputs up to 1.5 volts. There was a considerable difference in response at the high end between the two channels. One was down only 2.5 db at 15 kc. while the other was down 12.5 db. Channel separation was typically 35 db up to 3 kc., decreasing to 12.5 db at 10 kc. and 2 to 5 db at 15 kc.

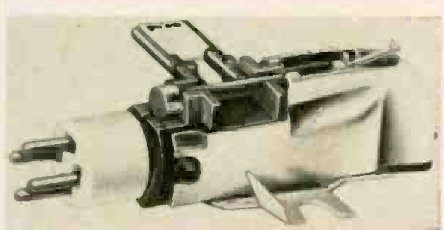
On our test unit, the optimum setting of the separation control proved to be far removed from the recommended range of settings. If it had been set as suggested in the manual, the separation would have been only 12 to 14 db, with no separation at 10 kc. and above. Since the circuits are essentially the same as those of the MPX-100 previously checked, we assume that this was a peculiarity of the test unit. It does point up, however, the desirability (with any adapter) of setting the separation control on test transmissions from an FM station rather than depending on suggested settings.

To summarize, the *Fisher* MPX-200 adapter offers the same fine performance as the MPX-100, lacking only some of the latter unit's flexibility and operating conveniences. The price of the MPX-200 is $79.50. ▲



Sonotone 9TASD-V Cartridge

For copy of manufacturer's brochure, circle No. 59 on coupon (page 17).



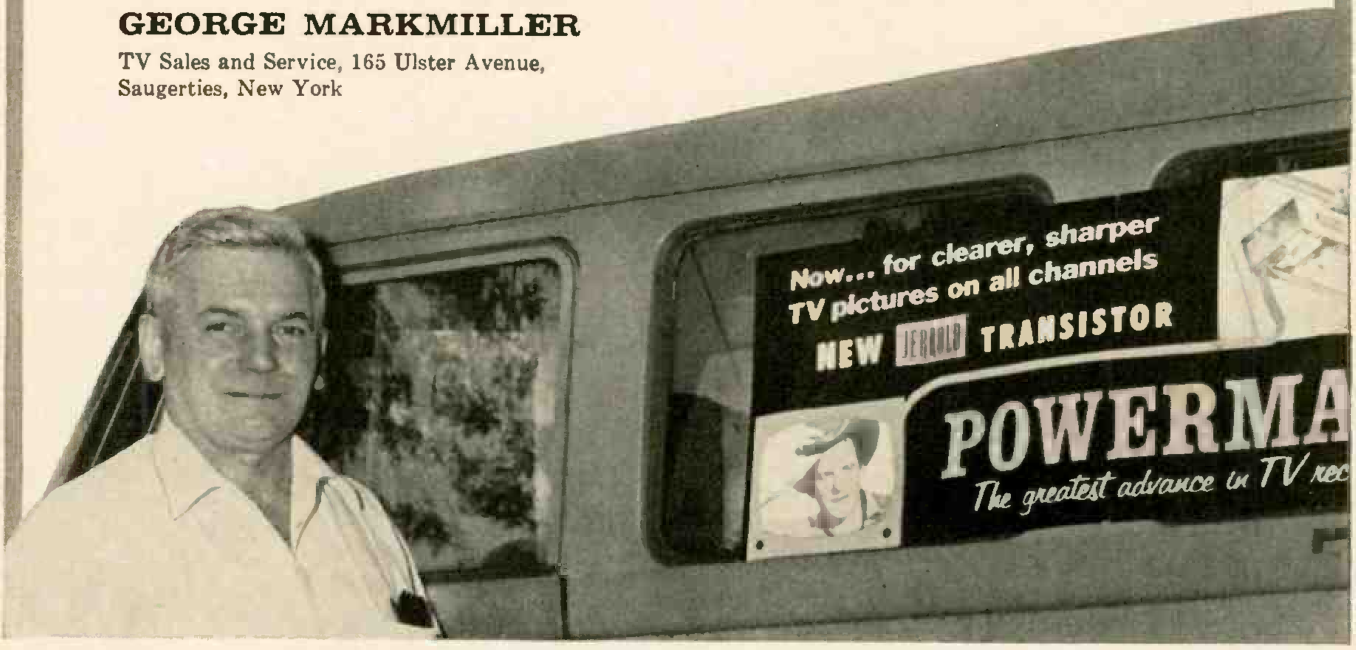
LAST YEAR, *Sonotone* introduced its "Velocitone" ceramic stereo cartridge, Model 9TSD-V. This cartridge was equipped with a turnover combination of a 0.7-mil diamond and a 3-mil sapphire stylus. It was supplied with plug-in adapters which converted its normally amplitude-responding characteristic to a velocity response and reduced its output level so that it could be used with the magnetic phono input of any preamplifier.

The Model 9TASD-V "Velocitone II" is an improved version of that cartridge. The stylus compliance has been increased from 3.3 to 5.1×10^{-6} cm./dyne, allowing a reduction of tracking force ranging from 3-5 grams to 2-4 grams in good-quality record players. Together with the tracking-force reduction is a three-fold reduction in distortion at high recorded velocities, as well as a slightly increased output and improved high-frequency channel separation. The older model was supplied with wire leads. while the new model has a keyed plug equipped with four pins which accommodate the standard cartridge connec-

(*Continued on page* 78)

"OVER $12,000 WORTH OF POWERMATES SOLD...AND IT'S JUST THE BEGINNING!"

GEORGE MARKMILLER
TV Sales and Service, 165 Ulster Avenue,
Saugerties, New York

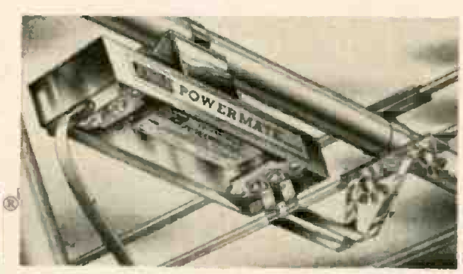


POWERMATE sells itself through its performance

George Markmiller's customers "were from Missouri" where TV reception was concerned. The products they had tried, in spite of high claims, had not produced snow-free TV from the distant New York stations. With the help of his Jerrold distributor, George used the potent promotional kit to tell his customers the POWERMATE performance story. Newspaper ads, truck banners, stuffers and store displays presold POWERMATE because the promotion was *custom-designed* for his area.

The real clincher came after the demonstration when one customer began to tell the other about POWERMATE's amazing reception. The Saugerties area had never seen such clarity in black and white *and in color*. As George says, "The performance of this unit has been the best advertising that has helped to sell it."

Jerrold's ready to set up a POWERMATE promotion designed for *your local area*. You can repeat George Markmiller's success story as hundreds are doing—all over the country. Write for the name of your nearest Jerrold distributor.



JERROLD®

TRANSISTOR
POWERMATE
ANTENNA AMPLIFIER
$39.95 LIST

JERROLD ELECTRONICS CORPORATION
A subsidiary of THE JERROLD CORPORATION
Philadelphia 32, Pa.

Jerrold Electronics Corporation
Distributor Sales Division, Dept. IDS-273
Philadelphia 32, Pa.

I want Jerrold to promote the POWERMATE in my LOCAL area. Send me the name of my nearest distributor.

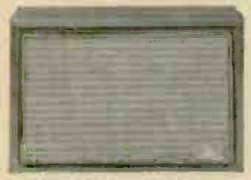
Name ______________________

Address ______________________

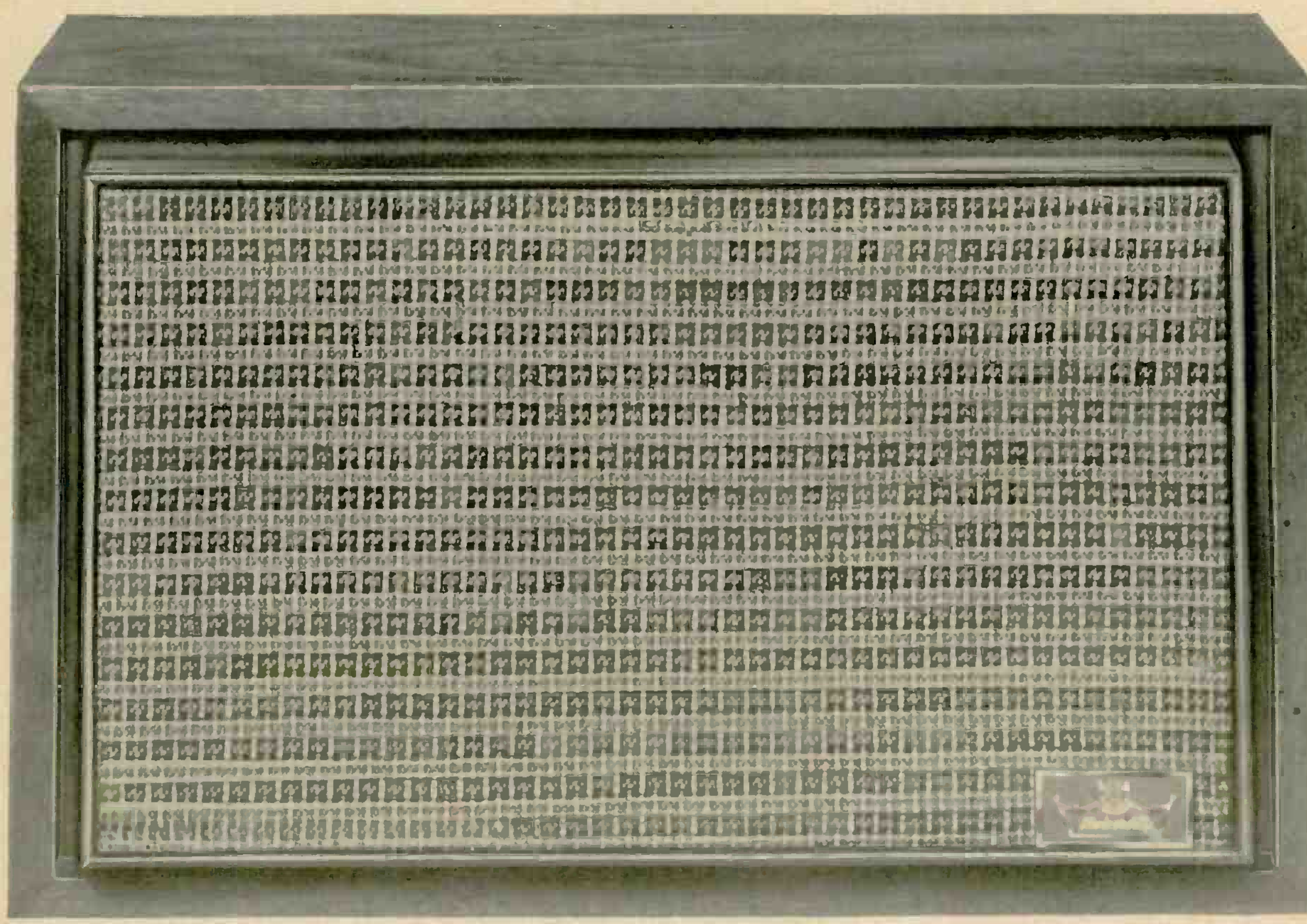
City ______________ Zone _____ State ________

CIRCLE NO. 130 ON READER SERVICE PAGE

looks like this



sounds like this!



Sensational University Mini-Flex with Optimum Q breaks through the small speaker quality barrier!

The Mini-Flex, another acoustic breakthrough from University, is the first speaker system of its type designed to fulfill its optimum performance potential—as stated in its printed specifications—without the use of "trick" amplifiers. It is a true 3-way speaker system, providing exciting bass response down to 40 cycles, exceptionally smooth mid-range and crisp, peak-free highs to 20,000 cps! Less than 0.4 of a cubic foot (15"x9"x 5")! A size hitherto considered impossible to produce performance to such specifications!

The reason—Optimum Q, the principle that eliminates the acoustic problems which, up to now, have prevented high fidelity bass performance in an ultra-compact enclosure. Optimum Q—in essence, the most ideal "marriage" of woofer and miniaturized enclosure yet devised, to assure the lowest resonant frequency possible in a system of Mini-Flex dimensions. Other factors behind its superb performance include: special mass-loading; unusual viscous-treated "moving seal" suspension; new mid-range speaker and tweeter, each with exclusive "diffractor barriers" for ideal stereo sound dispersion. And, it looks as good as it sounds! Its crafted "cabinet-within-a-cabinet" styling will enhance any room, any home. It may be used on a wall, floor, shelf—on a table (or even under it)! Oiled walnut. Only $69.95—at your audio dealer. For free 20-page Guide to Stereo High Fidelity, write: Desk S-11.

UNIVERSITY LOUDSPEAKERS
80 SOUTH KENSICO AVE., WHITE PLAINS, N.Y.
A Division of Ling-Temco-Vought, Inc.

U-11

The HIDDEN 500* wrote these 6 SUCCESS STORIES...

Service Technicians supply the happy endings!

Capacitor success stories are no novelty at Sprague. The "Hidden 500", Sprague's behind-the-scenes staff of 500 experienced researchers, have authored scores of them! And customers add new chapters every day. But none has proved more popular than the 6 best sellers shown here. Developed by the largest research organization in the capacitor industry, these 6 assure happy endings to service technicians' problems.

❶ DIFILM® BLACK BEAUTY® MOLDED TUBULAR CAPACITORS

The world's most humidity-resistant molded capacitors. Dual dielectric—polyester film and special capacitor tissue—combines best features of both. Exclusive HCX® solid impregnant produces rock-hard section—nothing to leak. Tough case of non-flammable phenolic—cannot be damaged in handling.

❷ DIFILM® ORANGE DROP® DIPPED TUBULAR CAPACITORS

Especially made for exact, original replacement of radial-lead tubulars. Dual dielectric combines the best features of both polyester film and special capacitor tissue. Exclusive HCX® solid impregnant—no oil to leak, no wax to drip. Double dipped in bright orange epoxy resin to beat heat and humidity.

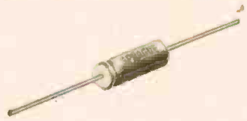
❸ TWIST-LOK® ELECTROLYTIC CAPACITORS

The most dependable capacitors of their type. Built to "take it" under torrid 185°F (85°C) temperatures—in crowded TV chassis, sizzling auto radios, portable and ac-dc table radios, radio-phono combinations, etc. Hermetically sealed in aluminum cases for exceptionally long life. Withstand high surge voltages. Ideal for high ripple selenium rectifier circuits.

❹ ATOM® ELECTROLYTIC CAPACITORS

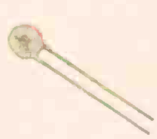
The smallest dependable electrolytics designed for 85°C operation in voltages to 450 WVDC. Small enough to fit anywhere, work anywhere. Low leakage and long shelf life. Will withstand high temperatures, high ripple currents, high surge voltages. Metal case construction with Kraft insulating sleeve.

❺ LITTL-LYTIC® ELECTROLYTIC CAPACITORS



Ultra-tiny size for use in transistorized equipment. High degree of reliability at reasonable price. All-welded construction—no pressure joints to cause "open" circuits. Withstand temperatures to 85°C (185°F). Hermetically sealed. Extremely low leakage current. Designed for long shelf life—particularly important in sets used only part of the year.

❻ CERA-MITE® CERAMIC CAPACITORS



Tiny, tough, dependable in practically every application. Low self-inductance of silvered flat-plate design gives improved by-pass action in TV r-f circuits. Higher self-resonant frequency than tubular ceramics or micas. Tough moisture-proof coating. Designed for 85°C operation.

**The "Hidden 500" are Sprague's 500 experienced researchers who staff the largest research organization in the electronic component industry and who back up the efforts of some 7,000 Sprague employees in 16 plants strategically located throughout the United States.*

SPRAGUE®
THE MARK OF RELIABILITY

Handy Hanging Wall Catalog C-457 gives complete service part listings. Ask your Sprague Distributor for a copy, or write Sprague Products Company, 51 Marshall Street, North Adams, Massachusetts.

CS-347 R1

CIRCLE NO. 156 ON READER SERVICE PAGE

Evolution in Electronics

INTEGRATED CIRCUITS

By LOTHAR STERN Motorola Semiconductor Products Inc.

A new manufacturing technique in which an entire circuit is fabricated without using conventional components. Small size, more reliability, longer life, reduced costs are the results.

WE ARE witnessing today an evolution in the field of electronics whose impending impact on the industry promises to eclipse even the dramatic changes brought about by the invention of the transistor some 15 years ago. This time, however, it is not the invention of a new product that will vitally affect the shape of things to come. Rather, it is the development of a new concept in manufacturing—a technique known as "integrated circuits."

In its ultimate form, the technology of integrated circuits represents a complete departure from current equipment design and manufacturing techniques. The conventional building blocks of electronics—resistors, capacitors, and inductors—will virtually disappear as separate entities. Their specific functions will be accomplished by microscopically small depositions or growths of material layers, or films, which may be individually unrecognizable and inseparable from a complete circuit. In fact, the entire complex electronic circuit will be so thoroughly united that the complete circuit function, rather than today's individual parts, will become the basic component of tomorrow's electronic equipment. And the process will yield advantages that past techniques cannot possibly duplicate.

The erstwhile rack of complex equipment, which the transistor has already reduced to single-drawer size, will be further diminished to matchbox proportions. The equipment will require only a small fraction of the operating power now needed for similar applications, and an increase in reliability by an order of magnitude is a conservative prediction. And finally, the processes of integrated circuits will eventually permit price reductions that will not only accelerate the logarithmic spiral of electronic progress but can open new areas of applications for every conceivable electronics market.

To appreciate the advantages of integrated circuits, let us take a close look at a very simple type of structure. Figures 1 and 3 show a typical 5-stage Darlington amplifier—a direct-coupled amplifier in which the output of one stage is connected directly to the input of the next—in schematic and integrated circuit form respectively. The actual circuit, too small to be analyzed with the naked eye, is shown, greatly enlarged in Fig. 3. The entire circuit, which is fabricated on a tiny chip of material less than one-sixteenth of an inch square, is then mounted between two pins of a standard transistor header. Since the header serves merely as a means for interconnecting this circuit with others in the complete equipment, it is quite possible, with a different packaging technique, to produce a unit whose total size is only little larger than the volume of the "chip" itself.

Actually, a direct-coupled amplifier is quite easy to fabricate since it involves only the interconnection of a number of active elements. A far more complex type of circuit is one combining both active and passive elements on a single substrate. Yet, even these have been fabricated successfully. The schematic diagram of such an amplifier, Fig. 2, shows two complete *RC*-coupled amplifier stages although there is no connection between the stages themselves. Rather, the input and output terminals of each stage are brought out to separate pins of a transistor header so that the circuit designer may employ either one or two stages, depending on his amplification requirements. This fabrication technique adds considerable flexibility to the completed device since

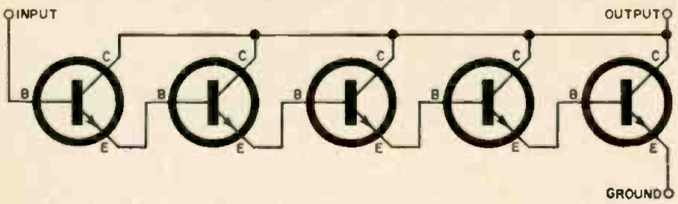


Fig. 1. Schematic diagram of Darlington type amplifier utilizing five direct-coupled stages. The total gain available is usually much higher than normally required so that the output is usually taken from one of the earlier stages of the amplifier.

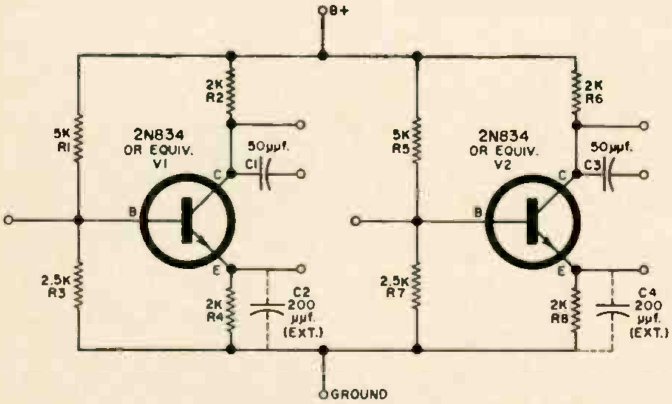


Fig. 2. Schematic diagram of two-stage RC-coupled amplifier.

the second stage adds little or nothing to the cost of the final device, thus permitting the same unit to be used as either a single-stage or two-stage amplifier. Fig. 4 shows a detailed drawing of the circuit pattern which permits correlation between the equivalent "pattern parts" and those shown on the schematic diagram.

Advantages of Integrated Circuits

From the foregoing it is quite apparent that the development of integrated circuits will produce an impressive reduction of size and weight in the over-all equipment. When the space-saving feature of a single integrated circuit is multiplied by a number of separate circuits, all of which can be mounted in a single transistor-type case, as in Figs. 5 and 6, the equivalent of 50 to 100 individual parts will occupy no more room than a single transistor. But, important as this space- and weight-saving feature may be, it is only secondary to the far greater advantages of reduced cost, greater reliability, and improved performance which integrated circuits will eventually provide.

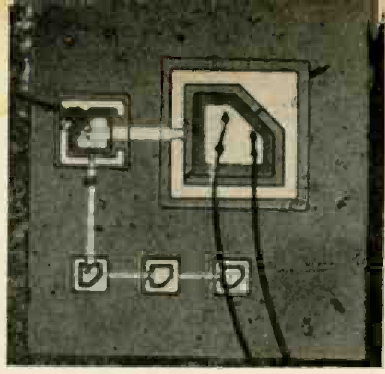


Fig. 3. Greatly enlarged view of 5-stage Darlington amplifier which is to be mounted between the pins of a typical transistor header. Output may be taken from any stage, hence offering various amounts of amplification from a single integrated unit.

Reducing Circuit Costs

In today's skyrocketing technology it is no longer a question of "can we develop an advanced electronic system," but rather "can we *afford* to develop a particular system." The increasing complexities and the mounting materials and labor costs associated with today's more sophisticated electronic equipment are already placing a heavy burden on our ability to pay the price for continuing progress. The anticipated cost-reducing features of integrated circuits, therefore, may well be their most important advantage. True, the cost of many presently available integrated circuits is quite high compared with identical circuits made in the conventional manner, but that is primarily because the former are fabricated in relatively small quantities for sampling purposes. As integrated circuits move from the experimental to the production stage the pricing pattern for off-the-shelf units in quantity should follow that of transistors in recent years.

There is good reason why this should be so. With the proper pattern and masks, two transistors, or even a dozen, can be fabricated on a single chip in the same amount of time and with virtually the same quantity of material as a single unit. Diodes, resistors, capacitors, and even small inductors can be deposited on the same substrate with the same processes used for the fabrication of transistors. Thus, the manufacture of complete circuits, in the long run, should be little more expensive than the cost of fabricating a single transistor at the present time. Considering the fact that hundreds of circuits can often be deposited on a single wafer, and that dozens of wafers can be processed simultaneously, Fig. 7, the cost advantages of integrated circuits become readily apparent.

Improved Reliability

With the ever-increasing demands made on modern electronic equipment, the reliability of individual components may well be the limiting factor as to the ultimate complexity that can be designed into a particular system. Consider, for example, a component that has a failure rate of 1% per thousand hours of operation. If a system is designed to use 100 such components, it is a reasonable assumption that one of these will fail after 1000 hours of operation causing the equipment to malfunction. A system using 1000 components can be expected to fail after only 100 hours and another utilizing 10,000 components is likely to quit functioning after only 10 hours of operation. Thus, in the expanding technology it is possible to design a system so complex that it will perform every conceivable function—but which uses so many parts that it will be impossible to keep it in operation.

Before the development of the transistor, the active elements—vacuum tubes—normally represented the most unreliable component in electronic equipment. Because of their relatively high failure rate, they were plugged into sockets so that they could be replaced easily and quickly in the event of failure. With transistorization, the picture has changed radically. Transistors are often wired directly into a circuit because, in the event of circuit failures, they are the last components to be suspected of causing the trouble.

In integrated circuitry, passive elements such as resistors

THIS MONTH'S COVER

Integrated L, C, and R components are shown on our cover this month. These components are deposited on tiny substrates that are mounted on 10-pin headers having outside diameters of only 0.35 inch. Greatly enlarged views of the components appear at the left, while the views at the right, enlarged only about 3 times, show how the substrates are mounted and connections made. The top photographs show a deposited inductive element. The center photos show capacitive elements, while the lower photos are of resistive elements. In the cases of the capacitive and resistive elements, a number of different values of C and R may be made available by bringing out a number of output connections to the header pins. The pins can then be interconnected in a number of ways to produce the values needed in a particular circuit.

(Photos: Motorola Semiconductor Products Inc.)

---

and capacitors can be made by exactly the same processes used in the manufacture of semiconductor devices. Their anticipated failure rate, therefore, is no greater than that of the most reliable components producible in today's technology.

Moreover, with integrated circuits the maze of interconnecting wires which characterizes conventional equipment and is the cause of a good percentage of equipment failures is substantially reduced. Within each circuit the various elements are deposited in adjacent and superimposed layers for which no separate connections are required. This feature alone causes a substantial reduction in potential trouble spots.

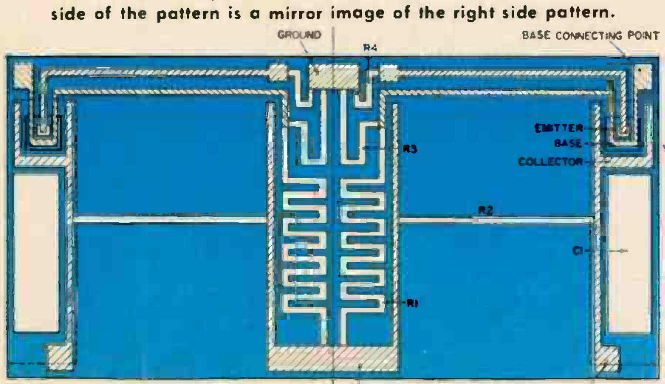
Improved Performance

Improved performance today is virtually synonymous with increased circuit speed. It is this aspect of the equipment that permits us to utilize higher frequencies and to increase the scope of operation of electronic computers. And, until recently, the capabilities of individual components represented the limiting factors in the ultimate attainable equipment speed.

Recent improvements in components, however, have resulted in some systems in which the propagation delay—in actual time required for electrons to travel from one point of a system to another—prohibits faster operation. While a transistor is able to switch at a rate of only a few nanoseconds (a few millimicroseconds), it actually may require more time for a signal to travel from the input to the output of a large computer due to the physical separation of components. Only a reduction of equipment size can pierce the speed-size ceiling to permit substantial improvements in performance.

Integrated circuits are the obvious answer to shorter propagation delays. The lack of physical separation of parts within a given circuit, coupled with the close spacing between separate circuits which considerably reduces wiring parasitics,

Fig. 4. Integrated circuit pattern of 2-stage amplifier with the various "components" labeled. Notice that the left-hand side of the pattern is a mirror image of the right side pattern.



promise a significant improvement in the speed-complexity product to meet the demands of tomorrow's equipment.

Evolution of Circuit Technology

The realization of integrated circuit advantages is based on a technology which represents a radical departure from the well-known design and construction concepts associated with the electronics art. Although the past decade has seen repeatedly successful efforts toward reducing the size and weight of electronic equipment—including miniaturization, subminiaturization, and finally microminiaturization—all of these were based on the principle of using separate parts, individually connected through wires or printed circuit patterns, to form a complete circuit. "Miniaturization," for example, was merely a concerted effort to reduce the size and weight of the separate passive circuit elements to parallel the size reductions precipitated by a switch from tubes to transistors. The popular shirt-pocket transistor radio attests to the success of this project.

But miniaturization was only the first step in overcoming the problems of an increasingly size-conscious science. To compress the size of equipment still further, or to increase the complexity of the circuits that could be squeezed into

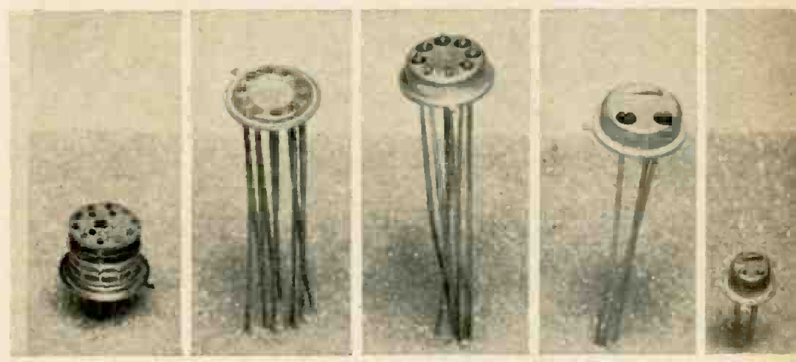


Fig. 5. Various transistor headers used for mounting circuits.

Fig. 6. Enlargement of unit shown at left in Fig. 5 shows four separate circuit layers capable of housing four isolated circuits with the equivalent of up to one hundred separate components.

a given volume, parts were again decreased in size in a stage of "subminiaturization" which retained the general shape of the parts but, in some cases, led to unique assembly techniques. The "cordwood" technique, in which cylindrical axial-lead components are stacked, with their leads fed through matched holes in parallel printed-circuit boards mounted in front of and behind the stack, is a good example.

Finally, in the ultimate size reducing process of "microminiaturization," tiny pill-type parts were pressed into equally

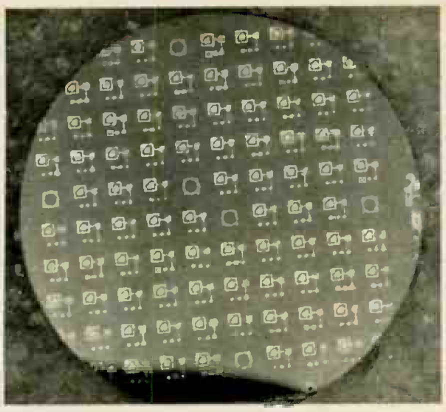


Fig. 7. Large numbers of integrated circuits are normally deposited or grown simultaneously through "masks" on thin silicon wafers. The wafers are then scribed and broken to yield up to several hundred separate circuits ready for mounting and bonding to a conventional transistor header or case.

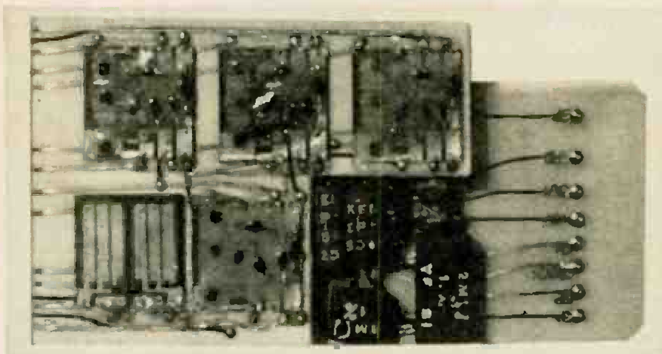


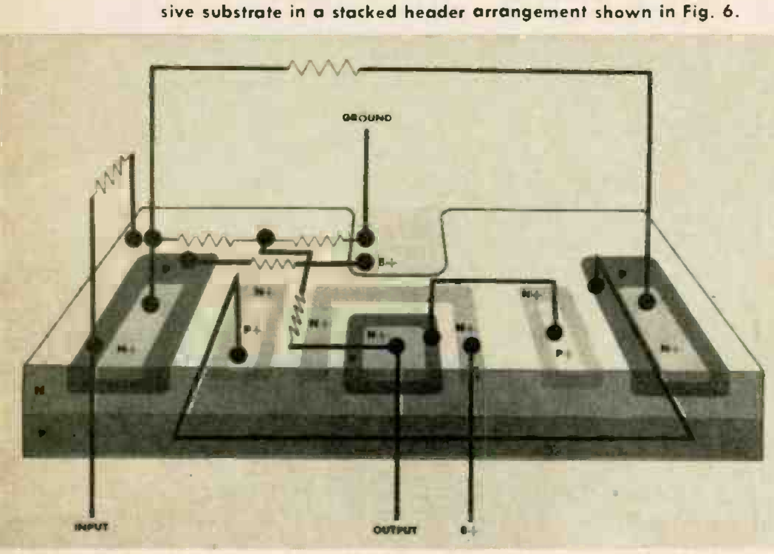
Fig. 8. Top view showing a stair-step voltage generator made up of 20 micro-transistors, 34 micro-diodes, and all associated passive elements, most made by thin-film processes.

small recesses in circuit boards and interconnected by printed wiring. This, for the first time, represented a departure from the conventional shape and form factor of the familiar parts. Yet, all three size-reducing steps had one thing in common—the circuit designer still retained uninhibited freedom of choice in the number of parts and parts values of the individual components.

Integrated Circuit Approach

The development of a thin-film capability represented the first real advance from the separate-parts techniques to current integrated circuit concepts. With thin films it is possible, by means of evaporation and anodization processes, to duplicate the functions of separate resistors, capacitors, and inductors with chemical layers of material deposited on *a glass or ceramic substrate*. Interconnections, made by overlapping or touching films, form a pattern of passive elements associated with a particular circuit. For the first time, the circuit designer found himself working with geometric patterns and configurations, rather than actual physical parts, in developing his circuit. But in so doing, he achieved not only additional size reduction, but gained an anticipated increase in reliability through the elimination of separately interconnected parts.

Fig. 9. Wide-band video amplifier composed of 3 transistors, 2 zener diodes, and 6 resistors. Both semiconductor and passive thin-film techniques are employed. With this approach, all active elements can be fabricated on a single semiconductor substrate and interconnected with passive elements on a passive substrate in a stacked header arrangement shown in Fig. 6.



Thin-film circuits, however, do not lend themselves to complete circuit integration. As yet, none of the many companies working in the field has perfected a means for depositing thin-film diodes or transistors—the active elements—on a glass or ceramic substrate. Complete thin-film circuits, therefore, combine thin-film passive patterns with microminiature, separately connected active components, as shown in Fig. 8.

The answer to truly integrated circuits lies in the more recent development of a *semiconductor integrated circuit technology* which combines thin-film passive parts with active elements on or within a single crystal *semiconductor* substrate. Already, processes have been developed which permit the deposition of resistance values ranging from a few ohms to several megohms, and capacitors to .01 μf. on such substrates by methods completely compatible with the fabrication of active elements. Thus, it is possible, as discussed earlier, to literally grow a complete circuit in a single, compatible fabrication process.

But semiconductor integrated circuits, too, have their limitations. It is difficult, for example, to obtain the required degree of electrical isolation between parts associated with certain circuits. Since all parts are fabricated within a semiconductor block, circuits of this nature are limited at present to configurations that can tolerate relatively high parasitic capacitance coupling between parts. Thus it is a matter of designing circuits that are tolerant of intercomponent coupling, or of combining passive thin-film concepts with semiconductor technology for the fabrication of more complex circuits, as visualized in Fig. 9. It is this combined approach that may well be employed for more complex integrated circuits in the immediate future.

Nevertheless, a wide variety of integrated circuits has already been produced by the semiconductor technique alone. These run the gamut from digital switching and logic elements—including flip-flops, "nor" and "nand" gates, etc.—to linear elements including both high- and low-frequency amplifiers. They are practical circuits that are being sampled by the industry for possible design in tomorrow's equipment. And, although relatively simple, they are indicative of the progress that can be expected. Epitaxial growth techniques, developed for growing crystals of highly controllable resistivities in selective patterns, are being employed to attack the isolation problems with encouraging results. Advanced methods of diffusion are being investigated and show promise of increasing isolation factors. It seems only a matter of time—a relatively short time—before more complex, truly integrated circuits can be fabricated to order in any desired quantity.

Opportunities in Integrated Electronics

The total impact of integrated circuits on the electronics society, far reaching as it may be, is not as immediate as it may appear on the surface. It must be remembered that the transistor displaced the vacuum tube in many possible applications only after 15 years of maturity. The infiltration of integrated circuits into the over-all economy is expected to follow a similar timetable. It is anticipated that they will live compatibly alongside transistors and even vacuum tubes for a good many years.

The reason for this is that the advantages of integrated circuits have, in many instances, outdistanced the present requirements. Although an improvement in reliability is of

(*Continued on page* 90)

DELAY-LINE NOMOGRAMS

By DONALD W. MOFFAT

Useful graphical information to speed the design of LC delay lines with various delays and rise times.

DELAY lines are finding many applications in electronic equipment because they are passive timing devices capable of extremely good accuracy under severe environmental conditions. Many of these lines can be made in any laboratory and the accompanying nomograms will enable the reader to design a delay line quickly for the desired characteristics.

Two broad classes of delay lines are the mechanical and the electromagnetic. The first group is characterized by long delays, up to thousands of microseconds, and large attenuation. They are made of special and expensive equipment and are not ordinarily within the province of anyone but the specialist in their manufacture. On the other hand, electromagnetic delay lines consist of a network of coils and capacitors, as shown in Fig. 1, and experimental models can be constructed at any electronic workbench.

The length of time by which such a line delays the signal is a function of just the total inductance and capacity, in accordance with the formula: $T = \sqrt{LC}$, which uses the basic units of seconds, henrys, and farads. If inductance and capacity are expressed in microhenrys and microfarads, respectively, then time will be calculated in microseconds. This equation shows that time delay can be increased by increasing either capacity or inductance or both.

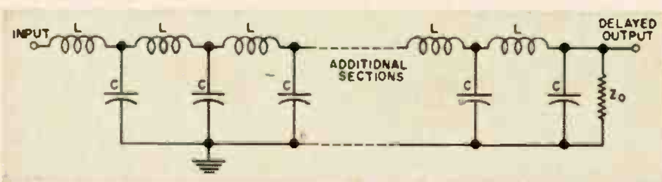
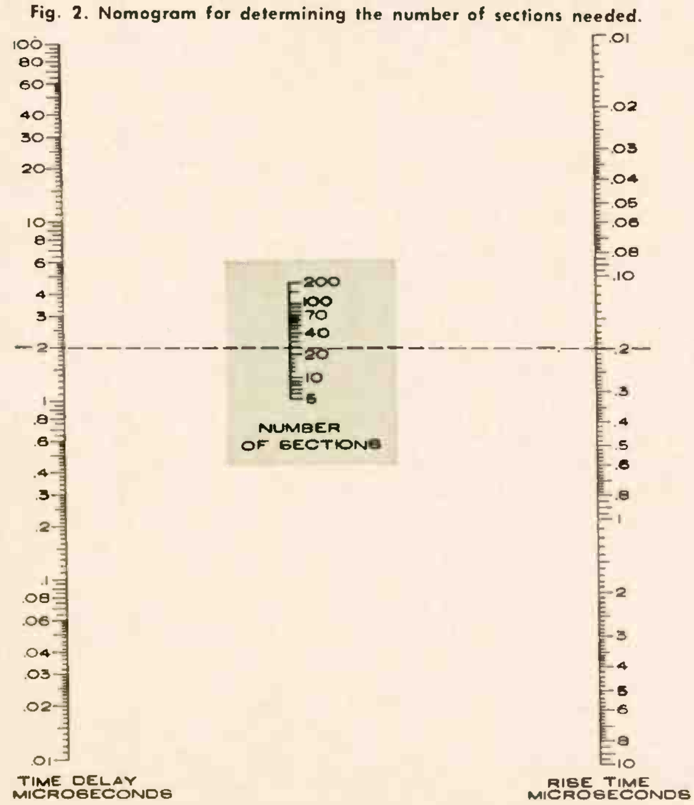


Fig. 1. Basic circuit arrangement of a multi-section LC delay line.

Fig. 2. Nomogram for determining the number of sections needed.



However, if the characteristic impedance of the line is to be considered, the ratio of L to C must be watched. Characteristic impedance of a line is the impedance which the line presents to the circuit that feeds it. For instance, if the signal from a source with 2000-ohm internal impedance drops to half its open-circuit value when a delay line is

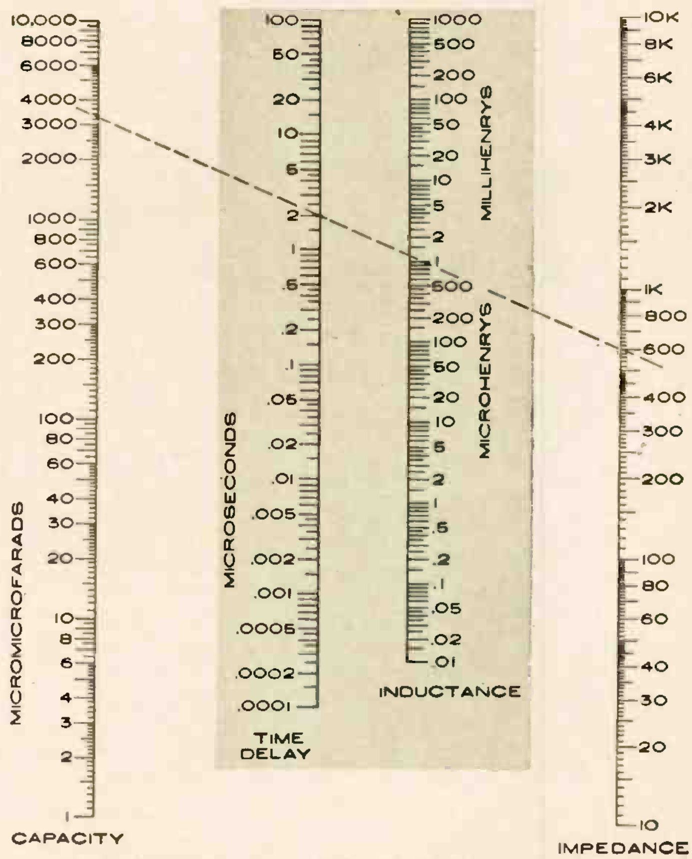


Fig. 3. Nomogram used to obtain total inductance and capacity.

connected across it, then the delay line also has an impedance of 2000 ohms. When the delayed signal reaches the end of the delay line, some of it will be reflected back unless the line is terminated in a resistance equal to its characteristic impedance. In general, proper matching will produce the best waveform and the maximum signal output.

The formula for characteristic impedance is: $Z_0 = \sqrt{L/C}$, where Z_0 is in ohms when both L and C have the same prefix, such as "micro." This equation shows that increasing inductance will increase impedance, increasing capacity will decrease impedance, and they can both be changed without affecting impedance if their ratio remains unchanged.

In Fig. 1, the coils are in series and the capacitors are in parallel. Therefore, total values as given by both the formulas are found by adding up those of each section. Conversely, the values for one section are found by dividing the totals by the number of sections. The number of sections is selected on the basis of the desired quality factor, which is defined as total delay divided by output rise time. The higher this ratio, the better the delay line because either a long delay or a short rise time will increase the quality factor. In de-

(*Continued on page 68*)

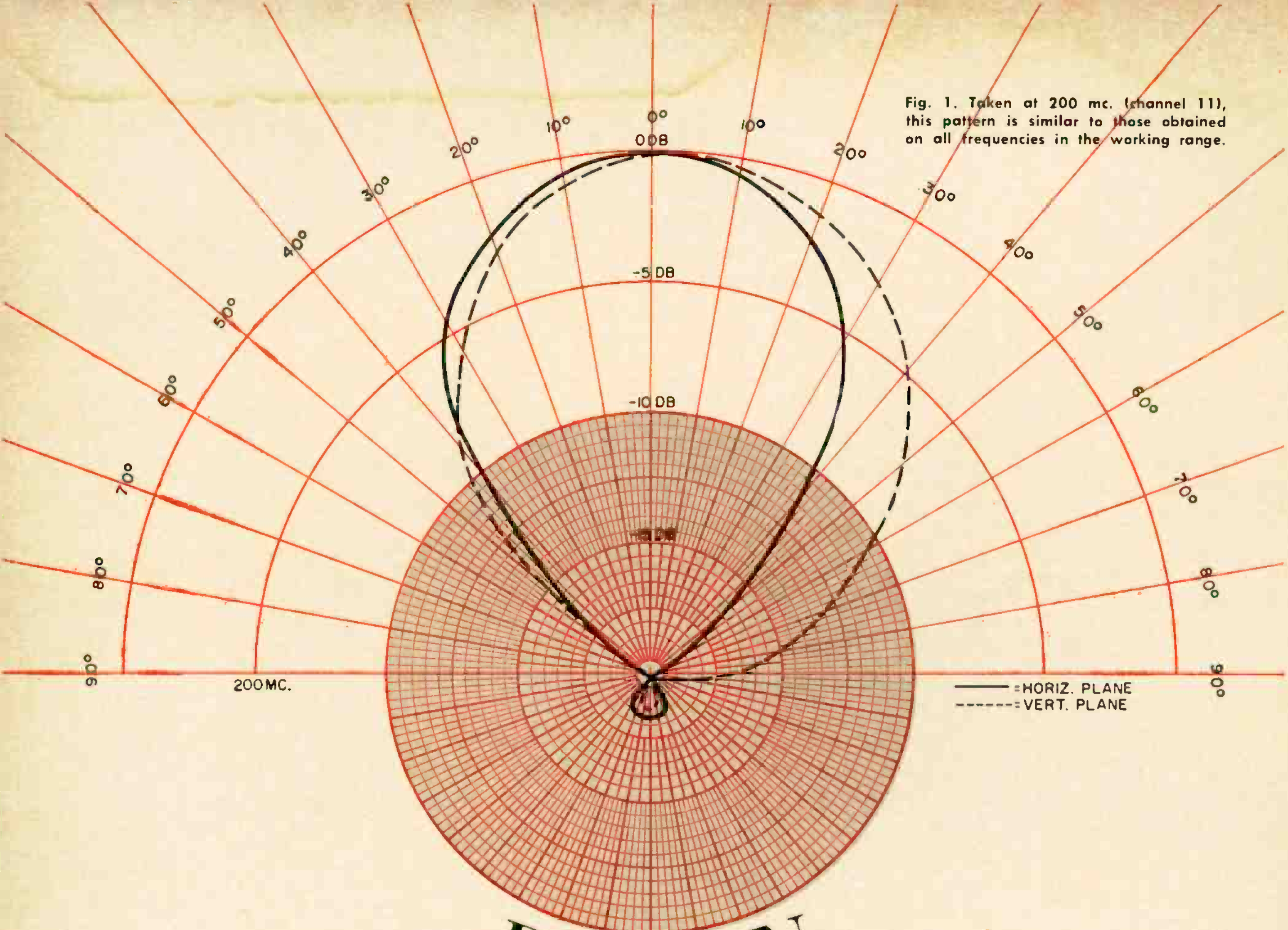


Fig. 1. Taken at 200 mc. (channel 11), this pattern is similar to those obtained on all frequencies in the working range.

DESIGN for an All-Purpose TV-FM Antenna

By GEORGE J. MONSER, American Electronic Laboratories, Inc.

Receive all v.h.f. and u.h.f. TV and FM signals on one broadband (54 to 890 mc.), high-gain antenna you can install in your attic.

THERE WAS a time when a collection of antennas at one site, of various shapes and sizes, marked the location of a radio amateur. With the rapid expansion and diversification of public broadcast services, current and imminent, laymen who want to enjoy everything available may also face the prospect of acquiring antenna farms.

Many people have been getting satisfactory results on TV and FM for years with single, all-channel antennas. But color TV reception is more critical with respect to irregularity of frequency response, noise, and ghosting. Similar problems exist with FM stereo reception as compared to monophonic performance. And now, with real activity in u.h.f. TV virtually certain, the public will be learning that present v.h.f. antennas don't work well in the higher range. The need for flat response, high gain, and good directivity over a number of bands, ranging from 54 to 890 mc., seems to indicate the corresponding necessity for many antennas.

Fortunately there is a way out. The concept of the log-periodic design makes it possible to construct a single antenna of extremely broad bandwidth with high, uniform gain and good directivity essentially concentrated in a single-lobe pattern. Furthermore the physical design can be simplified so that construction is easy and inexpensive.

The basic antenna on which the version described here is based provides a constant gain of 10 db over a tuned, half-wave, reference dipole from 54 to 890 mc. It has a nearly constant, resistive input impedance of 150 ohms. Thus direct connection to a 300-ohm line without additional matching provides a v.s.w.r. of at least 2 to 1, so that loss due to this mismatch is less than 1 db. Directivity patterns of the basic model, made up of aluminum rods, were taken at several points throughout its range. Since they are quite similar, it is pointless to show them all; the one in Fig. 1 (200 mc., channel 11) is typical. Half-power beamwidths are in the order of 60 degrees. Directivity is good, but not so narrowly beamed that precise orientation becomes overly critical. A fair degree of latitude is permissible before significant gain reduction occurs.

The author's version was constructed of strips of wood (plastic may be used), nails, and bare wire (AWG #20). He has installed it in his attic—an application to which the physical construction lends itself admirably. With it he is able to receive all transmissions from New York City, which is about 80 air miles from his home. Its performance is close to that of the model it follows. Small differences and what can be done about them, if necessary, will be noted.

The Basic Design

Important parameters in the log-periodic design are shown in Fig. 2. It consists of two tapered plates, an upper and a lower, which converge at their narrow ends. It is this apex, by the way, that faces toward the desired signal. Each plate consists of a center conductor electrically connecting to the series of zig-zag elements. The plate angle is α, and the separation angle between the plates is ψ. R_n is the distance from the apex to any element. R_{n+1} is the distance from the apex to the next larger element. The ratio between these is the constant τ, which is equal to .7. This factor may be used to determine spacing if the constructor should wish to add elements in either direction.

The size of the longest element determines low-frequency cut-off, with the size of the shortest determining high-frequency cut-off. Actually the half-element length, which is the perpendicular distance from the outer end of any element to the center conductor, is used for calculation. This length is a quarter-wave at the resonant frequency. Let us illustrate with the design required for reception from 54 to 890 mc. One wavelength at 54 mc. is 18 feet, so the size of the largest half element would be at least 4.5 feet. One wavelength at 890 mc. is 1.1 feet, so the smallest half element would be no longer than 3.3 inches.

To prevent size from becoming excessive, low-frequency cut-off of the author's version is somewhat above the range of channel 2. Since cut-off is not sharp, there is still an estimated 6 db of gain at 54 mc. However, flat response can be maintained to this frequency by extending the pattern to include another zig-zag element, whose spacing can be determined from the formula in Fig. 2.

There may be some roll-off at the high-frequency end, too. If reception of a weak u.h.f. signal close to 890 mc. is desired, it may pay to extend another small element in toward the apex: flat response across a desired bandwidth is assured by making the cut-off frequencies fall slightly beyond the desired limits.

Construction

Thin strips of wood, ½ inch by ½ inch, were used to construct the frame. One of the two identical sections is shown to the left in Fig. 3. If the antenna is to be used outdoors, nonconductive material that will withstand wind and weather better than the attic version should be chosen, but dimensions are the same. Each frame is glued and nailed at the points shown.

The distances along the side and center supports at which nails are to be driven are given from a line perpendicular to the apex. These points should be measured accurately. A one-inch nail was driven in half-way at each point, leaving half an inch protruding. Then, beginning at the apex, bare wire was attached to the first nail on the center support and strung from nail to nail in the pattern shown in Fig. 4A for each of the two plates. Another strip of wire is run along the center support from the apex to the nail that will be crossed by the largest element. This is also secured to all nails that it passes, to make electrical contact with all elements. For a better bond, the wire was soldered to each nail in the assembly. Crimp-on lugs could be used instead.

To check for uniformity, the two sections were aligned one on top of the other, as in Fig. 4B. One of them was then

(*Continued on page* 86)

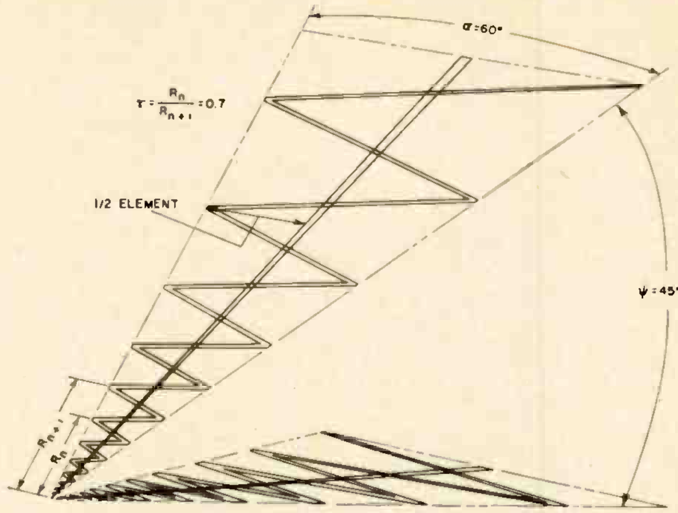


Fig. 2. Design data for developing the log-periodic antenna described here may be used to expand the author's version.

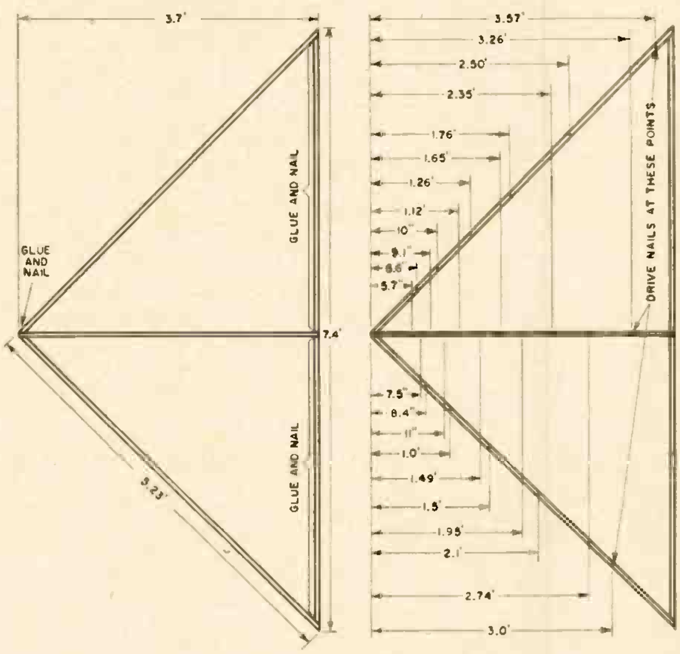
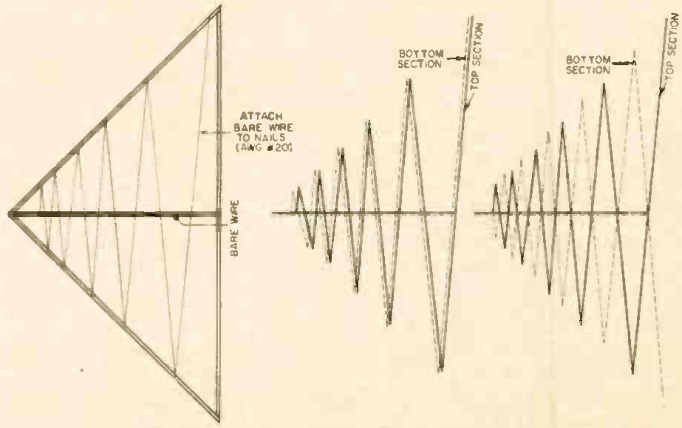
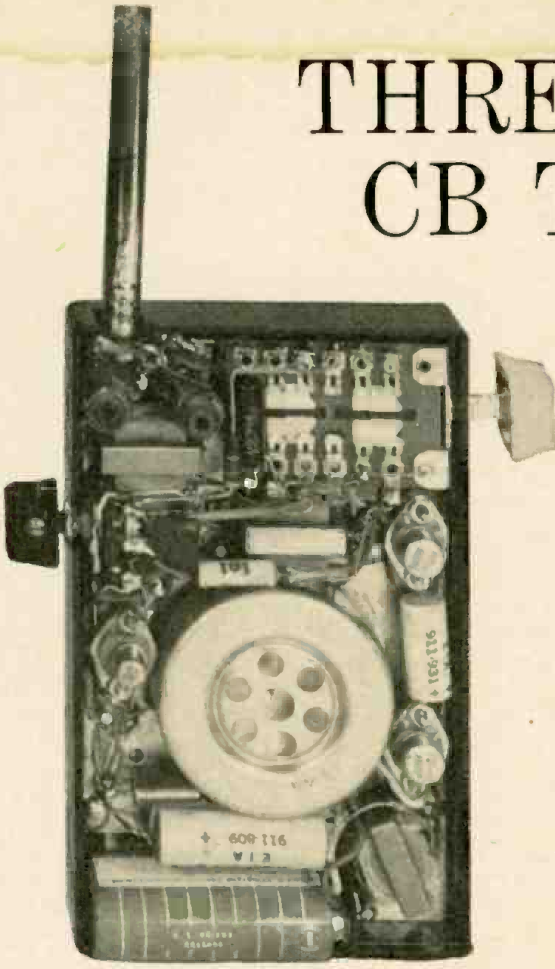


Fig. 3. Dimensions (left) for each of the two supporting frames. Locations of nails (right) to hold wire elements.

Fig. 4. How bare wire (A) is run from nail to nail. The two sections (B) superimposed. One is then flipped over (C).



THREE-TRANSISTOR CB TRANSCEIVER



Side view of transceiver with cover removed. This photograph is just about two-thirds the actual size.

EVER since the FCC approved the use of the 27-mc. Citizens Band for two-way radio communications by any U.S. citizen, interest and activity in this band have increased greatly. Today, many manufacturers have equipment on the market for operation in this service.

The equipment allowed by the FCC can be roughly classified according to the maximum power level of the transmitter, *i.e.*, either 5 watts or 100 milliwatts. Whereas the operator of the 5-watt equipment must obtain an FCC license and be at least 18 years of age, the 100-mw. equipment may be operated without a license by anyone, irrespective of age, provided the equipment meets the requirements set forth in Part 15 of the FCC Rules and Regulations.

Much of the equipment available for use in the Citizens Band is portable, with the small hand-held transceiver being the most popular. The design, price, and performance of the various units on the market vary widely. Some use a superregenerative detector in the receiver and a modulated oscillator as the transmitter. Others employ a superheterodyne receiver with dual conversion including noise limiter and audio squelch, and a transmitter consisting of a modulated output amplifier driven by a crystal-controlled oscillator. This article describes the design, construction, and operation of a three-transistor, low-power transceiver.

The price of high-frequency transistors is decreasing rapidly and is now more in line with the cost of tubes. Because of their smaller size and greater economy of battery power, transistors are well suited for use in portable transceivers.

With battery drain, cost, and size in mind, the number of transistors for the present design was limited to three. To get as much sensitivity as possible, while minimizing battery drain, the receiver consists of a superregenerative detector and two audio stages. The transmitter is a single transistor operating as a modulated crystal-controlled oscillator. The same transistor is used alternately as transmitter and superregenerative detector. Thus, only one high-frequency transistor is needed. This unit is the newly announced *Texas Instruments* "Dalmesa" transistor, Type 2N2189. The two audio transistors are general-purpose units, Type 2N1274. For more audio power, the 2N1374 may be used.

The 2N2189 may be obtained from any local distributor handling *Texas Instruments* transistors for about $1.50, the 2N1274 for $.69, and the 2N1374 for about $1.00.

The schematic diagram of the 100-mw. transceiver is shown in Fig. 1. When the push-to-talk switch is in the "receive" position, V_1 operates as a self-quenched superregenerative detector with an audio load (R_2) in its collector circuit.

A 27-mc. voltage is developed across the r.f. choke in the emitter lead and is fed back in-phase to the collector by C_5, thus giving a regenerative action at the resonant frequency of L_1 and C_4. The antenna circuit is link-coupled into the collector by L_2. The coil L_3 is used to tune out the capacity of the collapsible whip antenna.

The audio output of the detector is taken across the load resistor R_2. This output consists of the supersonic quench frequency (approximately 40 kc.) plus the modulation from the incoming signal. This signal is applied to a filter consisting of C_9, C_{10}, and L_4, to remove the quench that would otherwise saturate the audio section and prevent proper operation.

The output of the filter is the modulation from the incoming signal and is applied across the volume control and then into the base of the first audio stage. The audio stages are designed to deliver 35 mw. unclipped and 40 mw. at 10% clipping. This proved to be adequate in the units tried by the author. In the interests of economy, however, a small 3.2-ohm speaker may be used, along with a less expensive transformer T_2 with a 3.2-ohm secondary. In this case, both T_1 and T_2 will cost under a dollar each.

The use of transformer coupling in the audio does increase cost; but elimination of the interstage transformer would reduce the gain of the audio due to mismatching of the transistor impedances to the point that adequate volume could not be obtained.

The bandwidth of the audio amplifier is purposely controlled by capacitors C_{13} and C_{15} in order to further reduce the effect of the residual quench left by the quench filter, and to improve the noise level of the receiver.

The output stage of the amplifier has a somewhat unusual connection in that C_{14} goes from the emitter to the base-bias resistor. C_{14} is a bypass capacitor and serves only to place the incoming signal between the emitter and base leads of V_3.

SPECIFICATIONS OF TRANSCEIVER

D.C. input to transmitter	100 mw.
R.F. sensitivity	3 μv. for 10 db S/N ratio
R.F. power out	30 mw. (measured at link into 50-ohm load)
Audio power	35 mw.
Quench	40 kc.
Power drain (receiving)	130 mw.
Power drain (transmitting)	270 mw.

Table showing measurements made by author on two of the units.

Construction of a low-power unit built with inexpensive transistors. Modulated oscillator and superregenerative detector are employed in order to obtain maximum simplicity.

By JERRY NORRIS / Texas Instruments Inc.

Thus, a separate capacitor is not required to bypass R_{11} and R_{14}, and the performance is not degraded.

The transmitter section consists of V_1 operating as a modulated oscillator whose power supply is taken from the audio output stage. When the push-to-talk switch is flipped to "transmit," the emitter resistor is changed, the crystal short-circuit is removed, and the speaker is used as a microphone.

To prevent overmodulation which occurs on audio peaks due to the collector voltage of V_3 going to zero and thereby taking the collector voltage of V_1 to zero, a voltage divider from the speaker was incorporated. Consisting of R_8 and R_{13}, the divider proved adequate for normal speech when transmitting, however, it is by no means a limiter, and overmodulation will result if the speaker is subjected to unusually loud speech or noise.

If overmodulation occurs, a popping sound will be heard in the receiver followed by a rushing sound as the background noise of the receiver comes up. If the audio peaks cause this, the operator can talk softer or the value of R_{13} may be increased. The value of R_{13} depends somewhat on the specific speaker used and the voice characteristics of the operator.

During transmit, the emitter resistor R_5 is bypassed to audio by C_2 and to r.f. by C_3. Elimination of C_2 results in a slight loss in the percentage of modulation achieved. This is due to the feedback in the transistor from collector to emitter. If a high percentage of modulation is not a prime requirement, C_2 may be omitted in the interests of economy. The shunting of the crystal by S_{1A} is eliminated, allowing the crystal to provide frequency control of the oscillator. Modulation is accomplished by varying the collector supply by the changing audio voltage across the inductive reactance of the primary winding of T_2.

Construction

Layout of the parts should receive the same careful attention as bestowed on any other high-frequency receiver or transmitter. Placement of choke L_4 and the speaker should be such that magnetic coupling will be minimized.

The crystal lead going to the switch S_{1A} should be very short. The wiring of capacitor C_1 should be accomplished with leads as short as possible going from the capacitor to the switch and the switch to ground.

It is important in any receiver or transmitter to have very good ground points. However, in a hand-held transceiver, it is even more important. The effectiveness of the antenna system will, in part, be determined by the amount of ground plane area. If possible, therefore, the ground system in the circuit should be a metal plate. In the unit built by the author, the ground wire on the circuit was connected to a flat metal plate that measures approximately 4½" x 2½".

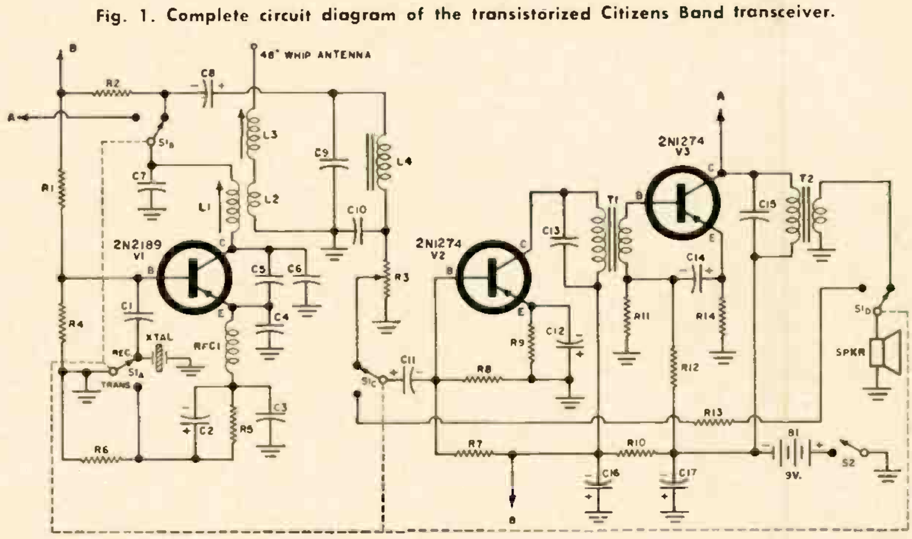
The crystal and transistors may be soldered into the circuit, but precautions should be taken to avoid damage to the crystal due to excessive heat. A pair of long-nose pliers between the crystal and the soldering iron is usually sufficient. All leads should be kept as short as possible.

Alignment

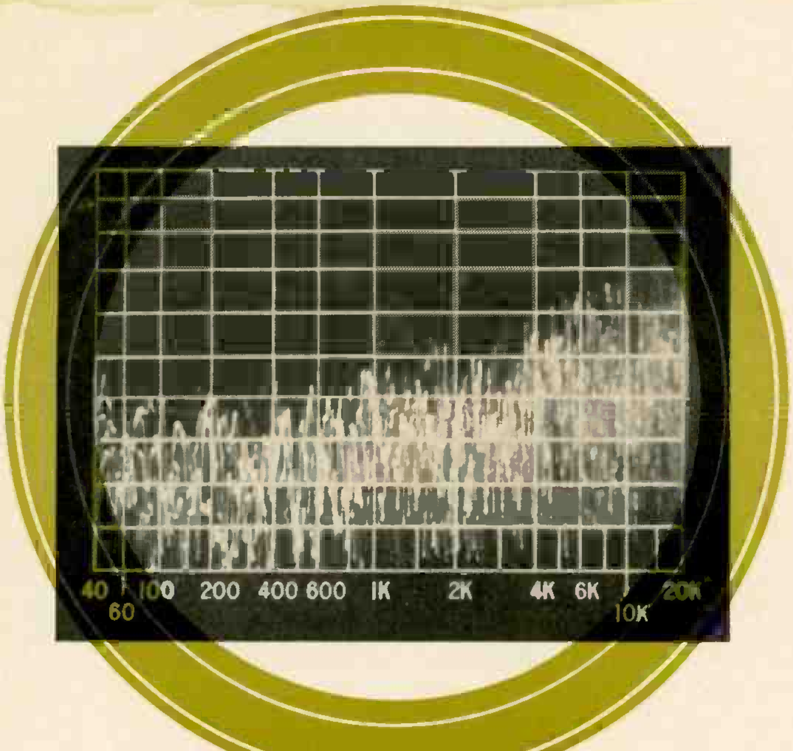
The transmitter section will be on the crystal frequency. Since the transmitter and receiver use the same tank coil, they should be tuned to the same frequency. To "tune up," adjust the slug in L_1 for the signal desired. In the absence of a signal, a loud rushing sound should come from the speaker. On-the-air signals may be used if they correspond to the transmitter frequency. After the desired signal is tuned in, adjust L_3 for maximum volume or minimum noise. The noise level adjustment is very effective if the transmitter is considerably removed from the receiver.

With two of the units, as built by the author, distances of 1/5th of a mile have been covered with ease. ▲

Fig. 1. Complete circuit diagram of the transistorized Citizens Band transceiver.



R_1—22,000 ohm, ½ w. res.
R_2, R_9—1000 ohm, ½ w. res.
R_3—10,000 ohm pot
R_4—2200 ohm, ½ w. res.
R_5—100 ohm, ½ w. res.
R_6—1800 ohm, ½ w. res.
R_7—33,000 ohm, ½ w. res.
R_8—6800 ohm, ½ w. res.
R_{10}—270 ohm, ½ w. res.
R_{11}—560 ohm, ½ w. res.
R_{12}—5600 ohm, ½ w. res.
R_{13}—3900 ohm, ½ w. res.
R_{14}—47 ohm, ½ w. res.
C_1, C_7—.001 µf. ceramic capacitor
C_2, C_8, C_{14}—5 µf., 9 v. elec. capacitor
C_4—.002 µf. ceramic capacitor
C_5, C_6—56 µµf. ceramic capacitor
C_3—12 µµf. ceramic capacitor
C_9, C_{10}—.05 µf. ceramic capacitor
C_{12}—40 µf., 3 v. elec. capacitor
C_{13}, C_{15}—.02 µf. ceramic capacitor
C_{11}, C_{16}, C_{17}—100 µf., 9 v. elec. capacitor
S_1—4-pole d.t. switch (Lafayette SW92 or equiv.)
S_2—S.p.s.t. switch (may be on R_3)
Xtal.—Third-overtone crystal (26.97-27.27 mc.)
Spkr.—100-ohm magnetic telephone receiver or 3.2-ohm PM speaker
RFC_1—22 µhy. r.f. choke
T_1—Driver trans. 20,000 ohm pri.; 1000 ohm sec. (Lafayette TR-110 or equiv.)
T_2—Output trans. 1000 ohm pri.; 100 ohm sec. (Argonne AR-136 or equiv.)
L_1, L_3—8 t. #24 en. copper wire closewound on ¼" paper form slug-tuned with powdered iron slug ⅜" long (Arnold Engineering Type A1-01)
L_2—2 t. #24 en. copper spaced dia. of wire, wound on cold end of L_1
L_4—30 mhy. choke (Bud CH-1227 or equiv.)
B_1—9 volt battery (Burgess 2U6, Eveready 216, or equiv.)
V_1—2N2189 transistor (Texas Instruments)
V_2, V_3—2N1274 or 2N1374 transistor (Texas Instruments, see text)



By LON EDWARDS / Solitron Devices, Inc.

White noise, a special type of random noise with uniform energy distribution, can be used to test many types of audio equipment. It is also used as audio analgesia and in a number of different industrial test applications.

WHITE NOISE/*its nature, generation, and applications*

WHITE noise is an often used, but hazily understood, term. Does white describe the color of the noise? It hardly seems possible. Yet noise is also described as pink and yellow. There is a precise meaning of white noise as used in electronics. A study of the origin and meaning of white noise will be a good introduction to considering a white-noise generator as a device for testing hi-fi components.

Most people can hear sound from vibrations ranging from about 20 to 20,000 cps if the energy reaches the inner ear. These lower and upper limits differ somewhat from person to person and, for one person, from time to time as well as with age.

Vibrations within the range of 20 to 20,000 cps will be called the vibration spectrum. The word "sound" will be reserved for those sensations one recognizes when energy from vibrations reach the inner ear.

When vibrations are such that one perceives a pattern in the sound, a special term is used to describe the sound. For example, when a vibration is repeated for a long enough time, the sound is called a musical tone. If the tone is given a position higher or lower than other tones in a musical scale, its position is described as pitch. Thus a repetitive vibration of 440 cps results in a musical tone defined by international agreement as the standard musical pitch and designated as A^1 on the musical scale.[1] In practice this pitch is taken from a tuning fork adjusted accurately and producing a nearly pure sine-wave. Other tones are related to this standard in a manner so as to comprise some sort of musical scale.

To help understand the idea of noise, imagine 19,980 tuning forks (one for each frequency between 20 and 20,000 cps) each capable of producing either a single cycle, several cycles, or many cycles of sound. Furthermore, each is to generate a pure sine-wave. Now, if it is possible to (1) cause each fork to vibrate for different lengths of time interspersed with periods of rest in random order and (2) keep all forks acting in a random relation to each other, the cacophony would be called random noise. All possible pitches might be heard, but in no distinguishable pattern. Such a chaotic condition might also be described as one of high entropy, *i.e.*, the vibrations are considered to be unorganized, based on the sound heard.

White noise refers to a special type of random noise. Suppose each tuning fork is driven with a different amount of energy, *i.e.*, each would produce a few cycles of varying amplitude energy from time to time. If this variation is now added to the two previously described conditions, the instantaneous energy of a particular fork will change constantly. Suppose we consider the instantaneous energy of each of 100 forks, say those of 200 to 299 cps. The relation of amplitude and phase of each to the others would be continually shifting in random fashion. Now suppose we measure the average energy of the 100 forks over a long period of time, say 100 minutes. We would find the average energy to be X. If we measure the average energy from many other 100-fork groups picked at random in the spectrum, we will find the average energy for 100 minutes for each group of 100 forks, irrespective of frequency, also equal to X. We now have the special condition referred to as "white." Under this condition, although the instantaneous energy of each fork changes, the long-time average for any 100 forks equals that for any other 100 forks. Noise from these forks would be called white noise rather than random noise. While all pitches could be heard in random order, the long-time average energies of the vibrations responsible for them would be equal. Thus, the vibrations for white noise are organized as far as long-time average energy is concerned but are random as far as instantaneous energy and order of frequency with time is concerned. Neither the instantaneous energy of a particular frequency nor the time of its appearance can be determined; both are random. However, in terms of statistical probability, the long-time energy per bandwidth can be predicted accurately.

To this point we have considered noise as a perception phenomenon and white as a particular kind of energy distribution in time. In electrical work, the concept of noise as just described (from acoustics) has been used to refer to any voltages that seem to be randomly active in a conductor. The word "white" has been borrowed (inaccurately) from optics and is used to mean *the long-time average energy distribution of the electrical voltages over a specified frequency spectrum.*[2] This meaning for white in electrical work has become so well established it is best to continue to use it, optics notwithstanding.

Hi-Fi Equipment Testing

Before describing a practical white-noise generator, let's digress to talk about using white noise to test hi-fi systems.[3] The most useful objective check on the performance of any electrical or acoustical system would be obtained if it could be made while the system is stimulated by the exact energy patterns it is to handle in practice. This can be done when the energy pattern is simple and standardized, *i.e.*, sinusoidal. But only rarely can it be done when the energy pattern to be handled is both complex, and to the system, randomly organized.

A prediction of the practical performance of systems in the latter category, such as hi-fi amplifiers and speakers, is often based upon their performance when stimulated by the sine-waves, tone bursts, sweeping sine-waves of varying frequency, square waves, and so on. In this process, the area of no-data gaps, *i.e.*, those segments of the total audio spectrum which lie between test stimulation points and performance stimulation points, depend on the degree to which the test signal duplicates the performance signal. The no-data areas between sine waves and music-energy waves are both frequent and large. Predicting the performance of a hi-fi system on music energy from its performance with sine-wave test energy amounts to basing the predictions on very few data; the probability of accuracy is low. This may account, in part, for the widely recognized discrepancy between performance predicted from technical specifications and the actual performance of the systems. On the other hand, testing the system with electrical impulses that are random both as to amplitude and frequency over the spectrum of interest, maintaining constant energy per bandwidth, reduces the no-data gap areas between test and performance stimulation points. This idea is even more sound when you consider that music can be conceived of as tones (energy of low entropy) organized into a pattern of sufficiently high entropy (approaching randomness) to provide a desired degree of sophistication.[4] If one accepts this concept of music, perhaps it follows that music-handling systems can be tested best with white noise, a signal of high entropy. If these arguments are accurate, then white noise should be useful in making objective tests on the performance of amplifiers, loudspeakers, cartridges, as well as the acoustic performance of auditoriums and music listening rooms in the home.

White-Noise Generator

In spite of the previous theory, there is little reference to white noise testing in popular literature. There may be many reasons for the apparent failure to exploit its capabilities among which have been the cost and complexity of suitable white-noise generators. This is no longer a deterrent. A silicon diode called the Sounvister is available in different types to cover the spectrum from less than 1 cps to more than 100

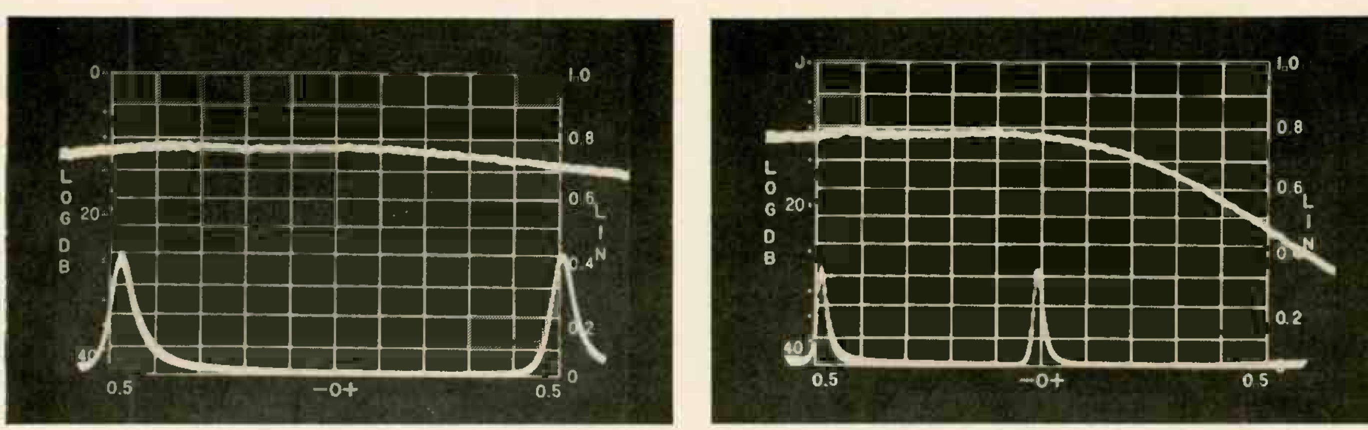
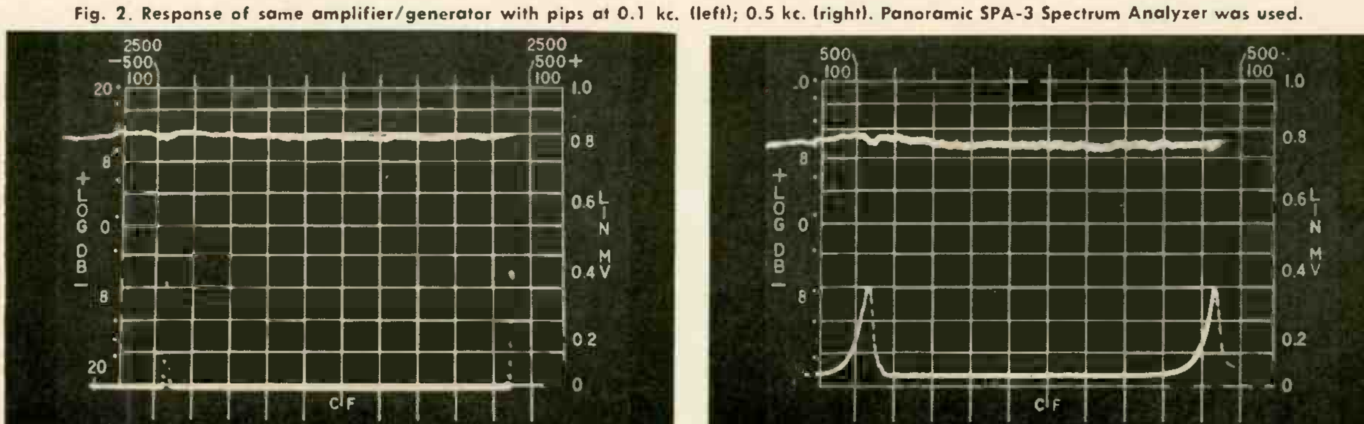


Fig. 1. Response of white-noise generator/amplifier in Fig. 4. Output is .75 v. r.m.s. across a 100,000-ohm load. Pips are at 0 and 50 kc.

Fig. 2. Response of same amplifier/generator with pips at 0.1 kc. (left); 0.5 kc. (right). Panoramic SPA-3 Spectrum Analyzer was used.



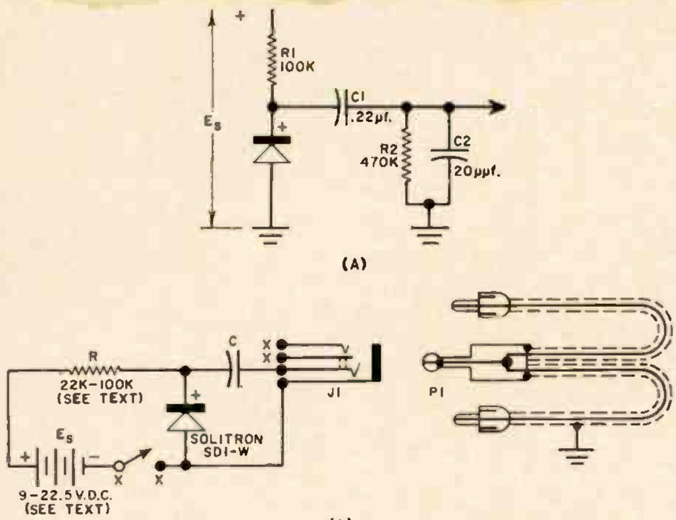


Fig. 3. Basic white-noise generator has 500-2500 microvolt output.

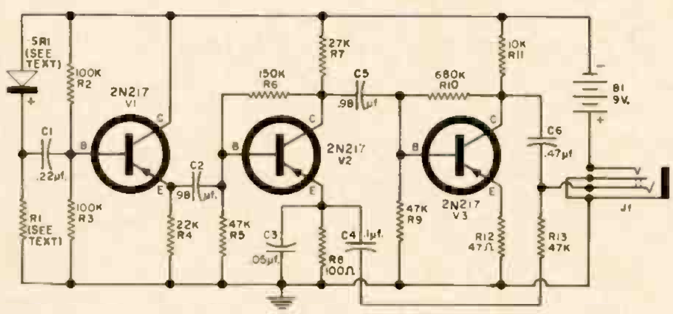


Fig. 4. Complete schematic of a white-noise generator/amplifier.

R_1—22.000-100,000 ohm, ½ w. res. (see text)
R_2, R_3—100,000 ohm, ½ w. res.
R_4—22,000 ohm, ½ w. res.
R_5, R_9, R_{13}—47,000 ohm, ½ w. res.
R_6—150.000 ohm, ½ w. res.
R_7—27,000 ohm, ½ w. res.
R_8—100 ohm, ½ w. res.
R_{10}—680.000 ohm, ½ w. res.
R_{11}—10,000 ohm, ½ w. res.
R_{12}—47 ohm, ½ w. res.
C_1—.22 µf., 10 v. capacitor*
C_2, C_5*—.98 µf., 10 v. capacitor*
C_3—.05 µf., 10 v. capacitor
C_4—.1 µf., 10 v. capacitor*
C_6—.47 µf., 10 v. capacitor*
B_1—9-22 v. battery (see text)
SR_1—White-noise diode (Solitron SD1-W, available from Solitron Devices, Inc., 500 Livingston St., Norwood, N. J., $7.50)
J_1—Phone jack (Switchcraft No. 13B)
V_1, V_2, V_3—"p-n-p" transistor (2N217 or equiv.)
**Centralab UK10 "Ultra-Kaps"*


Fig. 5. Author's generator is built in chassis box, has two outputs.

mc.[5] Among these, the SD1-W is designed for the 20-20,000 cps spectrum. It is the white-noise source in the compact generator to be described.

The SD1-W is a double-diffused, silicon junction diode. When a reverse voltage, applied to the SD1-W in the circuit in Fig. 3A, is gradually increased, the diode produces an increasing amount of random, non-white voltage. At some point, the diode suddenly goes into zener or avalanche operation with a resulting generation of reasonably white noise. As E_s is increased, the output drops and "whitens" even more.

Typical diodes have an output ranging from 500 to 2500 microvolts r.m.s. per 20 kc. bandwidth. Each SD1-W is accompanied by a specification sheet which suggests operating parameters for best performance of that particular unit.

If the output from the diode alone is sufficient, the circuit of Fig. 3B can be used. For greatest simplicity, the energizing voltage, E_s, can be specified as the nominal voltage of a small battery, such as 9 or 22.5 volts, when ordering an SD1-W diode. Since the current drain usually is under 500 microamperes, even the smallest battery will have a long operating life. The switching-type jack in Fig. 3B can be dispensed with and the unit can be allowed to operate continuously. Resistor R_1 is selected to adjust the current to that value recommended when a voltage other than the classifying voltage is used. The SD1-W diode is equivalent to a high-impedance generator and should not be used across a load much smaller than 100,000 ohms.

A simple transistor amplifier can be used to boost the output of a selected SD1-W to an r.m.s. value somewhere between 0.25 and 1.0 volt across a 100,000-ohm load. An amplifier built by the author for this purpose is shown schematically in Fig. 4. The white-noise diode, SR_1, used in this amplifier was selected to operate correctly with an energizing voltage of 9.0 volts. V_1 is used as an emitter-follower to provide a high-impedance load for SR_1. V_2 and V_3 are straightforward amplifier stages. C_2 and C_5 are obtained by paralleling two high-value .47-µf. capacitors. R_{11}, C_3, and C_4 form a frequency-selective feedback loop to compensate for departures from linearity of both the diode and the amplifier. The completed generator installed in a case with two connecting leads for stereo systems is shown in Fig. 5. Response curves for the output of a typical generator are shown in Figs. 1 and 2. Marker pips appear at 1 kc., 5 kc., and at 50 kc.

Several generators have been built using unselected 2N217 transistors and have performed as follows:

Output—between 0.25 and 1.0 r.m.s. volt across a 100,000-ohm load.

Frequency Response—20-20,000 cps, ±2db.

Current Drain—between 1.0 and 1.5 ma.

Applications

The author has found white noise to be useful, not only in development work, but also with complete hi-fi systems. It will reveal differences in acoustic performance of speaker systems more readily than any method yet tried. Harshness, boom, and hollowness can be detected readily. Of course, one cannot tell from the sound of white noise alone which system is best for music reproduction. But once a standard system has been selected, reproduction of white noise is an excellent method for checking balance and matching channel response. And, finally, acoustic response of the listening room to all frequencies can be judged qualitatively by simply playing white noise and walking around the room noting the variations in its character.

White noise is also being used in many ways in modern technology. Properly shaped, it provides the "waterfall" sound for audio analgesia. It can provide constant-level sound against which hearing ability can be measured or it can mask outside sounds which might invalidate results from laboratory experiments with animals. It can generate random numbers to test computers, simulate cosmic noise, calibrate astronavigational and tracking systems, provide a reference level for setting the sensitivity of receivers and activate shaker tables for component testing. ▲

REFERENCES

1. Culver, C. A.: "Musical Acoustics," McGraw-Hill Book Co., pg. 86.
2. Bennett, W. R.: "Electrical Noise," McGraw-Hill Book Co., pg. 14.
3. Terman, F. E. & Pettit, J. M.: "Electronic Measurements," McGraw-Hill Book Co., New York, pgs. 353-379.
4. Olson, H. F. & Belar, H.: "Aid to Music Composition Employing a Random Probability System," AES Convention paper No. 188.
5. Edwards, L. E., et al.: "White-Noise Manual, Featuring the Sounvistor White-Noise Diode," Solitron Devices, Inc.

Over-all view of adapter built into 5½"x 3"x 1¼" chassis.

FM STEREO MULTIPLEX ADAPTER

By CARL A. HELBER

Construction of simple switching adapter that requires no special coils or critical components. Inexpensive, general-purpose "p-n-p" type transistors are employed.

MANY articles have appeared in recent literature concerning FM stereo multiplex principles and a few have covered the construction of such adapters. In general, the construction articles have dealt with the more complex filter-type circuits wherein the L+R and the L−R signals are separated, processed, and then matrixed to yield left and right signals. Specially designed coil kits have been used in the construction of these adapters.

The purpose of this article is to describe a simple transistorized FM stereo multiplex adapter that requires no special coils or other components. Standard TV width coils are used. None of the components is critical and the transistors may be general-purpose *p-n-p* units such as the *Motorola* 2N1191.

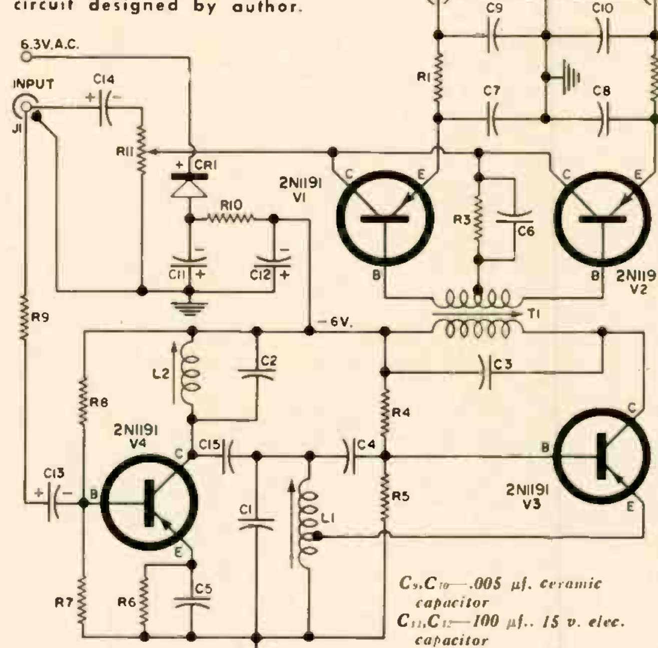
The principle upon which operation of this adapter is based is that the composite stereo signal (not including the pilot) can be considered to be the result of alternately sampling the left and then the right stereo channels at a 38-kc. rate. This being the case, restoration of the original pair of signals can be achieved by synchronously sampling the composite signal by means of two switches—one operating in effect in-phase with the left channel sampler at the transmitter and the other in-phase with the right sampler. The only filter required in this arrangement is for separation of the 19-kc. pilot signal which, after frequency doubling, becomes the switch-driving voltage. A mathematical analysis of the switch-sampling operation shows that ideally the sampling should occur precisely at the peak of the 38-kc. switching waveform used at the transmitter. Also ideally, this sample should be of infinitesimal width and should be held until the next sample is taken. Practically, it can be shown that the effect of increasing the switch on-time is to reduce the channel separation but that better than 26 db can be achieved with on-times of one-sixth of a cycle or less. Theoretically, only about 7-db separation can be achieved with one-half cycle on-time.

Basically the circuit shown in Fig. 1 consists of a single-pole, double-throw electronic switch synchronized with the second harmonic of the 19-kc. pilot signal. Transistors V_1 and V_2 are the switches and are connected in the usual inverted configuration commonly used with germanium transistors. The 38-kc. switching signal is applied between the base and the collector of the transistor. These *p-n-p* devices are driven into saturation when the base is driven negative with respect to the collector. In this condition the transistor looks like a very low impedance between collector and emitter. The .001-µf. capacitor connected to the emitter is thus charged to a voltage equal to the signal level existing at the time the transistor is saturated. When the switching signal applied to the base reverses, the transistor is essentially biased off and looks like a very high impedance between collector and emitter.

The *RC* network in the base return lead develops a few tenths of a volt of positive bias to aid in keeping the unsat-

(*Continued on page* 104)

Fig. 1. Switching type adapter circuit designed by author.



R_1,R_2—15,000 ohm, ½ w. res.
R—10,000 ohm, ½ w. res.
R—220,000 ohm, ½ w. res.
R,R—22,000 ohm, ½ w. res.
R—1500 ohm, ½ w. res.
R—100,000 ohm, ½ w. res.
R—5600 ohm, ½ w. res.
R_{10}—2700 ohm, ½ w. res.
R_{11}—6800 ohm carbon pot
C_1,C_5—.033 µf. paper capacitor
C—.005 µf. paper capacitor
C—.003 µf. paper capacitor
C—.01 µf. paper capacitor
C,C,C—.001 µf. ceramic capacitor
C_9,C_{10}—.005 µf. ceramic capacitor
C_{11},C_{12}—100 µf., 15 v. elec. capacitor
C_{13}—3 µf., 15 v. elec. capacitor
C_{14}—30 µf. 15 v. elec. capacitor
C_{15}—330 µµf. ceramic capacitor
L_1—Variable inductor, .3-3 mhy. tapped width coil (J. W. Miller 6320)
L_2—Variable inductor, 4-30 mhy. width coil (J. W. Miller 6315)
T_1—Tunable transformer 3.2-9 mhy. with a.g.c. winding (J. W. Miller 6317)
CR_1—1N60 germanium diode
J_1,J_2,J_3—Phono jack
V_1,V_2,V_3,V_4—"p-n-p" transistor (Motorola 2N1191 or equiv.)

VIBRATO SIMULATOR

Construction of a very simple, low-cost transistorized circuit that may be employed with musical instrument amplifiers in order to produce an effective vibrato.

By FRED IPPOLITO, JR.
Supervisor, Technical Publications, Sylvania Electronic Systems

THIS article describes the design and construction of a simple, low-cost, transistorized vibrato simulator which can provide most musical instrument amplifiers with a vibrato effect. Although this unit was built primarily for use with an electric guitar, it can be used for other musical instruments which have amplifiers. When used in conjunction with a guitar and amplifier, it produces a pleasant sounding amplitude-modulated signal; very similar to the effect of varying the volume control on the guitar.

Perhaps the term "tremolo" should be used, since an amplitude-modulated signal is produced, but somehow this suggests a rapid tremulant action which is not the effect this unit provides. The writer feels that this unit more closely simulates the subtle effect of a vibrato, especially at the very slow speeds it is capable of producing.

The vibrato simulator (see Fig. 1) is battery-operated, completely self-contained, and measures only 3¼" x 2⅛" x 1⅝" in size. No external power source is required and no circuit modifications to the amplifier are necessary. Installation of the unit consists of plugging it into the amplifier and plugging the instrument into the unit. The current drain on the battery is so low that in normal use the life of the battery should approach its shelf life.

Two controls are provided; one for adjusting the desired intensity and the other for adjusting the speed. A foot switch is also provided so that the musician can switch the vibrato effect in or out while playing.

Construction costs are small, less than ten dollars, even when all the parts are purchased. The builder will probably have some parts available, and the costs can be reduced further by variations in application and construction techniques which are discussed later.

The Circuit

The schematic diagram is shown in Fig. 2. Transistor V_1 is used in a sub-audio phase-shift oscillator circuit to produce the vibrato speed or frequency. Transistor V_2 is used in a voltage-divider network to modulate the incoming signal. The circuits for these transistors are interesting and rather unconventional.

Phase-shift oscillators are not as commonly used in transistor circuits as in vacuum-tube circuits. The primary reason is that phase-shift oscillators require high-gain amplifiers to overcome the losses in the *RC* feedback network. Although there is a wide variety of high-gain transistors available, it is their input-output characteristics that cause the problem. In the required common-emitter configuration, the transistor has a relatively high collector output impedance and a very low base input impedance. The use of the conventional feedback network of three equal-value resistors and capacitors, where the resistors are a high value, introduces an impedance mismatch at the base. This condition further increases circuit losses and the need for a high-gain amplifier.

The oscillator circuit used in this unit compensates for these conditions through the use of a tapered feedback network, where the resistance in each leg of the network (R_1, R_2, and R_3) is reduced going from the output of the transistor to the input. The *RC* constant is maintained, however, by increasing the value of capacitors C_1, C_2, and C_3 accordingly. This configuration provides a better impedance match for both output and input of the transistor and thereby reduces the losses normally encountered in transistor phase-shift oscillator circuits.

The effectiveness and efficiency of this oscillator is remarkable. Using a 15-volt battery, the sine-wave output signal at the collector is 8 volts peak-to-peak, with a current drain on the battery of only 300 μa. Further, this configuration allows the use of common variety low-cost transistors. In testing the circuit, the writer used at least ten 2N1265/5 transistors, with each providing satisfactory results. Although a 15-volt battery is used to provide sufficient output for this application, the circuit will oscillate with a voltage of 9 to 12 volts.

The oscillator frequency for this type circuit can be calculated using the formula: $f = 1/(2\pi RC\sqrt{3})$. With this formula, component values for the *RC* network of this circuit were picked for a frequency of 6 cps, since this is the most commonly used frequency in commercially available units and in electronic organs. Potentiometer R_2 provides for an oscillator range of approximately 4 to 14 cps. Resistor R_4 prevents oscillator cut-off at the maximum clockwise rotation of R_2, which is the fastest speed.

Capacitor C_4 couples the oscillator signal to potentiometer R_6, which is used to adjust the vibrato intensity. Switch S_1 is a momentary d.p.s.t. (normally open), used to make and break both the oscillator and modulator circuits. The switch is mounted in a plastic door stop (see construction details) and is used as a foot switch so that the vibrato effect can be switched in and out while the musician is playing the instrument.

Transistor V_2 is used as a variable resistance, in a voltage divider network consisting of R_8 and the combined resistance of R_9 and V_2. The input signal at J_1 is applied across this network while the output signal at P_1 is that which is developed across R_9 and V_2. With no oscillator signal applied to the base of V_2, the incoming signal from an electric guitar (usually 1 volt peak-to-peak max.) is divided almost equally between the resistance of R_8 and R_9, since each is 100,000 ohms. V_2 offers very little resistance to this small a signal, since its leakage current is much greater than the signal current flowing in the network. Applying the oscillator signal to the base of V_2 causes it to act as a switch. When the oscillator signal applied to the base is positive, the transistor is "off," that is, both diodes of the transistor, collector-to-base and emitter-to-base, are reversed-biased. In this condition the transistor acts as a resistance much greater than R_8 and the incoming signal appears almost entirely across R_9 and V_2. When the signal at the base swings negative, the transistor is "on." In this condition, the transistor is forward-biased and acts as a very low resistance, so that the incoming signal is essentially divided between R_8 and R_9.

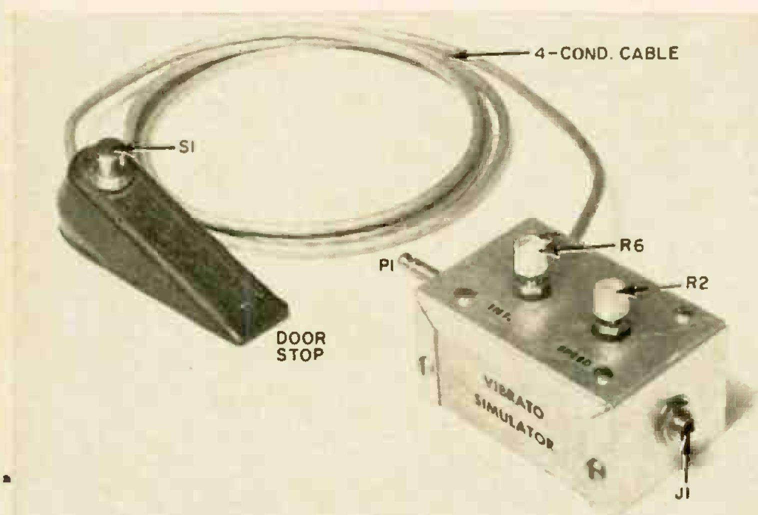
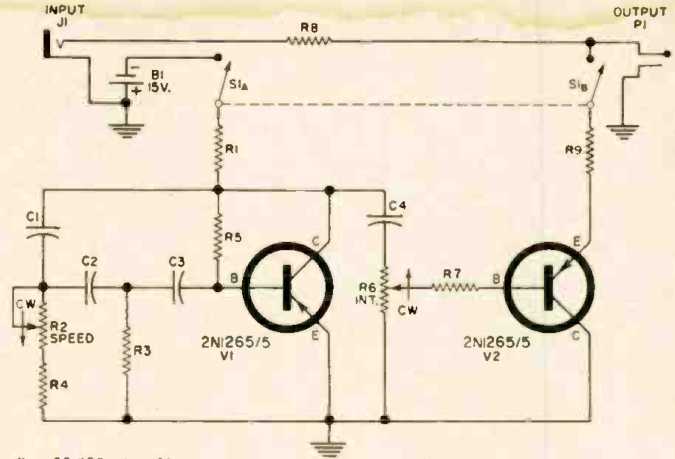


Fig. 1. Over-all view of vibrato unit and its foot switch.



R_1—30,000 ohm, ½ w. res.
R_2—10,000 ohm pot (Philmore PC-51 or equiv.)
R_3—3300 ohm, ½ w. res.
R_4—3000 ohm, ½ w. res.
R_5—620,000 ohm, ½ w. res.
R_6—500,000 ohm pot (Philmore PC-54 or equiv.)
R_7—470,000 ohm, ½ w. res.
R_8, R_9—100,000 ohm, ½ w. res.
C_1—.5 μf. capacitor (see text)
C_2—1.5 μf. capacitor (see text)
C_3—5 μf. capacitor (see text)
C_4—.05 μf. ceramic disc capacitor
B_1—15-volt battery (Eveready 411 or equiv.)
S_1—D.p.s.t. momentary push-button switch (normally open)
P_1—Flat-type phone plug (Switchcraft 220 or equiv.)
J_1—Phone jack (Switchcraft L-11 or equiv.)
V_1, V_2—2N1265/5 transistor (Sylvania)
1—3¼" x 2⅛" x 1⅝" chassis (Bud CU-3001A or equiv.)
1—5-foot, 4-conductor shielded cable (Belden 8434 or equiv.)
1—Foot switch case (plastic door stop, see text)

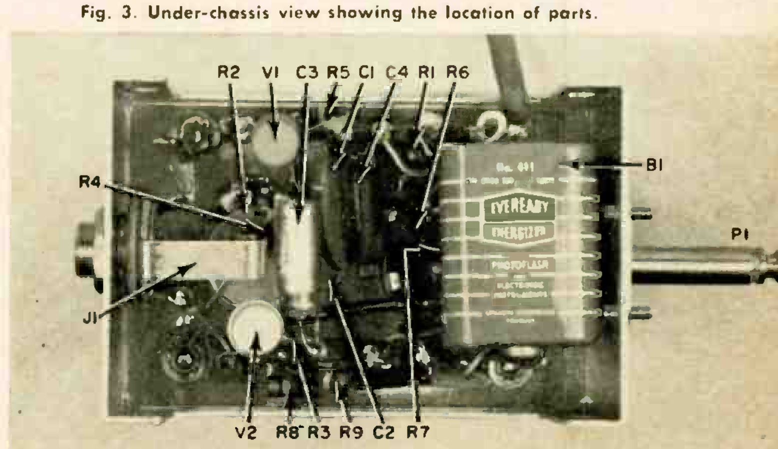
Fig. 2. Circuit diagram for the simple 2-transistor unit.

It can now be seen that the output signal appearing at P_1 which is fed to the instrument amplifier, will vary in amplitude at a rate equal to the oscillator frequency. Transistor V_2 does not act exactly as a switch with only a full "on" or full "off" condition. It responds to the magnitude of the sine-wave signal applied to its base. Therefore the per-cent of modulation or intensity can be adjusted through R_6. The values of R_8 and R_9 (100,000 ohms) were chosen for this unit to provide up to 50% modulation. Raising the value of R_9 will decrease this percentage while lowering the value will increase it. Changing the value of R_8 will also accomplish the same but in the reverse of the above conditions.

It is more desirable to keep the values of R_8 and R_9 high enough so that the resistance of V_2 in the circuit is negligible when no signal is applied to its base. There are two reasons for this. First, a transistor is a non-linear resistance and second, both diodes, collector-to-base and emitter-to-base, in a transistor are not symmetrical. Both of these characteristics can cause amplitude distortion which is detectable on a scope, even though not noticeable to the ear. Resistance values above 50,000 ohms for 2N1265/5 transistors are acceptable, while values of 100,000 ohms seem to be optimum. This holds for input signals up to 5 volts peak-to-peak. For greater input

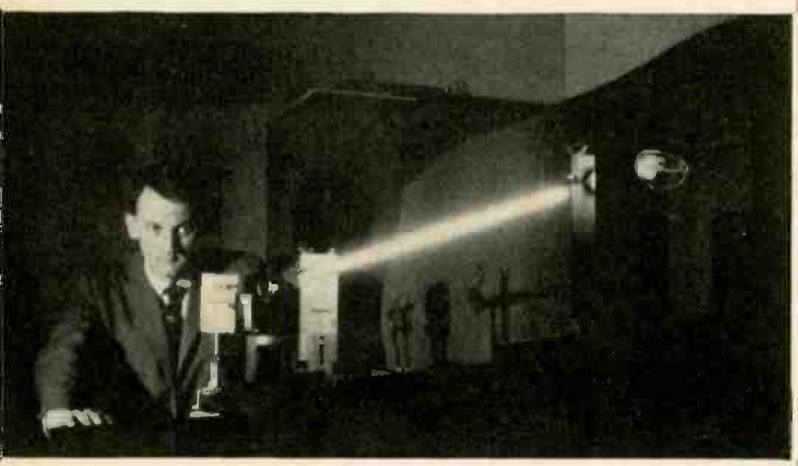
(*Continued on page* 76)

Fig. 3. Under-chassis view showing the location of parts.



RECENT DEVELOPMENTS IN ELECTRONICS

Laser Doppler Radar →
A modified interferometer using a laser as an energy source makes up a laboratory model of what Sperry Gyroscope Co. calls the first laser doppler radar. Engineers bouncing the laser beam off three small mirrors into a detector said they have proved the feasibility of a doppler radar that can detect and measure motion 10,000 times more accurately than the best microwave systems known. Such a radar could measure velocity from speeds of 5 miles per second all the way down to less than 1/10,000 inch per second. The development shows promise for broad application as a space vehicle rendezvous aid for tracking satellites.

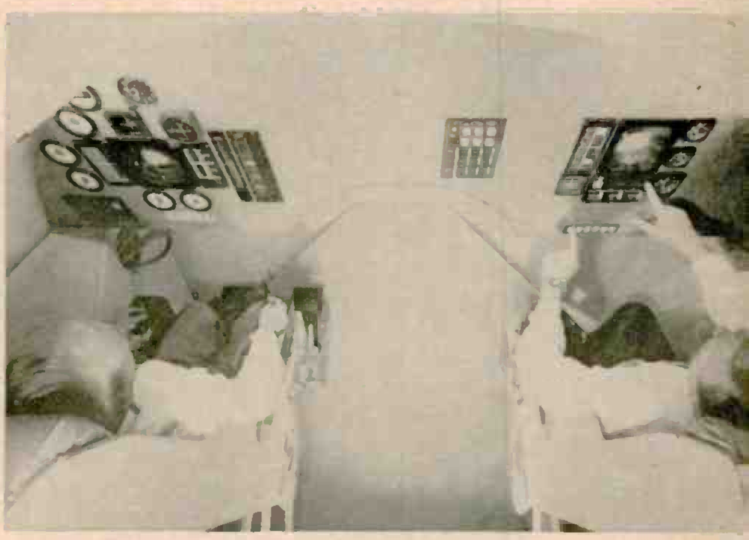


← New Gaseous Optical Masers
Engineer at Bell Telephone Laboratories is shown checking the alignment of helium-neon gaseous optical maser designed to emit coherent radiation in the visible spectrum. Reflecting mirrors in this new device have dielectric coatings which encourage maser radiation at 6328 angstroms. Previous optical masers of this type have produced beams of energy in the infrared and higher invisible energy portions of the spectrum. In addition, five new gaseous optical masers, each using a different pure noble gas as the active medium, have been announced. The masers, using helium, neon, argon, krypton, and xenon, emit continuous beams of coherent radiation at a total of 14 different frequencies.

Superconductive Magnet →
Experimental superconductive solenoid magnet, using niobium-tin windings made by a new RCA-developed process, is shown being lowered into a liquid helium bath prior to testing. Announcing the establishment of a new applied research laboratory to perfect techniques for mass-producing such magnets, the company said the magnets and other niobium-tin devices will eventually form the basis for "a vast new company business." Having no resistance to the flow of electric current and, therefore, requiring only enough power to get them started, superconductors are expected to lead to advances in electric and electronic technology.

← Computer-Controlled Borer

A numerically controlled jig borer, directed by a punched tape produced by an IBM computer, automatically machines a part used in a space exploration device. A new computer language, called "Autospot," was used to write a program which enabled the computer to generate the tool instructions in a fraction of the time required to prepare them manually.



Helicopter TV Pickup ↑

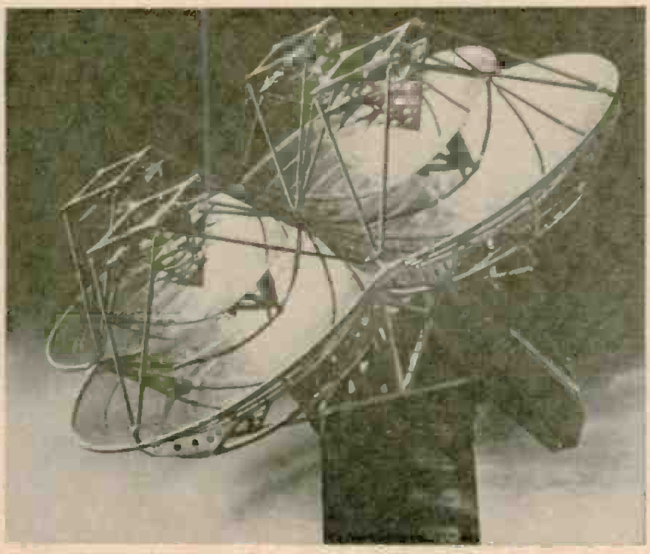
TV crew works at last minute adjustments as Air Force Sikorsky S-61 gets ready to take off from United Nations lawn in New York. Cameras aboard helicopter caught U.N. Building and New York skyline for recent "Telstar" broadcast to Europe. Microwave dish, right, caught signals from aircraft and transmitted them to central control for relay.

"Apollo" Instrument Mockup ↑

Mockup is used by Honeywell engineers to test experimental instrumentation for stabilization and control system of the 3-man moon vehicle. Instruments are controlled by analog computers that electronically simulate conditions that will be encountered on "Apollo's" space mission.

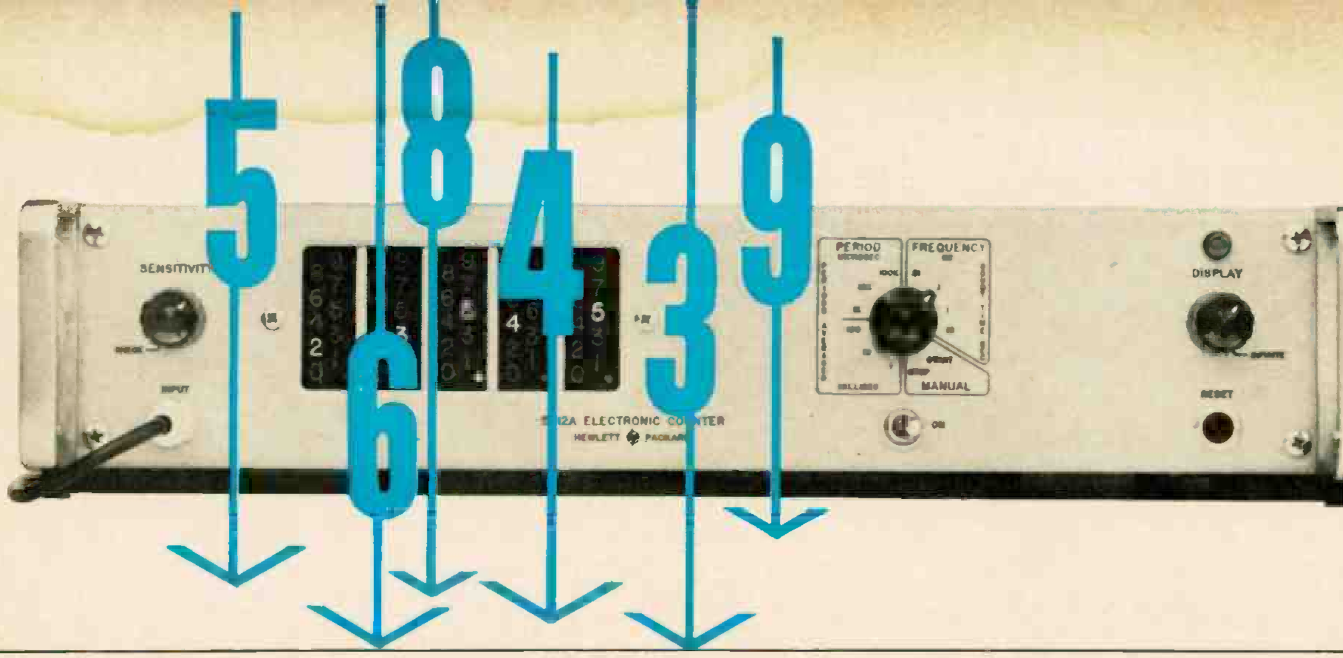
Wide-Band Multipurpose Antenna

Shown below is a new multipurpose antenna system with a bandwidth of 200 to 2300 mc. The antenna, developed by Radiation Inc., handles telemetry, surveillance, and communications signals. Closely spaced reflectors are combined with log-periodic feeds in the 20′ diameter array. ↓



Car-Noise Telemetry

To trace the source of noise or vibration, Volkswagen engineers will telemeter noise signals from a test car on the road to receiving equipment in a following vehicle. Transmitter and noise mike of the Bendix-designed gear are shown in car; recording receiver is in foreground. ↓



the Counter as a Test Instrument

THE simplest way to determine the frequency of a signal would be to use an accurately calibrated radio receiver and then read the frequency directly from the receiver's dial. Another method would be to display the signal on an oscilloscope. If the sweep frequency is known, it is possible to count the number of cycles displayed and calculate the frequency. Still another way is to beat the known-frequency output of an oscillator against the unknown signal and determine the latter by the zero-beat technique.

A much more precise and faster way of measuring frequency is with a digital counter. The unknown frequency is applied to the counter which displays it directly in Arabic numerals in cycles, kilocycles, or megacycles. In addition, time intervals can be measured directly and with great accuracy. The counter is extremely helpful where repeated measurements and accuracies up to five places are required. Such advantages are not usually possible with other instruments or methods. For these reasons, counters are widely used in industrial and military applications where precision measurements are important. Counters are often used when servicing computers and certain radar circuits.

The counter consists of four sections as shown in Fig. 1. The binary-counter section is a series of flip-flops connected so that two changes in one stage cause one change in the following stage. The second portion, the clock-pulse generator, is a well-stabilized, crystal-controlled oscillator whose output is the time reference for the instrument. The third portion consists of gates (similar to those used in keyed a.g.c. circuits) in which one signal gates or keys another one. The fourth part is a read-out device. This may be a series of neon indicators wired into the binary counter to indicate the number registered there. Or, it might be a series of "Nixie" indicator tubes driven by a binary-decimal matrix that changes the binary number of the binary counter into a decimal for display in Arabic numerals. A typical counter may contain a number of binary counters, auxiliary storage-shift registers, and circuits that generate multiples and sub-multiples of the clock frequencies.

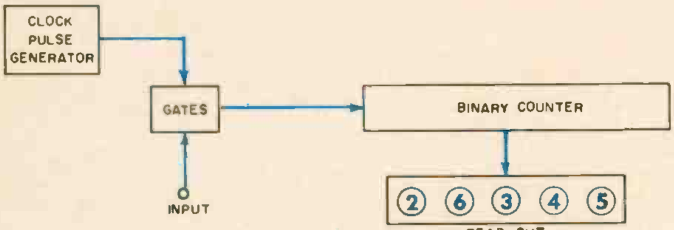


Fig. 1. Block diagram of a counter shows its basic sections.

The functions that can be performed by the counter depend on how the clock, binary counter, and gates are connected. To measure the unknown time interval between two pulses (for example 18 μsec. in Fig. 2) 1-μsec. clock pulses are fed into the binary counter through a gate that is turned on by the first pulse and turned off by the next one 18 μsec. later. The number in the binary counter, therefore, is the number of 1-μsec. clock pulses between the two input pulses. Since 1-μsec. clock pulses were used, the read-out will be in microseconds.

If each cycle of the unknown signal is counted by the binary counter and the gate is turned on for exactly one second the display would be the input frequency in cps.

Further applications of the counter are discussed below. In all cases the precision of the measurements depends on the accuracy of the clock-pulse generator. For this reason the clock oscillator usually is controlled by a crystal housed in a temperature-stabilized oven. It is necessary to allow at least half an hour warm-up time before making any measurements. Aside from the clock, all other circuits are digital, which means that they are either on or off, require no adjustment, and cannot contribute significantly to inaccuracy.

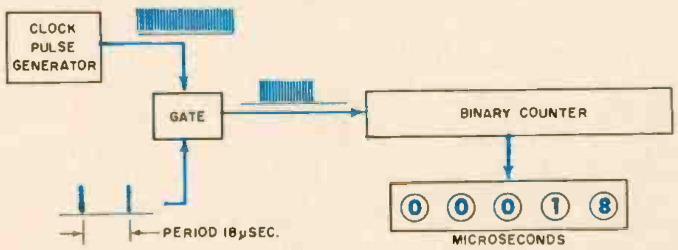


Fig. 2. Opened gate sends 18 one-μsec. pulses to the counter.

How They Are Used

As we mentioned, counters are widely used for frequency and time measurements. They have one great advantage over oscilloscopes in these applications in that they provide a direct indication that does not have to be interpreted. It is also possible to connect a digital printer to the counter to obtain a printed record of periodic readings. In checking the frequency stability of an oscillator, for example, the

By WALTER H. BUCHSBAUM, Industrial Consultant, ELECTRONICS WORLD

In addition to counting pulses, counters measure frequency and its periodic drift, phase difference, and the time interval between events.

counter and printer would be connected as shown in Fig. 4 to automatically print a record of frequency drift every ten seconds. In some newer models, the printer is part of the counter. If a counter is connected to a radiation detector, the radiation level in counts-per-minute can be monitored.

It should be obvious why counters are used widely in servicing computers and data processing devices. In these applications they can check the operation of sections of the computer, measure time intervals between gating and switching functions, and verify the computer's own counting operations. By using a preset count arrangement, the counter can work with other devices to provide an output whenever a predetermined number of events has occurred. For example a counter might be connected to a photocell to count the number of objects passing a point. After a predetermined count is reached, the counter can send a pulse to an actuator which will separate or pack the first batch. The next object would start the count over again.

It is possible to measure the phase difference between two signals or simply indicate the time period between them as shown in Fig. 5. One signal is connected to the "start" input of the gating circuit to turn it on. Clock pulses will now go to the binary counter. The second signal is connected to the "stop" input of the gate to turn it off. The number displayed represents the time period between the two signals.

In each case a direct read-out in microseconds or milliseconds is possible. A further refinement available in practically all counters is count averaging. In this mode of operation, the measurement cycles, usually 10 or 100, are added and the total is divided by the number of cycles.

Counters are available with different frequency and time-interval ranges. In their early stages of development, counters with a 100-kc. basic clock-pulse frequency were used for frequency multiplying up to 1 mc., which meant that the most accurate measurement that could be made was within ± 1 μsec. Today counters with clock-pulse frequencies up to 100 mc. permit measurements to within 0.01 μsec.

Fig. 3. Hewlett-Packard 5243L measures frequency to 500 mc.

The frequency and time range of the counter are but two of its important performance characteristics. Oscillator stability, which assures the accuracy of all measurements, is usually given in parts-per-million per week and is generally better than 1 p.p.m./week. Another important characteristic is the input sensitivity and impedance; this determines what kind of signals can be measured. Typical values are 0.1 volt r.m.s. at an input impedance of 1 megohm, shunted by about 50 μμf. That is the minimum-level input signal. However, a gain control for each input is usually available to permit the measurement of voltages up to about 300 volts. The counter will also have a scale-factor switch that automatically locates the decimal point in the read-out. A switch permits selection of the various functions such as frequency or period measurements, phase difference, or averaging. It's possible to make a single count, requiring manual reset for the next. ▲

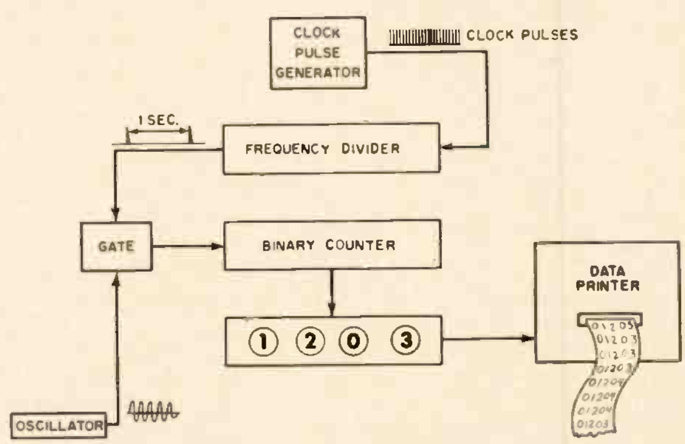


Fig. 4. Method of measuring oscillator frequency stability.

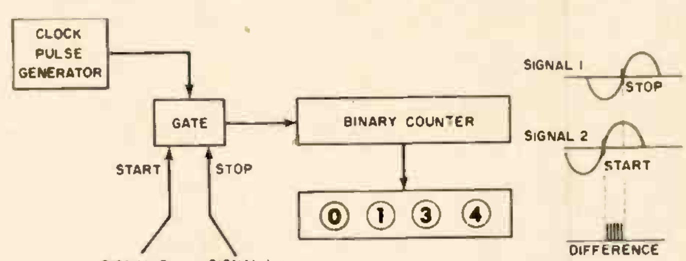
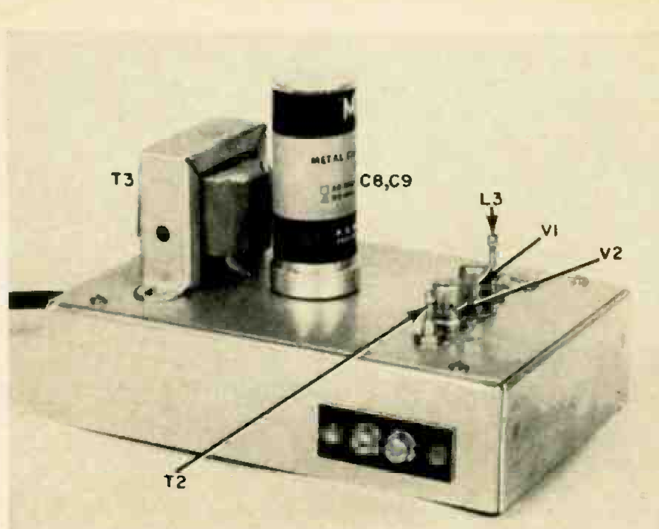


Fig. 5. Technique for measuring two-signal phase difference.

WIDE-BAND FM BOOSTER

By R. J. DICKSON

Complete construction details on a simple, stable two-nuvistor r.f. preamplifier having a gain of 15 decibels along with a very low noise figure.

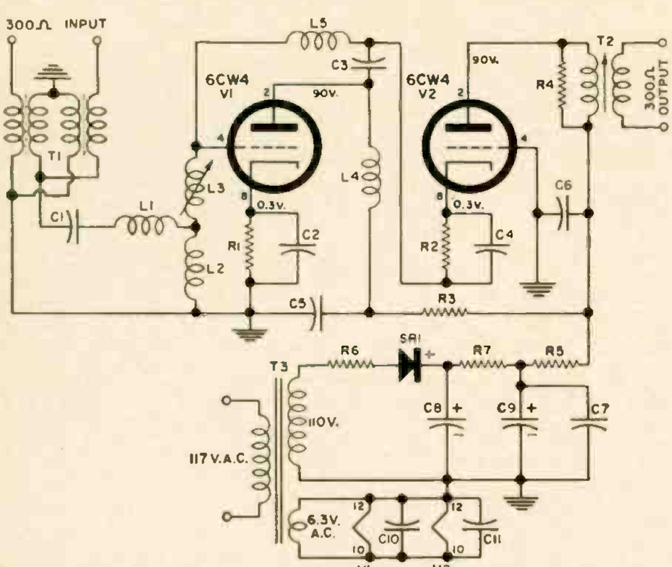


Booster was built on an aluminum chassis measuring 6" x 4" x 2".

WITH the advent of FM multiplex stereo broadcasting, interest in FM reception received a tremendous impetus. Although it is anticipated that in the next five years most FM stations will go to stereo, those now broadcasting stereo number less than 140. Unless the stereo fan lives near the larger metropolitan areas, he will probably encounter only one or two stations at the present time.

If stereo reception is desired from a distant station, it will be necessary to own a tuner with excellent sensitivity, or to improve the antenna system presently being used. Conservative estimates of signal-to-noise degradation for stereo reception range from 13 to 20 db for a given signal. The wide-band booster described in this article may be the solution to the problem of receiving stereo without objectionable background noise from distant stations. Possibly the FM listener is not yet equipped for stereo and is only interested in improving his monophonic reception, as was the case with the author.

Fig. 1. Complete schematic of the 2-nuvistor cascode preamp.



R_1, R_2—47 ohm, 1/4 w. res.
R_3, R_5, R_6—100 ohm, 1/4 w. res.
R_4—12,000 ohm, 1/4 w. res.
R_7—3000 ohm, 2 w. res.
C_1—10 µµf. capacitor
C_2, C_4, C_5, C_6, C_{10}, C_{11}—510 µµf. capacitor
C_3—270 µµf. capacitor
C_7—.01 µf. capacitor
C_8, C_9—50/50 µf., 150 v. elec. capacitor
L_1—Approx. .075 µhy. (see Table 1)
L_2—Approx. .06 µhy. (see Table 1)
L_3—Approx. .1 µhy. (see Table 1)
L_4—Approx. .25 µhy. (see Table 1)
L_5—Approx. 3.9 µhy. (see Table 1)
SR_1—Silicon rectifier, 400 p.i.v., 500 ma.
T_1—Balun coil (Coleman #1360 or equiv., see Table 1)
T_2—See Table 1
T_3—Power trans. 117 v. pri., 110 v. @ 30 ma. sec., 6.3 v. @ .6 a. (Olson T-173 or equiv.)
V_1, V_2—6CW4 nuvistor

Using this booster ahead of an old-vintage FM receiver of limited sensitivity really improved its ability to provide excellent reception on distant stations. This booster was tested on a recent model tuner with an advertised sensitivity of less than 1 µv. of signal for 20 db of quieting. Stations at distances of over 100 miles came in at varying degrees of limiting whereas, without the booster, they often were lost in the noise level.

Boosters using 5842/417A (low-noise frame-grid tubes) have previously been constructed using this same circuit with excellent results. Gain figures of up to 25 db and noise less than 3 db are possible with tubes in this class, but the price of these tubes ($8.00 to $15.00) discourages their use. Nuvistors are becoming very popular and approach frame-grid tubes in noise figures, so the idea of trying a pair of 6CW4 nuvistors in this proven, reliable circuit was tempting. Considering the advantages of nuvistors (low cost, small physical size, low power requirements), the project was definitely worthwhile.

Circuit Description

Two 6CW4 nuvistors are utilized in an improved fixed-tuned wide-band cascode amplifier which provides stable power gain with a very low noise figure of less than 3.5 db. Over 15 db of usable gain, within ± 2 db, is possible from this booster over the entire FM band. See Fig. 1.

Inductors L_1, L_2, and L_3 comprise a "T" network which contributes to the low noise figure and wide-band characteristics of this booster. Inductor L_5 provides neutralization, maintaining the low noise figure at these high frequencies by neutralizing the grid-to-plate capacitance of nuvistor V_1. L_5 is not critical and its value can range from 2.7 to 4.7 µhy. Plate inductor L_4 resonates with the output capacitance of V_1 plus the input capacitance of V_2.

T_1 is a balun coil which permits a 300-ohm, twin-lead balanced antenna system to be used with the "T" coil unbalanced input. A balun coil can be purchased at most electronic supply outlets, but can be constructed by following the instructions in Table 1 and Fig. 2. If the FM antenna system in use is unbalanced (uses coax for lead-in), then T_1 is unnecessary and can be eliminated. Connect the coax center conductor to C_1 and connect the coax shield to the booster chassis.

The individual inductance values of L_1, L_2, and L_3 are so small that it is doubtful if commercial units can be found, therefore, they must be constructed, following the instructions in Table 1. L_3 and T_2 are wound on 1/4" slug-tuned coil forms. T_1 is wound on a powdered-iron slug, or as in the author's case, two slugs glued together. All other inductors (L_1, L_2, L_4, and L_5) are wound on *Allen Bradley* 1/2-watt carbon resistors. The value of the resistor is unimportant, as long as a value above 0.5 megohm is chosen. Any resistance value below this will tend to lower the "Q." Other forms can be used in place of the resistors, but make certain the diameter is ⅜", otherwise the coil winding data in Table 1 will not be valid.

Resistor R_1, across the primary of T_2, is not very critical and can be eliminated if more gain is desired, but at a slight reduction in bandwidth.

Power requirements for this booster are very low. Filament voltage is 6.3 volts @ .26 ampere. Plate voltage is not critical and can range from a low of 60 to 70 up to 100 to 110 volts at about 16 ma. Power transformers which will provide these voltages can be purchased from several electronic firms for approximately $1.50. If a 2" x 3" space is available on the new receiver or tuner with which this booster is to be used, serious thought should be directed towards building the booster permanently into the existing equipment and utilizing its power supply.

Construction

The booster was constructed on an aluminum chassis 6" x 4" x 2" with a tin-plated top. This allows direct chassis soldering of the nuvistor sockets, resistors, inductors, and r.f. bypassing capacitors.

Photos show the mechanical layout. Layout and placement of parts is not too important, but be sure to keep all plate and grid leads as short as possible.

Construction details should be followed very closely for all r.f. chokes and transformers. A high-quality, high-frequency adjustable ¼-inch coil form should be used for L_3 and T_2.

Measure all lengths of wire very carefully to the exact number of inches specified in Table 1. Scrape all insulation away exactly ¼" on each end of all wires. (This ¼" for connection and soldering purposes has been allowed for.) File a small "V" notch on each end of the ½-watt resistor body for ease in winding. A kink found useful in winding the chokes was to bend one end of the resistor's pigtail into the shape of a "key" handle. This allows the resistor to be rotated with one hand while the wire is fed on in "lathe" action by the other hand.

When winding T_1, it is convenient to use two different colored #28 wires for identification purposes. Wind the two different colored wires on one end feeding both at the same time. When six turns are completed, apply coil dope or clear fingernail polish and wait until completely dry before winding the other end.

Adjustments

If the receiver or tuner to be used in conjunction with the booster contains a signal-strength meter, this can be used in the alignment. A v.t.v.m. can be used in place of the signal-strength meter. Connect the v.t.v.m. to the a.g.c. line in the receiver or tuner and set it for low negative d.c. voltage. Use a short piece of 300-ohm twin-lead from the output of the booster to the antenna input of the receiver or tuner. Warm up both booster and receiver for at least 5 minutes. Tune in a weak station at or near 94 mc. Adjust coil L_3 for a maximum on the meter. Now tune to about 102 or 103 mc. for a weak station and adjust the slug of T_2 for a maximum signal reading on the meter. Note: Two points should be found where the slug of T_2 will cause a maximum; choose the one where the slug is between the primary and secondary windings for best results. This is all the alignment necessary; sweep-generator alignment is not required.

Considerable increases in gain can be attained if the user wishes to sacrifice bandwidth by peaking both L_3 and T_2 near the center of the FM band (98 mc.). Performance of the booster can be judged to a fair degree by the increase in a.g.c. voltage readings. Select a station near the center of the band which has a low a.g.c. voltage of about −1 volt without the booster. Connect the booster and re-monitor this same station's a.g.c. It should increase to at least −4 or −5 volts.

If the booster does not perform as required, voltage checks should be made. Each nuvistor cathode should measure approximately .3 volt d.c. Plate voltage should measure approximately 90 volts, with the power transformer specified.

A grid-dip meter is a very useful tool in troubleshooting. Couple it loosely to L_3. A dip should occur at or near 94 mc. The primary winding of T_2 should also indicate a dip at or near 102 mc. All chokes and transformers have been carefully measured in inches and AWG wire size to give excellent results if the coil table winding data is followed very carefully. Three such boosters have been constructed from this data and they all worked perfectly after a slight adjustment of L_3 and T_2 slugs. ▲

PART	COIL FORM	AWG SIZE	WIRE LENGTH	SPACING & NO. TURNS
L_1	½-w. Allen Bradley res.	#20 en.	4½"	7 t. close-spaced
L_2	½-w. Allen Bradley res.	#20 en.	3½"	5 t. close-spaced
L_3	¼" dia. slug-tuned coil form	#26 en.	5"	4¾ t. spaced approx. ⅛" between turns
L_4	½-w. Allen Bradley res.	#26 en.	6"	11 t. close-spaced
L_5	½-w. Allen Bradley res.	#38 en.	20"	42 t. close-spaced
T_1	¼" x ¾" powdered-iron slug	#28 en.	7"	6 double t. close-spaced on each end; allow ¼" separation between sections
T_2 (Pri.)	¼" dia. slug-tuned coil form	#28 en.	7"	7 t. close-spaced
T_2 (Sec.)	¼" dia. slug-tuned coil form	#28 en.	5"	5 t. close-spaced; allow ⅛" separation between sections

Table 1. Coil-winding data for the home-built nuvistor preamp.

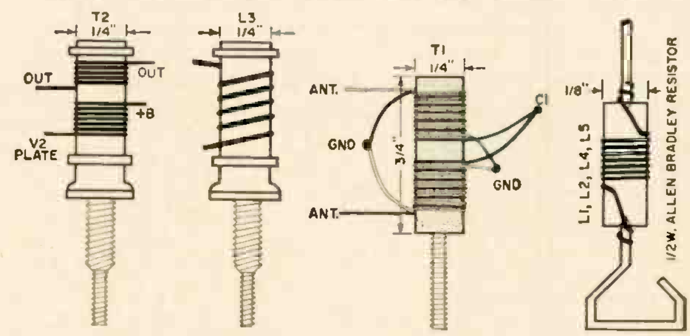
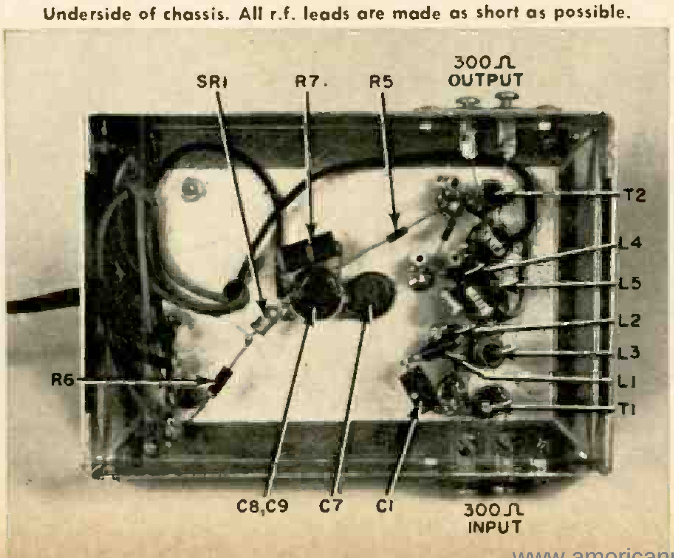
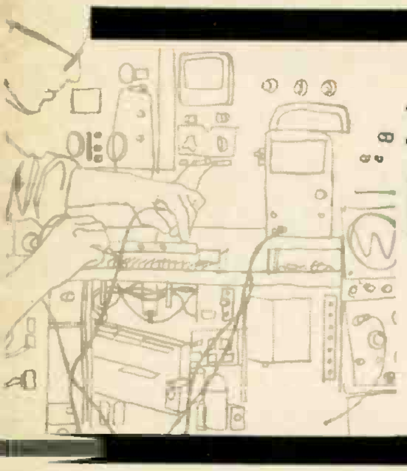


Fig. 2. Construction details of coils and r.f. transformers used in the booster. One lead of the resistor coil form is bent in the form of a key handle for ease in winding coil.

Underside of chassis. All r.f. leads are made as short as possible.





MAC'S ELECTRONICS SERVICE

By JOHN T. FRYE

Intermittent Roundup

BARNEY'S Irish temper had a short fuse, and it was sputtering. "Doggone these intermittent radios that refuse to 'intermit,'" he fumed. The owners don't give them any kind of a check. The first time the set refuses to come on when they turn the switch, they grab it up under their arm and gallop down here and tell us it's dead. We put it on the bench, and it plays perfectly for hour after hour in spite of our doing everything we can to make it cut out. Then we don't know if the plug simply wasn't in the wall socket firmly, or if there really is something wrong with the set that refuses to show up here but will likely rear its ugly head immediately the set is back home."

"My heart bleeds for you," Mac said with mock sympathy. "Intermittents waste more of the service technician's time than any other radio or TV fault. Anything that helps him cope with this familiar demon fattens his pocketbook, preserves his temper, aids his digestion, and doubtless improves his chances of eventual salvation. Suppose you put that thing on about 125 line volts while we sort of review what we know about intermittents and their cure."

Barney plugged the radio into the isolation transformer and adjusted the transformer for 125-volt output.

"Let's start by defining an intermittent as a radio or TV set that intermittently performs poorly, with intervals of normal operation in between," Mac began. "The poor performance can take the form of either partial or complete loss of sound or picture, of distortion of sound or picture, or of noise appearing in the sound or picture. The 'distortion' in a radio could well be a crackling, whistling, or motorboating; while in a TV set it could take the form of a loss of sync."

"Your definition is broad enough," Barney said impatiently as he glowered at the perfectly playing little radio; "let's get down to cases."

"A very common type is the *mechanical intermittent*," Mac said unhurriedly, pausing to light his pipe. "This is the one that can be made to reveal itself by jarring the set. The jarring may be caused by walking across the floor, by vibration of certain notes coming from the speaker, or by pounding the top of the cabinet in anger with the clenched fist. The cause is usually a loose connection, but search for the intermittent connection cannot be confined to poor solder joints. In addition, one may be found in such unsuspected places as connections inside the tube, at the contact of a tube pin with the socket, where a capacitor lead connects to the foil, and so on.

"Finding one of these can be quite tricky, but skillful, *gentle* tapping of suspected tubes, capacitors, or wires with a pencil or similar instrument is the best method to use. The accent is on 'gentle' for two reasons: first, too strong a blow will vibrate other parts near the one struck and produce confusing indications; second, a heavy jar will bend capacitor leads or otherwise jam the parts of the poor connection together and produce a temporary cure that will make quick location of the trouble impossible.

"The *thermal intermittent* is just about as common. This is the intermittent condition that only shows up when the radio or TV chassis is in a certain temperature range. Sometimes the set plays perfectly until it warms up; then it starts misbehaving. In other instances the set will perform erratically until it becomes thoroughly warm, after which operation is completely normal until the set is turned off. A really nasty version is the set that performs normally when cool or warm, but during the warming-up process it passes through a comparatively narrow temperature range in which the intermittent condition is evident. By the way, turn that set off now and let it cool down. Set the transformer for about 100-volt output."

Barney did as he was told and then said, "I think I know the methods we use to handle thermal intermittents. What we try to do is keep the defective part in its critical temperature range until we can locate it. Sometimes this means covering the set up with a heavy cloth so that it gets hot in a hurry. Again we heat individual suspected parts by holding the tip of a soldering iron close to them or shining an infrared spotlight on them. If we think they have passed through the critical heat range, we cool them off rapidly by spraying them with pressurized refrigeration gas, such as 'Circuit Cooler.' Metering and signal tracing are often used in conjunction with this temperature manipulation so that we can isolate the temperature-sensitive component when we force it to tip its hand."

"Let's not forget that hybrid, the *thermo-mechanical intermittent*," Mac chimed in. "This is actually a mechanical intermittent that only shows up when the affected part is in a particular temperature range. Tubes and capacitors are notorious offenders in this group. You can tap them all you want when they are not in that heat range, and you will get no cutting out, noise, oscillation, or what have you. By the same token they will not cause trouble unless they are subjected to vibration while in that range. That's why these sets will often play perfectly at a low volume level but will misbehave frightfully when the volume is boosted. To ferret out these nasty little cross-breeds, we simply combine the methods used to locate mechanical or thermal intermittents.

"We can get a lot of help in running down any kind of thermal intermittent, if we will just use it, from timing. After a set is turned on, different parts heat up in predictable sequence. First the tubes get hot; then the current-carrying parts, such as resistors, coils, and filter capacitors warm up. Finally other parts, such as bypass and coupling capacitors, are warmed by the heat radiated from the tubes and resistors or conducted through the chassis.

"Keeping this in mind can be a great help in knowing where to look for a temperature-sensitive part. If trouble starts almost immediately the set is turned on, look for trouble in the tubes. If the intermittent shows up a few minutes later, look for a defective coil winding or a bad current-carrying resistor. When the difficulty only makes itself known after the set has been on for an hour or so, look for a defective coupling or bypass capacitor, especially those considerably removed from any heat-radiating component."

"I believe the worst of the lot are the *shock-triggered intermittents*," Barney said thoughtfully. "You know the ones I mean: the sets that can be thrown in and out of the intermittent condition by snapping a light switch anywhere in the house, by the refrigerator's cutting on or off, or simply by touching a test lead to any part of the circuit. The shock of the tiny pulse of signal that occurs when any of these events take place is all that is needed to throw the delicately balanced condition one way or the other.

"That sensitivity to being touched with a test lead is one

(*Continued on page* 80)

Construction of a multipurpose thyratron timer that can count up to 10 times per second, operate at preset times and intervals, and signal time intervals audibly.

By SILOM HORWITZ

Front-panel view of timer which was built into two hinged chassis.

VERSATILE PROGRAMMED TIMER

CALL it an "intervalometer," "time computer," or just a "multipurpose counter and timer," and you would be right in all three cases. This versatile timing instrument can count up to ten times per second, turn things on and off at pre-determined intervals, time operations and processes, signal time intervals audibly, take electrical samples, and perform many other timing functions. Of course, there are other devices available to do these things separately; the advantage of this instrument is that if times above 1/10 second are involved, you can program it to do the job. In addition, for all its versatility, it is not expensive to build.

One of the most interesting facts about electronic devices is that several very simple circuits can often be "stacked" to make up a complex instrument capable of doing many more tasks than the simple circuits could do separately. This instrument is made up of just two such devices: a slow-speed pulser which operates at up to 600 counts per minute and a timer which can close a circuit for a time interval up to several minutes. Yet together, these circuits provide a very flexible and versatile instrument that can do almost anything in the line of timing.

Let's look at the circuit of Fig. 1. That part which includes V_1 makes up the "pulser." When S_2 is open, the plate is inoperative, and the grid acts as the plate of a rectifier, charging C_1, since the cathode is connected to the "hot" side of the line through R_5. This is the "standby" condition. When S_2 is closed, the cathode is now connected to the "ground" side of the line and the capacitor discharges through one of the grid pots. When the voltage at the grid reaches a critical value, the tube "fires," energizing the plate relay and opening the contact in the cathode line. This does two things: the relay is released as the cathode-to-anode circuit is broken, and the capacitor is charged during the brief interval the contact is open. This is repeated at a time interval set by the grid pot. With the 6-μf. capacitor specified, a resistance of approximately 12,000 ohms causes the tube to fire at intervals of 1/10 second (600 per minute), the maximum speed for which the circuit is designed. With about 7.5 megohms resistance, the speed is one per minute, the minimum speed for which this circuit has reasonable accuracy.

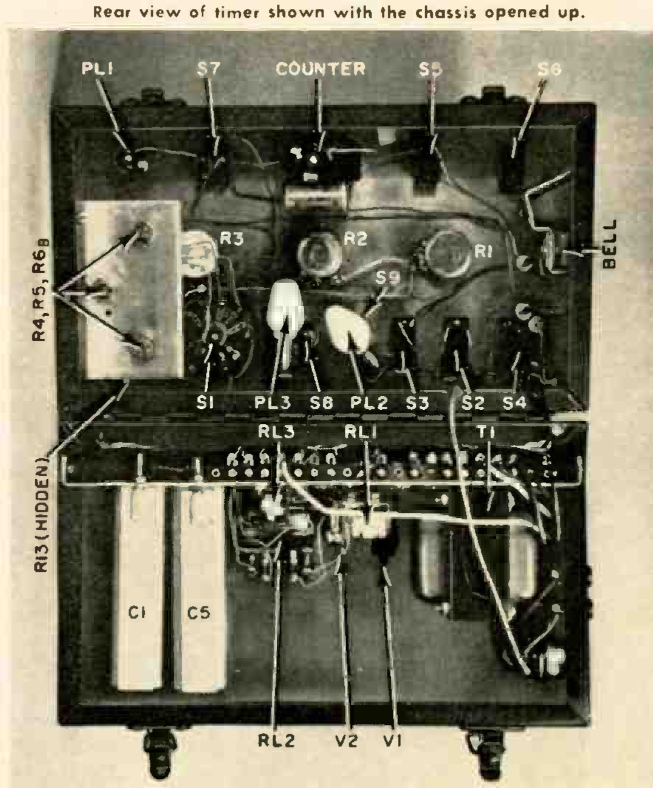
This part of the circuit also has another relay contact to operate a counter and bell (or gong), as well as to initiate the timer and power output circuit. Either an external trigger (switch contact), or an internal switch, can be used to connect the V_1 circuit to the various outputs.

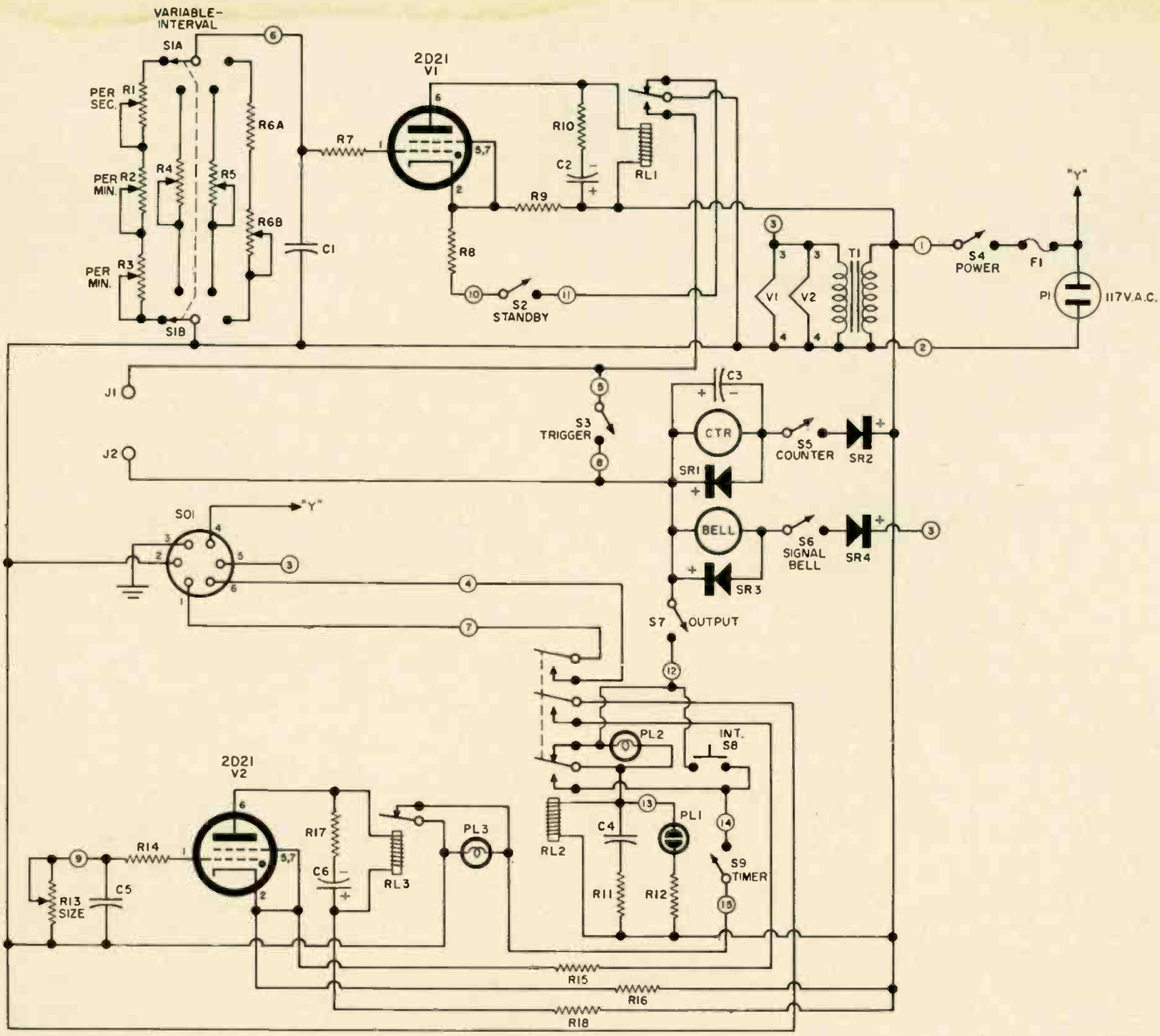
The thyratron V_2 with its associated *RC* components, make up the timing circuit. Here again, the grid is used during standby as a rectifier plate to charge a capacitor. This time, however, the relay contacts are used to hold on a power relay until the plate relay operates. When this happens, the circuit goes back to standby until another pulse is received from the V_1 circuit or the circuit is operated manually by the momentary switch S_8.

Circuit Features and Construction

The two grid capacitors are critical and absolutely leak-free units are needed for reliable operation. The ones shown are oil-filled military-type sealed units which most electronic surplus dealers have at very reasonable prices. Also suitable are the *Lafayette* oil-filled metallized capacitors (CF-114, 2 μf., and CF-115, 4 μf., used in parallel) which are low in price. Electrolytics are unsuitable and erratic timing will result if they are employed as the timing capacitors.

Rear view of timer shown with the chassis opened up.





R_1—200,000 ohm pot
R_2—2 megohm pot
R_3—10 megohm pot
R_4—50,000 ohm self-locking pot
R_5,R_{6B}—1 megohm self-locking pot
R_{6A}—3.3 megohm, ½ w. res.
R_7,R_{14}—2200 ohm, ½ w. res.
R_8—180 ohm, 1 w. res.
R_9,R_{16}—56,000 ohm, ½ w. res.
R_{10},R_{17}—100 ohm, ½ w. res.
R_{11}—220 ohm, ½ w. res.
R_{12}—Resistor in PL_1 lampholder
R_{13}—4 megohm pot
R_{15}—470 ohm, 2 w. res.
R_{18}—4700 ohm, ½ w. res.
C_1,C_5—6 µf. capacitor (see text)
C_2,C_4,C_6—2 µf., 150 v. elec. capacitor (450 v. may be used)
C_3—.22 µf., 200 v. paper capacitor
SR_1,SR_3—500 ma., 400 p.i.v. silicon diode
SR_2,SR_4—750 ma., 50 p.i.v. silicon diode
PL_1—Neon pilot light assembly (Dialight 95408 or 81408 series)
PL_2,PL_3—7-watt, 120 v. candelabra base lamp (in Diolight 600 series socket)
J_1,J_2—Tip jack
SO_1—6-prong socket
P_1—Recessed male a.c. plug (Amphenol 61-M10 or equiv.)
S_1—D.p. 4-pos. rotary switch
S_2,S_3,S_4,S_5,S_6,S_7,S_9—S.p.s.t. toggle switch
S_8—Push-button momentary contact switch, normally open
RL_1—S.p.d.t. 5000-ohm plate relay (Sigma 41F-5000S-SIL, see text)
RL_2—3-pole d.t., 110 v. a.c. power relay (author used surplus relay but Ohmite DOX-46T, Potter & Brumfield MR14A-115 or equiv. can be used)
RL_3—S.p.s.t. 3500-ohm plate relay (Sigma 11F-3500G-SIL or equiv.)
F_1—2 amp fuse in holder
CTR—Electro-mechanical counter with manual reset, 5 digit, 110 v. d.c. (Sodeco TceZ5E, available from Landis and Gyr, Inc., 45 W. 45th St., New York 36, N.Y., or an equivalent unit)
BELL—Single-stroke 6-8 v. gong or bell (see text)
T_1—Fil. trans., 6.3 v. @ 2 or more amps.
V_1,V_2—2D21 thyratron
Chassis—Two 7"x 12"x 3" (Bud AC408 or equiv.), one 2"x 4"x 1" (Bud CB1626 or equiv.), one 3"x 12"x 1" (see text)

Fig. 1. Complete schematic diagram and parts listing for the author's home-built timer unit.

As RL_1 can be called on to operate 600 times a minute, only a long-life relay should be used. The *Sigma* 41F is designed for one billion operations on dry circuit and should last almost that long as used here, as it is required to make and break only a fraction of its rated capacity. In addition, diodes and resistor-capacitor combinations are used to minimize contact arcing.

Another method is used to prevent arcing at the RL_2 and RL_3 contacts. Non-linear resistors are used. You don't see any in the circuit? Look again—those 7-watt lamps do the job and do it inexpensively. When cold, their resistance is only about 15 ohms, but when lighted, their resistance jumps to over 1500 ohms, so they absorb the inductive "kick" without interfering with the operation of the relays.

RL_2 and RL_3 are not meant to operate at the high speeds of RL_1, so less expensive units may be used. To take care of medium size loads in the output, however, RL_2 should have 8 or 10 ampere contacts.

Four different interval ranges are available through the rotary switch S_1 and six variable resistances. The combination R_1-R_2-R_3 provides the full range from 1 to 600 pulses per second, but for precise timing must be recalibrated each time used. The locking-type pots, R_4, R_5, and R_{6B} (trimmed by R_{6A}) once set, hold their resistance so that a high accuracy can be maintained.

Three outputs are available: a digital count, an audible signal, and a relay contact which can be used to close an external circuit or provide timed pulses of 6 and 110 volts. The electro-mechanical counter specified is a *Sodeco*, which is a low-current (18 ma.) device capable of operating up to 600 times per minute. The audible signal can be a bell or gong; shown is an *Edwards* solenoid-type gong, which is a standard inexpensive unit commercially available from electrical supply houses. An ordinary doorbell can also be used by shorting out the vibrating contact.

The cabinet is made up of two chassis. A piano hinge 11″ long fastens the chassis together at the base, while two suitcase clasps hold them securely at the top. Both these items are available at all well-stocked hardware stores.

The jacks, sockets, and main chassis are located in the rear half of the cabinet and the front half contains all the control components. The photographs show the location of these components. The main chassis, 3″ x 12″ x 1″, is a nonstandard size which can be made from an aluminum panel or a piece of sheet stock. The transformer, tube sockets, relays, and capacitors are placed as indicated in the rear-view photograph. Resistors should be mounted on lug strips or between socket terminals and lugs. Leads can be used as "hold-downs" for the two small electrolytics. In the schematic, Fig. 1, the numbered circles represent front-lug positions to which leads will be soldered from control elements to this circuit chassis. The sub-chassis for the locking-type pots should be completed before mounting in place. If speeds other than 2, 60, and 600 per minute are wanted, the resistance of the locking-type pots can be changed, allowing 120,000 ohms per second. For resistances above one megohm, better resolution and easier calibration results if you use a fixed resistor as part of the resistance.

Testing

Make sure all the toggle switches are off and connect the a.c. input. Turn on the main power switch, S_4, and wait one minute. (In order to prevent possible damage to the thyratrons, *always* warm up the unit at least a minute before operating. For calibration, the instrument should be warmed up at least ten minutes.) Turn R_2 and R_3 to minimum resistance and set R_1 about half way. Position S_1 to "Variable" and close S_2. RL_1 should be heard to click at a rate of about once a second. Now vary the resistance of R_1, which should speed up the relay with less resistance, slow it down with more. Turn R_1 back to its midway point and close S_3 and S_5. The counter should operate. Trouble here, if encountered, will most likely be improperly connected diodes. Then test the gong or bell by closing S_6. If both counter and signal do not operate, you have undoubtedly connected the diodes incorrectly.

Open S_3 and S_6, and close S_7. RL_2 should operate, as indicated by PL_1. Turn R_{13} to minimum resistance and close S_9. Rotate R_{13} slowly and RL_2 should remain energized for longer and longer times as the resistance is increased.

Calibration

For calibration you will need an electric clock with a large sweep second hand and a cable with plugs connecting pins 1 and 6 of SO_1 with J_1-J_2. You will use the clock to calibrate the timer pot, R_{13}, as well as the slower intervals of the pulser. For the fast pulse intervals, the cable will connect the

(*Continued on page* 94)

Table 1. Setup instructions for eight different programs that can be handled by the versatile timer.

PROGRAM	S_1 Interval	S_2 Standby	S_3 Trigger	S_5 Counter	S_6 Bell	S_7 Power Output	S_8 Internal	S_9 Timer	INPUT	OUTPUT	USES (see text)
1. Counting	Set	On	Off	On	Off	Off	Not used	Off	Contact for time interval counted	None	Time counting
2. Repetitive process control (Intervalometer)	Set	On	On or see "Input"	On, if desired	Off	On	Not used	On	May be used instead of S_3 for transducer control	Contact, 110v., or 6v.	To operate devices at repeated intervals
3. Repetitive audible timing	Set	On	On	On, if desired	On	Off	Not used	Off	Not used	None	Audible timing
4. Process timing (without counting)	Not Used	Off	Off	Off	Off	Off	Push to start	On	Not used	Contact, 110v., or 6v.	Process timing
5. Process timing (with counting)	Set	On	Off	On	Off	Off	Push to start	On	Contact from relay connected to output	Contact, 110v. or 6v.	Process timing with count
6. Warning	Set	On	Off	On, if desired	Off	On	Not used	On	Transducer	6v. or 110v. to operate horn, siren, or large bell	To operate repeated loud warning sound
7. Work sampling and testing	Set	On	On or see "Input"	On	Off	On	Not used	On	See text	Relay contact	Testing; sampling
8. Flashing	Set	On	On	Off	Off	On	Not used	On	Not used	Contact, 6v. or 110v.	Light flashing

S_4 "on" for all programs. It is assumed R_1, R_2, R_3, R_4, R_5, R_6, and/or R_{13} are set to desired values.

ELECTRONIC CONCEPTS:

FACT OR FICTION

By SOL HELLER
Instructor in Electronics, Voorhees Technical Inst.

Many notions widely taken for granted about circuit action, the use of components, and repair practices are not interpreted properly.

AN INSTRUCTOR in electronics is not surprised by the fact that certain fundamentals are not brightly lit in the minds of his students. What is startling, however, is the circle of confusion that exists around supposedly elementary topics even in the minds of some experts.

A prominent writer and E.E. degree holder, for instance, in an otherwise fine book for beginners, compounds this blooper: "As everyone knows, the frequency to which a tuning capacitor and coil resonate goes up as the capacitor plates are placed more fully in mesh." This isn't bad enough. He goes on for more than a page to explain why the statement is true.

The author has heard another brilliant specialist (no sarcasm is intended) express the view that the stage gains of a receiver are additive; if two stages, for example, have gains of 20 and 100 respectively, the over-all gain is 120. (And he wasn't referring to decibels.) I trust my worst student knows the over-all voltage gain is 2000.

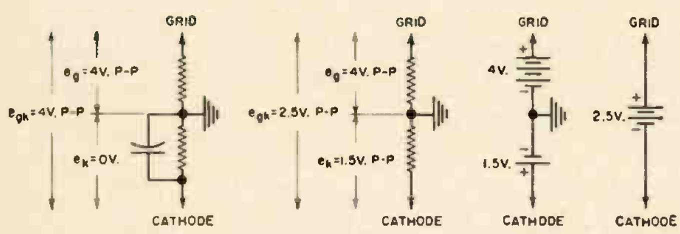
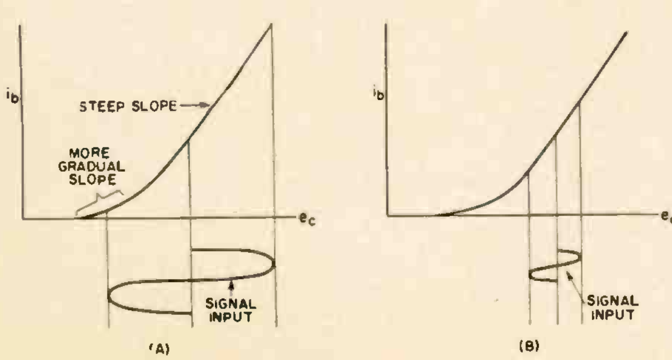


Fig. 1. How the effective input signal to a stage is reduced when a cathode bypass capacitor opens. The two conditions are compared in A and B; the explanation simplified in C and D.

Fig. 2. Large-signal input (A) may drive a stage into gradual portion of the tube characteristic. With signal input reduced (B) to use only steep part of slope, theoretical gain increases.



Even the most capable of us, when we begin to take certain fundamental and common concepts for granted, cease to think about them meaningfully. When that occurs, the principles involved can easily become distorted in application. It is surely interesting and probably helpful to examine some of the confusing concepts the writer has actually run into, both in his teaching and in service work. He hopes that, in attempting to clear up the errors of others, he doesn't display some of his own—but he cannot be certain.

FICTION: *Degeneration due to an open bypass capacitor reduces the gain of an amplifier.*

FACT: Without being warned, most readers would accept this statement completely—and we cannot quarrel with it if gain is defined as the ratio of the plate-to-ground signal voltage to the grid-to-ground signal voltage in a conventional, cathode-biased amplifier. If gain is considered as the ratio of the a.c. plate-to-cathode voltage to a.c. grid-to-cathode voltage, however, gain does *not* necessarily change when cathode degeneration is present. The amplitude of the output signal may indeed drop. If it does, however, the amplitude of the effective input signal has also changed proportionately.

Fig. 1 will make this clear. With normal cathode bypassing, the effective input signal, occurring between grid and cathode, is 4 volts peak-to-peak, let us say. The signal voltage between grid and ground has practically the same value, since the capacitor places the cathode at ground potential (Fig. 1A). With the capacitor effectively out of the circuit (Fig. 1B), the a.c. voltage across the cathode resistor—say 1.5 volt p-p—bucks the signal across the grid resistor, reducing the net input voltage to 2.5 volts p-p.

The bucking action becomes more evident if we consider the two voltages as produced by two batteries (Fig. 1C). The net grid-to-cathode or effective input voltage applied to the stage is as shown in Fig. 1D.

Confusion probably arises because it is assumed that cathode degeneration effects some change in the tube's operating characteristics that reduces its effectiveness as an amplifier. Actually, it is amplifying just as well, but its net input signal has been reduced. The gain is really unchanged.

Nor is that all. There are certain conditions under which the stage gain may even become *higher* when the cathode capacitor is removed. When a large signal is applied to a power amplifier, a large portion of the e_c-i_b characteristic is commonly used, as in Fig. 2A. Gain is proportional to the average slope of the portion used. If a smaller input signal is developed along the steeper part of the characteristic (Fig. 2B), gain will actually go up. This condition may occur when elimination of a cathode bypass capacitor reduces the net input signal.

If you define input and output signals appropriately, you can win bets on this one. In any case, let us consider another notion suggested by this situation in that the same circuit element is involved.

FICTION: *An open cathode bypass capacitor cannot change the d.c. electrode voltages of an RC-coupled amplifier.*

FACT: A thinking man, or at least one who smokes a thinking man's cigarette, is likely to endorse the statement firmly. After all, a capacitor bypasses a.c., but (disregarding possible leakage, of course) it acts as though it isn't there for d.c. So how can it make a difference?

Well, let's suppose our *RC*-coupled amplifier is slightly over-driven. Grid current will flow on the positive peaks of the input signal. This will develop a negative d.c., grid-to-ground voltage that will increase the operating bias somewhat over the value provided by other circuit constants.

If the cathode bypass capacitor opens or loses much of its capacitance, degeneration will occur. The grid-to-cathode signal, which is the input the tube sees, is greatly reduced by the degenerative action—as in our first case. The tube is no longer over-driven, grid current stops flowing, and the bias falls.

This change may be so small that acknowledging it as a significant shift in d.c. electrode voltages may seem like grasping at straws. But it is not the only one that occurs. The drop in bias increases d.c. plate current—which increases the d.c. voltage drop across the load resistance and thus causes the d.c. plate voltage to fall.

FICTION: *A defective 50L6 tube in an AM receiver using series-filament wiring is replaced with a 35L6. The only objection to this change is that the larger-than-normal heater voltage developed in the 35L6 may reduce tube life somewhat.*

FACT: Not so. If the heater is operated at a voltage in excess

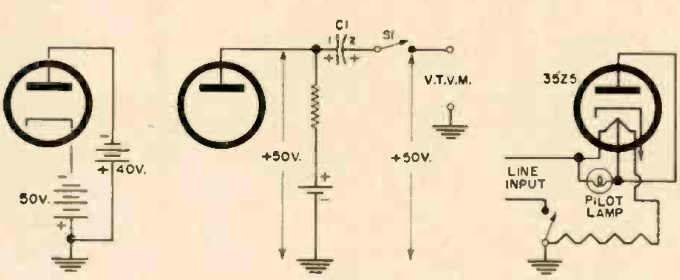


Fig. 3. How tube conducts (A) with negative voltage on plate. Instantaneous charge on a capacitor (B) at moment voltage is applied. Shunt pilot lamp (C) used in series heater wiring.

of the rated one for a prolonged time, part of the cathode coating material evaporates. (This is why tube life is reduced.) Some of the vapor produced condenses on the grid, giving the grid delusions of being a cathode. Grid emission results—*i.e.*, the grid emits electrons, and a positive grid-to-ground voltage develops. This reduces the bias and creates distortion in the stage using the 35L6.

Not to be overlooked is the fact that heater voltage and power will also rise in the other tubes being used. The effects of improper operation may be cumulative.

FICTION: *When the plate of a tube is at a negative potential with respect to ground, the tube cannot conduct.*

FACT: The potential difference between plate and cathode, rather than between plate and ground, determines ability to conduct. If the cathode is still more negative to ground than the plate, as in Fig. 3A, tube current can flow.

FICTION: *When a receiving-type tube is overdriven, plate current swings are limited at one extreme by plate-current cut-off, and at the other extreme by plate-current saturation.*

FACT: Cut-off does determine the maximum swing on negative peaks of the input signal, but grid limiting, rather than saturation, commonly determines the maximum plate current that will flow on positive signal peaks. Such limiting is established by the charging of a capacitor in the grid network due to grid current flow.

To illustrate the distinction, let us say that grid limiting takes place when the input signal reaches an amplitude at which the grid is made .5 volt positive to the cathode. Let us say that plate current, under this condition, is 10 ma. Then 10 ma. is approximately the largest value of plate current that will be able to flow, although saturation current for the tube may be considerably higher.

Since receiving-type tubes are not designed to withstand saturation current, tube damage is avoided with grid limiting. This technique is commonly used in the design of FM limiters, although there is a popular notion that the tube itself is saturated.

FICTION: *Alternating current flows through a capacitor.*

FACT: Not in the literal sense. The fallacy here is likely to be recognized quickly—by the very people who might make the statement carelessly. When an a.c. voltage is applied to a capacitor, electrons pile up on one plate and an equal number leave the other plate. This condition reverses in step with the signal frequency. However, assuming a perfect dielectric, no electrons flow through the capacitor itself.

FICTION: *When a voltage applied to a capacitor makes one of its plates positive at the instant of application, the other plate will go negative at the same instant.*

FACT: The voltage at plate 2 of C_1 in Fig. 3B will be as positive to ground as the voltage on plate 1, at the moment switch S_1 is closed. The second plate will become negative with respect to the first as the capacitor charges. With a long enough time constant, a v.t.v.m. connected as shown will demonstrate this.

FICTION: *A larger-value capacitor will present a smaller reactance to high signal frequencies than a smaller-value capacitor.*

FACT: Not necessarily true. Capacitors have some inductance as well as capacitance. The inductive reactance is proportional to the applied frequency. A high-value electro-

(*Continued on page 88*)

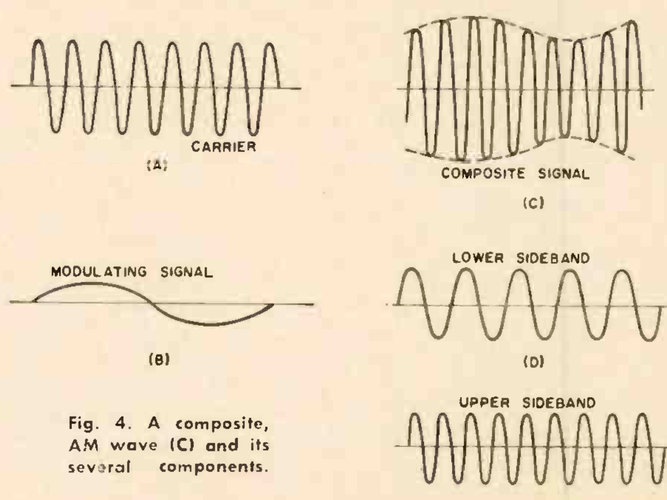


Fig. 4. A composite, AM wave (C) and its several components.

U.H.F. GRID-DIP METER *For the Ham Shack*

By JOSEPH A. HUIE, K2PEY

Construction of a versatile instrument that covers the range of 276 to 590 mc. with three plug-in coils.

SECOND only to the multimeter, the grid-dip meter is perhaps the most useful of all instruments to the amateur. Without it, he is virtually helpless when trying to do original construction work. It is needed for measuring tuned-circuit resonance, measuring signal frequencies, detecting parasitic oscillations, and indirectly it can be used to determine such things as inductance, capacitance, and relative "Q." For the h.f. and v.h.f. region, there are many grid-dip meters available in both kit and wired form. For u.h.f., and more specifically the ¾-meter band, the only instruments available are made for industrial use and they are more expensive than many amateurs can afford. Those working at 432 mc. must therefore build their own grid-dip meters. This article describes the construction of a u.h.f. grid-dip meter that covers the frequency range of about 300 to 600 mc. with three plug-in coils; it is compact and easy and inexpensive to build.

Design Considerations

There are a number of problems associated with building oscillators for u.h.f. work. Selection of the tube is very important, since only a few types perform well at u.h.f. Spurious resonances can knock out oscillation or cause mode jumping over part of the band. It is difficult to get a wide tuning range while maintaining continuous oscillation. This grid-dip meter is a good design compromise and has proved to be extremely useful when building and testing 432-mc. transmitters and converters.

The usual u.h.f. oscillator uses a Colpitts circuit with a split-section tuning capacitor. This circuit is shown in Fig. 3A. There are certain disadvantages to this circuit, however. For one thing, the tuning capacitor is in shunt with the oscillator tuned circuit and will tend to lower its resonant frequency. On the other hand, it is desirable to have as physically large an inductance as possible in order to couple the grid-dip meter to circuits under test. Thus, there is a problem in making the resonant frequency high enough. Trying to keep the minimum capacitance value low limits the maximum value of the variable capacitor. This, in turn, limits the tuning range.

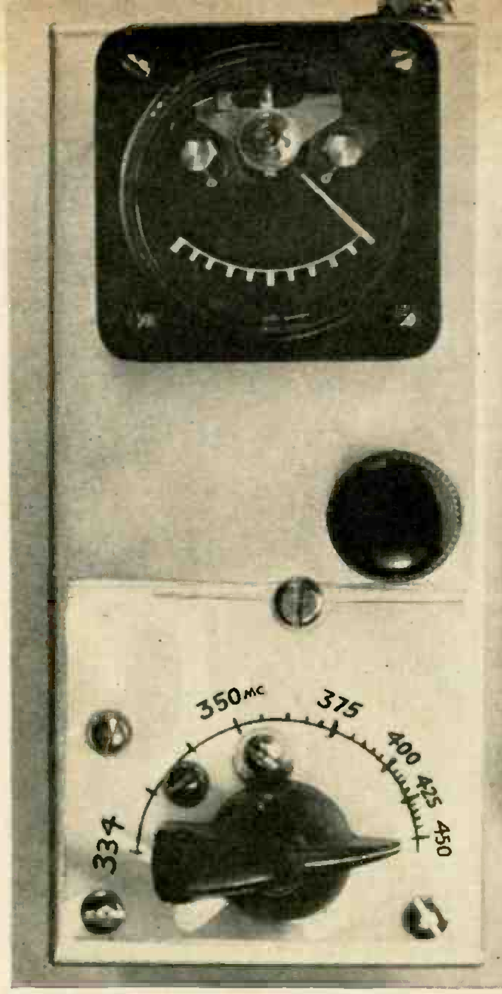


Fig. 2. Dial may be calibrated 0-180 degrees. If it is, make a set of calibration curves for each coil similar to curve of Fig. 5.

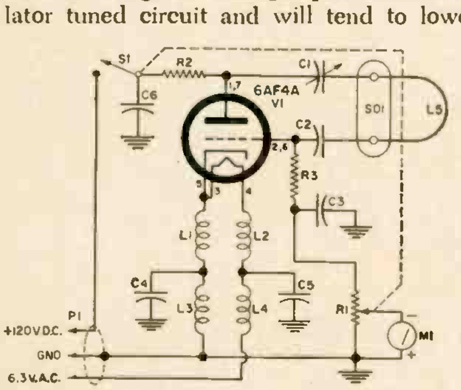


Fig. 1. Schematic of u.h.f. grid-dip meter which has a series-tuned circuit. Since author obtained power from separate source, power supply circuitry has not been included in this unit. Simple supply can be designed around silicon-diode rectifier.

R_1—1000 ohm pot
R_2—5600 ohm, 1 w. res.
R_3—6800 ohm, ½ w. res.
C_1—2.3-14.2 μμf. variable capacitor (E. F. Johnson 160-107 or equiv.)
C_2—500 μμf., 500 v. mica button capacitor (Erie type 360-CB-501K or equiv.)
C_3—1000 μμf., 500 v. capacitor
C_4,C_5,C_6—330 μμf., 500 v. capacitor
L_1-L_4—3.3 μhy. r.f. choke (Miller 9320-18 or equiv.)
L_5—Plug-in coil (see text)
M_1—0-100 microammeter
SO_1—Ceramic crystal socket (Millen 33302 or equiv.)
S_1—S.p.s.t. switch on R_1
V_1—6AF4A tube

Another problem is that the tuning capacitor has some lead inductance. The circuit becomes a parasitic resonant circuit at a frequency where the variable capacitor no longer looks like a capacitance but an inductance. It may be difficult to suppress the parasitic oscillations. This effect is sometimes referred to as mode jumping. If, when tuning an oscillator, the grid current jumps sharply, there is a problem. When the grid current shifts, the frequency also suffers a discontinuity and jumps from the desired frequency range to the parasitic resonant frequency.

After trying the circuit of Fig. 3A and encountering the problems mentioned, the author departed from convention and used a series-tuned circuit, shown in simplified form in Fig. 3B. The variable capacitor series-tunes the inductance so the lead inductance of the capacitor becomes just a part of the total inductance. It does not form a parasitic circuit. Since the tuning capacitor is in series, it raises rather than lowers the resonant frequency of the circuit, permitting a relatively large inductance loop. To eliminate grounding problems, the entire oscillator circuit including the tuning capacitor is mechanically isolated from ground. The complete schematic is shown in Fig. 1.

Construction

As in any u.h.f. circuit, the parts layout is very important. The grid-dip meter is built in a 5"x 2¼"x 2¼" metal cabinet (Figs. 2 and 7). The coils plug into a ceramic socket (.05" pin dia., .487" pin spacing). The socket is mounted on a polystyrene or high-quality phenolic insulator board and then secured to the aluminum box to reduce the pin capacitance to ground. A 0-100 microammeter measures the grid current (a 0-500 μa. or 0-1 ma. meter can be substituted with a corresponding reduction in sensitivity when used as a wavemeter). Potentiometer R_1 is used to adjust the meter sensitivity; a switch, S_1, on R_1 turns off V_1's plate voltage to permit the unit to function as an absorption-type wavemeter.

The internal construction is shown in Fig. 7. The tube socket is ceramic with the outside metal ring removed. The socket is supported only by heavily soldered connections to the coil socket and the tuning capacitor. The grid-blocking capacitor (C_2) is a 500-$\mu\mu$f. button type. Its outside ring is soldered between tube socket pins 2 and 6. The center tab on the button is tied to the coil socket by a short copper strip.

The tuning capacitor mounts on the small phenolic board which is supported by a ⅜" high phenolic post. An insulated phenolic-shaft extension is used to eliminate the effects of hand capacity when tuning the oscillator, since both rotor and stator of C_1 are floating with respect to ground.

The plug-in coils are made with 1/32" thick x ⅜" wide copper strips bent in the form of a long "*U*" with short lengths of #15 wire soldered on for pins. Three coils cover the range from 276 to 590 mc. Their dimensions and tuning ranges are shown in Fig. 4. If desired, multi-turn coils can be made for frequencies below 200 mc. The tuning range becomes restricted, however, at lower frequencies.

Testing and Calibration

Try the unit with all coils after it is assembled. The grid current will vary somewhat over the tuning range, but should always be over 100 microamperes when R_1 is at its maximum sensitivity position. There should be no sharp jumps or dips in the meter indication. The actual grid current varies from about 1250 to 250 μa. when the capacitor is tuned from maximum to minimum value with the highest-frequency coil. The variation is less for other coils. When a coil is not plugged in, the grid current should remain at a constant value of about 10 μa.

The dial can be calibrated against a commercial signal generator or wavemeter. Another way of calibrating it is by measuring the wavelength directly using Lecher wires as described in the 1955 edition of "The Radio Amateur's Handbook." Lecher wires are simply open-wire transmission lines with a coupling loop at one end and a movable shorting bar that adjusts their effective electrical length. They can be constructed as shown in Fig. 6. The wires are 1" apart.

To calibrate the grid-dip meter, couple the coil inductively (do not make direct contact) to the Lecher-wire loop. Move the shorting strips on the movable trolley to the loop end then slowly back away. When the meter "dips" note the position of the short on the scale (the length to the loop will be somewhat less than one-half wavelength). Move the short farther from the loop end until the meter dips a second time, then note the new position. The physical distance between the points at which the dip occurs is equal to one-half the wavelength ($\lambda/2$) of the oscillator frequency. The frequency is related to the measured half-wavelength by $F=5905/L$; where F is in mc. and L is in inches.

The procedure should be repeated with coupling to the grid-dip meter coil reduced until the dips are just barely noticeable. The data obtained with the coupling reduced will be more accurate because the oscillator frequency is less influenced by Lecher-wire resonance. The calibration curves developed should be similar in shape to that in Fig. 5.

Generally there will be no trouble with critical tuning when the meter is used as an absorption wavemeter. When operated as an oscillator, there may be some difficulty finding the dip of a resonant circuit. This is due, in part, to the problem of physically bringing the grid-dip meter coil close enough to the circuit under test. Such u.h.f. lumped-constant circuits seem to be particularly difficult to dip. The solution is patience and careful tuning of the oscillator. ▲

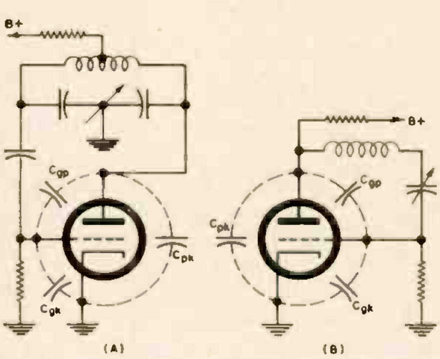


Fig. 3. (A) Colpitts oscillator circuit. Series-tuned oscillator (B) used by author.

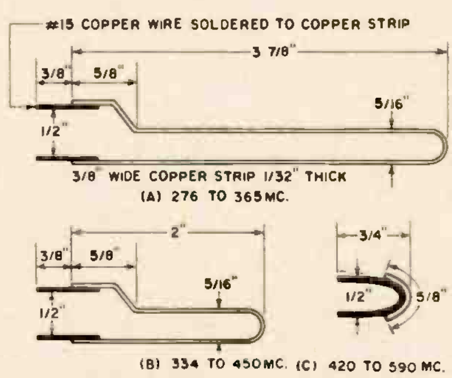


Fig. 4. The shape and dimensions of coils used for frequency range of 276-590 mc.

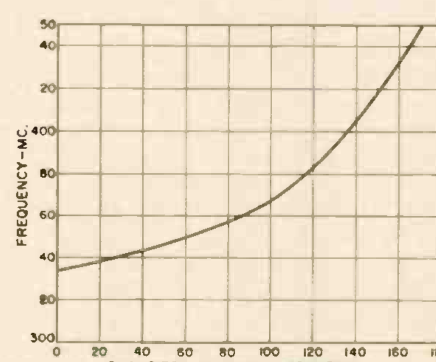


Fig. 5. If dial is marked in degrees, make and use curves like this for other coils.

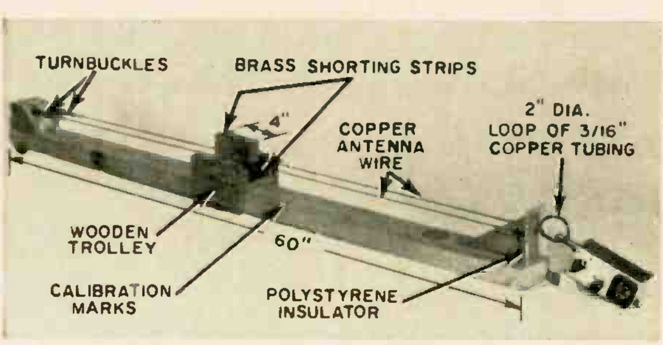
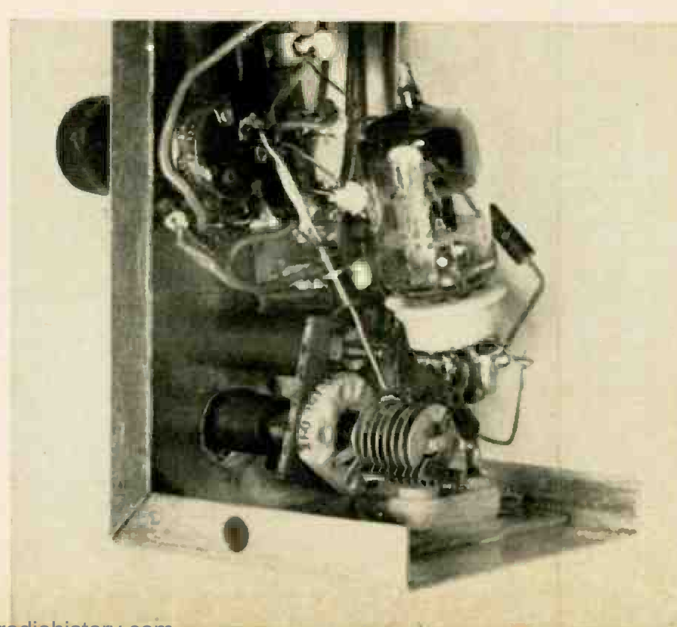


Fig. 6. Lecher-wire construction. 2"x 4" frame is 60" long. Block at left supports turnbuckles, used to pull wires taut. Shorting strips, four inches apart, must have sharp edges for good contact. Drill holes in flattened ends of copper-tubing loop to attach wires.

Fig. 7. C_1 is mounted away from case with phenolic spacer and board. ▶



EVOLUTION OF THE COMMUNICATIONS RECEIVER

PART 1. PRE-WAR SETS

A two-part series tracing circuit-design trends of amateur and short-wave communications receivers from the very earliest crystal and regenerative sets up to the present-day sophisticated models.

By MAURICE P. JOHNSON, W3TRR

THE history of radio reception probably began as far back as 1887 with the experiments of Heinrich Hertz in Germany. With a receiver consisting of a wire looped into a circular spark gap, he was able to detect radio signals by watching arcs across the gap. Such a primitive device would hardly inspire the technician of today; yet barely seven years later wireless communications was well on its way. In England, Oliver Lodge had managed to record Morse Code transmissions with a receiver consisting of an antenna, a tuned circuit, and a "coherer" type detector, which was essentially a glass tube filled with iron filings. Once Lodge's methods were revealed, a flurry of interest followed and "experimental wireless" activity began.

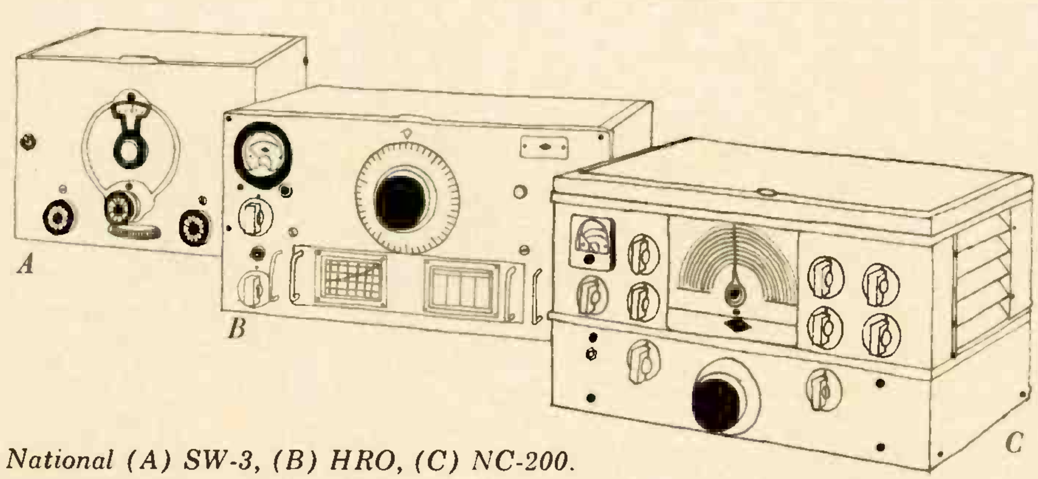
The development of the vacuum tube did much to spur receiver design in the years that followed. The discovery of the Edison effect had led to the diode or "oscillation valve" of Fleming. The Fleming valve could be used to detect r.f. signals and could thus replace the crystal detector. By 1906, de Forest had added the grid to control the current flow within the diode. This gave receiver designers the triode tube, or "audion" as it was called, which was able to amplify as well as to detect radio signals.

In the radio magazines of the early 1900's, some crystal detectors and their circuits (Fig. 1A) were pictured, but there were several allusions to the superiority of the audion circuits. Early tube manufacture was beset with problems, but designers hastened to incorporate the delicate triodes into receivers and many circuits were developed around them.

One of the most popular circuit configurations to evolve was the grid-leak detector (Fig. 1B), which permitted the triode to function as a detector as well as an amplifier. Sensitivity was improved by the gain thus introduced into the receiver, but selectivity was still limited by the single tuned circuit.

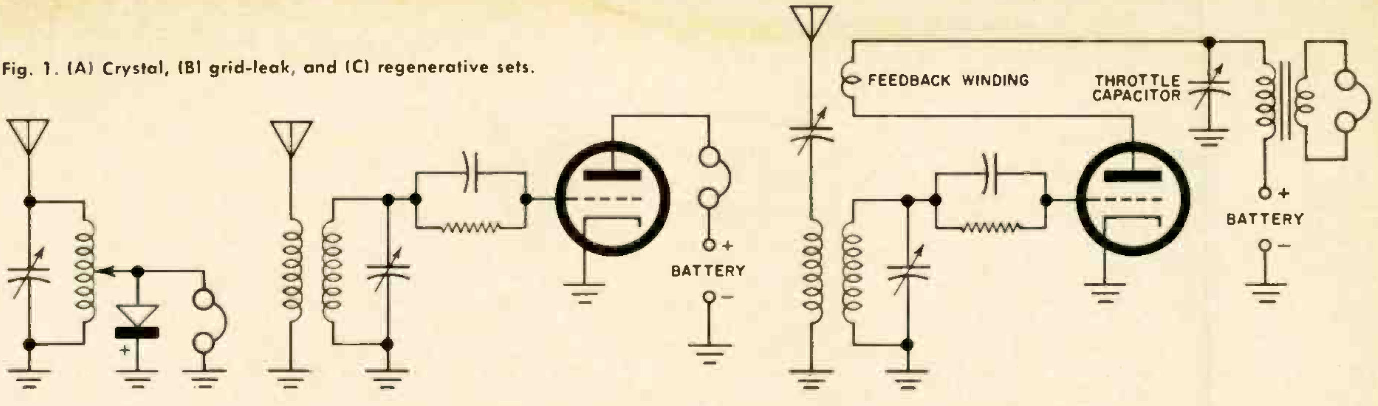
It will be noted that amplification is at audio frequencies since the tube gain follows the detection. Design refinements appeared as improved tube manufacture, antenna matching with an added primary coil, and audio transformers to couple the tube to the headphones. However, selectivity still suffered because of the grid-current loading on the tuned circuit.

Sensitivity continued to receive much attention. A most



National (A) SW-3, (B) HRO, (C) NC-200.

Fig. 1. (A) Crystal, (B) grid-leak, and (C) regenerative sets.



important forward step occurred with the invention of the regenerative circuit by Armstrong in 1914. This introduced positive feedback from the output to the detector input, which served to couple reinforcing energy back into the tuned circuit by means of a feedback or tickler coil. This resulted in tremendously increased sensitivity because of the re-amplification which took place. Control over the feedback energy involved a variable resistance shunting the tickler winding. Another regeneration control consisted of a variable plate bypass capacitor, familiarly known as the "throttle" capacitor. See Fig. 1C.

Sensitivity of the detector had now been amazingly improved but the addition of regeneration added a critical operating control to the receiver. The operating point of maximum sensitivity required careful adjustment of the feedback to a point nearly sufficient to overcome the circuit losses. Any further increase in feedback caused the circuit to "spill over" into self-oscillation. However, the oscillating detector did permit "autodyne" reception of unmodulated code (c.w.) signals.

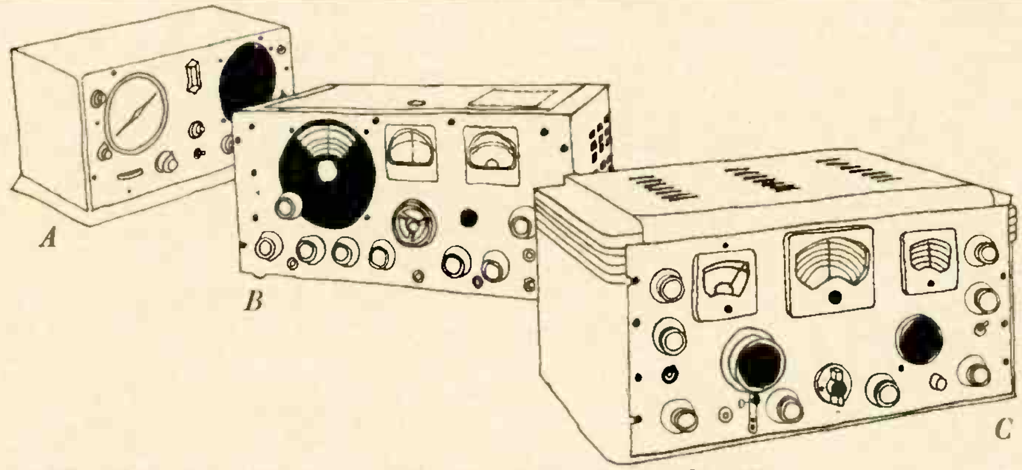
The ordinary grid-leak detector and the non-oscillating regenerative detector produce an audio output only from modulated signals. Audible reception of unmodulated c.w. signals was therefore impractical since no audio output was produced. However, if two r.f. signals are applied simultaneously to a detector, heterodyne or beat products appear in the output. If the separation between the r.f. signals is equal to an audio frequency, the beat is audible. In the oscillating regenerative autodyne detector, one r.f. signal is that being received, while the beating r.f. signal is that developed due to feedback in the detector. The received c.w. signal produces an audio note in the receiver output. Thus the regenerative detector was useful for reception of both modulated signals as well as unmodulated code signals.

Combinations of the regenerative detector coupled to audio amplifiers were developed, but the oscillating detector did have an inherent disadvantage. It acted as a transmitter as well as a receiver, radiating a signal from the antenna that caused interference in other receivers. This led to the name "blooper" for the set.

Radio continued to be of an experimental nature up until World War I when transmissions were forbidden. Until then, in addition to c.w. transmissions, voice modulation had developed as microphones and modulation techniques were perfected. During the war, considerable progress was made in tube production techniques. Following the war, radio broadcasting began and radio started its invasion of the home as an entertainment medium. Although this article is not really concerned with broadcast receivers, certain developments in the receiver art were directly attributed to the demand for broadcast receivers for home use and should be acknowledged.

The improved triodes were introduced as r.f. amplifiers ahead of the detector. The problem of increasing selectivity was attacked by tuning the r.f. stage, and the t.r.f. stage was born. A tuned-plate and tuned-grid load were thereby presented to the r.f. tube, but the triode with high grid-to-plate capacity was always a potential oscillator. To keep this stage from oscillating, several neutralization circuits were devised; one of the best was developed by *Hazeltine* in the "neutrodyne" receiver.

To increase the acceptance of radio in the home and to lift receivers to a level above that of "knob-twister's delights," the tuned r.f. circuits were ganged and tracked, resulting in one-knob tuning. The t.r.f. stage was finally tamed with the appearance of the screen-grid tube with its reduced interelectrode capacity. This obviated the need for neutralization. The demand for operation from the a.c. outlet in the home



Hallicrafters (A) 1935 "Super Skyrider," (B) S-27, (C) SX-28.

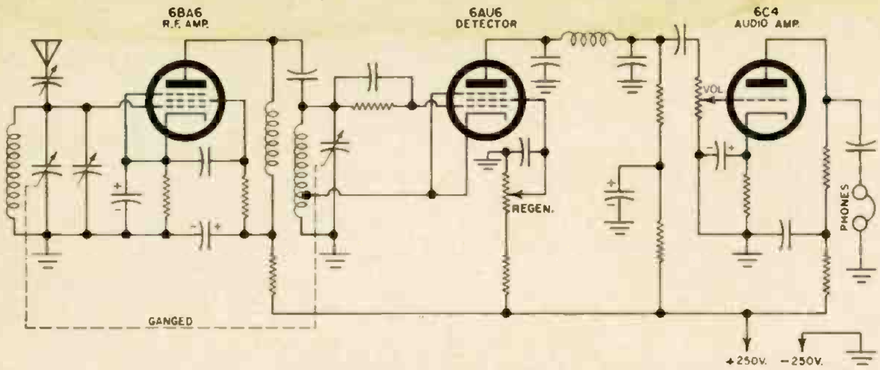


Fig. 2. Typical three-tube regenerative receiver using ganged tuning of the r.f. and detector stages. Trimmers are used for antenna matching and for improved tracking of the r.f. amplifier stage. The regeneration control varies the screen voltage of the grid-leak detector. Another stage of audio amplification was frequently used if a loudspeaker was to be employed. An a.c. rectifier, usually full-wave, completed the set's tube lineup.

resulted in battery eliminators, power packs, and new tube types. When all components were combined with the loudspeaker into furniture-type enclosures and cabinets, home receivers had arrived.

The t.r.f. receiver still suffered from varying sensitivity and selectivity across the tuning range, and this limitation was probably the main reason for its being gradually supplanted by the superheterodyne as *the* broadcast receiver circuit in the years that followed. However, the t.r.f. continued to find favor for short-wave reception for a much longer time.

Regenerative Communications Receivers

The evolution of the regenerative detector and t.r.f. stage has been briefly covered to portray the receiver design picture up to the mid 1920's. Although the superheterodyne had been developed by Armstrong before this time, it was a more complex circuit than the t.r.f. Tubes were comparatively expensive, and factors such as initial cost and current drain made the simpler circuits continue to find application.

Actually, the combination of a t.r.f. stage preceding a regenerative detector and followed by audio amplification proved to be a very practical circuit of such wide short-wave application that it probably deserves to be known as the beginning of the "communications" receiver. Many versions of the circuit continued in popularity in the late twenties, through the thirties, and at least up to World War II. Such receivers appeared in marine, aircraft, and police installations and have been used by amateurs, experimenters, and SWL's right up to the present.

A familiar set of the type in the early 1930's was the *Pilot* "Super-Wasp." This was available in both battery and a.c. versions and tuned 500 to 14 meters with plug-in coils. An article in the January, 1931 issue of "QST" described the *National* SW-5 "Thrill Box" as a new design offering "single control" and "socket power" with "tuned r.f. for the sake of selectivity and sensitivity, a screen-grid detector for the sake of sensitivity," and plug-in coils to cover the bands to 10 meters. Again the emphasis was on selectivity and sensitivity as measures of receiver worth. The circuit used type '24 screen-grid tubes for the t.r.f. and detector stages and '27 tubes in the audio. The r.f. and detector were gang-tuned with a drum dial, while an antenna trimmer and regeneration control completed the panel lineup. A separate a.c. power pack was used.

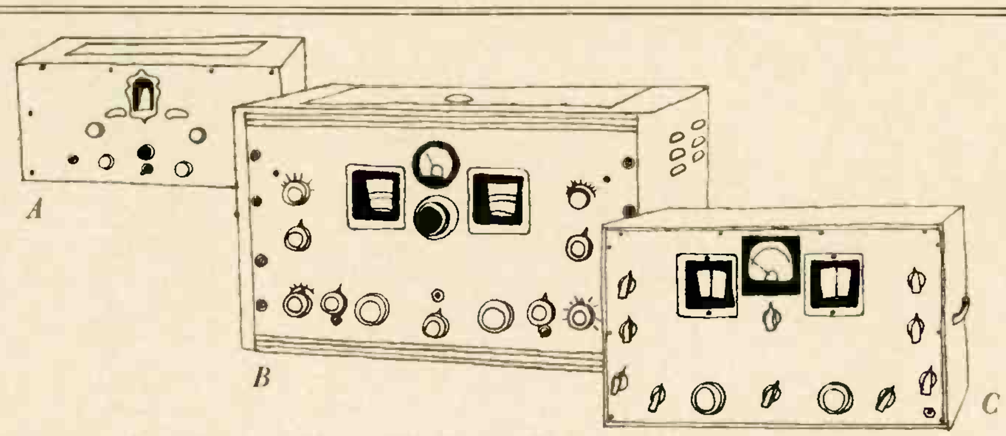
Variable-*mu* and receiving pentodes appeared and, in 1931, James Millen wrote of the application of new tubes to the famous *National* SW-3 receiver. This popular receiver could be used with a.c. power pack or batteries. A '35 variable-*mu* r.f., '35 regenerative detector, and '27 audio stage to power headphones comprised the a.c. lineup. For battery operation, these tubes were replaced with '36's and a '37. The receiver then found application in aircraft, auto, and portable installations.

The three-tube receiver circuit has survived until today and is still useful for experimenters and beginners. For a time, the 30, 33, and 34 tubes were popular for battery sets and the 58, 57, and 56 became a favored lineup for a.c. use. Metal tubes appeared and a pre-World War II *RCA* tube manual featured the circuit with 6SK7's and a 6C5. The circuit is still of interest and a representative version with more modern tubes is given in Fig. 2.

It is interesting to note that the basic circuit remained much the same from 1930 onward, the improvements being limited to utilizing the newer tube types as they appeared.

Superregenerative Receivers

Before passing on to the superhet, a variation of the regenerative detector should be mentioned. This is the superregenerative circuit developed by Armstrong in 1922. In this arrangement, a supplementary "quench" oscillator operating in the range of 20 to 100 kc. is tied to the grid of a regenerative detector (Fig. 3). This quench voltage acts as a varying grid bias which pulls the regenerative detector in and out of oscillation at a supersonic rate. Although the quench frequency is too high to be heard in the output, the



Hammarlund (A) "Comet Pro," (B) "Super Pro," (C) HQ-120.

GET INTO–GET AHEAD IN THE GROWING FIELD OF INDUSTRIAL ELECTRONICS

ELEMENTARY INDUSTRIAL ELECTRONICS, *Leonard C. Lane.* If you're ready to enter the fabulous field of industrial electronics, this two-volume course will arm you with the know-how necessary for success. If you're already in the field, you'll do your job better because you'll have a firmer grasp of the fundamentals of industrial electronics. Only a basic knowledge of electricity and electronics is required to get the most out of this two-volume course. All the major areas of industrial electronics that you are likely to encounter are made absolutely clear: relays, and switching, magnetic amplifiers, motor controls, electronic heating, instrumentation and many other topics. Mathematics is held to an absolute minimum. Illustrations, simplified diagrams reinforce and make each technical point understandable. #310, 2 Vol. Course **$7.80** ($3.90 ea. vol.).

IT'S EASY TO USE ELECTRONIC TEST EQUIPMENT, *Larry Klein and Ken Gilmore.* 192-page gold mine of practical information on electronic test equipment shows you how to select and use this equipment to best advantage in many, many applications. Covers from simple VOM's and VTVM's through signal generators, oscilloscopes and other test equipment and helpful accessories. Saves you money because you'll know what features to look for when purchasing new equipment, be able to keep your test equipment in top operating condition, learn new ways to use equipment. Invaluable ready-reference tool for the electronics experimenter, amateurs, service technicians. #308, **$4.00.**

USING THE SLIDE RULE IN ELECTRONIC TECHNOLOGY *by Charles Alvarez.* Finally! An easy-to-understand book to show you how to solve practical electronic math problems with a slide rule. Helps develop top slide rule speed and accuracy. Twenty exciting chapters illustrate the fast, short-cut techniques that normally take years of on-the-job work to learn. Chapters like Transformer Turns Ratio, Power Gain and RC circuits help transform beginners into masters of this timesaving tool. ***"The best handbook on the slide rule to come to my attention."***—H. M. HUGHES, National Technical Schools. #253, **$2.50.**

BASIC PRINCIPLES & APPLICATIONS OF RELAYS, *Harvey Pollack.* Lucid introduction to the construction, operation and application of relays. Discusses relay components; DC relays, their rectifier arrangements, selected circuits and contact protection. The chapter on electronic relays covers thyratron circuits together with various light-operated, cold cathode and combination relays. Time delay circuits are discussed with practical applications. Factors governing the choice of a particular relay for a specific circuit are made clear. #250-1, **$2.90.**

PHOTOELECTRIC CONTROL, *Harvey Pollack.* Extremely informative text, illustrates how photoelectric devices are used in industrial electronic systems. It's so easy to understand how these components operate when you read this book. Especially clear circuits and operation descriptions of modern photoelectric devices which control measuring, counting, testing and separating tasks gives you a special insight to their applications versatility. #250-2, **$3.50.**

HOW TO SOLVE PROBLEMS IN ELECTRICITY & ELECTRONICS *by Henry Jacobowitz.* This book shows you how to solve problems in electricity and electronics—simple DC through complex AC circuits. Readers quickly learn how to handle applied problems through proved step-by-step solution methods. Starting with simple DC problems, the text progresses through AC circuits, tubes, transistors, waveguides, antennas and other typical problems confronting technical students. In addition, it offers a concise review of principles and laws upon which solutions are based. #302, **$3.50.**

COMMUNICATIONS DICTIONARY, *James F. Holmes, P. E.* Indispensable, compact, inexpensive—this remarkable reference defines more than 2500 terms in the telecommunications and data processing fields. A must for anybody in telecommunications—radio, television, telemetry, facsimile, etc—and data processing. #301, **$1.50.**

INDUSTRIAL CONTROL CIRCUITS *by Sidney Platt.* ***". . . ideal as an introduction to electronic control systems . . ."***—ELECTRONIC WORLD. #202, **$3.90**

HOW TO USE METERS (2nd Ed.) *by John F. Rider & Sol D. Prensky.* ***". . . an indispensable addition to the art of meter instrumentation."***—DESIGN NEWS. #144, **$3.50**

BASIC RADIO *by Marvin Tepper.* ***". . . detailed coverage of basic radio communications . . ."***—ELECTRONICS. #197, 6 vols. soft covers, **$13.85;** #197-H, cloth, **$14.85**

FAMOUS 'PICTURE-BOOK' COURSES
by Van Valkenburgh, Nooger & Neville, Inc.

BASIC ELECTRICITY, 5 volume picture-book course—civilian version of the extremely successful illustrated training course used by the U. S. Navy to turn out trained technicians in record time. ***". . . The discussions are so lucid that almost anyone could learn, even by home study . . ."***—NATIONAL SCIENCE TEACHERS ASSOCIATION. #169, 5 vols., soft covers, **$11.25;** #169-H, 5 vols., cloth, **$12.75**

BASIC ELECTRONICS STANDARD 5 VOL. COURSE. Available as heretofore. The 5-volume civilian version of the U. S. Navy course. ***". . . a better and quicker way to teach and learn . . ."***—FT. GORDON RAMBLER. #170, set of vols. I to V in soft covers, **$11.25;** #170-H, all 5 vols. in cloth binding, **$12.75**

BASIC ELECTRONICS VOLUME 6 ONLY. For the great many tens of thousands who have completed the 5-volume course, the 6th volume on semi-conductors, transistors and FM is a book which you should own. ***". . . highly recommended; the section on transistors alone is worth the price of commission."***—POPULAR ELECTRONICS. #170-6, soft cover, **$2.90;** #170-6H, cloth, **$3.95**

BASIC ELECTRONICS EXPANDED COURSE. The integrated expanded course consists of 6 volumes including the 5 volume standard course, plus the 6th volume which expands into the areas of semi-conductors, transistors, and frequency modulation. #170-X, Set of vols. I to VI, soft covers, **$13.85;** #170-XH, 6 vols., cloth, **$14.85.**

BASIC SYNCHROS & SERVOMECHANISMS. ***". . . Lavish use is made of illustrations . . . and the accompanying text is concise and simpy worded."*** LIBRARY JOURNAL. #180, 2 vols., soft covers, **$5.50;** #180-H both vols. in one cloth binding, **$6.95.**

TRANSISTORS

FUNDAMENTALS OF TRANSISTORS (2nd ed. rev. & enlarged), *Leonard M. Krugman, P.E.* ***"Few who are interested in transistors can afford to be without it."*** — WIRELESS ENGINEER. #160, soft cover, **$3.50;** #160-H hard cover, **$4.50.**

BASIC TRANSISTORS "Pictured-Text Course." *Alexander Schure, PH.D.* ***". . . readily understandable without an instructor and suitable for individual as well as classroom study"***—PRODUCT ENGINEERING. #262, Soft cover, **$3.95;** #262-H cloth, **$5.50.**

PRINCIPLES OF TRANSISTOR CIRCUITS (2nd Ed. rev. & enlarged), *S. W. Amos, B. Sc.,* ***". . . an excellent introduction to the theory and practice of transistors and circuit design."***—RADIO ELECTRONICS. #241, **$4.25.**

INTERNATIONAL TRANSISTOR SUBSTITUTION GUIDEBOOK (4500 direct substitutions), *Keats Pullen Jr.* ***"Possible substitutions deemed 'doubtful,' that is they work only in some cases, were omitted . . . thus, substitutions guide is a 'safe' guide."*** — INDUSTRIAL ELECTRONIC ENGINEERING & MAINTENANCE. #276, **$1.50.**

COMPUTERS

COMPUTER ARITHMETIC, *Henry Jacobowitz, B.S.* ***". . . of interest to anyone . . . in the growing field of computers."*** —SUPERVISION. #297, **$3.00.**

BASICS OF DIGITAL COMPUTERS, *John S. Murphy* 3 volume ('pictured-text' course). ***"Provides a quick and thorough insight into the ABC's of digital computers."***—OFFICE AUTOMATION NEWS BULLETIN, #196 3 vols., soft covers, **$8.40;** #196-H cloth, **$9.50.**

BASICS OF ANALOG COMPUTERS, *T. D. Truitt & A. E. Rogers.* ('Pictured-Text' Course). ***"First comprehensive work on analog computers capable of explaining to almost anyone the basic principles involved, as well as their practical applications."***—DESIGN NEWS. #256-H Cloth, **$12.50.**

DESIGN OF TRANSISTORIZED CIRCUITS FOR DIGITAL COMPUTERS, *Abraham I. Pressman, M.S.* ***". . . by far the most comprehensive coverage on this subject to date . . . useful to circuit designers in the computer field."***—Reviewed for the PROCEEDING OF I.R.E. by William B. Cagle, Bell Telephone Labs., Whippany, New Jersey. #215, Cloth, **$9.95.**

SPACE AGE TECHNOLOGY

FUNDAMENTALS OF ROCKETS, MISSILES & SPACECRAFT, *Marvin Hobbs, P.E.* ***". . . of interest to anyone interested in principles and details of rockets, missiles and spacecraft."***—ELECTRONIC DESIGN. #278, Hard Bound, **$8.95.**

SATELLITE TRACKING, *Stanley J. Macko.* ***". . . an interesting and informative discussion of earth satellite orbit geometry."***—ELECTRICAL DESIGN NEWS. #289, Hard Bound, **$5.50.**

BASICS OF MISSILE GUIDANCE & SPACE TECHNIQUES, *Marvin Hobbs, P.E.* (Pictured-Text Course). ***"Tells the missile guidance story to the electronics man."***—RADIO ELECTRONICS, #229, 2 vols., soft cover, **$7.80;** #229-H, cloth, **$9.00.**

BASICS OF GYROSCOPES, *Carl Machover, E. E.* ('Pictured-Text' Course). ***"Dramatic and forceful, yet extremely lucid approach . . . very useful."*** INDIAN & EASTERN ENGINEERS. #257, 2 vols., soft covers, **$6.60;** #257-H, cloth, **$7.75.**

FUNDAMENTALS OF RADIO TELEMETRY, *Marvin Tepper.* ***". . . will make important telemetry fundamentals crystal clear to the engineer or layman new to the subject."***—POPULAR ELECTRONICS. #225, **$2.95.**

Mail to your distributor, book store or order direct:

ORDER TODAY—10 DAY GUARANTEE

John F. Rider Publisher, Inc. Dept. EW-11
a Division of Hayden Publishing Co., Inc.
116 West 14th Street, New York 11, New York

I have enclosed $________. Please send me the books checked below:

☐ #310, $7.80	☐ #180-H, $6.95
☐ #308, $4.00	☐ #160, $3.50
☐ #253, $2.50	☐ #160-H, $4.50
☐ #250-1, $2.90	☐ #262, $3.95
☐ #250-2, $3.50	☐ #262-H, $5.50
☐ #302, $3.50	☐ #241, $4.25
☐ #301, $1.50	☐ #276, $1.50
☐ #202, $3.90	☐ #297, $31.00
☐ #144, $3.50	☐ #196, $8.40
☐ #197, $13.85	☐ #196-H, $9.50
☐ #197-H, $14.85	☐ #256-H, $12.50
☐ #169, $11.25	☐ #215, $9.95
☐ #169-H, $12.75	☐ #278, $8.95
☐ #170, $11.25	☐ #289, $5.50
☐ #170-H, $12.75	☐ #229, $7.80
☐ #170-6, $2.90	☐ #229-H, $9.00
☐ #170-6H, $3.95	☐ #257, $6.60
☐ #170-X, $13.85	☐ #257-H, $7.75
☐ #170-XH, $14.85	☐ #225, $2.95
☐ #180, $5.50	

NAME____________________

ADDRESS____________________

CITY________ZONE____STATE________

Satisfaction guaranteed, or I can return within 10 days of purchase for full refund.

CIRCLE NO. 150 ON READER SERVICE PAGE

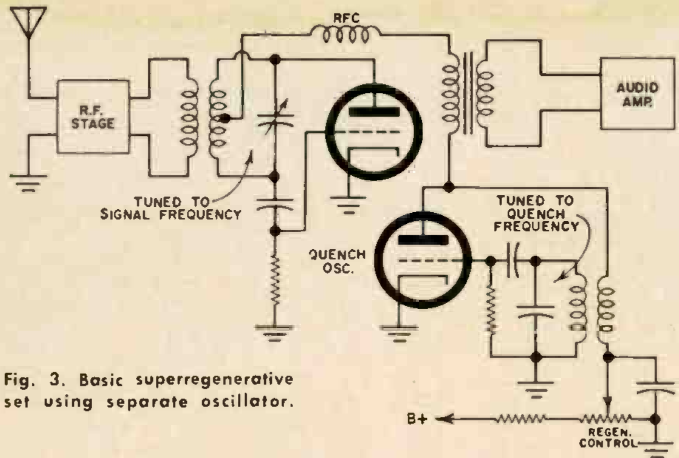


Fig. 3. Basic superregenerative set using separate oscillator.

superregenerative receiver is characterized by "regeneration hiss" because of the extremely high gain under no-signal conditions. Sensitivity of the circuit is greater than the straight regenerative detector, but selectivity is poor due to the grid loading and it tends to radiate strongly. It is seldom used without a preceding r.f. stage to reduce this radiation. Some variations of the circuit use self-quenching arrangements which eliminate the separate oscillator by combining both actions in the superregenerative detector.

The circuit has been useful for the ultra-high frequencies since the straight regenerative circuit is not very successful above 10 meters. The superregen was used extensively on the old 5-meter ham band in pre-World War II days. A typical 1933 circuit used a type 58 tube as t.r.f., a 24-A screen-grid type as regenerative detector with a '27 quench oscillator, and a type 59 audio output. By 1941, a similar t.r.f. superregenerative circuit utilized the 9002 triode in the regeneration stage and the 9001 in the r.f. stage to reduce radiation and antenna loading on the detector. Such circuits were used for the 112-mc., 224-mc., and higher bands.

The *National Company* produced the "One-Ten" receiver, which used a four-tube circuit to cover the range from one to ten meters. This used acorn r.f. tubes, with a 954 t.r.f. stage, a 955 self-quenching superregenerative detector, a 6C5 audio stage, and a 6F6 audio output. The receiver used plug-in coils to cover the tuning range. In the 1950's, superregens were largely supplanted by converters ahead of the usual communications superhets, except for some simple experimental applications.

The recent advent of the Citizens Band has brought renewed activity in superregen designs. Several Citizens Band kits and factory-built receivers use the t.r.f. superregen circuit to provide good sensitivity on the 27-mc. band with maximum circuit simplicity. "Walkie-talkie" versions of this circuitry are also popular.

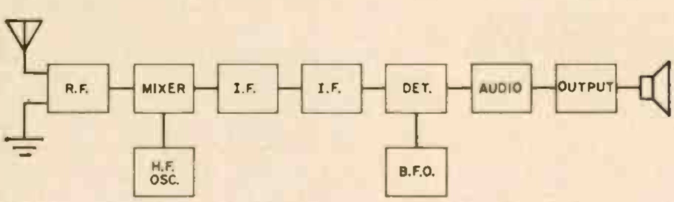


Fig. 4. Block diagram of the basic superheterodyne receiver.

The Superheterodyne

The superheterodyne receiver (Fig. 4), which was to emerge as the most satisfactory circuit approach for communications receivers, was developed during World War I. The heterodyne principle had previously been used to produce audio signals from code transmissions. However, Armstrong's idea was to produce a higher beat frequency, at the so-called intermediate frequency (i.f.), which could then be amplified in a fixed-tuned amplifier. This i.f. amplifier was followed by a detector and audio stages. The important advantage of this circuit was that the major portion of receiver gain was at the i.f. frequency so that sensitivity and selectivity became more or less independent of the received signal frequency. Thus, the remaining disadvantages of the t.r.f. receiver had been overcome, but at the expense of a more complex circuit. While the advantages of the superhet were quickly recognized, in its early days the cost of tubes was an inhibiting factor which limited application of the circuit to only the most expensive sets.

With improvements in tube performance and their reduced cost due to mass production, the superhet soon became the standard circuit for the home broadcast receiver. Some experimentation for suitable i.f. frequencies took place before the standardization at 455 kc. Present-day home receivers, portables, and auto radios are practically stereotyped in circuit, with differences in packaging and styling the major variations. However, adaptation of the superhet circuit to short-wave and communications receivers has been a continuing process that still occupies the time of receiver designers.

Because of cost, some early efforts to introduce the superhet to short-wave reception were directed toward converters for use ahead of broadcast receivers. A 1931 circuit of this type featured type '24 screen-grid tubes for the local oscillator and the high-frequency mixer, or first detector, as it was often called. Plug-in coils were used and much attention was centered on the problems of making the two tuned circuits "track" to permit single-control tuning.

The disadvantage of the converter was that the i.f. response of the broadcast receiver determined the over-all selectivity of the combination. Reception of code signals with the superhet required the action of a supplementary beating oscillator, the b.f.o., to generate an audible signal. This further complicated the converter approach for short-wave receivers since the b.f.o. signal properly should be applied to the second detector.

In the decade preceding World War II, considerable effort was concentrated on the development of superheterodyne communications receivers. Circuit designs evolved that were tailored to the special requirements of short-wave reception. The great importance of good selectivity ahead of the second detector was recognized in terms of improved r.f. and i.f. circuits. The fact that the necessary beat method of c.w. reception produced sidebands on both sides of the carrier was attacked by Lamb in 1932, with the result that "single-signal" reception became the primary receiver feature of the day. This reception technique was made possible by the introduction of a crystal filter in the i.f. amplifier. By tuning the desired sideband into this filter passband, the crystal bridge neutralizing or "phasing" capacitor could be adjusted to null out the undesired sideband, so that c.w. signals became effectively single-sideband at the second detector.

Selectivity continued to merit attention, and improved r.f. amplifiers appeared. The square-law second detector was supplanted by the linear diode detector. Automatic volume control was incorporated into the short-wave receiver. The rectified second-detector output was sampled through a long time-constant filter and was applied as degenerative bias to the variable-gain tubes of the r.f. and i.f. amplifier stages.

In 1934, crystal i.f. filters for single-signal reception and a.v.c. were the latest features of receiver design. Some representative sets at this time were: *McMurdo Silver*'s "5 series Supers," *Patterson*'s "PR-12," *RCA*'s "ACR-136," *RME*'s "9D," *Hammarlund*'s "Comet Pro," and others. The *Hallicrafters* name appeared on the first "Skyrider" at about this date.

Receiver coverage was pushed toward 30 mc. with the surge of interest in the ten-meter band. This increased the image problem, which was approached by increasing r.f.

selectivity, so that one or more tuned r.f. stages ahead of the converter became common. The 2A7 tube arrived as a combined electron-coupled oscillator and detector in one envelope, and was quickly utilized as a first detector as well as a second detector and b.f.o. Tube designs flourished and many receivers re-appeared in modified form to keep up with newer tube lineups. Then metal tubes arrived on the scene, to be quickly incorporated into receivers of advanced design.

Circuit refinements continued in the remaining years of the 1930's. This resulted in the decline of plug-in coils in favor of bandswitching, and communications receivers grew to be twelve- to fifteen-tube affairs with self-contained power supplies. *National* revised the earlier "HRO" and introduced the "NC-100," and "NC-200" receivers. *Hammarlund* had developed the "Super-Pro." *Hallicrafters* had been adding the numbers, advancing to the "Super Skyrider" designs.

Pre-War Circuit Features

Examination of the circuits of good communications receivers of the period just before World War II reveals many features shared by nearly all sets. The frequency coverage was usually all-band, from broadcast to ten meters, with a few versions extended to the lower marine bands, or above 30 mc. Two-knob tuning involved a multi-band calibrated main tuning dial coupled to the ganged tuning capacitor, plus an additional vernier bandspread dial for expanding ham bands or crowded shortwave broadcast regions.

The receiver front-end included bandswitching coil assemblies with one or two tuned r.f. amplifiers, followed by a tuned mixer stage and the high-frequency oscillator, usually tracking higher by the i.f. frequency than the incoming signal. Outstanding similarities of all designs were the use of 456-kc. i.f. channels, single conversion, and tunable h.f. oscillators. Two or three i.f. stages were used, with considerable attention given to control of the i.f. passband, since it determined the over-all selectivity. Variable i.f. bandwidth was usually provided, with the wider bandwidths established by the amount of coupling between i.f. transformer windings.

Sharper selectivity than that afforded by transformers alone was added by including a crystal filter in the i.f. path. The bridge-connected crystal, series-resonant at the i.f. frequency, had a parallel resonant notch which could be moved about in the passband by means of the phasing control. This action was useful in reducing interfering beats or signals. Being inherently high-"Q," the crystal produced a very narrow passband, which could be widened by external loading. *Hammarlund* developed one of the more versatile variable-selectivity i.f. crystal filters which found application in the "Super-Pro" and the "HQ-120" series receivers. This used steps of resistance loading to widen the filter bandwidth.

With the burden of selectivity relegated to the i.f. amplifier, the r.f. stages functioned mainly to improve the image rejection. A single r.f. stage was adequate to reduce image response on the lower tuning ranges, but two stages were necessary to even approach satisfactory image rejection on the higher bands. An image ratio of 20:1 was considered to be good at 30 mc. for a receiver with two r.f. stages and a 3-stage 456-kc. i.f.

A few additional comments may be made concerning other features of typical receivers. Separate mixer and h.f. oscillator tubes were used for isolation of the two circuits. Voltage regulation of the oscillator plate supply improved the voltage stability, while ceramic in coil forms, switch decks, and tube sockets, together with temperature-compensating capacitors helped to improve the frequency stability. For c.w. reception, a b.f.o. at the i.f. frequency was injected into the second detector. The a.v.c., applied to variable-*mu* tubes in r.f. and i.f. stages, could be disabled for c.w. signals. An "S" meter indicated received signal strength by measuring the reduction of plate current of an i.f. amplifier when the signal-developed a.v.c. voltage appeared on the grid. The diode second detector was usually followed by a peak-clipping diode audio noise limiter which reduced the effects of impulse-type noise pulses that fed through the audio circuits. A few receivers used the Lamb i.f. type noise silencer. Audio and r.f. gain controls were individually adjustable for optimizing operational gains. Few receivers tuned above ten meters, so that usable signal-to-noise ratios were determined by external noise on the antenna, and receiver noise figures of nearly 10 db were adequate. Mixer noise was not a great problem with one stage of r.f. gain ahead of the converter.

Some of the receivers being manufactured at this time included the "HRO" by *National*, *Hallicrafters*' "SX-28," *Hammarlund*'s "Super-Pro" and "HQ-120-X," the *RME* "69," the "490" by *Howard*, and others. One or two special-purpose receivers had appeared to reach beyond ten meters. Tuning ranges went from 27 to as high as 145 mc. with acorn tubes in capacitively tuned front-ends. Such specialized communications receivers were the *National* "NHU" and the *Hallicrafters* Model "S-27."

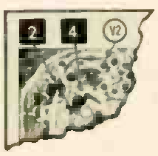
This was the state of communications receiver design when the years of World War II began for the United States.

(Concluded Next Month)

why take hours to troubleshoot when PHOTOFACT® does it for you in minutes!

IF YOU'RE NOT NOW A PHOTOFACT LIBRARY OWNER, YOU'RE MORE THAN PAYING FOR IT IN THE TIME YOU LOSE

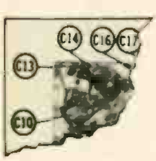
HERE ARE JUST A FEW OF THE DOZENS OF WAYS ***PHOTOFACT SAVES YOU TIME***



CircuiTrace® saves countless hours of foil tracing time. This exclusive Sams system pinpoints junctions and test points on schematic and printed board.

Field Servicing Notes spell out locations of adjustments for speedy "in home" servicing. Saves time spent in hunting for hidden adjustments.

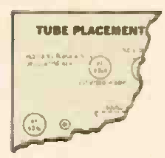
Clear Parts Symbols with values and associated information are shown plainly on the schematic—no time wasted in cross-reference "look-up."



Full Photo Coverage of the actual equipment makes identification of all components and wiring easy—you can *see* everything.

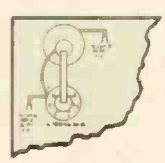
Disassembly Instructions, step-by-step, help you remove difficult chassis, subchassis, and assemblies in minutes.

Famous Standard Notation Schematic saves valuable hours—always uniform, accurate, complete for every model.



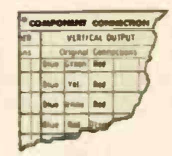
Tube Location Guide enables you to locate and replace proper tubes in seconds—a big time-saver on most repair jobs.

Waveform actual photos are shown on schematic for quick comparison of patterns on your scope. No time wasted in guesswork.

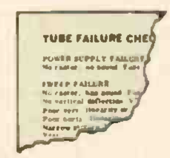


Terminal Identification saves you time; transformer and coil terminals quickly identified by color code or basing diagram shown on schematic.

Dial Cord Stringing instructions save you up to an hour or more of time and headaches on a single job.

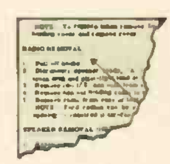


Exact Terminal Connections are indicated—no need for trial-and-error methods—a real time-saving feature.

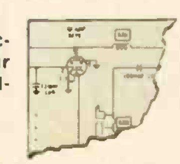


Tube Failure Check Charts spell out probable tubes responsible for failure—no need to waste time studying circuitry.

Unique Alignment System eliminates guessing; you get complete instructions with response curves, how to connect test equipment, proper adjustment sequence.



Auto Radio Removal instructions show you step-by-step procedure for removal of even the most complicated models—a big time-saver.



Alternate Tuner Data—separate schematics, alignment data and parts lists are provided—no time wasted interpreting various tuner versions.

OWN THE TIME-SAVING, PROFIT-MAKING PHOTOFACT LIBRARY

THIS EASY-BUY WAY

FREE FILE CABINETS

The PHOTOFACT Library more than pays for itself from the first day you put it into your shop. It gives you instant time-saving help on more than 52,000 listings of TV, radio, hi-fi and other home-entertainment equipment—virtually any model made since 1946. You can own a PHOTOFACT Library this special Easy-Buy way:

- NO INTEREST
- NO CARRYING CHARGES
- ONLY $10 DOWN
- UP TO 30 MONTHS TO PAY

You get FREE file cabinets with your PHOTOFACT Library—so you have all you need for time-saving, money-making service work right at your fingertips. Get the full PHOTOFACT Library details today.

You'll find dozens of other invaluable time-saving features in PHOTOFACT. Own the complete Library—so you can put your hands instantly on all the quick help you need for any job on your bench! Start a Standing Order Subscription today—keep up with current model output! See your Sams Distributor for full details or send coupon now.

SEND COUPON

HOWARD W. SAMS & CO., INC.

Howard W. Sams & Co., Inc., Dept. 5-L2
4300 W. 62nd St., Indianapolis 6, Indiana

☐ Send full information on Easy-Buy Plan
☐ Enter my Photofact Standing Order Subscription

My Distributor is: ____________

Shop Name ____________

Attn. ____________

Address ____________

City ____________ Zone ______ State ______

Delay-Line Nomograms

(*Continued from page 35*)

signing a delay line, the procedure is to select values of total inductance and capacitance, then divide those totals into the number of sections necessary to give the desired quality factor.

An Example

This example will help explain the use of the nomograms. Suppose it is desired to have a total delay of 2 μsec., a rise time of 0.2 μsec., and a characteristic impedance of 600 ohms. First, we refer to the nomogram in Fig. 3.

On Fig. 3, locate 2 μsec. on the "Time Delay" scale and 600 on the "Impedance" scale. Draw a straight line through these points and where that line crosses the other scales, it will give the required values of inductance and capacitance as 1.2 millihenrys and 3200 $\mu\mu$f., respectively.

Use Fig. 2 to determine the number of sections required. Locate 2 μsec. on the "Time Delay" scale, 0.2 μsec. on the "Rise Time" scale, and draw a straight line through these two points. At the middle scale the line indicates that 25 sections are required, therefore each coil should have an inductance of 48 microhenrys and each capacitor should have a value of 128 (nearest standard value of 130) $\mu\mu$f.

This basic section of 48 microhenrys and 130 $\mu\mu$f. can be used to make small corrections to the total delay. Each section contributes a delay of 1/25 of the total, or 0.08 μsec. and sections can be added without affecting the characteristic impedance of the line, because the ratio of L to C will remain unchanged as sections are added. ▲

L.V. POWER-SUPPLY HINT

By GUY D. AMORE

OCCASIONALLY a technician will work on a TV set with a faulty non-fused low-voltage power supply having one or more of the following bad components: a shorted rectifier tube, bad filter capacitors, bad transformer, or even "B+" shorted to ground.

Any one of these shorted components or conditions can cause an excessive amount of current flow in the low-voltage primary and secondary circuit. The result would be severe damage if the set isn't turned off.

In order to avoid any possible unforeseen damage, the author has incorporated a fuse in series on the cheater cord. This fuse will handle the average TV set power input of 250 to 275 watts. The in-rush current will not blow the fuse. If any one of the above conditions exists the fuse will blow.

When this happens, investigate the set for a faulty low-voltage power supply. The fuse holder is a Bussman Type HKP with a 3-amp "Slo-Blo" fuse. ▲

Free

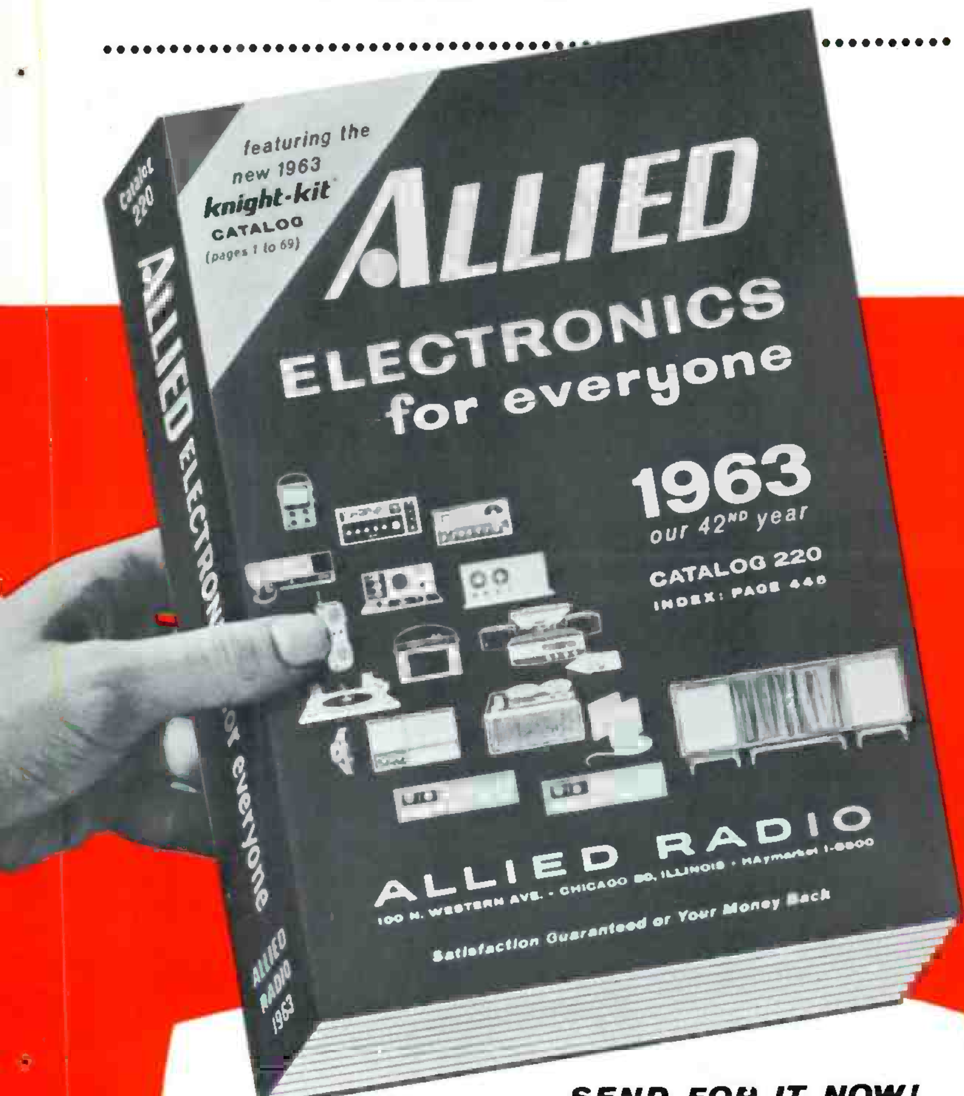
SEND TODAY FOR YOUR MONEY-SAVING

464-PAGE

ALLIED

1963 CATALOG

mail now



SEND FOR IT NOW!

WORLD'S LARGEST ELECTRONICS CATALOG

BIGGEST SELECTION • BIGGEST SAVINGS!

satisfaction guaranteed or your money back

NO MONEY DOWN: NOW! MORE BUYING POWER WITH YOUR ALLIED CREDIT FUND PLAN

SEE OTHER SIDE

For your FREE 1963 ALLIED Catalog, fill in card, detach and mail. (Please give second card to an interested friend.)

SEND CARD TODAY

mail now

Name ________ PLEASE PRINT

Address ________

City ________ Zone ____

State ________

11-1-L

YOUR Free ALLIED 1963 CATALOG

Name ________ PLEASE PRINT

Address ________

City ________ Zone ____

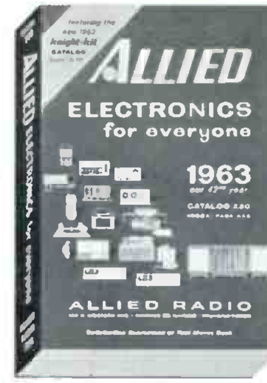
State ________

11-1-L

YOUR Free ALLIED 1963 CATALOG

mail now

Free SEND CARD TODAY FOR YOUR 464-PAGE ALLIED 1963 CATALOG

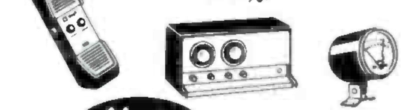


WORLD'S LARGEST • BIGGEST SELECTION • BIGGEST SAVINGS

NEW

1963 *knight-kits*®

Over 100 great do-it-yourself kits: Hi-Fi, Hobby, Intercom, Amateur, Citizens Band, Instrument—savings up to 50%.



NEW

Stereo Hi-Fi

Complete selection of components and systems; latest All-Transistor equipment and Stereo Multiplex FM.

NEW

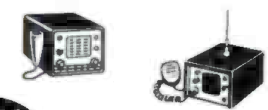
Tape Recorders

Complete recorders, tape decks, recording and pre-recorded tapes at big savings.

NEW

Citizens Band Radios

Latest 2-way radio—no exam required—complete selection of top-value CB equipment, including Walkie-Talkies.



NEW

Transistor, FM-AM Radios

Best buys in all types of compact transistor radios, including quality FM-AM portables.

NEW

Phonographs & Records

Big values in phonographs; latest stereo portables; famous-brand records at amazing discounts.

NEW

Ham Station Equipment

Largest selection of receivers, transmitters, antennas—everything in Ham station gear.

NEW

Test Equipment

Save on every type of instrument for home or professional use—all leading makes available.

PLUS • PA Systems & Intercoms • Top values in Power Tools, Soldering Guns, Hardware • Biggest selection of TV Tubes, Antennas; Parts, Tubes, Transistors, Books

satisfaction guaranteed or your money back

NO MONEY DOWN: Now! More Buying Power with Your Allied Credit Fund Plan!

mail now

Free MAIL CARD TODAY FOR YOUR 1963 ALLIED CATALOG

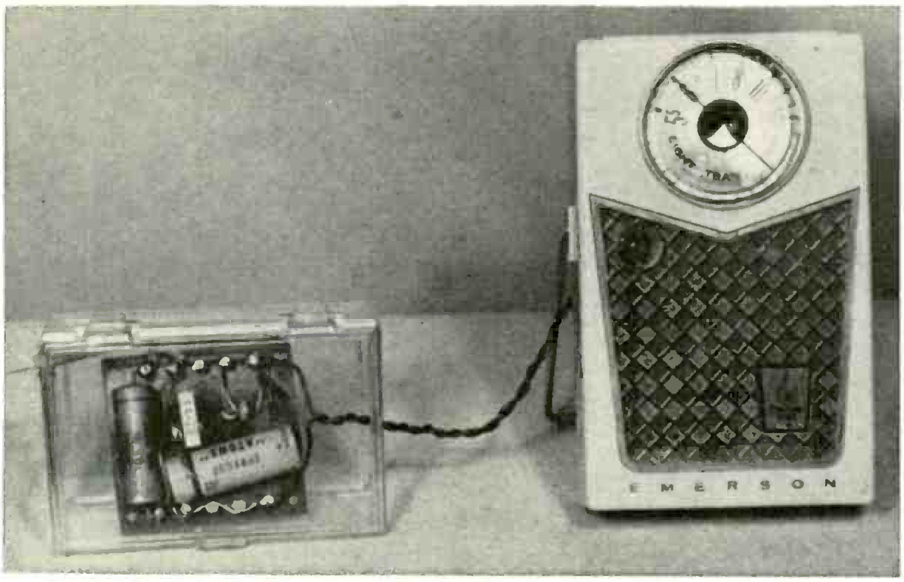
AND GIVE THIS CARD TO A FRIEND

TO:
ALLIED RADIO
100 N. WESTERN AVE.
CHICAGO 80, ILL.

PLACE STAMP HERE

TO:
ALLIED RADIO
100 N. WESTERN AVE.
CHICAGO 80, ILL.

PLACE STAMP HERE



Smaller than a pack of cigarettes, this supply is ideal for stay-at-home portables.

MINIATURE POWER SUPPLIES

By PAUL S. LEDERER

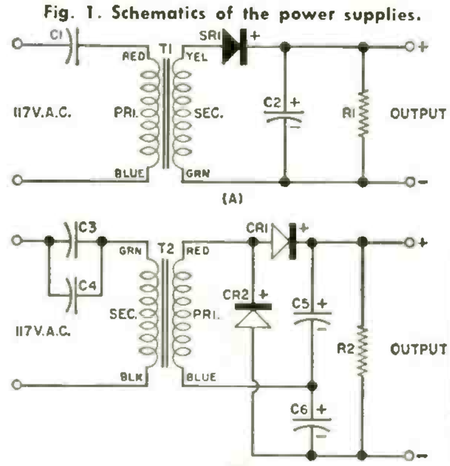
Small size is achieved by dropping line voltage with capacitor and by using transistor transformer.

MANY construction articles are published nowadays covering equipment using transistors. Typical examples are small radios, timers, two-terminal oscillators, crystal oscillators, unijunction transistor metronomes, intercoms, and other devices. Because of the low voltage and current requirements of these devices, batteries are frequently used as the source of power. Of course batteries are always used if the equipment is portable. But quite often these and other transistorized devices are designed for use in one location where a.c. power is available. Under these circumstances, a line-powered supply is the most practical since batteries have a limited shelf life and frequently must be replaced despite little use. Often transistor radios are used for long periods of time in kitchens and recreation rooms; under these conditions, their cost of operation will be much lower when they are line-powered rather than battery-powered.

The power supplies described here for transistor equipment are not expensive (about $6 for either), they are small (2¾"x 2½"x ⅞"), and they completely isolate the equipment from the power line. Their output power is somewhat limited but this has been the compromise for small size. While not suitable for all transistor devices, they are useful for many.

A transformer's core must be big to prevent saturation when large amounts of power are to be transferred from the primary to the secondary. As a result, power supplies that step down the line voltage and isolate equipment from the line are often quite bulky. If less than the full line voltage were applied to the primary winding, there would be less chance of the core saturating and, as a result, a smaller core could be used. The first solution to this problem is to use a dropping resistor in series with the primary of a stepdown transformer. This will prevent saturation but the output voltage will be low. Instead of using a transformer with a large stepdown ratio (some power supplies use a 117-v. to 6.3-v. filament transformer which is a ratio of 18.5:1), these supplies use transformers with smaller ratios such as 5:1 or 3:1. However there

Fig. 1. Schematics of the power supplies.

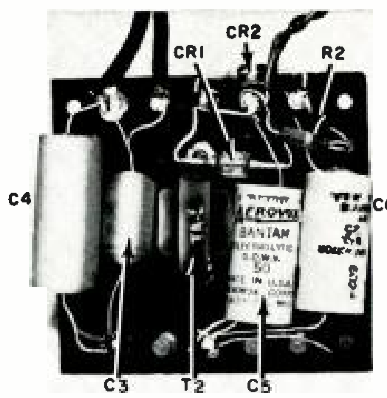


R_1—3000 ohm, ½ w. res.
R_2—20,000 ohm, ½ w. res.
C_1—.5 µf., 200 v. capacitor
C_2—250 µf., 12 v. elec. capacitor
C_3—.25 µf., 200 v. capacitor
C_4—1.0 µf., 200 v. capacitor
C_5, C_6—25 µf., 50 v. elec. capacitor
T_1—Transistor interstage trans. pri: 1500 ohms, sec: 500 ohms (Stancor TA-28 or equiv.)
T_2—Transistor driver trans. pri: 1000 ohms, sec: 200 ohms (Stancor TA-5 or equiv.)
CR_1, CR_2—Germonium diode (IN34)
SR_1—Silicon rectifier, 400 p.i.v., 200 ma. (International Rectifier 2E4 or equiv.)

would still be a drawback: the voltage dropped across the resistor will dissipate power and this means heat. To prevent heat the line voltage is dropped with a capacitor, an impedance with practically no internal heat-dissipating resistance. When a capacitor is used to drop the line voltage to a low enough value to prevent core saturation, a very small line-isolated power supply for transistorized devices is feasible.

Construction

Two supplies built with these design considerations are shown in the photographs. The smaller one (Fig. 1A) was designed to power a small transistor radio (*Emerson* 888) which uses four penlight cells. The power consumption, according to the manufacturer, is 7-40 ma. at 6 volts. Good volume was obtained on most stations with the volume control full up and the set drawing 9 ma. at about 6 volts. In this supply, the series combination of a .5-μf. paper capacitor and the primary winding of a tiny transistor interstage transformer is across the a.c. line. The output from the secondary is half-wave rectified by a silicon diode. Filtering is accomplished by a 250-μf., 12-volt electrolytic. A 3000-ohm bleeder resistor, whose function is to protect the capacitor against high, no-load voltages, completes the circuit. Where space permits, the use of a 25-volt capacitor is recommended. The output voltage and current capabilities of this supply are shown below:



Layout of the larger power supply's parts.

The ripple voltage ranges from about 80 mv. r.m.s. at low currents to 200 mv. r.m.s. at high currents. However, due to the relatively poor low-frequency response of most portable transistor radios, the ripple is barely noticeable.

D.c. Output Voltage	Output Current, Ma.
9.6	1.0
8.8	2.0
7.6	3.9
7.1	6.0
6.3	7.5
5.4	9.5
4.8	11.0
4.1	13.0
3.1	16.0

The second supply (Fig. 1B) was built with a transistor driver transformer with a capacitance of 1.25-μf. (1.0-μf. and .25-μf. paper capacitors in parallel) in series with the transformer *secondary* (used as the primary here) which is connected across the line. The output of the primary (used as the secondary) is connected to a full-wave voltage doubler consisting of two 1N34 diodes and two 25-μf. 50-volt capacitors. A 20,000-ohm resistor serves as the bleeder. The circuit was designed for devices requiring a higher d.c. voltage than

D.c. Output Voltage	Ma. Output Current,
44	0.7
38	1.8
30	3.1
27	3.9
23	6.0
19.5	7.0
16	8.5
13	9.5
9.5	10.5
6.5	11.0

could be delivered by the first supply.

The output capabilities of the larger supply are shown below.

The ripple is about constant at 500 mv. r.m.s. throughout the output range of this supply. ▲

UNUSUAL AUDIO SERVICE PROBLEM

By GREG OSGOOD

THE complaint was a constant squeal audible in a background-music system. The service call was to the funeral home in which the system was used. Thus began a merry chase that ended in an unusual section of an audio amplifier. The oscillation sounded ragged, was in the region of four or five thousand cycles, and was loud enough to be very annoying. A Viking tape deck was being fed into an Altec-Lansing amplifier, with the output distributed to several speakers throughout the building.

On-the-spot tube substitution and changes in lead dress at the amplifier input (since the oscillation seemed to be originating at the amplifier) made no difference in frequency or level, so the amplifier was brought to the shop. Decoupling filters and cathode bypass capacitors were checked, but they were quickly eliminated from suspicion. The next step was a check of lead dress. A wire was prodded here, and there, then there—and touching the last one changed the frequency of the squeal. This lead was followed up through the chassis until it lead, of all places, to the pilot light!

Yes, that was it: a neon pilot lamp in the "B+" output. Removing the lamp stopped the oscillation, and a new replacement worked just fine. At this point, troubleshooting had ended and theorizing began. Evidently a change in the characteristics of the neon lamp had caused it to act as a relaxation oscillator together with other constants used in this application.

This was the only case in which such a problem had been encountered, but several manufacturers use a similar arrangement—and it takes much less time to try another pilot lamp than to troubleshoot a chassis. ▲

Radio & TV News

Events in the Service Industry

WHEN television was young, it was common for the same dealer to sell and service the sets. As small dealers found they could not compete against large-volume retailers, either in price or in making available a wide range of models to choose from, many began to emphasize the service end of the business. A plan now being tested in selected market areas by *General Electric*, if it works out well, may help restore the role of the independent establishment with respect to set sales.

The dealer's profit position is improved by the elimination of two problems, delivery and inventory. The *G-E* district branch provides a display of major appliances for the dealer's floor, including stereo and TV. Deliveries are made on order out of district stock. Dealers carry no inventory and save the cost of transporting merchandise from warehouse to customer. The progress of this experiment will bear watching.

Function of Service

On another front, a *G-E* official expresses a notion whose reception is less cordial. John H. Miller, manager of product service, sales, and training, is quoted as saying that the primary objective of radio and TV service is to support the sale of new products. This may be entirely correct from the viewpoint of a manufacturer, whose foremost concern is to build confidence in his brand name. However, "TSA Service News" (TESA-King County, Washington), demurs: "We thought the primary objective of service was to please the customer (by giving him the service) he has a right to expect."

"TSA News" goes on to point out that, at the heart of this basic disagreement is an important difference in philosophy between independent service and the manufacturer. The former, accountable to the set owner only, is most closely oriented toward protecting the *customer's* investment, rather than the manufacturer's. From the broader consumer viewpoint, it would be hard to find a better justification for the perpetuation of an independent service industry than this distinction. Its logic, however, is not widely appreciated.

K. C. License Upheld

In a matter that has long been the subject of legal contention, Jackson County Circuit Court Judge Harry A. Hall has ruled the Kansas City ordinance for licensing TV and radio service dealers "legal and valid in all respects." His decision confirmed that "the city has the right and duty to enact ordinances for the public welfare. . . . The evidence shows that the repair and servicing of radio and television equipment require technical knowledge and special skill and, in general, come within the jurisdiction of the public authority to license and supervise in the interest of the public welfare."

Judge Hall also took note of the "almost identical ordinance" in effect for many years in Detroit, Mich., and the fact that it also withstood a court test. Attorney for the plaintiffs in the Kansas City action says that the fight is not being abandoned and that, if necessary, it will go to the state's highest court. The general feeling, however, is that the law is on the books to stay.

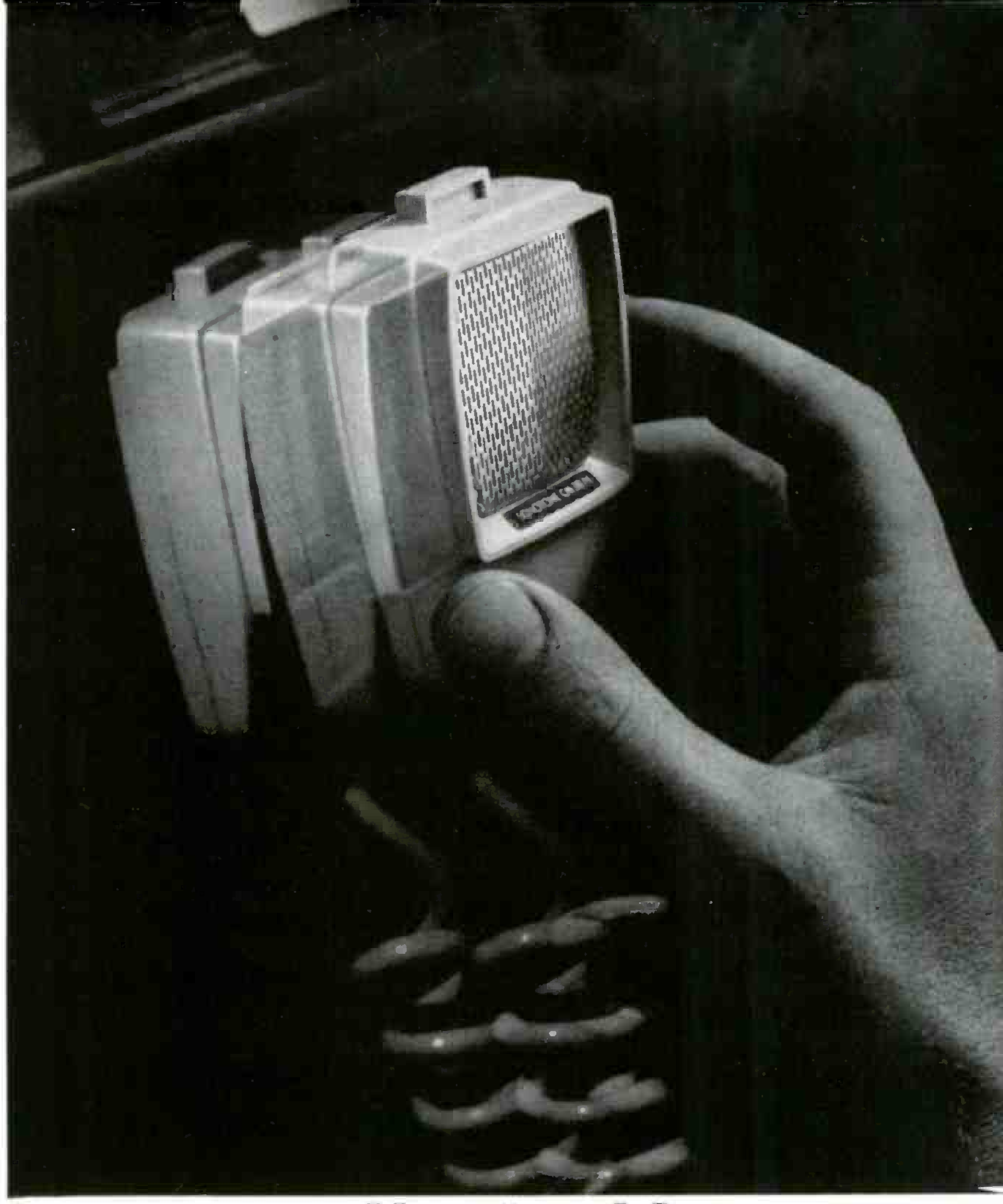
Pay TV and Service

Present course of the experiment in subscription TV on channel 18 (WHCT) in Hartford, Conn., should be heartening to independent service. By and large, service interests have opposed toll-TV as providing manufacturers with an excellent weapon (the decoder attachment) for taking over service of the entire system, including the set, on a captive basis. Manufacturers, on the other hand, have repeatedly avowed that their intentions are pure. So far, all claims and charges have been entirely theoretical.

In Hartford, specially trained teams are installing the *Zenith*-developed decoders on behalf of the station, affiliated with *RKO-General*. The men have strict instructions not to repair any sets. If a set is not in good shape, the device is not installed and the owner is instructed to contact his own TV service technician for repairs. Says WHCT station manager Charles O. Wood, "Half the people initially rejected because their sets weren't working properly have had them fixed."

From this, John Pinto, vice-president of *RKO-General*, is able to conclude: "We think we're creating business for servicemen." Concerning the decoders, which continue to be owned by the pay-TV firm and which may take half an hour or more to install, he says, "This is a complicated, uneconomic process. Here we think we're relieving servicemen of a lot of non-profit business." Rental fees for the unscramblers are intended to cover any service that may have to be performed on those devices only.

Earlier statements from *Zenith*, which is advising on the manner in which the decoders are to be handled, indicated that, at some future time, it might be possible to train and authorize local, independent dealers to work with the decoders. In any event, the promised "hands off" policy on the TV sets seems to be in force. ▲



Vibrato Simulator

(*Continued from page 45*)

signals, increase the values of R_8 and R_9.

Almost any transistor can be used in this circuit. The writer tried many, including 2N107's, with satisfactory results. If an oscilloscope is available and a signal source of 1 or 2 volts peak-to-peak, it is a simple matter to test the circuit for optimum resistor values. First, with the signal applied to the scope set the gain for 10 or 20 divisions on the screen. Then apply the signal to the network and observe the signal level at the junction of the two resistors. It is advisable to use equal value resistors for this setup, for when 50% of the input signal is observed on the scope, the resistance of the transistor in the network is negligible. An a.c. v.t.v.m. can also be used.

Construction

Construction details are shown in Fig. 1 and Fig. 3. The unit was completely assembled in a 3¼" x 2⅛" x 1⅝" "Minibox" (*Bud* CU-3001A) with a shielded cable going to the external foot switch. Although there is no critical requirement for parts placement, it is advisable to keep resistors R_8 and R_9 and the signal wires of P_1 and J_1 away from other components in the unit. It is also advisable to use just one or two ground lugs and make certain that a good mechanical and electrical ground is obtained.

When selecting capacitors C_1 and C_2, consider using the *Sprague* "Hypercon" ceramic disc type, part numbers HY-330 and HY-135 respectively. These are high-capacitance, low-power-factor miniature ceramic discs. They are also low priced. The manufacturer rates these with a capacitance tolerance of guaranteed minimum value. In checking an assortment of these capacitors on a bridge it was found that the 0.47-μf. units (HY-330) invariably exceeded .5 μf. and the 1-μf. units (HY-135) were closer to 1.5 μf. When selecting capacitor C_3, consider using a 4-μf. electrolytic rather than a 5-μf. unit. The low-priced variety of miniature electrolytics have capacitance tolerances of −20 to +150, the higher tolerance usually being the case. The capacitors listed above were used in this unit with excellent results. Of course, if standard-sized components are used, which normally have a ±20% tolerance, the specified values of .5 μf., 1.5 μf., and 5 μf. should be used.

Phone plug P_1 is a flat type with the plastic case removed. Drill a hole at one end of the chassis, large enough to pass the plug connectors through. Drill three additional holes corresponding to the screw holes on the plug to facilitate mounting it to the chassis. The three screws removed with the plastic cover can be used for this purpose. Mount the phone jack J_1 on the opposite end of the chassis. The two miniature potentiometers R_2 and R_6 are mounted on the bottom side of the chassis. All electrical components are assembled using two 6-terminal strips mounted on the chassis bottom.

The foot switch is a momentary d.p.s.t. push-button type, mounted in an ordinary plastic door stop, which can be purchased at most hardware stores. Since the unit is battery-operated and does not have a pilot light, a momentary switch was used to eliminate the possibility of leaving the oscillator on when the unit is not being used. A push-on, push-off type switch can also be used if desired.

The cable for the foot switch is a miniature four-conductor shielded type (*Belden* part number 8434). This cable is excellent for this purpose because it contains two pairs of wire separately shielded. It was noticed that if an unshielded cable is used, a small transient pulse, caused by the opening and closing of S_{1A}, is picked up through the wires of S_{1B} and transmitted to the amplifier as a click. If desired, two small-diameter, two-conductor cables (one shielded) can be used. Use the shielded pair for the modulator circuit since this will also help minimize stray hum and pickup.

The author made some attempt to keep the unit small which necessitated the use of miniature parts. These parts are generally more expensive and less readily available than standard size parts. There are, however, many different ways in which the unit can be built. For example, the entire unit can be assembled in a chassis fabricated to also serve as a foot switch (*Bud* chassis No. C-1606 can be used). This would eliminate the need for the shielded cable to the foot switch and would preclude the possibility of transient or hum pickup. The unit can also be assembled in a chassis which has provisions for mounting it to the amplifier case or chassis.

Another possibility would be to replace the 15-volt battery with an a.c.-operated power supply and assemble the entire unit in a chassis attached to the instrument amplifier chassis. In this case, the unit can be switched on and off using the instrument power switch. The oscillator circuit can be left running which would eliminate the need for the switch S_{1A} and a s.p.s.t. switch could then be used for S_{1B} to make and break the modulator circuit.

If the loss of approximately 50% of the input signal can be tolerated, switch S_{1B} can be eliminated leaving R_9 and V_2 permanently in the circuit. A two-conductor unshielded cable with a s.p.s.t. switch can be used to make and break the oscillator circuit. Most amplifiers for musical instruments have sufficient gain to accommodate this loss of input signal.

Construction techniques for this unit

are really the reader's choice and are as varied as his needs and imagination.

Operation

Once the vibrato simulator has been assembled, all that remains to be done is to put it to use. Plug the unit into the guitar amplifier and the guitar cable plug into connector J_1. Adjust the guitar and amplifier controls for normal operation. With the foot switch open, the guitar operates in the normal manner. Depressing the foot switch couples the vibrato circuit into the amplifier input. Adjust R_2 for the desired vibrato speed and R_4 for the desired intensity.

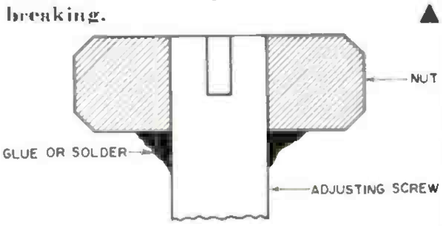
It is unlikely that trouble will be encountered unless, of course, an error has been made in wiring. In case of trouble, carefully re-check the wiring, especially the terminals of J_1 and P_1, since it is easy to reverse these connections and thereby ground the input or output of the unit. The oscillator can be checked for oscillation by connecting a v.t.v.m. between the collector and ground. A reading of approximately -3 volts should be obtained. Also, the pointer of the meter will be moving at the oscillator rate. Check to see if the circuit oscillates through the complete rotation of R_2. It is possible, using this transistor, to get one with an extremely low gain factor. Therefore, try another transistor of the same type, if everything else appears normal. The only other factor that can cause a problem is the variance in capacitance tolerances of C_1, C_2, or C_3 as mentioned earlier in this article. Capacitor values can easily be checked on a capacitor checker. ▲

ADJUSTING-SCREW MODIFICATION

By ROBERT K. RE

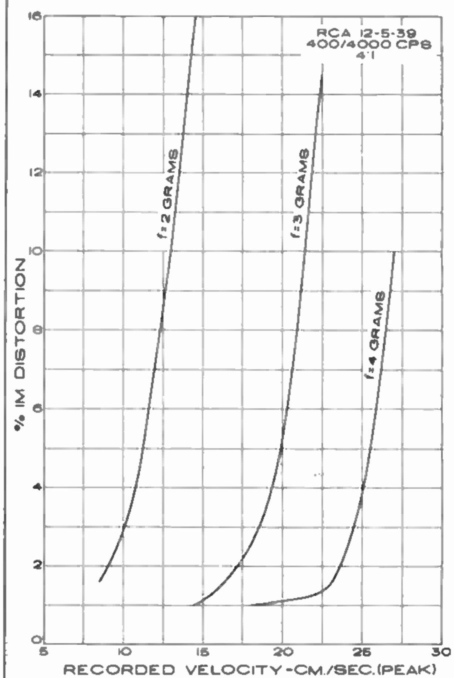
THREADED adjusting screws on electronic components serve very useful purposes, but they can cause a lot of grief for service technicians: screwdriver tips become chipped and broken, adjusting tools slip out of the slot, and half the screwdriver-slot breaks off. These problems can be minimized by using the following tip: if a small nut is screwed on the shaft until it is flush with the end, then glued or soldered in place, adjustment becomes easier.

Screwdrivers will not slip out of the slot, and spin-tites can be used to adjust the screw. The screw can be adjusted by turning the nut with the fingers, if desired, and plastic nut-drivers can be used where the metal type will cause detuning. A small spacer slipped over the end of the screw will also prevent the slot from breaking. ▲



EW Lab Tested

(Continued from page 26)



Note how intermodulation distortion falls as tracking pressure is increased. However, an increase in tracking pressure results in increased record wear. In this case, the increase would not be too significant. The standard reference levels (at 1000 cps) for mono records are 7 cm./sec. (peak) recorded velocity and 5 cm./sec. (peak) for stereo records. Occasionally, recorded peaks as high as 20 cm./sec. may be on a recording. The test record that was used was a 78-rpm disc with residual IM of less than 3%.

tion clips used in most high-fidelity tonearms.

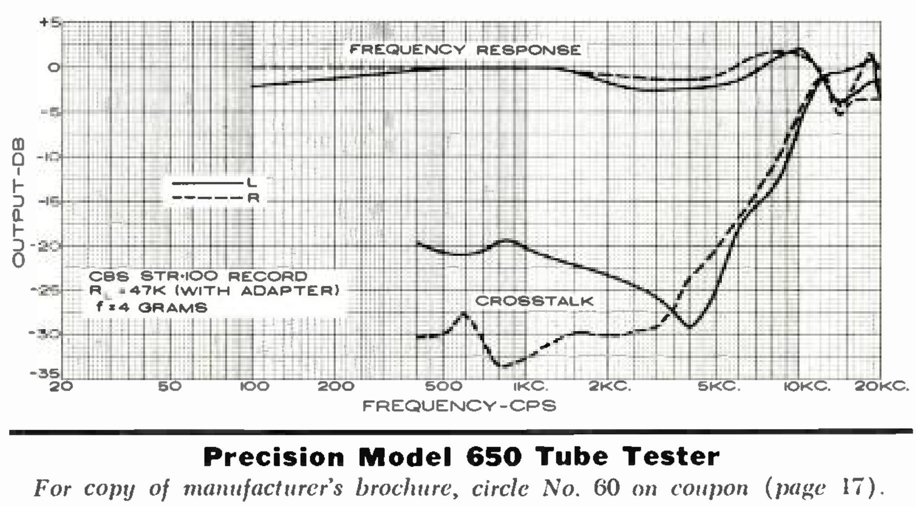
We measured the frequency response and channel separation of the new cartridge with the *CBS Laboratories'* STR-100 test record. The response (shown corrected for the recording characteristics of the test record) was within ±2.5 db up to 13 kc. After a slight dip at 14 kc., full response was obtained all the way to 20 kc. Crosstalk was down 20 to 30 db at middle frequencies, and 11 to 14 db at 8 kc.

The cartridge tracked very well at high velocities. Intermodulation distortion measurements with the *RCA* 12-5-39 lateral-cut 78-rpm test record confirmed *Sonotone's* claim for 5% IM distortion at 20 cm./sec. peak velocity and 3-grams tracking force. This is adequate for practically all records; at 4 grams the cartridge will track over 25 cm./sec. with low distortion. The 2-gram lower limit would only be acceptable for relatively low-level passages.

This cartridge has higher output than most, about 13 mv. at 5 cm./sec. Since it is inherently free from magnetically induced hum, it should provide an exceptionally good signal-to-noise ratio. Needle talk is audible at low listening volumes, but would not be noticed under normal listening conditions.

The listening quality of the cartridge is clean, bright, and crisp. Its extended high-frequency response and low distortion are very evident on wide-range speaker systems. Stereo effect is excellent; we could not hear the loss of high-frequency separation which our measurements revealed.

The cartridge is ideally suited for systems where 78-rpm records as well as LP and stereo discs are to be played. Its listening qualities are superior to many more expensive magnetic cartridges and the low tracking force is conducive to long record life. The list price of the cartridge is $19.25. ▲



Precision Model 650 Tube Tester

For copy of manufacturer's brochure, circle No. 60 on coupon (page 17).

SOME tube testers designed for the radio-TV service technician are expensive, elaborate, and very time-consuming to use, especially if a large number of tubes are to be tested. Others are inexpensive, simple, and easy to use, but they provide only a very limited amount of information about tube quality. The new Precision Model 650 Grid-Circuit Analyzer Tube Tester fits in between these two categories. Priced at $69.95 factory-wired, the tester is simple to use and a large number of tubes can be checked quickly and easily. Equally important, though, the unit provides in addition to the usual cathode-emission test, a test for shorts and leakage between all tube elements, and a test for grid emission, grid leakage, and gas. With such defects a tube

will develop reverse grid current that produces a positive bias. This bias bucks the normal negative grid bias and may cause signal overload and distortion, improper sync clipping, or, in a picture tube, loss of focus.

In addition to the tube tests, the Model 650 uses its built-in v.t.v.m. circuitry (normally employed for grid-circuit testing) as a high-range megohmmeter. The mid-scale reading of the megohmmeter is 4.5 megohms, with calibrations from ½ meg to 1000 megs. Interestingly, instead of using the usual 1½-volt battery as a voltage source for resistance readings, this tester uses d.c. voltage that we measured to be around 75 volts for this purpose. As a result, this feature is especially useful in finding high leakage across printed-circuit leads, capacitors, coils, and cables as well as measuring high-value resistors. Incidentally, the voltage does not represent a shock hazard since it is applied through a high-value resistor.

The tube tester does not waste space and wiring for testing the old 4-,5-,6-, and 7-pin tubes. Instead it concentrates on the up-to-date and very new types of receiving tubes. The unit checks 7- and 9-pin miniatures, octals, loctals, 9-pin novars, new 10-pin miniatures, 12-pin compactrons, and 5- and 7-pin nuvistors. Picture tubes can also be tested with a separately available adapter cable.

The circuit and switching are quite conventional. A built-in balanced-bridge v.t.v.m., using a 12AU7 tube, checks for reverse grid current. The input impedance of this circuit is around 4.5 megohms and it will show up grid and gas currents of under 1 μa. directly on the meter.

After using the tester on our bench to check a couple dozen tubes, we began to think of it as a "1-2-3" tester. After making the setup adjustments and inserting the tube, it is just a matter of (1) rotating a switch to check for shorts, (2) pushing a button to check for cathode emission, and (3) pushing another button to check the grid circuit. We also tried a couple of tubes that had low emission as indicated on another far more elaborate tube tester, and we found good agreement in the results obtained on the Model 650. One minor point has to do with the operation of the cathode-emission push-button. We would suggest that the user depress this button all the way and not hesitate in the partly depressed position, otherwise the meter shunt seems to be removed from the meter, causing it to go off-scale. Normally, when the button is fully depressed, the circuit is broken just for an instant and no harm is done. (According to the manufacturer, this condition is not typical and was probably due to misalignment of the push-button switch in the unit checked.)

If you've recently changed your address, or plan to in the near future, be sure to notify us at once. We'll make the necessary changes on your mailing plate, and see to it that your subscription continues without interruption. Right now — print the information requested in the spaces below and mail it to: ELECTRONICS WORLD, 434 So. Wabash Ave., Chicago 5, Illinois.

Name *Please PRINT!*

**Account No.*

Old Address

City *State*

New Address

City *Zone* *State*

Mail copies to new address starting with____________issue.

***(Your Account Number appears directly above your name on the mailing label.)**

Next we tested the megohmmeter accuracy by checking about a dozen accurate resistors ranging from 1 to 22 megohms. Most of the readings obtained were "right on the button" and as close to the correct values as we could read on the meter scale.

The setup data for testing tubes is printed on cards in a loose-leaf booklet that should be able to stand a lot of use and that can be kept up-to-date easily. The company has a subscription service for a nominal fee that will keep the listings current. Also, from time to time complete sets of revised data cards will be made available at nominal cost. This policy should keep the tester useful for many years to come.

In conclusion, the Model 650 fills a definite need as a convenient, easy-to-use tester that has several functions normally found on more elaborate testers. The lightweight and compact carrying-case size (9" x 13" x 4½") should make it easy to find a spot at the service bench for the unit as well as convenient to take into the customer's home for servicing.............E.W.

Mac's Electronics Service

(*Continued from page* 52)

of the things that make solving these intermittents so difficult. If the volume drops and you try to use the signal tracer to see where the signal is lost or to bridge a suspected capacitor with a good one, the instant you touch any part of the circuit with probe or lead, the volume hops back up and stays there. About all you can do is connect meters and signal tracers to different parts of the circuit and then wait for the intermittent condition to take place. When it does, if your signal indicating instruments are connected to the right places, you will get an indication that will pinpoint the defective part, or at least locate it in a comparatively small area."

"There are a few intermittents that are so comparatively easy to locate you might almost call them *good intermittents*." Mac said with smile. "I'm thinking about the worn volume control that causes the volume to hop up and down erratically or the set even to go into oscillation at certain settings. Then, too, there is the intermittent noise that can be easily traced to a rectifier mounted near the loop antenna. The slightest jarring of this tube will radiate noise into the antenna. A new tube, of course, is the cure."

"Metallic particles between tuning capacitor plates can also cause intermittent noise at certain dial settings," Barney threw in; "and sets that go completely dead shortly after they are turned on are usually caused by converter tubes or second detector tubes that short out internally as they warm up. Tapping these tubes will usually bring the signal back up for a few seconds. Tapping them again will make the sound disappear."

Mac reached over and felt the tubes of the little radio. Finding them completely cold, he turned on the switch. The dial lamp came on, flickered fitfully, and then went out. Barney did not need to be told what to do. Working with cautious haste, he eased the set over on its back, attached the common clip of the v.t.v.m. to one side of the power switch, and used the a.c. probe to explore the voltages present at the tube filament connections on the sockets. When he reached the 50C5, 100 volts was present at one filament connection and zero voltage at the other. Quickly he transferred the common lead clip to the dead socket connection and placed the probe on the other. A hundred volts was still indicated, but at that moment the dial lamp flickered on and the voltage fell to around fifty volts.

"Well, it *was* an intermittent," he admitted as he reached for a new tube. "How come it showed up for you and not for me?"

"Candidly, I don't *know* why operating a set with an intermittent filament at an elevated voltage for a few minutes and then allowing it to cool down and starting it up again at a reduced voltage will often make these stubborn cases 'intermit,'" Mac admitted; "but by sheer, blundering fool luck I've found out it does. Undoubtedly it has something to do with the expansion and contraction of the fractured filament and breaking down the temporary tiny weld that is holding the broken ends together and keeping the set going when you want it to quit. I always use this method as a last resort before returning an alleged 'dead' radio to a customer and telling him I just can't find anything wrong with it."

"I wonder how long I'll have to work at this business before some of your 'sheer, blundering fool luck' rubs off on me," Barney said wistfully as he put the little receiver back in its case. ▲

FACTORY SALES OF PHONO UNITS TOP 1961

According to figures just released by the EIA, factory sales of both mono and stereo phono units during the first six months of this year topped the same period in 1961 by 37,446 for mono and 31,889 for stereo units.

Although mono sales by distributors are ahead of last year by 33,698, the sales of stereo units are lagging by 4655 but the Association believes that this deficit will be removed before the year is over.

Thus far this year, February and March have produced the highest number of distributor sales with 188,857 stereo and 50,563 mono units sold in February and 236,051 stereo and 63,206 mono sales in March. Mono distributor sales in March actually topped factory sales for that month by some 2215 units.

The phonographs included in the EIA report are so-called "packaged units" and exclude component systems. ▲

ELECTRONIC CROSSWORDS

By DONALD W. MOFFAT

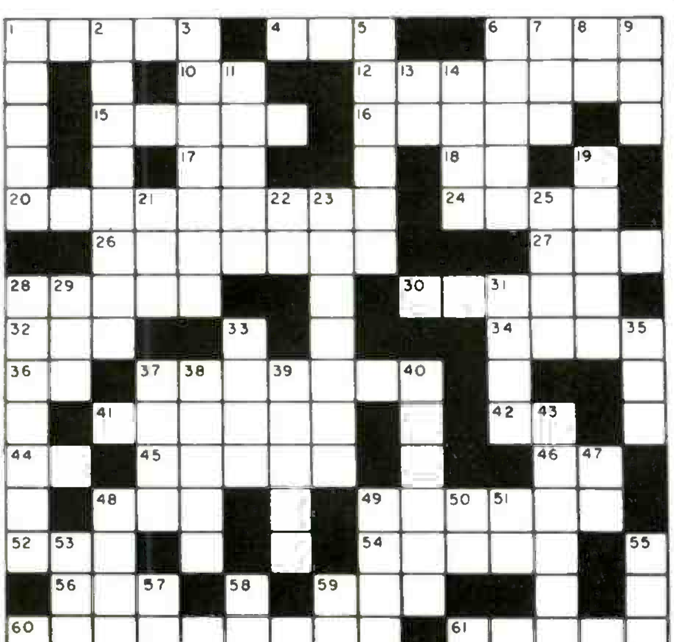
(Answer on page 111)

ACROSS

1. Unit of light.
4. Color for "two."
6. Wound with a knife.
10. Response to a doctor's request.
12. Short period of time.
15. Unit of loss.
16. Batteries that power "Telstar."
17. Midwestern state (abbr.).
18. Light metal (abbr.).
20. Slipstick.
24. Hole for a speaker.
26. Oscillations.
27. Tree.
28. Some are "twice told."
30. What the satellites do.
32. It usually means trouble when components do this.
34. As opposed to the "expensive spread."
36. Schematic notation for a relay.
37. Type of battery.
41. One type of computer.
42. Printers' measure.
44. Formerly (prefix).
45. Overweight.
46. Fellow ham.
48. Athena's habitual companion.
49. Three times.
52. Greek letter used to designated "time."
54. Rare member of the heron family.
56. 23rd letter in the Greek alphabet.
59. The "cheerful month."
60. Voltage.
61. Prefix for 1/100.

DOWN

1. Draws current.
2. Bone of the lower jaw.
3. Family name of the inventor of logarithms (pl.).
5. Type of antenna reflectors.
6. Type of oscillator.
7. A sailor (slang).
8. Indefinite article.
9. Unit of heat.
11. Listened to.
13. Refusal.
14. Hit with the open hand.
19. Describes solid, liquid.
21. Makes external thread.
22. Midwestern University (abbr.).
23. Capacitor failure.
25. Stir up.
28. Trig term.
29. Past.
31. Part of a skeleton.
33. Positive carrier.
35. Unit of resistance.
37. Noise on a CRT.
38. List of numbers.
39. Flux.
40. It cannot be destroyed.
43. In a liquid state.
47. Not you.
48. Expel.
49. Grayish blue.
50. This equals E.
51. A professional engineer.
53. The G.I.'s get their mail here.
55. 22nd letter of Greek alphabet.
57. That is (Latin).
58. Thing.
59. Unit of small current flow.



Xmas Shopping is Easy with Heathkit!

With a Heathkit Catalog you can relax and enjoy Christmas shopping—gift giving without ever leaving your living room! You'll find a Heathgift for everyone on your list, regardless of interest, from beginner to experienced technician. And you give so much more with Heathgifts, for you save two ways—by buying direct from Heath and by buying in kit form. Savings that total 50% or more!

Heathgifts are fun to give, fun to own, and they're fun to build . . . so much so that you'll be tempted to build them all before giving! Simple instructions enable you to complete any kit in your spare time—in a matter of hours—and they are unconditionally guaranteed to perform to factory specifications.

So give the best in electronic kits, give Heathgifts. Call or write our gift counselors if you need help or give a Heathgift certificate. Begin making your Heathgift List today and place your own name at the top!

Buy Now—No Money Down!

Here's help for your Xmas Budget! Order your Heathgifts now, and any purchase of $25 to $600 can be paid for later on Heath's liberal time-pay plan. *No money down!* Take *as long as 18 months to pay!* You'll find complete details in the new Heathkit catalog. Make out your Heathgift order and mail it today!

NEW 23" High Fidelity TV Kit—None Finer at Any Price!

SAVE $10, order GR-52, TV chassis & cabinet......only **$249.95**

SAVE $6, order GR-62, TV chassis & wall mt......only **$189.95**

OPTIONAL U.H.F. TUNER: Add at any time! Tunes U.H.F. Ch. 14-82. Mounts inside TV chassis. Complete with knobs and adapter strip. Factory assembled and aligned, ready to install.

GRA-22-3, no money dn., $5 mo...... **$27.95**

An outstanding TV value! Exclusive Heathkit advanced-design features include latest TV circuitry to bring you *both* Hi-Fi picture and sound! Incorporates the finest set of parts & tubes ever designed into a TV receiver. Easy to build too! . . . all critical circuits (tuner, I.F. strip & Hi-voltage sections) are supplied as factory-built, aligned and tested sub-assemblies, ready to install. The rest is easy with two precut, cabled wiring harnesses and circuit board. 70 lbs.

Kit GR-22, no money dn., $16 mo.. **$169.95**

BEAUTIFUL MODERN CABINET: Styled to match Heathkit AE-20 Hi-Fi Cabinets in rich, walnut solids and veneers. Complete with picture tube mask, chassis mounting board and extended-range 6" x 9" speaker for GR-22 TV set. Measures 36" W x 32⅜" H x 20½" D.

GRA-22-1, no money dn., $9 mo...... **$89.95**

"CUSTOM" TV WALL MOUNT: For rich, attractive custom wall installations. Includes cut and drilled board for TV chassis. Unfinished white birch. Measures 19⅞" H x 30⁷⁄₁₆" W x 1¹¹⁄₁₆" D. 13 lbs.

GRA-22-2, no money dn., $5 mo..... **$25.95**

NEW Deluxe CB Transceiver

4-tone selective call circuitry; 5 crystal controlled transmit & receive channels; variable receiver tuning; built-in 3-way power supply for 117 v. ac, 6 or 12 v dc; and more! Most complete CB unit ever designed! 22 lbs.

Kit GW-42, no money dn., $1 ..... **$119.95**

NEW Advanced Transistor Stereo Amplifier

Smooth power—superb dynamic range! 100 watts IHFM Music Power rated, 70 watts Heath rating. 13 to 25,000 cps response @ rated output. 28-transistor, 10 diode circuit. 28 lbs.

Kit AA-21, no money down, $13 mo. **$134.95**

Home and Save
HEATHKIT®

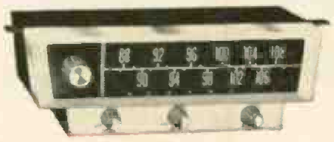
ANOTHER HEATHKIT FIRST!
A Real 2-Manual Organ for Only $329.95

The exclusive Heathkit version of the all-new Thomas Transistor Organ now, for the first time, offers you a real two-manual organ at the market-shattering low price of only $329.95 in easy-to-build kit form! Compares in features and performance with assembled units costing well over $700. Features two 37-note keyboards; 10 true organ voices; 13-note pedal bass; variable vibrato; expression pedal; variable bass pedal volume; manual balance control; correctly positioned over-hanging keyboards; built-in 20-watt peak amplifier and speaker system; beautifully factory assembled and finished walnut cabinet.

Kit GD-232 (less bench) . . . no money dn., as low as $22 mo. . . . **$329.95**

Hear It for Yourself!

Send for this Heathkit organ demonstration record . . . listen to the beautiful voices, rich mellow tone and astounding range of expression offered in this sensational instrument. Send just 50c to cover cost of handling and postage on this 7"—33⅓ rpm record. **Ask for record GDA-232-3.**



NEW 10-Transistor FM Car Radio

88 to 108 mc coverage; better than 1.25 microvolt sensitivity; AFC for drift-free FM reception; tone control. Factory-assembled tuning unit; easy circuit board assembly. 7 lbs.

Kit GR-41 . . . no money dn., $7 mo. . **$64.95**

NEW FM Portable Radio

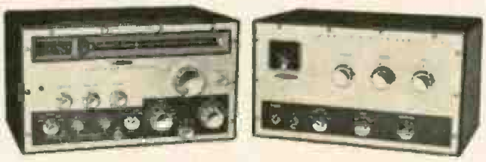
10-transistor, 2-diode circuit; vernier tuning; AFC for drift-free reception; tone control; 4" x 6" speaker; built-in antenna; prebuilt tuning unit. Battery lasts to 500 hrs. 6 lbs.

Kit GR-61 . . . no money dn., $6 mo. . . **$54.95**

NEW FM/FM Stereo Tuner

Stereo Indicator light; phase control for max. separation and lowest distortion; adjustable AFC for drift-free reception; bar-type tuning indicator; filtered outputs for stereo tape recording. Factory assembled tuning unit. 16 lbs.

Kit AJ-12 . . . no money dn., $7 mo. **$69.95**



NEW Heathkit SSB "Six Pack"

A brand new SSB exciter and linear amplifier for six meter operation; 125 watts P.E.P.! Only $289.90 for the pair . . . less than the cost of most transverters. Loaded with extras for maximum efficiency and operating convenience!

Kit HX-30 Exciter. **$189.95**
HA-20 Linear. **$99.95**

World's Biggest VTVM Value!

Measures AC volts (RMS), AC volts (peak-to-peak), DC volts, Resistance and DB. Has 4½" 200 ua meter, precision 1% resistors and 11 megohm input. Slim, all-purpose test probe incl. 5 lbs.

Kit IM-11 Special Value Price, ... **$24.95**

FREE 1963 HEATHKIT CATALOG
New edition — more than 100 new kits since last issue — over 250 kits all.

HEATHKIT by Daystrom

HEATH COMPANY
Benton Harbor 15, Michigan

☐ PLEASE SEND FREE 1963 HEATHKIT CATALOG

Name ____________
Address ____________
City ________ Zone ________ State ________

Order direct by mail or see your Heathkit dealer.
Ship ☐ Parcel Post ☐ Express ☐ C.O.D. ☐ Best Way

Ordering instructions: Fill out the order blank, include charges for parcel post according to weights shown. Express orders shipped delivery charges collect. All prices F. O. B. Benton Harbor, Mich. A 20% deposit is required on all C.O.D. orders. Prices subject to change without notice. Dealer and export prices slightly higher.

ITEM	MODEL NO.	PRICE

CIRCLE NO. 126 ON READER SERVICE PAGE

All-Purpose TV-FM Antenna

(*Continued from page 37*)

flipped over, as in Fig. 4C. This is important. For proper operation, the two plates must be complementary.

Then, with the sections secured together at the apex, they were opened at the wider ends to the desired angle of separation and braced in this position. The actual separation distance for this version is indicated in the side view of the completed antenna in Fig. 5. It is obtained by cutting a pair of struts slightly shorter than the indicated measurement and placing one at each side of the assembly's open end, from the bottom section to the top section. One of these is shown to the right in Fig. 5. Also shown are additional, shorter struts that were fitted in to provide support. The enlarged detail in this illustration indicates how the transmission line may be connected to the bare, center wires for

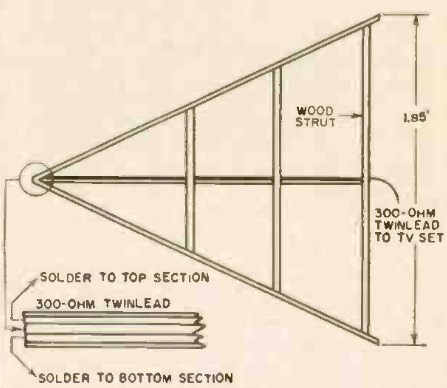


Fig. 5. Side view shows the support struts and how lead-in wire may be run.

each section at the apex and run out through the back or open end. One conductor of the transmission line is anchored to the center wire of the upper section, near the apex. The other conductor of the 300-ohm ribbon is similarly connected to the center wire of the lower section.

Because of its directivity in both planes, the antenna will have to be oriented both vertically and horizontally. Remember that the apex is pointed toward the desired signal. If the assembly is being installed in an attic, ropes, wooden struts, or other insulating members can be used to secure it in the proper position.

Whether a user builds the version described exactly or expands it somewhat for flat response to the frequency extremes, he will find that he has combined the desirable characteristics of a sharply resonant antenna with broad enough bandwidth to cover all foreseeable transmissions, TV or FM, for some time to come, as well as many non-commercial services in intervening bands. His antenna problem should be settled for some time to come. ▲

Calendar of Events

OCTOBER 25-27
1962 Electron Devices Meeting. Sponsored by PGED of IRE. Sheraton Park Hotel, Washington, D.C. Details from J. Earl Thomas, Jr., IBM Corp., Dept. 677, P.O. Box 110, Poughkeepsie, N.Y.

OCTOBER 26
Third Annual Seminar on Reliability in Space Vehicles. Sponsored by PGCP, PGED, and PGRQC of IRE, Los Angeles Section. Rodger Young Auditorium, Los Angeles. Details from IRE, 1 E. 70th St., New York 21, New York.

OCTOBER 30-31
Conference on Spaceborne Computer Engineering. Sponsored by PGEC of IRE. Disneyland Hotel, Anaheim, California. Program information from R. Kudlich, AC Spark Plug, 950 N. Sepulveda Blvd., El Segundo, Calif.

NOVEMBER 1-2
Sixth National Conference on Product Engineering & Production. Sponsored by PGPEP of IRE. Jack Tar Hotel, San Francisco. Program information from George F. Reyling, Varian Associates, 611 Hansen Way, Palo Alto, California.

Eleventh Annual Instrumentation Conference. Sponsored by the School of Engineering, Louisiana Polytechnic Institute, Ruston, La. Held on the University campus. Program details from Claud J. Irby, c/o the Institute.

Chemtronics Conference. Sponsored by American Society for Quality Control. Statler Hilton Hotel, New York, N.Y. Details from E. C. Torkelson, Bell Telephone Laboratories, 463 West Street, New York, N.Y.

NOVEMBER 4-7
Fifteenth Annual Conference on Engineering in Medicine & Biology. Sponsored by PGBME, AIE, ISA. Conrad Hilton Hotel, Chicago. Program information from D. A. Holaday, P.O. Box 1475, Evanston, Ill.

NOVEMBER 5-7
1962 Northeast Electronics Research & Engineering Meeting. Sponsored by Region 1 of IRE. Commonwealth Armory, Somerset Hotel, Boston, Mass. Program information from I. Goldstein, Raytheon Co., Box 555, Hartwell Road, Bedford, Mass.

NOVEMBER 12-14
Radio Fall Meeting. Sponsored by PGBTR, RQC, ED, EIA. King Edward Hotel, Toronto, Ont. Details from Virgil M. Graham, EIA Eng. Dept., 11 E. 42nd St., New York 36.

NOVEMBER 12-15
8th Annual Conference on Magnetism & Magnetic Materials. Sponsored by PBMTT, AIP, AIEE. Penn-Sheraton Hotel, Pittsburgh. Program information from G. W. Weiner, Research Labs., Westinghouse Electric Corp., Churchill Bor., Pittsburgh.

NOVEMBER 16-17
Second Canadian IRE Communications Symposium. Sponsored by Montreal Section of IRE. Queen Elizabeth Hotel, Montreal. Details from Alan B. Oxley, Canadair Ltd., Box 6087, Montreal, P.Q.

NOVEMBER 19-20
Mid America Electronics Conference. Sponsored by Kansas City Section of IRE. Hotel Continental, Kansas City, Mo. Program information from Dr. John Warfield, Dept. of E.E., University of Kansas, Lawrence. ▲

Electronic Concepts

(*Continued from page* 57)

lytic, for example, may have enough inductance to offer substantial reactance at high signal frequencies—enough, in fact, to make the component a poor bypass at such frequencies even though its capacitive reactance may be negligible. This is why paper capacitors of about .1 μf. are often used to bypass high-capacitance electrolytics.

FICTION: *It is good practice to replace an open pilot lamp in a table radio after all other repairs to the receiver have been completed.*
FACT: The lamp should be replaced before troubleshooting begins. In a circuit arrangement where it is in shunt with a portion of the heater of a 35Z5 or similar tube, as in Fig. 3C, an open in the pilot lamp will pose a threat to the parallel section of the heater.

The current surge that takes place when the set is turned on is likely to blow this portion of the heater. Originally the surge current, which divided between the heater section and the pilot lamp, was not so menacing. In addition, the voltage applied to the other section of the rectifier heater, as well as voltage applied to the other heaters in series with it, will be slightly reduced.

FICTION: *There is nothing wrong with using a larger-than-called-for value of coupling capacitor as a replacement.*
FACT: This is true sometimes, but not always. A larger value is likely to have more leakage current, which tends to make the grid of the stage to which it connects more positive with respect to ground. Also, it introduces a higher value of stray capacitance to ground. At certain frequencies, response of the stage involved may thus be affected. This would be the case in many video circuits. Finally, the larger coupling capacitor may permit undesired signals to pass through in greater amplitudes than was originally intended with the specified value. In a TV receiver, for example, video signal might be permitted to enter the vertical deflection circuits.

FICTION: *The r.f. carrier of an amplitude-modulated wave varies in amplitude.*
FACT: The amplitude of the r.f. carrier itself does not vary. What actually happens can be clarified with reference to Fig. 4. The r.f. carrier is *A*. The lower-frequency modulating signal is *B*. When these two heterodyne, as in the process of amplitude modulation, sum and difference frequencies are produced. These appear as the lower and upper sidebands in *D* and *E*. The mixture or addition of the r.f. carrier with these sum and difference frequencies (*A*, *D*, and *E*) results in a composite modulated wave (*C*) which does vary in amplitude as the audio signal does. But this composite wave—consisting of the carrier in combination with its sidebands—is not the carrier itself. ▲

ANTENNA QUIZ

By JOE TERRA

TRY matching the characteristics of the various antennas, given in the second column, with their names in the first column. You can check your answers on page 111.

1. Adcock
2. Beverage
3. Bilateral
4. Corner Reflector
5. Dipole
6. Diamond
7. Franklin
8. Ground Plane
9. Hertz
10. Marconi
11. Periodic
12. Yagi
13. Zeppelin

A. Quarter-wave vertical element and four horizontal radial elements. Generally non-directional with low angle of radiation.
B. Conductor half wavelength long at a given frequency. The most common form is separated at the center by an insulator.
C. A form of end-fire antenna array having maximum radiation in the direction of the array line.
D. An antenna made with its connection to the ground through a suitable tuning coil.
E. Conductor that is some multiple of a half wavelength long. Fed at one end by one lead of a two-wire transmission line that is also some multiple of a half wavelength long.
F. An antenna which is not grounded.
G. Directional antenna consisting of a very long single conductor a few feet off the ground.
H. Directional antenna array consisting of four long conductors laid out like an equal-sided parallelogram.
I. Impedance varies as the frequency is changed, due to reflections or standing waves within the antenna system.
J. Uses two flat conducting sheets behind the driven element. They are joined at an angle of 45 to 90 degrees with the driven element set at a line bisecting this angle.
K. Type of short-wave antenna in which several half-wave sections are used one above the other, with coils between the sections.
L. Two or more vertical conductors arranged for reception or transmission of radio waves such that the interconnecting horizontal wires have little or no pickup.
M. Has maximum response in two diametrically opposite directions.

+0 -¼ db from 1 to 1,000,000 cps. That's the bandwidth of the new Harman-Kardon Citation A—the world's first professional Solid State (transistorized) Stereo Control Center. It is totally new in concept, design and performance. When you hear it, you will share the experience of its creators—the experience of genuine breakthrough and discovery; the experience of hearing music as you've never heard it before. Citation A represents a towering achievement for Stewart Hegeman and the Citation Engineering Group. It will change all of your ideas about the reproduction of sound. Visit your Citation dealer now for an exciting premiere demonstration.

For more complete technical information on Citation A write to the Citation Division, Dept. EW-11, Harman-Kardon, Inc., Plainview, N.Y.

harman kardon

(*Continued from page* 34)

vital importance in many military systems, the present reliability of transistors, for example, is ample for the majority of applications. While the space- and weight-saving aspect of integrated circuits is mandatory for our unfolding space program, it is of little importance for TV sets, for instance, where the demand for ever-increasing picture tube sizes limits the minimum dimensions of the ultimate package. Even the cost-reducing features of integrated circuits are at present limited to special applications, such as computers, where only the need for thousands of similar circuits demands the production quantities necessary for low-cost fabrication. Thus, while integrated circuits may eventually obsolete a number of job classifications currently in demand, in the immediate future they will create an unprecedented demand for physicists, metallurgists, chemists, and semiconductor engineers needed to further develop the state of this art.

Even circuits engineers will be in increasing demand, although an important premium will be placed on circuit designers with considerable training or experience in one or more of the above-mentioned sciences. The reason is that integrated circuits designers must be thoroughly familiar with electronic circuits *per se*, but also with the fabrication procedures and characteristics of semiconductor processes. A particular circuit may be reproducible with discrete thin-film capacitors, yet it may be far less expensive and more efficient to fabricate the same circuit using the capacitive effect of a back-biased diode for the same purpose. The reduction of conventional circuits to integrated circuit form requires a specialized knowledge which opens new technical frontiers and increasing employment opportunities.

Integrated Engineering

But as the art of integrated circuits advances, the concept of engineering likewise will become more integrated. Today there are three broad and distinctly separate engineering categories—components engineering, circuits design, and systems engineering. The components engineer concerns himself only with the development of a range of component values which will become the tools of the circuit designer. He need not concern himself with the actual circuits nor does he require an intimate knowledge of the eventual application of his products.

The circuit designer, on the other hand, cares little about the component fabrication process as long as a particular part has the electrical characteristics to fit his circuit requirement. He does not even have to concern himself with the needs of the systems engineer but can concentrate primarily on the development of circuits.

Finally, the systems engineer treats the output of the circuit designer as his particular components, or building blocks, from which to construct a more complex system. In this technology, therefore, the three engineers can work virtually independent of each other, neither knowing nor caring about the work of the other.

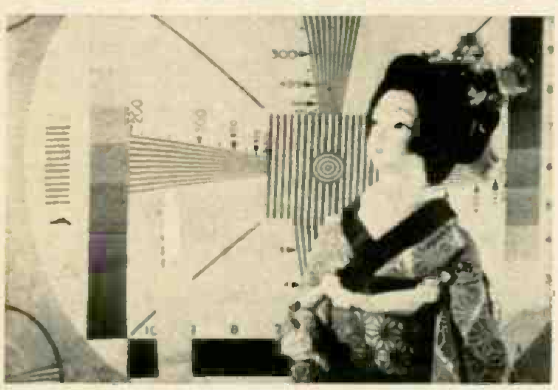
Not so with integrated circuits.

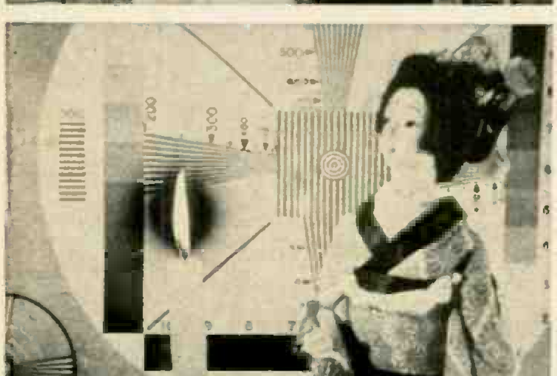
Here is an entirely new technology that demands the very closest cooperation among all phases of electronics engineering. The circuit designer now becomes the focal point of a team that must become almost as integrated as the circuits themselves. Not only must he acquaint himself with the various fabrication procedures for integrated circuit parts—since parts made by different methods such as diffusion, epitaxial growth, alloying, etc. may exhibit different electrical characteristics—he must also be thoroughly familiar with the end product. For integrated circuits are no longer an assortment of individual, easily replaceable parts, but rather a series of irreparable entities that, ultimately, will have to be designed to fit the specific needs of the final system.

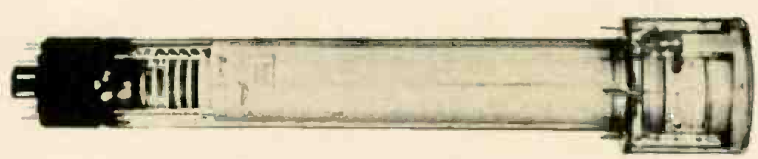
No longer can the circuit designer afford the luxury of designing a general circuit, hoping to modify it later for a specific requirement. Since the cost-reducing feature of integrated circuits lies in quantity production, and since most of the total cost is in the development of the first trouble-free production sample (virtually hundreds of identical circuits can be made almost as cheaply as a single unit) each circuit must be designed with the end product in mind.

It is anticipated that the systems engineer can design his system only after consultation with the circuit designer who determines the type of circuits to be used and the packaging techniques that can be employed. Both, however, will depend, to a great extent, on the components "process" engineer whose intimate knowledge of fabrication processes and capabilities must guide the design of both circuits and systems. The components man, therefore, must be almost as familiar with circuit requirements as with his own particular specialty.

Although the field of integrated circuits still has its specialists, each must have a working knowledge of the problems and objectives of the other. The principal rewards of this new field will be reaped only by men with that high order of initiative needed to meet the challenge of this vital new technology. ▲







Technical Books

"REPAIRING TV REMOTE CONTROLS" by Leon Cantor & Harry Horstmann. Published by *John F. Rider Publisher, Inc.*, New York. 121 pages. Price $2.50.

This is a handbook for the professional service technician and covers the various systems employed to control television receivers from remote locations. Emphasis is placed on the operation of the remote-control receiver and transmitter with circuit data, as well as testing and alignment information provided.

° ° °

"HOW TO READ SCHEMATIC DIAGRAMS" by Donald E. Herrington. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 124 pages. Price $1.50. Soft cover.

Here is a volume for those who want to step up from the level of being forced to construct electronic equipment from pictorial diagrams or not at all to the professional techniques of working with schematics.

The text not only covers the meaning and purpose of various types of electronic equipment diagrams but outlines a simplified approach to understanding such schematics. The material is presented progressively and concludes with a section on how to trace a signal through a typical superheterodyne receiver.

° ° °

"MODERN INFRARED TECHNOLOGY" by Barron Kemp. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 249 pages. Price $4.95. Soft cover.

Now that various types of infrared equipment are coming within the province of electronics technicians, this book should prove valuable to an extensive cross-section of technicians, engineers, and students.

The text covers the various principles of infrared instrumentation with illustrations, the construction, mounting, and use of visual and infrared lamps, as well as detectors and amplifiers. Commercial devices employing the infrared principle are covered in considerable detail.

° ° °

"INTRODUCTION TO ELECTRONICS" by Walter H. Evans. Published by *Prentice-Hall, Inc.*, Englewood Cliffs, N.J. 505 pages. Price $14.35.

This volume is offered as an introduction to electronics to those with a background in electrical engineering. Since a grounding in circuit analysis is prerequisite and it is assumed that the student has access to a laboratory, this volume will be of most value to those formally enrolled in engineering courses rather than those pursuing studies on their own.

The text material is presented progressively, starting with the transistorized radio receiver and continuing through diodes, diode applications, triodes, oscilloscopes, l.f. and h.f. amplifiers, negative feedback and linear oscillators, TV receivers, modulation and detection, electronic components, v.t.v.m.'s, digital computer and other switching circuits, and radar, microwaves, and antennas.

Several types of design problems are appended to each chapter to stimulate creative thinking along the lines covered in that particular chapter.

° ° °

"REPRODUCTION OF SOUND" by Edgar Villchur. Published by *Acoustic Research, Inc.*, 24 Thorndike St., Cambridge 41, Mass. $2.00 postage paid from publisher.

This is the second volume in the *AR* Library series and covers a wide range of information of interest to audiophiles and music lovers. The text material in this 90-page volume covers sound, standards of high fidelity, the sound reproducing system, disc recording, pickups and styli, pickup arms, amplifiers, preamps and control units, power amplifiers, negative feedback, loudspeakers, speaker enclosures, and room environment.

The text is well illustrated and the diagrams and photos help make the subject matter easy to assimilate.

° ° °

"ELEMENTS OF ELECTRONIC CIRCUITS" by J. M. Peters. Published in the U.S. by *John Wiley & Sons, Inc.*, New York. 94 pages. Price $4.50.

Subtitled "building bricks for circuit design," this volume is made up of a series of articles which appeared as a regular feature in the British publication *Wireless World*.

Written in simple, non-mathematical language, the author lays particular emphasis on physical explanations. The text is divided into nine chapters, each of which is a self-contained treatment of a particular subject. The text material is lavishly illustrated with schematics and graphs and covers general principles, two-state circuits, time bases, electronic markers, logarithmic amplifier, gates and coincidence circuits, delay circuits, pulse modulators, and waveforms which are operated on mathematically.

° ° °

"THE AGE OF ELECTRONICS" edited by Carl F. J. Overhage. Published by *McGraw-Hill Book Company, Inc.*, New York. 212 pages. Price $7.95.

This is a compilation of a number of papers presented in the course of the decennial celebration marking the founding of M.I.T.'s Lincoln Laboratory. The lectures were delivered by eight distinguished leaders in electronics and cover a wide range of subject matter and thinking.

Those participating in the lecture series include H. B. G. Casimir, L. V. Berkner, I. A. Getting, S. M. Ulam, E. G. Bowen, W. Shockley, C. H. Townes, and J. R. Pierce. Their subjects ranged from Maxwell, Hertz, and Lorentz to masers and satellite relays.

The technical level of this material is such as to appeal to the well-educated non-specialist and most persons will find this volume stimulating and thought-provoking. ▲

Versatile Programmed Timer

(*Continued from page 55*)

timer output contacts with the trigger input.

To begin, open all switches except S_1 and S_9. Connect the clock to pins 4 and 6 of SO_1 and short pins 1 and 2. Turn R_{13} to about the midway position and push S_8. Note the elapsed time on the clock and adjust R_{13} to give what you think will be 30 seconds. Repeat until five consecutive operations are each exactly 30 seconds long. Mark this position on the dial. In a similar manner, calibrate from 5 to 60 seconds, and any other times you may need. Then turn the knob back to the 30-second mark and time it again, exactly. You are going to use that 30-second time to calibrate the pulse intervals, so it should be perfect.

Disconnect the clock and insert the cable connecting pins 1 and 6 of SO_1 to J_1 and J_2. Open the cabinet and measure the resistance across R_1-R_2-R_3, with R_2 and R_3 at minimum. Adjust R_1 until its resistance is 12,000 ohms. Close S_2 and S_3, then push S_8. At the conclusion of the 30-second timing cycle, the counter should read close to 300; if more, increase the resistance of R_1, if less, decrease the resistance. Clear the counter and push S_8 again. Repeat until the count remains at 299 to 301 for three consecutive operations. Mark this position on the "Per Second" dial as "10." Calibrate the other speeds by increasing the resistance: for "5," the counter should read 149 to 151 at the end of the 30-second cycle; for "2," exactly 60, and for "1," exactly 30.

For the middle dial (R_2), calibrations up to 30 per minute (one pulse every 2 seconds) can be made by resetting R_{13} to the 60-second time, otherwise following the above procedure. For slower speeds, however, better accuracy will result if the intervals are timed by watching the sweep second hand of the clock. By noting when the counter operates in relation to the position of the second hand, you can note whether the pulser is gaining or losing time. R_2 and R_3 can then be compensated as necessary until the pulse occurs exactly on time.

The three fixed intervals are set on R_4, R_5, and R_6 in exactly the same way, except that S_1 is switched to the proper position, the pot unlocked, calibration made, the pot locked tightly, and the calibration rechecked. If locking-type pots are not available, use a very small amount of insulating varnish between the shaft and collar of an ordinary pot.

Programming

Table 1 lists several programs for which this instrument has proven useful.

Program 1 can be set up to count anything that can be related to a period of time. A contact (or low resistance) between J_1 and J_2 triggers the input. For example, a relay contact in a machine power circuit can provide the input to count the length of time the machine is operating. For machines which operate intermittently, total time "on" can be counted over whatever period of time is involved. With a photocell or other sensor (transducer), duration of physical events can be clocked. This includes clocking total daily sunlight, counting total time that temperature or humidity is above or below a set figure, and similar operations. The sensor or transducer can energize a relay to provide the input trigger contact, if its resistance is too high for direct insertion in the circuit.

With a normally open microswitch and a normally closed microswitch, time can be clocked for an object to travel from one location to another. For example, a paper tape is stretched across the starting line of a track running event, to keep open the normally closed switch. At the end of the measured distance, a similar tape is stretched to keep closed the normally open switch. The two switches are connected in series to the trigger input. When the runner breaks the first tape, the circuit is closed and the counter will begin to register the time. The circuit is opened when the first runner across the finish line breaks the second tape, and the counter stops, showing the elapsed time in whatever interval was chosen, most likely tenths of a second.

Program 2 provides repetitive process control, functioning as what is commonly known as an "Intervalometer." When set up for this program, the instrument turns on a machine or other device at pre-set intervals up to once a minute, continuing until it is shut off. The operating pulse can be of any length as set on R_{13}, up to a fraction of a second less than the interval between pulses.

Time-lapse photography is a typical use: instead of shooting a movie camera at 16 or 24 frames per second, it can be actuated once per minute to speed up very slow operations. (If frames are exposed once every 60 seconds, and projected 16 per second, an event which took place in ten hours will be seen on the screen less than 40 seconds!) Photographs at pre-set intervals are also used to record instrument dials intermittently, to save film. When electronic flash is used in this work, the camera shutter trips the flash, eliminating lighting problems. An arrangement can also be made for lamps to go on just before the camera operates by using an inexpensive thermal relay having a 3-second delay inserted in the lamp circuit. The normally open contacts are connected to the camera. The timer pot, R_{13}, is set to 4 seconds, and the output is connected to the lamp circuit. The lamps will now light for three seconds (to reach full intensity), then the thermal relay will operate the camera, after which the intervalometer will shut off, turning off both lamps and camera.

Program 3, audible timing, is used for those operations which require personal attention at specific intervals. For this purpose, the gong or bell is connected in the pulser circuit, set to sound at the interval required. In developing photographic film, for example, the tank must be agitated periodically. Instead of watching a clock, the audible signal will sound at the proper intervals, freeing the operator to do other work until he hears it. If the counter is also in the circuit, the total elapsed time will be shown, and no other timer is needed.

Program 4 uses the timer circuit for independent, non-repetitive operations. R_{13} is set to the desired time, the device to be turned on is connected to SO_1, and S_5 is pushed to start the timing cycle.

Program 5 uses the same timer setup as Program 4, but includes a visual, digital count of elapsed time. This is done by feeding back the output time (through contacts on a separate relay, or a set of separate contacts on an external power relay, if used) to the input trigger, and setting the pulser to the desired interval.

Program 6 is a specialized intervalometer program to sound a warning signal when a pre-set condition is sensed by a transducer or sensor. For example, if the trigger input is a thermostat set to contact at a certain temperature, and the output is fed to a siren or horn, an insistent, repeated warning sound will result if the temperature reaches or exceeds that setting. An infrared photocell will operate in a similar manner, or can be used to "see" the color of something being heated, sounding the horn when it has reached the proper condition, thus relieving the operator from the chore of keeping constant watch.

Program 7 provides a setup for testing or work sampling. In either case, the sampling interval is established by the pulser, and the sample size (length of pulse) established by the timer. Normally, the program is started and stopped manually through S_5, but automatic control is possible. To do this, a separate timer can keep the circuit operating for the desired time, or a relay can be included in the testing circuit to shut off the instrument if the item being tested breaks down.

For sampling, the time pulse from pins 1 and 6 of SO_1 is used to read a transducer, generator, or other device at the desired intervals, recording the information by photography or on recording paper. This is much less expensive than making a continuous record. In another application, samples are read until a specific condition occurs, when an external relay (connected to the input trigger) shuts off the process. By using samples, the differential between "on" and "off" states is much less critical, and very precise control is possible.

Many electronic and electrical components are tested for a breakdown point, on an intermittent basis. Again using the SO_1 output, voltages or currents of any desired value can be pulsed at intervals up to one per minute, with pulse lengths as short as 20 milliseconds. With a relay in the breakdown circuit to keep the input trigger closed, and the counter operating, the actual number of overloads to breakdown can be computed.

Program 8 can be set up for flashing lights at any of the possible time intervals, and for any length of time at each interval. This is a rather expensive way to do this, but there may be times when this instrument may not otherwise be in use, and using it for this purpose may then save you from building or buying a special unit. ▲

IRE-AIEE MERGE

MEMBERS of the IRE and AIEE have voted to merge into the Institute of Electrical and Electronic Engineers (IEEE) effective January 1963.

The 160,000-member organization has nominated Dr. Ernst Weber, President of Polytechnic Institute of Brooklyn to serve as president. Nominated for vice-president is Dr. B. Richard Teare, Jr. Dean, College of Engineering and Science, Carnegie Tech.

Donald G. Fink has been appointed General Manager of the merged societies and will leave his post as Director of the Philco Scientific Laboratory to accept the new position, effective January 1, 1963, but will remain at Philco until his successor is named. ▲

AMATEUR MOON BOUNCE

AMATEUR radio and u.h.f. radio history was made on August 9th at 0148 GMT when amateur radio station KH6UK in Hawaii and amateur radio station W1BU near Boston established two-way communication using the moon as a passive reflector on a frequency of 1296 mc.

The significance of the feat is that the two amateurs used mainly private resources, assembling most of their own equipment, and that they used relatively low power (about that used in a color TV set). They had to overcome tracking problems in order to constantly keep the moon in line with their antennas, and they had to fit all of their experiments into their own personal work schedules, keeping in mind the time difference between Boston and Hawaii.

Both men involved in this record-breaking feat, Sam Harrison of Medfield, Mass. and Ralph Thomas of Kahuku, Hawaii, are qualified engineers, long-time radio hams, and frequent contributors to amateur radio history.

The 5000-mile earth distance, 450,000-mile moon bounce opens up long-dreamed-of opportunities on this frequency, which was once thought to be effective only over very short line-of-sight distances. ▲

SILICON-RECTIFIER CHECKER

Indicates an open or shorted rectifier rated at 250 ma. or greater average current.

Designed primarily for rapid production-line use, it's also handy on service bench.

IN RECENT years, silicon-diode rectifiers have replaced selenium and vacuum-tube rectifiers in many industrial power supplies and in commercial entertainment-type electronic equipment. This widespread use has meant an increased load on inspection and service personnel when making rapid checks of relatively large quantities of silicon diodes to detect open and shorted units. This simple checker, described in *Westinghouse* "Tech Tips," No. 12, gives an instant qualitative check on any silicon rectifier rated at 250 ma. or greater average current. It makes a handy addition to the technician's test equipment and is also useful for production checking since it can be operated by unskilled personnel.

Operation

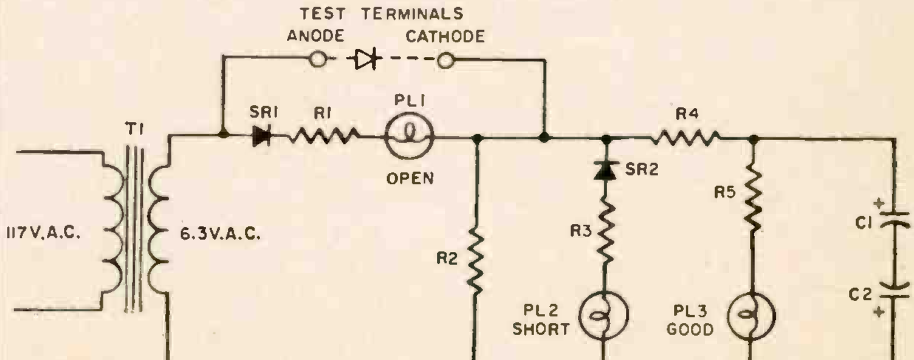
A schematic diagram of the checker is shown in Fig. 1. Transformer T_1 provides an isolated source of 6.3 r.m.s. volts for the circuit. With no connection across the test terminals (or with an open-circuit diode connected), PL_1 is lit by current through SR_1, R_1, PL_1, and R_2. The drop across R_2 is too small to allow PL_3 to light. PL_2 cannot light because of the reverse-connected diode SR_2. Thus, only PL_1 is lighted for an open circuit. If a good diode is connected to the test terminals with the polarity shown, PL_1 is shorted out and will not light. Half-wave d.c. of about 8 volts peak appears across R_2 with the upper terminal positive. PL_2 still will not light because of the reverse-connected diode, SR_2. C_1 charges up on the d.c. and permits PL_3 to light. PL_3 then, is the only lamp lighted and indicates a good diode.

When a shorted diode is connected to the test terminals, the PL_1 circuit is still shorted out but full a.c. voltage now appears across R_2. Diode SR_2 now conducts on the negative half cycles and lights PL_2. Since the R_4, R_5, PL_3, C_1, and C_2 circuit now sees an a.c. voltage, the capacitors acts as a low-reactance shunt across R_5 and PL_3 so PL_3 does not light. PL_2 is the only one lighted and indicates a shorted diode.

When a good diode is connected with its polarity opposite to that shown, all three lamps light. This seeming paradox can be resolved with a little more analysis. The test diode conducts on negative half cycles of the supply voltage, thereby developing a half-wave d.c. across R_2 with the upper end negative. This polarity allows SR_2 to conduct, so PL_2 lights. Also, since the voltage across R_2 is d.c., C_2 charges up and allows PL_3 to light. Finally, the SR_1, R_1, PL_1 circuit is not shunted out on the positive half cycles, so PL_1 lights.

The entire set of pilot-lamp indications is shown in the table. A unique indication is given for all diode connec-

Fig. 1. Complete schematic. Be sure to connect the negative terminals of C_1 and C_2.



R_1,R_3—33 ohm, 1 w. res.
R_2—10 ohm, 5 w. res.
R_4,R_5—10 ohm, 1 w. res.
C_1,C_2—1000 µf., 15 v. elec. capacitor
T_1—Filament trans. 117 v. pri., 6.3 v. @ 1 amp sec. (Stancor P-6134 or equiv.)
SR_1,SR_2—Silicon rectifier (IN1217)
PL_1,PL_2,PL_3—No. 49 pilot lamp and holder

Test Diode	Lighted Lamps		
	PL_1	PL_2	PL_3
Open	X		
Shorted		X	
Good (normal polarity)			X
Good (reverse polarity)	X	X	X

Chart of test indications

tions and it is not necessary to reverse a diode if it is inadvertently connected backwards. Only good reversed diodes will light all three lamps.

The checker can be built in very compact form as shown. All component parts easily fit into a 5¼" x 3" x 2⅛" chassis box (*Bud* CU2106A or equiv.) The test terminals are brought out to a pair of binding posts for connection to clip leads or a test fixture. Pilot light colors are white for PL_1 (open), red for PL_2 (shorted), and green for PL_3 (good). Wiring and construction are straightforward and adjustments are not necessary. A line switch was not provided since the current drawn is so small the unit can be left on continuously.

However, it may be added in the primary side of T_1. A pilot lamp may be connected to the secondary. Insulate the test terminals from the chassis. ▲

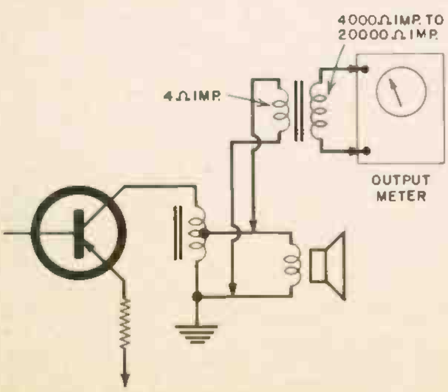
USING AN OUTPUT METER ON TRANSISTORS

By A. P. CARPENTER

IT IS difficult to obtain sufficient reading on the output meter when aligning transistor radios or those with transistor output stages, because of the low-impedance of transistors.

An easy way to overcome this difficulty is to obtain an output transformer for a tube-type radio (any tube radio) and solder clips on all four leads. Connect the voice-coil leads of this transformer to the speaker leads of the set you are aligning, leaving its speaker connected. Leads of this tube-type transformer, which formerly went to "B+" and output tube plate, are now connected to the output meter. A more-than-adequate meter reading will now be obtained. The attenuator will undoubtedly have to be turned back.

This same idea will also work for aligning tube-output radios when the output plate is inaccessible. Connect in the same way. Note: A single-ended output transformer works best. ▲



HE-20C DELUXE CITIZENS BAND TRANSCEIVER

Now Officially Approved For use in CANADA By Dept. of TRANSPORT Type Approval No. 169361029. Tops in CB world ■ 8 crystal controlled receive positions, 8 crystal controlled transmit positions ■ Tuneable over all 23 channels ■ Direct reading "S" meter indicates RF Power Output, Transmitter and Antenna Efficiency and Receiver "S" readings ■ Effective noise limiter ■ Built-in 12 or 6 volt power supply for mobile use. With crystals for channel 9.

No Money Down **109.50**

4-TRACK STEREO TAPE DECK

99.50 less case No Money Down

Deluxe Professional Quality Built-in Transistorized Stereo Record/Play Preamps ■ Plays: 4-Track Stereo, 2-Track Stereo, and 4-Track Mono Tapes ■ Records: 4-Track Stereo or Mono and Sound-on-Sound ■ 2 Record Level Meters ■ Tape Index Counter ■ Automatic Stop at end of tape ■ 2 Speeds: 3¾ ips and 7½ ips ■ Frequency Response @ 7½ ips, 40-18,000 cps ■ Takes up to 7" reels.

NEW!

39.95 No Money Down

LAFAYETTE 4-BAND SHORTWAVE BROADCAST RECEIVER

■ Covers 550 KC to 30 MC in four bands—tunes foreign broadcast programs plus ships, planes and amateurs ■ Sensitive superheterodyne circuit ■ Easy-tune slide rule dial ■ Built-in 4" speaker ■ Receives voice or code signals

LAFAYETTE *Sets the Pace!*

33.95 EACH

2 for **62.90**

No Money Down

LAFAYETTE 10-TRANSISTOR CITIZENS BAND "WALKIE TALKIE"T.M.

50% more powerful—now with 10 transistors, plus diode, thermistor and extra RF stage ■ Transmits and receives up to 2 miles ■ Up to 50 hours battery life ■ Push-to-talk operation ■ Complete with leather case, earphone, antenna and batteries.

LAFAYETTE STEREO MULTIPLEX TUNERS

FM-AM STEREO MULTIPLEX TUNER

89.50 No Money Down

FM MULTIPLEX TUNER

76.50 No Money Down

FEATURES OF BOTH LAFAYETTE TUNERS

Highest Quality Reception—Superb Styling! ■ Wide-band Design ■ Duplex 3-Gang tuning condenser provides tuned RF stage for greater sensitivity and selectivity ■ Built-in Multiplex with excellent separation ■ Sensitive tuning Meters ■ Variable AFC control ■ FM stereo Noise Filter ■ Smooth Flywheel Tuning.

FM Stereo Adapter

(*Continued from page 43*)

urated transistor turned off but, more important, to allow the saturation time to be reduced to one-sixth of a cycle or less. With the circuit shown, the measured separation using a simulated signal was at least 27 db over the entire audio range. The 15,000-ohm resistors and the .005-μf. capacitors serve as de-emphasis filters.

Transistor V_3 is a 19-kc. oscillator with its collector circuit tuned to 38 kc. Transformer T_1 is a standard TV width control with a center-tapped a.g.c. coil. This coil is adjustable from 3.2 to 9 mhy. on the primary side. The oscillator tank coil is another tapped width control adjustable from 0.3 to 3 mhy. and is tuned to 19 kc. by the .033-μf. capacitor. An 0.8-volt r.m.s. signal appears across the coil. Under these conditions, a 3.6-volt r.m.s. signal at 38 kc. appears across the primary of T_1. The corresponding switching voltage across half the secondary is 0.48 volt r.m.s.

Synchronization of the oscillator is accomplished by filtering out the 19-kc. pilot signal from the composite stereo signal by means of tuned amplifier V_1. Here again the tuned collector circuit uses a standard adjustable TV width control. The amplifier gain of approximately 30 allows very positive oscillator synchronization with pilot signals as small as 0.03 volt r.m.s.

The adapter is built into a box chassis 5½"x 3"x 1¼" and is not critical as to layout. The total d.c. power required is 1 ma. at 6 volts. A simple diode rectifier followed by an *RC* filter converts the 6.3-volt a.c. heater voltage from the tuner into the required d.c. The other side of the 6.3-volt supply should be grounded to the chassis of the converter. A low-impedance source of the composite input signal is required and can usually be obtained by a slight modification of the FM tuner. The author shunted the 100,000-ohm resistor between the ratio detector and the multiplex jack of his tuner with a 2700-ohm resistor and obtained satisfactory results. The outputs of the adapter are connected to a stereo amplifier.

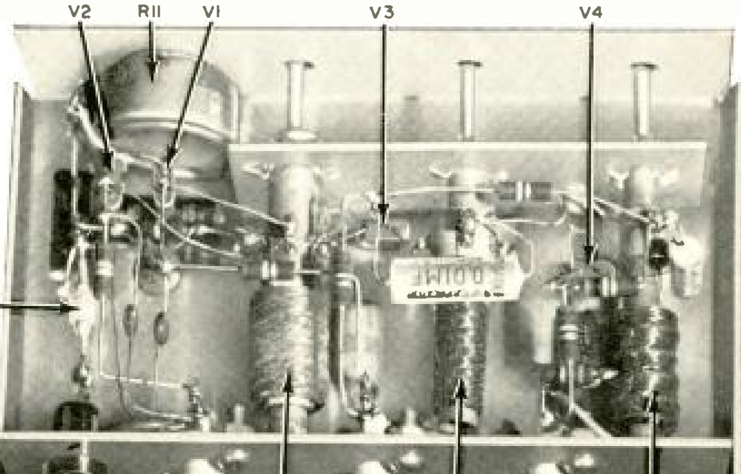
Alignment

Alignment of the adapter is best accomplished with an audio generator and an oscilloscope. With the audio generator set to 19 kc., a signal of approximately .05 volt r.m.s. is applied to the input terminal. The emitter of V_3 is temporarily shorted to ground and with the oscilloscope connected to the collector of V_1, L_2 is adjusted for maximum voltage. The emitter short is then removed from V_3 and with the scope sweep externally synced with the audio oscillator, the waveform observed at the top of L_1 is brought into synchronism with the audio oscillator by adjusting the slug in L_1. The same number of cycles should appear on the screen as appear when the audio oscillator is being observed. This adjustment is refined later.

Next the scope is connected to the collector of V_3 and T_1 is adjusted to give a 38-kc. waveform with equally spaced zero crossings. Final adjustment of L_1 is needed to give proper channel separation. The local station in the author's area modulates only one channel (usually the left one) when making station announcements. For proper phase adjustment, L_1 is simply adjusted until all of the sound emanates from one speaker.

No SCA filter has been included in this adapter since the local FM stereo station is not using this service at present. When and if this should occur, it will probably be necessary to incorporate a band-rejection filter between the tuner and the adapter input. In all probability, a suitable filter can be devised using standard TV coils, but as yet no practical experience along this line is available. ▲

Under-chassis view. All adjustments are accessible from the rear.

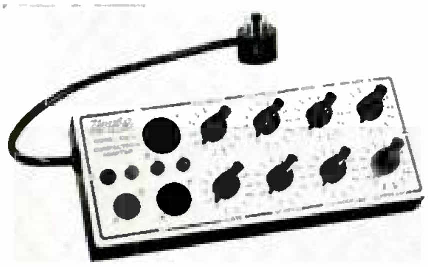


New Products and Literature

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 17.

TUBE TESTER ADAPTER

1 **The Hickok Electrical Instrument Company** has just introduced a new universal tube tester adapter for testing compactrons, novars, 5- and 7-pin nuvistors, and 10-pin tubes on older manual tube testers.



The CA-4 adapter has sockets for all of the new tubes, together with eight 11-position selector switches enabling proper setup for the new tubes. Because no elements are paralleled, all tests can be made to handbook specifications. The adapter connects to the octal socket of any manual tube tester.

CCTV EQUIPMENT

2 **Motorola Inc.** has announced a new line of closed-circuit television equipment consisting of three transistorized cameras and a glare-proof monitor.

The cameras are offered in indoor, all-weather, and explosion-proof versions. All three units are equipped with special light compensation circuitry which adjusts camera sensitivity to light conditions varying from 10,000 footcandles to 1 footcandle. An electronic regulator holds the pictures sharply in focus despite line voltage fluctuations and ambient temperatures.

The monitor uses a 14" picture tube to provide pictures with 650 lines of horizontal resolution. It is available in cabinet or rack-mounted versions.

REGULATED POWER SUPPLY

3 **Heath Company** has added a solid-state, regulated power supply to its line of test instruments in kit form.

The IP-20 features voltage - regulated, transistorized circuit; variable 0-50 volt output at up to 1.5 amperes; four current ranges (50 ma., 150 ma., 500 ma., and 1.5 amp); adjustable current limiter 30 to 110% on each current; and relay protection against heavy overload and short-circuit.

TEST COMPONENT

4 **Kay Electric Co.'s Pinlite Division** has announced the availability of a new clear plastic device containing a microminiature incandescent lamp, a small battery, and a switching arrangement which can be used as a practical test component or a display piece.

Called the "Thumb-Thing," the new device permits the testing of the company's "Pinlites" in any of their thousands of applications without fear of losing or mishandling the lamps.

Two models are available. Model 15 features the type 15-15 axial lead (1.5 volts, 15 ma.) light while the Model 12 uses the type L 12-12 lens-type (1.2 volts, 12 ma.) unit.

TV CAMERA TESTER

5 **Photo Research Corp.** has developed a precision instrument for TV camera alignment and sensitivity testing. The unit attaches to the lens mount of any TV camera and checks it for opto-mechanical alignment and calibration, and eliminates the variables present when external test patterns are used.

Various types of test patterns, on special slides, are inserted into the unit, which accurately aligns and focuses them onto the camera tube. Internal light level and color temperature for the test pattern is adjustable and accurately reproducible.

All standard SMPTE and EIA black-and-white and color test patterns are available.

D.C. PANEL METER

6 **Metetelic Corporation** has developed a compact and rugged d.c. panel meter which is available in all standard ranges for current or voltage measurement.

Over-all size of the Type 100 is 1⅞" wide, ½" thick, and 2¾" deep, including the terminal

screws. The curved dial face is a full ½" x 1⅞" and has black numbers on white for optimum readability. The instrument is housed in a dust-proof steel case and has a clear plastic window. Accuracy is 2% of full-scale.

NIGHT CAMERA

7 **Aerojet Delft** recently demonstrated a new passive night camera capable of taking pictures in the dark. Installed in a closed-circuit TV hookup, the camera employs the principle of electronic amplification of whatever light is normally available. No supplementary light source is required.

The new camera can be used in connection with night telescopes, motion picture cameras, x-ray equipment, and in closed-circuit TV systems. The intensifier tube, the basic component of the camera, can produce an image more than 1000 times brighter than seen by the unaided eye at night.

SUBSTITUTION BOX

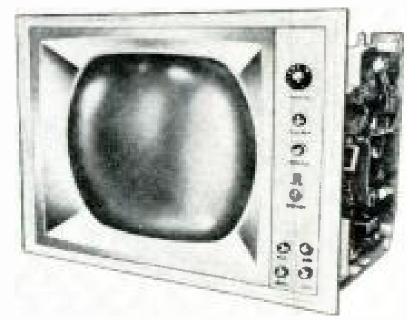
8 **Mutron, Inc.** has just introduced a capacitor substitution box which is engineered especially for transistor work. Operating on the binary

principle, the unit covers the range from 1 to 255 μf. in steps of 1 μf. with tolerance —10% +30%.

COLOR-TV RECEIVER KIT

9 **Transvision Electronics, Inc.** has added a color-TV receiver to its line of kits.

The new 21" kit, produced under license from



RCA, contains the same circuitry found in commercial receivers. All critical circuits are fully pre-wired, adjusted, and tested by RCA. The instrument uses a 21" bonded-face-plate color tube which reduces light reflections and improves color contrast.

The kits are available with and without audio circuitry and with an optional wireless remote control system at extra charge.

ELECTRICAL THERMOMETER

10 **Ameresco, Inc.** is handling the distribution of the Model T-1 precision electrical thermometer made by **Siemens & Halske.**

Designed for production, laboratory, maintenance, or field applications, the instrument will quickly determine temperatures of surfaces, liquids, or gases upon application of the thermistor sensing probe.

The unit has a direct-reading combination Fahrenheit-centigrade scale.

TV-FM SET COUPLER

11 **Aerogap** has announced the availability of a new TV-FM set coupler which can be used either indoors or out. The device snaps around the existing antenna line without tools.

The "Transceptor" operates on an electromagnetic principle and loss due to placement on the line is only ½ db for l.f. channels, ¼ db for high, with more signal available for the additional sets. Isolation is 12 db between the final set and any auxiliary sets on the line and 24 db between auxiliary sets.

TECHNICIAN'S SOLDERING IRON

12 **Ungar Electric Tools** is now offering the "Imperial 6060" soldering iron which has been especially designed with the needs of the electronic service technician in mind.

The unit consists of a pastel-colored "Perma-Cool" handle with matching color cord set, a 40-watt long-life heat cartridge (heat range from 750 to 950 degrees F), two thread-on soldering tips, and a can of "Heat Seal" to insure maximum heat transfer.

SOLDER DISPENSER

13 **Electronic Parts Co., Inc.** is handling the distribution of a lightweight, easy-to-operate solder dispenser which the company claims saves from 35 to 50% production time.

Leaving one hand free to hold the piece, thereby eliminating a jig in many cases, the unit permits soldering in one operation without pretinning and terminal lugs. The adjustable mounting makes it adaptable to most smaller irons now used on printed-circuit boards, terminal boards, and barrier strips. The solder is advanced through the feed tube direct from the roll.

HI-FI—AUDIO PRODUCTS

FM TUNER

14 **Precision Electronics, Inc.** has announced production of the **Grommes** Models 101B FM tuner and 101BM FM multiplex tuner.

Both units provide frequency coverage 20-20,000 cps ± 0.5 db. Sensitivity is 1 μv. (2 μv.

IHFM). Hum and noise is 70 db below 100% modulation while distortion is .5% harmonic or IM. The Model 101B provides mono FM reception with multiplex output while the 101BM has both mono and multiplex circuitry. The over-all size of the instrument is 14⅛" w. x 11½" d. x 4⅝" h.

SQUARE MIKE BOOM

15 **Telex, Inc.** has recently introduced a new microphone boom of square cross-section which is said to provide greater ease of adjustment and improved ruggedness under severe operating conditions. It slides smoothly and, once adjusted, holds its position firmly.

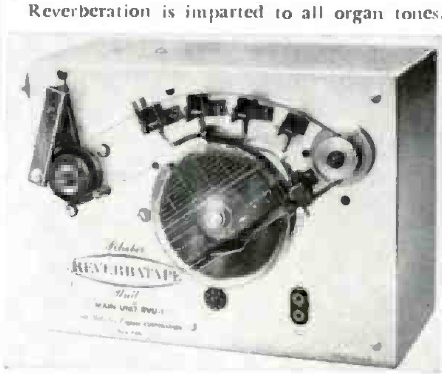
Both the boom-mike assembly and the "Magna-Twin Mark III" headset, for which it is optional equipment, are engineered to be tamperproof and completely field serviceable.

The headset is of the magnetic type and has a frequency response of 50-10,000 cps. It is especially suited to language laboratories and certain industrial applications.

ORGAN REVERB UNIT

16 **Schober Organ Corporation** has recently introduced a reverberation device which can be installed in any electronic organ. The "Reverbatape" unit employs no springs but incorporates a small tape-recorder mechanism with a continuous loop of tape and several playback heads.

Reverberation is imparted to all organ tones,



including low pedals and high overtones. By means of a special control, the player can vary reverberation up to a maximum of 6 seconds to suit any type of music or the sound in an auditorium of any size. The new circuitry causes the sound decay to be realistic at all control settings.

AMPLIFIER SHUT-OFF

17 **Robins Industries Corp.** has just introduced a new device for use with component hi-fi systems to turn off amplifiers automatically when the automatic changer stops.

Called the "Stop-O-Matic," the unit is designed to be used with either stereo or mono record changer systems. The device has two outlets, one for the changer and the other for the amplifier, plus an a.c. line cord. Other electrical devices can be shut off when the last record has played by inserting a cube tap into the amplifier outlet. The unit measures 6" x 2" x 1½" and comes ready for mounting by means of two screws. Model HFS-1 is for European changers while the HFS-2 is designed for U.S.-made units.

PREMIUM RECORDING TAPE

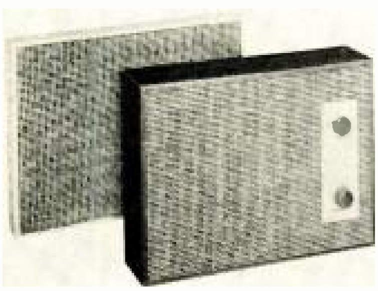
18 **Reeves Soundcraft Corp.** is now marketing a new premium-quality recording tape, "Golden Tone," designed specially for today's advanced recorders.

The new tape has a dynamic range of 77 db and a high-frequency output 25% greater than standard tapes. A new slitting technique in its manufacture is said to reduce skew and burrs to a minimum.

It is currently available on 7" reels, ranging from 1200 to 2400 feet to the reel.

SPEAKER BAFFLE LINE

19 **Argos Products Co.** has announced a new line of public address baffles which is being marketed as "Multi-Baffles." The new line is offered in two basic designs with identical styling. The surface-mount units, just 3½" deep, contain all electrical equipment and may be mounted flush on wall or ceiling. The recessed



model projects from the ceiling or wall surface only 1½". The surface break required is a 6" circular hole to accommodate the speaker. Both units feature a removable front panel. There are six models currently available in each version.

STEREO ATTENUATORS

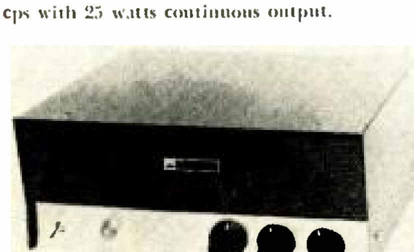
20 **Centralab** has announced the availability of a new line of wirewound stereo attenuators designed for installation in standard junction or switch boxes.

The new units are approximately half the depth of conventional four-section stereo "L" pads and thus can be used where conventional units will not fit. Only two of the stereo attenuators are needed to do the work of a four-section "L" pad. The attenuators are 1⅝" in diameter and 1 5/32" deep with a round brass ¼" diameter shaft that extends 1⅞" from the mounting surface.

Rated at 10 watts audio, 5 watts d.c., the attenuators are packaged individually with complete instructions, a gold anodized dial plate, and a black setscrew knob.

TRANSISTORIZED AUDIO AMPLIFIER

21 **Nassau Laboratories** has just introduced a completely transistorized audio amplifier as the Model NLAA-25. Bandwidth is 20 to 15,000 cps with 25 watts continuous output.



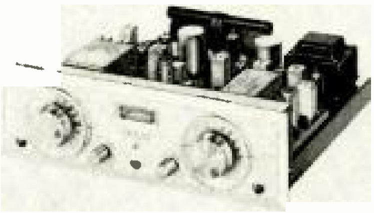
There are three separate audio channels which can be mixed as desired and fully controlled from the front of the amplifier. Channel 1 is a switchable low- or high-impedance microphone channel, channel 2 is a switchable high-impedance, 1600-ohm, or balanced-to-ground 600-ohm music input, while channel 3 is a second microphone channel which is included as optional equipment. Separate bass and treble controls can be had either outside the case for convenience or inside the case to avoid tampering.

The unit will operate on 117 volts, 60 cycles or from a 24-volt power pack.

FM MULTIPLEX TUNER

22 H. H. Scott, Inc. has added the Model 333 AM-FM multiplex tuner to its line of audio equipment.

The new instrument can be used as an AM tuner, an FM tuner, an FM multiplex tuner, or as an AM-FM stereo tuner. Sensitivity of the FM



section is 2.5 μv. (IHFM). There are two AM bandwidth positions and a ferrite core antenna for AM. The FM detector bandwidth is 2 mc. There are three FM i.f. stages and two FM limiting stages. The front-end is silver-plated for stability. There is an audible monitor tone to indicate multiplex broadcasts.

CB-HAM-COMMUNICATIONS

DEVIATION METER

23 Motorola Inc. has developed a new deviation meter which has been incorporated in its S-1059A portable test set used for two-way radio servicing.

The meter covers all two-way radio frequencies from 20-500 mc. It has direct-reading frequency deviation ranges of 8 kc. and 16 kc. full-scale with an accuracy of ± 5%. A third range, with full-scale reading of 1.6 kc., is provided for tone-squelch deviation measurement.

Transistorized for reliability and compactness, the unit is operated by two mercury batteries and has a connector for external 12 ± 2 volt d.c. supply. The instrument is mounted at the top of the S-1059A test set model.

CB TRANSCEIVER

24 Cadre Industries Corp. is now offering a new 5-watt transceiver as the Model 500 for class D CB service in the U.S. and as the 500-C for land and mobile radiotelephone service in Canada.

The circuit uses 18 transistors and 8 diodes. Sensitivity is .5 μv. with selectivity at 10 kc. approx. 40 db. Power output is 2.4 watts minimum d.c. operation and 2.5 audio output at 1 μv. Audio response is 300-3000 cps ± 3 db. Output impedance is 50 ohms. The unit weighs 6 pounds or 9½ pounds with a battery pack. It measures 11⅜" x 5⅜" x 3⅛" over-all.

TRIPLE-CONVERSION RECEIVER

25 Hammarlund Manufacturing Company has recently introduced a new amateur radio receiver featuring triple conversion and improved electrical and mechanical stability.

Designated the HQ-170A, the circuit is a 17-tube superhet with automatic noise limiters and allows triple conversion for i.f. frequencies of 3035, 455, and 60 kc. According to the company, this provides excellent rejection of image response. The second i.f. is heterodyned with a crystal-controlled oscillator while the third i.f. is heterodyned with a high-stability adjustable oscillator which contains micro-accurate vernier tuning control.

The receiver tunes the 6, 10, 15, 20, 40, 80, and 160 meter amateur bands.

CB TRANSCEIVER

26 Sonar Radio Corp. has announced production of its Model G CB transceiver which features eight crystal-controlled channels.

The circuit includes a dual-conversion tunable receiver for all 23 channels, class B push-pull

modulation, "S" meter and transmitting tuning meter, adjustable squelch, crystal spotting switch, and illuminated panel.

The Model G weighs only 9 pounds and comes complete with one pair of crystals and a high-impedance ceramic microphone. The unit measures 11¼" long x 9½" wide x 4¾" high. The instrument incorporates a heavy-duty, two-way power supply.

AIR-WOUND COILS

27 Illumitronic Engineering Corp. is now offering a new series of "Air Dux" coils with diameters up to five inches. A higher "Q" can be realized with the larger coil diameter and the use of large copper, tinned, or silver-plated wire gives greater current and power handling capabilities to the coils. When wound with a larger conductor, with increased spacing between turns, the coils deliver the same inductance in a given length, according to the company.

A wide variety of mountings is available in the new series.

COMMUNICATIONS ANTENNAS

28 Mark Products Division has added a series of low-priced omnidirectional base-station antennas to its line for two-way communications in the 150- and 450-mc. ranges. The "Beacon" line includes units ranging in length from 8 feet to 21 feet.

At the same time the company announced the HW-5 a five-band mobile antenna for the amateur operator. The unit permits switching to any of five bands from the driver's seat while the car is in motion. It has switching control for 80-40-20-15-10 meters and may be used with all mobile transmitters and transceivers.

PHONE-ANSWERING SET

29 Electronic Secretary Industries, Inc. is now in production on the Model FP telephone-answering set which will answer the telephone and record up to 240 incoming messages.

The unit answers the phone with a 20-second message, tape-recorded in the businessman's own voice. A "beep" tone then tells the caller when

to start his tape-recorded message, which may be up to 30 seconds long. Messages can be played back through the speaker in the unit.

ANTENNA TUNING UNIT

30 Electronics Associates is currently introducing a new unit for tuning mobile or ground-plane antennas for minimum standing-wave ratio and maximum r.f. output. The tuning unit is designed for CB, ham, and police equipment. It uses no coils or capacitors and is said to take the guesswork out of antenna installations by indicating on-frequency accurately. The unit covers CB channels 2-23, ham bands 28-150 mc., and police bands 25-50 mc.

PAGING TRANSMITTER

31 Multitone Electronics Limited is now offering a new radio paging transmitter which is specifically designed to solve staff-locating problems in small offices, plants, stores, hotels, clubs, and other businesses.

This desk-model radio transmitter operates on the Citizens Band and is equipped with built-in selective paging facilities and integral antenna. Maximum outdoor range is 1/8 mile but an external antenna may be used if more extensive coverage is needed.

MANUFACTURERS' LITERATURE

POWER TRANSISTOR DATA

32 Clevite Transistor has issued two technical data sheets covering its new 5 and 15 ampere germanium power transistors. Designed specifically for high-power switching, control, and amplifier applications, MIL-S-19500 specs are exceeded by the new units. Bulletins TB 231-2 and 231-3 provide complete technical details.

SILICON RECTIFIER BULLETIN

33 Tung-Sol Electric Inc. has issued a one-page product bulletin which describes a diffused-junction silicon rectifier having a maximum average forward current of 25 amperes at 150 degrees C case temperature.

The bulletin shows an illustration and outline drawing of the press-fit rectifier, which has a knurled base for inserting the device under pressure into a heat-sink mounting hole. Five electrical characteristic curves show typical ratings for peak reverse voltage, forward voltage, surge overload current, average forward current, and heat sink output current rating for 1/8" copper plates.

AUTO RADIO REPLACEMENTS

34 Stancor Electronics, Inc. has issued a new transformer and coil replacement guide covering almost 60 different brands and manufacturers of car radios.

In addition to listings by radio model or chassis, each model or chassis is cross-referenced to the manufacturer and year of auto usage. Separate cross-reference tables for each manufacturer list the equivalent Stancor part number of every manufacturer's part.

CATALOGUE OF KITS

35 Heath Company has just issued its new 1962-1963 catalogue which pictures and describes in detail an extensive line of stereo hi-fi components, ham radio gear, test and lab equipment, marine equipment, science kits, educational kits—all in ready-to-assemble form as wired units of various types.

Complete technical specifications as well as special features are listed for each product, along with such pertinent data as assembly time, enclosure types and styles, tube line-ups and other information of interest to those ordering equipment by mail. Each unit is illustrated with a large, clear photograph. This 100-page catalogue is free on request.

ADDING SOUND TO SLIDES

36 General Techniques, Inc. is offering copies of a booklet which illustrates a new technique of adding sound to 35 mm. slides. The new method involves a pencil mark less than 1/2" wide on the oxide face of the recording tape to actuate the change mechanism in an automatic slide or film strip projector.

Copies of the booklet, "Make 'Talkies' Out of Your Slides," are available on request.

CB PRODUCTS

37 Browning Laboratories, Inc. has just released a new all-products brochure which deals with the company's models in the field of CB communications equipment.

Full-color photos, price lists, and complete specifications accompany the descriptions of transmitters, receivers, transceivers, etc.

TUBE INTERCHANGEABILITY

38 RCA's Electron Tube Division has issued an 8-page "Interchangeability Directory of Foreign vs USA Receiving-Type Electronic Tubes" which is now available on request.

The new edition, form No. ICE-197B, indicates the USA direct replacement type or similar type, if available, for more than 800 foreign tube types used principally in AM and FM radios, TV receivers, and audio amplifiers.

ENCAPSULATED RECTIFIERS

39 Erie Resistor Corporation is distributing copies of its Bulletin 523 which present complete electrical and mechanical specifications on a new line of miniaturized encapsulated silicon rectifiers.

The new line of general-purpose diffused silicon rectifiers features high forward conductance, low leakage currents, reliable operation, and low thermal resistance.

TV KIT CATALOGUE

40 Transvision Electronics, Inc. has just issued a 12-page catalogue entitled "Professional Series TV Kits and Wired Chassis." The publication describes and illustrates a new line of receivers of various types, along with an extensive line of accessories to permit custom wall or cabinet installations.

PRODUCT GUIDE

41 P. R. Mallory & Co. Inc. has issued a 28-page product guide which provides technical details on the firm's line of batteries, buzzers, capacitors, controls, communications equipment, contacts, converters, diodes, "Inductuners," jacks and plugs, metals, pots, rectifiers, relays, resistors, switches, vibrators, among others.

The products are illustrated and, where applicable, performance graphs accompany the technical specifications on the products.

HI-FI ACCESSORY

42 Royce Electronic Developments, Inc. is now offering a 6-page booklet entitled "Audio Robots are for Sleeping" which discusses the basic fundamentals of extension speakers in hi-fi systems and the ways in which automatic control can be accomplished at a remote point from the main high-fidelity system.

ELECTRONICS TEACHING PROGRAM

43 Electronic Teaching Laboratories is now offering a 12-page bulletin which explains in considerable detail its "Monitor Electronics Teaching Programs" which are designed especially for school, industry, and government training programs in various phases of electronics. The system involves 40 modular circuit panels, each with built-in power supply. The panels are designed to be used individually or combined with other panels to produce more complex circuits.

ELECTRONICS CATALOGUE

44 Allied Radio Corporation has issued its 1963 catalogue of electronic equipment and components as No. 220. This new publication runs to 460 pages and includes a 68-page section listing the firm's "Knight-Kits."

The listings are indexed not only by product but by manufacturers to facilitate locating a specific component.

TRANSISTOR REPLACEMENTS

45 General Electric Company has announced the availability of a radio transistor replacement guide in the form of a 17" x 22" wall chart. The chart (ETR-3345) cross-references the company's 8 basic "universal" replacement transistors with 1218 types of transistors commonly used.

MINIATURE TOOLS

46 Mini-Tool Technical Industries, Inc. has issued a 24-page catalogue covering its line of tools and instruments for miniature assembly and micro-fine work. Included are pliers, tweezers, microscopes, taps, dies, and hi-speed drills.

MINIATURE LAMPS

47 General Electric Company's Miniature Lamp Department has issued a 28-page catalogue covering an extensive line of lamps in all types and sizes for a wide variety of applications.

Included are lamps designed for automotive, aircraft, lanterns, marine, military, tractor lamps, special service lamps, and bicycle and motorcycle lamps. Electroluminescent lamps are also covered. Factors involved in making the proper selection are discussed in some detail in this publication.

ENGINEERING DRAFTING GEAR

48 V. & E. Manufacturing Company has issued a compact, pictorial 24-page buying guide which lists types, specifications, and features of its drafting machines and accessories as well as full details on special accessories for engineering department use.

ALTITUDE TRANSDUCERS

49 H. E. Sostman & Co. is offering catalogue sheets covering the various types of transducer and regulated power units it manufactures.

The material includes a description of the elements employed in the instruments, altitude and pressure ranges, resistance ranges, sensitivity, case style, and all pertinent data.

The various catalogue sheets describe transducers in general and Type 1150 altitude transducers and systems in particular. Complete information on the Type 1210 regulated power unit is also included.

TAPE ERASURE INFORMATION

50 Minnesota Mining and Manufacturing Co. is offering copies of its instrumentation bulletin No. 5 which details studies made on the probability of accidental erasure of magnetic tape by stray magnetic fields.

The bulletin reports that an experiment designed to simulate actual aircraft shipping conditions found the demagnetizing force of a plane's main power cable, where the worst erasing conditions exist, was considerably less than that required for discernible erasure even when an erase force and tape are in close contact.

Full details on the erasure studies, findings, and preferred shipping methods are included in this free bulletin.

ELECTRONICS/HI-FI CATALOGUE

51 Lafayette Radio Electronics Corporation has just released its 1963 product catalogue which lists hundreds of items in electronics and stereo hi-fi equipment.

Running to 388 pages, the publication features equipment in both kit and factory-wired form, as well as products from all of the major manufacturers of hi-fi equipment. There is a complete selection of CB equipment, optics, books, tools, radio and TV components and accessories, cameras, p.a. systems and parts—almost anything needed by hobbyists, students, experimenters, and those in industry.

MATV SYSTEMS GUIDE

52 Blonder-Tongue Labs is now offering a compact master TV reference manual designed to guide technicians and TV countermen in the selection of proper systems and equipment.

The booklet covers smaller systems only, featuring clear diagrams and descriptions of typical installations that can be placed in TV showrooms, service shops, apartment houses, hotels, motels, and other institutions. One section is devoted to home systems, enabling technicians to meet the growing demands of multi-set owners for reception outlets throughout the home.

FOUR-LAYER SWITCHING DEVICE

53 Tung-Sol Electric Inc. is offering copies of a new technical bulletin which describes its Type 2N2260 "Dynaquad," an alloy junction "p-n-p-n" device that can turn on and off at a speed in the order of 0.1 μsec. The six-page bulletin describes in detail the operating features of the unit in terms of its equivalent circuit of two complementary transistors and includes a schematic diagram which shows directions of currents through the device.

All electrical and physical specifications are given in the bulletin, along with ten typical characteristic curves.

SEMICONDUCTOR LISTING

54 Amperex Electronic Corp. has announced publication of its new condensed semiconductor catalogue. The 15-page catalogue includes basic specifications of the new line of universal communications transistors manufactured by the PADT process.

The catalogue also contains a complete listing and specifications of a comprehensive line of germanium "p-n-p" and "n-p-n" audio, computer, switching, and v.h.f. transistors for converter, mixer, and oscillator applications.

FERRAMIC TOROIDS

55 Indiana General Corporation is offering copies of its new four-page ferramic toroid selector which gives complete specifications for these ferrite materials.

Dimension data adheres to the recommended specifications of the Ferrite Manufacturers Association, M.P.I. Standard #21-61. Magnetic properties and application data is given for each of the standard ferrite bodies described in the bulletin along with inductance nomogram aids in material and part size selection.

PULSE TRANSFORMERS

56 Technitrol Inc. has issued a technical bulletin covering its new line of subminiature pulse transformers, called "Genie-II" units.

The bulletin includes two tables listing 44 different tranformers and gives individual values for turns ratio, magnetizing inductance, leakage inductance, winding resistance, interwinding capacitance, and effective distributed capacitance. Drawings in the bulletin show outside case dimensions and lead spacings for standard and optional lead configurations. A wiring diagram illustrates the various winding connections which are available. ▲

ANSWERS TO QUIZ

(Appearing on page 88)

1. L	5. B	9. F
2. G	6. H	10. D
3. M	7. K	11. I
4. J	8. A	12. C
	13. E	

Answer to Electronic Crosswords

(Appearing on page 81)

L	U	M	E	N	■	R	E	D	■	■	S	T	A	B
O	■	A	■	A	H	■	■	I	N	S	T	A	N	T
A	■	N	E	P	E	R	■	S	O	L	A	R	■	U
D	■	O	■	I	A	■	■	H	■	A	L	■	S	■
S	L	I	D	E	R	U	L	E	■	P	O	R	T	■
■	■	B	I	R	D	I	E	S	■	■	■	O	A	K
T	A	L	E	S	■	■	A	■	O	R	B	I	T	■
A	G	E	■	■	H	■	K	■	■	■	O	L	E	O
N	O	■	S	T	O	R	A	G	E	■	N	■	■	H
G	■	A	N	A	L	O	G	■	N	■	E	M	■	M
E	X	■	O	B	E	S	E	■	E	■	■	O	M	■
N	■	O	W	L	■	I	■	T	R	I	P	L	E	■
T	A	U	■	E	■	N	■	E	G	R	E	T	■	C
■	P	S	I	■	I	■	M	A	Y	■	■	E	■	H
P	O	T	E	N	T	I	A	L	■	C	E	N	T	I

PHOTO CREDITS

Page	Credit
22	H. H. Scott, Inc.
26	Fisher Radio Corp.
26 (bottom)	Sonotone Corp.
32, 33, 34	Motorola Inc.
40, 41, 42	Solitron Devices, Inc.
49	Hewlett-Packard Inc.
79	Precision
98	Westinghouse Electric Corp.

JUST RECEIVED! VICTOREEN RADIATION DETECTOR (DOSIMETER)

Model 306 BRAND NEW, actual value $45.00 SPECIAL, WHILE THEY LAST **$8.95**

ARC-3 RECEIVER!

Complete with All Tubes Exc. Used **$19.95**

Like NEW .... $29.50.

Crystal-controlled 17-tube superhet, tunes from 100 to 156 MC., AM., on any 8 pre-selected channels. 28-volt DC power input. Tubes: 1-9002, 6-6AK5, 1-12SH7, 3-12SG7, 1-9001, 1-12H6, 2-12SN7, 1-12SL7, 1-12A6.

Power Supply Kit for above 15.00

Factory Wired and Tested 19.95

ARC-3 TRANSMITTER

Companion unit for above, tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes: 3-6V6, 2-832A, 1-12SH7, 1-6J5, 2-6L6. Exc. Used .... Only **$18.95**

Like new condition $28.50

ARC-3 PUSHBUTTON CONTROL BOX $5.95

SPECIAL! BC-603 FM RECEIVER

Converted for 35. to 50 Mc. Brand New, checked out .... SPECIAL **$34.50**

EXTRA SET OF 10 TUBES FOR ABOVE brand new in original boxes $3.95

FT-237 MOUNTING BASE for BC-603 Rcvr and BC-604 Xmitter. Brand New $5.95

12 or 24V Dynamotor for Above. Exc. Used $4.25 .... Brand New $5.50

4-Section Antenna for BC-603, 683 Receivers. Complete with mounting base. BRAND NEW $4.95

AC POWER SUPPLY FOR BC603, 683

Interchangeable, replaces dynamotor. Has On-Off Switch. NO RECVR. CHANGE NEEDED. Provides 220 VDC @ 80 Ma, 24VAC @ 2 Amps $12.95

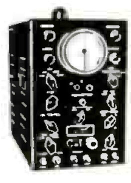
Complete 240-page Technical Manual for BC-603, 604 .... $3.15

BC-604 TRANSMITTER—Companion unit for BC-603 Rcvr. above. With all tubes. BRAND NEW $8.95

4-Section Antenna for BC-604, 684 Transmitters. Complete with mounting base. BRAND NEW .. $4.95

We carry a complete line of spare parts for above

TS-100AP 'SCOPE



EXC. USED (worth $750)
OUR LOW PRICE **$39.50**
Brand New $69.50

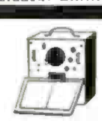
Can be used with linear sweep or general purpose test scope. Cables included. Also used with circular sweep as precision range calibrator. Self-contained in metal case 8" x 12½" x 16" deep. For 110 V 50 to 1200 cycles AC. Excellent used, like new, with all tubes including crystals and C.R. Tube.

LM FREQUENCY METER

Crystal calibrated modulated, Heterodyne, 125 Kc to 20,000 Kc With Calibration book. Complete. Like New $58.50

BC-906 FREQ. METER—SPECIAL

Cavity type 145 to 235 Mc. Complete with antenna. Manual and original calibration charts included. BRAND NEW. OUR LOW PRICE ... $11.88



BC-221 FREQUENCY METER

SPECIAL BUY! This excellent frequency standard is equipped with original calibration charts, and has ranges from 125 Kc to 20,000 Kc with crystal check points in all ranges. Excel. Used with original Calibration Book, Crystal, and all tables—LIKE NEW!

Unmodulated ... $72.50 Modulated $99.50

BC-221 1000 Kc Crystal Brand New $8.95

TS-16/APN TEST SET

For aligning and calibration of radio altimeters. May be used to check calibration of count or circuits and modulator sweep freq. and bandwidth of transmitter. Audio-oscillator range: 340 to 7250 cycles. 24 V.D.C. input. Complete with tubes, connecting cables, instruction summary. BRAND NEW $14.50

TEST SET TS-175/U. Portable crystal controlled heterodyne type unit used in field testing of CW or MCW RF Transmitters and Signal Generators. Range 85 to 1000 Mc. Power requirements: 6V DC and 135 VDC. Exc. Cond. $169.50

TEST SET TS-174/U Frequency Meter similar to above but for 20 to 250 Mc. Power input 5.5V DC and 121.5 V DC. Exc. Cond. $169.50

TS-170/ARN-5 TEST OSCILLATOR, portable, battery-operated, crystal controlled, for frequencies 332.6 Mc., 318.6 Mc., and 335 Mc. Power input 1.5 VDC and 90 VDC. Less Batteries. Exc. Cond. $22.50

SCR-625 MINE DETECTOR

Complete portable outfit in original packing, with all accessories. Brand New **$27.50**

WESTERN ELECTRIC MERCURY RELAY

Single Pole Double Throw, 4500 ohm coil with 24 volt heater. Operating Current: 8 Ma. Release Current: 5.2 Ma. High Pressure Hydrogen Sealed. Uniform high speed operation assured even at subzero temperatures by heater enclosed in housing. Western Electric #D-171584. (equivalent to 275-D) BRAND NEW $2.95

LIMITED QUANTITY SPECIALS!

BC-312 MOBILE RECEIVER 6 bands, 1500 Kc to 18 Mc. With Tubes and 14 V Dynamotor. Like New $79.50

BC-312 for AC operation $89.50

AN/APT-5 AIRBORNE RADAR SET, with tubes. Like New $49.50

AN/APT-5 BRAND NEW $69.50

POWER SUPPLY for AN/APT-5, complete. Brand New, for 80/115 V 400 to 2600 cycles $14.95

ATTENTION: IMPORTERS-EXPORTERS of ELECTRONIC EQUIPMENT

We specialize in the export of electronic equipment, Parts, and Electronic Tubes at LOWEST prevailing prices. All packing and shipping is made directly from our own warehouses in NYC, to give you substantial savings in handling costs! Your inquiries invited.

LORAN APN-4

FINE QUALITY NAVIGATIONAL EQUIPMENT

Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.

INDICATOR ID-6B/APN-4, and RECEIVER R-9B/APN-4, complete with tubes. Exc. used $49.50

Receiver-Indicator as above, BRAND NEW $88.50

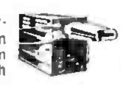
INVERTER POWER SUPPLY for Loran. Made by Eclipse—Pioneer Div. INPUT: 24 V DC @ 75 A. OUTPUT: 115 V AC @ 10.5 Amps. 800 cycles. Complete with two connecting plugs BRAND NEW $49.50

12-Volt Inverter Power Supply, Like New .... P.U.R.

Shock Mount for above $2.95

We carry a complete line of spare parts for above.

LORAN R-65/APN-9 RECEIVER & INDICATOR



Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used.

Value $1200.00. Our Price $79.50

Used, less tubes, crystal and visor, but with 3BP1 C.R. tube $29.50

INVERTER POWER SUPPLY. INPUT: 24 V DC. OUTPUT: 115 V AC. 800 cy. BRAND NEW $49.50

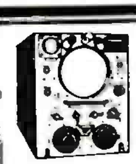
12-Volt Inverter Power Supply, Like New .. P.U.R.

Shock Mount for above $2.95

Circuit diagram and connecting plugs available.

We carry a complete line of spare parts for above.

LORAN APN/4 OSCILLOSCOPE



Easily converted for use on radio-TV service bench. LIKE NEW! Less tubes, but including 5" Scope, type 5CP1 only $14.50

BENDIX DIRECTION FINDERS

For commercial navigation on boats.

MN26Y 150-325 Kc; 325-695 Kc; 3-4.7 Mc. Complete with tubes, dynamotor. BRAND NEW $19.50

MN28Y Receiver Control Box .... $ 4.95

MN26C Receiver 150-1500 Kc continuous tuning with 12 tubes and dynamotor. Used ... 18.95

MN26C Receiver as above. BRAND NEW 27.50

MN20E Rotatable Loop for above 4.95

MN52 Azimuth Control Box 2.95

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 Mc.	12.45	17.95
BC-455	Receiver 6-9 Mc.	11.50	13.95
1.5 to 3 Mc.	Receiver Brand New		$17.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions $8.95

Factory wired, tested, ready to operate .. $12.50

SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only 49c

2.1 to 3 Mc. Transmitter. Brand New $12.95

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW $9.75

Like New $7.95

BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW $10.95

Like New $7.95

T19 TRANSMITTER 3-4 m.c. complete with all tubes and crystal. Exc. Used $9.95

BC-696 TRANSMITTER 3-4 Mc Complete with All Tubes & Crystal. Like New $11.95

BC-456 Modulator .... USED 3.45 NEW 5.95

MD7 Modulator. Like New $9.95

ALL ACCESSORIES AVAILABLE FOR ABOVE

2 VOLT BATTERY "PACKAGE"

1—2V. 20 Amp. Hr. Willard Storage Battery. Model 20-2. 3" x 4" x 5¼" high $2.79

1—2V. 7 prong Synchronous Plug-in Vibrator 1.49

1—Quart Bottle Electrolyte (for 2 cells) 1.45

ALL BRAND NEW! Combination Price $5.45

WILLARD 6-VOLT MIDGET STORAGE BATTERY

3 Amp. Hour. BRAND NEW. 3⅜" x 1 13/16" x 2⅜". Uses Standard Electrolyte .... Only $2.95

SCHEMATIC DIAGRAMS For most equipment on this page, each .. **65c**

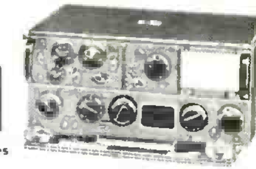
Please include 25% Deposit with order—Balance C.O.D. or Remittance in Full. 50c Handling Charges on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C. All Merchandise subject to Prior Sale and Price Change.

G & G RADIO SUPPLY CO.

Telephone: CO 7-4605
77 Leonard St.
New York 13, N. Y.

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc



$69.50 exc. used

Complete with Tubes

Famous Collins Autotune Aircraft Transmitter. AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP813 is modulated 813 in final up to 90%, class "B." A Real "HOT" Ham buy at our low price! Orig. cost $1800.

AN/ART-13 XMTR as above. Like New .. $79.50

0-16 Low Freq. Osc. Coil for ART-13 .... 7.95

24V Dynamotor for ART-13 .... 11.95

Same as above less meter 39.50

We carry a complete line of spare parts for above.

APR-1 Navy VHF-UHF radar search Receiver, 80 Mc to 950 Mc in 2 bands. BRAND NEW $79.50

TUNING UNITS for above: TN1, TN2, TN3. BRAND NEW, each $39.50

AN/APR-4 RECEIVER only. 38 to 4000 Mc in 5 tuning unit ranges. High precision lab instrument. Input 115 V60 cy. Like New $79.50

Tuning Units TN16, 17, 18 each $39.50

Tuning Unit TN19, Brand New $89.50

Tuning Unit TU54 .... $149.50

FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc. citizens radio 460-470 mc. fixed and mobile 450-460 mc. television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton. BRAND NEW

Shipping weight 25 lbs. SPECIAL! $19.50

PE-101C Dynamotor, 12/24V input $7.95

UHF Antenna Assembly 2.45

Complete Set of 10 Plugs 5.50

Control Box 2.25

SPECIAL "PACKAGE" OFFER:

BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE. BRAND NEW. While Stocks Last $29.50

APN-1 FM TRANSMITTER-RECEIVER

420 to 460 Mc Aircraft Radio altimeter equipment. Tubes: 4-955, 3-12SJ7, 4-12SH7, 2-12H6, 1-VR150: Complete with tubes, brand new $9.95

APN-1 exc. Used $6.95

RCA GEIGER COUNTER MODEL WF-16A

Highly sensitive portable instrument, uses bank of ten bismuth-type Geiger-Counter Tubes, measures up to 200,000 counts per minute in three ranges. A professional tool: measures 11-4-7/8x7½". wt. approx. 8 lbs. with batteries. Original List Price $750.00.

BRAND NEW, Complete, our price. Special $89.50

TG-34A CODE KEYER

Self-contained automatic unit, reproduces code practice signals recorded on paper tape. By use of built-in speaker, provides code-practice signals to one or more persons at speeds from 5 to 25 WPM.

Like New, Tested $26.50

Set of 15 Reels, Code Practice Lessons .... P.U.R.

MOBILE-MARINE DYNAMOTOR

Model DM35

Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs. BRAND NEW $14.95

OTHER DYNAMOTOR VALUES:

Type	Input	Output	Excellent Used	BRAND NEW
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A	575V .16A		
	28V 7A	540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-53A	28V 1.4A	220V .080A	3.75	5.45
DM-64A	12V 5.1A	275V .150A		7.95
PE-73C	28V 20A	1000V .350A	8.95	14.95
PE-86	28V 1.25A	250V .050A	2.75	3.85

DM-42A DYNAMOTOR. Input 12 V DC @ 30 Amps. Output 515 V DC @ 215 Ma. and 1030 V DC @ 260 Ma. Wt. 38 lbs. BRAND NEW, each $6.95

DM-37 DYNAMOTOR. Input 25.5 V DC @ 9.2 A. Output 625 V DC @ 225 Ma. BRAND NEW. Each $3.25

CARTER GENEMOTOR

INPUT: 5.9 V DC @ 32 Amps.
OUTPUT: 405 V DC @ .270 Amps.
BRAND NEW. Special $8.95

MICROPHONES

Model	Description	EXC. USED	BRAND NEW
T-17D	Carbon Hand Mike	$4.45	$7.95
RS-38	Navy Type Carbon Hand Mike	3.95	5.75

HEADPHONES

Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.19	$4.49
HS-33	Low Impedance	2.69	4.59
HS-30	Low Imp. (featherwt.)	.90	1.65
H-16/U	High Imp. (2 units)	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEADSETS, BRAND NEW. PER PAIR $3.25

CD-307A Cords, with PL55 plug and JK26 Jack .. .99

Earphone Cushions for above—pair .... .50

ELECTRONICS MARKET PLACE

RATE: 60¢ per word. Minimum 10 words. January issue closes November 5th. Send order and remittance to: ELECTRONICS WORLD, One Park Ave., N. Y. C. 16, N. Y.

ELECTRONICS ENGINEERING AND INSTRUCTION

USED Correspondence Courses and Books sold and rented. Money back guarantee. Catalog Free. (Courses Bought.) Lee Mountain, Pisgah, Alabama.

ELECTRONICS! Associate degree—29 months. Technicians, field engineers, specialists in communications, missiles, computers, radar, automation. Start February, September. Valparaiso Technical Institute, Dept. N, Valparaiso, Indiana.

FCC LICENSE in six weeks. First class radio telephone. Results guaranteed. Elkins Radio School, 2603C, Inwood, Dallas, Texas.

ENGINEERING and Art Degrees earned through home study. Electronics, mechanical, liberal arts. When writing specify course desired. Pacific International College of Arts & Sciences, primarily a correspondence school. Resident classes also available. 5719-C Santa Monica Blvd., Hollywood 38, California.

FOR SALE

TV Tuners—Rebuilt or Exchanged $9.95 complete—all types—fast, guaranteed service. Send tuner with all parts to: L. A. Tuner Exchange, 4611 West Jefferson Blvd., Los Angeles 16, California.

TUBES—TV, Radio, Transmitting And Industrial Types At Sensibly Low Prices. New, Guaranteed, 1st Quality. Top Name Brands Only. Write For Free Catalog or Call WAlker 5-7000. Barry Electronics Corp., 512 Broadway, New York 12N, N. Y.

DIAGRAMS for repairing radios $1.00. Television $2.00. Give make, model. Diagram Service, Box 672-E, Hartford 1, Conn.

GOVERNMENT Surplus Receivers, Transmitters, Snooperscopes, Parabolic Reflectors, Picture Catalog 10¢. Meshna, Malden 48, Mass.

PROFESSIONAL Electronic Projects—Organs, Timers, Computers, Industrial, etc.—$1 up. Catalog Free. Parks, Box 1665, Lake City, Seattle 55, Wash.

PRECISION Resistors, carbon-deposit. Guaranteed 1% accuracy. Millions in stock. ½-watt, 8¢. 1-watt, 12¢. 2-watt, 15¢. Leading manufacturer. Rock Distributing Co., 902 Corwin Rd., Rochester 10, N.Y.

SCHEMATIC diagrams, exact replacement parts orders: Japanese transistor or tube radios, recorders, transceivers, electronics equipment. Give model and manufacturer, $1. Techservices. CPO 849, Tokyo, Japan.

CONVERT any television to sensitive, big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans, $2.00. Relco, Dept. EW, Box 10563, Houston 18, Texas.

"FREE—R.C.A., G.E. etc. tubes catalog. Discount to 75% from list. Picture tubes at 75¢ inch up. Parts, parts kits at 1/10 original cost. Needles, tube testers, silicons, seleniums 7" TV bench test tube—$6.99—and more." Arcturus Electronics Corp., E.W. 502-22nd Street, Union City, New Jersey.

INVESTIGATORS, free brochure, latest subminiature electronic listening devices. Dept. 11B, 11500 NW 7th Ave., Miami 50, Florida.

SAVE money! Amazing circuit increases tube life in TV, Hi-Fi, etc. Plans $2.00. Lewis, P.O. Box 211, Cherry Hill, N.J.

BEFORE you buy receiving tubes, test equipment, Hi-fi components, kits, parts, etc. . . . send for your giant free Zalytron current catalog, featuring Standard brand tubes; RCA, GE, etc.—all brand new premium quality individually boxed, one year guarantee—all at biggest discounts in America! We serve professional servicemen, hobbyists, experimenters, engineers, technicians. Why pay more? Zalytron Tube Corp., 220 West 42nd St., New York City.

SAVE dollars on radio, TV-tubes, parts at less than manufacturer's cost. 100% guaranteed. No rebrands, pulls. Request Bargain Bulletin. United Radio 1000-W, Newark, N.J.

SUPERSENSITIVE directional microphone picks up faint sounds at 300 feet. Detects sound through ordinary walls. Easily built for $7.00. No electronic experience necessary. Illustrated plans, $2.00. Dee Company, Box 7263-D, Houston 8, Texas.

TV tubes subscription service. Let us solve your new TV tube stocking problems. Write today for complete information. No obligation. Telefix, P.O. Box 361, Levittown, N.Y.

TELEVISION camera kit, easy to build step by step instructions, suitable for Ham TV, Educational, Industrial, Medical uses. Craftsmen Instrument Labs Inc., 60-30 34th Ave., Woodside L.I., N.Y.

DIAGRAMS for repairing radios, $1.00, televisions $2.00. Give make and model. Al Melko, 700 Brewster Street, Bridgeport 5, Connecticut.

TV TUNERS rebuilt or exchanged, $9.95. Fast, guaranteed. Complete crystal alignment. Valley Tuners, 18530 Parthenia, Northridge, Calif.

DIAGRAMS: Radio, 75¢, television, $1.50. Baker, 129 Cooper, Santa Ana, Calif.

DIAGRAMS—TV, $2; Radios, $1. Hiett Diagrams, Box 816, Laredo, Texas.

601-2 Amplex recorder, 10 mikes, 8 stands, 1000' mike cable, line transformers, etc. Charles Goodman, 10 Woolson St., Mattapan 26, Mass., CY 6-7332.

EXOTIC EARRINGS! Details free. Pair, $1.00. OHGA, ZD-380, Sigakenkusatu, Japan.

TV TUNERS REBUILT AND ALIGNED per original factory specifications using xyal controlled equipment only $9.50. 24 hour service for unmutilated units. Ship complete tubes or write for free mailing kit and dealer brochure. J W ELECTRONICS, P.O. Box 51A, Bloomington, Indiana.

TRANSISTORS, Diodes, Rectifiers, S.C.R. Etc. Name Brands, Top Quality. We Overstocked For Our Own Mfg. All Specs Guaranteed. Write for Our Free Price List. Autocrat Inc., P.O. Box 536, Dept. C, Dayton 6, Ohio

WANTED

CASH Paid! Sell your surplus electronic tubes. Want unused, Clean radio and TV receiving, transmitting special purpose, Magnetrons, Klystrons, broadcast types. Want military and commercial lab test equipment such as G.R.H.P., AN UPM prefix. Also want commercial Ham Receivers and Transmitters. For a Fair Deal write: Barry Electronics Corp., 512 Broadway, New York 12, N. Y. (Walker 5-7000).

QUICKSILVER, Platinum, Silver, Gold. Ores Analyzed. Free Circular. Mercury Terminal, Norwood, Massachusetts.

WANTED: Collins, Hammarlund Receivers SP-600, 51J, R-390A, R-388. Teletype, Kleinschmidt. Cash, or trade. Alltronics-Howard, Box 19, Boston 1, Mass. (Richmond 2-0048).

TAPE AND RECORDERS

TAPE Recorders, HI-FI Components. Sleep Learning Equipment, Tapes. Unusual Values. Free Catalog. Dressner, 1523 EW Jericho Turnpike, New Hyde Park, N.Y.

RENT Stereo Tapes—over 2,500 Different—all major labels—free catalog. Stereo-Parti, 811-G, Centinela Ave., Inglewood 3, California.

SELF-Hypnosis. New concept teaches you quickly by tape or LP-record. Free literature. McKinley Publishers, Dept. T6, Box 3038, San Bernardino, California.

4/TR Stereo Tapes—bought, sold, rented, traded! Free Catalog/bargain closeouts. (Columbia) 9651 Foxbury, Rivera, California.

SAVE 30% Stereo music on tape. Free bargain catalog/blank tape/recorders/norelco speakers. Saxitone, 1776 Columbia Road, Washington, D.C.

HIGH-FIDELITY

DISGUSTED with "HI" HI-Fi Prices? Unusual Discounts On Your High Fidelity Requirements. Write. Key Electronics, 120 Liberty St., New York 6, N. Y. DI6-4191.

RECORDERS, Components! Free wholesale catalogue! Carston, 125-R, East 88, N.Y.C. 28.

PRICES? The Best! Factory-sealed Hi-Fi Components? Yes! Send for free catalog. Audion, 25T Oxford Road, Massapequa, N.Y.

WRITE for quotation on components, recorders. Free catalog. Hi-Fidelity Supply, 2817-WC Third, N.Y.C. 55.

LOW, LOW quotes: all components and recorders. Hi-Fi, Roslyn 9, Penna.

HI-FI Components, tape recorders, all brands, at low, low "We Will Not Be Undersold Prices." 15-day money back guarantee. Easy-Pay-Plan. Quotations by return mail. Hi-Fidelity Center, 220-NC East 23rd St., New York 10, N.Y.

INDUCTORS for Crossover Networks, 118 types in stock. Send for brochure. C & M Coils, P.O. Drawer 1147, Huntsville, Ala.

RECORDS

RARE 78's. State Category. Write Record-Lists, P.O. Box 2122, Riverside, Calif.

HELP WANTED

EARN Extra money selling advertising book matches. Free Samples furnished. Matchcorp, Dept. MD-112, Chicago 32, Ill.

GOVERNMENT SURPLUS

JEEPS $278. Airplanes $159, Boats $7.88, generators $2.68, typewriters $8.79, are typical government surplus sale prices. Buy 10,001 items wholesale, direct. Full details, 627 locations and procedure, only $1.00. Surplus, Box 177-C33, Abbottstown, Penna.

U.S. GOVERNMENT SURPLUS—Jeeps, $264.00; radios, $2.53; guns, typewriters; cameras; tools; thousands of items. Fabulously low surplus prices. Complete information sent immediately. Send $1.00 to: Surplus, Box 512-R, New Orleans 1, Louisiana.

SHOPPING GUIDE CLASSIFIED

A HANDY GUIDE TO PRODUCTS, NOT NECESSARILY ELECTRONIC, BUT OF WIDE GENERAL INTEREST.

PHOTOGRAPHY-FILM, EQUIPMENT, SERVICES

SCIENCE Bargains—Request Free Giant Catalog "CJ"—144 pages—Astronomical Telescopes, Microscopes, Lenses, Binoculars, Kits, Parts. War surplus bargains. Edmund Scientific Co., Barrington, New Jersey.

MEDICAL FILM—Adults only—"Childbirth," one reel, 8mm $7.50; 16mm $14.95. International W, Greenvale, L.I., New York.

STAMPS AND COINS

TERRIFIC Stamp Bargain! Israel-Iceland-San Marino—plus triangle set—Plus Antigua-Borneo-Virgin-Scouts-Congo-Russia—Plus large stamp book—all four offers free—Send 10¢ for mailing cost. Empire Stamp Corporation, Dept. Z2, Toronto, Canada.

EDUCATIONAL OPPORTUNITIES

LEARN While Asleep, hypnotize with your recorder, phonograph. Astonishing details, sensational catalog free! Sleep-Learning Association, Box 24-ZO, Olympia, Washington.

LEARN while asleep. Remarkable, scientific. 92% effective. Details free. ASR Foundation, Box 7021, Dept. e.g., Lexington, Kentucky.

BUSINESS OPPORTUNITIES

I Made $40,000.00 Year by Mail Order! Helped others make money! Start with $10.00—Free Proof. Torrey, Box 3566-N, Oklahoma City 6, Oklahoma.

ASSEMBLE artificial lures at home for stores. Materials supplied free. Profitable! Write: Lures, Ft. Walton Beach 1, Florida.

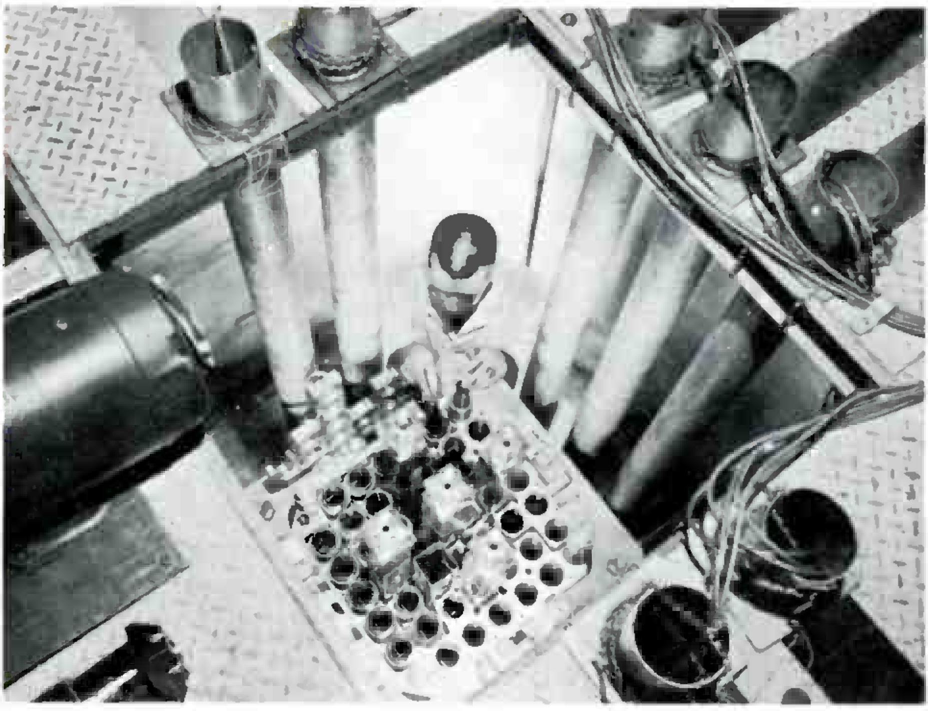
MAKE $25-$50 week clipping newspaper items for publishers. Some clippings worth $5.00 each. Particulars free. National, 81, Knickerbocker Station, New York City.

MISCELLANEOUS

AUTHORS! Learn how to have your book published, promoted, distributed. FREE booklet "ZD," Vantage, 120 West 31 St., New York 1.

ELECTRONICS WORLD NOVEMBER 1962
ADVERTISERS INDEX

Printed in U.S.A.



CREI can prepare you for a rewarding career in the NUCLEAR FIELD

WELL PAYING, EXCITING POSITIONS are created every day in the rapidly expanding nuclear field. Yet many are unfilled because industry cannot find enough qualified men.

YOU CAN PREPARE YOURSELF to take advantage of these opportunities and build a rewarding career in this industry of the future through a CREI Program in Nuclear Engineering Technology. And you can do it at home without giving up your present job.

YOU CAN QUALIFY for this program if you have a technical background and a high school education or the equivalent. For complete information on career opportunities and CREI Programs, use postpaid air mail card below.

JUST OFF THE PRESS—FREE 58-PAGE BOOK describing CREI Programs and career opportunities in electronic and nuclear engineering technology.

Cut Out And Mail Postpaid Airmail Card.

CREI **THE CAPITOL RADIO ENGINEERING INSTITUTE**
Founded 1927
Dept. 1111-K, 3224 16th St., N.W., Wash. 10, D.C.

Please send me details of CREI Home Study Programs and Free Book, "Your Future in Electronics and Nuclear Engineering Technology." My qualifications are noted to obtain immediate service.

CHECK FIELD OF GREATEST INTEREST:

- ☐ Electronic Engineering Technology
- ☐ Servo and Computer Engineering Technology
- ☐ Communications
- ☐ Nuclear Engineering Technology
- ☐ Aero and Navigational Engineering Technology
- ☐ Automation and Industrial Electronic Engineering Technology

Name ______ Age ______

Address ______

City ______ Zone ______ State ______

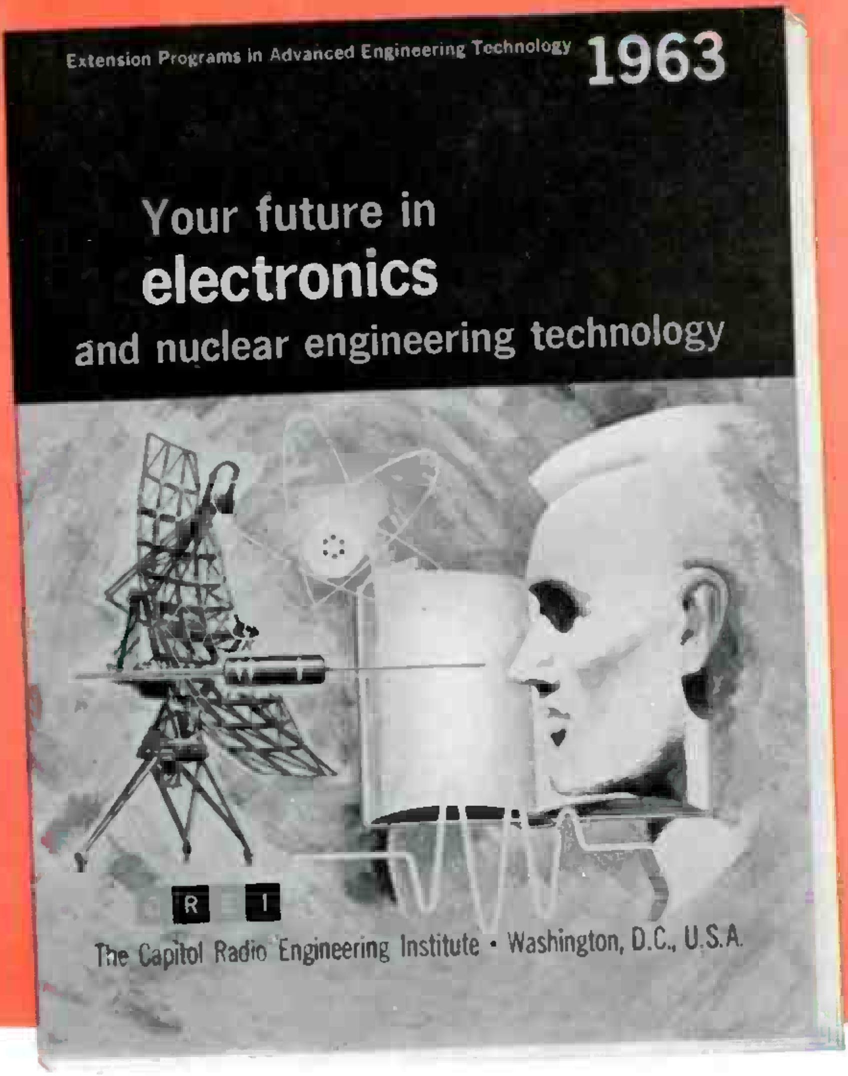
Employed by ______

Type of present work ______

Education: Years High School ______ Other ______

Electronics Experience ______

Check: ☐ Home Study ☐ Residence School ☐ G.I. Bill #32



FREE 58-page book just off the press

Get the facts on career opportunities in electronics and the new field of nuclear energy

If you are qualified for a CREI Home Study Program, send postpaid card below for your FREE copy of 58-page book describing CREI Programs and opportunities for rewarding careers in electronic and nuclear engineering technology.

No Stamps Required. Fill Out and Mail Card Today.

VIA AIR MAIL

First Class
Permit No. 288-R
Washington, D. C.

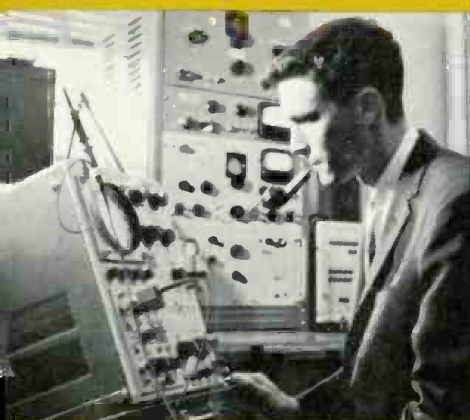
BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed In United States

Postage Will Be Paid by

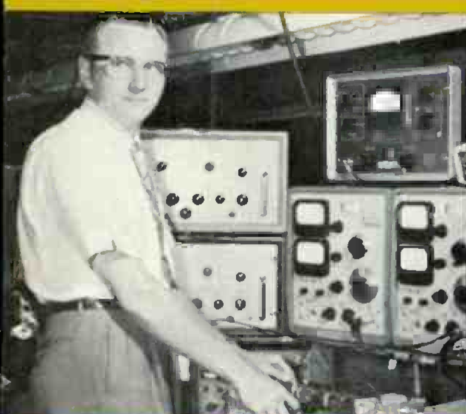
CREI

The Capitol Radio Engineering Institute,
3224 Sixteenth Street, N.W.
Washington 10, D. C.

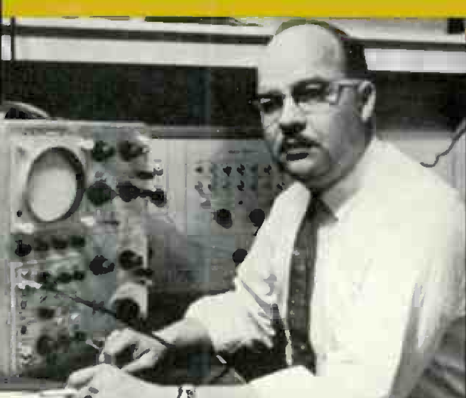
Why do these men now enjoy profitable careers in electronics that others still dream about?



ROBERT T. BLANKS (CREI grad 1960) is Engineer, Research & Study Div., Vitro Labs., Division of Vitro Corp. of America, Silver Spring, Md.



RICHARD S. CONWAY (CREI grad 1960) is Supervisor, Electronic Test Department, Wilcox Electric Co., Kansas City, Mo.



MEARL MARTIN, Jr. (CREI grad 1956) is a Senior Engineer and Field Support Manager, Tektronix, Inc., Portland, Oregon.

Advanced technical knowledge acquired through CREI Home Study Programs is the key to their success.

SUCCESS IS NO ACCIDENT. There is a reason why some men move ahead in electronics while others stand still, year after year, in routine, low-paid jobs. Responsible, rewarding positions in electronics require advanced technical knowledge. Without such knowledge, you cannot hope for success no matter how ambitious you are.

THE THREE MEN SHOWN HERE realized that career opportunities would open up for them only if they gained the practical knowledge of electronic engineering technology demanded by industry. They did this through CREI Home Study Programs and achieved the success they desired.

YOU HAVE THE SAME OPPORTUNITY. Through CREI Home Study Programs, you can acquire the practical working knowledge of advanced and up-to-date electronic engineering technology that will put you on the level of specialization where men are most in demand.

YOU WILL FOLLOW THE FOOTSTEPS of the thousands of CREI men who hold positions as associate engineers, engineering aides, field engineers, project engineers and technical representatives. They work in every area of electronics, from manufacturing to the space program.

YOU ARE GUIDED and assisted by CREI's staff of experienced instructors. When you enroll in a CREI Home Study Program, you study courses to which a number of leading engineers and scientists have made substantial contributions.

YOU HAVE A CHOICE OF PROGRAMS covering every important field of electronics:

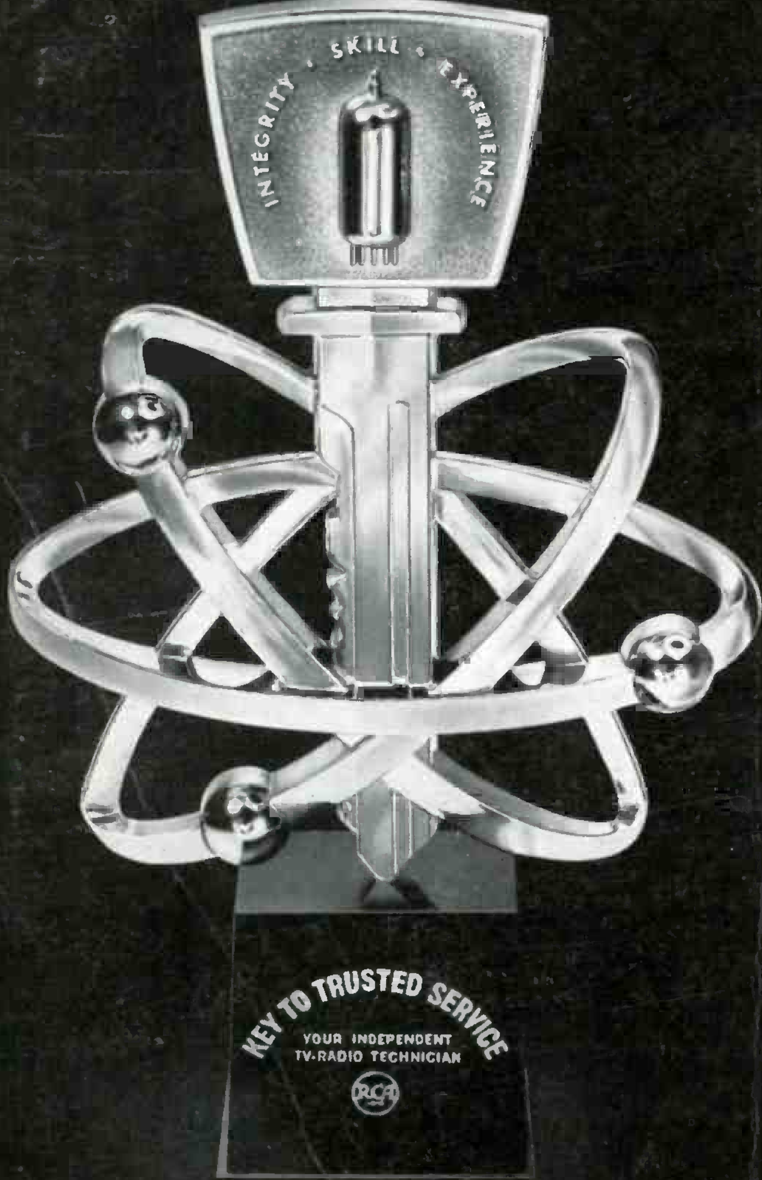
SERVOMECHANISMS • INSTRUMENTATION • RADAR
COMPUTERS • AERONAUTICAL AND NAVIGATIONAL
COMMUNICATIONS • AERO-SPACE • TELEVISION
AUTOMATION AND INDUSTRIAL ENGINEERING TECHNOLOGY
NUCLEAR ENGINEERING TECHNOLOGY

CREI EDUCATION IS WELL RECOGNIZED by industry. Large corporations such as National Broadcasting Company, Pan American Airways, Federal Electric Corporation, The Martin Company, Canadian Broadcasting Co., Mackay Radio, and many others.

CREI HAS 35 YEARS OF EXPERIENCE in advanced technical education through home study. CREI has developed electronics courses for the Army Signal Corps, special radio technician courses for the Navy, and group training programs for leading aviation and electronics companies. CREI also maintains a Residence School in Washington, D. C.

YOU CAN QUALIFY for a CREI Program, if you have basic knowledge of radio or electronics and are a high school graduate or the equivalent. If you meet these qualifications, write for FREE 58-page book describing CREI Programs and career opportunities in advanced electronic engineering technology. Mail postcard—no stamps necessary—or write to:

CREI The Capitol Radio Engineering Institute
Dept. 1111-K, 3224 Sixteenth St., N.W., Washington 10, D.C.



RCA's Key to Trusted Service...

YOUR KEY TO MORE AND BETTER BUSINESS

Each day you see more and more of these *Key to Trusted Service* symbols displayed in radio-TV-HiFi service shops all over the country.

This symbol is the focal point of a major RCA promotional program to identify and "boost" outstanding service dealers in each community.

RCA is advertising nationally on Walt Disney's "Wonderful World of Color"—urging consumers to look for and patronize service shops displaying the key statuette.

Your Authorized RCA Tube Distributor has all the facts on how you can become a KEY service technician in your community. Call him today.

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

RCA® **The Most Trusted Name in Electronics**