JULY, 1960

ELECTRONICS WORLD

50 CENTS

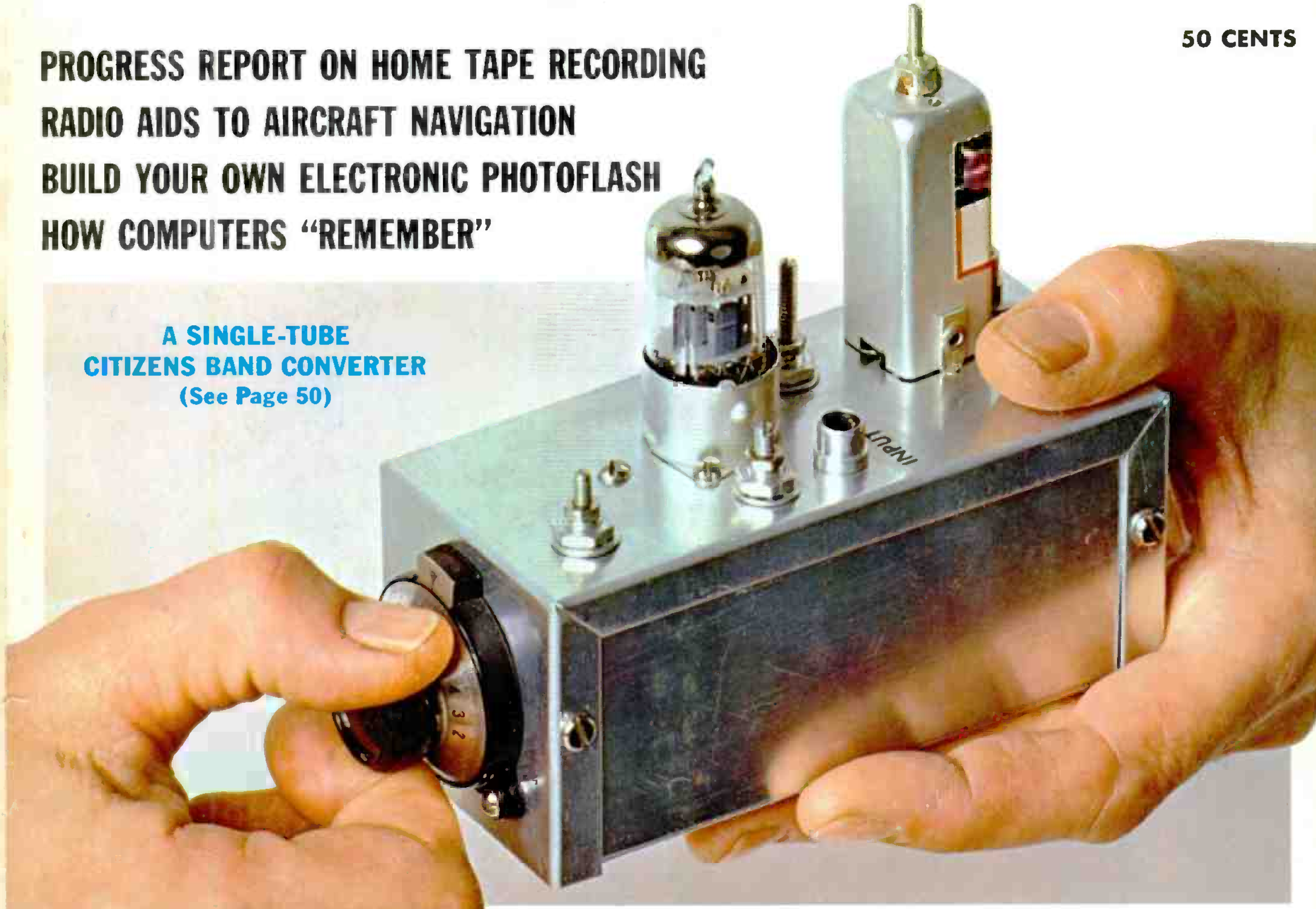
PROGRESS REPORT ON HOME TAPE RECORDING

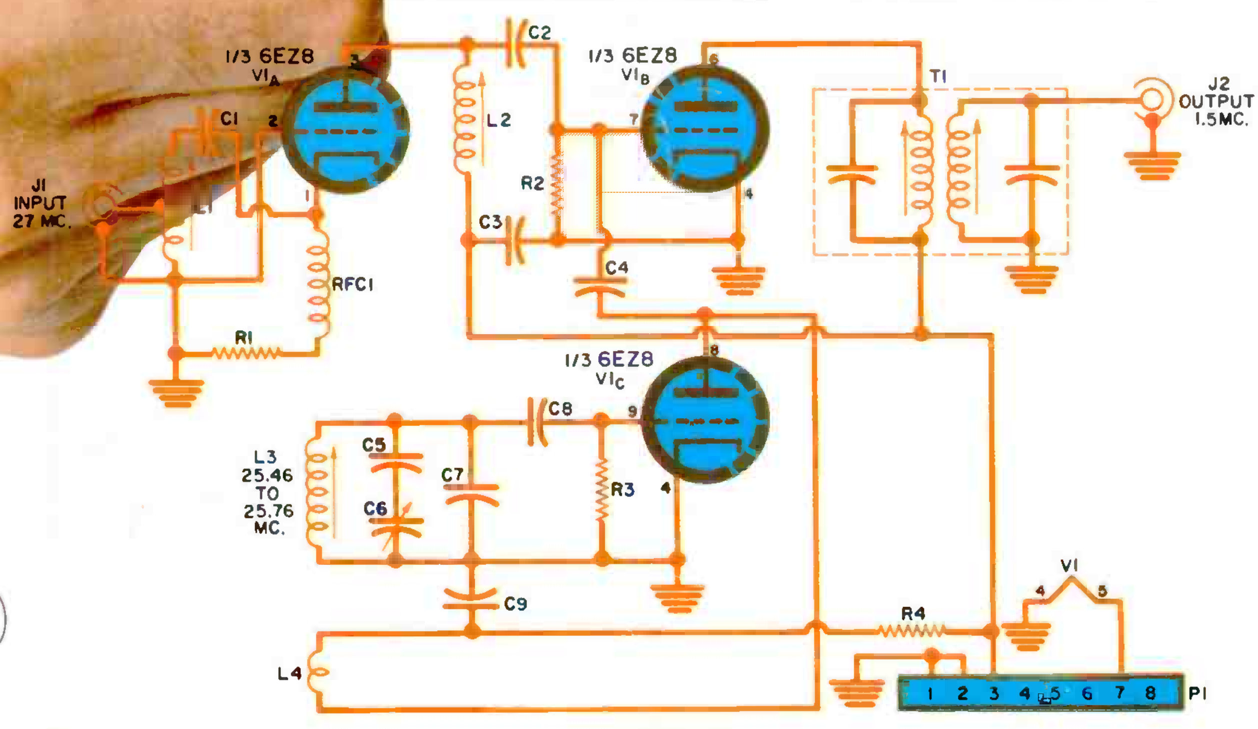
RADIO AIDS TO AIRCRAFT NAVIGATION

BUILD YOUR OWN ELECTRONIC PHOTOFLASH

HOW COMPUTERS "REMEMBER"

A SINGLE-TUBE CITIZENS BAND CONVERTER (See Page 50)





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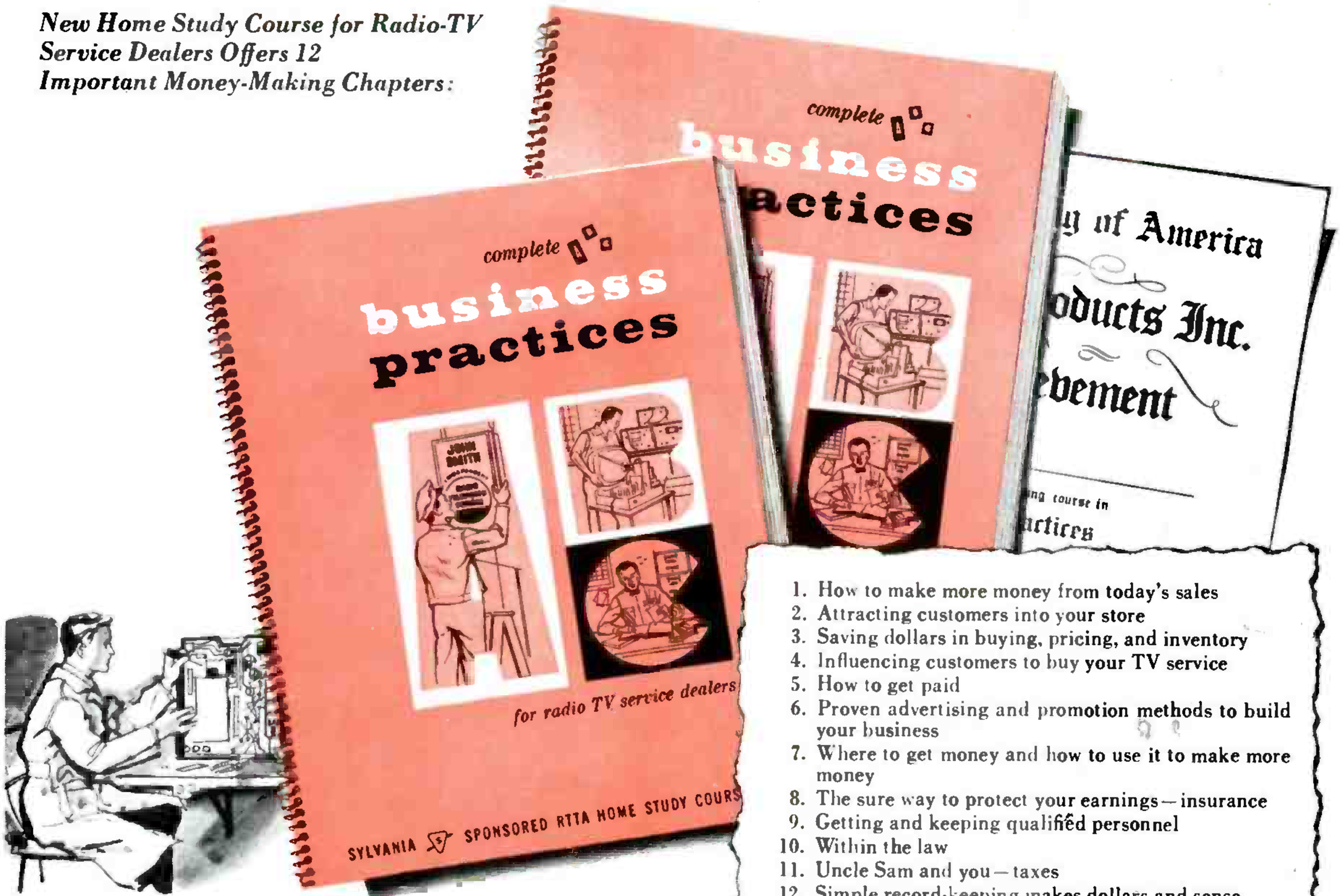

1. How to make more money from today's sales
2. Attracting customers into your store
3. Saving dollars in buying, pricing, and inventory
4. Influencing customers to buy your TV service
5. How to get paid
6. Proven advertising and promotion methods to build your business
7. Where to get money and how to use it to make more money
8. The sure way to protect your earnings—insurance
9. Getting and keeping qualified personnel
10. Within the law
11. Uncle Sam and you—taxes
12. Simple record-keeping makes dollars and sense

As a service dealer you wear two "hats"—(1) you are a technical expert, qualified to repair and maintain electronic equipment, and (2) you are an independent shopowner, a businessman important to the economy of our country.

You can succeed in your profession only if you are thoroughly trained in both service and sales.

SYLVANIA now offers an outstanding, valuable course in "business practices." It's easy to get. Easy to use. Sure to help you build more profits.

A certificate of achievement is awarded on completion of the course. Display it in your shop . . . it tells all your customers that you are a trained serviceman—a trained businessman.

YOUR AUTHORIZED SYLVANIA TUBE DISTRIBUTOR HAS COMPLETE DETAILS. CALL HIM NOW. CHECK YOUR TUBE STOCK FIRST. AND ASK HIM FOR SYLVANIA TUBES!

Electronic Tubes Division, Sylvania Electric Products Inc., 1740 Broadway, New York, N.Y.

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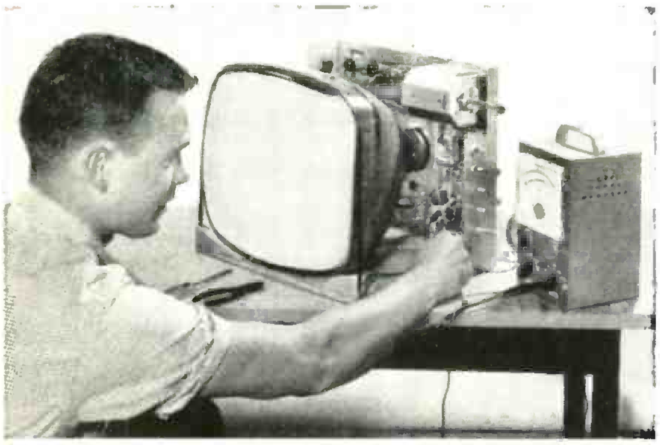
Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

Train at Home for Success in RADIO TELEVISION ELECTRONICS

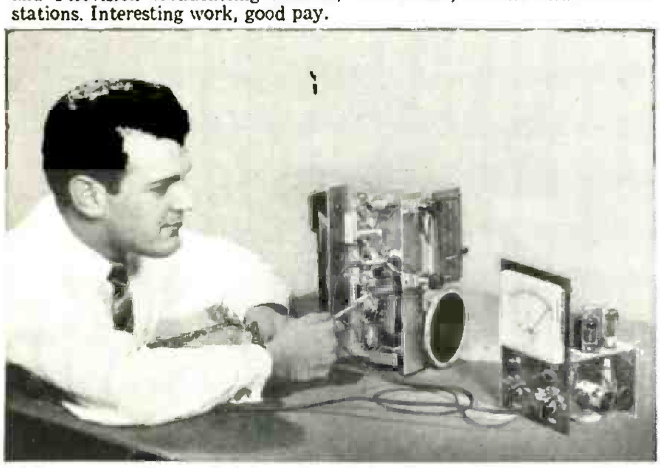


You Learn at Home by Actual Practice

With NRI kits you build actual Radio-Television circuits and testing instrument. Practice locating and fixing Radio-Television troubles. Learn soon to earn extra money.

Good Jobs in Radio-TV Communications

NRI trained men hold good jobs as operators and technicians in Radio and Television broadcasting stations, with Police, Marine and Aviation stations. Interesting work, good pay.



There's Good Pay in Radio-TV Servicing

NRI trained technicians are needed, paid well, to help maintain 150 million home and auto Radios, 38 million TV sets. Color TV adding opportunities. Excellent field for spare time earning.

Join the thousands N.R.I. has trained for Successful Careers in Radio-TV

J. E. Smith
Founder

Get the benefit of NRI's 40 years experience training men for success in this field. Get personal attention of experienced instructors. Also get practice with Radio-TV equipment—learn by *doing*—with kits supplied as part of your course. Courses are easy to learn. Most successful NRI men start without any knowdege of Radio, many without a high school education.

Find Out What Radio-TV Offers You

As trained Radio-TV Technician, you are prepared to supply much needed services. The technician is a respected and appreciated member of his community. Get Sample Lesson FREE. See how practical NRI has made learning at home. Mail the coupon. You also get 64-page Catalog telling about NRI, the lessons, equipment supplied, instruction services.

N.R.I. TRAINED THESE MEN FOR SUCCESS

"I am a police captain and have a good spare time Radio-Television service business. Just opened new shop." C. W. LEWIS, Pensacola, Florida.

"Received my License and worked on ships. Now Chief Engineer Station WAPA. Grateful to N.R.I." R. D. ARNOLD, Rumford, Rhode Island.

"Enrolled while meat market manager. Got serviceman job. In a year my pay increased 50%." C. CARTER, San Bernardino, California.

"Have a Radar job. Also do spare time Radio-Television servicing. Have my own amateur Radio Station." F. ZAWAKE, Scranton, Pennsylvania.

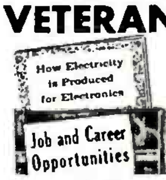
Added Income Soon—$10, $15 a Week in Your Spare Time

Soon after enrolling, many NRI students earn $10,$15 a week extra fixing sets in spare time. Vacuum Tube Voltmeter you build with parts we send helps you locate and fix troubles. Special lessons show you how. Many students use spare time earnings to pay for their training, and provide capital to start their own businesses when they get their National Radio Institute Diploma.

Color TV Making More Jobs

Radio-Television is an industry noted for continued and spectacular growth. Number of trained men employed has increased steadily. Color TV and other late developments are creating need for more technicians. The future is very bright for trained men. Find out how you can get ready at low cost, on easy terms. Send for FREE Sample Lesson and Catalog. Mail coupon today—**National Radio Institute, Dept. OGE Washington 16, D. C.**

VETERANS—Approved under GI Bills



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ACCREDITED MEMBER, NATIONAL HOME STUDY COUNCIL

ELECTRONICS WORLD

JULY, 1960

VOL. 64 ■ NO. 1

ZIFF-DAVIS PUBLISHING COMPANY
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CONTENTS

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Men 17-55

READ THESE AMAZING FACTS ABOUT A MAN WHO COULD BE YOU!

Are *YOU* One of the men who could prepare for a job that *PAYS REAL MONEY* in

TELEVISION
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Electronics

EMPLOYMENT SERVICE

NOTHING ELSE LIKE IT

NO PREVIOUS TECHNICAL EXPERIENCE NEEDED

NO ADVANCED EDUCATION NEEDED

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ONLY DeVRY OFFERS ALL THESE FEATURES!

Only DeVry Tech provides Training Movies to make the basic principles of Electronics crystal clear! DeVry's explanations and illustrations are a pleasure to follow. Over 300 practical experiments with actual Electronic parts are included to give you on-the-job type know-how. You even build your own test equipment.

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The Industry knows the quality of DeVry training. That's why our Employment Service usually has more demands for graduates than we can fill. We can also help you get started in your own shop.

ARE YOU PASSING UP THE PAYCHECK—THE SOLID FUTURE—THE REAL BREAK—YOU'VE ALWAYS DREAMED OF?

You meet them almost every day . . . the men who want to advance out of humdrum, low-pay, or no-future jobs. Some are men who had to quit school too soon; men just out of school with no idea of what to do; or men looking for help in planning a better future. Yet, many of them could—can, if they're 17-55—train at home, in their spare time, for an exciting career with real money and an inspiring future in the field of Electronics. And the tragedy of it is: they don't know it! They think they need an advanced education, or some special experience, or a lot of money, to start—but what they need most is the will to win. Maybe you're a man like that. Well, here's great news! It's not too late! Electronics offers men like you, when trained, dozens of different job opportunities—from guided missile control to running your own radio-television service shop. Get the full story of the jobs you may prepare for . . . NOW . . . BEFORE the years and responsibilities close in on you. Send coupon today—no obligation.

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Large modern training centers in Chicago and Toronto offer DeVry students day and evening classes. The staffs, facilities and experience of these centers stand back of the home training programs. Whether you train at home or in residence, you're a DeVry Tech man. Look into it now!

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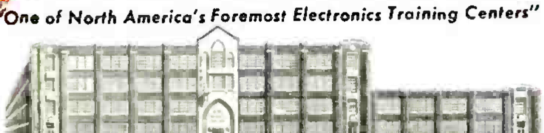

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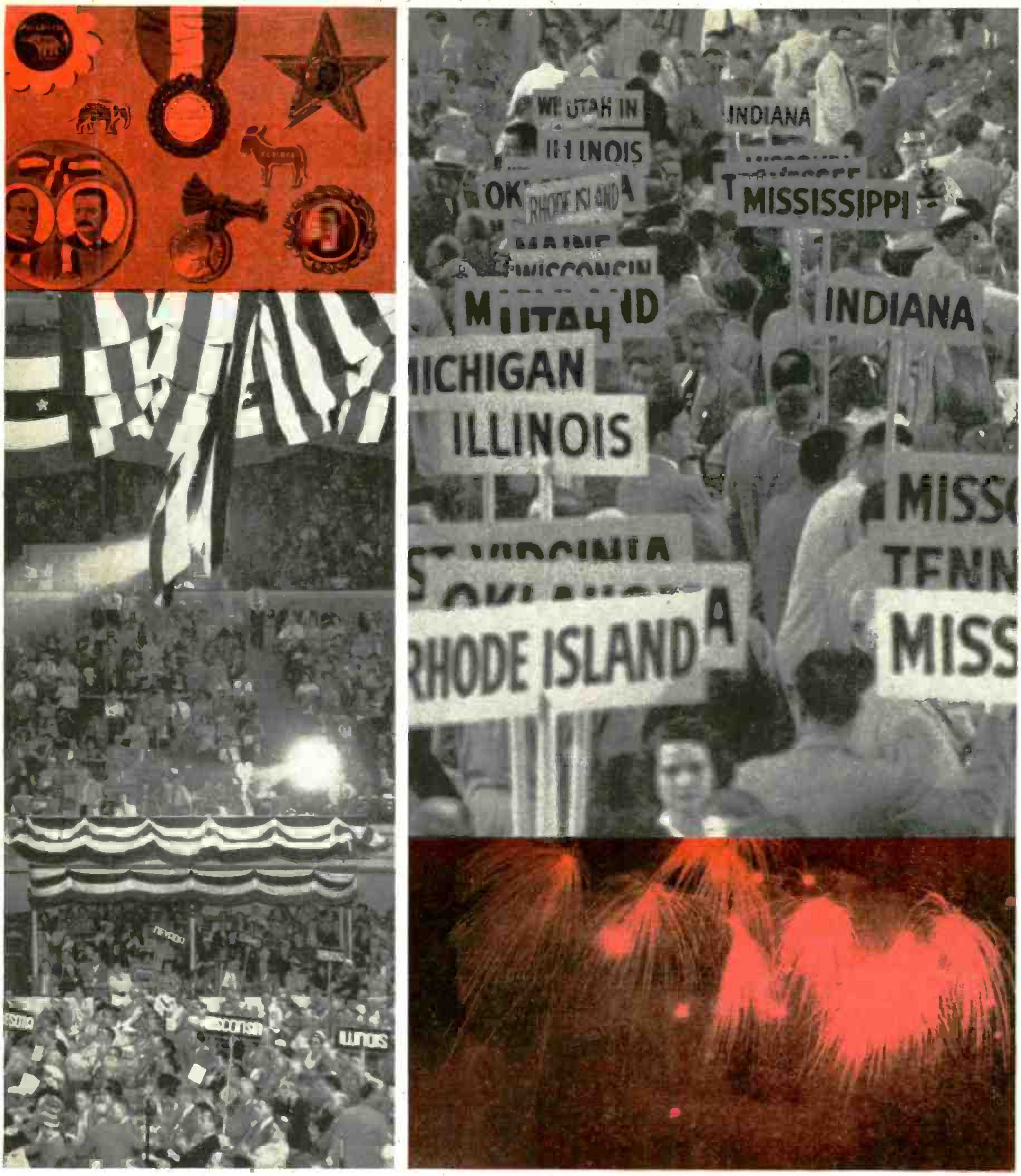


tion CBS-Radio network reaching more than 11 million listeners per broadcast. The result will be a tremendous parade of customers looking for their local Service Dealer who sells Westinghouse TV and Radio Tubes. Get ready to cash in on this profit opportunity. Put up the special Westinghouse Tube displays. Tie in with your own advertising. BUT FIRST—call your Westinghouse Distributor and place your tube order right away! You're going to need a lot!

YOU CAN BE **SURE**...IF IT'S **Westinghouse**

Westinghouse Electric Corp., Electronic Tube Division, Elmira, New York
Tune in Westinghouse-CBS TV-Radio Coverage, Presidential Conventions, July 10-29.

...for the Record

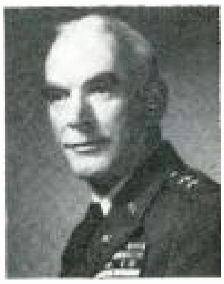
By **W. A. STOCKLIN**
Editor

A CENTURY OF SIGNALS

THE twentieth of June marked a century of service by the U. S. Army Signal Corps to the Army and to the Nation. During its first hundred years, the art of communication has progressed from colored signal flags to a communications satellite relaying voice and teletypewriter messages from outer space!

An Army surgeon, Major Albert J. Myer, is credited with founding the Signal Corps as a separate branch of the services. His interest stemmed from an attempt to help the deaf which, in turn, led to a system of sign language between military outposts. Thus, within a century, signal flags painstakingly spelling out messages have been replaced by electronic computing machines and electric signals which flash information to the ends of the earth and beyond at speeds measured in millions of "bits" of data per second.

This progress is awe-inspiring and we, along with all of our fellow Americans, salute the U. S. Army Signal Corps for a job "well done." We have long nourished a warm spot in our hearts for the Signal Corps which dates back to World War II days.



Major-Gen. Nelson
Chief Signal Officer

Since the growth of our civilian electronics industry has closely paralleled that of the military—in many cases through mutual cooperation—the accomplishments of the Signal Corps today are of continuing interest as a clue to "things to come" in the civilian market. Printed-circuit wiring, modules, and many other miniaturization techniques used in consumer equipment today were developed for, and sometimes by, the Signal Corps for military electronic applications.

The modern-day Signal Corps is a far cry from the infant organization of the Civil War era, although the same pioneering spirit characterizes both establishments. The Corps of the 1800's readily adopted the then-new electric telegraph and the hand-operated magnetos used to power the equipment; they participated in the First Polar Year (1881) just as they played a prominent and important role in the International Geophysical Year.

Phenomenal growth in recent years—accelerated by the missile and space era—has characterized many of the Signal Corps' major efforts. The advent and rapid development of Army missiles engendered a relatively new and expanding mission area for the Signal Corps—that of combat surveillance and target acquisition.

Automatic data processing, added to the world-wide communication system in 1955, is being directed to tactical communications and militarized equipment for use in the field army is under development. These and other advances in elaborate tactical communications, including a tiny belt-pack or helmet radio carried by an individual soldier, made possible by micro-miniaturization techniques; mobile and air transportable long-range communications central for STRAC-type missions; and satellite communications have revolutionized the art of signaling.

Under its eighteenth Chief Signal Officer, Major-General R. T. Nelson (appointed May 1, 1959), the Army Signal Corps continues to seek improved command control systems of communication, combat surveillance, electronic warfare, and avionics for the Army and to contribute to the electronic science and capability of America's space effort.

Among promising new items and systems under advance development are a mobile radio switching central, carried in an Army vehicle, which will handle up to 48 radio "subscriber sets" in jeeps—much the same as a telephone switchboard handles telephone calls; a push-button telephone to replace the conventional dial type; smaller and lighter miniaturized telephone, teletypewriter, and radio equipment—all geared for combat use; jet surveillance drones and advanced sensors of improved resolution and discrimination; small tactical computer equipment; and a mobile decision-making complex on which visual displays of information and communications means will be centralized.

While some of these units, by their very nature, will remain in the military "arsenal," much of the equipment and many of the techniques will, in time, benefit the civilian population. As has been the case since the founding of the Signal Corps a century ago—as the Corps sows, the civilian reaps. Today's military communications satellites may, within a relatively short space of time, provide us with TV programs, radio broadcasts, and two-way communications from countries overseas—shrinking the globe still another notch.

So for past services and the brilliant future we can confidently predict for the Signal Corps—a big thanks and a sincere Happy Hundredth! —30—

2 Great *knight-kit*® Citizens Band Transceiver Kits

A PRODUCT OF ALLIED RADIO

YOUR CHOICE OF THE FINEST VALUES IN 2-WAY RADIO EQUIPMENT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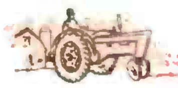
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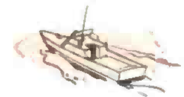
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FREE Examination Privilege

We invite you to take advantage of our exclusive free examination offer. Order a Knight-Kit Transceiver. Examine it on arrival. Inspect the quality of the components, the circuitry, the easy-assembly manual. We're so confident you'll want the kit, we can make this offer: If you're not COMPLETELY SATISFIED, just return the kit for full refund!

Citizens Band Superhet Transceiver Kit

Y-712L

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$5

BEAUTIFUL STYLING...UNEXCELLED PERFORMANCE

Have dependable, economical 2-way radio communication with this top-rated, do-it-yourself transceiver. Has two crystal-controlled transmitting positions; operates at maximum FCC legal power input of 5 watts fully modulated. Superhet receiver is continuously tunable over the full 22 channel band; also has two optional crystal-controlled fixed frequency positions. Works just like press-to-talk intercom—speaker also serves as mike.

Ultra-selective, highly sensitive dual-conversion superhet receiver features built-in adjustable squelch and noise limiter. Sensitivity (manual) is better than 1 μv for 10 db S/N; crystal, ½ μv. Includes built-in AC power supply. Easy to assemble; has dependable printed circuitry and pre-aligned IF transformers. With distinctively styled high-impact case, 5 x 12 x 12". Complete with all parts, wire-type doublet antenna, and one transmitting crystal (available for any channel from 1 to 22—specify preference). FCC application form is included (license is available to any citizen over 18—no exams to take). See below for DC mobile supply, vertical antenna, etc. Wt., 20 lbs.

Model Y-712L. *$5 Down.* ONLY $79.95

Y-729L. 3 Ft. Vertical Antenna. 2 lbs. NET 6.50
Y-714L. Mobile Mounting Bracket. 4 lbs. NET 5.35
Y-723L. 6-12 V. Mobile Power Supply. 6 lbs. NET 10.95
Y-769L. Optional Receiving Crystal (specify frequency) .. 1.99
Y-719L. Optional Hand-Held Mike. 1 lb. NET 9.50

Manufactured and sold exclusively by **ALLIED RADIO**

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Now have your own private 2-way radio system at an amazingly low cost! Consists of easy-to-assemble superregenerative receiver and 5-watt transmitter. Readily fits car, boat or desk. Single, one-switch operation permits talk or listen. Receiver tunes all 22 channels continuously. Built-in AC power supply. Handsomely styled case, 7x10x8". With mike, doublet antenna, and transmitting crystal (specify channel—1 to 22—if you have a preference). See below for antenna, mobile power supply, etc. Shpg. wt., 10 lbs.

Model Y-713L. *$2 Down.* ONLY $39.95

Y-729L. 3 Ft. Vertical Antenna. 2 lbs. NET 6.50
Y-723L. 6-12 V. Mobile Power Supply. 6 lbs. . 10.95
Y-724L. Mobile Mounting Bracket. 4 lbs. NET. 5.35

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100 N. Western Ave., Chicago 80, Ill.

Please ship: ☐ Y-712L Transceiver. ☐ Y-713L Transceiver.
☐ Y-729L ☐ Y-723L ☐ Y-714L ☐ Y-724L
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☐ Send latest catalog describing Knight-Kits.

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Within the Industry

RICHARD E. KRAFVE has been elected president of *Raytheon Co.*, Waltham, Mass., succeeding Charles F. Adams who has been named to the newly created position of chairman of the board. Mr. Krafve, is former vice-president of the *Ford Motor Co.* who joined *Raytheon* in April 1959 as group vice-president and a director last September. A native of Minnesota, he attended the Minnesota College of Law and the University of Minnesota.

During the war, Captain Krafve served as control officer and later director of the Control division, Third Service Command.

* * *

SYLVANIA ELECTRONIC SYSTEMS, a division of **SYLVANIA ELECTRIC PRODUCTS INC.** has announced plans for a new Applied Research Laboratory facility and new headquarters building, each totalling approximately 45,000 square feet, on a 55-acre site adjacent to present division facilities in Waltham, Mass. . . . **UHER TAPE RECORDERS** has moved to larger quarters in New York City . . . **CLEVITE TRANSISTOR's** new $4 million plant in Waltham, Mass. is expected to open July 1 . . . **ATLAS SOUND CORP.**, Brooklyn, N. Y. has announced plans for a new factory annex to adjoin present facilities . . . **DELCO RADIO DIVISION, GENERAL MOTORS**, recently broke ground for a new engineering building in Kokomo, Ind. Featured in the ceremonies was the use of a hand-held portable garage-door opening device that activated a 25-ton bulldozer . . . **TALK-A-PHONE CO.**, Chicago, is in full operation at its new plant, specializing in the manufacture of intercommunications systems . . . **GRANCO PRODUCTS, INC.** has moved offices and production lines to a larger plant in Kew Gardens, Long Island, N. Y. The new location, a 63.000 square foot building, is expected to triple the company's production capacity.

* * *

GEORGE E. ALTHOUSE has been selected to fill the newly created position of Customer Service Manager at the *Heath Company*, Benton Harbor, Mich. In his new post, Mr. Althouse will direct the activities of the recently consolidated technical consultants, service repair, adjustments and service parts sections. A five-year veteran with *Heath*, Mr. Althouse was formerly office manager and before that, supervisor of sales. Before joining the firm, he was assistant to the Postmaster in Benton Harbor where he gained much of his direct mail know-how.

Mr. Althouse is a veteran of the U.S. Navy in World War II and attended Michigan State University.

Moving into the post of office manager vacated by Mr. Althouse is Matthew R. Cutter, who joined the company in 1955.

* * *

G. BARRON MALLORY has been elected president of *P. R. Mallory Co., Inc.*, Indianapolis, Ind. . . . **THEODORE LINDENBERG** has been named director of engineering for the *Astatic Corp.*, Conneaut, Ohio . . . **J. W. RINGROSE** has been appointed chief applications engineer of *Semiconductors, Ltd.*, while **J. H. THORP** has been named sales manager of the British firm . . . **ARTHUR L. KOEHLER**, appointed manufacturing manager of *Sorensen & Co.*, South Norwalk, Conn., will take charge of all production in the company's plants there and in New York City . . . **WEBSTER H. WILSON** has been elected president of *Hazeltine Corp.*, Little Neck, N. Y. . . . **GEORGE J. FEDER** has been appointed manager, Somerville Operation Services, for the *RCA* Semiconductor and Materials Division, Somerville, N. J. . . . **ROY N. SUNDSTROM** has been named to the new position of senior project engineer for the Electrical Products Division of *Corning Glass Works*, Corning, N. Y. . . . **I. ROBERT ROSS** has been appointed general manager of *U.S. Transistor Corp.*, Syosset, Long Island, N. Y., where he will be in charge of sales and production administration . . . **ALBERT K. HAWKES** has been promoted to supervisor in electronic research at Armour Research Foundation of the Illinois Institute of Technology . . . **FRANK GENOCHIO** has moved up to vice-president in charge of sales at *Kaar Engineering Corp.*, Palo Alto, Calif. . . . **ROBERT E. DRYDEN** has been appointed vice-president, engineering at *Pearce-Simpson, Inc.*, Miami, Fla. . . . **ANTHONY DILLON** has assumed the post of general sales manager at *Sony Corporation of America*, New York, N. Y. . . . **HOWARD B. SALTZMAN** has been elected executive vice-president of *Alpha Wire Corp.*, New York, N. Y., while Jack Kirschbaum and Philip Freidin have been elected to the offices of vice-president in charge of sales and treasurer respectively . . . **DR. SIDNEY J. STEIN**, who is the director of research and of engineering for *International Resistor*

Introducing a new small-size bi-directional Ribbon Microphone VM-16, Velocity Type.

MODEL VM-16

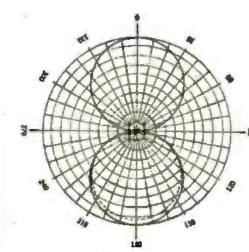
- Superlative high quality response characteristics.
- Engineered in collaboration with the Technical Research Laboratory of the Japan Broadcasting Corporation (NHK).
- Outstanding results when used for FM broadcasting and high fidelity recording because of its exacting quality of tone reproduction.
- Because of the above superior characteristics, its small size and non reflecting satin-chrome finish, it is ideally suited for TV broadcasting.

MODEL VM-16

SPECIFICATION

Frequency Response: 50-15,000 c/s ± 3 dB
Output Level: -80 dB (150 ohms/1,000c/s)
Impedance: 150 ohms, 250 ohms or 600 ohms
Directional Characteristic: Bi-directional
S/N 20 dB or below (in parallel field at 1 m gauss)

Directional Characteristic



—— 500 c/s, 1000 c/s .... 8000 c/s

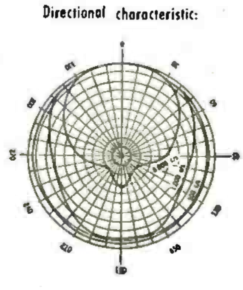
AIWA

MODEL DM-20

SPECIFICATION

Frequency Response: 70-10,000 c/s ± 5dB
Output Level: -79 dB (150 ohms, 1,000 c/s)
Impedance: 50 ohms, 150 ohms, 250 ohms, 10 K ohms and 50 K ohms
Directional Characteristic: Non-directional

Directional characteristic:



MODEL DM-20

Newly Developed, Economical Dynamic Microphone DM-20

- The DM-20 features a strong diecast body formed after exhaustive acoustical research to achieve reproduction of full audio range.
- Introduces a new plastic diaphragm free from mechanical distortion and physical deterioration.
- An exceptional dynamic microphone for studio broadcasting or recording, resulting in improved, clear and lifelike tone quality.
- Broadens the realism of the tone reproduction in tape recording, well above currently used types of microphone.
- Reasonable price.

AIWA CO., LTD.
Tokyo, Japan

Co., Philadelphia, Pa., has been elected a vice-president. He will implement *IRC's* new expansion plans.

* * *

PETER J. GRANT has been appointed president of *Sylvania Home Electronics Corp.*, marketing subsidiary of *Sylvania Electric Products Inc.*, it was announced recently by Marion E. Pettegrew, senior vice-president. Mr. Grant, who has been vice-president, national sales since April 1959, succeeds Robert L. Shaw who resigned. In his new position, Mr. Grant will be responsible for all marketing operations for the division's home electronic products, which include television sets, radios, and stereo phonographs. Mr. Grant joined *Sylvania* in 1951 as a sales representative for the company's lighting products. Since his transfer in 1952 to Home Electronics, he has served as district sales manager, Eastern regional sales manager, manager of sales management development, manager of marketing services, national sales manager, and vice-president of national sales.

A native of Lakewood, Ohio, he was graduated from Ohio State University in 1948.

* * *

ASSOCIATION OF ELECTRONIC PARTS AND EQUIPMENT MANUFACTURERS, INC. has announced the election of new officers. President of the Association is Irving Rossman, executive vice-president of *Pentron Electronics Corp.* Other officers are: first vice-president, Warren Stuart, manager of field sales and sales training, *Belden Mfg. Co.;* second vice-president, Bruce Vinkemulder, assistant general sales manager, *Centralab Division, Globe-Union, Inc.;* treasurer, Kenneth Hathaway, manager, radio and electronic distributor division, *Ward Leonard Electric Co.;* executive secretary, Kenneth C. Prince. The new officers will serve one year.

Named to the board of directors for a three-year term were Wilfred L. Larson, president of *Switchcraft, Inc.;* Robert E. Svoboda, general manager, *Amphenol* distributor division, *Amphenol-Borg Electronics Corp.;* and Richard Crossley, president, *Electro-Products Laboratories.*

* * *

STANDARD COIL PRODUCTS announces that construction of its 58,000-square foot plant in Oshkosh, Wis. should be completed about August 1 . . . **LAMBDA ELECTRONICS CORP.** expects to complete its 76.000-square foot plant in Huntington, L. I., N. Y. late this year . . . **AMPEREX ELECTRONICS CORP.**, Hicksville, L. I., N. Y. has acquired a plant in the Woonsocket Industrial Park in Slatersville, R. I., for large scale production of PADT transistors and semiconductor diodes . . . **ELGIN NATIONAL WATCH CO.** will set up a new research and engineering plant for **ELGIN MICRONICS** near Palatine, Ill.

* * *

WILLIAM (BILL) ORR, W6SAI, has been appointed Manager of the Amateur Service Department at *Eitel-McCullough, Inc.*, San Carlos, California manufacturer of *Eimac* electron-power tubes, according to O. H. Brown, Director of Marketing. A world-traveled amateur radio authority, Mr. Orr is editor of the "Radio Handbook" in addition to his duties at *Eimac*. He also is the author of the "Beam Antenna Handbook," "VHF Handbook," "Quad Antennas" and other ham publications. He received his first amateur licence (W2HCE) in 1934 and has been licensed as W6SAI since 1938. He holds WAZ, DXCC (265 countries) and numerous other awards. Prior to joining *Eimac*, Mr. Orr and his family spent 14 months touring Europe and Africa, visiting 23 countries and meeting friends contacted over the air. Amateur operations were conducted in such spots as Finland, Sweden, Vatican City, Monaco, and Andorra, in addition to the islands of St. Pierre and Miquelon.

Born in St. Louis, Missouri, Mr. Orr attended Columbia University, UCLA, and gained his B.S. degree from the University of California. —30—

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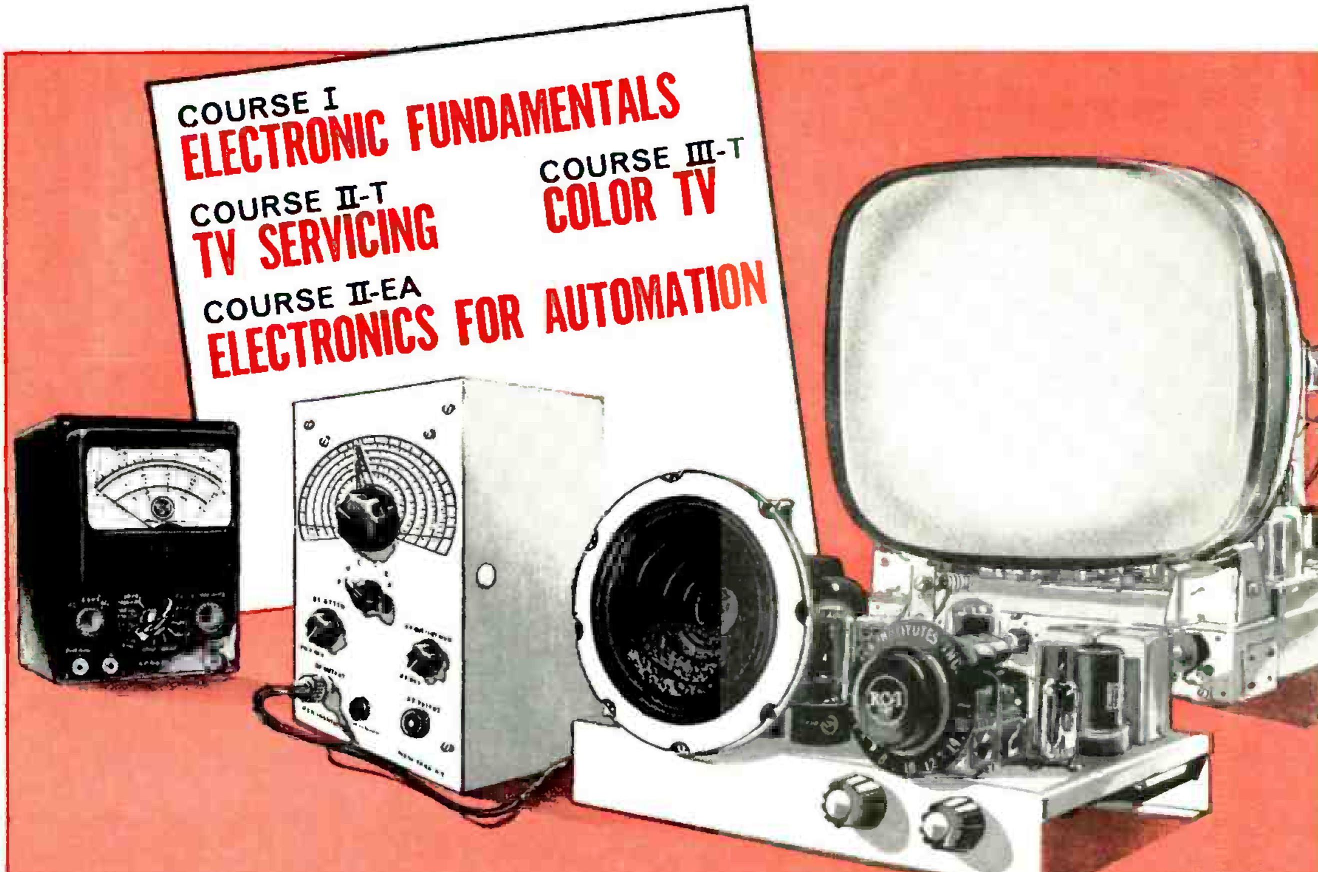

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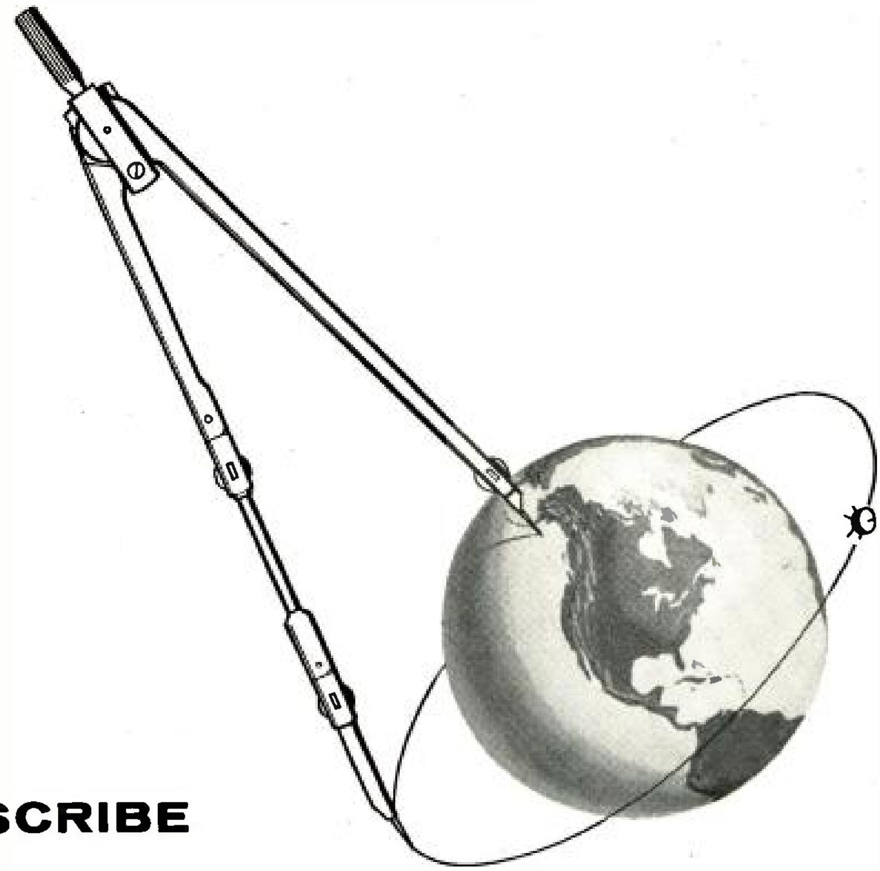

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Two Bell Laboratories engineers, T. J. Grieser and D. R. Hagner, look over the second-stage section of the Air Force Thor-Able missile used to launch the NASA Tiros weather satellite.

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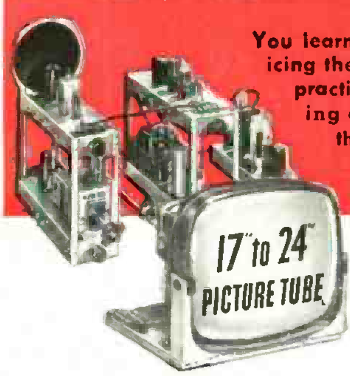

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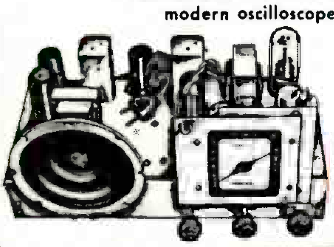

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Spot News

Latest Information on the Electronic Industry

By ELECTRONICS WORLD'S WASHINGTON EDITOR

NEW "TRANSIT" SATELLITE TO CARRY ELECTRONIC MAPPING DEVICE—A six-pound transponder --receiver/transmitter component of SECOR (Sequential Correlation Range) that measures distance by radio—will be placed aboard a Navy "Transit" satellite next fall to assist the Army in obtaining more precise geodetic and mapping information. Four portable stations, movable from one point to another on the earth's surface, will simultaneously send to and receive radio signals from the instrument. This will be possible because signals traveling at the speed of light can be rapidly converted into measurements of the distance from the ground stations to the satellite. Thus, with three stations at widely separated known points on the earth, up to 2000 miles apart, the location of the fourth, or unknown, point can be determined by triangulation computations. Considered part of "Project Betty", which has three "Minitrack Mark II" stations on Pacific Ocean Islands taking observations on the Navy "Vanguard" satellite since 1958, the new technique is said to be better suited than "Minitrack".

NATIONAL SPACE GOALS STRESS ELECTRONIC POTENTIALS—A 12-point space program, with heavy emphasis on the vast possibilities of electronic systems, was outlined recently by Senator Alexander Wiley before the Senate Aeronautical and Space Sciences Committee. In 1961, he said, we should look for not only successful manned space flights, but the establishment of a communications-satellite system including transmission of radio, telephone, teletypewriter, and television; weather satellites; and an adequate national warning-tracking system with radar and sentinel satellites to provide us with a space-guard against surprise attack. And by 1963-64, the Senator added, electronics should play a major role in lunar soft landings carrying television, seismograph, and radiation detection devices to observe and analyze the surface and subsurface of the moon.

ULTRA-SENSITIVE RUBY MASER ELECTRONIC EAR DEVELOPED FOR ARMY—A 25-pound ruby maser electronic ear, considered to be one of the most sensitive listening devices invented and keen enough to pick up faint radio signals from interplanetary rockets, has been developed for the Signal Corps by Hughes Aircraft. The maser (Microwave Amplification by Stimulated Emission of Radiation) is expected to detect radio beeps from space vehicles millions of miles away and enable our defense systems using long-range, high-angle radars to detect intercontinental ballistic missiles far earlier than they can now. In operation, a special 2-carat synthetic ruby inside the maser is cooled to 452 degrees below zero Fahrenheit—about as cold as any object in the universe can become. At this temperature the jewel can detect and amplify almost imperceptible faint radio signals.

AIR-TRAFFIC COMMUNICATIONS TO GET MORE CHANNELS—Effective this July there will be available for air-traffic control five additional megacycles—adding 100 more channels to the communications system. Over 300 of the changes (in the 126.825-128.825 and 132.025-135.0 mc. bands) will become operational on the 7th of this month with an equal number to go into effect within 90 days. Due to the limitations of airborne radios now on aircraft, not all planes will be able to utilize the extra frequencies. This includes equipment which will not tune to frequencies above 127 mc. and where selectivity characteristics require 100-kc. channel separation. The new plan provides, at this time, for the accommodation of limited equipment users through a duplication of some services and the restriction of many other services to channels between 118-127 mc. with a separation of 100 kc.

ROCKET-BORNE RADIOSONDE DEVELOPED—A rocket-borne radiosonde, featuring a transmitter and silver-zinc batteries in an 18-inch fiber glass shell, has been designed and built at the U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J. Developed to probe electronically the atmosphere up to a height of 40 miles for weather data, twice the usual ceiling for weather balloons, the device will be extremely valuable for plotting upper atmosphere conditions. Packed into the nose cone of a 77-pound rocket (ARCAS), the radiosonde, after release, floats earthward on a 15-foot parachute. Wind speed and direction are spelled out by an automatic ground tracker, called a "rawin set".

-30-

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10th Anniversary Line

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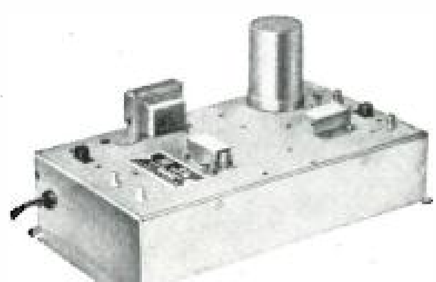

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THE "30" SLUG

To the Editors:

I have been a subscriber to your magazine for a good many years, but I confess there is still one thing that puzzles me. At the end of every article, the number "30" appears. Just what does this number mean anyway?

L. R. Edwards
Chicago, Illinois

The "30" symbol is a carryover from the old days of hand telegraphy, and it stood for the "end of transmission." When reporters filed their stories via telegraphy, the symbol appeared at the end of their stories. Hence, we use the "30" simply to indicate "end of story."—Editors.

* * *

CONTACT CLEANERS

To the Editors:

The article "Know Your Electronic Chemicals" in your February 1960 issue is quite interesting. However, if I may, I would like to point out a few disturbing paragraphs along with some suggestions.

You point out that many contact cleaners leave a film behind that serves to lubricate the wearing surfaces and that this film should be conductive. Actually this film should not be conductive, and the switch contacts should make contact of their own accord. The film may serve as a light lubricant, but definitely should not be conductive. If this were so, spraying a tuner, for example, with a chemical cleaner that would deposit a conductive film would prove disastrous, especially to high-frequency circuits.

There are two other chemicals well worth mentioning. One is xyzol and the other is trichloroethylene. Xyzol is highly inflammable, quickly dissolves grease and grime, and does a superb job. Other than that, its properties are not known. On the other hand, trichloroethylene is a fantastic cleaner, swiftly dissolves grease and grime, and supposedly has the reputation of polishing and plating any alloy in one quick operation. I have used both chemicals with excellent results. I also feel that petroleum jelly or white Vaseline is worth mentioning as a suitable lubricant for switch bearings, cams, etc.

The acetone that you mentioned, outlined in Table 1 on page 52, is about the best chemical available for cleaning printed circuits after a soldering job, for example. This quickly removes excess rosin and residue and leaves a sparkling printed circuit board. I've used this chemical for nearly two decades.

The carbon tet that you mention is a very dangerous chemical and should be used out in the open only. I understand that many government agencies have outlawed carbon tet since it generates poison gas known as phosgene, the type used in World War I. Penetration of carbon tet through the skin may also prove fatal.

John Jordan
Newark, New Jersey

Concerning the use of a contact cleaner which leaves a conductive film, we would like to point out that the word "conductive" merely refers to the relative resistance which any material has. Many oil-based lubricants present a very high resistance, such as 2 or 3 ohms per square unit over a thickness of 0.0001 inch. This would show up as contact resistance and result in noisy and intermittent switch operation. A conductive lubricant may present 0.01 ohm at the same thickness. The resistance of such a film covering the insulating material between contacts depends on the path's length and is usually well over several thousand ohms. It is on these terms that we recommend the use of chemicals as contact cleaners.

Xyzol is indeed a very powerful solvent but, unfortunately, it attacks a number of widely used plastics, resistor and capacitor markings, and it is also very volatile and dangerous.—Editors.

* * *

QUADRATURE FM DETECTORS

To the Editors:

I would like to bring to your attention an error in the article "Quadrature FM Detectors" by Ken Bramham in the December issue of Electronics World. Although the narrative portion is quite interesting and accurate, the error actually lies in Fig. 4B.

As Mr. Bramham stated in the discussion, the voltage developed across the *LC* resonant circuit associated with the quadrature grid (G_3) is 90 degrees out-of-phase (lagging) with the signal introduced on the limiter grid (G_1) provided, of course, that the frequency driving G_1 is equal to the resonant frequency of the quadrature grid tank. If, however, the frequency of the input signal increases, the quadrature grid circuit will change from resistive (where inductive reactance was equal to capacitive reactance and the resistance was that inherent in the circuit) to capacitive, where there will be a further voltage lag angle introduced depending upon how capacitive the circuit becomes, which in turn is a function of the initial frequency increase. Therefore, G_3 voltage will lag G_1 voltage by more than 90 degrees, causing the angle of 6BN6 plate current flow

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FRANCIS J. MCMANUS
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to be reduced and raising the average plate voltage. If, on the other hand the input signal frequency had decreased, the quadrature tank would have appeared inductive, the voltage on the quadrature grid would have lagged the limiter grid by less than 90 degrees, and the average plate voltage on the 6BN6 would have decreased.

Referring to Fig. 4B, Mr. Bramham has illustrated just the opposite effect of plate current and voltage *versus* frequency deviation.

EDWARD L. JAYSON
Port Washington, New York

Thanks to Reader Jayson for pointing out the inconsistency. His analysis appears to be quite correct, and Author Bramham concurs.—Editors.

* * *

TRANSISTORIZED FM RECEIVER

To the Editors:

In your article "Portable Transistorized FM Receiver," which appeared in your March, 1960 issue, you say that one 2N224 is equivalent to two 2N225's. According to my *Lafayette* catalogue, one 2N225 is equivalent to a pair of 2N224's. Which is right?

DONALD E. SAVAGE
Rome, New York

The Lafayette *catalogue is right on this one. Unfortunately, we got our 2N's transposed in the article and in the diagram.—Editors.*

* * *

NEW G-E TV CIRCUIT

To the Editors:

Your article entitled "New TV Designs for 1960" in the March issue of ELECTRONICS WORLD is very interesting and informative. Naturally, I am gratified to find *General Electric* is included in your coverage, and trust you will continue to follow our developments in the future.

However, I am somewhat concerned that the most important improvement incorporated in the M5 clipper circuit is not completely explained. I refer to the a.g.c. function performed by the circuit, which is the reason for the re-

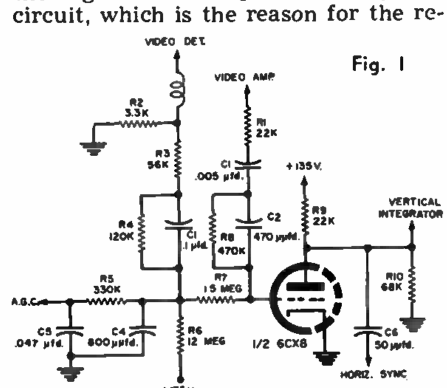

Fig. 1

turn to an opposite signal phase at the detector. Referring to Fig. 2 in your article (reproduced above as Fig. 1), the circuit operation is as follows:

1. Positive going sync pulses from the video amplifier are applied to the clipper grid.

2. Grid current resulting from rectification of these pulses flows through R_7, R_4, R_3, and R_2 to ground.

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3. The proper negative voltage level to apply as a.g.c. is found at the junction of R_7 and R_4. Unfortunately, there normally is a substantial video modulation present at this point, which is undesirable on an a.g.c. supply.

4. The point on this string of load resistors where the negative sync information from the detector and the positive sync information from the video amplifier just cancel out is the junction of R_4 and R_8.

5. By the addition of C_1 (.1 μf.) across R_4; this a.c. balance point is transferred to the junction of R_7 and R_4.

This circuit advantage provides practically ripple-free negative d.c. voltages for the a.g.c. line. Shorter time-constant decoupling filters may be used and thus provide faster a.g.c. control action as needed for airplane flutter or other rapid fading.

R. C. HANNUM
Supervisor-Technical Service
General Electric Co.
Syracuse, New York

The G-E circuit referred to is certainly quite interesting and well worth the analysis given above.—Editors.

* * *

"WHITE ALICE" SYSTEM

To the Editors:

After reading your article on tropospheric radio communication in the March issue, we found it very interesting and enlightening, but slightly misleading.

We are currently stationed in Alaska at a remote Air Force site which is served by the "White Alice" system. The site we are on is Tin City Air Force Station, which was incorrectly referred to in your article as Wales. Wales, in reality, is a small Eskimo village approximately five miles from Tin City and is not served by "White Alice." Your article also stated that Wales, correctly called Tin City, is 56 miles from Russia. We are actually 48 miles from the coast of Siberia, but only 26 miles from the Big Diomede Island which is Russian controlled and located west of the International Date Line, separating Russia from the U. S.

The power fluctuations you mentioned are caused at this station by the fact that "White Alice" operates on the same power as the site's radar. Although the only two things on this power are "White Alice" and the radar set, the fluctuations nevertheless exist. This power is generated by several generators in parallel. The radar set draws more power than "White Alice." When the radar transmitter high voltage is turned on or off, there is a tremendous change in power. While the generators are compensating for this sudden drop, or increase, whichever the case may be, there are slight variations in voltage and frequency, which frequently cause difficulties.

BARRY R. BOOLE
Radar Maint. Tech.
RICHARD J. EICHER
Radio Maint. Tech.
Tin City, Alaska

—30—

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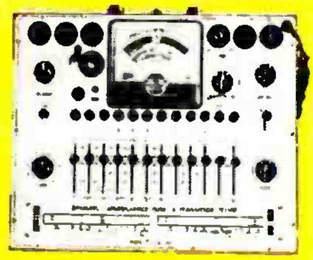

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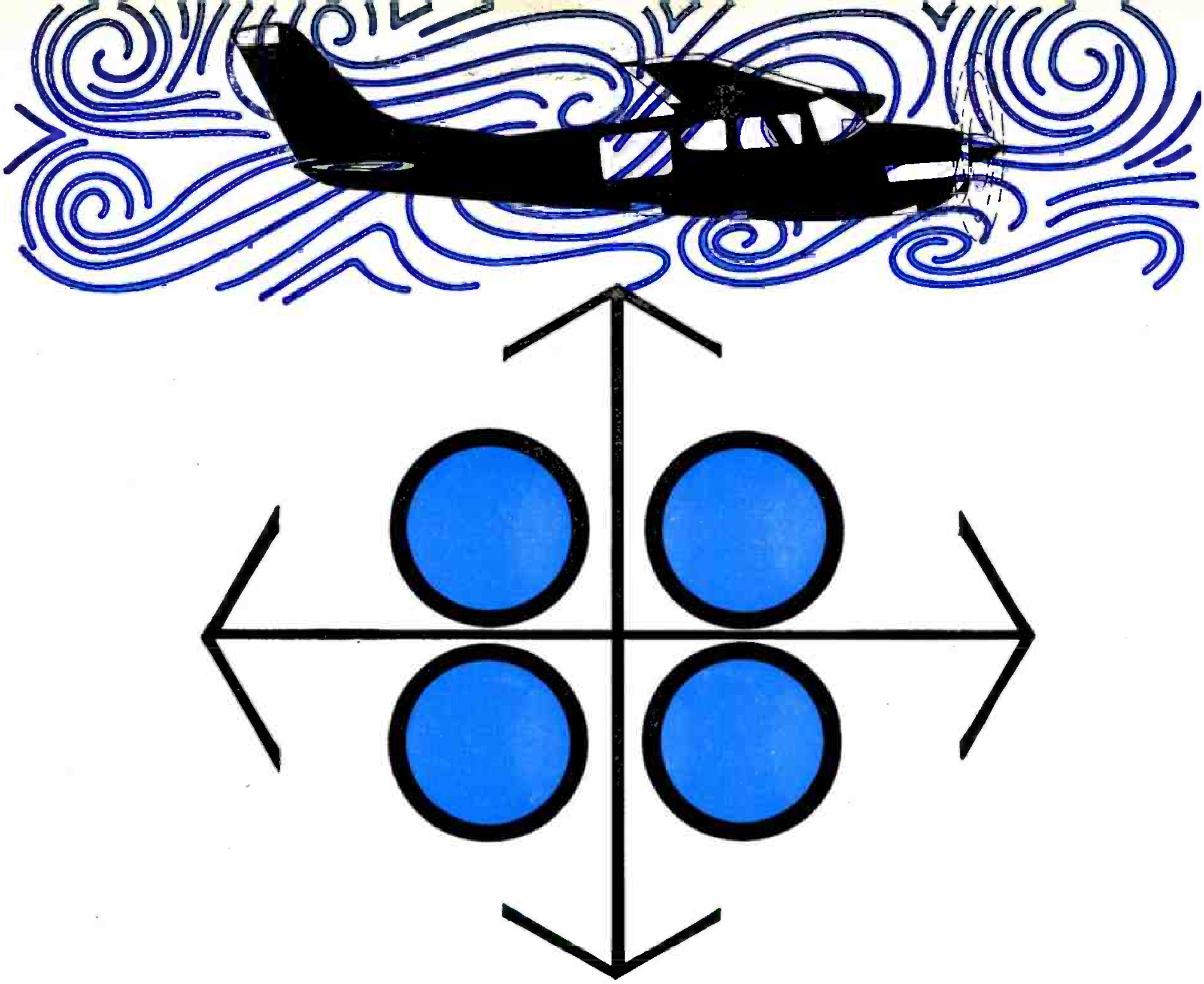


Radio Aids to Aircraft Navigation

Part 1. Low-Frequency Ranges & Direction Finding

By **FRANCIS A. GICCA**
Senior Engineer, Raytheon Co.

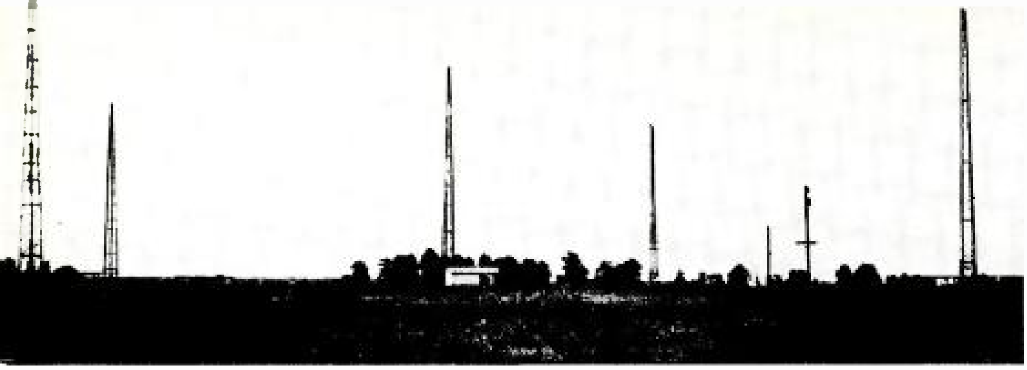
Operation and use of important electronic aids that make flying safe—with emphasis on private-plane applications.

OUR AUTHOR is well-qualified to write on this important subject. His professional work is directly concerned with the development of navigational and guidance systems. Also, he possesses a Private Pilot's License and is personally acquainted with the operation and use of all the systems described in this series of three articles. Finally, he has assembled several complete navigation systems for a flying club and has had to service all of this equipment.

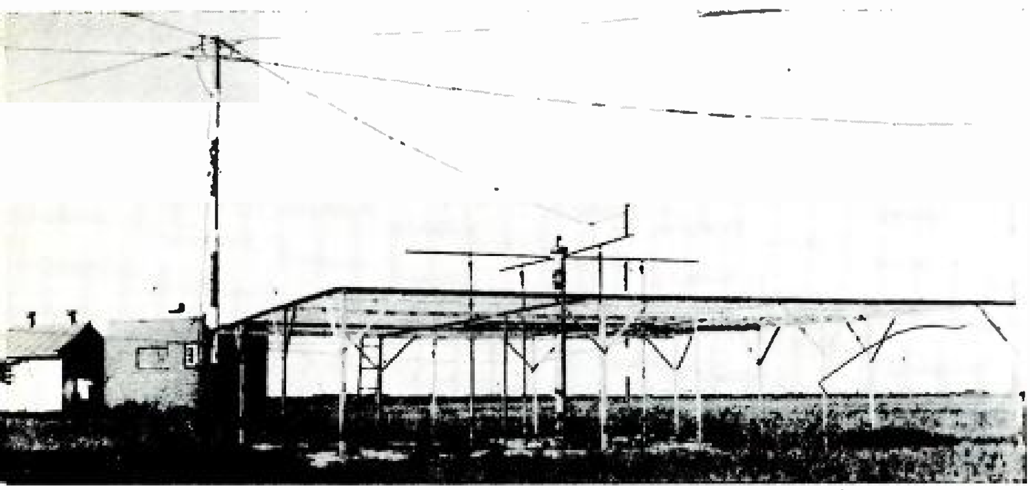
THE success of any transportation system depends greatly upon its ability to maintain safe, scheduled operation. Since World War II the airplane as a means of dependable transportation has grown to the point where most long-distance travel is done by air. This tremendous growth of air transportation is due, to a large extent, to the development of radio aids for aviation which allow modern aircraft to operate under all weather conditions. Radio today provides aviation with communications, traffic-control and, perhaps most important, navigation. For, without radio navigation, it would be impossible for airplanes to fly from city to city and land safely under any but the most favorable weather conditions.

Recently, the United States system of traffic-control and navigation has been under criticism as being unable to cope with the problems of high-density, high-speed air traffic. In many cases, these criticisms are valid. It must also be noted on the positive side, however, that the United States maintains the most complex and efficient system of traffic-control and federal radio aids to navigation in the world. Nevertheless, the Federal Aviation Agency is currently spending thousands of dollars for the improvement and safety of civil aviation. In the months ahead, words like ADF, VOR, and ILS will appear often in the press as the FAA makes its recommendations for some modernization of the airways system.

This three-part article will explore the operation of America's complex network of radio aids to aircraft navigation. Radio navigation is a fascinating field and, with the current national interest in aircraft control, it is certainly worthwhile to understand the operation of the present navigational systems. Aircraft navigation can be broadly classified into two categories. The first concerns all long-range sys-



Four-course low-frequency radio-range station showing the five antenna towers.



This four-course low-frequency radio-range station is of the loop type (as are about one-third of FAA's low-frequency ranges; the balance are 5-tower Adcock types). The long-wire antennas in the background are the two loops which are at 90 degrees to each other and are used to form the actual low-frequency range courses. The antenna structure in the foreground is a marker antenna array. This projects a 75-mc. signal directly upward in order to provide a positive "fix" over the station itself.

tems which allow a pilot to fly his plane between two distant cities. The second group may be termed "terminal navigation" and includes all systems which guide the pilot to his terminal airport and allow him to perform a safe instrument landing.

This first article will describe the operation of the two oldest schemes of long-range navigation which are in widespread use today. The second part will describe VOR, the modern system of long-range navigation. The final article in this series will describe all currently used systems for terminal navigation of aircraft.

Nearly all long-range air travel today is conducted along civil airways, ten-mile-wide highways in the sky which interconnect all major and minor cities in the country. It is the primary task of all long-range navigational systems to lead aircraft along these routes. In all cases, this end result is achieved by having the airplane follow a radio beam oriented along the center-line of the civil airway. However, the methods used to create this beam and the equipment needed for reception vary widely.

Low-Frequency Radio Range

The low-frequency radio-range scheme of airborne navigation was the first system generally adopted in the United States. The first station began broadcasting in 1931 and there are about four hundred range stations in operation today. Because of the inherent simplicity of the range system of navigation, it is still the most widely used method of radio navigation, although it has several serious limitations.

Radio-range stations broadcast in the low-frequency band of 200 to 415 kilocycles. Each station transmits four "on the beam" courses, nominally 90 degrees apart, by interlocking two figure-eight antenna radiation patterns. These individual quadrantal courses are identified by a 1020-cycle code modulation. In two diagonally opposite quadrants the letter *A* is transmitted in international Morse code (· —), and in the remaining pair of quadrants the letter *N* (— ·) is transmitted. Each quadrant slightly overlaps the neighboring quadrants and in the narrow wedge formed by the overlap the two signals are heard with equal intensity. The dots and dashes interlock in this narrow region to produce a continuous "on the beam" signal, or monotone. Thus, a pilot with a simple, inexpensive low-frequency receiver can easily navigate. He will hear

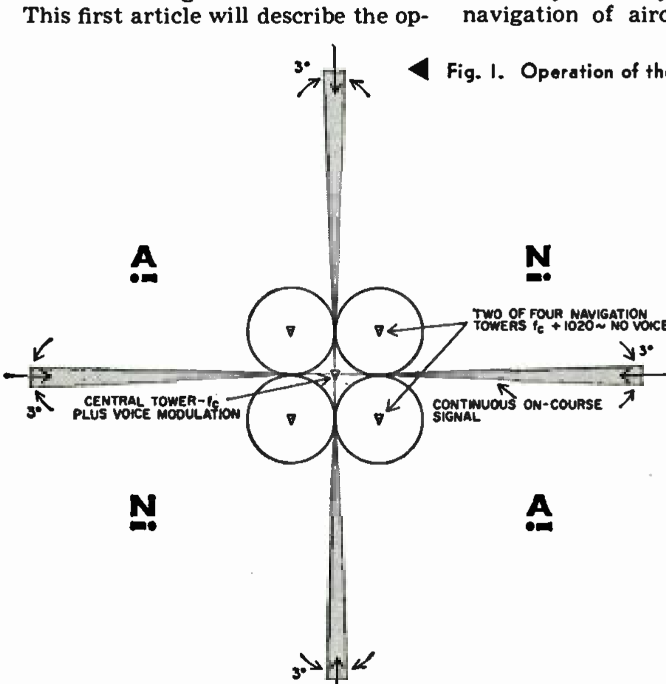
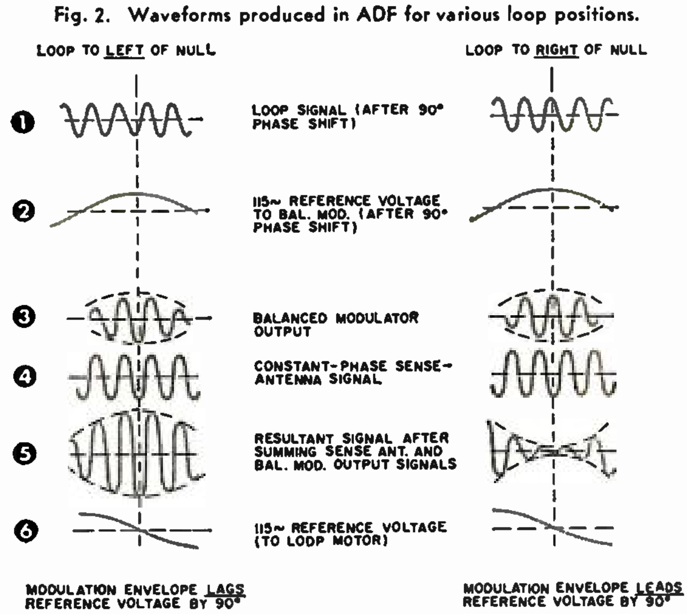


Fig. 1. Operation of the low-frequency radio-range station.

Fig. 2. Waveforms produced in ADF for various loop positions.



a continuous tone when he is on course, but if he drifts to either side of the beam he will hear either the *A* or *N* begin to predominate and must re-adjust his heading to stay on course.

The simplest radio-range station, shown in Fig. 1, consists of two pairs of vertical transmitting antennas about 130 feet high set at opposite corners of a square. The field radiation pattern of each of these pairs is a figure-eight, with the pattern of one pair displaced 90 degrees from the other. A transmitter is switched from one pair of antennas to the other to transmit the *A* on one pair and the *N* on the other. These signals are overlapped in time so that along the bisector of the two figure-eight patterns, where the intensity of the signal received from both pairs will be equal, the continuous "on the beam" signal is heard over a region with a width of about 3 degrees. The on-course legs of the beam need not be at right angles to each other. By appropriate tuning of the antennas, the beam may be directed at various angles in order to lie along civil airways. The signals transmitted by the four corner antennas are continuous and contain no modulation. Midway between the two pairs of towers just described is a fifth tower which transmits continuously a signal differing in frequency by 1020 cycles from the transmission of the corner antennas and radiating equally in all directions. It is the 1020-cycle beat between the center antenna and the four corner antennas which causes the code modulation which is heard in the receiver.

The central transmitter is voice-modulated for station identification and for transmission of weather and traffic control information. The federal radio-range installations shown in the photographs on the facing page are typical of the antenna installations that are employed.

The chief virtue of the low-frequency radio-range system is its simplicity since only a low-frequency receiver is required for navigation. However, there are many limitations, some of them serious. First, the low-frequency radio band is inherently noisy and highly susceptible to static. The static during a local thunderstorm may make it impossible for a pilot to aurally follow the on-course signal when he may need it most. Second, a pilot has no choice in direction of flight since he can only fly one of the four on-course radials from the station. Furthermore, all courses are ambiguous. That is, it is impossible to determine in which direction along an on-course radial a pilot is flying without special maneuvers. Third, and most important, low-frequency signals tend to bend under certain atmospheric conditions creating deadly "ghost" on-course signals. This is particularly true near mountain areas.

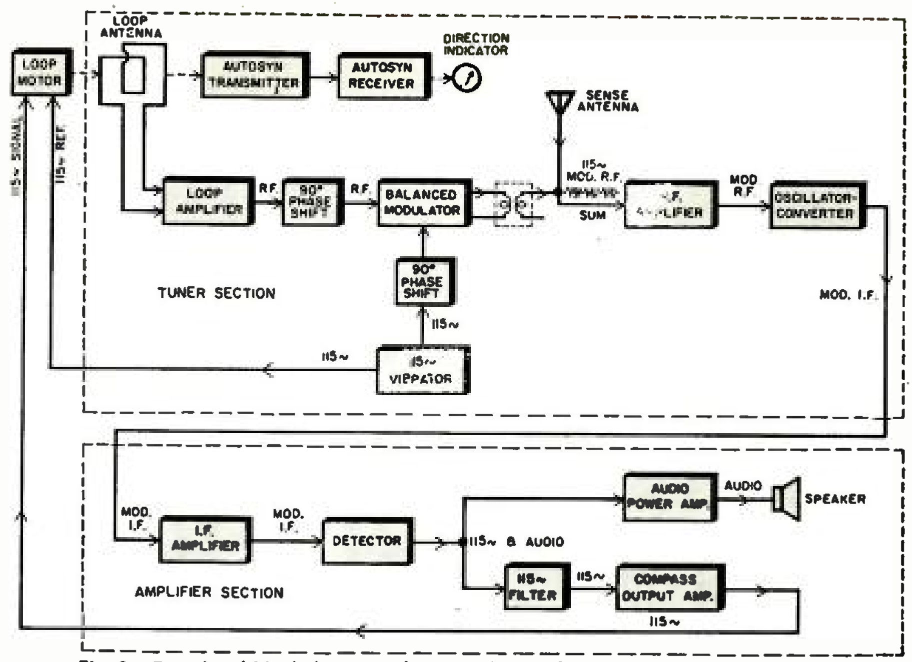


Fig. 3. Functional block diagram of a typical aircraft automatic direction finder.

Radio Direction Finding

Several direction-finding schemes have been devised which allow a pilot to either "home" on a ground transmitting station or determine his azimuthal direction from the station. "RDF" (*R*adio *D*irection *F*inding) generally refers to all types of manual direction finders while "ADF" (*A*utomatic *D*irection *F*inding) refers to direction finders which automatically determine the direction of the transmitting station. Recently, the term "Radio Compass" has come to mean an automatic direction finder, and that is the term we will use.

Perhaps the greatest advantage of radio direction finding as a navigational aid is the fact that this system does not require a special ground transmitting station for its operation. Theoretically, any station on the ground can be used for RDF orientation. In practice, however, only standard AM broadcasting stations, the low-frequency range stations, and special low-frequency beacons are used in order to avoid the necessity of carrying a large number of receivers covering all frequency bands.

All RDF systems require a directional receiving antenna, a receiver, and a bearing indicator. Antenna systems used with RDF equipment vary radically in design. The latest and most sophisticated is *Lear's* "Gonio Loop," a flat-wound ferrite core that is electronically, rather than mechanically, rotated. More familiar is the circular loop about one foot in diameter which is manually rotated. Such a loop has a

The ADF receiver unit described in the accompanying text.

Two-band l.f. unit. 200-415 kc. is for low-frequency ranges.

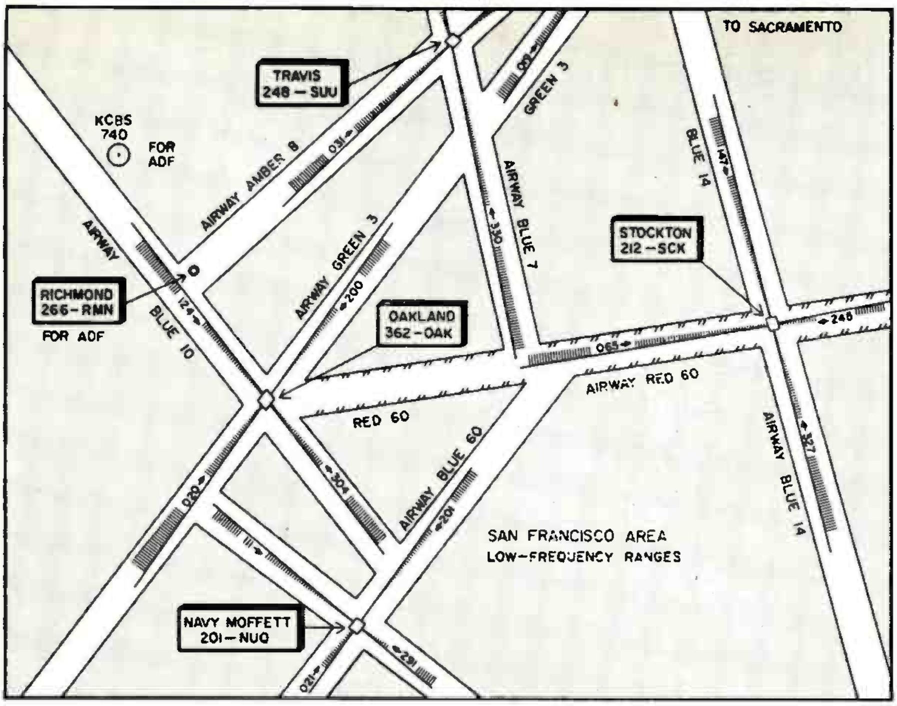


Fig. 4. Simplified navigational chart showing low-frequency radio aids.

figure-eight receiving pattern perpendicular to the plane of the loop. When the plane of the loop points at the transmitting station, signals are received with maximum volume. When the plane of the loop is at right angles to the direct line to the station, signals are received with minimum volume. This minimum volume point, or "aural null" is used by all direction finders for orientation rather than the aural maximum point since the null can be determined more accurately. Note that since the loop plane has two sides, there will be two aural nulls, one on each side of the loop. For this reason, the simple manual loop is ambiguous since it is impossible to determine whether the station lies in front or behind the plane of the loop. This makes it impossible for a pilot to home on a station without special orientation flying to determine whether he is flying towards or away from the station.

The mainstay of the single-engine lightplane flyer is a simple two-band receiver covering the low-frequency radio range and standard broadcast bands and including a manually rotatable loop for RDF use. With such a receiver, the private flyer can inexpensively navigate through the use of the radio ranges and RDF, as well as maintain radio contact with ground traffic-control and weather stations. Most of this equipment is purchased by the small plane owner as used equipment since simple RDF equipment is no longer being manufactured.

ADF systems have almost universally replaced the simple manual loop RDF. ADF receivers are unambiguous, that is, they always point at the station and do so automatically. Unlike the manual loop, modern ADF loop antennas use a small horizontal ferrite core upon which symmetrical turns of wire are wound. Like manual loops, these ferrite loops also have a figure-eight receiving pattern and are inherently ambiguous. Unambiguous reception is due not to the antenna pattern, therefore, but rather to the method in which the loop is used in the ADF.

A typical ADF receiver, the *Lear* ADF-12E, is shown on page 31. In this ADF receiver the aural null property of the directional ferrite loop *and* its phase characteristics are used. As the loop crosses the null point from left of station to right of station, the output of the loop shifts 180 degrees in phase. This effect is utilized in the receiver to give "left of null, right of null" sense to the system. A second antenna is used in the ADF-12E receiver. This second antenna is a long-wire, non-directional "sense" antenna. Since it is non-directional, its phase is constant irrespective of the location of the transmitting station and is used to provide a fixed phase reference against which the loop's phase output can be compared in order to rotate the loop to a null. When the loop is left of true null its output *leads* the sense antenna output by 90 degrees, and when the loop is right of true null its output *lags* the sense output by 90 degrees.

Referring to Fig. 3, the amplified r.f. output voltage from the loop is first phase shifted by 90 degrees in the phase shifter. This 90-degree shift is introduced as a delay in phase. The result is that if the loop originally led the sense antenna by 90 degrees, it is now in-phase with the sense antenna as a result of being delayed in phase. Likewise, if the loop originally lagged the sense antenna by 90 degrees, it now lags the sense antenna by 180 degrees. These waveforms are shown at (1) in Fig. 2, which shows important waveforms in the ADF-12E receiver.

This phase-shifted loop signal is now applied to a balanced modulator where it is AM-modulated at 115 cycles which is produced by a synchronous vibrator from the aircraft's d.c. supply. Before application to the balanced modulator, the 115-cycle signal is first phase-shifted by 90 degrees, waveform (2) in Fig. 2. The balanced modulator simply AM modulates the loop signal carrier close to 100% at a 115-cycle rate. The balanced modulator output waveform is shown at (3) in Fig. 2.

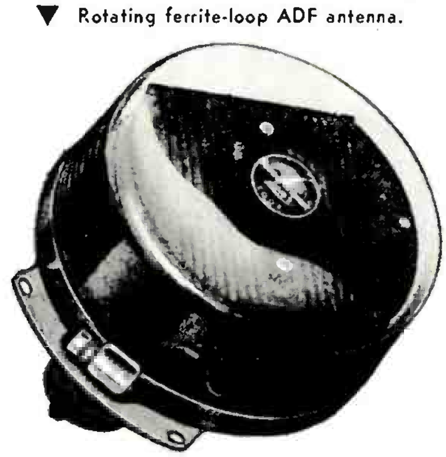
After being modulated in the balanced modulator, the loop signal is now mixed with the constant-phase sense antenna signal. The net output pro-

(*Continued on page* 104)

Another typical ADF receiver unit.

Direction indicator employed with ADF.

Rotating ferrite-loop ADF antenna.



Fusing TV Tuners

By **PAUL MITNAUL**

A familiar repair headache in the front end can be avoided, making happier technicians and customers.

As IS THE case with other parts of the TV receiver, tuner design has undergone quite a few changes since the early 30-tube sets began to find favor with the public. From the outset, the front end was a particularly tricky circuit for the service technician to work on, with replacement often following trouble instead of repair. What with progressive design changes over the years, many technicians have had difficulty keeping up with trouble-shooting technique for the tuner, and still avoid repairs in this portion of the set as though it were a nest of rattlesnakes.

One way of avoiding trouble is to prevent it. Fortunately one of the most frequent troubles with one of the most popular tuner designs in use today can be avoided in a relatively simple way. The design in question is the cascode circuit, which uses a twin-triode r.f. amplifier like the 6BQ7, 6BS8, 6BZ7, or some similar type. The problem lies in the pattern of failure.

When a cascode front end acts up, the first suspicion is that the twin-triode needs replacement. This is generally true. Furthermore, the tube fault is likely to be an interelectrode short (or high leakage) since, to obtain high gain, elements in these tubes are quite close to each other. When shorting occurs, current through the tube is considerable, and any resistors or other components in series with the triodes can break down or change in value. In the tuner circuit of Fig. 1, for example, resistors R_8 and R_{14}, shown in broken-line circles, are in danger. Replacing them or other affected parts involves a touchy repair.

Preventing such difficulties can be achieved simply by fusing the tuner. Generally neglected by the set manufacturer, this precautionary feature can be added easily by the technician without the need to get inside the front end itself. A cartridge fuse in series with the "B+" line for the entire tuner will generally do the job. Then, when a tube shorts, it is only necessary to replace the tube and the inexpensive fuse. Further checking for component damage—or the risk of a callback—is virtually eliminated. This removes much strain from the consumer-technician-manufacturer relationship, especially if the set was involved in such difficulty in the recent past.

Choosing the right fuse is relatively simple. To demonstrate, an *RCA* cascode tuner (type KRK 22-R) will be used. In addition to the 6BQ7 r.f. tube (Fig. 1), it uses a 6X8 as oscillator-mixer. The tube manual indicates that the 6X8 is likely to draw about 19 ma. for both sections; and the 6BQ7, with both plates in series, draws about 10 ma. Thus the entire tuner takes about 29 ma. from "B+." However, actual tuner current was metered. It varied from a low of 18 ma. when a strong signal was tuned in to a high of 28 ma. with no signal input. Accordingly a 250-volt fuse rated at 1/32 ampere (about 31 ma.) was chosen.

Although this seemed to allow little margin, remember that any fuse can carry an overload of about 10 per-cent indefinitely. A slow-blow type will stand up against short-term excesses.

With the particular *RCA* tuner, it was simple to solder the fuse holder directly to terminal No. 4 ("B+" at the rear of the tuner, as shown in Fig. 2). A similar arrangement is possible in most cases. Where it is not convenient, the "B+" lead for the tuner only can be opened anywhere along its length to accommodate the addition.

To make certain of the right fuse value, total tuner current should always be monitored during greatest drain (off channel) although a tube-manual check is helpful. If it seems that the 1/32-amp. unit is too small, a 1/16-amp. fuse (about 62 ma.) may permit the power rating of endangered resistors to be exceeded. This can be checked. If necessary, separate fusing of "B+" to the twin-triode might be considered. As a rule, such measures are not needed.

It has been easy to sell this addition, at a small added charge, whenever repair work is being done on a set that could benefit from it. This has been the author's practice for quite some time, and everyone is satisfied with the results. —30—

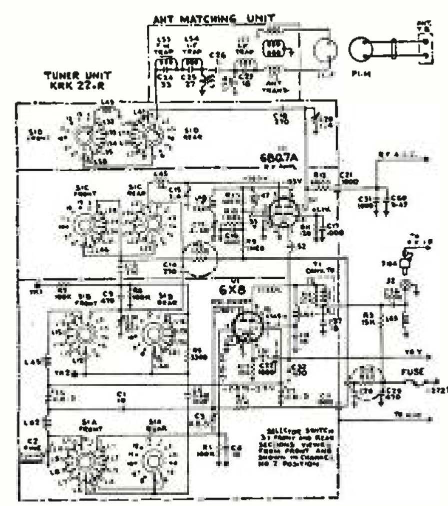
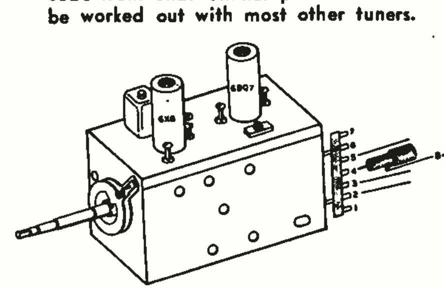


Fig. 1. This cascode circuit shows components (circled) that are likely to burn up when the r.f. tube shorts.

Fig. 2. Where the fuse and fuse holder can be added to a typical RCA cascode front end. Similar placement can be worked out with most other tuners.



DESIGN of a Transistorized Phono Preamp

By H. F. STARKE / Applications Engineering, Raytheon Co.

Practical design hints along with useful circuits for both magnetic and ceramic high-fidelity phonograph pickups.

THIS article deals with the design and construction of several practical transistorized preamps for phono pickups. Such preamps would be useful under one of the following conditions:

(1) The user already has a complete system, containing whatever compensation seems appropriate for the pickup in use, and would like to interpose a preamp mainly for the purpose of improving the signal-to-noise ratio. Because of the more favorable source impedance, this is usually more readily accomplished with the inductive type of pickup than with the ceramic. The general requirements for this preamplifier are: low distortion, best signal-to-noise ratio, and relatively low gain.

(2) The user has a flat power amplifier of acceptable performance and wishes to build a transistor preamp incorporating RIAA equalization to be used with an inductive pickup. He requires only that the gain be substantially equal to that of its vacuum-tube counterpart and that its signal-to-noise ratio be considerably better.

(3) In this case, the equipment on hand includes a ceramic pickup loaded with the resistance value recommended by the manufacturer. The user has purchased a test record and taken a frequency response curve. He is not overjoyed with the results and wonders why some improvement could not be effected through the use of a preamp having somewhat better equalization.

Pickup Characteristics

The majority of modern phonograph pickups fall into two general classifications with important differences as to impedance and response characteristics. The inductive device is characterized by a voltage in series with an inductance plus a small amount of resistance. Whether the core is moved, its reluctance varied, or the coil moved, the response is, in general, the same and all may be referred to as "magnetic."

Like its predecessor, the crystal pickup, the ceramic element is a capacitive device and since its capacitance is fairly low it must be regarded as a high-impedance source. Although the older crystal element usually showed a capacitance not too far from 500 $\mu\mu$f., its modern equivalent often has considerably less than this. Information as to the value for some specific unit is frequently unavailable and the user must either measure it himself or rely upon the manufacturer's statement as to the best "matching" resistor.

Since the voltage available from the magnetic unit depends on the rate of flux cutting, the device is said to be responsive to *velocity* which, of course, rises with frequency with the usual 6 db-per-octave slope. The capacitive unit, on the other hand, depends on the piezo-electric properties of its element, which is insensitive to rate and responds only to pressure. Because the latter varies directly with the amplitude of the motion of the stylus, the capacitive pickup is described as *amplitude* responsive.

The difference between these response types must be considered in relation to the industry recording and playback characteristics. The standard (AES, RIAA, and NAB) is expressed in terms of the correct system frequency response when using an inductive pickup. This is shown as "A" in Fig. 1, using the asymptotes for clarity and simplicity; the smooth cornerless curve is readily synthesized by using a point 3 db from the crossover and points 1 db from the asymptote at one-half and twice the crossover frequency.

Curve "B" of Fig. 1 is complementary to "A" and is the velocity response of the recording charactertistic. In other words, it is the relative response of an inductive pickup working into a resistive load having a value considerably higher than the reactance of the pickup at any frequency of interest. Curve "C" (Fig. 1) is derived from "B" and is the amplitude response of the recording characteristic. Again, it should be noted that this is an open-circuit voltage obtained only by operating into a load resistor of considerably higher value than the reactance of the element at any frequency in the band. All curves have a common reference level of 0 db at 1 kc. and "D" in Fig. 1 has been drawn through this point with a slope of 20 db per logarithmic cycle. The latter represents the open-circuit output of an inductive element from a hypothetical recording of constant level without reference to the pre-emphasis and de-emphasis recording standards adopted by the industry.

Since "D" also represents the output developed by a capacitive element across a load approaching a short circuit (from the same constant level recording), it follows that if "D" is added to "C" the result is "B" again. In brief, if a ceramic cartridge is operated into a resistor giving a crossover of 60 kc. or higher, the ceramic is said to have "velocity response" and to require the same equalization as an inductive cartridge. This technique, while of somewhat questionable value for a vacuum-tube system, becomes quite useful in relation to the design of a transistorized preamp for the ceramic cartridge.

In the standard, the crossovers are defined in terms of the time constants of equivalent *RC* networks: 3180, 318, and 75 microseconds. The latter works out to 2120 cycles but since most designers prefer to simplify this value to 2 kc. (an even two octaves from the next crossover at 500 cycles), one wonders why the corresponding time constant was not made 80 microseconds in the first place. It is somewhat inconsistent to split hairs between 2120 and 2000 cycles in one sentence and allow a ±2 db tolerance in another.

Flat Amplifier for Magnetics

The amplifier shown in Fig. 2 is flat ±0.2 db from 30 to 20,000 cps. Gain is 26 db and at 2 volts output the total distortion is less than 1%. If both emitter bypasses are reduced to 20 μf., response is down 1.1 db at 30 cps and if the smaller bypass (0.004 μf.) is omitted at the second stage emitter, response is down 1.5 db at 20,000 cps.

Since this unit is intended to operate from an inductive source with equalization at other points in the system, its input impedance should be considerably higher than the source reactance at 20,000 cps. If the transistors have current gains of 100 or more, this condition is met for cartridges up to 500 mhy. The trend in recent years has been in the direction of lower inductance in magnetic units.

Transistor noise will be less of a problem than hum pickup at the cartridge. If the use of a magnetically shielded pickup having rather low output is contemplated, it may be worthwhile to use a low-noise type transistor (2N422) in the first stage.

For various practical reasons, it may be decided to incorporate the necessary equalization in the preamp itself. With respect to the treble roll-off with crossover at 2000 cps (Fig. 1A), the designer must choose between the following two approaches: (1) The input impedance (resistive) may be adjusted to equal the reactance of the cartridge at 2000 cps or (2) the input impedance may be made relatively high with treble roll-off being obtained from a simple parallel network elsewhere in the amplifier.

The first of these requires considerable stabilization because the desired impedance will change quite rapidly with changes in operating current. Furthermore, if the cartridge should be replaced by another unit having a different value of inductance, it may be necessary to make extensive re-adjustments of the first-stage operating point.

The amplifier shown in Fig. 3 is, accordingly, based on the second approach. The input impedance of this amplifier is considerably higher than the 20,000-cps reactance of any magnetic pickup commonly available and the treble roll-off is obtained by an *RC* network in the collector circuit of the first stage, as previously noted. The double arrows indicate the break points for the purpose of building the first stage into the tone arm and, if this is done, it should be noted that the capacitance of the output cable parallels the .0018 μf. for roll-off. (The exact value here will depend somewhat on transistor characteristics because the resistive component of the network is paralleled by the output impedance of the transistor, although the effect of the latter is considerably reduced by the series feedback in the emitter.) The network between the first and second stages is designed to keep d.c. out of the volume control and to leave the treble crossover relatively undisturbed for volume changes. Devices for obtaining low boost (500 cps) and bass flattening (50 cycles) appear in the third stage.

Gain is 30 to 35 db and with a 22-volt supply distortion is very low for inputs up to 100 millivolts. Response should be within one-half db of the RIAA curve from 30 to 15,000 cps. If it should be found to require trimming, the following procedure is recommended: (1) Remove the .0018-μf. collector bypass in the first stage, (2) increase the interstage capacitor value from .25 μf. to 10 μf., and (3) disconnect the series *RC* feedback circuit in the third stage.

The amplifier should now be reasonably flat over the entire range and the three crossovers with the required slopes are readily investigated one at a time. In place of the pickup, a small transformer may be used with metered and attenuated secondary voltage. If the 20,000-cps response is down more than 1 db (before applying the 6 db-per-octave treble cut) it may be lifted with a small bypass (2200 μμf.) across the second stage series feedback resistor (2700 ohms).

For the benefit of those who aren't happy unless the curve is within ±0.2 db of the standards over the entire range, it may be noted that the AES-RIAA-NAB standard specifies: "Tolerance—The maximum deviation of the system from this characteristic shall not exceed plus or minus 2 db."

Since the source impedances here are of levels resulting in the lowest available noise figures, the signal-to-noise ratio (for thermal noise only) is 5 to 10 db better than a vacuum tube operated at a point resulting in an equivalent noise input resistance of 3000 ohms. In addition: (1) the transistor has a better spectral characteristic than the tube in the important region below 1000 cps where the amplifier gain rises; (2) the transistor is non-microphonic; and (3) in the event that hum is picked up at the input circuit, it is more readily phased out with transistors, later in the system, than with tubes.

The last named point has nothing to do with the pickup; the reduction of hum in this element is the problem of the manufacturer. We are referring

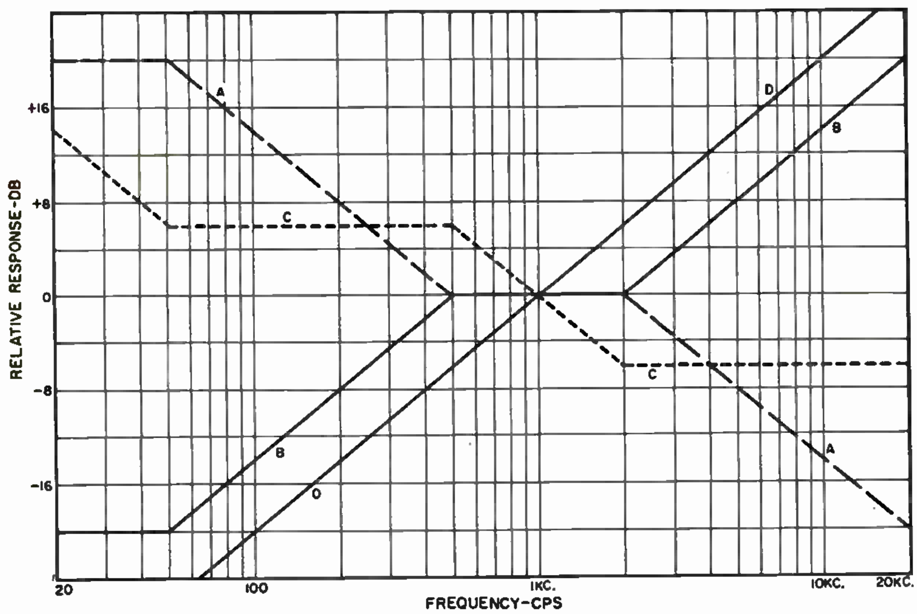
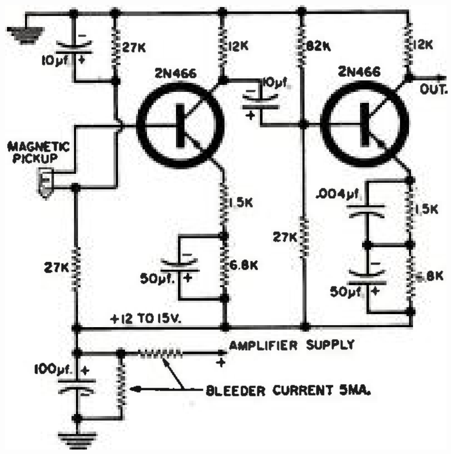


Fig. 1. (A) Standard playback curve using the asymptotes for clarity and simplicity rather than the smooth cornerless curve usually shown. (B) Velocity response of the recording characteristic and complement to curve "A". (C) Amplitude response of the recording characteristic. (D) 20 db per logarithmic cycle response curve.

Fig. 2. Flat preamp for magnetic pickup.



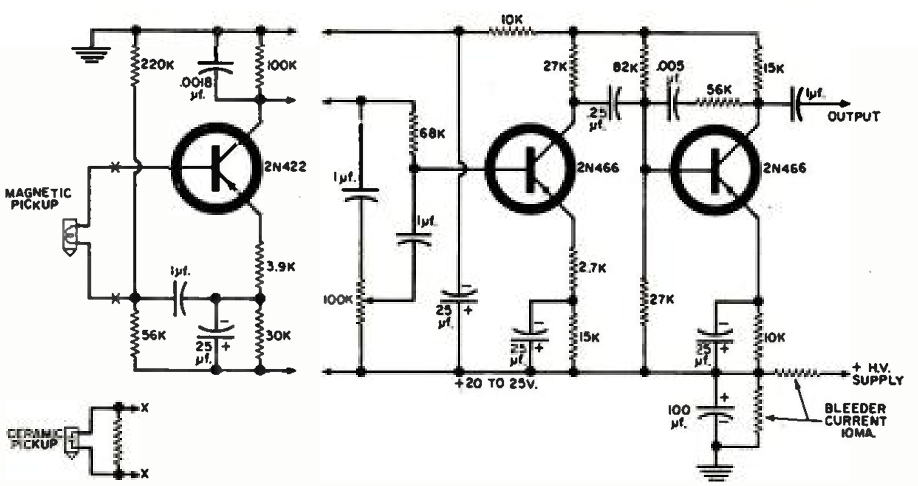


Fig. 3. Equalized preamp for magnetic and ceramic cartridges. Treble equalization is accomplished in first stage, while bass equalization is accomplished in the third stage. The second stage may be considered to be the volume-control stage of preamp.

more particularly to the fact that the transistor input stage has but one hum-sensitive element, the input base, while the tube has several hum-producing mechanisms including: (1) stray emission from heater to cathode; (2) stray emission from cathode to heater; (3) thermally sensitive emission from the cathode extremities; (4) heater-cathode leakage; and (5) direct field effect.

As a consequence, the hum picked up by the transistor base has but one phase, with principal components at the fundamental line frequency and its third harmonic, while the hum appearing in the vacuum-tube plate circuit is of pseudo-polyphase waveform and it is usually impracticable to buck out more than one component. Furthermore, the relative strength of the various components can change considerably with line voltage changes.

Equalized Preamps for Ceramics

Published material on ceramic units usually includes a column giving the load resistor for best match. This appears to be based on the supposition that the amplifier has a bass boost control to supplement the choice of load giving a 2000 cps crossover. If such a control is not available, the over-all response is shown in Fig. 4 which is the result of applying the amplitude response curve of Fig. 1C to an equivalent *RC* network with crossovers as indicated. However, response will be quite flat if the bass control is available and, as is often the case, has a crossover at 500 cps.

The foregoing technique is more suitable for vacuum tubes than for transistors. Even if the capacitance of the element is as high as 1000 μμf., the transistor input must be 80,000 ohms which is not a particularly favorable value as far as the noise figure is concerned; in general, pickup capacitances are considerably less than this.

In the case of the transistorized preamp for the ceramic unit, the signal-to-noise ratio will be better with the velocity response arrangement with a high crossover because the noise factor of the transistor increases appreciably for generator impedance much in excess of 5 or 10 kilohms. With this method of operation, the signal-to-noise ratio of a transistorized preamp will be poorer than the tube version by approximately the noise factor of the transistor at the predetermined generator impedance and operating point. If this sounds alarming, we hasten to add that this does not take into account these additional factors: (1) the transistor has a considerable advantage in relation to the hum problem; (2) the transistor is non-microphonic; and (3) the noise power spectrum of a low-noise transistor is superior to that of the average vacuum tube in the important range below 1000 cps. At the higher gains required by RIAA equalization at these frequencies, this factor tends to reduce the difference in signal-to-noise ratio due to the transistor noise figure.

Returning to Fig. 3, it will be noted that the alternative connection shows the loading resistor at the element so that the input impedance of the transistor may be made high enough to also accommodate an inductive unit having an inductance of 0.5 hy. or more. As noted previously, the resistor should not be more than 10,000 ohms even though this will place the crossover for a 200 μμf. element at 80,000 cps. The operating current of the input stage has been selected to give a low-noise figure and it may be noted, at this point, that this current is considerably lower than the 1 ma. value commonly found on data sheets for general-purpose a.f. types since the latter represents a more or less standard test condition rather than the best point for low-noise operation.

Ceramic vs Magnetic

A comparison of the two basic systems as to performance and mechanical parameters is obviously out of place here. Unfortunately, the recent design trend, particularly with the advent of stereo, has been in the direction of poorer signal-to-noise ratios although such degradation is more rapid for the capacitive than for the inductive element. This is true whether the input system uses vacuum tubes or transistors and if the use of a capacitive element is contemplated, the electrical parameters of the device should not be overlooked.

As described in the comments on pickup characteristics, the amplitude response of the capacitive element may be converted to the equivalent of a velocity responsive system by loading it with a resistor giving a crossover of 60,000 cps or higher. This technique is quite advantageous when applied to transistor inputs but before such a system is described it will be informative to see how it affects the signal-to-noise ratio in a typical design using tubes.

Let us assume that the cartridge has a capacitance of 500 μμf. and an open-circuit output of 500 mv. at 1000 cps. One method of operation is to choose a grid leak of such a value that the input is down 3 db at 50 cycles so that bass flattening is not required elsewhere in the amplifier. In this event, the combination of a 6-megohm leak and the necessity for increasing the amplifier gain by some 12 db from 2000 cps to the top of the band results in a signal-to-noise ratio somewhat poorer than the method described earlier involving placing the input crossover at 2000 cps and raising gain from 500 cps down.

For the 160,000-ohm leak which would be required in the latter type of operation, the resistor noise is 7.15 μv.

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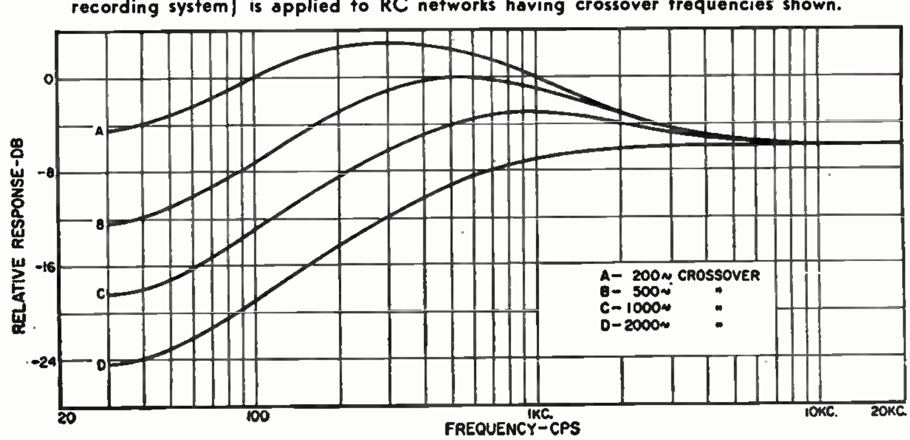
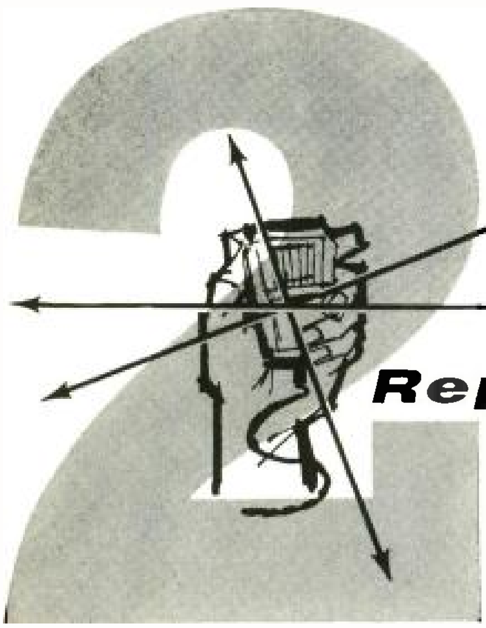
Fig. 4. Response obtained when the curve of Fig. 1C (amplitude response of the recording system) is applied to RC networks having crossover frequencies shown.



EDITOR'S NOTE: *It is often said that, for two-way communications, systematic maintenance programs are superior to hit-or-miss service procedures in which the technician goes into action only after trouble crops up. We are seldom told why this is so. The author, affiliated with a good-sized organization that specializes in this field, gives his reasons. He can cite figures and give examples to show that both the equipment user and the servicing agency benefit in many ways.*



2-Way Mobile Repair vs. Maintenance

By JERRY S. STOVER
Communications Engineering Co.

A successful specialist in this field not only picks the better program, but offers evidence.

INDUSTRIAL maintenance programs have been in use for hundreds of years. Even the early users of Watts' steam engine learned that a policy of "wait until it quits" resulted in higher over-all costs and reduced the dependability and ultimate life of the engine. Probably the best examples of modern day maintenance programs are those of large auto and truck fleet operators. They have learned through experience that operating costs are reduced and equipment utilization is improved by proper over-all servicing procedures.

The same is true of other equipment used in industry, whether they be turbines, bulldozers, or drill presses. Because two-way radio is used in the minute-to-minute direction of expensive personnel and equipment, it is one "tool" where the utmost in reliability and performance must be achieved.

Once an organization becomes geared to the use of radio, the failure to receive an important message quickly and accurately can have a more detrimental effect than if the radio had never been installed. The value of radio lies in its ability to handle messages speedily and accurately. When it begins to perform poorly, with reduced coverage, reduced clarity, or reduced reliability, this value drops rapidly. Therefore, the selection of a maintenance program warrants careful study.

Two-way radio maintenance differs from the usual mechanical maintenance in one very significant respect. A car or truck can be repaired and sent out to do a productive job independent of other vehicles in the fleet. This is not true of a mobile radio unit. No matter how well the individual radio unit may be performing, it has no value until it becomes an integral part of a communications system which includes other vehicles and stations. Thus, radio maintenance must be treated on a *system* basis rather than on the basis of individual repair jobs.

Therefore, instead of a "fix it when it quits" service policy, most firms with important industrial operations select a comprehensive maintenance program which includes system engineering, radio procedures, interference reduction, and necessary FCC measurements.

The program can be provided either by the user's own radio department or by contracting with companies versed in radio-system maintenance. Unless the user has a large number of mobile units concentrated in one area, it is usually more economical to contract for the service. One company maintenance man trying to cover a widespread system loses so much time in travel that his effectiveness is reduced while costs begin to increase sharply.

In the past it has been the practice of some companies to justify the cost of a radio man on the payroll by assigning additional duties, such as dispatching or instrument repair. Where the radio system is limited, this arrangement may work satisfactorily but, if many radios are involved, duty conflicts arise which compromise efficiency of several operations. More important, this can cause the radio man to lose sight of his primary mission—maintenance of communication—and he becomes only a "repair man," with consequent decrease in system efficiency. Also, administrative costs involving training, travel expense, vacation and sick relief, test equipment, and spare parts tend to increase the cost of self-maintenance.

Because the *maintenance* of communication involves so much more than mere *repair*, it can best be performed under a flat-rate contract when using outside agencies.

The company the author represents serves, under flat-rate contracts, several hundred two-way radio users, representing a total of approximately 1000 base stations and 5000 mobile units. Although our services are not billed on a "per call" basis, we do prepare separate job tickets which are transferred to *IBM* punch cards. These are sorted and computed to provide us with cost accounting breakdown by area, customer, technician, and equipment.

A recent analysis, covering some 15,000 service jobs on mobile units, showed that only 70% of our service costs involved repair to the equipment. The remaining 30% included such non-repair items as engineering problems, noise and interference, FCC measurements, and preventive-maintenance inspections. The complete breakdown of our findings with respect to mobile-unit maintenance costs is as follows:

Non-repair items	30%
Tube replacement	30%
Component replacement	8%
Vibrator replacement	7%
Fuse replacement	5%
Re-tuning	5%
All others	15%
	100%

It is service performed in the non-repair category that insures that a system maintained under a flat-rate service policy will perform better and more reliably than a system using a repair-only type of service. Comparison of the two types of service cannot be based on assumptions, but must be borne out by broad-based analysis of cost and quality of service.

We recently completed a frequency change involving nearly 3000 mobiles and 200 base stations. This entailed a check of all the equipment and necessary maintenance to bring it up to full factory specifications. The labor and materials required (over and above the change-over materials) are a good indication as to the general condition of the equipment prior to change-over.

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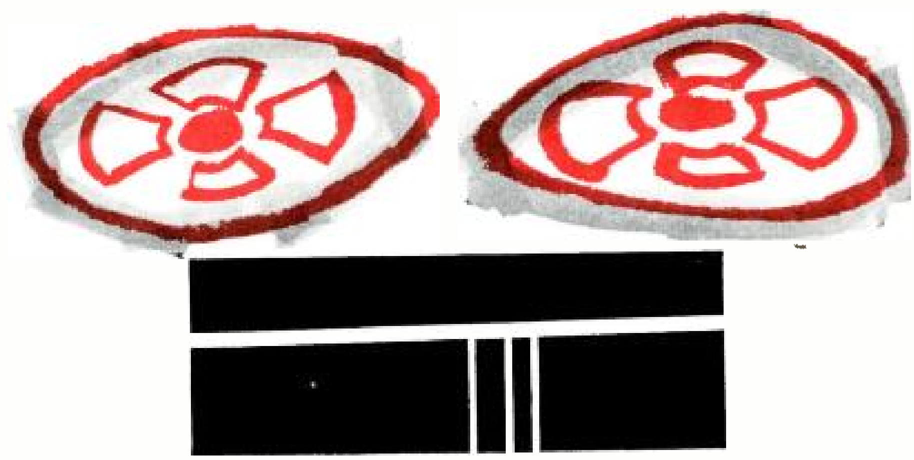
TAPE'S PROGRESS

By **HERMAN BURSTEIN**



There is much activity in the hi-fi tape field today. Here is a summary of where tape stands now and where it's going.

A Status Report

IN 1958 and 1959 tape was the sick man of the high-fidelity industry. The single-groove stereo disc had made a dramatic entrance and usurped attention to the virtual exclusion of tape. Besides, stereo tape was a good deal more expensive than the stereo disc, and the technology of reproduction *via* tape was undergoing several changes at once. Thus a good deal was to be resolved before many persons would be willing to invest in tape machines and pre-recorded tape for high-fidelity purposes.

Today, in contrast, tape is probably the liveliest topic in audio. It is not that the stereo disc has lost ground, but that tape is emerging from the shadow of the former. Questions as to tape speed, equalization, type of head, number of recorded tracks, role of the tape cartridge, etc. have either been resolved or appear well on the way to settlement. In addition, various mechanical features that make the tape machine simpler and more convenient to use have become commonplace. Hence it appears that tape is destined for a resurgence that will lift it to a position far more prominent than heretofore.

Tape Speed

Less than five years ago it wouldn't have been at all difficult to find someone who would argue that high fidelity was impossible at a tape speed of 7½ ips. That was the era when professional studios still operated at 30 ips, and 15 ips was considered the minimum speed for high fidelity—more so for the home than the studio. Even within the past two years questions have been raised whether the best commercial pre-recorded tapes at 7½ ips were as good as their best disc counterparts.

Improvements in tapes, transports, tape ampifiers, heads, and techniques have made it clear that high fidelity is attainable at lower speeds than before. Almost all professionals have standardized on 15 ips, and 7½ ips is conceded to be entirely adequate for home use. This means that at 7½ ips one can have not only treble response virtually flat to 15 kc., *but also low distortion and a high signal-to-noise ratio.* (Too many make the mistake of thinking that extended treble response is the only or chief criterion whether a given tape speed is adequate.)

The once scoffed-at speed of 3¾ ips has risen in esteem. Response to 15,000 cps is now feasible at this speed, rivalling 7½ ips in this respect although noise and distortion are not as low as at 7½ ips. Over-all, 3¾ ips can provide "good fidelity," consistent with the quality of many moderate-price audio systems and satisfying the requirements of the many listeners who do not demand the ultimate in sound reproduction.

A serious role has developed for the 1⅞-ips speed. It is proving suitable not only for speech but also for music where "relaxed" standards of reproduction apply, for example, background music or dance music for a party, where the circumstances of ambient noise and listener preoccupation with other matters do not warrant high-fidelity reproduction.

In sum, it appears that in home use 7½ ips is the speed for true high fidelity; 3¾ ips for good fidelity; and 1⅞ ips for utilitarian purposes.

The slower speeds, coupled with other developments that have taken place in the past few years, offer fascinating possibilities in the economy of recording, that is, in the amount of program material that can be put on a single 7-inch reel of tape. At 3¾ ips, using double-play tape (2400 feet on a 7-inch reel) and 4-track mono recording, 8 hours and 32 minutes can be recorded on one reel. At 1⅞ ips, the total time goes up to 17 hours and 4 minutes; one can record for 4 hours and 16 minutes before the reels need be reversed.

Cost of Pre-recorded Tape

Until quite recently pre-recorded stereo tape generally cost at least twice as much and often three times as much as the same material on a stereo disc. The relatively smaller scale of pre-recorded tape production accounted for only part of this differential. Also a key factor was the cost of the tape itself, compared with the few cents worth of vinylite that goes into a disc. Moreover, stereo tape was recorded at 7½ ips and was of the 2-track variety,

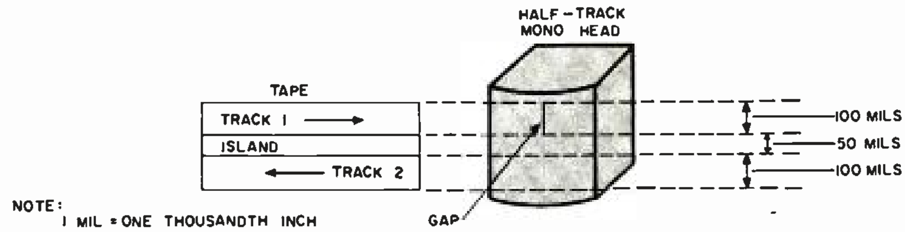


Fig. 1. Tape head and tape-track arrangement employed for half-track mono.

meaning that the tape was recorded only in one direction; hence, in relative terms, a good deal of tape was needed.

With the advent of 4-track stereo recording—utilizing the tape in both directions—and with the achievement of good results at 3¾ ips, the amount of tape required has been cut by 75%, substantially reducing the cost of pre-recorded tape. In addition, techniques of tape duplication have improved, with resultant economies. Altogether, it is now economic to offer pre-recorded stereo tape—4-track, 3¾ ips—at nearly the same price as stereo discs. Even at 7½ ips, the difference between tape and disc has been brought down to the range of a dollar or two in many or most instances.

Head & Track Arrangements

In the days of mono reproduction, things were quite settled for a long time as far as track arrangements for home recording were concerned. Half-track recording was the accepted method. As shown in Fig. 1, about 40% of the width of the standard ¼-inch tape was recorded in one direction and, after reel reversal, 40% in the other direction, with a safety island between tracks to prevent crosstalk.

When stereo came along, essentially the same track arrangement was used, except that one track was for the left channel and the other for the right channel. Initially, staggered heads were employed, namely two conventional mono heads, spaced about 1¼" apart, with the gap of one spanning the upper track and the gap of the other spanning the lower track.

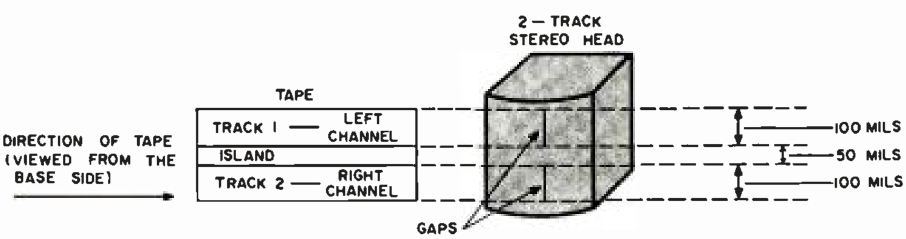


Fig. 2. With a two-track (half-track) stereo tape, this is the arrangement.

This state of things did not continue very long. Changes came left and right (pun intended). The in-line head, consisting of two heads in the same housing, one above the other and with co-linear gaps, displaced the staggered head arrangement, although not without difficulty. Fig. 2 represents the in-line head. Staggered heads had the advantages of lower cost because of the technical difficulties of manufacturing in-line heads, no crosstalk between head sections, and no problem of getting both gaps in exact azimuth alignment. On the other hand, they were space-consuming. Eventually the problems associated with the in-line head were resolved and the staggered head arrangement became obsolete. So did the tapes that had been recorded with staggered heads.

Advent of the stereo disc put into sharp focus a serious problem of stereo tape: it was recorded only in one direction. This was a problem not merely of tape cost, but also of convenience. It was necessary to rewind the tape before putting it away, instead of being able to play it back in the opposite direction (after reversing the reels of course) as with mono half-track recordings.

Four-track tapes and heads, illustrated in Fig. 3, solved the problem. Tracks 1 and 3 are used in one direction, and tracks 2 and 4 in the other. Today, virtually every tape machine made for home use permits playing 4-track as well as 2-track stereo tapes. As far as pre-recorded tapes are concerned, the trend is strong toward 4-track recordings, with the 2-track version becoming obsolete. In light of previous comments on tape speed, the combination for high fidelity appears to be 4-track recordings at 7½ ips.

Compared with 2-track stereo tape, 4-track tape has a basic disadvantage because the narrower track produces a lower signal-to-noise ratio in playback. But 4-track tape also has two distinct advantages (1) azimuth alignment becomes less critical as the track width decreases. (2) the wider spacing between the sections of a 4-track head—compare Figs. 2 and 3—results in less crosstalk.

Most home machines use the same head for recording as well as playback. Therefore such machines permit 4-track stereo recording. But the situation is less clear in machines that use separate heads for recording and playback. While they all permit 4-track playback, some of them employ 2-track record heads. Others, however, employ 4-track record heads. On the whole, it appears that eventually all home machines will provide for 4-track recording as well as 4-track playback.

The introduction of 4-track heads has brought with it a very interesting development, namely 4-track mono recording. Referring to Fig. 3, the recording sequence is tracks 1, 4, 3, and 2. Through proper switching facilities, including the shut-off of bias-erase current to the record and erase heads on one channel, many or most home machines enable the operator to record and play back twice in one direction and twice in the other, thereby doubling the playing time of a reel of tape. Since the extra switching is relatively simple and inexpensive, it can be expected that eventually all home machines will permit 4-track mono operation.

Cartridge vs Open Reel

It has long been the goal of a section of the tape industry to make it as simple to play a pre-recorded tape as a phonograph disc. Toward this end, certain convenience features have become commonplace, such as in-line loading (merely dropping the tape through a slot instead of laboriously threading it among various guides), footage counters (to facilitate location of a desired section of the tape), and automatic stop mechanisms that operate when the tape breaks and/or runs out.

However, the tape cartridge offers the most effective way of putting tape on a par with discs for simplicity of operation. One merely places the cartridge in position, pushes a button, and the tape machine takes over. The operator does not even have to touch the tape itself.

For quite a while, development of a mechanically satisfactory tape cartridge and cartridge player appeared problematical. But mechanical success is now assured. Equally important, it appears that the cost of a cartridge player, originally rather forbidding, can be pared down to an attractive figure. Moreover, there has recently been an announcement that a cartridge changer (analogous to a record changer) is in the process of development using ⅛-inch tape operating at a speed of 1⅞ ips. Engineering samples of these units have been heard and their performance is quite good. As regular models are not

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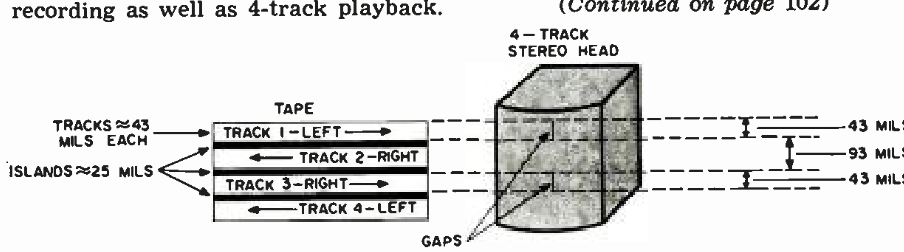
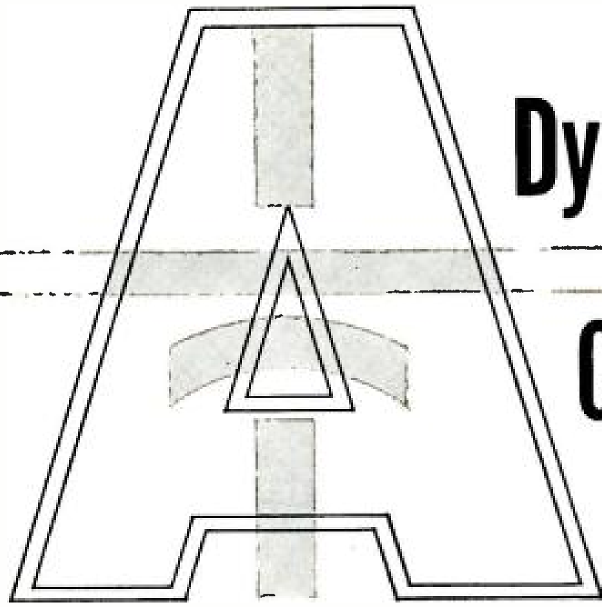


Fig. 3. Four-track (quarter-track) stereo tape utilizes this arrangement.



Dynamic Capacitor Checker

By **B. E. WRIGLEY**

Multiple unit checks value and leakage; indicates open or shorted capacitors.

CAPACITOR checkers vary from expensive instruments with laboratory precision to the simplest of neon indicators. The average service technician or experimenter needs a unit somewhere between. The one to be described offers an accuracy of measurement and positiveness of test well within the needs of most out-of-laboratory workers.

This unit (Fig. 1) performs three basic functions: It will measure capacitance; it will measure (where leakage is a factor) the amount of leakage current under working conditions; and it will give positive indication of shorted and open capacitors. Despite its versatility, it is not an expensive instrument to build. Priced new, with careful shopping, all components would total less than $20.00. It actually cost the writer only $3.75 in new parts—the rest came from the junk box.

Circuit Analysis

The circuit is functionally divided into two portions, although the "Meter and Function" switch (S_1) in Fig. 2 is common to both. The first section, a Wheatstone bridge adapted to capacitor measurement, follows the plan shown in Fig. 3. It covers measurement of capacitance by meter null from 10 $\mu\mu$f. to 1000 μf. An internal source of a.c. taken from the 5-volt winding of the power transformer operates the bridge. Each side of the bridge becomes a voltage divider when an a.c. voltage is applied as indicated. There will then be a point on potentiometer R_5 which will match, in opposing phase, the voltage at the junction of one arm of the capacitive divider against the voltage of the other. This is the null point, which can be calibrated on the pot dial with various values of known capacitors used in the position normally taken by the unknown unit. Thereafter, of course, the pot dial is simply rotated to the point at which the meter nulls and a reading is taken of the unknown.

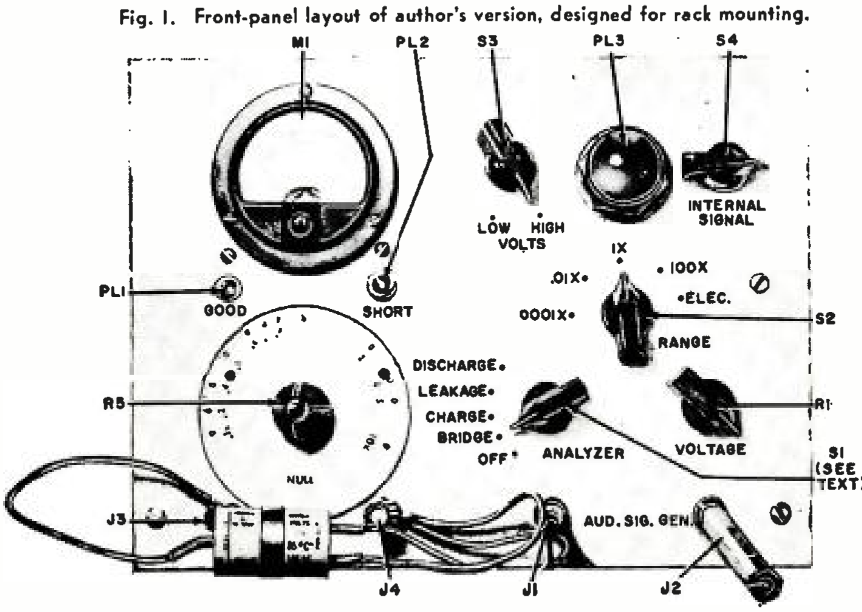


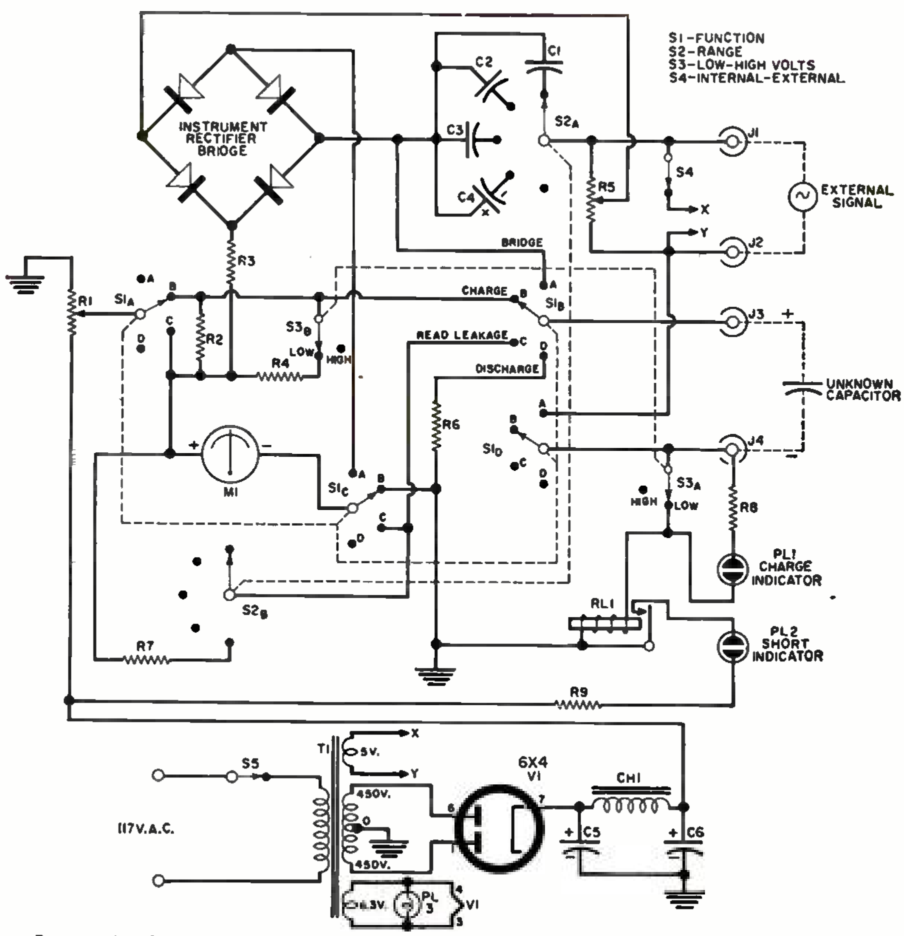
Fig. 1. Front-panel layout of author's version, designed for rack mounting.

S_4 (see Fig. 2) provides the means for introducing an external a.c. source, such as the output of an audio generator, through J_1 and J_2. The external signal is to be preferred with low-value capacitors, which present a high impedance to the 60-cycle signal of the internal voltage, passing very little current. This results in a smaller meter deflection and more difficulty in reading the null point. Use of varying high-frequency audio signals (say 10 to 50 kc.) results in greater meter deflection in the low-capacitance range and, in addition, offers an approximate check of a capacitor's frequency sensitivity.

Measurement of most electrolytics is possible since the low value of applied a.c. can only damage such units with very low voltage ratings. Null reading of electrolytics leaves something to be desired because of the slow reaction of the meter, necessitating a rocking of the null control to gain an accurate reading. However, since the bridge measurement can be augmented by a dynamic leakage test, the true condition of an electrolytic can be determined.

Accuracy of reading depends largely on the accuracy of the standards (C_1 through C_4 on S_2). Units of 1 per-cent tolerance were used. Both accuracy of reading and adequacy of ranges were beyond ordinary needs.

The second section of the circuit provides for measurement of leakage and shorting. Simplified circuit functions are shown in Fig. 4. With the function switch in its B position, the proper operational voltage is selected by R_1 and applied to the capacitor under test, which is connected between J_3 and J_4. Here M_1 acts as voltmeter with a nominal range of 0-500 volts. Actually a lower voltage range is provided in this metering position on section B of switch S_3, which shunts resistor R_2 with R_4 to permit readings from 0-50 volts. Values of these two resistors, although not particularly critical, are based on



R_1—50,000 ohm, 20 w. wirewound pot.
R_2—1 megohm, ½ w. res.
R_3—18,000 ohm, ½ w. res.
R_4, R_9—100,000 ohm, ½ w. res.
R_5—500 ohm, 2 w. wirewound pot.
R_6—200 ohm, 10 w. res.
R_7—400 ohm, ½ w. res. (Meter shunt. Value depends on value of meter and should equal the meter resistance)
R_8—10,000 ohm, ½ w. res. (see text)
C_1—100 μμf., 100 v. capacitor ± 1%
C_2—.01 μf., 100 v. capacitor ± 1%
C_3—1 μf., 100 v. capacitor (close tolerance, see text)
C_4—100 μf., 25 v. elec. capacitor (see text)
C_5, C_6—40/10 μf., 450 v. elec. capacitor
S_1—4-pole, 4-pos. non-shorting rotary switch (with auxiliary power switch, see text)
S_2—D.p. 5-pos. non-shorting rotary switch
S_3—D.p.d.t. switch
S_4—S.p.s.t. switch
S_5—S.p.s.t. switch (see text)
RL_1—Any sensitive plate-current-type relay, preferably over 6000 ohms, to close on approx. 1 ma. (Sigma 4F, 10,000-ohm coil or equiv.)
PL_1, PL_2—NE-51 neon pilot light
PL_3—6.3 volt pilot light
T_1—Power trans. 450-0-450 v. @ 100 ma. (min.); 5 v. @ 1 amp.; 6.3 v. @ 1 amp.
CH_1—4 hy., 50 ma. filter choke (Stancor C-1706 or equiv.)
M_1—500 μa meter (see text)
Bridge—Copper oxide bridge rectifier (Conant Series 160, 10 ma. or equiv.)
V_1—6X4 tube

Fig. 2. Circuit includes capacitance bridge and leakage-current metering.

a meter resistance of 400 ohms. A word of caution here. Since S_3 does not limit the voltage available to the capacitor under test, control R_1 should always be set to its minimum position before S_3 is closed. This switch also provides short-circuit protection, on its A section, as we shall see later.

S_1, after the bridge or capacitance-measurement test, is rotated to its B position to charge the test capacitor, and this should cause PL_1 to light temporarily. Good mica, ceramic, or paper units will cause a flash. Light intensity will decrease with good electrolytics. Leaky capacitors will produce intermittent flashing. A steady glow indicates a short; complete failure to flash signals an open unit. The basic circuit involved is shown in Fig. 4A.

This short indication is direct as long as the voltage applied is above the firing point of the neon lamp (about 80 volts, d.c.). However, shorting or heavy leakage will not show up here when low-voltage capacitors are being put to the test. This creates a problem since, if the user goes on to the next step (reading leakage, by rotating S_1 to its C position), the meter is in series with "B+" and the shorted capacitor (Fig. 4B). Meter damage is then a definite risk. To provide adequate warning, a sensitive relay that will close on approximately 1 ma. is inserted in series with the capacitor and meter movement (Fig. 4C) and, in the low-voltage position of S_3, PL_1 is shorted out completely. Since RL_1 is not critical, there are many inexpensive units available at surplus that will serve. Closing of the relay contacts activates PL_2 and the user is warned to progress no further on tests.

This added indicating circuit extends protection down to the use of about 15 volts applied to the unknown capacitor. Below this point, leakage may be read on the meter, without fear of damage, even with a direct short.

In the leakage test (third position, C, of S_1) the meter measures leakage current directly (Fig. 4B). To measure heavy leakage on high-value, high-voltage units, a fifth position on section B of range switch S_2 inserts a current-halving shunt (R_7, which will always be equal to the internal resistance of the meter, although shown as 400 ohms in this case). Meter current readings are doubled when this shunt is in place.

Leakage measurement need not be precise for most purposes. A rule of thumb is to allow an average of .02 microampere per microfarad per volt. For most applications, a leakage as high as .05 μa./μf./volt is tolerable. Sensitivity of this test, by the way, is primarily limited by the purse of the builder. A 500-μa. meter, like the one shown, will give adequate readings for all but capacitors of very low value. This range could be extended by using a more sensitive meter and switching in more shunts.

Position D on S_1, which discharges the component under test, is simply to protect the user, particularly on electrolytics.

Construction

Layout is non-critical, but Fig. 1 can serve as a guide. All components other than the power supply and high-value capacitors of the bridge were panel mounted. The entire unit was designed to be slipped into a test-bench panel, but a utility box will serve ideally for the purpose. A minimum of 8 by 5 inches of panel space will probably be needed.

R_1, the charging-voltage control, is a 20-watt, 50,000-ohm wirewound potentiometer. A more inexpensive pot could be used—but power dissipation must be kept in mind. Moreover, use of a higher resistance (thus lower wattage) will slow the charging action. This is not necessarily a drawback to the patient user.

The power supply is straightforward, offering 450 volts d.c. adequately filtered for dynamic testing. Here again compromise with expense was kept in mind. A power supply which would reach the peak voltages required to test extra-high-level capacitors (*e.g.*, 1000 volts or more) was more expensive than the benefits it offered. T_1 was pirated from an old radio. Actually, any transformer that provides from 250 volts and beyond will suffice, although the higher voltage is to be preferred.

NE-51 bulbs were used as PL_1 and PL_2. Any neon will suffice, but other bulbs may require adjustment of the

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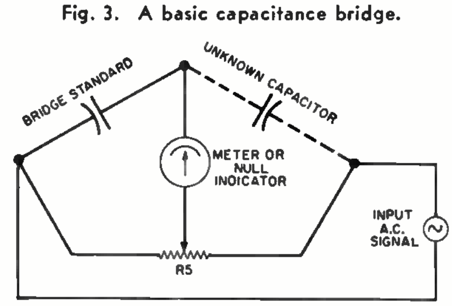
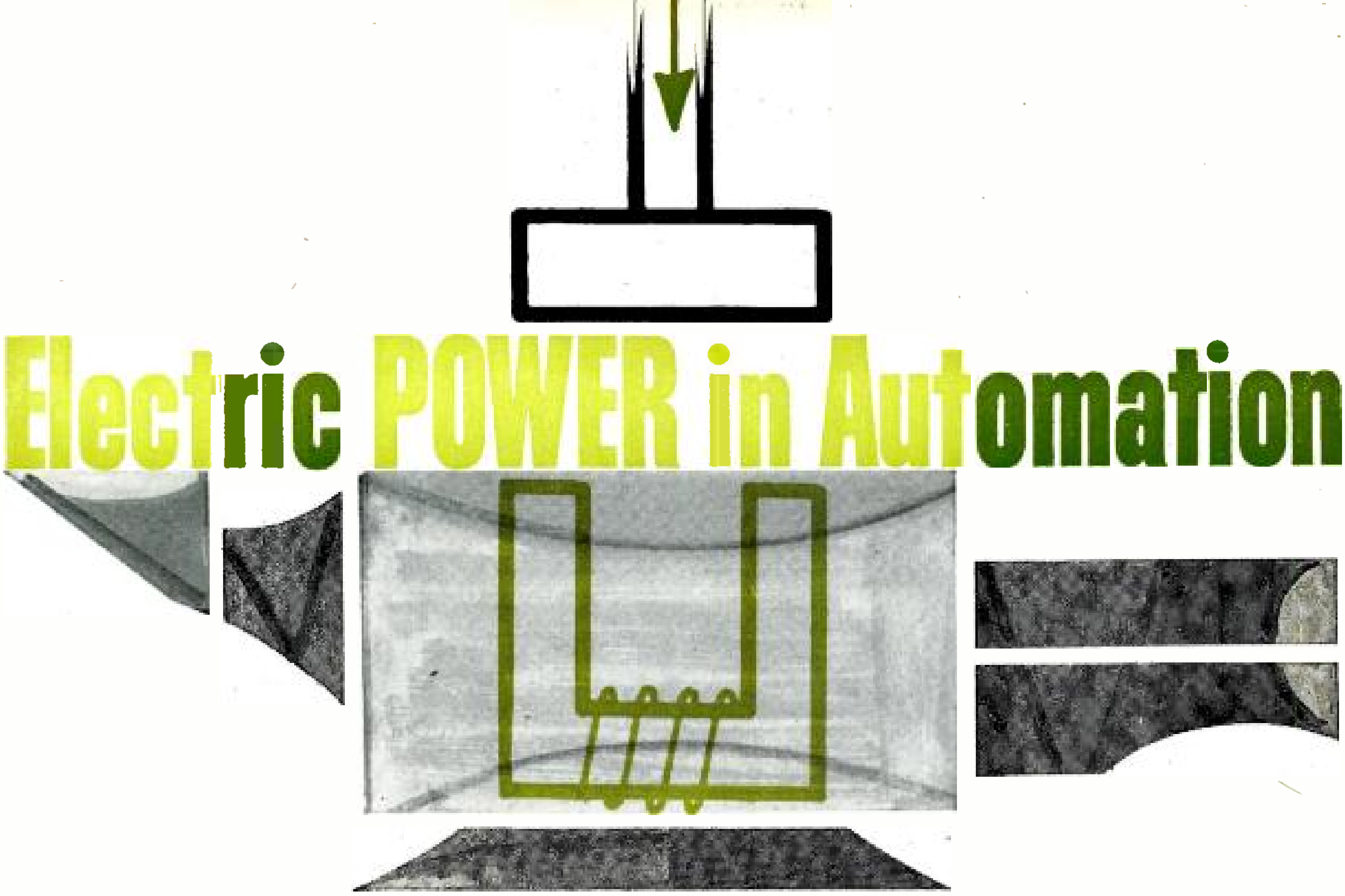
Fig. 3. A basic capacitance bridge.



Electric POWER in Automation



By **WALTER H. BUCHSBAUM**
Industrial Consultant, ELECTRONICS WORLD

Solenoids and motors are frequently used to carry out the functions dictated by a control system.

AT FIRST glance, the title may indicate the treatment of a rather superfluous subject. Electrical power is obviously used in automation. However, we are not concerned here with electricity as it is used to activate electronic sensing and control circuitry and associated devices. Aside from the existence of these circuits, every automatic system has "muscles" that carry out the decisions made by the rest of the system. Electrical power is often the necessary muscle power.

After the sensing circuits and the electronic "brains" (or decision-making circuits) have had their say, how are the decisions executed? How is the output of a control system translated into the physical force that moves, hammers, bends, pulls, or otherwise shapes a work piece?

Many types of actuators are used to provide the final muscle power. Hydraulic or pneumatic principles are used in many of these actuators. Many others are electrical machines—like the electric motor. Such devices are much older than the field of electronics as we know it today. Yet, partly because of the needs of electronics, there has been such development in the field of electrical power machinery that today's motors bear as little resemblance to their forebears as do today's automobiles to those of 1913 vintage.

There is a wide variety of motors and solenoids in current use, and many of them have been influenced in their design by the electronic circuits that regulate or control them. Although the electronic technician who must maintain industrial systems is not ordinarily expected to work directly on the power machinery, he must know something about the nature and function of such equipment and understand how it fits into the over-all system. Often such an understanding is essential to determine whether a system failure is or is not in his portion of the combination. To be able to read prints and follow other basic maintenance literature, he must be able to recognize basic symbols for devices that are non-electronic.

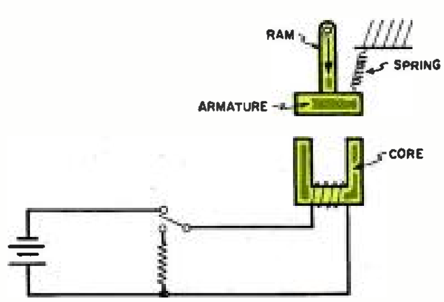
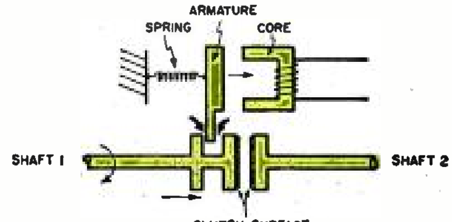


Fig. 1. Electromagnetic field of activated solenoid's core pulls in armature.

Fig. 2. A solenoid may be used to engage or disengage a friction clutch.



Conversion into Motion

Practically all of the electrical machines in existence do not convert electrical energy *directly* into a motion or pressure, but do so by first setting up a magnetic field and then using the magnetic force between two iron pieces. A simple example is the solenoid shown in Fig. 1. When current flows in the coil, a magnetic field is set up in the iron core and this attracts the *T*-shaped ram which, in turn, is put into motion.

Basically there are only two types of motion possible with electrical machines, linear or rotary. The first is usually obtained by solenoids and the second—the largest application of electricity in automation—is the action of an electric motor. In the latter, the attraction and repulsion between the stationary pole pieces and the rotating member generate the rotation and the torque.

Solenoids

In many automation systems, solenoids are used to perform quick, short strokes that do not require too much force and are not part of a continuous process. For example, a solenoid can be used to open the latch of a door or push a "reject" stamp against a defective unit in an automatic inspection line. Only rarely is one used in riveting, making eyelets, punching, or other less simple operations. The reason for this lies in the basic mechanics of solenoid action.

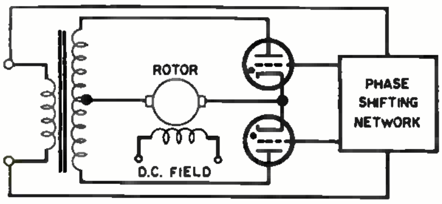


Fig. 3. This arrangement for speed control is used with large d.c. motors.

As shown in Fig. 1, a spring keeps the armature or moving section separated from the main core so that the former remains in this position until power is applied to the coil. Fundamental electricity teaches us that current through the coil builds up as a function of time and inductance, and this means that it takes a little time until full current flows through the coil. The magnetic force is strictly proportional to the current flowing through the coil, and it therefore does not reach its peak until the current is maximum.

Magnetic attraction is a function of the square of the distance between the two elements. This means that the force applied to the armature is smallest at the start and increases as the ram moves closer to the core. In other words, the armature starts moving slowly and gathers force until it smacks against the core. This feature alone presents a mechanical problem that limits the use of solenoids to intermittent-duty applications.

When the actuating switch is opened, the energy stored in the coil must be dissipated and, since arcing would quickly wreck the switch contacts, arc suppressors or dummy loads (like the resistor shown) must be used.

Solenoids are always used together with some mechanical linkage and, if the linkage sticks, the solenoid will often fail to operate, since the starting force is usually small. In many instances, a solenoid is part of some other control mechanism, such as the clutch shown in Fig. 2. Actually the entire assembly of clutch, armature, and plunger usually is a single, integrated unit, but the action of the solenoid can be understood better by separating them in the drawing.

Shaft 1 rotates and, when the solenoid pushes the clutch surfaces together, shaft 2 is connected to shaft 1. In this arrangement, there are two major sources of friction, shown by the heavy arrows in Fig. 2, which must be overcome by the holding power of the solenoid. When this friction becomes too great—due to lack of lubrication, for example—the clutch will fail, even though the solenoid may still be in good condition. Solenoids are often used to control valves in hydraulic or pneumatic systems. The same servicing problems apply there, and it is always wise to make sure that solenoid failure is *not* due to mechanical trouble in the related mechanism.

Electric Motors

There is probably no home in the U. S. today that does not have at least several electric motors of one kind or another. Because most homes use a.c. power, these motors will tend to be of the induction type; but in industry d.c. motors are also used widely. There are motors that fit into a wrist watch and run a year from a battery the size of a dime; and then there are motors having over 1000-horsepower output that require a room full of electronic gear for starting and speed control. In between these extremes are a series of standard motor types in wide use for specific industrial applications. Some of these types are not involved too frequently as parts of an automation system. Others, like the servo motor, are particularly useful in positioning and other operations that are automated.

To understand the relationship to the over-all system of any motors used, the electronic technician should know something about the characteristics of the various types. He should also be able to recognize them as they are symbolically represented on the prints he will use in tracing and troubleshooting. The most commonly used types are represented in Fig. 4, and Table 1, which is coordinated with this illustration, provides information about the units that can be helpful.

In addition to the windings shown here, the reader should understand that other starting, compensating, and con-

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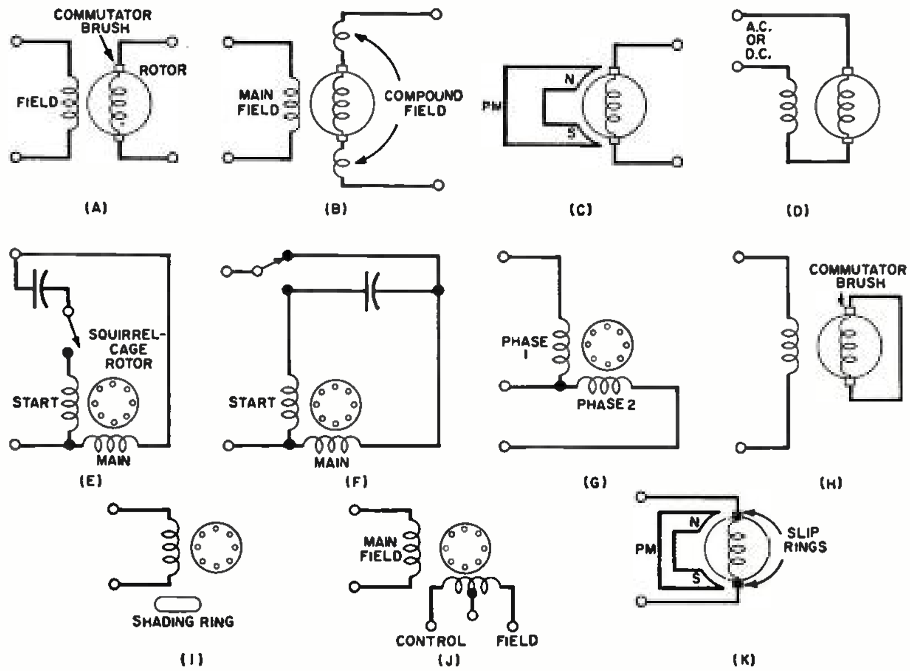


Fig. 4. Symbols for motor types that may be encountered in automated systems.

Table 1. Useful information concerning the common motor types shown in Fig. 4.

TYPE & FIG. 4 REFERENCE	STARTING TORQUE	SPEED CONTROL	OPERATING FEATURES	TYPICAL APPLICATIONS
D.c. shunt (A)	Medium	Thyratron or voltage control	Adjustable speed; constant torque or constant power	Pumps, conveyors, wire and paper winding
D.c. compound (B)	High	Usually not used	Speed adjustable over small range; high but varying torque	Flywheel drive, shears, punch presses, hoists
D.c.-PM field (C)	Low	Power tubes or transistors		Fans, blowers, battery-operated devices
Universal series d.c. or a.c. (D)	Very high	Thyratron, saturable reactor, series resistor	High speed; high efficiency	Hoists, cranes, vehicles, hand tools, appliances, general utility
Capacitor start a.c. (E)	Very high	Saturable reactor	Limited range of speed control as torque drops with voltage	Compressors, pumps, blowers
Capacitor running (reversible) (F)	Low	Usually not used	Speed varies greatly with load	Fans, blowers, centrifugal pumps
Squirrel-cage induction (poly-phase) (G)	Depends on type used	Saturable reactor, resistors	Available in six classes of performance characteristics	General-purpose industrial motor used as main power source for heavy machinery
Repulsion-start, induction-run (H)	Very high	Usually not used	High starting-current surge	Pumps, compressors, conveyors
Shaded pole (I)	Very low	Usually not used	Relatively inefficient, but low in cost	Fans, blowers, heaters, phonographs
Servo (J)	High	Power amplifier, saturable reactor	Accurate control through special control winding	Positioning systems, computers
Synchronous (K)	Low	None	Constant speed depends on number of poles and line frequency	Clocks, timers, blowers, fans, compressors

Longest Army Closed-Circuit TV Link

◀ The longest CCTV circuit in Army history linked West Point and Redstone Arsenal, Ala. for the transmission of a one-hour orientation course in missiles. Some 17 cameras and 3 mobile TV units provided a panoramic view of activities at the Arsenal, located some 1100 miles to the south of West Point, where about 1200 cadets watched the showing. Cooperating with the Army were *RCA*, whose electronics gear was used, and *Teleprompter Corp.*, the producer.

The "Shape Recognizer"

An early experimental step toward machines that read is demonstrated by a *Bell Laboratories* scientist. The machine displays a lighted square, showing that it has "recognized" a drawing of a square. The device also identifies triangles, pentagons, hexagons, and circles. ▼

Recent Developments in Electronics

Rotating Radio Telescope

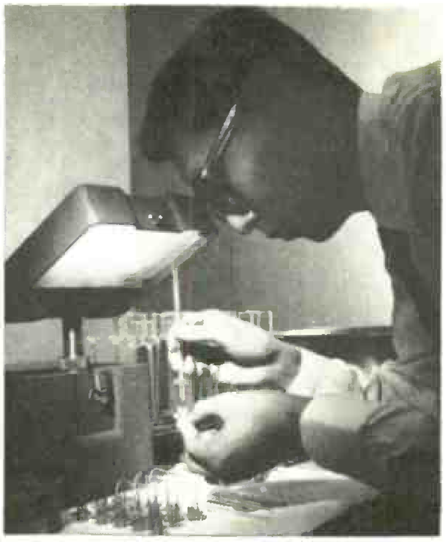
◀ A time exposure provided this dramatic illustration of an 85-foot diameter radio telescope in use at the National Radio Astronomy Observatory in Green Bank, W. Va. Tracking celestial objects with this unit, designed and built by *Blaw-Knox Co.*, is simplified because of equatorial mounting. The telescope's axis is parallel to the earth's axis and it turns at a constant rate of speed—one revolution per day—to follow discrete radio noise sources.

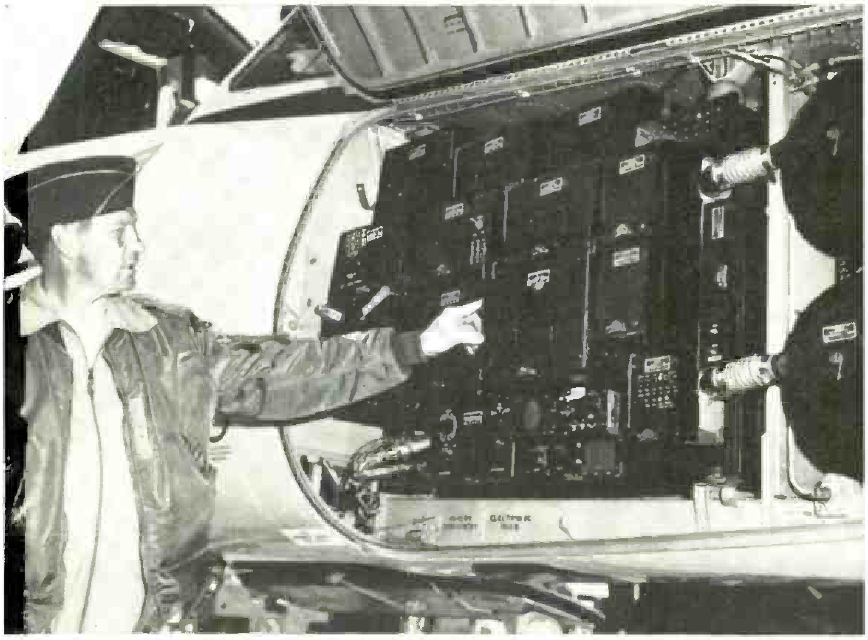
Airborne TV Ice Watch

A TV-equipped helicopter is being used by the Navy as an advanced eye to help ships ply the perilous waters of the Antarctic. The USS "Glacier," an icebreaker, recently charted a course through heavy floes there, with the assistance of the copter which flew ahead of the ship. A TV camera aboard the copter transmitted a picture of ice conditions back to a monitor aboard the "Glacier" enabling the ship to pick a path of least resistance. The helicopter used was the Navy version of *Bell's* commercial "Ranger" series. ◀

Tubes Sealed by Optical Lapping

A sealing technique adapted from optical manufacturing processes, which substantially increases electron-tube reliability and life, was demonstrated by *Chatham Electronics* (division of *Tung-Sol*) and the U. S. Army Signal Supply Agency. In the usual production, a tube's glass-button base is sealed to the glass bulb by means of high-temperature gas flames. This method may contaminate the tube's cathode and subject the elements to stress which may result in failure or reduced life. With the new method the glass surfaces are carefully lapped so that a tight fit occurs and a vacuum may be produced without heat. Final sealing, but at a low relative temperature, is accomplished by induction heating. Engineer at right is studying interference rings, or fringe patterns, at the mating surfaces of the tube bulb and button stem. Monochromatic helium light is used to make these rings visible. The new technique, known as polyoptic sealing, has been the subject of a preliminary evaluation program and is based on a similar sealing process pioneered by the French electronic company *Compagnie Generale de Telegraphie Sans Fil.* ▶





Electronic Brain Pilots Cross-Country Flight

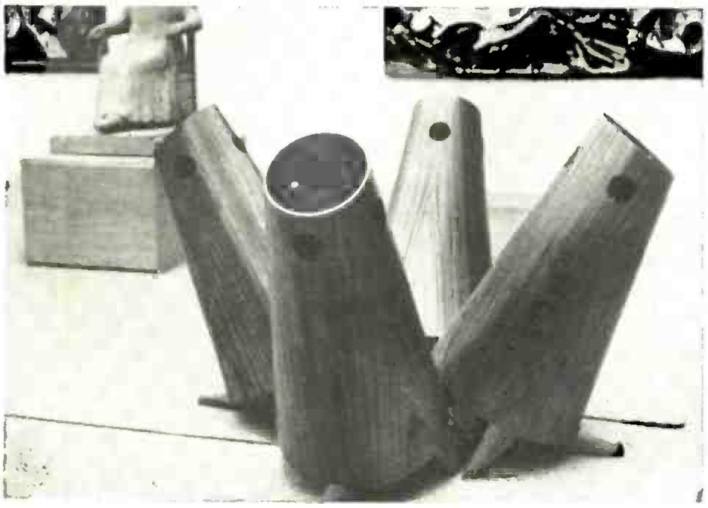
◀ An Air Force all-weather interceptor recently flew itself non-stop across the continent from California to Florida. The 2500-mile flight, made without refueling, was under the control of a *Hughes Aircraft Co.* electronic system (part of which is shown at the left) which took over the controls shortly after take-off.

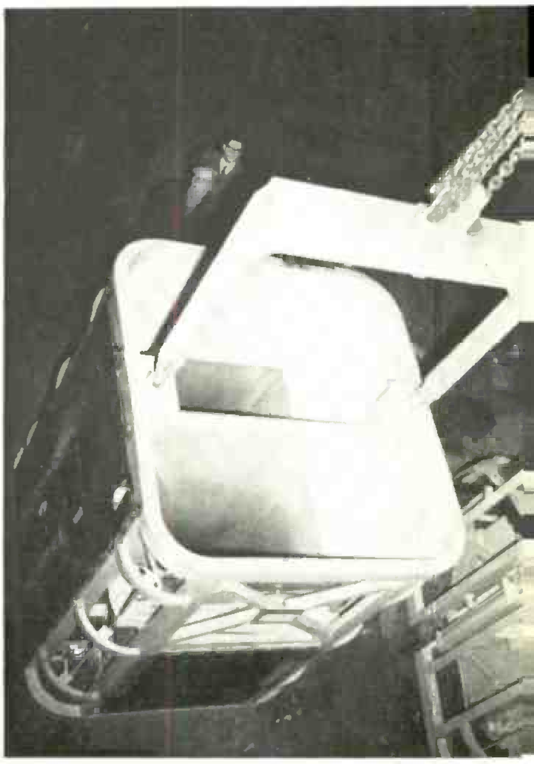
Radio-Controlled Concrete Bucket

The large 8 cubic yard concrete bucket shown below is the first radio-controlled unit scheduled for construction operations. The bucket is one of three similar units being used in the construction of Greers Ferry Dam in Arkansas. The self-powered hydraulic units are equipped with an automatic latch for engaging a cableway sling, and for manual operation. ▼

Swedish Integrated Speaker System

The *Elektron Lund* speaker system, four of which are shown below, includes woofer, mid-range speaker, and tweeters, along with two separate power amplifiers (one for treble, the other for bass), all built into a striking enclosure. The system is now being marketed in this country. The amplifiers, whose response complements that of the speakers, are each 10-12 watt units employing output-transformerless circuits. ▼





pix tube as tuning eye

By A. V. J. MARTIN

A European circuit avoids eye-straining, detuned TV images after the viewer has settled down to watch.

A POSITIVE tuning indicator on a television set, while not a necessity, can be quite a convenience. Consider the location of the ordinary viewer as he adjusts for fine tuning. He is so close to the picture itself that he cannot observe whether the set is properly tuned. When he resumes normal viewing position, he is likely to find that he is overtuned (etched edges and ringing in the picture) or undertuned (a smeared picture with loss of detail). One or more additional attempts at fine tuning may be needed, backing off from the receiver with each to check on the picture.

The idea of using the picture tube itself as a fine-tuning indicator is not new, but a circuit developed by *Schaub-Lorenz* and used in some European receivers is of special interest. Its commercial adoption here is not likely because of the additional circuitry required, but it might tempt the adventurous experimenter. The added circuit (Fig. 1), which is switched in only during the fine-tuning procedure, basically uses horizontal pulses to produce a bright, vertical bar on the picture tube (see *A* of the insert to Fig. 1) whose width is greatest when the receiver is correctly tuned. For more sensitive indication, a vertical pulse is combined with the circuit in such a way as to change the shape of the bar into a triangle (see *B*).

There are two functions required here: obtaining the basic pulses to produce the bar or triangle on the picture tube, and providing a means for varying their width in accordance with the tuning condition. The first function is performed by feeding horizontal scanning pulses (waveform *A* in Fig. 1) to transformer T_1. The function of the vertical pulses will be ignored for the moment. The primary of transformer T_1 is resonated at the horizontal frequency, so that the waveform coupled to diodes D_1 and D_2 (waveform *B*) is a sine wave and other, undesired information is filtered out.

The diodes and their associated network act as a full-wave rectifier. Accordingly the output from this frequency-doubling circuit is a signal at twice the horizontal frequency that has been peaked (waveform *C*). This signal, when the fine-tuning circuit is turned on, goes through the switch to the grid of the clipper V_2. The latter removes the rounded portions of the peaked pulses, producing a triangular output, as shown in waveform *D*. These pulses, in turn, next have their tips cut off by limiter V_3, whose output is then a train of positive-going pulses, essentially rectangular (waveform *E*), that are fed to the picture-tube grid.

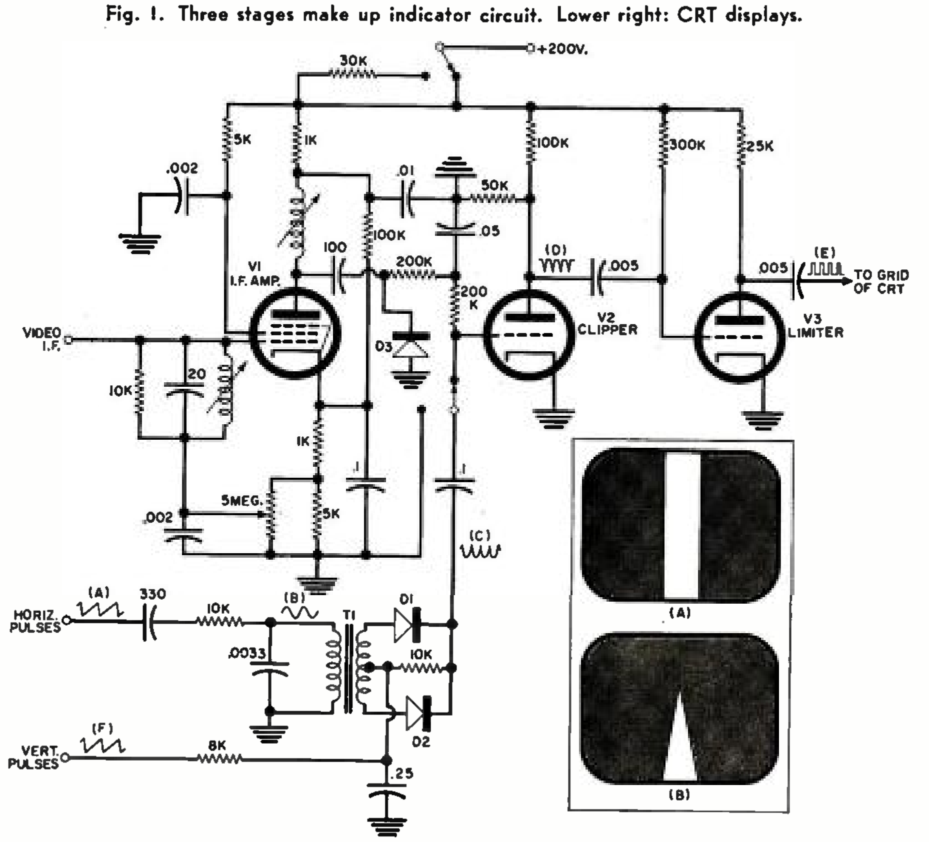
The phase of these square waves is such that every other one falls at about the center of each line of scan, producing brightness in the middle of the raster. Alternate pulses occur during retrace time and are suppressed by a retrace-blanking network in a portion of the receiver not shown. Note that the width of the rectangular pulses (waveform *E*) is essentially the width of the triangular pulses (waveform *D*) at their base. This latter width is determined by the point at which clipper V_2 cuts off the peaked waveform fed to it. The clipping point, in turn, may be adjusted by manipulating the bias for this tube. To make this bias dependent on the condition of fine tuning, the circuit associated with V_1 and D_3 is added.

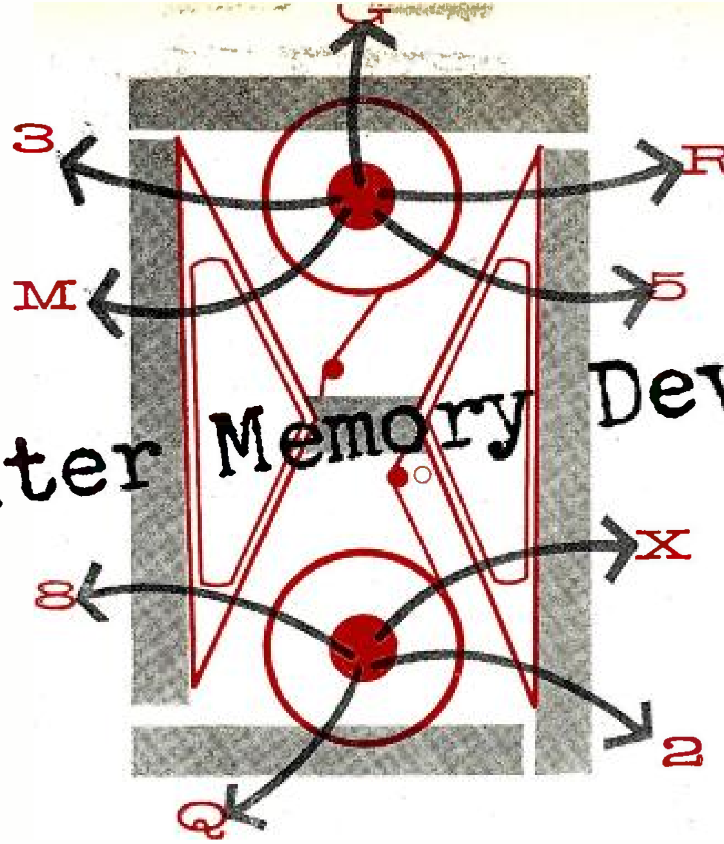
V_1 is an extra i.f. amplifier added strictly for the indicating circuit. The coil at its plate is adjusted so that maximum output from this stage occurs when the fine-tuning control is correctly adjusted. This output is rectified by diode D_3 and filtered to provide a d.c. bias at the grid of clipper V_2, where the peaked pulses are also introduced. Thus, when the fine tuning is correct, the clipper is biased so that it cuts off only a small portion of waveform *C*, producing an output of triangles that are very wide at their base. The rectangular pulses, then, are also widest under this condition, and the vertical bar on the picture tube will also be at its widest. As fine tuning strays from the optimum condition, V_1 and D_3 re-bias the clipper so that it passes a smaller portion of the peaked pulses fed to it, producing triangles of shorter duration (narrower at their base). This decreases the width of the square pulses and narrows width of the vertical bar seen on the screen.

While the vertical bar gives a good impression of tuning accuracy, this is improved by a simple circuit addition that converts the visible display into a triangle, whose variation in height gives a very sharp indication. Vertical scanning pulses (waveform *F*) are also fed to the grid of the clipper along with the output of the peaked doubler, as shown, through a simple network. This

(*Continued on page* 94)

Fig. 1. Three stages make up indicator circuit. Lower right: CRT displays.





Computer Memory Devices

By **ED BUKSTEIN**
Northwestern TV & Electronic Inst.

For speed and automation, storing information is important. Magnetic tapes and drums are used.

PART 1

AS COMPARED to mechanical calculators such as the ordinary adding machine, the electronic computer has two important advantages: *high speed* and *automatic operation*. Both of these advantages result from the use of memory or storage devices. The numbers to be used in calculation and the instructions which specify the types of operations to be performed (addition, subtraction, etc.) are stored in the memory device before the calculation begins. The computer then extracts this information as it is needed during the course of the computation. As a result, the computer is able to perform a lengthy series of calculations without the intervention of a human operator.

In this sense, the computer is automatic. By contrast, the operator of an office-type adding machine must punch-in new information (through the keyboard) before each individual step of the calculation. Since the machine is "idle" during the time the operator is entering new information into the keyboard, the calculation progresses at a relatively slow rate. A full day's work might therefore be required to complete a calculation which an electronic computer could perform in a matter of seconds.

The memory section of a computer is also used to store partial answers, obtained in early steps of a calculation, which may be required in a later step. Final answers are also stored in the memory and, at some convenient time, can be transferred to a print-out device, such as an electric typewriter. Many computers are so designed that the print-out function can be performed while the computer is simultaneously working on another problem.

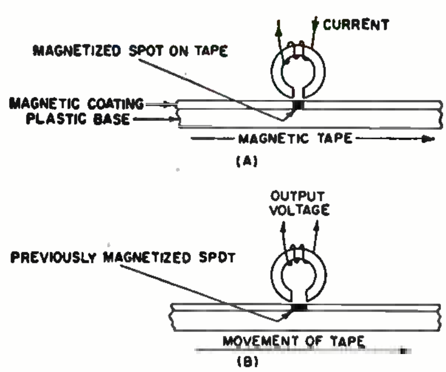
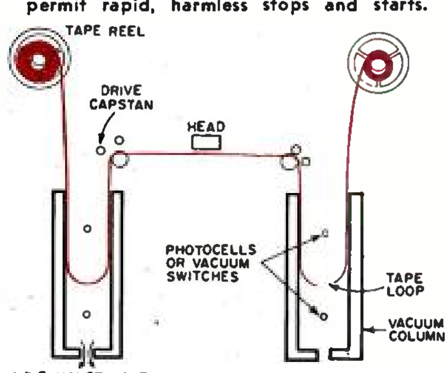


Fig. 1. As with sound, electromagnetic heads (A) record and (B) play back data.

Fig. 2. Tape-tensioning vacuum columns permit rapid, harmless stops and starts.



Magnetic Tape Storage

The magnetic tape recorders used for data storage in digital computers differ in physical detail, but not in basic principle, from those used for audio recording. This basic principle is illustrated in Fig. 1. As shown, the tape consists of a plastic base coated with a thin layer of magnetic oxide. This tape is moved through the machine by a motor-driven transport mechanism. The path of the tape is such that the magnetic coating passes adjacent to the air gap in the *write* head (Fig. 1A).

If a pulse of current is passed through the coil of the write head, magnetic lines of force will be established in the core. These lines of force bridge the air gap by flowing through the magnetic coating of the tape. The section of tape under the air gap therefore becomes magnetized as a consequence of the current flow through the write coil.

Playback, known as *reading* in computer terminology, is accomplished by

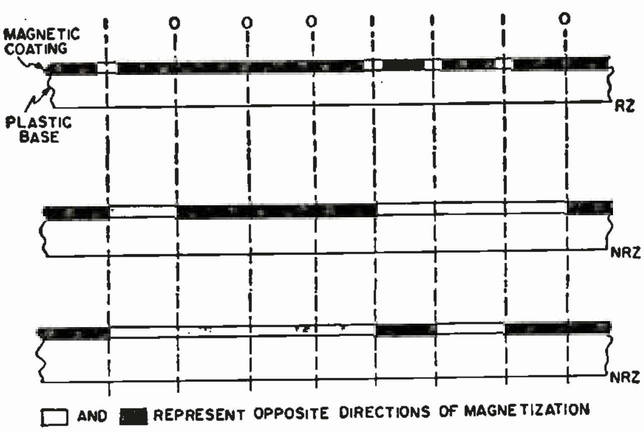


Fig. 3. In return-to-zero recording (A), binary 1 is represented by tape magnetization in one direction and binary 0 by magnetization in the opposite direction. In non-return-to-zero recording, direction of magnetization is changed (B) only when switching from one digit to the other or (C) only when 1 is recorded.

moving the tape adjacent to the air gap of a *read* head (Fig. 1B). As the magnetized tape passes the gap, a magnetic field is established in the core and the lines of force cut across the coil. The voltage induced in the coil constitutes the output.

In computer practice, the same head is used for both writing and reading. This is permissible because the two operations do not occur simultaneously. Information is recorded in a number of parallel tracks across the width of the tape and a separate head is provided for each track. Binary-coded decimal, excess-3 code, and 7-bit code are frequently used for storing data on magnetized tape (see "Numbers Systems and Codes," ELECTRONICS WORLD, November 1959).

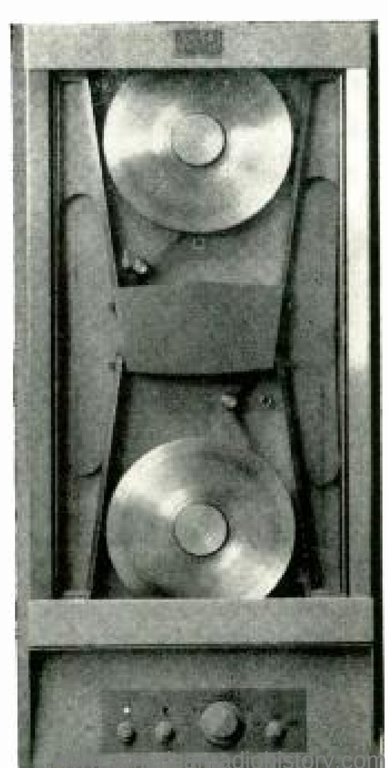
Recording is interrupted at periodic intervals so that the information is recorded in *blocks*. Typically, each block of information occupies about an inch of tape length, and the blocks are separated by about a quarter inch of blank tape. Such grouping of the recorded material is an aid in locating and selecting desired data for read-out. Counting circuits that respond to the passing blocks of information activate the reading circuits when the desired block passes under the reading heads.

In audio recording, the *degree* of magnetization of the tape is an important factor and varies with the audio signal being recorded. In computer applications, however, the *direction* of magnetization is the important factor and the degree of magnetization conveys no intelligence. For improved signal-to-noise ratio, the write currents are made sufficient in amplitude to magnetize the tape completely to saturation. The recorded tape is therefore fully magnetized in one direction or the other.

Since data is recorded in binary form, one direction of magnetization represents binary 1 and the opposite direction of magnetization represents binary 0. This technique, known as *RZ* (return-to-zero) recording, is illustrated in Fig. 3A. In the method known as *NRZ* (non-return-to-zero) recording (Fig. 3B), the direction of magnetization of the tape changes only when the data changes from 0 to 1, or from 1 to 0. In another variation of NRZ recording, the direction of magnetization changes only when a 1 is to be recorded. As shown in Fig. 3C, each change in the direction of magnetization represents a 1, and the 0 is recorded by maintaining the magnetization in the same direction it had during the previous bit. As compared to *RZ* recording, the *NRZ* techniques are characterized by less frequent changes in the direction of magnetization. This is an important advantage because it permits more bits of information to be recorded on a given length of tape.

The mechanical requirements of a tape machine designed for computer work are somewhat more demanding than those of a machine designed for audio applications. This is so because the computer tape must be frequently started, stopped, and reversed in direction. To prevent tape breakage and to permit rapid acceleration and deceleration, the tape is allowed to hang in a loose loop on each side of the head, as shown in Fig. 2. The loops hang down into vacuum columns, so that the atmospheric pressure on top of the tape maintains a slight tension on the loops.

This arrangement permits the tape to be started and brought up to speed in a very short time because the motor need accelerate only the tape in the loop. The other reel and the remaining tape "catch up" a short time later.



Start and stop times of five milliseconds are typical. Each reel has its own motor, and a servomechanism control prevents the loops from becoming too short or too long. The servomechanism responds to signals supplied by either pressure switches or photocells located in the vacuum columns.

The *Ampex* FR-300 digital tape handler, shown in Fig. 4, has a standard speed of 150 inches per second forward or reverse, and a fast speed of 225 inches per second. Start and stop times are 1.5 milliseconds. The tape-tensioning air columns of this machine are constructed as shown in Fig. 5. Air drawn from the exhaust ports maintains tension on the loops, and the loops contract or expand as the tape accelerates or decelerates. To minimize wear, the FR-300 drives on the tape backing rather than on the oxide side. This machine handles either half-inch or one-inch tape widths, providing 8 or 16 recording tracks.

Magnetic tape, as a storage medium, offers the advantage of very great capacity. At a *packing density* of 200 bits per inch, a half-inch tape 1200 feet in length can store literally millions of bits of information. Tape lengths of 2400 and 3600 feet are also commonly used and provide even greater storage capacities. Furthermore, a single computer may have at its command a large number of tape machines.

One disadvantage of tape storage, however, is its relatively long *access time*. Since the information required at some particular instant may be out at the far end of the tape, several minutes may be required to bring it under the reading heads. For this reason, computers utilize magnetic tape for reserve storage, but use a medium having a shorter access time for the main memory. The magnetic drum is often used for this purpose.

The Magnetic Drum

The magnetic drum consists of a motor-driven, aluminum cylinder

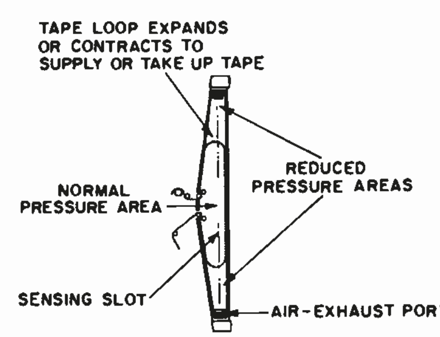


Fig. 4 (Left). Upper portion of rack-mounted Ampex FR-300 digital tape handler with standard speed of 150 inches per second and a fast speed of 225 ips.

Fig. 5 (Above). Detail of one of the vertical vacuum columns used in the handler of Fig. 4. Compare this arrangement with the one highlighted in Fig. 2.

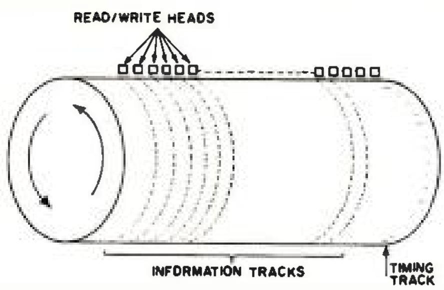


Fig. 6. Access time of a magnetic drum is shorter than that for a reel of tape.

coated with a thin layer of magnetic oxide. Writing and reading are accomplished in a manner similar to that used with magnetic tape. In a sense, the drum surface is like a short, wide tape with the ends joined to form a continuous loop. As shown in Fig. 6, many parallel tracks can be recorded on the drum. A twelve-inch drum, for example, may hold 200 tracks of information. The number of bits that can be stored in each track is, of course, determined by the diameter of the drum. Drum diameters from five to ten inches are common, but smaller and larger sizes are sometimes used.

Magnetic drums are normally provided with separate heads for each track. It is possible, of course, to use fewer heads so mounted that they can be moved from one track to another. This arrangement however, results in an increase of mechanical complexity as well as an increase of access time.

The heads of a magnetic drum may be connected in parallel (through diodes) as shown in Fig. 7. Since the diodes are biased in the non-conducting direction, the heads are effectively isolated from each other. Any given track can then be selected for writing or reading by making the associated diodes conductive. If, for example, a positive control signal is applied to the grid of V_3 in Fig. 7, this tube will become conductive and the voltage at point X will rise from a negative to a positive value. Since diodes D_5 and D_6 are now forward biased, the head for track 3 is connected to the read and write amplifiers.

Drum storage is *cyclic,* because each revolution of the drum brings the same information under the reading heads. The access time of the drum is therefore determined by the rate of revolution. Since it may happen that the desired information has just passed the reading heads at the time it is needed, the *maximum* access time is the time required for the drum to complete one revolution. It may happen, however, that the desired information is just approaching the reading position at the time this information is required. In such a case, the actual access time will be much shorter than the maximum access time. For this reason, access time is often specified as an *average* value, equal to the time required for the drum to make one half revolution.

A common value of drum speed is 3600 rpm, but rates in excess of 12,000 rpm have been used. At 3600 rpm, the maximum access time would be 16.7 milliseconds and the average access time would be approximately 8.3 milliseconds.

The magnetic drum used in *Royal McBee Corporation's* LGP-30 computer is shown in Fig. 8. Data on this drum is divided into groups known as *words,* each of which contains 32 bits including the sign bit (plus or minus) and the spacer bit. The drum holds 4096 such words. The drum surface can be seen in Fig. 8 between the rows of heads.

Many computers are designed to handle numbers that are 10 to 12 digits in length. Since each of these decimal digits can be represented in coded decimal notation by four binary bits, 40 to 48 bits are required to represent each decimal number. In addition, another four-bit combination is used to indicate whether the number is positive or negative, bringing the total to 44 to 52 bits. This amount of information is known as a *word,* and many such words may be recorded in each track of a magnetic drum.

To read a particular word from one of the drum tracks, it is necessary to activate the reading circuits just before the first bit of the desired word reaches the head, and to de-activate the circuits as soon as the last bit of the desired word has been read. For this purpose, a timing track is recorded on the drum as shown in Fig. 6. On this track, a series of pulses is recorded in positions such that each pulse passes under the reading head at a time when the first bit of a word is approaching the reading heads on the other tracks.

The pulses from the timing track are fed into a word counter, as shown in Fig. 9. This binary counter therefore advances its count each time a new word moves into the reading position. A comparator circuit (coincidence detector) produces an output when the number in the word counter is equal to a number previously stored in the *address selector* flip-flops.

If the fifth word on the track is to be read, for example, the address selector must first be set to 101 (decimal 5). This is done automatically by the *control* section of the computer. As the drum revolves and the word counter advances, the comparator produces an output signal when the word counter reaches 101 (first and third stages in the *one* condition and second stage in the *zero* condition).

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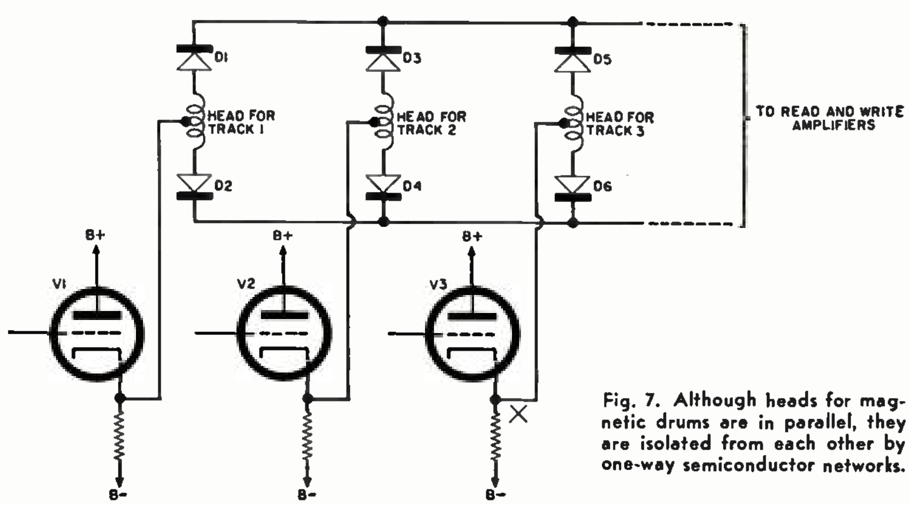
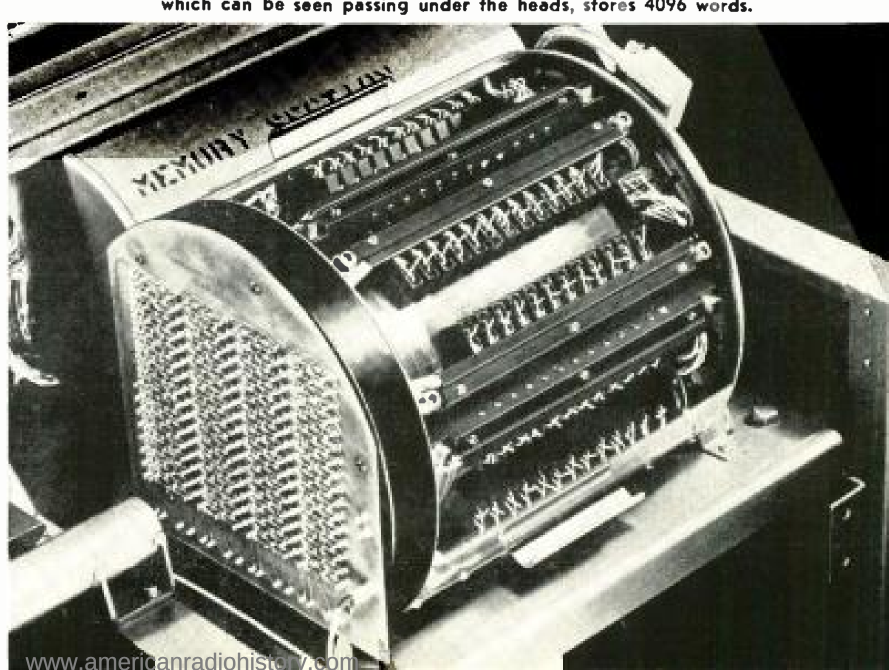


Fig. 7. Although heads for magnetic drums are in parallel, they are isolated from each other by one-way semiconductor networks.

Fig. 8. The magnetic drum of this Royal McBee LGP computer, which can be seen passing under the heads, stores 4096 words.



Cover Story

Triple-Triode Citizens Band Converter

By **P. E. HATFIELD**/Receiving Tube Dept., General Electric Co.

Construction of a well-designed tunable converter for broadcast receiver. Costs about $10 to build and uses new triple-triode tube. Can also cover 10-meter band.

MUCH of the equipment suggested for use in the Citizens Band has employed the time-tested super-regenerative receiver in the interests of simplicity. This has allowed rapid occupancy of the band and has gotten the service off to a good start.

However, the increase in Citizens Band activity has demonstrated the well-known shortcomings of the super-regenerative circuit especially when no r.f. amplification is used: lack of selectivity and moderate sensitivity, plus radiation of a strong signal.

The superheterodyne circuit has distinct advantages, but construction of a complete receiver of this type is both costly and moderately difficult. Use of a converter ahead of a reasonably good receiver allows this receiver to supply much of the required gain and selectivity.

A converter can, of course, consist of nothing more than an oscillator-mixer, feeding a following receiver. Superior performance may be obtained if an r.f. amplifier is used ahead of the mixer. This would normally dictate a minimum of two tubes. A recently announced *General Electric* tube, the 6EZ8, contains three triodes in one envelope and allows the construction of a small three-stage converter with one tube.

The converter to be described was designed to be used in connection with any broadcast receiver capable of being tuned to 1500 kc. It may serve as the main Citizens Band receiver or make it possible to have auxiliary or monitoring receivers available at low cost. The cost of the converter is approximately ten dollars and will be even less if junk-box parts are available. The sensitivity, selectivity, and frequency stability are good, although these qualities are all governed, in part, by the receiver used as an i.f. amplifier. A bonus to the constructor who is also a ham is the easy adaptability of the converter to the ten-meter amateur band, a result of the wide tuning range of the slug-tuned coils used. The basic circuit is shown in Fig. 1.

Circuit

One section of the triple-triode is used as a grounded-grid input stage. This contributes useful gain as well as providing isolation between the antenna and mixer stage. This isolation decreases oscillator radiation, which sometimes reaches serious proportions with a superregenerative detector or a simple mixer-oscillator coupled to an antenna. A broadband input circuit is used so that no tuning is required.

A second section of the tube is used as a mixer with a broadband grid circuit. Use of broadband circuits in both the r.f. amplifier and mixer simplifies construction of the converter; only the oscillator need be tuned, and this eliminates the problems of ganging and tracking.

The oscillator employs a high-"*C*" tickler-feedback circuit which operates on the low-frequency side of the incoming signal. The circuit constants are selected to provide adequate bandspread of the Citizens Band. Simple modifications required to give complete ten-meter bandspread will be described later.

Construction

The converter is constructed in a 2½" x 2¼" x 5" chassis box. An inexpensive vernier dial is used to operate the oscillator tuning capacitor, the only control on the converter. Input and output connections are made through phono-type connectors and power is fed in through an octal plug, arranged to mate with an octal socket on the matching power supply. If desired, a cable could be substituted for the power plug.

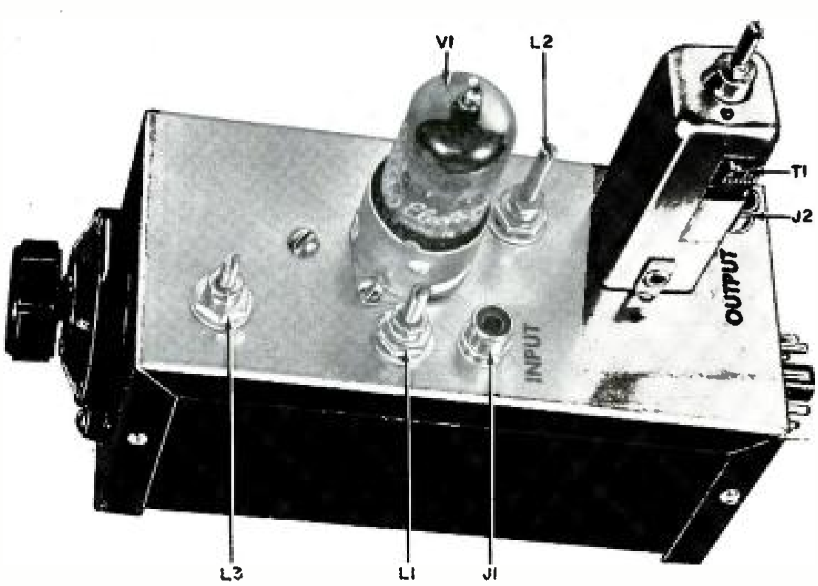
Parts layout is not especially critical. Since only one tube is used, the parts may be grouped around the socket with as short leads as practical, following the layout shown clearly in the photographs.

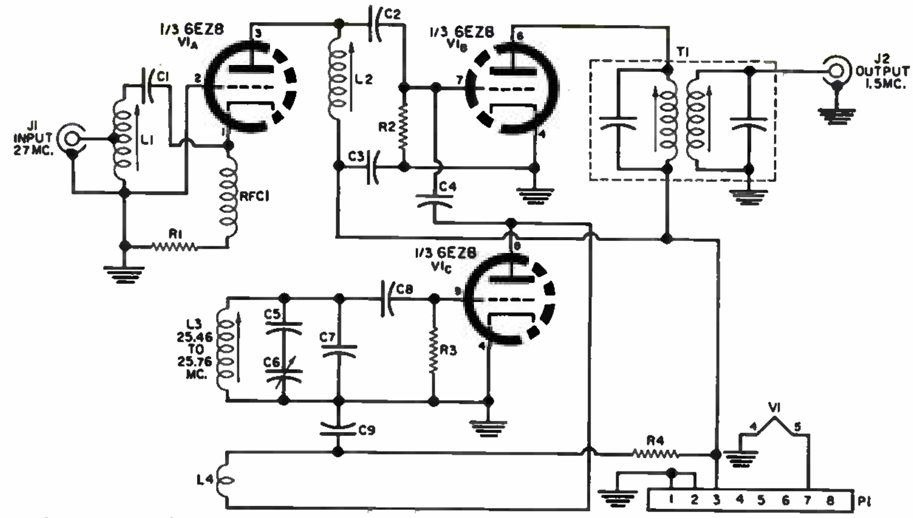
An old TV booster or u.h.f. converter might be used to supply the cabinet, chassis, dial, and power supply at a considerable saving in parts cost.

If power is to be taken from the receiver to be used as an i.f. amplifier, detector, and audio amplifier, the separate power supply can be omitted. (Of course, this cannot be easily accomplished with an a.c.-d.c. receiver, but nearly any transformer-operated receiver will stand the small additional power drain of the converter.) If a power supply is constructed, it will be required to provide 6.3 volts at 450 ma. and approximately 100 volts at 10 ma. This is well within the capabilities of the smallest booster or converter transformers.

The power supply is built in the same size box as the converter and has an octal socket mounted on one end to match the plug on the converter. A booster transformer is used for power. A selenium rectifier, simple *RC* filter,

Top view of the converter. A slug-tuned i.f. transformer is used for T_1 in this model, but a capacitor-tuned transformer is equally suitable. One slug screw on T_1 projects out of the bottom of the shield can and is adjusted through opening.





R_1—270 ohm, ½ w. res.
R_2—1 megohm, ½ w. res.
R_3—10,000 ohm, ½ w. res.
R_4—2700 ohm, ½ w. res.
C_1—470 μμf. ceramic capacitor
C_2, C_8—100 μμf. mica capacitor ±10%
C_3, C_9—.001 μf. ceramic capacitor
C_4—1 μμf. ceramic capacitor
C_5—10 μμf. silver mica capacitor (see text)
C_6—2.8-17.5 μμf. var. capacitor (Hammarlund Type HF-15). For 10-meter operation a 3.5-27 μμf. var. may be substituted (Johnson Type 25L15, see text)
C_7—150 μμf. silver mica capacitor
J_1, J_2—Coax or phono jack
RFC_1—750 μhy. r.f. choke
L_1—20 t. #26 en. closewound, tapped 6 t. from gnd. end (CTC Type LS3, ⅜" form, 20063-B slug)
L_2—18 t. #26 en. closewound (CTC Type LS3 form, 20063-B slug)
L_3—4 t. #24 en. spaced to ¼" (CTC Type LS3 form, 20063-B slug)
L_4—10½ t. #28 en. closewound at distance of ¼" from gnd. end of L_3.
T_1—1400-1600 kc. i.f. output trans. (Miller Type 12-W2)
V_1—6EZ8 tube (G-E)
P_1—Octal plug

Fig. 1. Separate sections of the 6EZ8 are used as r.f., mixer, and oscillator stages.

and line switch complete this assembly. The suggested circuit is shown in Fig. 2. The use of a regulator tube is not mandatory but it does improve stability. If the 0B2 is not used, remove R_7 and increase the value to R_6 to 4700 ohms at 2 watts. Output voltage will then be about + 100 volts.

Connecting the Converter

If the receiver to be used with the converter is transformer-operated and does not use a loop antenna for its input coil, connection of the converter is relatively simple. A piece of 50- or 75-ohm coaxial cable not more than 2 feet long (up to 6 feet of low-capacity auto radio lead-in cable may be used) should be employed to connect the converter output to the antenna and ground binding posts of the receiver.

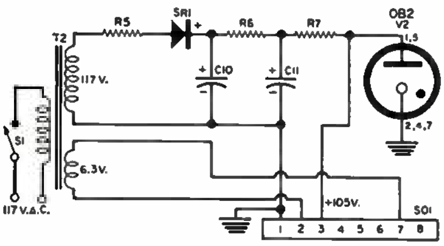
Use of an a.c.-d.c. receiver will require blocking capacitors in *both* leads from the converter in order to keep the converter chassis from being "hot." These capacitors may be any value from 0.01 to 0.1 μf.

A receiver with a loop antenna may give trouble with pickup of broadcast stations which will ride in with the signals from the converter. The best solution to this problem is to remove the loop and substitute a shielded antenna coil. If the slug-tuned variety is used, no difficulty should be encountered in obtaining tracking of the receiver in the broadcast band.

Alignment for Citizens Band

The converter may be aligned with a signal generator or by using on-the-air signals. If an on-the-air signal is used, it will be necessary to know the channel frequency, as the oscillator dial must be set to place the signal in its proper position on the dial.

After the converter is hooked up to the receiver and power supply, turn it on and allow approximately ten minutes' warm-up time before starting alignment. Tune the broadcast receiver to a relatively clear channel near 1500 kc. and feed in a signal of known frequency in the Citizens Band, either from a signal generator directly connected or from an antenna and a local station. Set the dial at a position which will place the signal at the proper part of the dial and adjust the slug in L_3 until the signal is heard. Now adjust the slugs in L_1, L_2, and tune T_1 for maximum signal, keeping the signal tuned in with C_6.



R_5—47 ohm, ½ w. res.
R_6, R_7—680 ohm, 2 w. res.
C_{10}-C_{11}—40/40 μf., 150 v. elec. capacitor
S_1—S.p.s.t. toggle switch
SO_1—Octal socket
SR_1—35 ma., 130 volt selenium rectifier (Tarzian Model 35 or equiv.)
T_2—Power trans., 117 v. @ 20 ma.; 6.3 v. @ 1 amp.
V_2—0B2 tube (see text)

Fig. 2. Suggested circuit for 105-volt d.c. power supply. The 0B2 regulator is helpful in stabilizing oscillator plate voltage and thus eliminating frequency shifts that may be caused by power-line voltage variations.

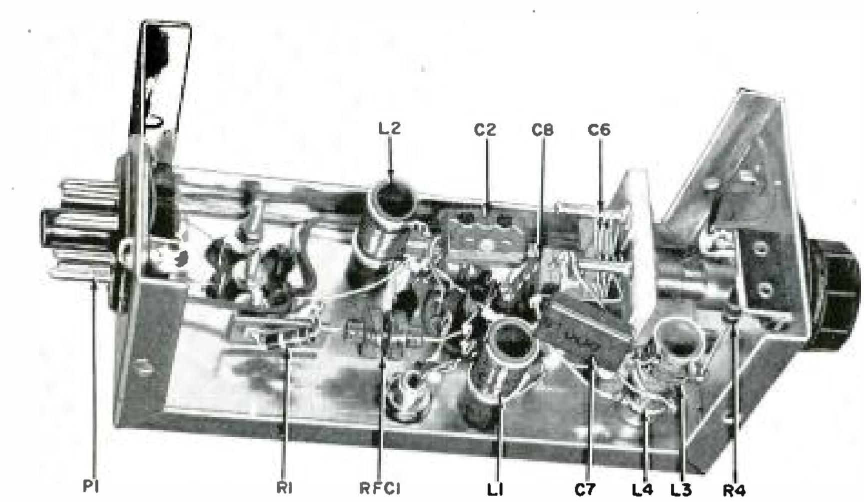
10-Meter-Band Alignment

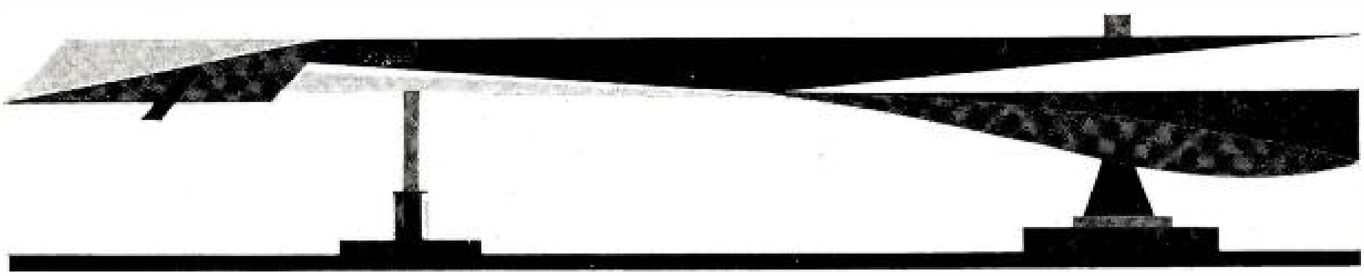
The converter may be aligned to cover any 400-kc. portion of the ten-meter band without changing the capacitors in the oscillator circuit. If the 10-μμf. capacitor (C_5) is removed from the oscillator circuit and the stator of the tuning capacitor connected directly to the top end of L_3, more of the band may be covered. If full ten-meter-band coverage is desired, omit the 10-μμf. capacitor and substitute a 3.5 to 27-μμf. capacitor in place of the 2.8 to 17.5-μμf. unit specified.

To align. tune the broadcast receiver to 1500 kc. and feed a 28.8-mc. signal into the converter. Set the converter

(*Continued on page* 109)

Bottom view with shielding cover removed. The oscillator tuning capacitor, C_6, is fastened to the top of the box with a small angle bracket. Some capacitors already have this bracket attached. Tie points were used to anchor small parts in two places.





Photocell Control For Phonograph

By **LAWRENCE W. DOBBINS**

Build this simple, low-cost, dependable circuit to turn off phonograph turntable at the end of a record.

SERIOUS music lovers and hi-fi fans who want to listen to their records without the distracting rumble and wow often associated with record changers are obliged to buy a good turntable and a separate tone arm and then mount these components on a base. Superb record reproduction can result from such a "do-it-yourself" phonograph, but the record player is, in many cases, completely manual. Once a record is started on the turntable someone must be present to turn off the instrument when the disc is finished. Even the serious listener (who normally sits beside the turntable in rapt attention) occasionally gets called to the phone or otherwise interrupted by family activities after the record is started. When these interruptions occur, a device which will automatically turn the phonograph off is certainly convenient and, in addition, can prevent unnecessary wear on the stylus.

An interrupted beam of light was chosen as the actuating mechanism for the phono shut-off because it is simple, reliable, and requires no energy from the record groove for operation. Other phono shut-offs have been described where the absence of a signal on the record for a period of 30 seconds or so would cause the turntable to stop. These devices are somewhat unreliable because the turntable may be stopped in the middle of a low-volume passage or may not operate because of a noisy oscillating groove at the end of the record. The photocell is used as a position-sensing device—the tone arm interrupts a beam of light when the stylus reaches the end of the record, thereby turning the turntable motor off. This control is relatively inexpensive—the total cost is under $10 using a surplus relay.

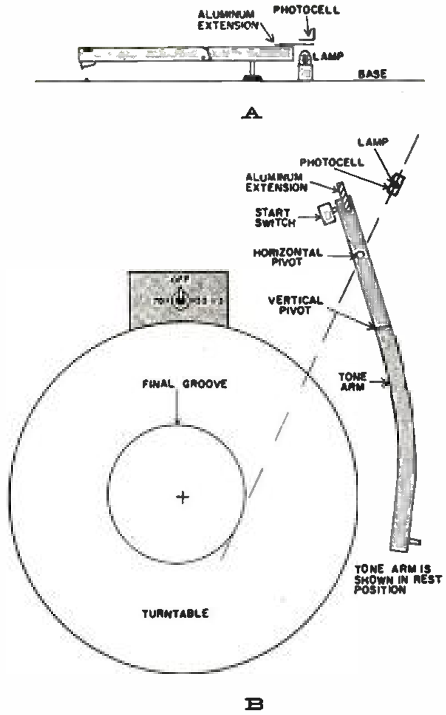


Fig. 1. Side and top views of phonograph.

Operation

The control circuit consists of a selenium photocell, a transistor-operated relay, and a power supply.

The turntable is started by actuating a start switch which simultaneously applies power to the turntable motor and the power supply for the transistor-relay amplifier. After being started, the motor will continue to run until the beam of light shining on the photocell is interrupted. The photocell generates about 0.3 volt when illuminated by a #46 pilot light placed one-half inch away. This small voltage will not operate an inexpensive relay directly therefore this voltage is used to forward-bias the base-emitter junction of a transistor which causes current to flow in the collector circuit and operate a relay. R_2 causes a back bias to appear between the base-emitter junction when the photocell is not illuminated, thereby stopping the flow of current in the collector circuit. The transistor is thus used as a switch—when it is conducting, only 0.2 volt is dropped across it and when turned off the current is reduced to a few microamperes.

The "start" switch, S_2, is connected in parallel with the normally open contacts of the relay. When the start switch is closed momentarily, power is applied to the turntable motor and the transistor power supply. If the photocell is illuminated, current begins to flow in the relay coil causing the contacts to close, maintaining the flow of current to the phono motor and the transistor power supply. The phono motor will then be stopped at the end of the record when the tone arm interrupts the beam of light.

The "start" switch, S_2, is connected in parallel with the normally open con-switch since the power supply for the transistor is turned off with the motor. The oscillating final groove on modern records could cause the turntable motor to turn on again as the turntable coasted to a stop if the transistor power supply were energized continuously.

On the author's phonograph, the start switch is mechanically operated when the tone arm is moved beyond the

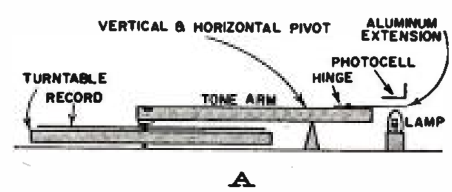
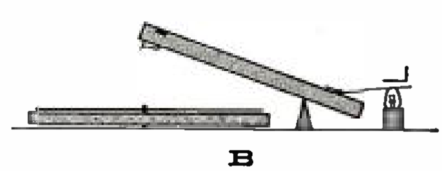
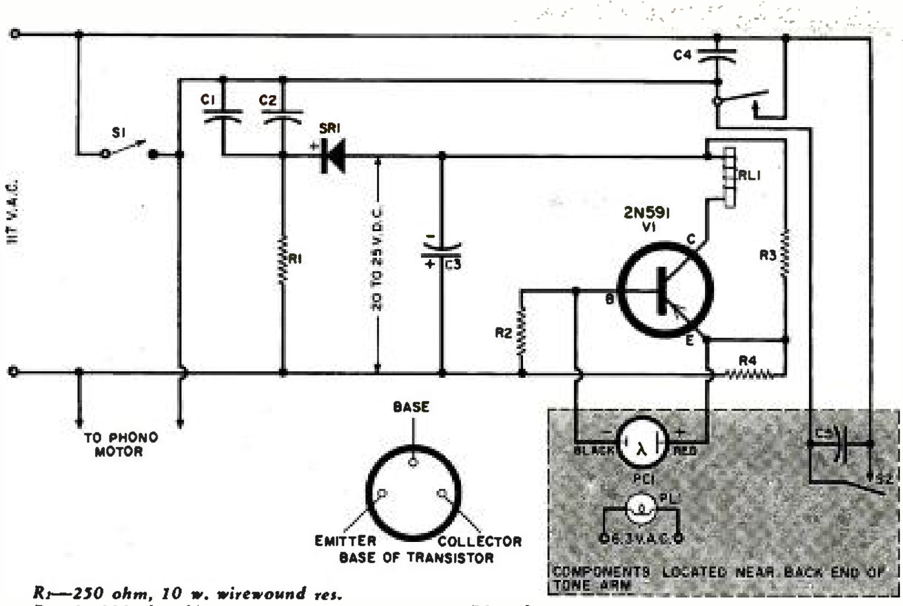


Fig. 2A. Use of photocell control unit in conjunction with a one-piece tone arm.

Fig. 2B. The hinged aluminum extension remains horizontal when the arm is raised.





R_1—250 ohm, 10 w. wirewound res.
R_2—82,000 ohm, ½ w. res.
R_3—4700 ohm, ½ w. res.
R_4—150 ohm, ½ w. res.
C_1, C_2—1 µf., 600 v. paper capacitor
C_3—25 µf., 50 v. elec. capacitor
C_4, C_5—0.1 µf., 600 v. paper capacitor
SR_1—Crystal diode (1N538, 1N539, 1N602, 1N1763, or 1N1764)
RL_1—S.p. a.c.-d.c. relay, 5000 ohms @ 3 ma. (Sigma 41F-5000-S-SIL or equiv.)
S_1—S.p.s.t. toggle switch ("Manual-Auto")
S_2—Momentary contact switch ("Start")
PC_1—Photocell (International Rectifier B-2-M or equiv.)
PL_1—#46 pilot light
V_1—"p-n-p" transistor (RCA 2N591)

Fig. 3. Complete circuit diagram and parts listing for photocell control unit.

edge of a 12-inch record. At the end of a record-playing session, it is important that turntables driven with a rubber idler wheel be placed in "neutral" to prevent flat spots from developing on the idler. As the tone arm is placed in the rest position, the turntable starts, acting as a reminder to disengage the idler wheel at the end of a record-playing session. The author's turntable is equipped with a single control which turns the motor on and engages the idler wheel. This control is now used only at the beginning and end of a record-playing session. Thus the automatic turntable control operates without adding more switches to the control panel.

The 20-volt power supply for the transistor is unusual in that the 117-volt a.c. input is reduced in an *RC* voltage divider. A capacitor was used to reduce the power dissipated in the voltage divider. The voltage rating of these capacitors should be 600 volts due to the large applied a.c. voltage. R_1 dissipates about four watts which is almost the entire power dissipated in this device. A transformer was not used for the voltage reduction because of its high cost and because of the undesirable amount of heat generated by a transformer. The isolation afforded by a transformer is not required since all parts of this control circuit can be insulated from the hi-fi amplifier. Both the relay contacts and the start switch are bypassed with 0.1-µf. capacitors to prevent clicks and pops in the amplifier and to reduce arcing at the contacts. S_1 allows the phonograph control to be bypassed quickly, if desired.

Construction

The power supply, transistor, and relay are mounted in the aluminum "Minibox" shown in Fig. 4. The "Minibox" measures 5¼" x 3" x 2⅛". This layout is not obligatory, however, since the circuit is not critical. The transistor must be protected from the heat of the soldering iron by firmly gripping each lead with a pair of pliers between the transistor body and the connection being soldered. The transistor can be mounted in a socket, if desired, to avoid any soldering problem. The positive lead of the photocell is connected to the emitter of the *RCA* 2N591 transistor.

Installation of the photocell and the light source will pose individual problems, depending on the type of phono arm and the arrangement of components within the cabinet. The beam of light is interrupted by a small piece of aluminum which extends from the back end of the phono arm. A *Fairchild* tone arm was used in the author's phonograph, as shown in Fig. 1. The back end of the *Fairchild* arm does not move up and down, allowing close spacing between the vertically mounted pilot light and the photocell directly above it. This circuit will permit the gap between the photocell and lamp to be as large as ⅝ inch. The photocell is mounted so that the turntable motor is turned off when the stylus approaches within 2¼ inches of the record center.

In cases where the back end of the tone arm moves up and down, the beam of light can be interrupted with a piece of aluminum mounted on a hinge, as shown in Fig. 2. The hinge will allow the arm to be raised at the end of a record when the aluminum extension is located between the photocell and the lamp.

A piece of vinyl tape was placed over the relay pole piece to minimize the difference between pull-in and drop-out current.

Conclusion

This photocell-operated phono turn-off has worked successfully with a collection of 150 records and has virtually eliminated the need for a mad dash to the phonograph to save the stylus before being ground to dust in the final record grooves. —30—

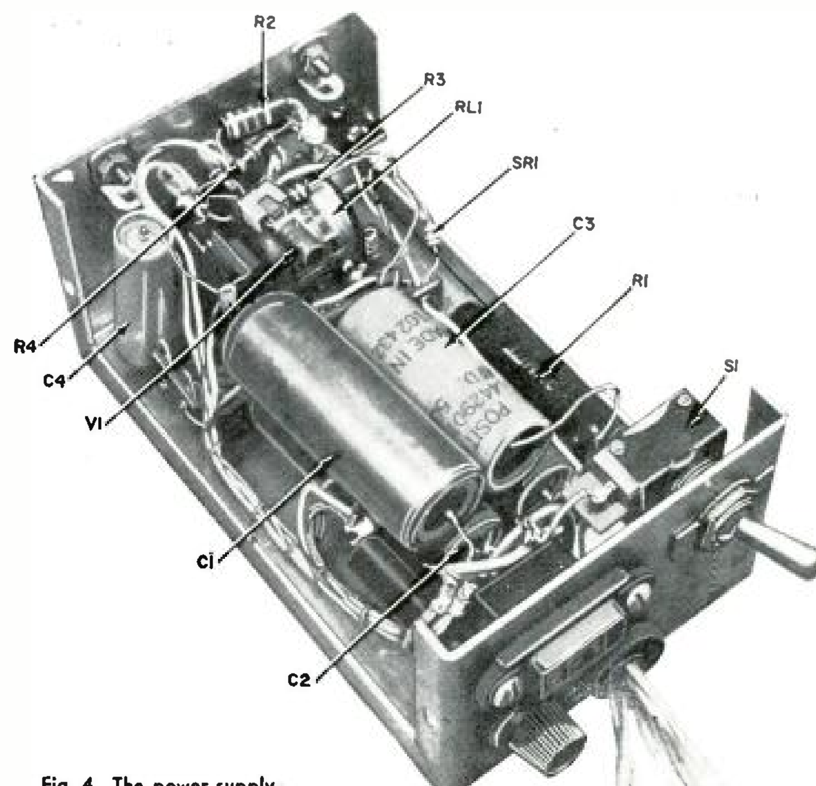
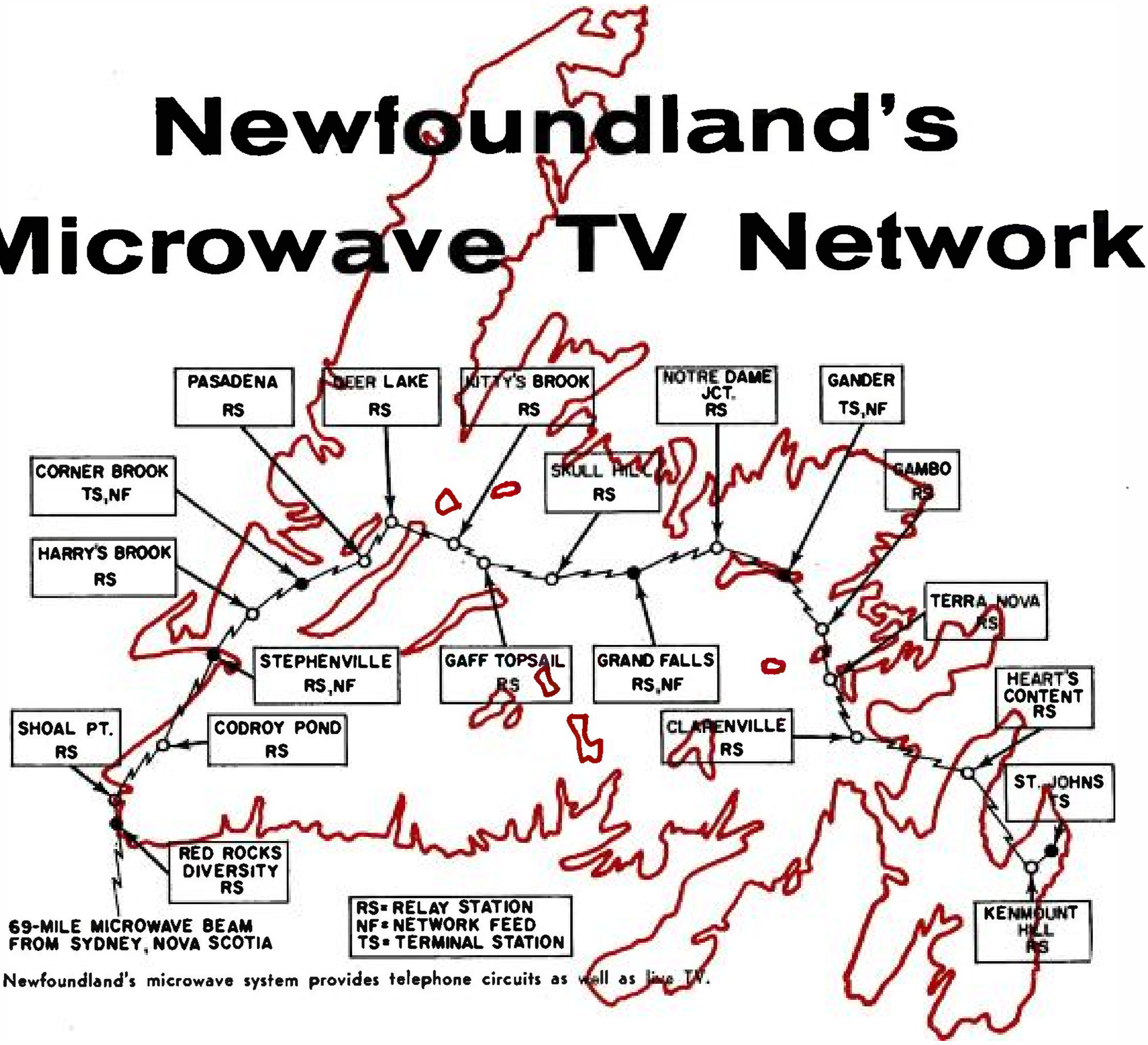


Fig. 4. The power supply, transistor, and relay are in this small chassis box.

Newfoundland's Microwave TV Network



Newfoundland's microwave system provides telephone circuits as well as live TV.

By **HUGH G. JARMAN**

Canadian Broadcasting Company's coast-to-coast TV network is now complete with the full operation of a $9-million microwave system spanning Newfoundland.

ONE day last summer a select group of television viewers—a group barely large enough to fill an average living room—gathered to watch a program which 10,000,000 of their fellow Canadians didn't see.

This was not a case of the *Canadian Broadcasting Corp.* catering to a chosen few but a group of *Canadian National Telegraph* engineers and the "show" they were seeing was one of their own devising—the final testing of the new microwave television network linking Newfoundland with the rest of Canada and completing *CBC*'s coast-to-coast system.

This key link was completed under a "crash" program and was actually ready ahead of schedule, enabling the *CBC* to cover the arrival of the Queen and Prince Philip in Canada on June 18, 1959. The original plans envisioned TV transmissions into Newfoundland by June but no one thought programs could be originated and transmitted to the rest of the country by that date.

The whole program had its origins back in 1955 when the *CBC* asked *Canadian National Telegraph* to submit a proposal, on a competitive-bid basis, for extending their network from Sydney, Nova Scotia to St. Johns, Newfoundland.

CNT was awarded the contract and immediately authorized its chief engineer to proceed with plans for the largest construction job in the organization's history. As many as 54 *CNT* engineers, as well as drafting and clerical employees, were directly involved in the project at one time or another.

The reader examining the route map accompanying this article might object that the engineers "took the long way around" in setting up the network and that they would have been better advised to cut straight across southern Newfoundland. Actually the final route was dictated by *CBC*'s specialized needs as well as by *CNT*'s own particular commercial requirements.

The string of repeater stations roughly parallels the *Canadian National Railway's* main line—an extremely important factor when it came to access for construction and maintenance. In addition, *CNT* has been able to provide 85 new telephone circuits using the same facilities on the microwave system as the TV network. This pre-planning makes provision for more than 800 telephone circuits which may be added as required.

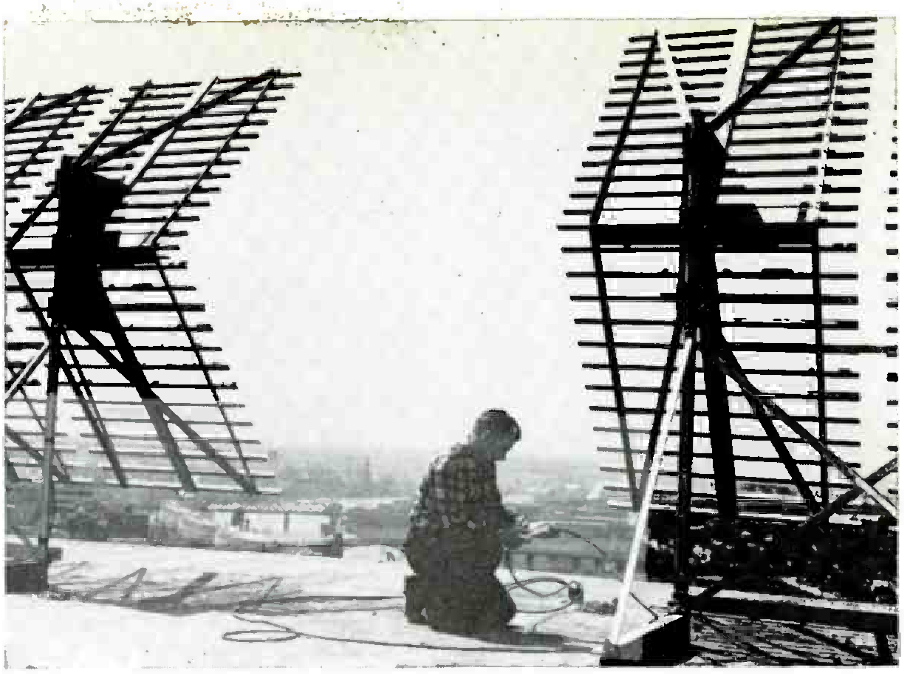
Newfoundland, with its relatively few miles of highway and with its hundreds of communities relying mainly on coastal steamers for transportation, is in critical need of more telephone, telegraph, and radio facilities than any other Canadian province.

The rugged Newfoundland terrain posed tough engineering problems all along the route. The first step was to have physical surveys and radio tests made by firms specializing in that type of work. Under the direction of *CNT* engineers, they plotted the best locations for each of the repeater stations —19 of them on the island proper and 2 on Cape Breton.

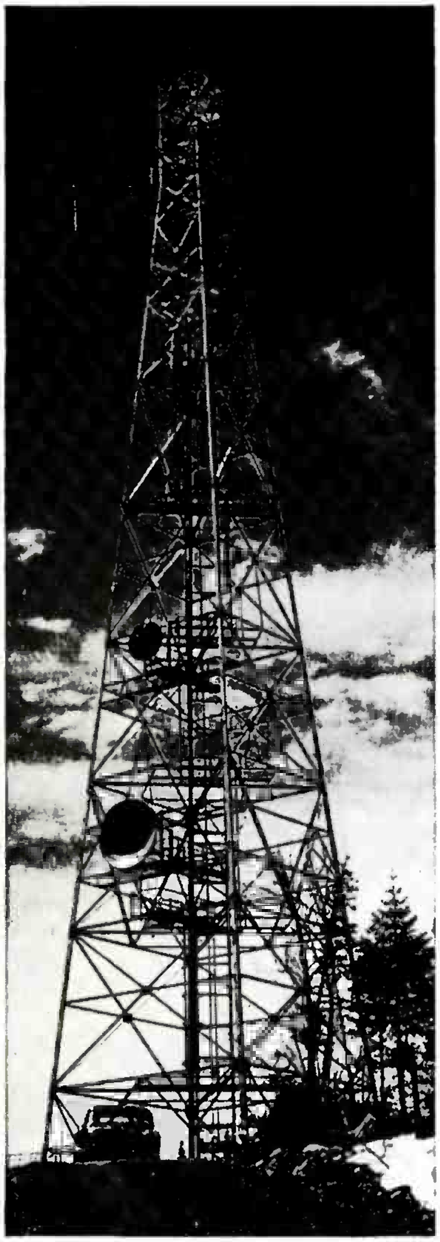
With the surveys completed, *CNT* started awarding contracts for the towers and buildings to house the repeater equipment and power generating machinery. It had been originally planned to make the construction a "summer project" but it developed into a "year-around" proposition right through what turned out to be one of the worst Canadian winters in 35 years.

With 35-foot snowdrifts and winds that howled at 135 miles an hour, the men worked under almost impossible handicaps. It was often necessary to chip the wind-blown ice off the towers before work could continue.

The distance between the microwave repeater stations varies from 3 miles to 40 miles overland with one hop covering 69 miles. The 69-mile link is the "water hop" over Cabot Strait, from Red Rocks, Newfoundland to Cape North, Nova Scotia—what is claimed to be the longest line-of-sight microwave link in the world. This "hop" is a source of special pride to the *CNT* engineers. Its successful operation was made possible by new techniques developed by *Standard Telephone and Cables Ltd.*, the supplier of the microwave equipment, using "space diversity" reception with phasing control.



These reflectors face a similar pair located some 69 miles across the open sea.



This hill-top installation at Deer Lake is typical of Newfoundland's repeater stations.

There are longer over-the-water hops in existence but they are spanned by the "scatter" technique which requires vastly more power than the line-of-sight system used by *CNT* and *CBC* in this installation. At each repeater station, parabolic reflectors, 14 feet in diameter and referred to as "dishes," pick up the weak (1 microwatt) incoming signal. Amplifiers then boost the signal to 5 watts and re-transmit it to the next station.

Since "line-of-sight" implies that the antennas on one tower are aimed directly at those of the next tower in the line, "panning the dishes" is a precise and tricky technique which must be followed in setting up the microwave link. The engineers had to first install the dishes on their respective towers, adjust them so that they faced each other, tilt and swing them as required by the test readings obtained, and finally lock the antennas into position.

During these adjustments, the engineers at each end kept in contact by means of two-way radio. When thought is given to the tight limits of tolerance that these adjustments required, the job of lining up the dishes over 69 miles of open sea must be regarded as a major engineering achievement. It is much as if you and a friend took dinner plates, stood seven miles apart with a lake between you, and got the plates to face each other exactly—all this while standing in the propeller wash of a Super Constellation while ice water was being sprayed on you.

The towers that support the dishes are designed to provide maximum rigidity as the quality of the transmitted signal would be seriously affected if there were any sway or vibration. Accomplishing this with a steel tower as much as 200 feet high is no minor-league engineering feat. These towers have been constructed to withstand winds of hurricane force and to resist rapid ice formation during severe winter storms.

The power generating equipment at the repeater stations is of various types depending on the accessibility or otherwise of commercial power. In each case, however, there is an elaborate standby installation to take over in the event that normal power fails.

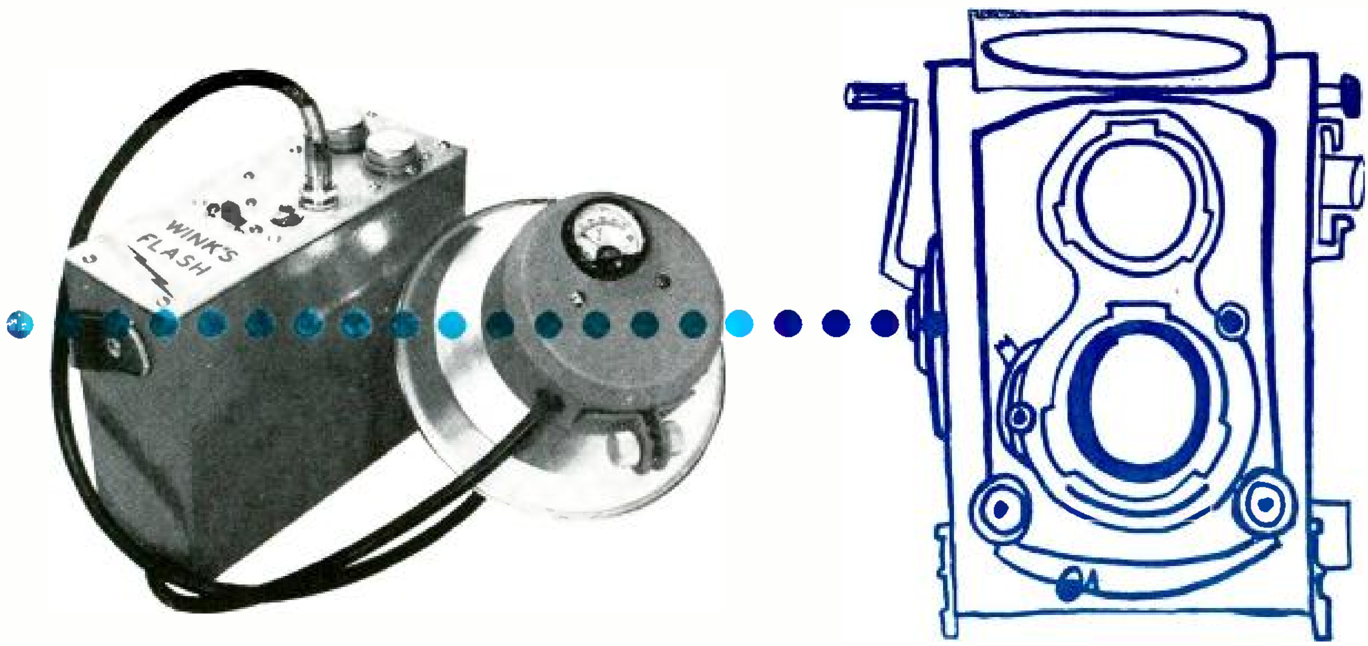
Obviously there must be no interruption of power irrespective of circumstances and, in addition, the voltage must be maintained within ± 1% of its normal value. In some instances where there is no commercial power available diesel-powered alternators are used.

Much of the generating machinery and control equipment used in the installation was designed and built by *CNT*'s engineering department. They have devised a scheme whereby the standby diesel engine is linked by a clutch and installed on the same shaft that connects the motor to the alternator. If power fails, the load is automatically picked up by the diesel.

Where commercial power is not available, the repeater station houses two complete diesel-driven generators —each one working week-in and week-out to supply current to the motor that runs the alternator. An electric clock automatically switches from one diesel set to the other every seven days. The idle set then serves as the standby unit.

In some cases it proved impossible to

(*Continued on page* 110)



Professional Electronic Photoflash

By **R. L. WINKLEPLECK**

Complete construction details on a well designed unit that is not cheap to build but is economical to operate.

ELECTRONIC photoflash has increased in popularity by leaps and bounds during the past few years. Many casual amateur photographers have their own outfits or are actively looking over the field and virtually every professional lights his pictures electronically.

There are several good reasons why this whirlwind change is taking place. Operating cost of an electronic unit is low—with no bulbs to buy. The flash-tube itself enjoys an almost unlimited life and the only operating cost is for batteries. The burst of light from ionization of gas in the flashtube is so brief that all action is frozen and there's little reason to worry about either camera or subject movement. The light itself has some interesting characteristics. It closely approximates daylight, which is of decided interest to the color photographer, and it has a peculiar soft quality which is especially attractive in portraiture. Further, it seems to have a greater depth of effective illumination in that less frequently than with bulbs is the foreground burned out and the background left dark.

These features are so compelling that seldom does a photographer go back to bulbs after once using electronic flash. But there's another side to the coin. Electronic flash units are expensive to purchase—just how expensive depends upon several factors. They use a lot of current since the electricity actually produces the light instead of merely starting the fire as is the case with flashbulbs. The electronic flash unit is both heavy and bulky when compared with a flashbulb unit but this is partially offset by the fact that there's no supply of bulbs to carry and dispose of in some dark corner when no one's looking.

If you use a case or two of bulbs a year electronic flash is definitely a good investment. The big question is the type of electronic unit to get and this is a really big question since there is a wide choice. There are actually hundreds of different commercial units on the market and they vary in many respects. The smaller, lighter, and cheaper units have limited light output. Some operate only from house current and these are usually less costly than those of similar output operating from batteries. The line cord restricts operations, however. Some units use high-voltage batteries and these are usually in the lower price range but they're heavy and the batteries alone may cost fifteen dollars. For dollar economy it's necessary to take a lot of pictures before old age overtakes them and makes replacement necessary.

Some electronic flash units are designed for the ultimate in compactness but this usually runs up the price.

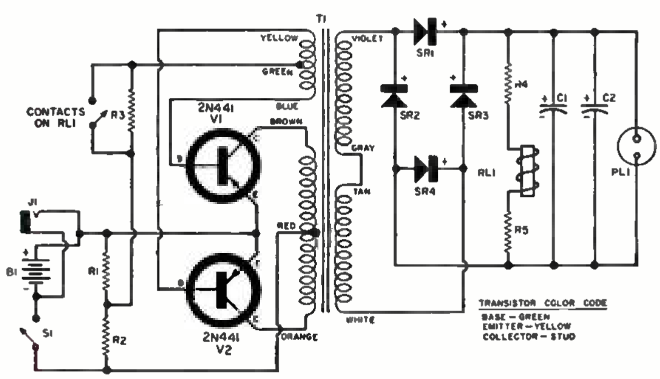


Fig. 1. Power supply circuit diagram for the photoflash unit. This highly efficient circuit charges the two 500-µf. capacitors to 450 volts in less than about fifteen seconds.

R_1—470 ohm, 1 w. res.
R_2—30 ohm, 10 w. res.
R_3—430 ohm, 1 w. res.
R_4—100,000 ohm, 1/2 w. res.
R_5—39,000 ohm, 1/2 w. res.
C_1, C_2—500 µf., 450 v. low-leakage elec. capacitor (Sangamo DCM or equiv.)
RL_1—5000 ohm d.c. relay (Potter & Brumfield RS5D)
PL_1—2-connector polarized female mike plug
S_1—S.p.s.t. slide switch
B_1—Four 1.2-volt nickel cadmium batteries (available from Esse Radio, 42 W. South St., Indianapolis 25, Ind., see text)
J_1—Phone jack
T_1—Toroid trans. (Sunair Electronics, Inc. Type 4-500-05. Available from manufacturer at Ft. Lauderdale, Fla., see text)
SR_1, SR_2, SR_3, SR_4—High-voltage silicon rectifier (International Rectifier 1N1706)
V_1, V_2—Power transistor (Delco 2N441)

Further, high light output and real compactness do not go hand-in-hand. Some of the battery units use rechargeable batteries; others use four to six conventional "D" cells. Some secure the necessary high voltage from low-voltage batteries with a vibrator and transformer and some of the newer ones use the more efficient transistor-voltage amplifier. Some units require a long time to recycle or recharge the capacitors for the next flash and some use a monitor or cut-off system to hold the unit in stand-by readiness without exhausting the batteries unduly. The more of the desirable features in a unit the more it costs but, very roughly, the retail price averages about one dollar a watt-second. A watt-second, incidentally, is a measure of the stored electrical energy and an approximate indication of the light output. The rating of any unit may be calculated from the formula $W\text{-}S = CV^2/2$ where C is the capacitance in microfarads and V is the voltage in kilovolts.

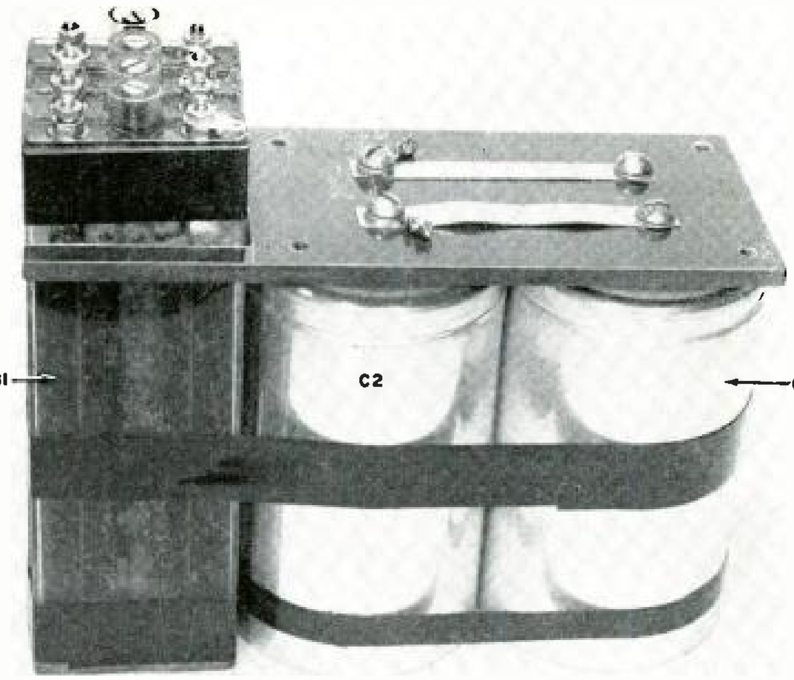
This thoroughly confusing introduction, which only touches on the problems associated with acquiring an electronic flash outfit, should make it clear that there can be no one unit which will best serve the needs of all photographers. Each person must decide what he wants most in an electronic flash and what he's willing to sacrifice to get it. Are you willing to carry more bulk and weight to get more light? Will you stand hitched to an electrical outlet to secure low first cost and economical operation? Will you put some effort of your own into a build-it-yourself electronic flash to have an outfit with all the characteristics you want at reasonable cost?

Circuit Features

If your answer to the last question is "yes" then this electronic flash outfit may be what you've been looking for. It's *not* cheap. You can buy any number of commercial units for less money. But it's a bargain if you want the many extras it provides.

Before going into details, here's a quick sketch of what's offered. An over-the-shoulder case about the size of a large binocular case contains the batteries, power supply, and energy storage capacitors. The lightweight flashtube, reflector, and firing circuit fasten to the camera. Lifetime rechargeable nickel-cadmium batteries supply the energy. The freshly charged batteries will operate the unit for over 150 flashes. They may then be recharged overnight with the charger. Operating cost is thus practically nil.

A highly efficient, heavy-duty transistorized power supply charges two 500-µf. capacitors to 450 volts in less than fifteen seconds. This is a whopping 101 watt-seconds. A relay in the power supply switches the current to standby when full charge is reached. This reduces the battery drain from 6-7 amperes while charging to 1 ampere or less. It eliminates the need to keep switching the supply on and off to conserve the batteries while waiting for a picture. All this is compactly arranged in the power unit.



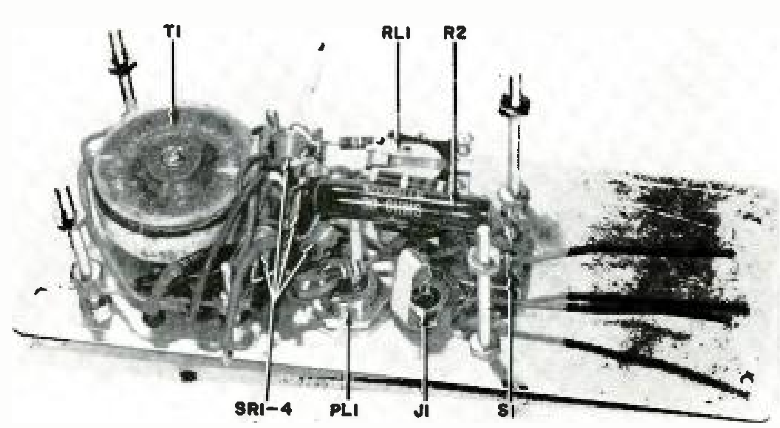
The two storage capacitors, C_1 and C_2, are mounted to a plastic panel by their studs. The four battery cells fit in a cut-out of panel and are taped in place.

Now, in the flash unit, a miniature voltmeter replaces the conventional ready-light. In most electronic flash outfits the ready-light goes on when the charge in the storage capacitor reaches about 375 volts. In some units it starts flashing slowly at this voltage and speeds up as the voltage increases. In others it goes on and stays on. It's extremely difficult to determine the exact charge from these neon lights and the voltage difference is important. For instance, in a unit rated at 100 W-S at 450 volts, the actual rating at 400 volts is only about 90 W-S, a reduction in light output which requires correction in color photography and makes an observable difference in black-and-white negative density. With the meter this possibility of error is eliminated.

In the flash head is a thyratron gas tube firing circuit. Conventionally, the flash tube is fired by discharging a capacitor through the camera flash contacts into the ignition transformer. The flow of current is not great but the shutter's sync contacts are small and they frequently fail after a comparatively short life. The thyratron reduces this current flow almost to zero. Some trigger tube firing circuits in the past have been somewhat erratic.

The tube used in this unit incorporates a second grid which makes possible a "keep alive" current and firing is very consistent. The tube offers two extra dividends. It eliminates the possibility of the slight but annoying shock received when touching the sync leads of the direct-fired circuit and it makes "slave" operation possible. Simply by inserting a phototube in the sync socket in place of the camera sync cord, the unit becomes a slave which operates in response to the flash from any other light source and offers all

Underside of aluminum top panel showing parts placement. The toroid transformer is mounted between plastic sheets and rectifiers are soldered to terminal strip.



the advantages of multiple lighting without interconnecting cords.

The reflector is a 6½-inch stepped, polished type which makes maximum use of the light from the flash tube. Smaller reflectors may be used but the correct reflector may easily double the effective light as compared with a small, poorly designed one. It doesn't make sense to go to so much trouble and expense to secure high light output only to have the wrong reflector waste it. Some commercial units would produce more useable light if their reflectors were larger.

Which brings us to the subject of performance claims for commercial units. Some statements are completely factual and may be substantiated by actual trial. There are unfortunately, however, no standardized testing methods among manufacturers and some of the claims can be charitably classified as gross exaggeration. Some of the claimed exposure times can only be duplicated with the fastest films, greatly overdeveloped. Recycling times reported are frequently achieved only with fresh batteries and they are generally computed only to the 375-volt level at which the ready-light goes on. Please, compare the performance of this unit with the *actual* performance of others and, if you decide to buy rather than build, test the commercial unit thoroughly. There are many good ones—and many others.

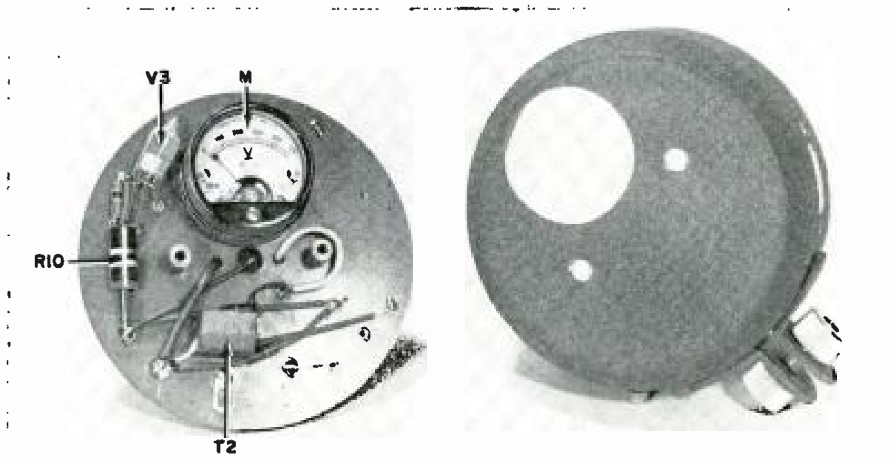
Construction Details

Construction of this electronic flash unit is not especially complicated. The real work is more mechanical than electrical in order to achieve convenience and compactness. The photographs show clearly the general layout. This may be changed as desired, keeping in mind only that the heavy current-carrying leads from the storage capacitors, C_1 and C_2, to the flashtube, V_4 (Fig. 2), must be relatively large. Number 18 stranded wire is satisfactory. The cord connecting the power supply with the flash head is ordinary #18 stranded, 600-volt rubber insulated electrical cord.

Fig. 1 is the schematic of the power pack. The transistors are comparatively new, heavy-duty *Delco* units rated at 13 amperes collector current. Smaller ones could be used but this would require changing the values of R_1 and R_2 and lengthening the recycling time. These transistors have the mounting stud collector leads common with the cases. They must be electrically insulated from the mounting panel with either mica or anodized aluminum washers so the considerable heat they generate can be easily dissipated. If you are unable to locate these *Delco* units the *Bendix* 2N677 or 2N677A transistor will be satisfactory.

The transformer is a special small toroid type made for this specific application. It can be small because of the 1000-2000 cps frequency of the circuit. It is available directly from *Sunair* for $16.00. It is designed for an output of 500 volts with a 4-volt input. The full-wave bridge rectifier uses four efficient high-voltage silicon rectifiers. These are conveniently mounted on a tie-strip and, because of crowding, have been dipped in Glyptol, an insulating varnish. The two energy storage tanks, capacitors C_1 and C_2, are low-leakage units and any other make designed especially for photoflash use would be satisfactory. Dropping resistors R_4 and R_5 are selected to pass sufficient current to cause the relay to pull in when the capacitor charge reaches 450 volts. Resistor R_8 across the normally closed contacts of the relay serves to reduce the transistor base current when the relay is actuated to an amount which will just maintain the 450-volt charge.

The four battery cells are surplus nickel cadmium units using a potassium hydroxide electrolyte which does not give off corrosive fumes on either charge or discharge. They are rated at 10 ampere-hours and their low internal resistance provides good voltage maintenance even at high discharge rates. They may be recharged at least 5000 times without capacity decrease. These batteries are available for $1.95 used or $2.95 new per cell and the new ones are probably the better buy.



One side of the mounting board in flash-head assembly with parts in place. It fastens to the back cover with two machine screws threaded into the spacer posts.

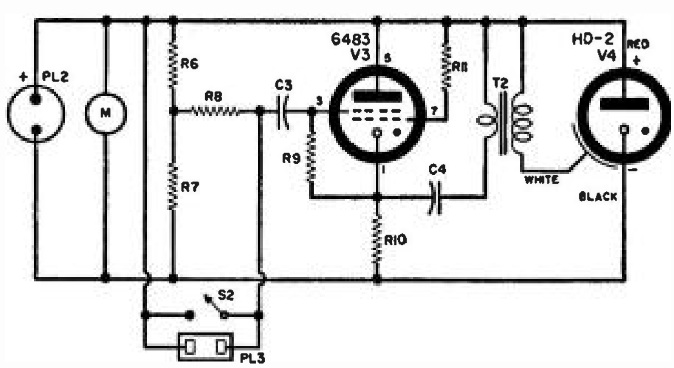


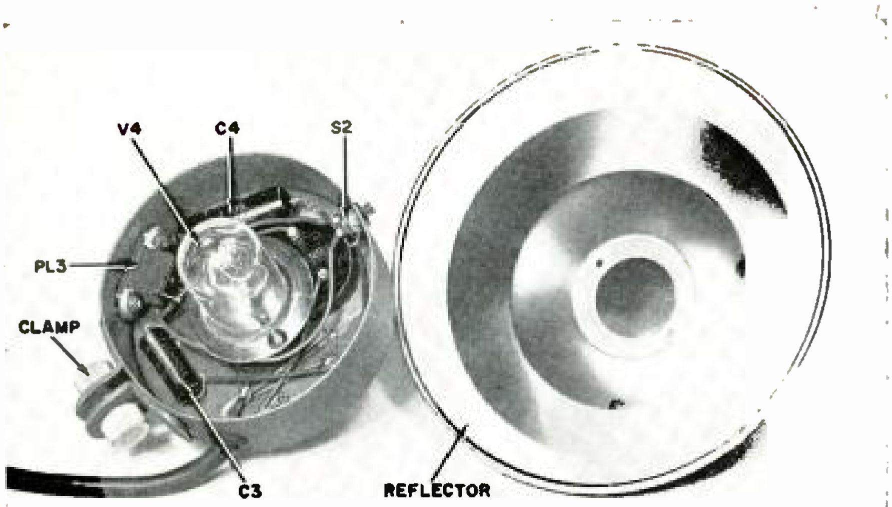
Fig. 2. Flash-head assembly circuit diagram for the photoflash unit. The rating of this professional-type unit is about 100 watt-seconds.

R_6, R_8, R_9—5.1 megohm, ½ w. res.
R_7—2.7 megohm, ½ w. res.
R_{10}—100,000 ohm, 2 w. res.
R_{11}—10 megohm, ½ w. res.
C_3—.01 µf., 200 v. tubular capacitor
C_4—.1 µf., 600 v. tubular capacitor
M—1½", 500 v. d.c. meter
S_2—S.p.s.t. miniature push-button switch ("open flash")
PL_2—2-connector polarized male mike plug
PL_3—2-prong electrical outlet ("sync connection")
T_2—Ignition coil (Amglo ST-25)
V_3—Thyratron tube (Sylvania 6483)
V_4—Flashtube (Amglo Type HD-2, see text)

The arrangement of these components is shown in the illustrations. A ¼-inch plastic panel supports the storage capacitors by their studs and is cut out to accept the four storage batteries which are taped in place. All the other components in the power supply are attached to the top panel of aluminum. The toroid coil is mounted in a small plastic sandwich just below the transistors. After these parts are all wired the aluminum panel is mounted across the tops of the batteries and 1½ inches above the plastic panel to which it is attached with four 2-inch machine screws. The completed unit then slips into a wood and Masonite open top box with outside measurements of 3" x 7¾" x 6¼". An over-the-shoulder leather carrying strap attaches to the box.

The power cord attaches to the power pack with a standard two-connector microphone plug so the flash head may be removed if desired. If you expect to always use these two units together and see no reason to separate them, this connector plug may be omitted.

You're working in close quarters when wiring the flash head assembly according to the Fig. 2 schematic but the *Amglo* flash tube, reflector, back



Mounting board in place in the back cover with cord, sync socket, and switch installed. Two screws holding the flash tube are removed to attach the reflector.

cover, and mounting board make possible a neat, compact unit. The reflector is identified as *Amglo* part AR-365 and the back cover and mounting board is R-65C. The 1½-inch meter has a plastic mounting flange which is filed off. Holes are cut in the aluminum housing and in the composition mounting board just the size of the meter and it is then cemented to the board which is completely wired before placement in the back cover. The various components are mounted on both sides of the board through holes drilled in it. Eyelets may be set in these holes and the components soldered to the eyelets. Holes are cut in the housing for the sync plug (an ordinary electrical outlet) and for the cord from the power unit (protected by a rubber grommet) and for the open-flash switch. These are not installed, however, until the completely wired panel is fastened in position. They are then put in place, wired into the circuit, and the reflector is attached.

As is especially important with any portable equipment, construction must be strong and all components firmly attached so they'll neither move around nor work loose. Keep in mind that you are working with comparatively high voltage and high amperage. Insulate the wiring and keep exposed connections as well separated as possible. *Above all,* handle this voltage with great respect. When a charged storage capacitor must be discharged it should be shorted with a power resistor of several hundred ohms. Shorting the terminals with a screwdriver will produce a rifle-like blast and a flash of fire as the tip of the screwdriver is vaporized. Accidental contact is always unpleasant and could be fatal. Please be careful.

Checking the Operation

When construction is completed recheck the wiring carefully. Are the soldered joints strong? Are there any places where high-voltage breakdown can take place? Are the polarities of batteries, transistors, capacitors, meter, and flashtube correct? Have you observed the toroid transformer color coding? If all is well turn the unit on and watch the voltmeter. Almost immediately the voltage should start climbing. This will be slow as the electrolyte in the big storage capacitors reforms and it may take a couple of minutes to reach 450 volts. At about this point the relay should be activated, placing R_3 in the transistor base circuit and slowing the charging rate and flow of battery current. If the rate of charge stops much before reaching 450 volts (and the batteries are fully charged) either R_4 or R_5 should be slightly larger and if the voltage continues to climb steadily without actuating the relay, the value of either of these resistors should be reduced slightly to increase current flow through the relay. After the relay operates the voltage should hold steady. If it drops slowly R_3 should be smaller. If it continues to climb increase the value of R_3.

With the unit charged, close the sync contacts either by connecting a sync cord to the camera shutter and operating the shutter or by pushing the open-flash button, S_2, on the top of the back cover. The gas in the flash tube should ionize with a burst of bluish white light of approximately one millisecond duration.

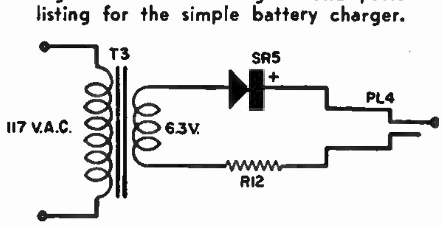
The reflector assembly may be mounted on the camera with a mounting bracket also available from *Amglo* (which permits tilting the reflector for bounce light) or with any suitable mounting bracket or shoe assembly. Standard sync cords are available at any photo shop. Remember this is synced for zero or "X" delay.

The exact exposure will depend on a number of variables and can best be determined by trial. To establish a flash number set up a picture representing average conditions—possibly a family group in the living room. Place camera and mounted flash a fixed distance from the subject and make a series of exposures varying *only* the camera aperture. Develop the film and print all negatives which show any image. The aperture at which the best picture was taken multiplied by the camera-to-subject distance is the flash number for this combination of camera, film, and flash unit. For instance, suppose the camera-to-subject distance chosen is ten feet and the print taken at f.11 is best. Your flash number is 10 x 11 or 110. Whenever you're taking flash shots just divide the distance into 110 to determine the correct lens aperture. Incidentally, if you do your own dark-room work, don't judge the quality of electronic flash negatives by usual standards. They may look thin and flat but they will usually print beautifully.

The manufacturer of the thyratron trigger tube recommends this firing circuit and advises that it may be used for "slave" operation simply by attaching a type 929 phototube to the sync outlet. The phototube should be mounted in a housing which directs the light to the sensitive area of the tube and a simple adapter may be made to permit plugging the tube into the sync outlet. Both plug and outlet should be marked so the anode of the tube is connected to the positive side of the outlet. For dependable slave

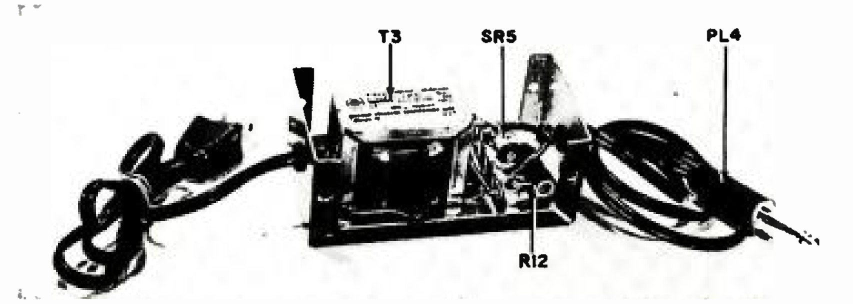
(*Continued on page* 77)

Fig. 3. Schematic diagram and parts listing for the simple battery charger.



R_{12}—5 ohm, 5 w. res.
SR_5—200 ma. silicon rectifier
PL_4—Phone plug (see text)
T_3—Fil. trans., 6.3 v. @ 1.2 amp. (Stancor P-6134 or equiv.)

Internal view of the charger showing component placement. The center-tap of the filament winding is unused. The phone plug fits the socket on panel of power unit.



an R-C substitution box

By **FRANK DAMICO**

A wide range of resistor and capacitor values is obtainable with simple construction and switching.

MANY VERSIONS of resistor or capacitor substitution boxes have appeared through the years, ranging from simple units employing a single-deck rotary switch with a dozen or so positions to cover the most popular component values, to those which use multiple switches for greater flexibility. Some units, in an effort to get the most value from the least amount of parts, employ numerous toggle switches in complicated circuits to supply a good many more component values than the basic number used in the unit. These, however, become rather involved. Construction cost, together with the difficulty of operation, often detract from their value.

The author's version of "the most for the least" (Fig. 2) was inspired by the need for a wide-range unit that was to be used, for the most part, in audio experimentation. Every effort was made to supply a wide variety of resistor and capacitor values for the least number of parts, with the switches an important part of the consideration. Complicated switch tossing was also minimized.

The unit employs twelve pairs of resistors, five pairs of tubular capacitors, and two pairs of electrolytics for a total of thirty-eight components. By using a multiplier switch (S_2 in Fig. 1) to connect these basic pairs in series, in parallel, or make them available as single units, a total of fifty-seven resistor and capacitor values is obtained, which is 50 per-cent more than the number of units involved.

Each basic pair provides three values. For example, the pair of 10-ohm resistors, R_1 and R_2, affords 5 ohms, in parallel; 10 ohms, using one of these alone; and 20 ohms, in series. The pairs were chosen carefully to meet two requirements. To begin with, there is no duplication of values. In addition, "even" values were chosen for the original components so that the values obtained through series or parallel connections would be immediately obvious without resort to calculations. The overlap is such that the total of available resistances and capacitances is spread out well over a wide range. Thirty-six resistance values are spread out from 5 ohms to 20 megohms. Twenty-one capacitor values range from 50 μμf. to 100 μf.

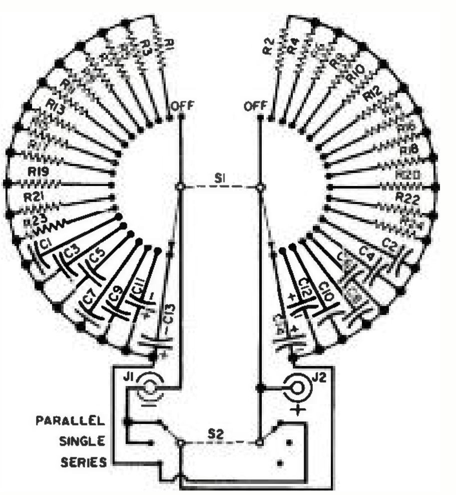
A two-gang, 20-position switch that will handle 19 positions plus one "off" position (S_1) selects basic pairs of components. S_2 determines the manner in which the selected pair is used. Fig. 3 indicates how this is done for each of the three possibilities. Capacitors have been used here to illustrate an important point. Where polarity is important, as with electrolytics, the capacitors are always connected to each other and to the output jacks in such a way that no problems arise. J_2 is always the positive end of the capacitor or pair of capacitors, and J_1 is always the negative end of any combination.

Due to the differences indicated in Ohm's Law between connecting a pair of resistors in parallel (or in series) and connecting a pair of capacitors in parallel (or in series), the user must remember that two positions of S_2 will work one way with one type of component and another way with the other type. In the series position, resistor pairs are added up, but the value of a pair of capacitors is half that of one taken alone. In parallel, capacitor pairs provide the value of both units added together while resistor pairs become half the value of one unit. To avoid confusion, it would be possible to mark three concentric circles of values around the external knob for S_1, one circle for each position of S_2. However, the user is not likely to find this necessary.

Construction

Putting the unit together is fairly simple, with most of the builder's time being devoted to wiring selector S_1. The placement of parts is shown in Fig. 4. The unit was built into a *Bud* "Minibox," 8 inches by 6 inches by 3½ inches. The big switch, of course, is wired first. All resistors and the smaller capacitors (C_1 through C_8) have one end connected directly to switch terminals. Of these, all even-numbered components (R_2, R_4, etc.) each have one lead wired

Fig. 1. The main switch, about which the unit is planned, is special but not highly expensive. An added multiplier switch increases the range of values.



R_1, R_2—10 ohm, 1 w. res.
R_3, R_4—100 ohm, 1 w. res.
R_5, R_6—150 ohm, 1 w. res.
R_7, R_8—1000 ohm, 1 w. res.
R_9, R_{10}—1500 ohm, 1 w. res.
R_{11}, R_{12}—10,000 ohm, 1 w. res.
R_{13}, R_{14}—15,000 ohm, 1 w. res.
R_{15}, R_{16}—100,000 ohm, 1 w. res.
R_{17}, R_{18}—150,000 ohm, 1 w. res.
R_{19}, R_{20}—1 megohm, 1 w. res.
R_{21}, R_{22}—1.5 megohm, 1 w. res.
R_{23}, R_{24}—10 megohm, 1 w. res.
Note: All resistors to be ± 5% or ± 10%.
C_1, C_2—.0001 μf., 600 v. capacitor
C_3, C_4—.001 μf., 600 v. capacitor
C_5, C_6—.01 μf., 600 v. capacitor
C_7, C_8—.1 μf., 600 v. capacitor
C_9, C_{10}—.5 μf., 400 v. capacitor
C_{11}, C_{12}—20 μf., 450 v. elec. capacitor
C_{13}, C_{14}—50 μf., 450 v. elec. capacitor
S_1—Two-gang, 20-pos.-per-pole, non-shorting rotary switch including "Off" position (JBT MS-20-2)
S_2—D.p. 3-pos. single-gang, non-shorting rotary switch (Mallory 3223J or equiv.)
J_1, J_2—Phone tip, banana, or all-purpose jack (1 red, 1 black)
1—Dial plate (optional, marked "Off" through 19, JBT EP-19)
1—Terminal board (for C_7, C_8, C_9, C_{10})
1—Insulating board (for C_{11}, C_{12}, C_{13}, and C_{14} if twist-prong electrolytics are used)
1—8" x 6" x 3½" "Minibox" (Bud CU-2109)

to a terminal on the rear deck (the one nearest the viewer in Fig. 4), and all odd-numbered components each have one lead connected to a terminal on the front deck.

Wire the rear deck first, making the connected component leads as short as possible, with the uncut free leads pointing straight back toward the rear wall of the box. The free ends are then soldered around a "ring," formed from a length of bus bar or heavy copper wire, after trimming these ends as neatly as possible. The front deck is then wired in the same manner, except that it will be necessary to space the bodies of these units away from those on the rear deck.

This should be done by forming a right angle with the lead of each component connected to the front deck. This lead, trimmed to about 1¼ inch, is first soldered with the component pointing out from the switch. The lead is then bent at about ¾ inch from the connection so that the body now points toward the rear wall, parallel to the matching component on the rear deck. These free ends are also trimmed and soldered around a ring, as was done with the rear-deck units on the inner ring.

The rings can be formed by bending the bus bar or heavy wire around a glass jar or round can of suitable diameter. The ring for the rear-deck units is 3 inches in diameter, and the outer front-deck ring is 3¼ inches. The free ends of these rings can be joined to complete the circles by forming a spring or spiral made up of #20 solid wire. Simply slip the spring over the free ends and solder. The two spirals can be seen above C_{11} and C_{13} (Fig. 4).

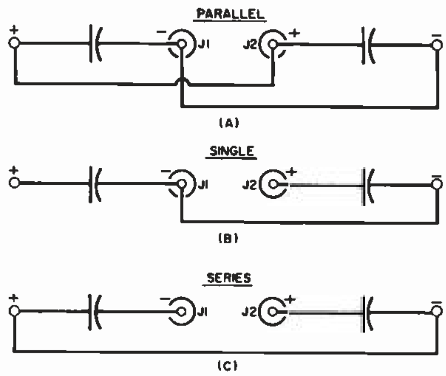


Fig. 3. How component pairs are used in each of three multiplier-switch positions. Polarity of electrolytics is considered.

C_7, C_8, C_9, and C_{10} are mounted on the terminal board seen above S_1. C_{11}, C_{12}, C_{13}, and C_{14} are mounted below S_1 on an insulating board. Twist-prong electrolytics were used without insulating wafers, and so this type of mounting was dictated. If tubular electrolytics are to be used, the board can be dispensed with and the capacitors can be strapped to the bottom of the box.

A study of the schematic will show that the box cannot be used as a common negative for the electrolytics. The output jacks (J_1, J_2) should not only be color coded or otherwise marked to indicate polarity, but should also be insulated from the box. All wiring involving the capacitors mounted on the two boards is completed on the boards before the latter are mounted in their respective positions. Flexible leads brought out from the boards are connected to appropriate points on S_1, S_2, or the rings. The polarity of the electrolytics and the larger tubulars must be observed.

The resistors used were one-watt units of 5 per-cent or 10 per-cent tolerance, but should be reasonably matched on an ohmmeter or bridge. The electrolytics are 450-volt units, and the .5-μf. capacitors have a 400-volt rating. All the others are 600-volt units. The .0001-μf. units may be mica or tubular (the author used micas).

If all new construction is attempted, it would be wise to purchase the smallest capacitors available, such as *Sprague* "Midgets" for the electrolytics and *Cornell-Dubilier* "Cubs" for the others. *Ohmite* "Little Devils" are a good choice for the resistors. The use of small-sized components will make construction easier if the recommended box is used—or could result in a more compact unit if desired.

The method of calibrating S_1 used in the author's version (Fig. 1) need not be followed. White bristol paper cemented on a round plate could be employed with the values marked in ink. Or else, a dial plate is available for use with this switch, marked "Off" through "19," and a small chart could be cemented somewhere on the box showing the basic value at each rotation of the switch.

As noted earlier, this substitution box was originally planned with audio work in mind. However, its broad and comprehensive coverage has made it just as valuable in every other application to which it has been put. —30—

Fig. 2. A pair of connector jacks and only two controls, for choosing any of 57 values, keep the box functionally simple.

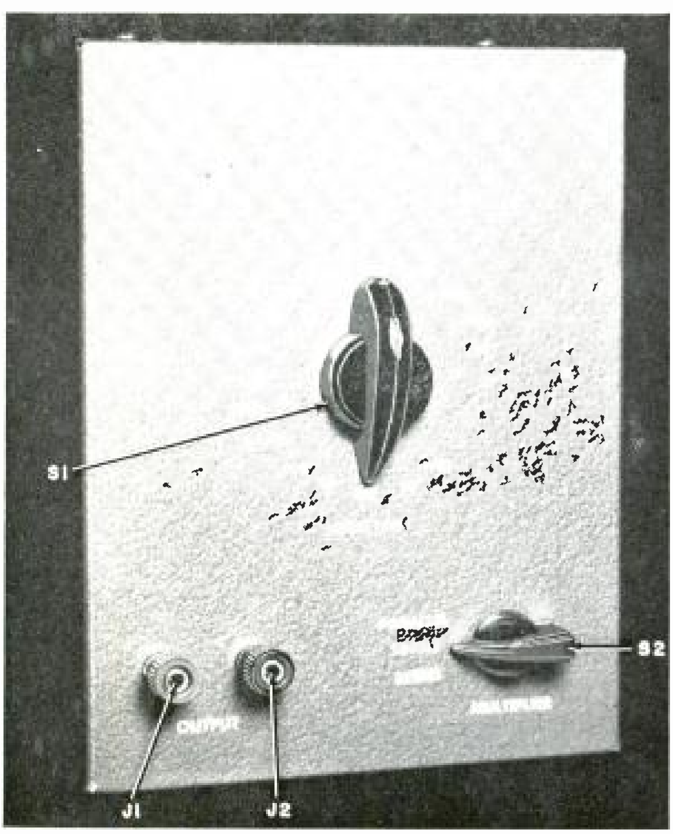
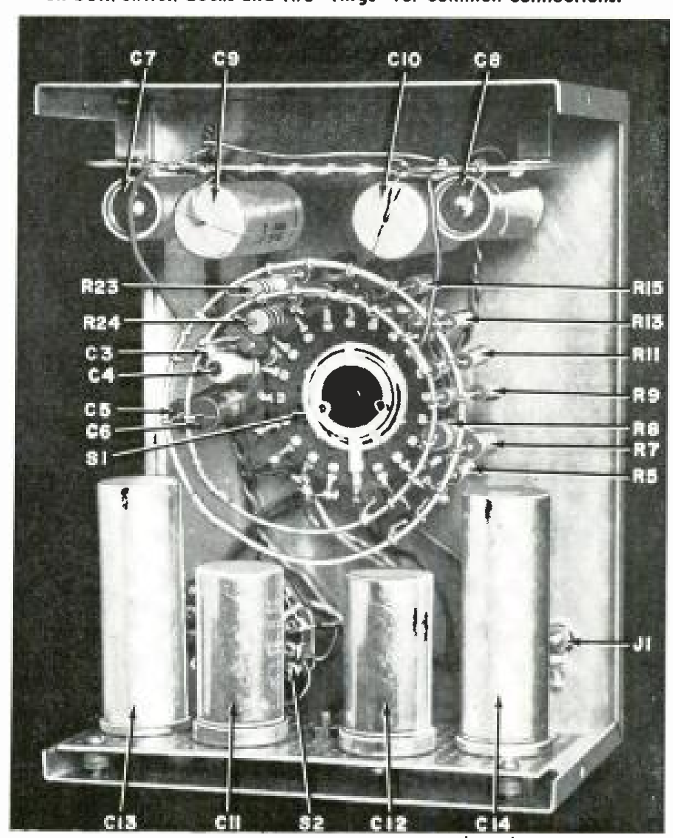
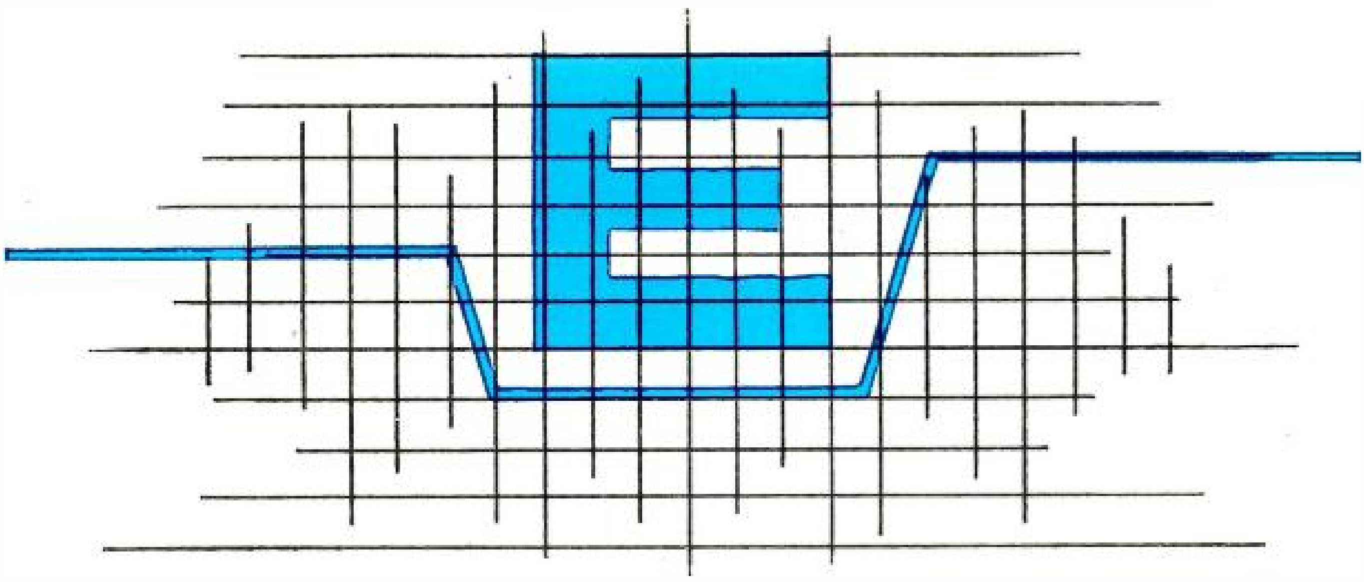


Fig. 4. Rear view shows relationship between component pairs on both switch decks and two "rings" for common connections.





Voltage Regulation for Transistors

By **KENNETH BRAMHAM**

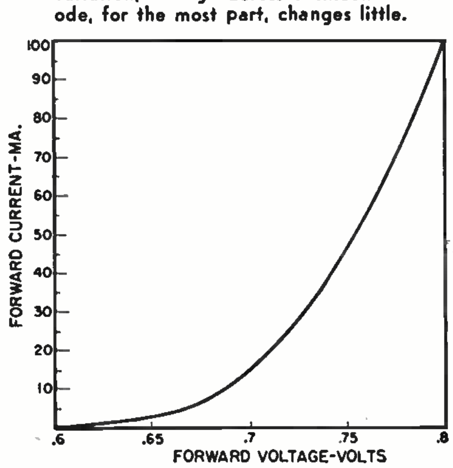
Especially useful with supplies for transistorized gear, inexpensive semiconductor diodes may be used for close stabilization of other low-voltage sources.

THE ABILITY to design a simple voltage regulator circuit is often useful to the service technician when he is working on transistorized communications or industrial equipment. Service problems tracked down to a varying supply voltage, or to battery-operated equipment to be converted for power-line operation, are both instances where the ability to add voltage regulation is useful. For the technician building his own transistorized test equipment or the ham turning to transistorized gear, a few basic voltage-regulator circuits are essential. The type to be described fills a need for low-cost regulators in the .3- to 3-volt range, which includes the bias voltage of many transistor circuits.

Why this special need for regulation with transistor circuits? The transistor is a current-drawing device operating at relatively low voltages. Wide variations of current drain often occur in normal operation, and cause widely varying voltage drops across the internal resistance of the supply. These voltage changes are particularly bothersome in the case of circuits using a fixed bias supply, where the relation of bias to "B" voltage must be maintained within narrow limits if the circuit is to work as intended.

A voltage-reference component is, of course, the first requirement of any regulator circuit. For our low-voltage regulator, the silicon junction diode will be used as a reference element, and a brief review of its characteristics is in order. The junction diodes so familiar to the service technician as power rectifiers have the characteristics of low resistance in the forward direction and a very high resistance when the polarity of the applied voltage is reversed. Each diode type has certain limitations as to the maximum current in the forward direction and maximum voltage in the reverse direction. If the forward-current rating is exceeded, the diode junction overheats and is destroyed; if the inverse voltage rating is exceeded, the normally very small reverse current, due to secondary emission in the junction, starts to increase and creates an "avalanche" of increasing current which, in turn, overheats and destroys the junction. The "perfect" diode would have infinite resistance in the inverse direction and no resistance in the forward direction. In short, it would therefore have no limitations as to current and voltage.

Fig. 1. For a given range of current variation, voltage across a silicon diode, for the most part, changes little.



A voltage-current curve for a typical silicon rectifier is shown in Fig. 1. Here we see that a change in current through the diode from almost zero to 100 milliamperes results in a change in the voltage drop across the diode from .6 to .8 volt, but that this change in voltage is not linear. (The linear voltage change across a pure resistance would be a straight line.) It is possible, however, to use a small part of the voltage-current curve to give a reasonably small voltage change for a current change of, say, 20 or 30 ma. This suggests the use of a semiconductor diode as a voltage-reference element of sufficient accuracy for our purpose, although not of the accuracy expected with a higher-cost zener diode manufactured specifically for voltage-regulator service.

And now, another brief review—the basic principles of voltage regulation. Voltage variations across a load originate in two ways; through changes in voltage of the source (which may be

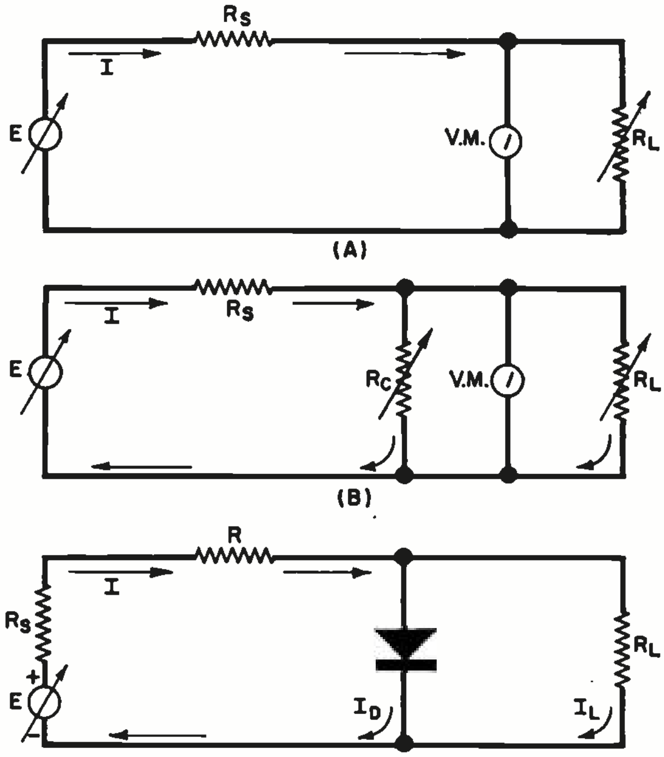


Fig. 2. Variations in the output voltage of a power supply (A) can arise either because of changes in source voltage E or in the load R_L, producing changes in the drop across the internal resistance of the supply, R_s. It is possible to adjust for such changes (B) by inserting a potentiometer, R_c, and resetting it manually. For automatic, quick-acting regulation (C), resistor R is put in series with the load and a regulating diode is put across the load. Fig. 1 shows the voltage-current characteristic of the diode making this possible.

either a rectified a.c. supply or a battery), and through changes in the resistance of the load (causing a change in voltage drop across the internal resistance of the source). A simplified, equivalent circuit of a typical power supply and load is given in Fig. 2A where the voltage source, E, is shown variable, representing either an a.c. power line subject to fluctuations or a battery that deteriorates with use. The resistor, R_s, represents the power-supply components in the case of an a.c. supply, or the internal resistance of a battery. The load resistor, R_L, represents the circuit being supplied, and is shown variable to account for changes in current drain. If either of the two variable components is changed, a change in voltage across the load will result.

Our equivalent circuit is shown modified in Fig. 2B to include a variable resistor, R_c, across the load. It is now possible to compensate for changes in source voltage and load resistance by adjusting R_c, thus regulating the current through R_s and the voltage drop across it, to maintain a constant voltage across the load. A manual compensation circuit of this type would hardly be practical for actual use, as it would require constant attendance and would depend upon the voltmeter's efficiency and operator's reaction time for its operating speed. Obviously, we need some form of *automatic* compensating resistance to replace both meter and operator. The silicon junction diode is the component we will use.

A very simple voltage regulator circuit is shown in Fig. 2C consisting of a regulating resistor R (which is much greater than the source resistance) placed in series with the supply, and a silicon rectifier diode across the load. Variations in current through the diode, caused either by supply-voltage changes or by the effective resistance of the load (in parallel with the diode), will produce voltage variations in accordance with the voltage-current curve of Fig. 1. By limiting the diode current to a range from, say, 10 to 20 ma., we are able to limit the voltage range from .69 to .71 volt, or .7 volt ± 1.43 per-cent. This tolerance is more than adequate for the majority of applications encountered by the technician. (In theory, we have one other variable besides current and voltage; this is the temperature of the silicon junction, which can be ignored in most service jobs.)

Now let us apply this regulator circuit to an actual case. A regulated supply is needed to provide 1.4 volts to a transistor circuit from a 117-volt a.c. supply, replacing a zinc-carbon (1.5-volt) or mercury (1.34-volt) dry cell. The load current is known to vary from 5 to 10 ma., while the a.c. supply is known to vary from 95 to 120 volts. A 6.3-volt filament transformer is a stock component, as are silicon rectifier diodes. One diode and a resistance-capacitor filter along with the transformer can be used to make a half-wave rectifier with a d.c. output of 3.5 to 4.5 volts when connected to our 95- to 120-volt supply. From Fig. 1 we see that a diode conducting 15 ma. will have .7 volt across it: Two diodes in series will therefore give the required 1.4 volts. The completed circuit is shown in Fig. 3; all that remains is to calculate the value of R, from the following formula:

$$R = \frac{V - V_o}{I_L + I_d}$$

where, V = mean rectified supply voltage; V_o = desired output voltage; I_d = diode current; and I_L = mean output current.

Thus,

$$R = \frac{4 - 1.4}{.0075 + .015} = 116 \text{ ohms.}$$

The closest standard value likely to be in stock would be 100 ohms, and this is the value we choose for R.

Now the worst possible conditions of voltage and current will be 4.5-volts d.c. with a load of 5 ma., and 3.5-volts d.c. with a load of 10 ma. In the first case, the drop across R is measured as 3.1 volts. Thus, by Ohm's Law, current through this 100-ohm resistor is 31 ma. Since I_L has been given as 5 ma., this leaves 26 ma. as current through the diode. Fig. 1 shows that, with this current through it, the drop across one diode will be about .74 volt—or 1.44 volts through two of them.

With 3.5 volts from the supply and 10 ma. drawn by the load (the other extreme), 2.1 volts are measured across R, indicating 21 ma. total current. Thus I_d is 11 ma., the drop across one diode (Fig. 1) is .69 volt and, across two, 1.38 volts.

This type of circuit is not limited to silicon diodes. The germanium junction diode may be used, and with much greater accuracy than the silicon diode, but the voltage across a germanium junction is in the region of .3 volt and circuit values must be calculated around this level. The combination of a silicon and a germanium diode in series can be convenient when a 1-volt reference is needed. In fact, various combinations permit flexibility in establishing different regulated voltages.

However, it is not practical to apply this circuit, using semiconductor diodes, where output voltage requirements are so high as to need more than three or four diodes. The reason is that the cost then exceeds that of a regular zener diode manufactured specifically for voltage regulation. The technique can, however, be used with good results in such low-voltage applications as the transistor bias supply and other transistor circuits. -30-

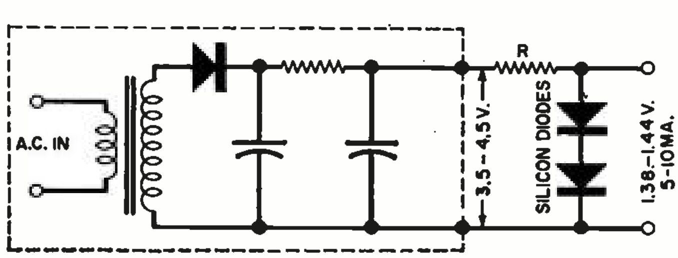
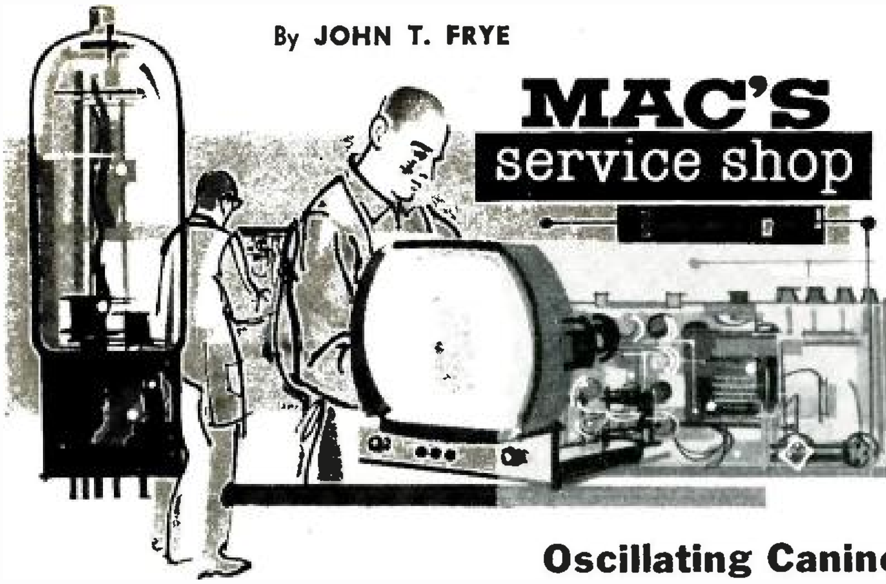


Fig. 3. Silicon (or germanium) diodes can be used in series to obtain a stable output at a desired voltage from a relatively unstable source, such as the power supply shown in broken lines.

By JOHN T. FRYE

MAC'S service shop



Oscillating Canine

BARNEY stopped short in the door of the service department as he heard a droning voice, mixed in with slow-speed code, emanating from a three-way portable sitting on the end of the service bench.

"What station's that?" he demanded of Mac, his employer, who was looking down at the receiver with a smile of satisfaction.

"It's the aviation range station at Center City operating on a frequency of 266 kilocycles," Mac explained. "This station puts out a continuous weather report for planes in this general area. The reports are on tapes that are changed at frequent intervals. That 'dit-dah, dit-dah, dit-dah' in the background shows we're not in the center of the beam."

"Just a minute, just a doggoned minute!" Barney interrupted. "That's a broadcast receiver, pure and simple. How come it's pulling in that low-frequency station—and why is it?"

"The receiver belongs to Mr. Smith, owner of the Bon Ton Department Store. He is a flying enthusiast with his own plane. As such, he likes to keep an eye on the weather, even when he is down at the office. When conditions are particularly good, he can sneak off for an hour or so of flying. With this in mind, he asked me if I could convert one of the many broadcast receivers he had lying around the house so that it would pick up this weather report.

"At first I shied away from the idea. I was thinking in terms of trying to make the broadcast receiver tune the whole low-frequency band from 200 to 550 kilocycles; and you know what a complete re-doing of the front end that would take; then, too, I was concerned with the idea an aviation weather receiver should be very, very dependable because the flier's life might depend on it. But Mr. Smith explained he only wanted to receive just this one station and that the receiver would be used only in his office or at his home. His plane was fully equipped with all sorts of standard aviation radio equipment. This put a different light on the project, and I agreed to see what I could do.

"Actually the solution turned out to be ridiculously simple. After putting the receiver into good operating condition—it needed new filter capacitors—I had only to pad the oscillator and antenna circuits down to where the 266 kc. station could be picked up with the receiver dial sitting on 600 kc. I picked this dial setting so as to have a little tuning leeway and yet be able to use most of the capacity in the receiver's tuning capacitor.

"For padders I used the double compression trimmers out of a discarded i.f. transformer. These had a measured maximum capacity of about 200 μμf. each; and one was more than enough to lower the oscillator frequency from 1056, where it sat to tune in 600 kc., down to 722 kc., where it had to be to produce a 456 difference beat with 266 kc. However, since you have to quadruple the capacity of a parallel tuned circuit to halve the resonant frequency, I knew I'd have to use considerably more extra capacity than the 200 μμf. available in the other trimmer to lower the frequency of the antenna circuit from 600 to 266 kc. A little cut-and-try procedure, using the grid-dip oscillator to keep track of resonance, revealed that a .001-μf. silver mica in parallel with the 200-μμf. trimmer and the set's tuning capacitor did the job in fine shape."

"Having to listen to that program very long would drive me nuts," Barney said as the taped voice, punctuated with the slow code, droned on and on. "It would be easy, though, to use a d.p.s.t. switch to cut out the extra capacities and restore ordinary broadcast reception."

"Yes, and I mentioned that to Mr. Smith; but he said it wasn't worth the trouble to him. He already had lots of broadcast receivers," Mac answered.

"Well," Barney said with a deep sigh, "you've solved your problem, but I've still got mine."

"You mean you're still working on that little transistor set you started on this time yesterday?"

"Yes, and at the rate I'm going, I'll be still working on it a week from now. That little monster is a real live dog."

"The only trouble is that it oscillates, isn't it?"

"Oh yes, that's the *only* trouble," Barney answered sarcastically; "but I've got news for you: running down oscillation in a printed circuit transistor receiver is a lot different than hunting the same difficulty in a tube receiver."

"From what I've heard, it's an r.f. or i.f. rather than an audio oscillation."

"True. You get a heterodyne whistle on every station."

"I suppose you started by changing the battery."

"Right. I'm hep to the fact that some of the cheaper receivers depend on the low resistance of a good battery to tie signal-carrying return circuits down to ground. When the battery is partially exhausted, its internal resistance goes up and permits coupling between some of the return circuits that can cause oscillation. A new battery made no difference."

"Then I suppose you paralleled all the decoupling capacitors, one at a time, with a unit you knew to be good."

"Yes, and since this is a well-designed receiver, there were several of those capacitors. I had to remove the speaker to get at some of them, but I never missed a one. I'll stake my reputation as a hot-shot electronic technician that there are no open capacitors."

"At the moment you wouldn't be putting up much," Mac said with a wry grin. "About next, I imagine you checked the alignment."

"Your crystal ball is clear today! I went over the alignment two or three times, and there is nothing wrong in that department."

"How about the possibility that the printed circuit board was cracked so as to produce a break in the grounding lead? That would leave part of the grounded circuit floating."

"I thought of that, too," Barney said triumphantly, "and I jumpered across various portions of the ground bus. It's OK."

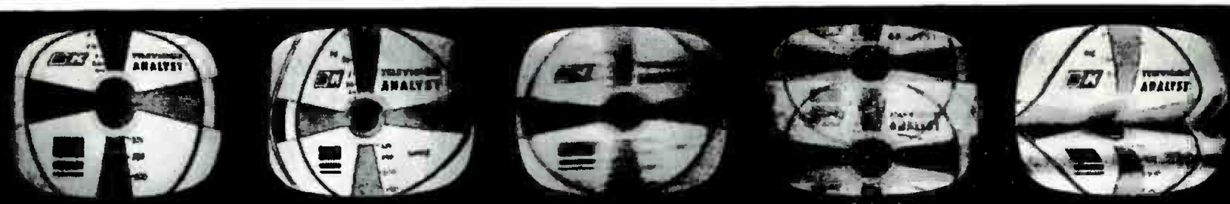
"H-m-m-m-m, how did a careful voltage check turn out? Maybe some of the bias resistors have changed value and altered stage gain."

"All voltages are right on the button, but I did not stop there. I pulled all the transistors from their sockets and did a complete resistance check. The resistances at all check points provided in the service data are well within five per-cent of values specified."

"This is getting interesting," Mac said as he reached over and picked up the circuit diagram. "Looking at this, I can see one very nasty possibility: the i.f. stages are neutralized, and if one of those neutralizing capacitors opened up, or if this resistor in series with a neutralizing capacitor opened up, the stage would oscillate quite merrily."

"You've got to do better than that," Barney gloated. "I used a little variable trimmer capacitor in place of each of those little ceramic neutralizing capacitors and varied it back and forth

(*Continued on page* 92)



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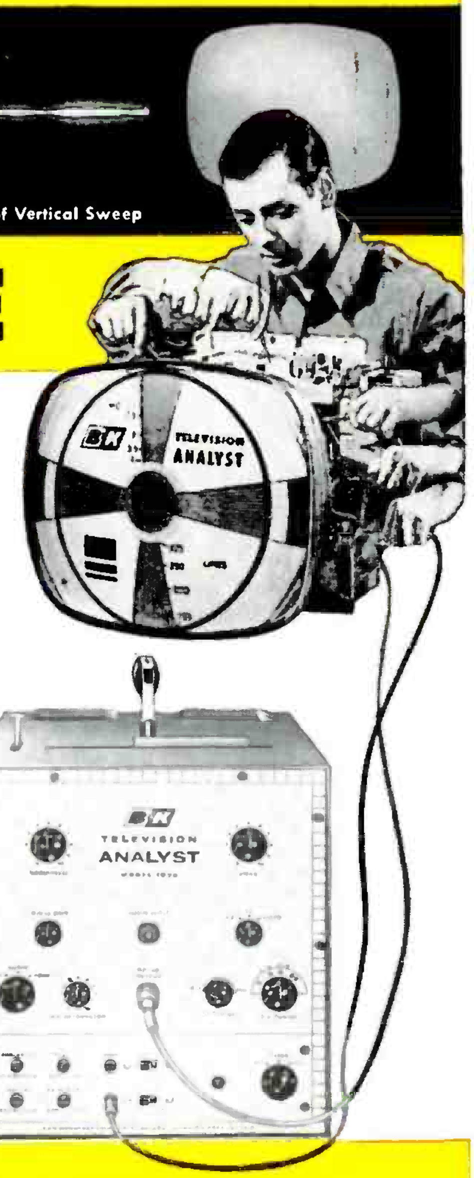

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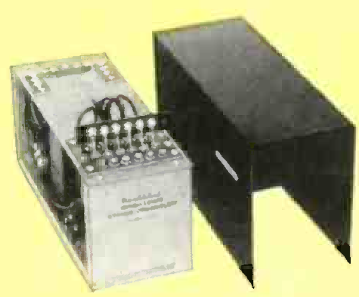

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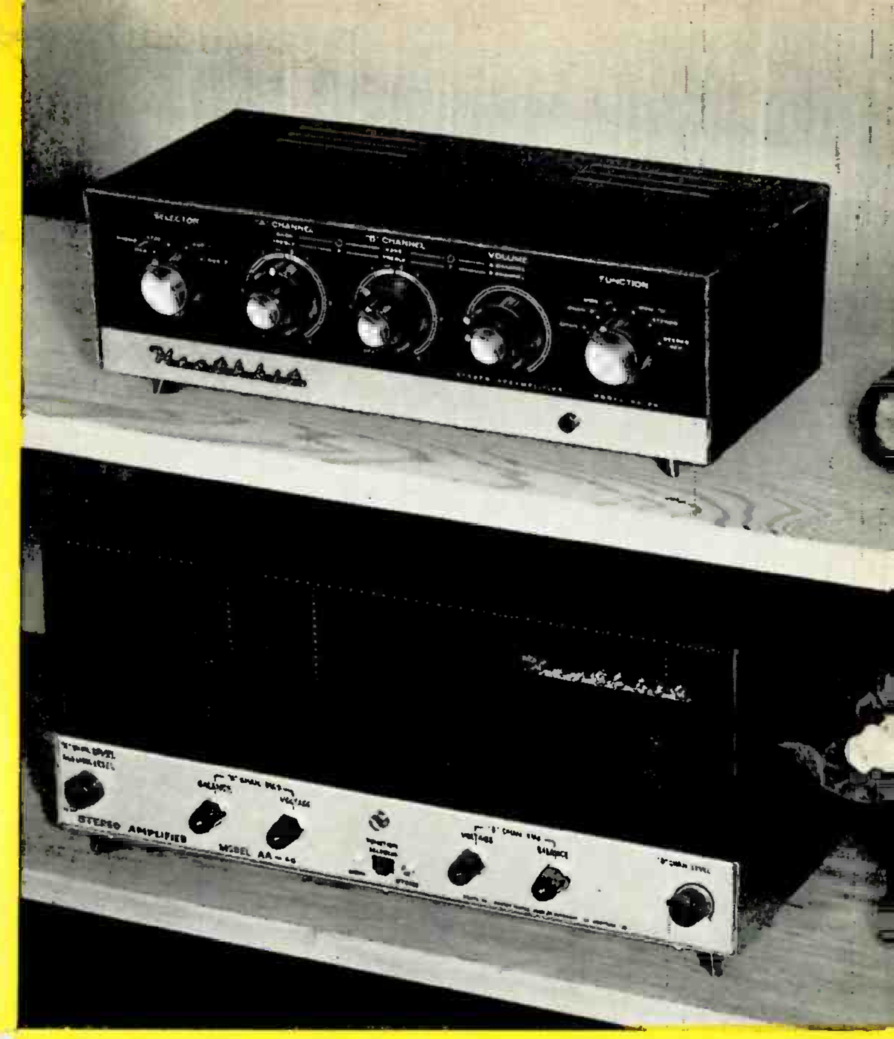

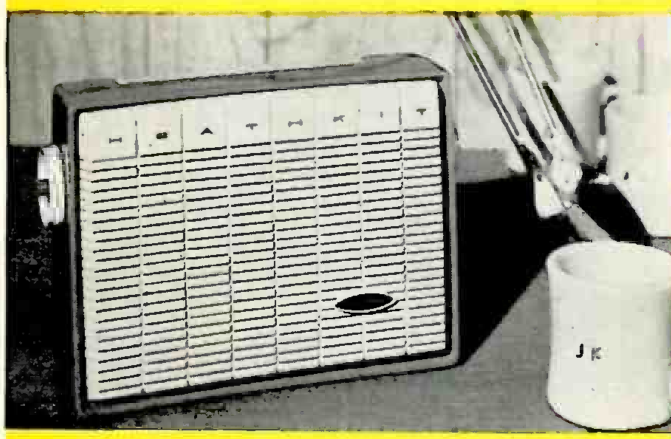

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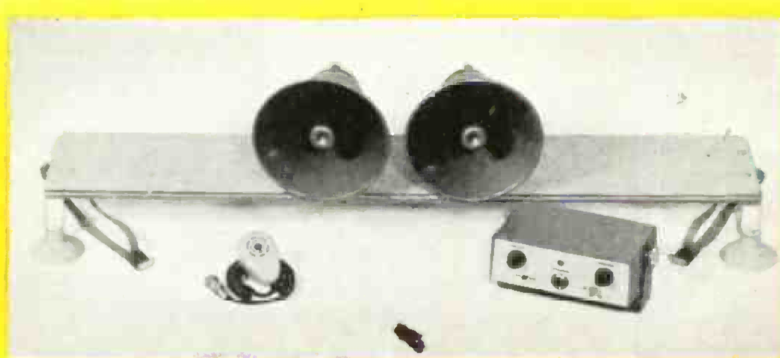

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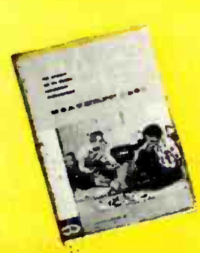

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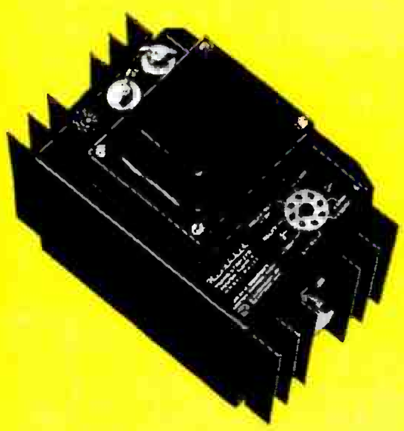

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Fig. 1. Using a 19-in. (diagonal measurement) CRT, set width is only 18 in.

19-inch Transistor TV

Motorola is now producing this self-contained, battery receiver that also works from a.c. line.

A SPECIALLY designed battery, a new transistor tuner, and a redesigned CRT have helped make possible *Motorola's* first commercial, portable TV with a large screen. The set (Fig. 1) weighs in at 40 pounds including the battery and features a telescoping antenna for completely independent operation.

Its 19AEP4, 114° CRT is a 19XP4 whose gun structure has been modified to give sharp focus with only 100 volts on the screen (G_2). Also the filament has been designed for 12.6 volts at 150 ma.

The sensitive front end is a *Standard Coil* turret tuner using three transistors—r.f. amplifier, oscillator, and mixer—to which strips for u.h.f. reception can be added. The noise figure is 10 db, and a 15-microvolt signal will produce the 20-volt peak-to-peak output from the video amplifier needed to drive the CRT. The tuner can be seen on the hand-wired vertical chassis in the upper, left-hand corner of Fig. 2.

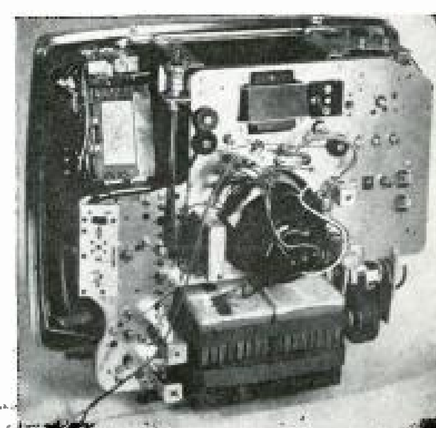
The 5-pound, rechargeable, silver-cadmium battery (20-22 volts) maintains its output well for the playing cycle of five to six hours. Guaranteed for a full year, it can be recharged at least 500 times. Charge begins when a detachable line cord is plugged into an a.c. outlet while the receiver is in the "off" condition, and is automatically interrupted by a relay when full charge is reached. If the receiver is turned on while the line cord is connected, the battery is disconnected and the built-in charger becomes the power supply for the receiver circuits. Available separately at $88, this power pack is estimated to provide viewing at the cost of two cents per hour.

Using 23 transistors and 12 diodes, the circuit includes a three-stage i.f. amplifier; a two-stage video amplifier; and a two-stage, amplified, keyed a.g.c. circuit in conjunction with a three-position sensitivity switch. The push-pull audio output delivers ⅔ watt at 10% distortion.

A regulated, 15-kv. flyback supply provides high voltage. Regulation permits the same brightness and sharpness obtained with supplies rated at 18-20 kv., which actually fall off drastically under normal loading. This circuit also provides "B+" for the video amplifier to obtain sufficient drive for the CRT.

Dubbed the "Astronaut," the luggage-styled set features a carrying handle and detachable front cover to protect the CRT in transit. Its price is $275 excluding the battery pack. —30—

Fig. 2. Wrap-around chassis takes little room. CRT determines over-all size.



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Cleaning After Rubbing For 90 Sec.	GOOD	Good	Good	Good	Good	Fair	Poor	Good	Fair	Poor
Protection After 30 Sec. Exposure to H_2S Gas	GOOD	Fair	Fair	Good	Good	Fair	Very Poor	Good	Very Poor	Good
Protection After 2 Hours Exposure to H_2S Gas	BEST	—*	—*	2nd Best	5th Best	—*	—*	3rd Best	—*	4th Best
Flash Characteristics	None at 200°F.	—*	—*	Greatest tendency	Boils at 70°F. Tendency to ignite	—*	—*	Tendency to ignite	—*	Slight tendency to ignite
Attack On Plastic Material	NO	—*	—*	Yes**	Yes**	—*	—*	Yes**	—*	Yes**

**Not tested further following sub-standard performance in 30-second exposure test.*

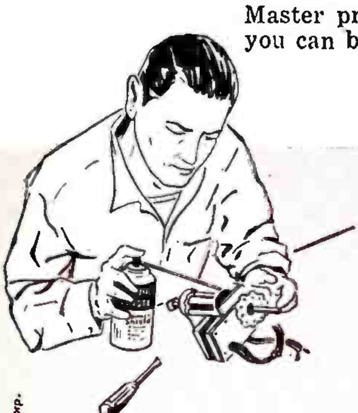
***Presence of solvents and chlorinated hydrocarbons.*

Channel Master introduces the first triple-action spray!

Channel Master set out to provide a superior cleaner, lubricant, and protector for electrical contacts. Contact Shield was the result.

To verify our own estimates of the product's effectiveness, Contact Shield was submitted to a nationally known independent testing laboratory.

This famous testing organization made a thorough study of Contact Shield, as well as of nine similar products on the market. The above findings demonstrate conclusively that this new Channel Master product is the most reliable contact spray you can buy!



Here's why Contact Shield is best:

- provides the most long-lasting protection
- eliminates background and resistance noises
- is safer. Will not ignite, flash, or cause short circuits... propellant is actually a fire extinguisher
- contains no solvents to attack plastics
- performs at temperatures from −95°F. to +320°F.

CHANNEL MASTER works wonders in sight and sound

Ellenville, New York

Hi-Fi-Audio Product Review

VU METERS

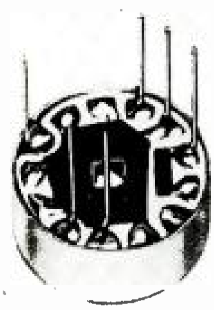
PACE Electrical Instruments Co., Inc., 70-31 84th St., Glendale, Long Island, N. Y. has added a full line of standard vu meters to its existing line of panel meters.

The new vu indicators are available with A or B scale plates and in sizes of 2½", 3½", and 4½", round or rectangular, and in either acrylic or phenolic cases.

The meters are designed for service in monitoring panels, tape recorders, sound level indicators, p.a. systems, and other audio applications. They employ double bridge d'Arsonval movements with wide-band, full-bridge rectifiers. For further information, write to the manufacturer.

TINY TRANSISTOR AMPLIFIER

Centralab, Division of *Globe-Union, Inc.*, 900 East Keefe Ave., Milwaukee 1, Wis. announces that its model TA-12, said to be the smallest 4-stage transistor amplifier ever built, is now generally available through electronics parts distributors. Heretofore, the TA-12 was sold only to the original equipment market.



The TA-12 is a 73-db gain audio amplifier with a diameter of 0.531 inch, and height of 0.228 inch. It has an input impedance of 2500 ohms nominal, power output up to .5 mw, and frequency characteristic of ±5 db, 300 cps to 20 kc. The single unit integrates, by means of packaged circuitry, 12 resistors, 5 capacitors, and 4 transistors. Its component density is 357 per cubic inch. For further information, write to the manufacturer.

"INVERTED" SPEAKER

Utah Radio & Electronic Corp., 1124 E. Franklin St., Huntington, Ind., has introduced an "inverted" loudspeaker in which the pot and magnet assembly is placed inside the cone instead of behind it.

Called "Magni-Magic," the speaker is produced in both the 8-inch and 6 x 9-inch oval sizes. The manufacturer states that the new design permits full reproduction plus power handling ability within a compact package and a minimum of space.

For additional information, write to the manufacturer.

DYNAMIC MICROPHONE

Electronic Applications, Inc., Stamford, Conn. is offering a dynamic cardioid microphone said to cover the full audio spectrum. Sensitivity is listed as 2.5 mv. per millibar at 1000 cps. The cardioid pattern (−15 db at 180°) tends to eliminate unwanted background noise and room resonances or reverberation. A bass-attenuation switch for voice cuts 8 db at 200 cps when needed.

Designated as Model AKG D 11 N, the microphone comes in a polystrol case with built-in folding table stand, a receptacle for a standard miniature 3-pin plug, and 4-foot shielded cable. The AKG D 11 N is a product of *Akustische und Kino-Gerate Gmbh*, Vienna, and is imported and serviced in the U.S.A. by the Stamford organization.

HEATHKIT STEREO AMP

Heath Company, Benton Harbor, Mich. has announced a new dual 35-watt power amplifier in kit form. The unit may be used as a dual-channel basic amplifier, 35 watts per channel, or as a 70-watt monophonic amplifier. Response is said to be 20 to 20,000 cps ±1 db, with less than 1 per-cent distortion at full rated output.

Listed as "Heathkit" AA-40, the new unit is equipped with a "stereo-mono" switch as well as individual channel level controls and a mixed channel output for a center-channel speaker. Full details are available from the manufacturer.

NEW RECORD CHANGER

Arkay International, 88-06 Van Wyck Expressway, Jamaica, N. Y. has announced its new "Human Brain" record changer. According to the manufacturer, the changer will play

all size records, mixed or the same diameter, and guarantee perfect alignment with the starting groove of each record.

The changer is available in kit or factory-wired form. For further information, contact the manufacturer.

UHER TAPE RECORDERS

Uher Sales & Service, 346 West 44th St., New York 36, N. Y. has introduced a new line of tape decks and recorders, including a voice-operated stereo record/stereo playback machine as well as a transistorized, battery-operated unit.

Known as the Stereo Record III, the voice-operated model also features automatic slide projector synchronization, permits playback on one track while recording on the other, and claims a frequency response of 40 to 20,000 cps. The machine can handle both quarter-track mono and stereo tapes.

These tape recorders are made in West Germany. For additional information contact the N. Y. organization.

DUAL-CHANNEL SPEAKERS

Radio Frequency Laboratories, Inc., Boonton, N. J. has announced a line of dual-channel, single-cabinet speaker systems for stereo or monophonic high-

fidelity applications. Called "Spatial Fidelity," the new speaker systems are available in a variety of sizes, shapes, and furniture styles.

According to the manufacturer, the single-cabinet system provides full dimensional stereo no matter where the listener is in the room. The new systems are said to utilize the walls, ceiling, and furnishings of a room to achieve a sense of spaciousness and dimension. This is accomplished through the design and geometry of the enclosures as well as by the positioning of the speakers within them.

For full details, write to the manufacturer.

GELOSO MICROPHONES

American Geloso Electronics, Inc., 251 Park Ave., South, New York 10, N. Y. is offering two series of dynamic non-directional microphones. Both series are available in high- and low-impedance models.

The "Gold Line" series M60 and M61 microphones are said to offer a flat frequency response of 60 to 14,000 cps. The "Slim Jim" series M62 and M63 microphones have the same specifications but are adapted for special services requiring a light, easy-to-handle unit.

The microphones are produced by *Geloso S.p.A.*, Milan, Italy. For additional information, contact the American representative.

NEW STEREO CARTRIDGE

Dyna Empire, Inc., 1075 Stewart Ave., Garden City, N. Y. has announced a new "Audio Empire" stereo cartridge. Listed as the Empire 108, the new pickup uses a moving magnet structure and is suited for playing both stereo and mono records.

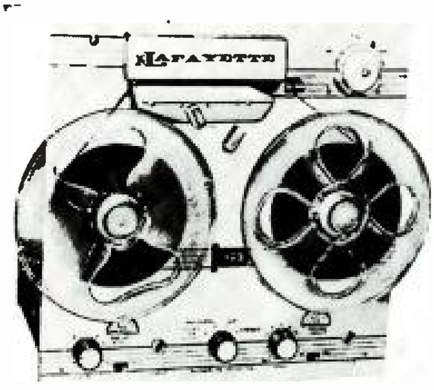
Frequency response is stated as 15

cps to 20 kc. ±2 db; channel separation, more than 25 db; output voltage, 8 mv. per channel balanced to within ±1 db; compliance, 6×10^{-6} cm./dyne: recommended tracking force, 1.5 to 5 grams.

The model 108 is a four-terminal cartridge. Additional information is available from the manufacturer.

LAFAYETTE TAPE DECK

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. has introduced a new "precision" tape deck said to offer performance and features for-



merly found only in costly professional equipment.

Listed as Model RK-107, the new tape deck features a separate recording preamplifier with individual vu meters integrated with the tape mechanism. The deck may be used for playing half-track or quarter-track tapes and for recording quarter-track monophonically or stereophonically. Frequency response is stated as 30 cps to 17 kc. at 7½-ips speed; 40 cps to 15 kc. at 3¾-ips speed.

Two separate motors are used; one is for tape drive, the other for fast forward and rewind. Among the controls is a "cue" position that permits manual positioning of the reels to select a desired spot on the tape.

SPEAKER SWITCHES

Mosley Electronics, Inc., 4610 N. Lindbergh Blvd., Bridgeton, Mo. has announced a flush wall plate switch, Model FAS-6, which facilitates push-button selection of any combination up to six remote speakers.

Each FAS-6 switch kit includes the switches, face plate, and mounting brackets. The push-buttons are numbered "1" through "6." For full details, write to the manufacturer.

STEREO PREAMP KIT

Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. has released a new "Knight-Kit" stereo preamplifier. Featuring printed-circuit construction, the unit may be used as the control center for a stereo or monophonic high-fidelity system. Provision is made for channel reversal as well as combining channels for monophonic use. Dual-concentric clutch-type controls permit adjustment of volume, treble, and bass of each channel separately or simultaneously. Five positions of record equalization are provided.

The input stage uses 12AY7 tubes. All tube filaments are heated with d.c. to minimize hum. Other features include scratch and rumble filters, cathode-follower outputs, and separate tape recorder outputs. The kit is supplied with all parts, tubes, case, solder, wire, and step-by-step instructions.

PHONO BASES

Audiotex Mfg. Co., a division of *GC-Textron Electronics,* 400 So. Wyman St., Rockford, Ill. has announced a new line of "customized" phono bases to match the size and color of seven popular record changers.

For further information on the new "Meta-Lux" line, contact the manufacturer.

NEW "SUPER TWEETER"

University Loudspeakers, Inc., 80 So. Kensico Ave., White Plains, N. Y. has brought out a new high-frequency speaker with a claimed response to 40,000 cps.

Designed to cover the range upward from 3000 cps, the "Sphericon" Model T-202 uses a domed phenolic diaphragm acoustically loaded by a conoidal ring for smooth response. The tweeter, for which a 120-degree dispersion pattern is claimed, has a built-in crossover network as well as a level control attached to a 36-inch long cable. Efficiency is high, power capacity is 30 watts, nominal impedance is 8 ohms. According to the manufacturer, the "Sphericon" T-202 can be matched perfectly to any speaker system without sacrificing bass efficiency.

CEILING SPEAKER BAFFLES

Utah Radio & Electronic Corp., Huntington, Ind. has announced a full line of ceiling baffles for flush-mounting of speakers in diameters of 3½ to 12 inches. Models are offered in both steel and aluminum construction. A large demand is anticipated for an all-aluminum model designed for an 8-inch speaker that is louvered for 360-degree sound dispersion.

Speaker and baffle mounting hardware is furnished with each model. Plaster rings and baffle housings (speaker enclosures) also are available for use with the new ceiling baffles.

"KNIGHT" STEREO CARTRIDGE

Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. announces its new "Knight" KN-500X stereo magnetic cartridge. Featuring a 4-coil moving-magnet design, the KN-500X uses a .0005-inch diamond stylus and is designed to track at pressures of 1 to 4 grams.

Frequency response is said to be 20 to 20,000 cps, ±2 db. Channels are balanced to within ±1 db. Stated compliance is 5.5×10^{-6} cm/dyne; channel isolation, more than 20 db. The new cartridge is listed as Stock No. 89 RC 225.

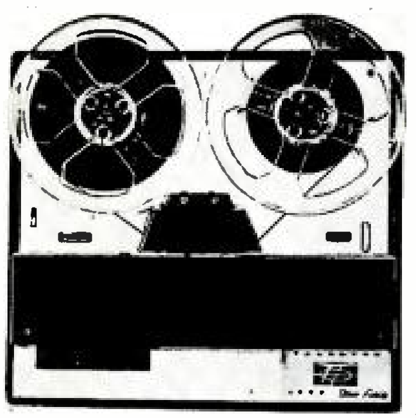
2-SPEED TAPE RECORDER

Radio Shack Corp., 730 Commonwealth Ave., Boston 17, Mass. has introduced a new low-cost, dual-track tape recorder. Bearing the "Realistic" label, the unit operates at either 3.75 or 7.5-ips speed; performs the functions of record, erase, playback, and rewind; has external jacks for microphone, radio-phono, and external speaker; and includes a microphone, radio patch cord, and 5-inch blank reel. It is furnished with carrying case. For full details, write to the company.

TAPE DECK AND PARTS

Telectrosonic Corp., 35-18 37th St., Long Island City 1, N. Y. is offering a new line of magnetic tape recorder equipment which permits the user to start modestly and, through a "building block" program, expand the basic tape system.

Included in the new line are five different tape decks and six preamplifiers. The combinations provide for different systems of play and record in monophonic and stereo. For details, write to the manufacturer.



AUDIO CATALOGUES

UTAH SPEAKERS

Utah Radio & Electronic Corp., 1124 E. Franklin St., Huntington, Ind. is offering a new catalogue describing its line of speakers for various applications. Included in the catalogue are crossover networks and a listing of new ceiling baffles.

STYLUS BOOKLET

Duotone Co., Keyport, N. J. is distributing a new booklet which discusses diamond styli.

Written for consumers, the booklet covers needle wear and offers advice on how and when to replace a stylus. It is available through dealers.

STEREO DISC STANDARDS

American Standards Association, Dept. PR 135, 10 E. 40 St., N. Y. 16, N. Y. has announced IEC (International Electrochemical Commission) Publications 98 and 98-1, which deal with the cutting of records. No. 98 is titled "Recommendations for Lateral-Cut Commercial and Transcription Disk Recordings." No. 98-1, a supplement to 98, is titled "Recommendations for Stereophonic Commercial Disk Records," IEC Publications 98 and 98-1 are available at $4.00 and $1.60 respectively, from the ASA.

HI-FI KITS BOOKLET

Lafayette Electronics Mfg. Corp., 104-46 Dunkirk St., Jamaica 12, New York has released a 20-page catalogue describing its line of kits for building hi-fi and stereo components.

The two-color booklet contains general and technical descriptions and is lavishly illustrated. For your copy, write the company direct.

ALTEC HI-FI DATA

Altec Lansing Corporation, 1515 S. Manchester Ave., Anaheim, Calif. is now offering a two-color catalogue which gives details on its hi-fi equipment as well as illustrating custom monophonic and stereo installations.

Described in detail are tuners, preamps, amplifiers, speakers, speaker components, speaker systems, enclosures, and microphones. A special feature is a section which diagrams the proper placement of speakers and other components in a room.

For a copy of the booklet, *"Altec*, the True Sound of Music," contact your local dealer or write the company for a copy of Publication No. AL 1302.

TAPE-HEAD REFERENCE GUIDE

Robins Industries Corp., Flushing 54, N. Y. has published a 16-page "Tape Recording Head Reference Guide." Listing more than 25 different brands of tape recorders, the Guide contains cross-reference data, specifications, and illustrations of record/playback and erase heads, heads for 2- and 4-track stereo, and heads for 2-track monophonic. According to the company, the Guide should prove a valuable aid to service technicians and dealers who repair, upgrade, or convert existing recorders to stereo.

The book is priced at 50 cents, but is being offered at no charge under certain conditions to distributors and their service dealers. Form number of the volume is RMM-2. Write the company for details.

SCOTT TECHNICAL DATA

H. H. Scott, Inc., 111 Powdermill Road, Maynard, Mass. has announced publication of two technical bulletins of interest to audiophiles.

One bulletin covers the firm's new 272 72-watt complete stereo amplifier while the second publication is concerned with the 314 AM-FM tuner.

Complete specifications and technical information are included in the publications. For a copy of either or both of these bulletins, write Dept. D of the company. Request Booklets 272 and 314.

STEREO/MONO UNITS

Harman-Kardon, Inc., 520 Main St., Westbury, Long Island, New York is currently offering copies of its free catalogue which illustrates and describes a complete line of stereo and monophonic high-fidelity instruments in all price brackets.

The new publication provides information on AM-FM tuners, all-in-one compact stereo receivers, amplifiers, and preamplifiers.

The line offers a variety of styles to fit any interior as well as a series designed for built-in and custom installations. The bulletin offers a unique selection of finishes on instrument panels, as well as optional enclosures.

PHONO ACCESSORIES

Duotone Company, Keyport, N. J. has a 40-page phonograph and accessories catalogue available which is being offered to dealers of audio gear.

Complete information on needle replacements for every type of phono unit is given along with a selection of various record accessories. —30—

Allied Radio Corporation, Chicago, has just completed the installation of a new stereo "Auditioner" console for the demonstration of high-fidelity stereo systems. Designed and built for the company, the console permits the quick and easy selection of countless system combinations consisting of famous-name tuners, preamps, basic amplifiers, tape recorders, turntables, and record changers. The performance of any combination of these components can be demonstrated through any two of the 64 speakers in the studio. The unit also features remote controls which permit the prospective purchaser to control volume and balance of the various speaker systems.

Professional Photoflash

(*Continued from page* 59)

operation it may be necessary to replace C_4 with a .25-μf. capacitor and the T_2 trigger coil with a larger, more efficient unit such as the *Amglo* MT-55. These are both larger than the ones specified and it may be difficult to find room for them in the back cover.

Battery Charger

The separate battery charging unit (Fig. 3) consists of a filament transformer, a current limiting resistor and a silicon rectifier. They may be conveniently mounted in a *Bud* CU-2115, 4" x 2" x 2¾" "Minibox." The 2¾" dimension of the one illustrated was cut down to the height of the transformer for compactness. A phone plug on the charger and a phone jack on the power pack permit quick coupling with no danger of accidentally reversing the polarity. The charging rate is over 200 ma. when the batteries are discharged and it slows as they approach full charge. Overnight charging will usually bring them back to full charge even after extensive use. While the batteries are spillproof and may be operated in any position, they should be upright while charging as they generate some gas during the latter part of the charging period.

This flash outfit is good for at least 150 flashes between charging without unduly prolonging the recycling period. In one test it was fired 100 times over a period of one hour. Battery voltage had dropped from 4.8 volts to 4.4 volts *under load*. Recycling time at the end of the test was 16 seconds—only two seconds longer than at the beginning. And remember, this is the recycling time to 450 volts.

Circuit Modifications

Obviously, many modifications are possible. Any other components of equivalent performance may be substituted for those specified. The power-supply circuit may be incorporated in an existing flash outfit. The thyratron trigger circuit may likewise be added to an existing unit. Possibly a less elaborate and less expensive outfit is desired and the trigger tube and meter may be eliminated or one storage capacitor may be used to provide only 50 W-S of energy. Proceed cautiously in modifying the power supply, however. This combination is excellent but many transistor power supplies fail when fed into 1000 μf. of capacitance which acts almost like a short circuit. If other batteries are used remember that current drain while charging the capacitors reaches a 6 to 7 ampere peak. Ordinary flashlight batteries won't take it.

This is a professional electronic flash unit with real professional performance. It's not cheap to build but it sure is economical to operate. At a net saving of over ten cents per flash as compared with bulbs, it's a bargain. -30-

DID POPOV INVENT RADIO?

Aleksandr Popov (1859-1906)

By **THEODORE M. HANNAH**

We call Marconi "father of radio;" Russians give Popov credit. Who is correct and exactly what did Popov do?

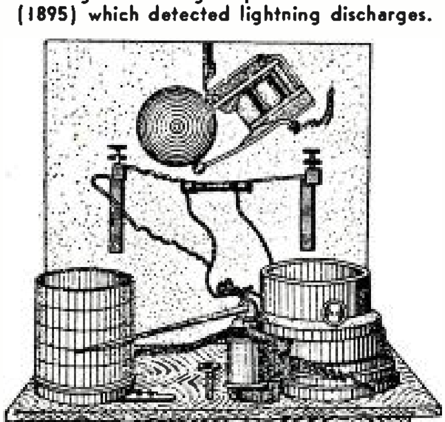
ASK an American who invented radio and he will probably say "Marconi;" ask a Russian and he will very likely say "Popov." Who is right? Can either Marconi or Popov be considered the inventor of radio? For that matter, who *is* Popov?

Throughout the communist world Aleksandr Stepanovich Popov is recognized as the sole inventor of radio. A cursory examination of any recent Russian electronics journal makes this abundantly clear, for 1959 was the centennial of Popov's birth (he was born March 16, 1859[1], in what is now the Sverdlovsk oblast). To commemorate the anniversary, a number of special events were held during 1959: scientific meetings in Moscow and elsewhere; dedication of a statue of Popov in Leningrad; the Russian amateur radio organization held an international radio contest on Popov's birthday and then offered a special award to any amateur who contacted 100 Russian amateur stations during 1959; special postage stamps have been issued, etc. Popov is memorialized in other ways too. The Russian equivalent of the IRE is known as the Popov Society; scientists—both Russian and foreign—who make outstanding contributions to the radio art receive Popov gold medals; the first page or so of every Soviet book on radio-electronics is ritualistically devoted to a tribute to A. S. Popov, "the inventor of radio."

The Russian claim of priority in the invention of radio is based on an event of May 7, 1895 (since 1945 this day has been celebrated as Radio Day in the Soviet Union). At a meeting of the Physics Branch of the Russian Physical-Chemical Society in Petersburg, Popov, then an instructor at the Kronstadt naval school, reported on and demonstrated his invention, a "radio receiver." The device was actually designed only to receive and record lightning discharges; the term "radio receiver" (usually prefaced with "the world's first") became commonly applied to Popov's device only after the advent to power of the Communists in Russia. This may be not so much willful distortion as it is a problem of definition. Popov's device *did* detect and record electromagnetic radiation (if only static crashes), and in that sense it *was* a radio receiver; yet, because there were no transmitting stations at that time, can his invention really be called a radio receiver?[2] In a way this is the reverse of the old question: "If a tree falls in the forest but there is no one there to hear it, is there any sound?" In 1895 there *was* someone to hear, but there was no *tree,* at least not near Petersburg.

While an instructor at Kronstadt, Popov had access to a well-equipped laboratory and a library well stocked with foreign periodicals and books. Popov was particularly interested in the work of Heinrich Hertz and he repeated many of the German's experiments in electromagnetic waves. The experiments and writings of Sir Oliver Lodge, Edouard Branly, Augusto Righi, and others also influenced his thinking. The detector which Popov demonstrated before the Physical-Chemical Society meeting was basically Branly's coherer (a metal-filing type) to which Popov added an arrangement for automatically tapping back the filings to a sensitive condition after they had cohered upon the reception of oscillations. Each static discharge caused a bell to ring or a mark to be made on a paper tape. The implication conveyed in some descriptions of Popov's receiver is that the tapping device was original with Popov.[3] Actually, an automatic tapper was a part of the receiver which Lodge demonstrated at a meeting of the British Association for the Advancement of Science in 1894.[4] What may have been original with Popov was the addition of choke coils to protect the coherer from the effects of local sparking at the relay contacts.[5]

Drawing illustrating Popov's first receiver (1895) which detected lightning discharges.



Contemporary Soviet accounts of Popov's invention attach considerable importance to the antenna which he used with his receiver. Described as a long vertical wire, insulated at the upper end and connected through the coherer to ground at the lower end, it is claimed to have been the final element needed for the reception of radio signals. The literature is not conclusive on this point; Hertz had been using a loop antenna for his experiments, but whether Popov was the first to employ an antenna and ground system remains an unanswered question. There is evidence that Marconi had been using such a system in his experiments conducted at or before this time.[6]

It should be pointed out that Popov foresaw that his invention might be used for purposes of communication. During his demonstration of May 7, 1895 he is reported to have said:

> "With further improvement, my device can be adapted to the distant reception of signals by means of rapid electric oscillations, as soon as a sufficiently powerful source of such oscillations is found."[7]

Perhaps unknown to Popov, a source of such oscillations had already been found. During the summer of 1894, at Pontecchio, near Bologna, Italy, a young man named Guglielmo Marconi succeeded in receiving *and* sending wireless signals over a distance of about three-quarters of a mile. Similar experiments had also been made by Lodge and Sir Henry Jackson. From then on, progress was swift. Marconi moved to England, and by the beginning of 1896 was receiving Morse code messages over a distance of nearly two miles. On June 2, 1896 Marconi applied for the first patent ever granted for a system of wireless telegraphy based on the use of electric waves.[8] During 1896-97, transmitting distance was increased to four miles over land, then nine miles across the Bristol Channel. In 1899 wireless signals spanned the English Channel, the first instance of international radio communication. In the same year British warships, using Marconi equipment, exchanged messages at distances of 75 miles. Only two years later, on December 12, 1901, with Marconi at the receiving station in Newfoundland, the letter "S" was transmitted across the Atlantic. World-wide radio communication was now within reach.

What was Popov doing during this time? In January, 1896 a report of his demonstration of the previous May was published in the *Journal* of the Russian Physical-Chemical Society under the title "A Device for Detecting and Recording Electric Oscillations." On March 24, 1896 Popov sent his first message by wireless. Transmitted over a distance of about 600 feet, the message consisted of two words: "Heinrich Hertz." Early the following year he was communicating with ships over short distances.[9] His equipment was employed in what was probably the first use of radio in the saving of human lives. In February, 1900 a message was flashed from Petersburg to the icebreaker "Ermak" instructing it to rescue some fishermen stranded on floating ice in the Gulf of Finland. In 1901, the year Marconi sent signals 2000 miles across the Atlantic, Popov established communication between ships on the Black Sea; the distance was 80 miles.

How then can the Russians claim that Popov invented radio? Two arguments are used: (1) that Popov's demonstration of 1895 predated Marconi's patent of 1896, and (2) that, in any case, Marconi's invention was a direct copy of Popov's.

Popov is said to have refused to take out a patent on his invention, contending that the discovery should benefit the scientific world at large.[10] This may be true (university professors are traditionally uninterested in patenting their discoveries), or it may be a convenient means of explaining how Marconi, rather than Popov, came to be almost universally recognized as the father of wireless communication.

With respect to the second argument, it is certainly true that no *one* inventor or invention was responsible for radio. And there *was* considerable similarity between the inventions of Marconi and Popov, just as Popov's was similar to and based upon Lodge's, Lodge's upon Hertz's, etc. But this is really not the point. The thing that the Russians seem to overlook is that neither Popov, nor Lodge, nor Branly, nor Hertz recognized the fact that radiation was the real key to wireless. And, as the courts later held, none of these scientists ever fully realized the practical possibilities of wireless as a means of communication. Marconi grasped both of these ideas. If not a creative inventor, Marconi was blessed with a genius for perfecting the crude laboratory-type apparatus of his predecessors and for promoting wireless telegraphy as a practical instrument of communication. He was, in short, the midwife of radio.

Without admitting that he was responsible for practical wireless telegraphy, Soviet sources, particularly the earlier ones, give at least some credit to Marconi for his contributions to the development of radio. A Soviet encyclopedia begins its article on Marconi by saying: "Marconi (1874-1937), Italian engineer and radio technician, the inventor, after Professor A. S. Popov, of the radiotelegraph."[11] This early source is kinder in its treatment of Marconi than one published in 1954. The latter dismisses Marconi as an opportunist who, taking advantage of the fact that Popov had not patented his invention, went ahead and obtained a patent on his device, which was, after all, only a copy of Popov's.[12]

The contributions of the men who pioneered in the study of electricity and electromagnetic waves—Galvani, Volta, Morse, Bell, Faraday, Henry, Thompson, Branly, and Lodge—are freely acknowledged in the Soviet literature, but in a condescending sort of way. The Russians take the attitude that what these men did was but prelude to Popov's "invention" of radio.

An interesting feature of Soviet accounts of Popov is that, of all the inventions claimed to have been made by Russians, radio seems to be the one first claimed. The argument that Popov was the real inventor of radio was put forth at least as early as 1925;[13] other Russian inventions (including baseball and the hula hoop) were announced considerably later.[14]

There is no denying the fact that Popov's considerable talents were little appreciated by the tsarist government. It must have been particularly galling to Popov to see, in 1902, his rival Marconi decorated by the Tsar with the Order of St. Anne. There is no record that Popov ever received similar recognition from his government.[15]

Popov's last few years were spent in Petersburg as a professor, then director, of the Electrotechnical Institute. He died on January 13, 1906 at the age of 47. The brain hemorrhage which caused his death was due, according to one recent Soviet source, to heated arguments between Popov and the tsarist minister to whom he was subordinate.[16]

Returning to our original question, did Aleksandr Popov invent radio? No, and neither did Marconi. The latter made wireless practical, but without the pioneering work of scientists like Popov, Marconi's achievements would have been impossible.[17]

An American scientist who recently visited the Soviet Union brings back an interesting anecdote. In a discussion of Russian claims that Popov invented radio, a Soviet electronics engineer is quoted as saying: "Well, Marconi did something too, and what difference does it make? We now have radio and that's good!" And it *is* too.

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[1] All dates are New Style.

[2] Dictionary definition of radio: "The transmission and reception of signals by means of electric waves without a connecting wire . . ."

[3] See, for example, *Bol'shaya Sovetskaya Entsiklopediya (Large Soviet Encyclopedia)*, First Edition, Vol. 46, columns 422-23, and *Encyclopaedia Britannica*, 1956, Vol. 18, pp. 230-31.

[4] W. H. Eccles, *Wireless*, London, Oxford University Press, 1933, pp. 53-54. Quoted in W. Rupert Maclaurin, *Invention and Innovation in the Radio Industry*, New York, Macmillan, 1949, p. 18.

[5] *Ibid.*, p. 20.

[6] Orrin E. Dunlap, Jr., *Radio's 100 Men of Science*, New York, Harper, 1944, p. 172, and *Encyclopaedia Britannica*, Vol. 14, p. 869.

[7] *Bol'shaya Sovetskaya Entsiklopediya*, *loc. cit.*

[8] This was British patent No. 12,039. The equivalent American patent, No. 586,193, was granted him on July 13, 1897.

[9] A description of Marconi's wireless system was not published until June, 1897.

[10] Dunlap, *op. cit.*, p. 127.

[11] *Bol'shaya Sovetskaya Entsiklopediya*, First Edition, Vol. 38, column 155.

[12] *Bol'shaya Sovetskaya Entsiklopediya*, Second Edition, Vol. 26, p. 299.

[13] Postage stamps honoring Popov as the inventor of radio were issued that year.

[14] Popov is also credited with discovering the principles of radar and radio direction finding.

[15] His contributions to the sciences were recognized by the Fourth International Electrotechnical Congress, held in Paris in 1900. There he received an honorary degree and a gold medal. *Bol'shaya Sovetskaya Entsiklopediya*, Second Edition, Vol. 34, p. 159.

[16] N. M. Izyumov, *Kurs Radiotekhniki (A Course in Radiotechnology)*, Moscow, 1958, p. 6.

[17] While acknowledging the contributions of some of his predecessors and contemporaries, Marconi appears never to have been aware of Popov's existence.

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SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Model 77 — VACUUM TUBE VOLTMETER ... Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price

- ✓ Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- ✓ Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- ✓ Model 77 uses new improved SICO printed circuitry.
- ✓ Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

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- ✓ Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
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- ✓ Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

SPECIFICATIONS

• **DC VOLTS**—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak)—0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER**—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms • **DECIBELS** —10 db to + 18 db, + 10 db to + 38 db + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only......................

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THE ONLY 20,000 OHMS PER VOLT V.O.M. SELLING FOR LESS THAN $50 WHICH PROVIDES ALL THE FOLLOWING FEATURES:

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- ✓ **HANDSOME SADDLE-STITCHED CARRYING CASE** included with Model 80 Allmeter at no extra charge enables you to use this fine instrument on outside calls as well as on the bench in your shop.

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

- • A built-in Isolation Transformer automatically isolates the Model 80 from the power line when capacity service is in use.
- • Selected, 1% zero temperature coefficient metalized resistors are used as multipliers to assure unchanging accurate readings on all ranges.

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0 to 15/75/150/300/750/1500/7500 Volts.

6 A.C. VOLTAGE RANGES:
(At a sensitivity of 5,000 Ohms per Volt)
0 to 15/75/150/300/750/1500 Volts.

3 RESISTANCE RANGES:
0 to 2,000/200,000 Ohms. 0-20 Megohms.

2 CAPACITY RANGES:
.00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.

5 D.C. CURRENT RANGES:
0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.

3 DECIBEL RANGES:
− 6 db to + 18 db + 14 db to + 38 db + 34 db to + 58 db

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Only ....

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GENOMETER

7 Signal Generators in One!

Model TV-50A—Genometer
Total Price $47.50
Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

- ✓ *R.F. Signal Generator for A.M.*
- ✓ *R.F. Signal Generator for F.M.*
- ✓ *Audio Frequency Generator*
- ✓ *Bar Generator*
- ✓ *Cross Hatch Generator*
- ✓ *Color Dot Pattern Generator*
- ✓ *Marker Generator*

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peak wave audio signal.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV): Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency)

THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

$47.50 NET

EXAMINE BEFORE YOU BUY!

USE APPROVAL FORM ON NEXT PAGE

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

Model TW-11—Tube Tester
Total Price $47.50
Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity fuse types, etc.
★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.
★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES: Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a handsome, portable Saddle-Stitched Texon Case. Only.......................... **$47.50**

SUPERIOR'S NEW MODEL 82A

Multi-Socket Type TUBE TESTER

Model 82A—Tube Tester
Total Price $36.50
Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert tube into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button—

THAT'S ALL! Read emission quality direct on bad-good meter scale.

SPECIFICATIONS

- Tests over 600 tube types
- Tests OZ4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously

Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL! Read quality on meter. Inter-element leakage if any indicates automatically.

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only **$36.50**

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

TESTS AND REJUVENATES ALL PICTURE TUBES

Model 83—C.R.T. Tube Tester
Total Price $38.50
Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types —from 8" to 30" types.

ALL COLOR TUBES

Test ALL picture tubes—in the carton—out of the carton—in the set!

● Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
● Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
● Model 83 employs a 4" air-damped meter with quality and calibrated scales.
● Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

● Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
● Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only..... **$38.50**

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- ☐ Model TV-50A....Total Price $47.50 — $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model TW-11.....Total Price $47.50 — $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 82A.......Total Price $36.50 — $6.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 83........Total Price $38.50 — $8.50 within 10 days. Balance $6.00 monthly for 5 months.

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Measurement of Meter Resistance

By **JOHN GERSTLE**

Simple method gives a high degree of accuracy. Does not require elaborate laboratory equipment.

IT IS common practice to measure meter resistance using the circuit of Fig. 1, where R_m = the meter resistance; R_s = a variable shunt resistance; I_m = the current through the meter; R_p = the variable resistance to limit the current through the unshunted meter to full-scale value; and E = the voltage source.

Using this method, the procedure is to vary R_p until the meter reads full-scale value. The shunting resistor, R_s, is then inserted and varied until the meter reads half-scale value. The value of R_s at half-scale is then measured to give the meter resistance.

This method is entirely suitable for the well-equipped laboratory where the R_s value for the half-scale reading can be accurately measured on a precision instrument, such as a bridge.

For the ordinary experimenter or service technician to whom such laboratory equipment is not available, the following method can be used with a high degree of accuracy.

The circuit for making this measurement is exactly the same as that shown in Fig. 1 except that the meter can be shunted with any accurate fixed resistor of a value somewhere near that of the meter resistance. Such a resistor is much more likely to be available or obtainable than an accurate bridge.

Actually, it is unnecessary for the shunted meter to be set initially to full-scale value but doing this will give a more accurate result.

The equation for meter resistance in terms of shunt resistance R_s, unshunted meter current I_m, shunted meter current I_s, and meter resistance R_m, is:

$$R_m = R_s\left(\frac{I_m}{I_s} - 1\right)$$

This equation can be used to calculate the meter resistance even though the shunt resistance is not equal to the meter resistance. As an example, suppose it is desired to measure the resistance of a 1 ma. meter that is known to have a resistance of approximately 30 ohms and, say, only a 25-ohm shunt resistance is available.

If measurement shows the shunted meter current to be .45 ma. when the 25-ohm resistor is used, then: R_s = 25 ohms; I_m = 1 ma.; and I_s = .45 ma. Substituting these values into the original equation, we have:

$$R_m = 25\left(\frac{1}{.45} - 1\right) = 25\ (1.22)$$

or, R_m = 30.5 ohms (the value of meter resistance).

If, in this example, the usual method of measuring meter resistance had been followed, then: R_s = 30.5 ohms; I_m = 1 ma.; and I_s = .5 ma. or the current when the meter is shunted. Substituting these values in the original equation, then:

$$R_m = 30.5\left(\frac{1}{.5} - 1\right) = 30.5\ (1)$$

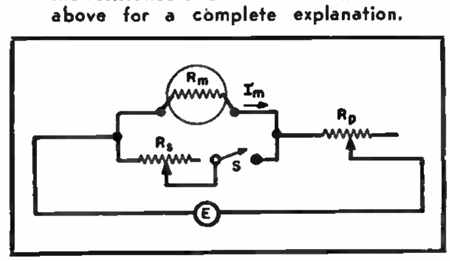
or. R_m = 30.5 ohms. This shows that either method gives exactly the same result.

In measuring meter resistance it is not advisable to use a switch to cut in the shunt resistor as most switches, in time, develop enough resistance to introduce inaccuracy when measuring a low-value meter resistance. The switch shown in Fig. 1 was inserted merely to show that the shunt resistor is not always in the circuit.

In selecting the fixed shunt resistor, a preliminary check with common resistors should be made to determine the approximate value of the meter resistance should this value be unknown.

For high accuracy, the fixed shunt resistor should reduce the meter reading to between .4 and .6 of its full-scale value. However, any meter reading will give an approximation of the meter resistance. —30—

Fig. 1. Circuit employed to measure the resistance of a meter. See the text above for a complete explanation.



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Service Industry News

YOU WILL never stir up much of an argument by repeating the old truism, "You can't please everybody." Few recognize the truth of that well-worn phrase more than do editors who try to make each of their hundreds of thousands of readers happy with everything they choose for publication. Witness the letter we got from L. B. H., an independent service operator from Palmerton, Penna., who also happens to be the author of a number of successful articles, over the years, in this and other publications.

He believes that, with "Service in 1959" (April 1960 issue), we have "thrown one of the worst below-the-belt punches at the service industry" he has seen. Particularly, Mr. H. is disturbed over what he calls our "favorable comment on licensing." As a matter of fact, as we will note shortly, we think this correspondent has failed to understand our actual position. However, let's first give him the chance to make a few more points.

"If you are so conscientiously concerned about abuses in the industry," he adds, "why not delve into the manufacturer's practice of peddling $100 sets for $400 that usually conk out about the second day after arriving from the 'printers'? The public, however, has been so overwhelmingly impressed . . . that the service man who can't fix it with a flick of the wrist must surely be a shady character . . . Now, you are all for hanging a 'license' tag on him.

"These 'licensed' service men will, of course, all be Phi Beta Kappa, honor-bound not to try to sell tubes or accessories and—oh, yes—their numbers must be in bold yellow across their backs . . . Would you like a bit of constructive criticism? 'Thou shalt not sell that which thou canst not service in its entirety.' "

That's quite a bit off one writer's chest. For our part, we have never taken a stand either for or against licensing. If Mr. H. will check our past issues, he will find he is not the first "anti" whose viewpoint was run in this space. In fact, the April article to which he objects acknowledges (third paragraph) that many service dealers and associations are opposed to licensing. We used this issue, however, to illustrate the point that the maturing service industry is now getting things done where, not so many years ago, it was relatively ineffectual.

All right, then; why did we have to pick on licensing? Simply because the service industry itself has made it the foremost issue before it and because most members of the industry do favor it. These are facts, not opinions. We have done everything in our power to sample the service associations throughout the nation—more than 200 of them—on this (and other) issues. We receive an impressive volume of mail from service dealers and technicians, in and out of associations, on this (and other) matters. We implement this with every other sampling technique we know. We doubt that many people are in a better position to know what industry feeling is on this matter.

We believe it would be morally wrong for us to cheat the industry of its obligation to make up its own mind on this important issue, and we will not do so. However, we must also report the cold fact that, for better or

Half a dozen service-industry leaders from Florida: the newly elected officers of the Television & Electronic Service Association of Miami. From left to right, in the back row: Charles D. Pierce, 2nd vice-president; Roger Misleh, 1st vice-president; James J. Ross, corresponding secretary; and Sam Kessler, recording secretary. Front row: C. W. Minter, treasurer, and A. Edward Stevens, president.

worse, an impressive majority is in favor of licensing. Stating as much is not exactly what Mr. H. charges us with doing. As for this writer's other comments, we are not inclined to argue with him. We have had our say on poor layout for serviceability, printed-wiring problems, quality control, and other matters.

We cannot resist a footnote before dropping this subject. Under "Must Reading," the April issue of the "TSA Newsletter" (Northeastern New York) says "every upstanding technician" should take the time to read "a very enlightening article, 'Service in 1959.' Don't miss this discussion," says the editor. As we started out to say, "You can't please everybody."

Beginner's Dilemma

Another recent letter, by contrast, comes from a relative newcomer. "The course that I studied TV repairing in taught us not to speak against any other repairmen," writes H. C. W. of San Bernardino, Calif., "but many of your readers who seem to be very capable repairmen appear as though they were running around like hungry wolves seeking any beginners that they might devour . . . Some of your readers would make it impossible to get repair experience in the manner that the course has recommended; that is, by fixing TV sets for your friends and neighbors.

"I would like to ask you or any of your readers what I should do—and what *you* did—to get this experience! Let the man that is innocent among you cast the first stone."

Mr. W. has something of a point. If lack of experience is a crime, then all of us have been guilty at one time or another. However, there are many different ways of getting experience. Many of us, no matter how well grounded we were in theory at the outset, at no time presumed to take chances on other people's sets by plunging right in on our own. We managed to tie in with established, reliable shops, where we could work under the surveillance of more knowledgeable men who could protect us (and the customers) from our inevitable, early blunders. We didn't always land a job on the first try but, when we did, it was by representing ourselves honestly—as eager, well-informed, but inexperienced men who were essentially looking for apprenticeship.

Today Mr. W. is in a much better position to use that approach than was possible up to a few years ago. Many forward-looking service associations, aware of his particular problem, have begun to experiment with apprenticeship programs, conditional membership for newcomers, and other such "door openers." As it happens, a good deal of this activity is going on in Mr. W's home state. We have taken the liberty of referring him to a local group.

We cannot dictate a "one right way." However, learning to walk before one learns to run can surely do no harm and may do much good. —30—

Technical Books

THIS month we continue to bring you capsule reviews of outstanding new technical books. In this way, we are able to provide pertinent information on the many excellent publications received here, with the hope that you will follow up with a more leisurely examination of these books at your bookseller or distributor.

AUDIO AND HI-FI

"HI-FI MADE EASY" by Norman H. Crowhurst. Published by *Gernsback Library, Inc.*, New York. 224 pages. Price $2.90, soft cover; $5.00, hard cover.

The author—an audio consultant, engineer, and prolific writer in this area—here tackles some of the basic concepts and techniques of high-fidelity sound for the average, non-technical reader. The book is illustrated, not with diagrams or photographs, but with saucy little cartoons that make a technical point by analogy. Although primarily aimed at the beginner, this book might appeal to some advanced audiophiles as well.

"A GUIDE TO STEREO SOUND" by David Tardy. Published by *Popular Mechanics Press*, Chicago. 192 pages. Price $4.95.

This book examines, in simple language and with abundant illustrations, the fundamental concepts involved in stereophonic sound for the home, explains how many of the approaches used differ from each other, and how home stereo differs from movie stereo. Included are discussions of the relation of stereo to hi-fi, multiple channel setups, sound and location, microphone techniques as they relate to playback, stereo amplifiers, broadcasts, tapes, and discs.

THEORY AND FUNDAMENTALS

"LOW FREQUENCY AMPLIFIERS" edited by Alexander Schure. Published by *John F. Rider, Inc.*, New York. 88 pages. Price $1.80. Soft cover.

This book deals with the audio band from 20 to 16,000 cycles, clarifying the application of vacuum tubes and transistors to audio-frequency amplifiers. Special emphasis is given to the design of systems, showing and solving specific design problems.

"LOW FREQUENCY AMPLIFIER SYSTEMS" edited by Alexander Schure. Published by *John F. Rider Publisher, Inc.*, New York. 80 pages. Price $1.80. Soft cover.

A companion volume to the book described above, this work deals with low-frequency amplifying systems with special emphasis on coupling methods suitable for this frequency band, as well as such topics as phase inversion, inverse feedback, and circuit design.

"PHOTOTUBES" edited by Alexander Schure. Published by *John F. Rider Publisher, Inc.*, New York. 96 pages. Price $1.80. Soft cover.

This book deals with the principles underlying the operation of the different types of phototubes that have become vital elements in many applications of industrial electronics and other fields. Theory, structure, and types of phototubes are covered, as well as the essentials of phototube amplifiers.

"MAGNETIC AND ELECTRICAL FUNDAMENTALS" by Alexander Efron. Published by *John F. Rider Publisher, Inc.*, New York. 132 pages. Price $2.50. Soft cover.

An accurate and readable explanation of the subject is provided in this book, with the emphasis on the physics viewpoint. The material should interest students as well as technicians who want to expand their personal store of basic information.

"FUNDAMENTALS OF ELECTRONICS" by Matthew Mandl. Published by *Prentice-Hall Inc.*, Englewood Cliffs, N. J. 574 pages. Price $10.60.

This volume covers basic theory as well as the practical aspects of electronics, and provides a solid foundation for more advanced or specialized studies. It is aimed at the serious reader who wants a thorough grounding in this area. Subjects covered include: electron theory, circuit elements, series and parallel circuits, power sources and measuring devices, magnetism, a.c. theory, inductance and capacitance, resonance, vacuum tubes, transistors, amplifiers, oscillators, modulation, receiver principles, transmission lines and antennas, miscellaneous circuits, and test equipment.

"MAGNETISM AND ELECTROMAGNETISM" edited by Alexander Schure. Published by *John F. Rider Publisher, Inc.*, New York. 78 pages. Price $1.80. Soft cover.

This book deals with those aspects of magnetism and electromagnetism that underlie the operation of communication and industrial electronic devices. Its intent is to explain the major theoretical considerations of its subject matter at the intermediate level.

"ADVANCED MAGNETISM AND ELECTROMAGNETISM" edited by Alexander Schure. Published by *John F. Rider Publisher, Inc.*, New York. 104 pages. Price $2.25. Soft cover.

This is a companion volume to the book described above. Advanced concepts are explained, and the author penetrates more deeply into the subject, covering such topics as Biot's Law, the Curie-Weiss Law, the domain theory of magnetism, the cyclotron, the mass spectograph, and terrestrial magnetism.

"R-F AMPLIFIERS" edited by Alexander Schure. Published by *John F. Rider Publisher, Inc.,* New York. 104 pages. Price $2.40. Soft cover.

An excellent discussion of low- and high-powered r.f. amplifiers is given in this book. Design and theory are covered, with special emphasis placed on resonant circuits. Practical examples of design are included in this useful volume.

"TELEMETERING SYSTEMS" by Perry A. Borden and W. J. Mayo-Wells. Published by *Reinhold Publishing Corp.,* New York. 349 pages. Price $8.50.

Full details on the practical aspects and possibilities of stationary and mobile telemetering are explained in this book. The various systems of telemetering are thoroughly discussed, as are such topics as telemetering pickups, links and channels, remote reading, reliability and testing, and others. Diagrams, photos of equipment, and extensive lists of reference works enhance this book's usefulness for the advanced technician who is interested in this field.

"FUNDAMENTALS OF ELECTRONICS" by E. Norman Lurch. Published by *John Wiley & Sons, Inc.,* New York. 631 pages. Price $8.25.

This book, with the same title as the volume described before, inevitably invites comparison with it. Actually, Lurch's work is on a somewhat more advanced level technically and presumes a previous knowledge of d.c. and a.c. circuits. This book goes more deeply into certain aspects of basic electronics, and relies more heavily on mathematics and more complex circuit diagrams to help explain various points. All in all, a book for the non-engineer who is advanced beyond the beginning stages of technical development.

"FUNDAMENTALS OF ELECTRICITY" by Kennard C. Graham. Published by *American Technical Society,* Chicago. 342 pages. Price $4.75.

This is the fourth edition of a work that has long been a popular and efficient guide to electrical fundamentals. Subjects covered include: the nature of electricity, electrical quantities, Ohm's law, magnetism and electro-magnetism, generators, motors, power and heating effects, transformers and rectifiers, measuring devices, waves, and automation devices. The book is liberally illustrated and includes a glossary of terms.

"WHAT IS CYBERNETICS?" by G. T. Guilbaud. Translated by Valerie MacKay. Published by *Criterion Books, Inc.,* New York, N.Y. 126 pages. Price $3.50.

Written by an eminent French authority on cybernetics, this book is a popular introduction to "the study of systems of control and communications in animals and in electrically operated devices such as calculating machines." It explains, in non-technical language, the fundamentals of control systems, signals and messages, feedback, information theory and related pertinent subjects.

"DIGITAL COUNTERS AND COMPUTERS" by Ed Bukstein. Published by *Rinehart & Co., Inc.,* N. Y. 248 pages. Price $7.00.

Partially based on a series of articles by the author for this publication, this work approaches the subject of computers from two ways. First, the author explains the electronic circuitry that is involved. Then, the book goes into such topics as the number theories and counting systems by means of which computers do their work.

"DIRECT CURRENT ELECTRICITY" by Alexander Efron. Published by *John F. Rider Publisher, Inc.,* New York. 100 pages. Price $2.25. Soft cover.

The text covers d.c. fundamentals from the viewpoint of the student of physics as well as the beginner in electrical engineering. The book moves logically from electrochemistry through circuit analysis and on to measuring instruments and magnetic laws.

(To be continued)

Two-Way Mobile Maintenance

(*Continued from page* 37)

In all areas the units that had been maintained under a service policy were in much better condition than those that had been maintained under a "call when it quits" basis. Since both types of maintenance were rendered by essentially the same personnel, the reasons for the differences in condition cannot be attributed to differences in competence of personnel. Although our program of routine inspections, particularly on stations, accounts in large measure for the superior condition of "service policy units," we believe that equal reasons for the improvement are as follows:

1. Under a one-price service policy. drivers and dispatchers never hesitate to call for service at the least sign of trouble, since it costs nothing extra to have the equipment checked. There is no tendency to "get by" with inferior performance only to have equipment fail at what may be a critical and costly time for the user.

2. A radio service organization whose profits and growth depend on the system staying in operation can afford to be more thorough than an individual whose profits depend on how many hours he spends on a disabled unit of the system. Callbacks, always a source of irritation (even when the customer does not pay for them), are considerably reduced.

3. Any *organized* maintenance program, whether it concerns radios, automobiles, or elevators, is more efficient than a non-organized program.

In addition to providing better performance and reliability for the radio investment, we believe a service policy is more economical and provides an accurate means of determining the true radio operating costs.

The preparation of individual invoices covering radio repair is costly for the servicing company. Verification by the user can be even more costly, since personnel doing this work are not familiar with the radio terms and materials.

For example, one invoice may list a discriminator transformer at $3.85 and another may list a plate transformer at $87.00. Not only must the user determine if the pricing on the particular transformer is correct, but he wants to know whether the replacement transformer was necessary. It is also difficult to keep records of, and establish charges for, special engineering required in certain stubborn cases of system trouble, diagnosis, and other operational problems.

All of these problems are eliminated under a flat-rate service policy where a single monthly invoice is rendered, covering the number of units and stations in service. This is not to say that detailed cost accounting and radio maintenance is not necessary but, instead, it is done by the radio contracting firm. This enables the contractor to control costs and maintain

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
12 Volt Inverter Power Supply for above. BRAND NEW $32.50
28 Volt Inverter Power Supply, exc. cond. $49.50
Circuit diagram and connecting plugs available.

TS-100AP 'SCOPE

(WORTH $750) OUR LOW PRICE **$29.50**

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.

GOLD PLATED SPECIAL! TS-1/ARR-1 TEST OSCILLATOR

Portable, complete with two 955 tubes, cavity and antenna. BRAND NEW, in metal housing 9¾" x 6¾" x 7" high. OUR LOW PRICE, each .. **$3.45**

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 $26.95
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 4.25
MN52 Azimuth Control Box 2.95
Flexible Mechanical Cable for Above 3.95
MN28C Receiver Control Box 4.95
Other Accessories available from stock.

NAVY AIRCRAFT RADIO RECEIVER

ARB/CRV 46151—190 to 9050 Kc in 4 bands. 6 Tube Superhet communications receiver, with local and remote tuning, band change. Sharp and broad tuning. AVC, CW. Illuminated dial. Complete with tubes and dynamotor. BRAND NEW $34.50
Like New $26.50
Power Supply 110 V. AC. Wired $8.50

MICROPHONES

Model	Description	Excellent Used	BRAND NEW
T-17	Carbon Hand Mike		$5.45
T-30	Carbon Throat Mike	$ .34	.74
T-45	Army and Navy Lip Mike		1.25
TS-9	Handset		3.88
TS-11	Handset		3.95
TS-13	Handset		4.25
RS-38	Navy Type		4.75

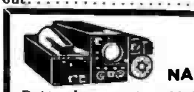
HEADPHONES

Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.19	$4.65
HS-33	Low Impedance	2.69	4.65
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

NAVY DYNAMIC HEADSET, HI-FI 40 to 14000 cycles, no distortion, complete with cushions, checked out .... Exc. used **$7.95**

LORAN APN-4



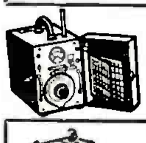
FINE QUALITY NAVIGATIONAL EQUIPMENT

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 .. **$79.50**
12 V. Inverter Power Supply for above. BRAND NEW $32.50
28 V. Inverter Power Supply for above, exc. cond. $49.50

RADIO RECEIVER NAVY TYPE RAY-3

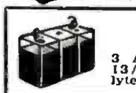
Model AN-PR6N is for 14V DC operation.
These receivers are supplied complete with built-in dynamotor, 11 tubes. Weston output meter on front panel, as well as coax antenna and output connection, phono jack, on-off switch. For 14V or 24V, please specify.
Like New Condition .... Our Price **$14.95**

BC-906 FREQ. METER—SPECIAL



Cavity type, 145 to 235 Mc. BRAND NEW, complete with antenna. Manual included.
OUR LOW PRICE **$10.88**

WILLARD 6-VOLT MIDGET STORAGE BATTERY



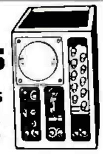
3 Amp. Hour. BRAND NEW. 3⅝" x 1-13/16" x 2⅜". Uses Standard Electrolyte .... Only $2.95

2 VOLT BATTERY "PACKAGE"

1—2V. 20 Amp. Hr. Willard Storage Battery. Model #20-2. 3" x 4" x 5½" 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**

SCHEMATIC DIAGRAMS For any equipment on this page, each.. **65c**

BC-603 FM RECEIVER



20 TO 27.9 MC.
Excellent Used **$14.95**
BRAND NEW $16.95

10 Channel, pushbutton tuning or continuous tuning. Complete with speaker, tubes, squelch.

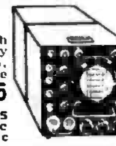
12 or 24V Dynamotor for Above. Exc. Used $4.25 .... Brand New **$5.50**
BC-604 TRANSMITTER—Companion unit for BC-603 Rcvr above. With all tubes. BRAND NEW $10.95
With Tubes. Used $4.95

SPECIAL! BC-603 FM RCVR CONVERTED FOR ANY FREQUENCY FROM 30 TO 50 MEGACYCLES!

BRAND NEW! Checked out, perfect working condition, ready for operation. Specify Frequency desired (between 30-50 Mc) when ordering. **$27.50**

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. $10.49
Complete 240-page Technical Manual for BC-603, 604 .... $2.95

BC-929 3-INCH SCOPE



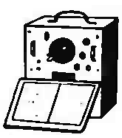
Low cost station monitor and/or bench scope. Has Horiz., focus, sweep, intensity controls. Tubes: 2—6SN7, 2—6H6, 1—6X5, 1—6G6, 1—2X2, 3BP1 CR Tube. Voltage req. 115V 400 cy. and 24VDC.
Complete with tubes, exc. used .. **$9.95**
BRAND NEW $12.95
Conversion instructions for 110V 60 cyc AC 65c

TERRIFIC BUY!

FAMOUS SCR-510 COMPLETE SET

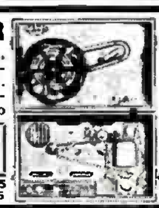
Consisting of: BC-620 FM TRANSCEIVER, 20-28 Mc., with Power Supply for 6 or 12 Volt DC operation, including all components: Antenna, Mast Base and Sections, Handset, Technical Manual and all other accessories, ready for operation. BRAND NEW, in original packing.
OUR LOW PRICE, While They Last! .. **$59.50**

BC-221 FREQUENCY METER



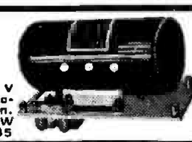
SPECIAL BUY! This excellent frequency standard is equipped with original calibration charts, and has ranges from 125 Kc to 20,000 Kc with crystal check points in all ranges. At our smashing low price it's FIRST COME FIRST SERVED! Hurry, quantity is limited. Excel. Used with original Calibration Book, Crystal, and all tables **$59.50**

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.
BRAND NEW **$22.50**
Checked out, exc. used $18.95
Single Reels of Tape, Each. $1.85

MOBILE-MARINE DYNAMOTOR



Model DM35
Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs. OUR LOW PRICE. BRAND NEW ... $8.45

OTHER DYNAMOTOR VALUES:

Type	Input	Output	Excellent Used	BRAND NEW
DM-25	12V 2.2A	250V .050A		$4.50
DA-1A	28V 1.6A	230V .100A		3.25
DM-28	28V	224V .07A	2.75	4.75
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	7.95	10.50
PE-86	28V 1.25A	250V .050A	2.75	3.85

BD-77 DYNAMOTOR Input 14V @ 30A. Output 1000V @ .350 A, with starting solenoid, Filter Box and Mounting Base .... Like New $14.95

STANDARD TUBES

Removed from Brand New Gov't Equipment

RECEIVING					
6AG5	.35	12SG7	.75	807	.95
12AT7	.45	6J5	.65	813	6.95
6AK5	.40	6H6	.55	814	2.25
6C4	.25	6SL7	.85	815	2.15
6AL5	.38	12A6	.45	826	.44
6AC7	.55	SPECIAL PURP.		1625	.29
6J6	.32	2C39	3.50	4X-150	5.95
6V6	.65	3E29	4.25	6072	2.50
				1P25A	7.95

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
51 Vesey St., New York 7, N. Y.

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc
$48.50

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. PP811s modulate 813 in final up to 90%, class "B." A Real "HOT" Ham buy at our low price! Orig. cost $1800. Exc. Used **$48.50**
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

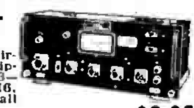
BC-652A RECEIVER—Hot Special! 2000 to 6000 Kc AM Receiver, 2-band, complete with all tubes, 200 Kc Xtal Calibrators, and 12 V Dynamotor. Fine for 80-meter Ham band, Marine, etc. Provides for CW, MVC, AVC. Speaker Jack and two Headphone Jacks. Shpg. Wt. 50 lbs. Like new, only .. $22.50

POWER SUPPLY for BC-620, 659, available for 6, 12 or 24 Volts DC. Specify $8.95

BC-659 TRANSMITTER & RECEIVER

27 to 38.9 Mc. F.M. Two preselected channels crystal controlled. 5 watts. Complete with speaker, tubes. Used **$10.95**
Less tubes, used $5.95
Antenna for BC-659. Telescoping 20" to 8-Ft. $2.95

FM TRANSMITTER-RECEIVER



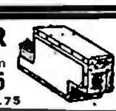
APN-1. 420 to 460 Mc Aircraft Radio altimeter equipment. Tubes: 4—955, 3—12SJ7, 4—12SH7, 2—12H6, 1—VR150. Complete with all tubes. For 27 V DC.
BRAND NEW **$8.95**

BC-733 VHF 10-TUBE AIRCRAFT RECEIVER. 6-channel xtal control. Freq. 108.3 to 110.3 Mc. Dual filter range. Easily converted for tracking Sputniks!
Brand New complete with tubes **$8.95**
Dynamotor for above 24 V. New $5.95

BC1206-C BEACON RECEIVER

195 to 420 Kc. made by Setchel - Carlson. Works on 24-28 volts DC. 135 Kc. IF. Complete with 5 tubes. Size 4" x 4" x 6". Wt. 4 lbs. BRAND NEW ... **$9.99**
Brand New, less tubes . $5.95
USED, with tubes 5.95
USED, less tubes 2.95

ARC-5/R28 RECEIVER



2-meter Superhet. 100 to 156 Mc in 4 crystal channels. Complete with 10 Tubes. BRAND NEW **$24.45**
110V AC Power Sup. Kit for above $9.75

ARC-5/T-23 TRANSMITTER

100-150 Mc Includes 2—832A, 2—1625 Tubes. BRAND NEW **$21.50**
SPECIAL OFFER! Limited quantity ARC-5/T23 xmitters. Excellent Used, less tubes $5.95
MD-7 MODULATOR for T-23, complete with 4 tubes. LIKE NEW **$9.95**

ARC-5 MARINE RECEIVER-TRANSMITTER

Navy Type Comm. Receiver 1.5 to 3 Mc BRAND NEW with 6 tubes **$16.95**
Navy Type Comm. Transmitter 2.1-3 Mc BRAND NEW with 4 tubes and Xtal **$12.45**
MODULATOR for above, new with tubes $5.95

SCR-274 COMMAND EQUIPMENT

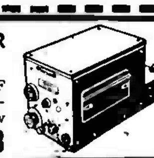
ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 Mc.	9.45	12.45
BC-455	Receiver 6-9 Mc.	11.50	13.95
BC-450	3-Receiver Control Box	1.29	1.75

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case. Instructions **$7.95**
Factory wired, tested, ready to operate ... $11.50
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only **49c**

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW .. **$7.85**
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW **$9.75**
BC-459 TRANSMITTER—7-9.1 Mc. complete with all tubes and crystal. **$13.95**
BC-456 Modulator .... USED 3.45 NEW 5.95
BC-451 Transmitter Control Box .. 1.25 NEW 1.49
ALL ACCESSORIES AVAILABLE FOR COMMAND EQUIPMENT.

234-258 MC RECEIVER



AN/ARR-2

BRAND NEW 11-tube UHF Tunable Receiver with schematic. Only a few at this low price!
Complete with tubes **$8.88**

Send Name, Address on Post Card for FREE CATALOG of Wonderful Surplus Buys!

Portable test instruments are desirable, as they permit routine checking without removing units from vehicles.

service rates that are both reasonable and realistic.

Another benefit to the customer is improvement in reliability of the equipment, from a viewpoint other than those already mentioned. As an example, we determined that it would be economical for us to install, at our own expense, special premium tubes in certain equipment located in remote areas where the cost of tube replacement was much higher than normal. In some instances, these more expensive tubes were "paid out" within a year due to reduced service calls. At the same time, of course, the customer benefited due to reduced "outages" of the equipment.

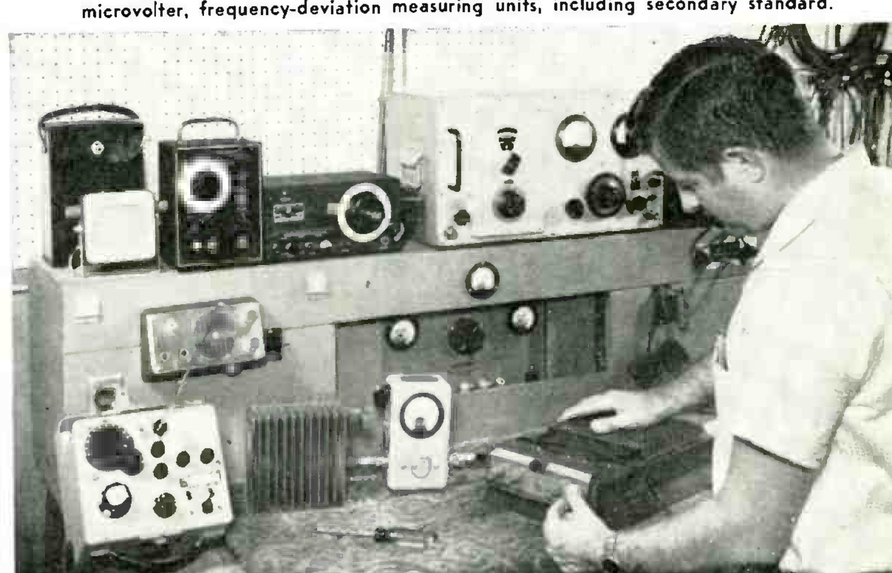
In the past year we have all heard a great deal about transistors and the manner in which they are being applied to two-way radio equipment. Already they are being widely used in the power-supply portions of two-way equipment and are now being introduced into the receiver and some stages of the transmitter with marked reductions in battery drain. As indicated earlier, tube replacement is the largest single cost of repair so that the use of more reliable transistors should improve system reliability and reduce repair cost. However, it must be noted that tube replacement still represents only 30% of *total radio maintenance* costs. Thus, even if a large number of the tubes are replaced by transistors, it is unlikely that maintenance costs will be "slashed" as claimed by some of the more enthusiastic proponents of transistors.

In summary, the radio maintenance engineer should provide complete communications service and not limit his horizons to tube replacement, discriminator readings, and plate current measurement. Instead, he must constantly observe the operation of the entire system to determine if changes in the equipment, antenna directivity, or other operational features can be made that will further improve the value of radio to the user. He should keep in mind that present-day industrial operations are not static. A two-way radio system properly designed by a sales engineer to meet a user's operating requirement several years ago may not meet current requirements due to shifts in areas, change in operations, or expansions.

An alert maintenance organization is usually the first to notice the need for system modification. For example, it may note that there are an increasing number of service calls for a particular area which, upon investigation, will show that the user is now operating in areas beyond the original range planned for that station. The service organization must then work closely with the operating department to determine the nature of the trend and whether changes in the coverage might be warranted either through antenna directivity or relocation of the station.

Only in this way can the mobile radio expert properly carry out his mission of providing communications instead of mere repair service. —30—

Quality work calls for precision equipment. This includes battery eliminator, microvolter, frequency-deviation measuring units, including secondary standard.



Mac's Service Shop

(Continued from page 64)

without helping the oscillation a bit. And there's nothing wrong with that resistor, either. Unsoldering those neutralizing capacitors and soldering them back is quite a tedious job, I might mention."

"I can imagine," Mac muttered as he continued studying the diagram. "Of course we could be up against a defective transistor, but I doubt it."

"The transistor checker doubts it, too," Barney said. "They all check good with normal gain and no excessive leakage."

"Is there any way you can stop oscillation and still get reception?"

"Yes, if I put my finger on the collector or base of the mixer stage the oscillation stops and the local station can be heard."

Mac was silent for several minutes as he scrutinized the diagram. Then he put it down and picked up the little chassis and looked it over closely. "Hand me a 2.2k resistor," he finally said to Barney.

Carefully he shaped the resistor leads until he could bridge the resistor across a couple of points on the printed circuit board; then, holding the resistor in place, he turned on the receiver. It played perfectly, without a sign of oscillation, until he removed the resistor. When he did that, the oscillation returned.

"Well I'll be!" Barney exclaimed with a mixture of relief and disgust in his voice. "I was so sure those resistance checks were all correct."

"They probably were; but this open resistor—if it *is* open—would not show on those checks," Mac answered as he plugged in the pencil soldering iron.

"Take a look at the diagram. The set has an r.f. stage ahead of the mixer, but only the antenna circuit and the oscillator circuit are tuned with the tuning capacitor. The collector of the r.f. stage is coupled to the base of the mixer through a capacitor. Now notice this parallel-tuned circuit in the collector lead of the r.f. stage. See the coil resistance is given as 19 ohms. But notice, too, that this 2.2k resistor is actually connected directly across the tuned circuit. It 'loads' the circuit, lowers the '*Q*,' and broadbands the response. With the resistor in place, the r.f. stage is probably designed to deliver uniform response across the whole broadcast band; but when the resistor opens, the '*Q*' of the tuned circuit and the impedance at the input of the mixer stage shoots up sharply while the frequency response narrows—which makes things dandy for the mixer stage to oscillate at the i.f. frequency." As he finished speaking, Mac lifted the unsoldered resistor from the printed circuit board and placed the ohmmeter test leads across it. The meter pointer did not even flicker. "It's wide open all right," he said as he started soldering the new resistor in place.

"An open 2.2k resistor would never show across 19 ohms," Barney mused; "but what ever made you suspect that resistor might be open?"

"Your excellent, methodical procedure had just about eliminated everything else; and when you said you could kill the oscillation by putting your finger on the base or collector of the mixer, I started looking for something that would normally load a portion of the circuit as the presence of your finger did. That line of reasoning pointed squarely at the quarter-watt resistor. Incidentally, I've noticed quarter-watt resistors are more prone to open-circuiting than are half-watt units, even when they carry no current."

"Well, I wish I'd found the trouble myself, but I'm happy it's been found," Barney announced. "Ain't it a great feeling when a problem that's been deviling you for a long time is finally whipped? I feel exactly like a cork that's been held under water for a long time and has finally been released so it can pop to the surface." —30—

BOOSTING AUDIO IN COMMAND SETS

By **HARTLAND B. SMITH, W8VVD**

On the ham band one often hears complaints regarding the low audio level produced by surplus Command Receivers such as the BC-455 and the R-26/ARC-5. Many who have hooked 6-ohm speakers to these sets blame the lack of sufficient volume level on the fact that there is no driver for the 12A6 output stage. Apparently they feel that since there is no audio amplifier between the detector and the output tube, a Command Receiver just won't furnish enough power to operate a loudspeaker.

Actually, the reason for low volume is a mismatch between the 12A6 and the speaker. The output transformer of a Command Receiver has a turns ratio of 8:1. The recommended load for a 12A6, according to the tube charts, is 7500 ohms. Since the impedance ratio of a transformer is equivalent to the square of its turns ratio, the Command Receiver output transformer has an impedance conversion ratio of 64:1. Thus, it will step down the 7500-ohm load on the plate of the 12A6 to a value of approximately 117 ohms (7500/64). A 6-ohm speaker connected across the 117-ohm terminals of the output transformer will develop very little acoustic power because of the exceptionally poor impedance match.

The cure for the low audio is not, therefore, added amplification, but a better impedance match. This may be effected in two ways. You can put a step-down transformer (125 ohms to voice coil will be OK) between the Command Receiver and the speaker, or, if you don't mind digging into the receiver itself, you can remove the 8:1 transformer and replace it with a small universal type plate-to-voice-coil transformer. In either case, after you've made the change, you will be surprised at how much volume is produced by the Command Receiver.

Hooked to a good antenna, the ham band sigs will come through so loud you definitely will want to keep the gain control below maximum setting. —30—

Electronic Crosswords

By **GORDON B. DUNCAN**

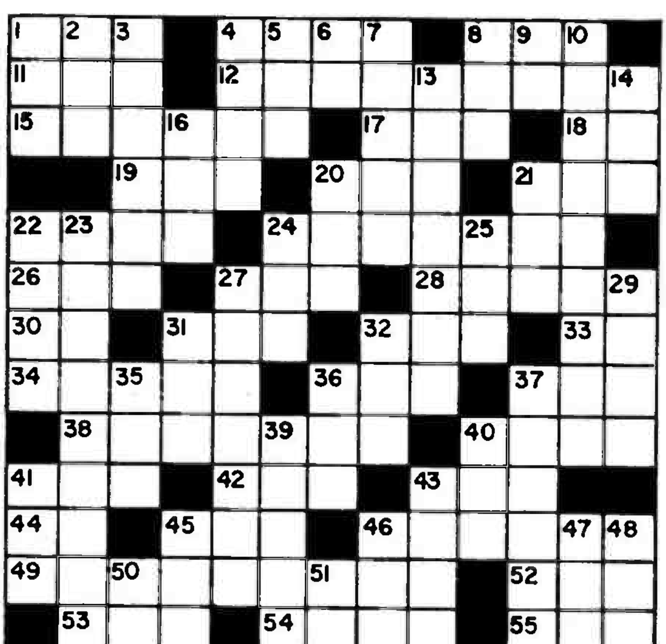
HOW'S your knowledge of electronic terminology and are you "up" on some of the little-known words to be found in any standard dictionary? Here is a chance for you to test yourself. If you get stuck, the answer is on page 120.

ACROSS

1. Resistor striped brown-black-green (colloq.).
2. Book of Bible (abbr.).
8. Word common to cps, rpm, and mph.
11. Feminine pronoun.
12. Animals who enjoy vegetables with their meat.
15. Source of power for home lighting in ancient Greece.
17. Unit in Morse Code.
18. Pitcher's dream (abbr.).
19. Old game revived for electronic brains.
20. Power ratio unit.
21. Wire size (slang).
22. Try to persuade.
24. Positive particles in atom.
26. Excessively.
27. Adjust meter readings (abbr.).
28. Main artery.
30. Prerequisite for some electronic jobs (abbr.).
31. Supplied with signal.
32. Past time.
33. "Either's" twin.
34. Scornful expression.
36. Raw metal.
37. Method of shipping (abbr.).
38. Obsolete sewing machine part.
40. Low audio frequency.
41. Compensation for signal variations (abbr.).
42. Wet soil.
43. Liable to cause misadjustment of ion trap.
44. Henrys times volts (abbr.).
45. American soldiers (slang).
46. Usually can't have built-in hi-fi.
49. Causing current to lag voltage.
52. Female deer.
53. Male progeny.
54. Time of orbital cycle.
55. Hobbyist who tunes in overseas broadcasts (abbr.).

DOWN

1. Transconductance of 200 6AU6's parallel.
2. Fish equipped with 600-volt "batteries."
3. Foreigner in Mexico (esp. Yankee).
4. Rhythmic utterance.
5. The d.c. equivalent of a.c.
6. Closed position of s.p.s.t. switch.
7. AM portion of TV wave.
8. Resistor with variable tap (colloq.).
9. One side of Ohm's Law equation.
10. Most numerous components in any kit.
13. Electromotive force.
14. Basic source of energy (colloq.).
16. Compete.
20. An Army Ordnance Research Group (abbr.).
21. Swank suburban apartment (phone-book abbr.).
22. Shoshonian Indian.
23. X-ray units.
24. Speaker volume control.
25. Result of too much registration.
27. Type of capacitor.
31. Charge for professional services.
32. Plural of "am."
35. Voltage drop across wave-shaping network (symbol).
36. Not the latest.
37. Units of capacitance.
39. Condition of many dim picture tubes.
40. Taboo.
41. Storybook user of R/C cave opener (first name).
43. Taunt.
45. Core of CRT.
46. Government agency producing electric power.
47. At present.
48. Wired communication (abbr.).
50. Auxiliary verb.
51. Equal conductance (symbol).



Pix Tube as Tuning Eye

(*Continued from page 46*)

provides a steady but gradual change in bias, from one horizontal scanning line to the next during each raster frame, in addition to the bias established by the output of D_3. Thus there is a slight, progressive difference in the width of the pulse from one scanning line to the next, enough to produce a triangle, as shown at *B* in the insert of Fig. 1. For a portion of the vertical scan, the vertical pulses manage to cut off the clipper (and consequently the square pulses) entirely, so that the top of the triangle is kept visible.

At correct tuning, triangle height is maximum. When the receiver is detuned 100 kc. on a reasonably strong signal, triangle height is reduced about 20 per-cent, a very noticeable difference. Thus greater accuracy than within 100 kc. is possible, although even this degree of detuning is difficult to recognize in the picture, what with the wide-band reception and detection involved. A 5-megohm potentiometer, in the cathode of V_1, acts as a sensitivity control to adjust for differences from one transmission to another. With this, average triangle height is set so that it is adequate to indicate tuning variations clearly but not so large as to drive triangle tips off-screen.

When the indicating circuitry is not in use, turning it off, as indicated by the switches shown in the schematic, keeps it in a stand-by condition, ready for use when desired. Plate voltage for the three stages is reduced by a 30,000-ohm dropping resistor. Output pulses from the doubler, required to activate the circuit, are switched to ground so that there is no effect on the picture being viewed. —30—

PROTECT METER MOVEMENT

By ROBERT HERTZBERG

IF YOU have occasion to carry a multimeter in a car, protect the needle against excessive movement and possible damage by connecting a dynamic brake to the plus and minus jacks. This "brake" is nothing more than a shorting link of wire, the ends of which are stiffened with solder. Set the meter to its lowest current scale.

A swinging needle makes the meter act as a small generator. The load imposed by the shorting link tends to slow it down. A few high-grade meters have a "transit" position for the range switch which accomplishes the same job. —30—

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Whether electronics is your hobby or business—you can't afford to miss articles like these—samples of the wealth of information that is yours in the authoritative August issue of ELECTRONICS WORLD.

New Tube Tester Data

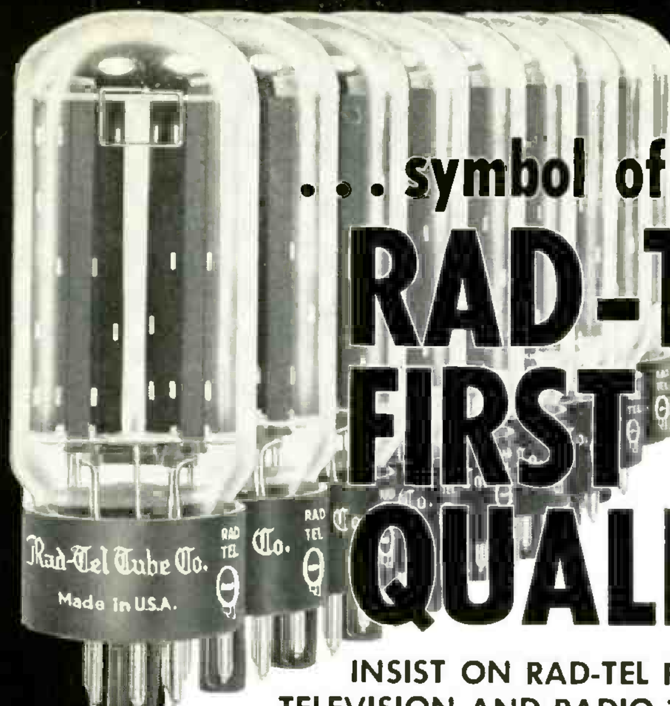
Hole locations for new types for RCA testers and corrections. First part of list appeared in June.

RCA AUTOMATIC TESTER, WT-110A

TUBE TYPE	HOLE LOCATIONS TO BE PUNCHED	NOTES
5DB5	A2, B8, F4, G6, K1, L5, L6, L10, M4, M10, N2, N9	Test P1 and P2. Reject if below 4.
10DR7 Triode #1	A4, B5, C8, D7, G6, J1, K6, L1, M5, M10, N5, N9	For gas test, see instructions;
10DR7 Triode #2	A4, B5, C9, D2, G1, J7, K6, L1, L6, L7, M5, M10, N5, N9	
11C5	A3, B4, C1, D2, E6, G7, I9, I10, J1, K5, L1, L6, L7, M1, M10, N2, N9	
12AE7 Triode #1	A4, B5, C8, D7 G6, J1, K7, L2, L6, L7, M2, M10, N3, N9	For gas test, see instructions.
12AE7 Triode #2	A4, B5, C3, D2, G1, I7, I9, J1, K5, L2, L6, L7, M2, M10, N3, N9	
12BD5	A2, B7, C3, D1, E8, G5, I6, I10, J8, K7, L1, L6, L7, M2, M10, N3, N9	
12DT6	A3, B4, C2, D1, D7, E6, G5, I6, I10, J4, K7, L1, M2, M10, N4, N9	Reject if below 3. For gas test, see instructions.
12DU7 Tetrode	A4, B5, C2, D1, E3, G6, I7, I10, J1, K4, L2, L6, L7, M2, M10, N3, N9	
12DU7 Diode	A4, B5, C2, F9, G7, K6, L4, M2, M10, N3, N9	Reject if below 4. Test P1 and P2.
12FR8 Triode	A4, B5, C2, D1, G9, J2, K9, K10, L2, M2, M10, N3, N9	For gas test, see instructions.
12FR8 Pentode	A4, B5, D3, E6, G7, J2, K3, L2, M2, M10, N3, N9	For gas test, see instructions.
12FR8 Diode	A4, B5, C2, G8, I6, I10, K10, L3, M2, M10, N3, N9	Reject if below 2.
12FT6 Triode	A3, B4, C2, D1, G7, I6, I10, J1, K10, L2, M2, M10, N3, N9	
12FT6 Diode	A3, B4, C2, F5, G6, I6, I10, K10, L3, M2, M10, N3, N9	Test P1 and P2. Reject if below 2.
12FX8 Triode	A4, B5, D6, G8, J2, K8, L2, M2, M10, N3, N9	For gas test, see instructions.
12FX8 Heptode	A4, B5, C7, D2, D9, E1, G3, I6, I10, J2, K9, K10, L2, M2, M10, N3, N9	For gas test, see instructions.
14A4	A1, B8, C7, D6, G2, I6, I10, J2, K7, L1, L6, L7, M2, M10, N3, N9	
14V7	A1, B5, B8, C4, C7, D6, E3, G2, I8, I10, J1, K5, L1, L6, L7, M2, M10, N3, N9	
17CA5	A3, B4, C1, D2, D5, E6, G7, I6, I10, J5, K1, L1, L6, L7, M4, M9, N2, N8	
17EW8	A4, B5, B9, C3, C8, D2, D7, F1, G6, I7, I8, J1, K9, L1, L6, L8, M3, M9, N2, N8	Test P1 and P2.
17R5	A3, B4, C1, D2, E6, G7, I6, I10, J9, K10, L1, L6, L9, M4, M9, N2, N8	
19CL8 Tetrode	A4, B5, C8, D9, E7, G6, I6, I10, J2, K3, L1, L6, L7, M4, M9, N3, N8	
19CL8 Triode	A4, B5, C3, D1, G2, I6, I10, J2, K1, L1, L6, L7, M4, M9, N3, N8	
19EA8 Triode	A4, B5, C8, D9, G1, I6, I9, J1, K1, L1, L6, L7, M4, M9, N3, N8	
19EA8 Pentode	A4, B5, C7, D2, E3, G6, I6, I10, J2, K3, L1, L6, L7, M4, M9, N3, N8	
25AU4	A7, B8, C3, G5, I6, I10, K4, L4, L6, L10, M1, M9, N5, N8	Reject if below 4.
25FY8 Triode	A4, B5, C8, D1, G9, J2, K5, L1, M1, M9, N5, N8	
25FY8 Pentode	A4, B5, C2, D3, E7, G6, I8, I10, J1, K2, L1, L6, L7, M1, M9, N5, N8	
32A8 Triode	A4, B5, C8, D1, G9, J2, K7, L1, M3, M10, N2, N8	For gas test, see instructions.
32A8 Pentode	A4, B5, C2, D3, E7, G6, I6, I7, J1, K4, L1, L6, L7, M3, M10, N2, N8	
35EH5	A3, B4, C1, D2, E6, G7, I7, I10, J1, K6, L1, L6, L8, M5, M10, N1, N8	
60E3	A3, B4, C7, G5, I6, I10, K5, L4, L6, L10, M5, M9, N5, N7	Reject if below 4.
1203A (Same as 7C4)	A1, B8, C7, G4, K6, L3, M5, M10, N2, N9	Reject if below 4.

OTHER CORRECTIONS

1. Remove first data on 6CZ5.
2. Remove first data on 6DQ5.
3. Remove second data on 12AU7.
4. Correct 25GD6 data to read 25CD6.
5. Remove double reference to 6V6.



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	1AX2	.62
	1B3GT	.79
	1DN5	.55
	1G3	.73
	1J3	.73
	1K3	.73
	1L6	1.05
	1LN5	.59
	1R5	.62
	1S5	.51
	1T4	.58
	1U4	.57
	1U5	.50
	1X2B	.82
	2AF4	.96
	2CY5	.71
	3AL5	.42
	3AU6	.51
	3AV6	.41
	3BA6	.51
	3BC5	.54
	3BE6	.52
	3BN6	.76
	3BU8	.78
	3BY6	.55
	3BZ6	.55
	3CB6	.54
	3CF6	.60
	3CS6	.52
	3CY5	.71
	3DK6	.60

Qty.	Type	Price
	3DT6	.50
	3Q5	.80
	3S4	.61
	3V4	.58
	4BC5	.56
	4BC8	.96
	4BN6	.75
	4BQ7	.96
	4BS8	.98
	4BU8	.71
	4BZ6	.58
	4BZ7	.96
	4CS6	.61
	4DE6	.62
	4DK6	.60
	4DT6	.55
	5AM8	.79
	5AN8	.86
	5AQ5	.52
	5AT8	.80
	5BK7A	.82
	5BQ7	.97
	5BR8	.79
	5CG8	.76
	5CL8	.76
	5EA8	.80
	5EU8	.80
	5J6	.68
	5T8	.81
	5U4	.60
	5U8	.81
	5V6	.56
	5X8	.78
	5Y3	.46

Qty.	Type	Price
	6AB4	.46
	6AC7	.96
	6AF3	.73
	6AF4	.97
	6AG5	.65
	6AH6	.99
	6AK5	.95
	6AL5	.47
	6AM8	.78
	6AN4	.95
	6AN8	.85
	6AQ5	.50
	6AR5	.55
	6AS5	.60
	6AT6	.43
	6AT8	.79
	6AU4	.82
	6AU6	.50
	6AU7	.61
	6AU8	.87
	6AV6	.40
	6AW8	.89
	6AX4	.65
	6AX7	.64
	6BA6	.49
	6BC5	.54
	6BC7	.94
	6BC8	.97
	6BD6	.51
	6BE6	.55
	6BF6	.44
	6BG6	1.66
	6BH6	.65
	6BH8	.87

Qty.	Type	Price
	6BJ6	.62
	6BK7	.85
	6BL7	1.00
	6BN4	.57
	6BN6	.74
	6BQ5	.65
	6BQ6GT	1.05
	6BQ7	.95
	6BR8	.78
	6BU8	.70
	6BY6	.54
	6BZ6	.54
	6BZ7	.97
	6C4	.43
	6CB6	.54
	6CD6	1.42
	6CF6	.64
	6CG7	.60
	6CG8	.77
	6CM7	.66
	6CN7	.65
	6CR6	.51
	6CS6	.57
	6CU5	.58
	6CU6	1.08
	6CY5	.70
	6CY7	.71
	6DA4	.68
	6DB5	.69
	6DE6	.58
	6DG6	.59
	6DQ6	1.10
	6DT5	.76
	6DT6	.53

Qty.	Type	Price
	6EU8	.79
	6EA8	.79
	6H6GT	.58
	6J5GT	.51
	6J6	.67
	6K6	.79
	6S4	.48
	6SA7GT	.76
	6SK7GT	.74
	6SL7	.80
	6SN7	.65
	6SQ7	.73
	6T4	.99
	6U8	.78
	6V6GT	.54
	6W4	.75
	6W6	.69
	6X4	.39
	6X5GT	.53
	6X8	.77
	7AU7	.61
	7A8	.68
	7B6	.69
	7Y4	.69
	8AU8	.83
	8AW8	.93
	8BQ5	.60
	8CG7	.62
	8CM7	.68
	8CN7	.97
	8CX8	.93
	8EB8	.94
	10DA7	.71
	11CY7	.75

Qty.	Type	Price
	12A4	.60
	12AB5	.55
	12AC6	.49
	12AD6	.57
	12AE6	.43
	12AF3	.73
	12AF6	.49
	12AJ6	.46
	12AL5	.45
	12AL8	.95
	12AQ5	.52
	12AT6	.43
	12AT7	.76
	12AU6	.50
	12AU7	.60
	12AV5	.97
	12AV6	.41
	12AV7	.75
	12AX4	.67
	12AX7	.63
	12AZ7	.86
	12B4	.63
	12BA6	.50

Qty.	Type	Price
	12BD6	.50
	12BE6	.53
	12BF6	.44
	12BH7	.73
	12BL6	.56
	12BQ6	1.06
	12BY7	.74
	12BZ7	.75
	12C5	.56
	12CA5	.59
	12CN5	.56
	12CR6	.54
	12CU5	.58
	12CU6	1.06
	12CX6	.54
	12DB5	.69
	12DE8	.75
	12DL8	.85
	12DM7	.67
	12DQ6	1.04
	12DS7	.79
	12DZ6	.56
	12EL6	.50

Qty.	Type	Price
	12EG6	.54
	12EZ6	.53
	12F5	.66
	12F8	.66
	12FM6	.45
	12K5	.65
	12SA7M	.86
	12SK7GT	.74
	12SN7	.67
	12SQ7M	.73
	12U7	.62
	12V6GT	.53
	12W6	.69
	12X4	.38
	17AX4	.67
	17BQ6	1.09
	17C5	.58
	17CA5	.62
	17D4	.69
	17DQ6	1.06
	17L6	.58
	17W6	.70
	19AU4	.83

Qty.	Type	Price
	19BG6	1.39
	19T8	.80
	21EX6	1.49
	25BQ6	1.11
	25C5	.53
	25CA5	.59
	25CD6	1.44
	25CU6	1.11
	25DN6	1.42
	25EH5	.55
	25L6	.57
	25W4	.68
	25Z6	.66
	35C5	.51
	35L6	.57
	35W4	.52
	35Z5GT	.60
	50B5	.60
	50C5	.53
	50DC4	.37
	50EH5	.55
	50L6	.61
	117Z3	.61

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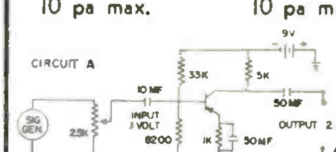
ICBO @ 6V 10 pa max. IEBO @ 3V 10 pa max. hfe ckt A 25 min.



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Sound on Tape

By **BERT WHYTE**

AFTER the initial furor caused by all the slow-speed tape cartridges which were demonstrated at the IRE Show in New York, the tape world is rather quiet. Of course much of this can be attributed to the seasonal lulls, but it is also due to the fact that, for the most part, the public reacted with interest, but also with a rather "let's wait and see" attitude regarding the proposed new systems.

The consensus seems to be that since the final curtain was almost rung down on tape a few years ago, the present four-track system has enough to offer and is a relatively stable situation. Better to have this despite its limitations than to chase some ephemeral will-o-the-wisp cartridge deal which might result in drying up the available tape supply, such as happened when the stereo disc came along.

This is not to say that anyone wants a static situation but rather, because of the hard knocks the tape fan has received, he looks at things in a very realistic light and displays a much more sophisticated attitude than of yore. And this attitude seems to be reflected in the slow, evolutionary changes that are taking place in the tape business.

For instance, despite denials in some quarters, it has been the sales pattern that two-track stereo tapes were either equal or, in some cases, above the sale of four-track stereo tapes. This was only logical to expect since many owners of two-track machines were literally starved for material, caused by the long drought during the initial stereo disc days.

Now, as many new four-track machines have reached the market and many owners of two-track machines have converted to four-track, there has at last been a gradual lessening of demand for the two-track product. Not that this is now an insubstantial market! Most companies involved intend to supply the two-track market as long as there is sufficient demand to maintain production and make a profit. But the handwriting is on the wall and the encroachment of four-track is greater every day.

Most qualified observers feel the dam will really break at the onset of the Fall market, and that the four-track stereo tape will rule the roost! Impetus for this is furnished by the addition of the huge *London* catalogue and the upswing in activity on the part of producers already marketing four-track tapes.

There is a strong rumor that *RCA*, who has for some time maintained a solid front against reel-to-reel, four-track stereo tape will soon capitulate and issue much new four-track material. And a late flash of good news . . . *Capitol Records* which gave us so many fine tapes in the heyday of the two-track format and which stopped production with the onset of the stereo disc, has announced its intention to produce four-track stereo tapes. This will be domestically produced material and will also afford enthusiasts their first taste of *Angel-EMI* tapes. A very few of these were released in the old format and then cut off with the disc-induced cessation of production, so that few people have had a chance to hear some of these fine tapes.

With all this activity, tape is really "back in the act," and my one major gripe with four-track tape . . . a dearth of classical material . . . will be soon satisfied with the *Capitol* and probable *RCA* issues. It is to be hoped that this will stimulate other producers to step up their classical releases.

As it stands now, one must look to the *Everest, London,* and *Vanguard* catalogues for the bulk of four-track classical releases. Let's hope these other outfits get the message and surprise us with some classical goodies.

DEBUSSY
LA MER
THE AFTERNOON OF A FAUN
RAVEL
RAPSODIE ESPAGNOLE

L'Orchestre de la Suisse Romande conducted by Ernest Ansermet. London four-track stereo LCL80013. Price $7.95.

This is one of the new *London* tapes and, as with any Debussy-Ravel music conducted by Ansermet, I was eager to have a listen. To this music Ansermet has addressed himself countless times and with his long association with the composers and with the Diaghilev Ballet, his readings have been accepted as near-definitive.

Perhaps he has gone to the well once too often, but here I find his interpretations less of an exciting musical experience than in former recordings. His tempi seem overly slow and deliberate, he appears to use odd accents and phrasings, and the dynamic expression seems constrained. Maybe this is the way Ansermet feels the music should be played these days . . . as for me I'll take his earlier readings.

Perhaps these mannerisms are more exaggerated by the sound which didn't meet expectation. For one thing, the recorded level on the tape is comparatively low and the dynamic range seems severely limited . . . this from a company like *London* whose wide dynamics are virtually a trademark! The sonic texture is "flabby" and the whole sound rather lifeless. It is really an oddball for, in general, the sound is clean and balances well preserved and reverb has been expertly utilized for depth effects.

What is more puzzling is that if one tries to pin the blame for these faults on a disparity between the British CCIR equalization and our own NAB equalization, it is not always the case as witness the reported tape below.

As usual, I'll be in London in late summer and just for my own satisfaction I'm going to play some of these rebellious tapes on English tape machines with the CCIR equalization and hope to find some answers. I suspect that I will find that with these tapes which don't measure up to the usual *London* quality a new recording technique is being used which does not have the appeal for American ears, or has not been as perfected as the original techniques, rather than have the blame lie with any processing error.

RIMSKY-KORSAKOV
CAPRICCIO ESPAGNOL
GRANADOS
ANDALUSIA
CHABRIER
ESPANA
MOSKOWSKI
SPANISH DANCES
London Symphony Orchestra conducted by Ataulfo Argenta. London four-track stereo LCL80014. Price $7.95.

This is the very antithesis of the previous tape as regards to sound. This is high level, big, bold, and brassy, with some huge percussion very cleanly recorded, and nice bright string and wind tone.

The late Argenta was one of our most promising talents as a listen to this tape will prove. If he was not always perfection in a steady metrical beat, he still had an uncanny knack of pacing a performance so that it blazed with life. His dynamic expression was particularly varied and plastic and gave his readings an unmistakable stamp.

The stereo effects here are all that one could desire . . . good directionality without excessive spread . . . clever handling of reverb for good front-to-back depth effects, and great ease of aural positioning. Instrumental definition was of very high order and frequency range was impressively wide.

Tape hiss level was barely apparent when the tape was played at a good, room-filling level. When *forte* and *piano* sections of the opposite tracks were juxtaposed, there was some cross-channel leakage, but it was well down in level and would not be a problem except with the very biggest, top quality tape systems. —30—

Manufacturers' Literature

INDUSTRIAL TV CATALOGUE

Radio Corporation of America, ITV-Dep't. 759, Building 15-1, Camden 2, N. J. has announced a 112-page catalogue of closed-circuit television equipment for industry. Described as the first complete listing of its kind, the catalogue is intended as an aid in planning TV systems for a number of industrial applications.

Equipment listed includes cameras, housings, lenses, monitors, switchers, microwave gear, and the new *RCA* Television Tape Recorder. The catalogue should be requested on your company letterhead.

PANEL-MOUNTING METERS

Metronix, Inc., Chesterfield, Ohio is offering a new folder of data sheets describing its line of panel-mounting electronic voltmeters ("PMEV's"). These instruments are designed expressly for continuous monitoring of critical parameters in systems and consoles.

The folder, which discusses the reason for the development of PMEV's, includes descriptions and specifications on single and multiple range meters, both commercial and military types.

POWER SUPPLY CATALOGUE

Sorensen & Company, South Norwalk, Conn. will send on request a new 32-page handbook and catalogue describing more than 400 power supply models. Data is furnished on regulated d.c. supplies, frequency changers (variable frequency power sources), high-voltage power supplies (to 600 kv.) and other high voltage products, miniature transistorized inverters and converters, and a.c. line-voltage regulators.

A section of the catalogue provides technical data on the selection and use of these products.

NEW SWITCH CATALOGUE

Cinema Engineering Division, Aerovox Corporation, Sales Service Department, 1100 Chestnut St., Burbank, Calif. has made available a new catalogue describing the line of *Cinema* switches. Included in the 28-page illustrated booklet is general information on various types of switches, as well as terminal board reference charts, mechanical dimensions, engineering data, and product descriptions.

DIGEST OF PILOT LIGHTS

Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y. is offering a new 24-page Digest of condensed technical data on "Dialco" pilot light assemblies and the lamps for which they were designed. Described as a quick reference source to aid in the selection of pilot lamps, the Digest also includes information on lens holders, cable connectors, and bracket-mounted sockets for small lamps. Illustrations, charts, and circuit diagrams are provided. Request your copy by writing to Mr. R. E. Greene at the company address, asking for Form L-161B.

GERMANIUM TRANSISTORS

Electronic Transistors Corp., 9226 Hudson Blvd., North Bergen, N. J. announces a 4-page catalogue covering 412 germanium transistor types that are in stock or in production by the company.

According to the manufacturer, the catalogue covers virtually every known type for applications in computers, aircraft, missiles, military, marine, entertainment, and general industry. All are produced to registered EIA specifications.

RADIO SHACK SUPPLEMENT

Radio Shack Corp., 730 Commonwealth Ave., Boston 17, Mass. has issued a new 48-page supplement to its regular catalogue. Available free to the general public, the new publication lists and describes high fidelity and ham equipment, industrial and general type merchandise, records and tape, as well as sale items such as special purchases and closeouts.

INVENTORY HANDBOOK

The Business Publications Division of *Dun & Bradstreet, Inc.,* P.O. Box 803, Church Street Station, New York 8, N. Y. has issued a booklet "Inventories and Business Health." Written by a *Dun & Bradstreet* vice-president, Roy A. Foulke, the 61-page volume discusses the causes and effects of inventory losses in small businesses. The author also suggests certain "guides which can lead the business man to a fuller comprehension of inventories and their control" to improve business. Cost of the book is $1.00.

PLASTIC BOXES

Bradley Industries, 1650 North Damen Ave., Chicago 47, Ill. has issued a 16-page catalogue describing this company's line of small clear plastic boxes in a variety of shapes and styles. Primarily aimed at the industry, this catalogue points to the use of these boxes in terms of sales, packaging, product care, and handling costs.

MECHANICAL FILTERS

Collins Radio Co., Western Division, 2700 West Olive Ave., Burbank, Calif. has issued a specification sheet listing all of its mechanical filters in easy-reference tabular form. More than 90 different filters are covered. For a copy, write to the company and request Bulletin CR-WD-1005.

BRITISH TUBE LISTINGS

English Electric Valve Co., Ltd., Chelmsford, Essex, England has published a 36-page, spiral-bound book that supplies abridged data for all of this company's tubes (called "valves" in Britain).

Titled "Abridged Valve Data," the booklet describes various tube types including thyratrons, magnetrons, and TV camera tubes. A replacement index is also included. To receive a copy, write to the Technical Publications Dept. at the company address.

HIGH-TEMPERATURE CAPACITORS

Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J. is offering a 4-page product bulletin PS-6A describing new high-temperature mica and mylar motor-starting capacitors. These units have working ranges from −65°F to +700°F and −75°F to +400°F respectively.

To receive a copy of the bulletin, write to S. Banaski, Marketing Dept., at the manufacturer.

SEMICONDUCTOR MANUAL

Sylvania Electric Products Inc., P.O. Box 37, Buffalo 9, N. Y. has announced a semiconductor replacement guide, by equipment brand and model number.

The new manual provides replacement information and mechanical specifications for transistors, diodes, and rectifiers used in TV sets, radios, phonographs, tape recorders, and other home and hobby gear. The manual is available at 50 cents a copy from authorized *Sylvania* dealers or from the manufacturer direct.

EIA ENGINEERING REPORT

The Electronics Industries Association (formerly RETMA), 11 West 42 Street, New York 36, N. Y. has made available an engineering report that includes a bulletin of JEDEC type registrations for components. A list of other new EIA standards, as well as recent news of committee meetings, is included.

TV SERVICE BULLETIN

Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill. is offering a 4-page folder entitled "Servicing the Vertical Sweep System."

Practical hints on locating defects as well as techniques for determining suitable replacements for blocking oscillators and vertical output transformers are given. The publication is available free from *Stancor* distributors or by writing direct to the company.

SUBMINIATURE CAPACITORS

Mucon Corp., Dept. K, 9 St. Francis St., Newark 5, N. J. announces a 4-page bulletin K-1, describing its complete line of subminiature ceramic capacitors. Information included in the bulletin covers properties, ranges, terminal arrangements, and transistor circuit applications.

TEST EQUIPMENT

Precision Apparatus Co., Inc., 70-31 84th St., Glendale 27, L. I., N. Y. has released a 20-page catalogue that lists its lines of "Precision" test equipment and "Pace" panel meters.

The booklet, amply illustrated, contains general and technical descriptions, recommended uses, and prices. Accessories, such as probes and carrying cases, are included.

TV SERVICE BULLETIN

Supreme Publications, 1760 Balsam Rd., Highland Park. Ill. is offering a bulletin that describes in detail this publisher's recent "1960 Television Servicing Manual" as well as other *Supreme* publications.

WIRE CATALOGUE

Columbia Wire and Supply Co., 2850 W. Irving Park Rd., Chicago 18, Ill. has issued Supplement 108A to augment its regular and complete catalogue No. 108.

The supplement includes items not shown in the regular catalogue, including "Permaline" package TV transmission line, Citizens Band antenna kits, heavy duty extension cord, and others. —30—

Tape's Progress

(Continued from page 39)

expected to reach the market until 1961, we will just have to wait and see what effect these machines have on the over-all situation. (Editor's Note: For complete details on this newly proposed system, see our article "1⅞-ips Stereo Tape System" in the June issue.)

All told, it can be expected that pre-recorded tapes in cartridge form will appear in volume in the near future. Cartridges are presently intended for operation at 3¾ ips, although it is contemplated that in a year or less it may be feasible to provide good quality at lower speeds.

On the other hand, many tape enthusiasts will still prefer the open reel, particularly if pre-recorded tape is offered at no higher speed than 3¾ ips in cartridges. For the recordist, the open reel permits easier physical access to the tape, facilitating such procedures as editing and splicing.

Whatever form pre-recorded tape may take—cartridge or open reel—the rest of the audio system is ready for it. For some time, nearly every preamplifier or integrated amplifier made has incorporated an input specifically intened for the output of a tape head and supplying the necessary amplification and equalization. Therefore the individual having no desire to record tape but only to play it can purchase a transport mechanism and plug the output of the head into the audio system's preamplifier.

Standard Equalization

One of the most nebulous aspects of the tape situation has been playback equalization. Whereas the disc industry decided for once and for all upon a standard playback characteristic (RIAA curve) as far back as 1954, the issue is still unsettled in the case of tape.

The closest the tape industry has come to adoption of a standard has been the proclamation by manufacturers of tape recorders and preamplifiers that at 7½ ips they adhere to NAB (formerly NARTB) equalization, which is an *official* standard only at 15 ips. NAB playback equalization consists of bass boost commencing (3 db up) at 3180 cps, rising 6 db per octave with declining frequency, and tapering off (3 db below maximum) at 50 cps.

While a number of manufacturers have faithfully conformed to the 3180 cps turnover frequency, others have been less exact. Often a "modified" NAB curve has been used, having a turnover around 1600 cps; the result, when playing pre-recorded tapes conforming to NAB equalization, as most tapes do, is a significant deficiency of bass. This gives the non-conforming manufacturers an edge with respect to signal-to-noise ratio, because hum in playback is usually the chief deterrent to a high signal-to-noise ratio; de-emphasizing the bass lowers the hum.

However, it appears that adherence to NAB equalization at 7½ ips has grown to majority proportions and is continuing to increase. It is to be expected that all will conform in the near future, unless the MRIA (Magnetic Recording Industry Association). now at work on tape standards, decides upon a new equalization curve for 7½ ips.

The matter of equalization has been even less clear at 3¾ ips, but is also coming out of the dark. In the recent past, not even an unofficial standard was proclaimed. At least three different playback curves have been employed at this speed, having a bass turnover frequency of 795, 1326, or 1590 cps. It now seems that a playback curve with a turnover of 1326 cps has a good chance of becoming the standard.

The problem of choosing a playback equalization curve for a given tape speed is that of achieving the optimum combination of good treble response, low distortion, and high signal-to-noise ratio. At a given speed, it is possible to use, within limits, various playback curves, each of which is complemented by appropriate record equalization to provide flat record-playback response. Without going into the intricacies of tape equalization and the relationship of such equalization to treble response, distortion, and signal-to-noise ratio, let it simply be said here that there is just one optimum playback equalization for each tape speed.

Recording Level

As with equalization, there has been considerable lack of unanimity as to the maximum permissible recording level consistent with high fidelity. Tape machines have been variously rated at 1%, 2%, 3%, or 5% harmonic distortion, meaning that their record level indicators have been set to indicate maximum permissible recording level when harmonic distortion reaches one of these amounts. The difference between 1% and 5% harmonic distortion may at first seem fairly innocuous, but not when one realizes that the corresponding IM distortion may be 5% to 10% in the first case and far in excess of 30% in the second case.

Each increase of 1% in harmonic distortion in the range of 1% to 5% corresponds roughly to a 3 db rise in recording level. Therefore a machine rated at 3% harmonic distortion can quote a signal-to-noise ratio about 6 db higher than one rated at 1%. And the machine rated at 5% can quote a signal-to-noise ratio 6 db higher still.

A recording level that allows harmonic distortion to reach 5% seems excessive for high-fidelity requirements and perhaps for other uses as well. On the other hand, a recording level that stops at 1% distortion often tends to make an unnecessary sacrifice in signal-to-noise ratio. As a consequence, more and more machines, including the high-price ones, have been converging upon 3% harmonic distortion as the maximum permissible amount. It is to be hoped and expected that through MRIA or other means, unanimity will be reached on maximum recording level.

Mention has been made of the fact that a large number of home machines include such operating conveniences as in-line loading, footage counters, and automatic stops. Another tendency is toward better record level indicators; some machines that formerly employed neon lamps now use magic-eye tubes, while some that employed magic-eyes either are using newer types of magic-eyes which are easier to read or else have graduated to meters.

But in one vital respect there is yet no sign of ground being broken, namely provision for measuring and adjusting speed. In the case of record players, a good deal of attention has been given to speed-adjusting devices and to built-in stroboscopes for checking speed accuracy. Not so, as yet, in the case of tape recorders.

Since accurate speed and thereby accurate pitch are just as important in high-fidelity reproduction *via* tape as *via* disc, there is every reason to expect that one of the imminent developments in the tape field is the appearance of devices to insure accuracy of tape speed.

In conclusion it would seem then that the tape industry is active and healthy and raring to go to still greater heights of accomplishment and consumer acceptance. —30—

SHOCK MOUNTING WITH CABLE STRAPS

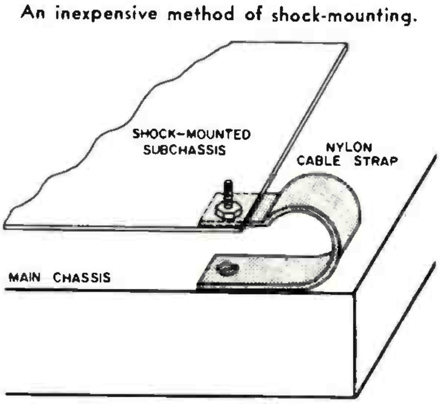
By WILLARD WEISS

A CONVENIENT way of shock mounting a subchassis on a larger chassis is to use nylon cable straps or clamps as supports. Sensitive and microphonic electronic circuits can be isolated in this manner.

The nylon clamps provide a very soft and springy support which is superior in some ways to rubber shock mounts. In addition they are more readily available than the rubber type of mount. They come in various sizes and stiffness. Normally one support is used at each corner of the sub-chassis but for heavier units as many as are required may be used around the edge.

The clamps the author has found most suitable are those made by Burndy Electrical Co. These units have mounting tongues spaced at the optimum distance. The spacing can be adjusted by heating the clamps if necessary. See diagram below. —30—

An inexpensive method of shock-mounting.



Radio Aids to Navigation

(Continued from page 32)

duced when these two signals are mixed depends upon the relative phase between them which, in turn, depends upon the loop position from true null. If the loop and sense signals are in-phase (that is, the loop is left of null) the two signals will tend to add together. When loop AM modulation is at maximum, the net output will also be at a maximum. However, if the loop and sense signals are 180 degrees out-of-phase (that is, the loop is right of null) the two signals will tend to subtract and cancel each other. Therefore, when loop AM modulation is at maximum, maximum cancellation occurs and the net output will be at a minimum. The result is that the 115-cycle modulation envelope of the mixed signal either leads or lags the 115-cycle reference produced by the synchronous vibrator by 90 degrees depending upon the relative position of the loop. The waveforms produced are shown at (5) in Fig. 2.

The combined r.f. signal now proceeds through a conventional superheterodyne receiver. At the output of the detector, the detected 115-cycle modulation is separated from communication voice frequencies by a filter. The filtered 115-cycle signal is then amplified in a push-pull compass output power amplifier and is then used to power the control winding of a two-phase loop motor. The reference winding of the loop motor is powered by the 115-cycle vibrator supply.

The two-phase loop motor has two important characteristics. First, it develops maximum rotation torque when its two windings are fed 90 degrees out-of-phase with each other. Second, the direction of shaft rotation depends upon whether the signal winding voltage leads or lags the reference winding by 90 degrees. As was pointed out earlier, the 115-cycle modulation either leads or lags the 115-cycle reference voltage by 90 degrees depending upon whether the loop is to the left or right of a true null. The loop motor is connected so that it will rotate the loop which is attached to its shaft in a direction which moves the loop towards a null. When the null is reached, there is no output from the loop antenna since it is at the aural null, hence no signal is delivered to the signal winding of the loop motor and it stops. In this manner, the ADF-12E receiver automatically rotates the loop to a true, unambiguous null. A synchro transmitter connected to the loop relays the position of the transmitting station from the aircraft to a direction indicator on the cockpit control panel.

Several companies manufacture ADF equipment similar to the ADF-12E. Many lightplane owners, however, cannot afford this equipment which is expensive due to the high cost of the synchro transmitter and receiver and precision two-phase loop motor used. Since many pilots are interested in using ADF merely for homing to a station, the rotating loop antenna can be replaced by a fixed loop whose aural null is straight ahead. *Aero Signal Labs* produces the inexpensive RDF-2 "Bird Dog" direction finder with circuitry similar to the ADF-12E. However, the loop is fixed for homing and the loop control signal is used to move a meter pointer rather than rotate the loop. This meter then indicates the airplane's homing heading error. If the pilot keeps the meter centered by altering his heading in accordance with the deflections of the meter, he will fly direct to the transmitting station.

Direction finders suffer from the same limitations that radio ranges suffer from and these limitations are due mainly to the poor propagation characteristics of the low and medium frequencies used. In a thunderstorm an ADF direction indicator will aimlessly rotate, pointing at the direction of lightning flashes and discharge static. Unlike the radio-range system, however, planes using ADF receivers can fly along any radial to or from a station and are not limited to flying but four courses as they are with ranges. Furthermore, ADF can be used to obtain running fixes from several stations in order to establish actual position above the ground. This is obviously not possible with radio ranges.

Navigating

Fig. 4 is a simplified radio navigation chart for the San Francisco area showing low-frequency navigation aids. Four low-frequency radio ranges are shown; Travis Range (identified by the letters "SUU" on 248 kc.), Oakland Range (OAK on 362 kc.), Stockton Range (SCK on 212 kc.) and Navy Moffet Range (NUQ on 201 kc.). The

A low-frequency aircraft radio direction finder is shown in this photo along with its indicator.

shaded areas represent the four on-course radials broadcast by the stations. Noticc that nearly all of these radials have been oriented to lie along civil airways.

Also shown are two stations intended for ADF use. Commercial station KCBS (740 kc.) lies almost along airway *BLUE* 10. A federal low-frequency beacon, Richmond Beacon (RMN on 266 kc.), is located along airway *AMBER* 8 to aid in ADF navigation along this airway.

Suppose an airplane wishes to fly from the east along airway *RED* 60 to Oakland Range. Using a low-frequency radio-range receiver, the pilot can tune in Stockton Range at 212 kc. and fly the east-west on-course signal until he flies over Oakland Range. With an ADF receiver he can home-in on Oakland Range itself at 362 kc. However, the fact that he homes-in on Oakland does not guarantee that he is on airway *RED* 60 since *any* radial from the Oakland Range can be flown with ADF. In order to stay on the airway, the pilot must also use his compass to keep his heading along the airway.

In order to fly from Stockton Range to Travis Range along airways *RED* 60 and *BLUE* 7, an aircraft should have two range receivers, one tuned to Stockton Range (212 kc.) and the second tuned to Travis Range (248 kc.). The pilot can then fly along the east-west Stockton on-course signal until the off-course code signal from Travis Range becomes a continuous tone at the intersection of airways *RED* 60 and *BLUE* 7. The pilot can then turn towards Travis and follow this range signal to the station.

Flying from Travis to Oakland *via* airways *AMBER* 8 and *BLUE* 10 can be easily accomplished by an aircraft with a range *and* ADF receiver. Using ADF the plane can home-in on Richmond Beacon (266 kc.) and monitor Oakland Range (362 kc.) on the second receiver until the off-course signal becomes on-course. The pilot can then head towards Oakland Range along airway *BLUE* 10.

From these "paper flights" it is obvious that navigation can be made easier for the pilot if his aircraft is equipped with more than one type of navigation receiver. For this reason, as well as safety, most commercial airliners carry several receivers, and installations of dual-ADF's and low-frequency range receivers are common. Furthermore, this allows the pilot to tune in the weather forecasts which are broadcast by range stations twice each hour without disturbing the navigational receiver.

Commercial carriers also generally equip their aircraft with dual installations of VOR, the v.h.f. system of navigation. VOR incorporates all the advantages of ADF without many of its disadvantages. Next month we shall discuss this modern system of airborne navigation which is rapidly replacing the ranges and ADF in popularity for long-range navigation.

(*To be continued*)

New Audio Test Report

ELECTRONICS WORLD LAB TESTED

Norelco Stereo "Continental 400" Tape Recorder

Madison Fielding Model 630 FM Tuner

Garrard Model 210 Record Changer

Norelco Tape Recorder

VERSATILITY of operation and an excellent tape-deck mechanism are the two outstanding features of the *Norelco* Stereo "Continental 400" tape recorder, which we have just checked. The recorder is a four-track machine that will both record and play back stereophonically as well as monophonically at tape speeds of 7½, 3¾, or 1⅞ ips. Built into the unit are two playback power amplifiers, one of which drives the built-in speaker and the other drives the outboard speaker in the removable lid. Provisions are also included for mixing from the stereo microphone (supplied with the recorder) and the radio-phono input, for dubbing a signal onto a previously recorded track without erasing, and for stereo headphone monitoring. A built-in 4-digit counter and a magic-eye (EM84) recording indicator are included. Inputs are provided for microphone and two radio-phono circuits, and outputs are provided for use with external amplifiers or external speakers.

We were quite pleased with the performance of the recorder both on record and playback. The stereo microphone, consisting of crossed dynamic elements with built-in transformers all in a single housing, was convenient to use and we were able to produce some very acceptable live stereo recordings with it. Admittedly the mike is not quite broadcast-quality, but it is far better than a good many of the inexpensive ceramic or magnetic mikes often supplied with recorders.

When we tried out the unit on the playback of some pre-recorded tapes, our audience was very much impressed with the quality and the separation produced. This was true even though the built-in playback amplifiers use just a single-ended EL84 for each channel and the built-in speaker is only a 4 x 6-inch oval for one channel with a 6-inch outboard speaker for the other. Naturally, in order to fully appreciate the high quality of most stereo tapes, we would suggest the use of external amplifiers and speakers; the built-in amplifiers and speakers may then be used for monitoring.

While examining the unit, we found a rather interesting construction used for the outboard speaker. When we removed the back panel of the recorder's lid, we could see the cone and voice-coil connections of the 6-inch speaker but no magnet was in sight. Upon removing the speaker, we found that it has an "inside-out" construction, with the magnet and supporting basket in front of the cone rather than behind it. This makes the entire speaker very shallow and permits the use of a medium-sized unit in the lid of the recorder. We also noticed in the recorder itself a rather flat dry-rectifier assembly mounted on the chassis. This rectifier, a full-wave bridge, supplies "B+" to the recorder's circuits.

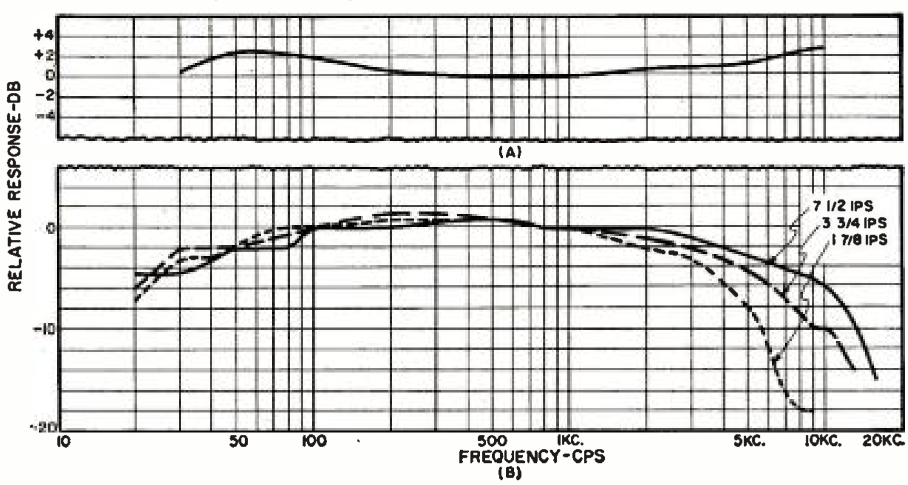
During all our playback tests, we were pleased with the silence of the tape deck and the complete absence of audible wow or flutter, even at the slowest speed of operation where these problems are usually most severe. We played a selection including sustained piano chords, and we could detect no waver or irregularity in the long-lasting tones.

Test Results

After using the recorder for several days, we subjected it to a number of tests, the results of which are discussed below. Most of our measurements were taken at the output jacks which supply signal to external amplifiers, hence the characteristics of the recorder's playback power amplifiers are not included in our response curves. We did this since these are the outputs that most of our readers would probably use. Also, we found that the recorder's tone controls (one clutch-type control for each channel) did not provide bass boost in the maximum counterclockwise position, flat response at mid-position, and treble boost in the maximum clockwise position as described in the instruction booklet. A check of the circuit shows that these appear to be conventional treble-cut controls, with maximum cut fully counterclockwise and the flat position fully clockwise. Hence, all our measurements were taken with the controls fully clockwise.

Playback response: This was measured with a special 7½-ips test tape

(A) Playback response at 7½ ips using a test tape that had been recorded with the standard NAB equalization. (B) Over-all record-playback response at various speeds.



(*Audiotex* 30-208) which has a frequency run from 30 to 10,000 cps recorded with the standard NAB equalization. The output response is within +3 db and −0 db over the entire range of the tape (see Fig. 1A).

Over-all record-playback response: This was checked by recording *via* the radio-phono input the output of a low-Z audio oscillator between the frequencies of 20 and 20,000 cps. The output of the oscillator was first set for a 1-volt signal and the level control on the tape recorder was set for maximum record level. Then the output of the oscillator was reduced to 20 db below this level. Under these conditions, the results shown in Fig. 1B were obtained. Recordings were made at all three speeds. Note that the average output is down about 3 db at 35 cps and down about 6 db at 20 cps at the low-frequency end for all speeds. At the high-frequency end, the superiority of the highest speed is evident from the curves even though much more treble boost equalization is used at the lower speeds. At 7½ ips, response is −3 db at 5 kc. and −6 db at 10 kc., with some level still on the tape out to about 18 kc. At 3¾ ips, response is −3 db at 4 kc. and −6 db at 6 kc., with some level still measurable out to about 14 kc. At 1⅞ ips. response is −3 db at 3 kc. and −6 db at 4 kc.. with some level still measurable out to about 8.5 kc.

Sensitivity on record: At maximum gain a signal of 125 mv. into the radio-phono input is required for maximum recording level. With a 1-volt input. the gain control is set to the 1 o'clock position for maximum record level.

Maximum power output: The highest power delivered by the built-in playback amplifiers is 4 watts per channel at 1000 cps before distortion becomes evident in the output waveform. With maximum recording level applied and with maximum playback gain setting, an output power of 5.1 watts per channel at 1000 cps was produced, but the waveform was clipped.

Signal-to-noise ratio and channel separation: Because of residual tape hiss both on the desired and opposite channels, it was difficult to measure signal-to-noise and separation. However, we used a scope to approximate the amplitude of the hiss and crosstalk at maximum gain. Using this method, the maximum signal-to-noise and stereo crosstalk (separation) is better than 40 db. Residual hum with the tape stationary but with the motor running is about −65 db referred to maximum output.

Speed accuracy: Using a tape-strobe disc, tape speed was found to be 1.3% fast on 7½ ips, and .5% fast on 3¾ ips. The former figure is fairly good for home machines, while the latter figure may be considered to be of semi-professional rank. (See "Measuring Tape Speed" in our June issue.) In addition, this speed error was fairly constant at the beginning, middle, and end of a reel of tape. As a result, when a pre-recorded tape is played back, the sound heard would be pitched high by the above amounts. The slight increase in pitch would be audible only upon a direct A-B comparison with the original recording, however.

In summary then, the *Norelco* "Continental 400," particularly when used with external amplifiers and speakers, is a worthy addition to any hi-fi system. The complete tape recorder. including the stereo microphone, is priced at $399.50. —30—

Madison Fielding FM Tuner

A TUNER with a stationary pointer and a moving dial has recently been placed on the market by *Crosby Electronics, Inc.* under the name of the *Madison Fielding* Model 630. In addition to the unusual dial arrangement, this tuner has another uncommon feature in that the a.f.c. action can be adjusted by a front-panel control. This latter arrangement permits the listener to set the tuner either for very light a.f.c. action or for maximum locking-in, depending on local conditions and whether one is just searching through the band or wants to pull in a particular station. The stationary pointer, which doubles as tuning indicator, is the glowing portion of a type EM84 tuning-eye tube that is visible as a vertical line from the front.

Performance tests on one unit which we checked indicated a tuning range from 87.5 mc. to 108 mc. with very close correspondence between the dial reading and a crystal-calibrated signal generator. Alignment of the entire tuner was carefully checked and only one side of the detector transformer was found to need touch-up. The r.f. portion of the FM tuner consists of a separate subchassis which appears to be of foreign manufacture and which is not readily accessible for alignment. The r.f. tracking was found to be excellent at 100 mc. with only a slight drop-off at 90 and 106 mc.

Performance tests, in accordance with the IHFM (Institute of High Fidelity Manufacturers) standards, yielded the following results:

Volume sensitivity: 90 mc.. 1.8 microvolts; 98 mc.. 1.2 microvolts; 106 mc., 1.6 microvolts.

Usable sensitivity for 20-db quieting: 90 mc., 1.8 microvolts; 98 mc., 1.8 microvolts; 106 mc., 1.8 microvolts.

Usable sensitivity for 30-db quieting: 90 mc., 3.5 microvolts; 98 mc., 3.0 microvolts; 106 mc., 2.5 microvolts.

Since the manufacturer's data includes sensitivity for full limiting, this test was also performed and full limiting was obtained with 1.4, 1.2. and 1.0 microvolts input at 90, 98, and 106 mc. respectively.

I.F. Bandwidth: 350 kc.

Detector peak separation: 800 kc.

Detector linear region: 410 kc.

A.F.C. range at 98 mc.: +700 kc.. −550 kc. (max. a.f.c).

A.F.C. stability: no discernible drift over one hour.

Audio output: 1.8 volts peak-to-peak. undistorted.

Audio response: within ±1 db from 50 cps to 15,000 cps of the standard de-emphasis curve.

From this data it is apparent that this is one of the better performing tuners and both tube complement and components show this as well. All tubes are foreign. but equivalent and interchangeable with such standard types as 6AQ8, 6BX6, 6DA6, and 12AU7. Printed wiring is used with all parts mounted on the top deck and all wiring at the bottom. The only disappointing part in this area is the relative inaccessibility of one test point which connects to the limiter grid and is used for r.f. and i.f. alignment. The other test point, the output of the detector. is available at a special audio output jack which is ahead of the de-emphasis network and is intended for use with a stereo multiplex adapter. In this respect the manufacturer offers advice on how to build a stereo adapter within the confines of the tuner chassis.

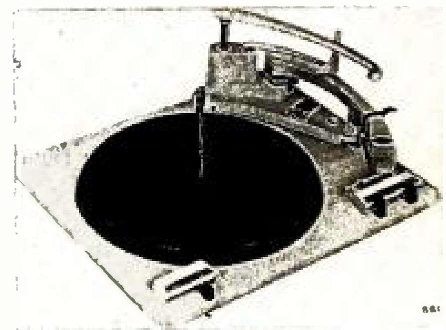
One of the pleasant surprises which the user can look forward to is the inclusion of a twin-lead FM antenna and a complete audio cable in the shipping carton. The cabinet is plastic-covered metal with fairly conventional chassis and bottom cover arrangements. The unit retails for $84.95. —30—

Garrard Record Changer

FOR those of our readers whose first concern when playing their records is operating convenience, a record changer is a "must." An intermix changer provides even more convenience, since no adjustment is required for different record sizes. The Model 210 is *Garrard's* deluxe version of an intermix record changer, which has been designed and wired for stereo operation. The changer will play automatically or manually up to eight 7-, 10-, or 12-inch records at 16⅔, 33⅓, 45, or 78 rpm. The two larger sizes may be intermixed in any order. The changer may also be stopped and restarted while playing a record without the record changer's cycle going into operation.

The turntable is driven by a four-pole induction motor *via* an idler puck running between a stepped motor drive and the table rim. The turntable is fairly heavy and is covered with an attached rubber pad to prevent record slippage. A convenient stylus-pressure control is provided which allows an adjustment to be made with the arm in the normal playing position. This is an improvement over having to tilt the arm upward and set a hard-to-reach stud or adjusting screw. In this case simply turning a knurled ring near the tone-arm pivot does the job accurately. The tone-arm also has a small locking tab beneath it to hold the arm in a fixed position when the unit is not in use. When the changer is started, the arm is unlocked from its rest position automatically.

When we checked one of these changers, we found that it went



through all its operations properly. A measurement of speed accuracy of the unit showed that the turntable was running very slightly fast (by about .3 per-cent) on all speeds. This variation is within standard speed tolerances and should cause no difficulty. We were able to hear the 100-cps tone recorded on our test record (ELECTRONICS WORLD Stereo-Mono Test Record #1) at a level of −40 db with respect to standard reference level. This indicates satisfactory rumble performance. When we first tried out this test, we permitted the changer to rest on the three support brackets riveted to the base plate. Under these conditions, rumble was objectionably high, but as soon as the changer was lifted from our workbench, rumble dropped way down. Under normal operating conditions the changer is suspended from three shock-mount springs and, of course, does not rest on the support brackets mentioned above. Although the wow and flutter are not as low as that obtained with a professional-type turntable, performance is, in general, quite adequate for high-fidelity applications.

The changer is attractively finished in ivory with black and chrome trim. It sells for $49.50 complete with plug-in shell and mounting hardware for a phono cartridge. —30—

Citizens Band Converter

(*Continued from page* 51)

dial at mid-scale and adjust the slug in L_3 until the 28.8-mc. signal is received. Now tune T_1 for maximum signal response. Set the signal generator to 28.4 mc., tune in the signal, and adjust the slug in L_1 for maximum signal. Following this, set the signal generator to 29 mc., tune in the signal, and adjust the slug in L_2 for maximum. Slight readjustment of the slug in L_3 may be necessary to place 28 mc. at maximum capacity of the tuning capacitor. When this is done, 29.7 mc. should be near minimum capacity.

Antenna

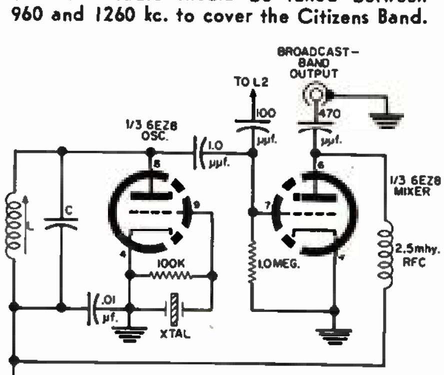
Although signals may be received on a random length of wire, best results will be obtained if an antenna designed for the band being tuned is used. This may be a ground plane, whip, or beam antenna.

Modifications

The basic circuit of the converter may be used in a number of other ways. Fixed-tuned operation with the associated receiver used as a tunable i.f. system may be accomplished by substituting a crystal-controlled oscillator for the self-controlled one, and making the output circuit of the mixer broadband. This allows elimination of the dial and tuning capacitor. A third-overtone crystal between 25.7 and 26.3 mc. should be used for Citizens Band operation. The required modifications of the oscillator circuit are shown in Fig. 3, which also shows the mixer circuit with an r.f. choke substituted for the output transformer indicated in Fig. 2.

For increased convenience of operation, a change-over switch to connect the antenna directly to the broadcast receiver for broadcast listening could be incorporated, but was omitted from this model for the sake of simplicity and low cost. —30—

Fig. 3. Suggested changes to adapt converter for crystal-controlled operation. Coil and capacitor in the oscillator plate circuit should resonate at the crystal frequency. A coil the same as L_1, but without a tap and with a 10-μμf. capacitor shunting it, should tune to 26 mc. For a 26-mc. crystal, the broadcast radio should be tuned between 960 and 1260 kc. to cover the Citizens Band.



Dynamic Capacitor Checker

(*Continued from page* 41)

series resistance in the PL_1 circuit to allow proper pull-in of the relay. The resistor R_8 was chosen to allow the relay to activate on the high-voltage range at 100 volts. This, with the low-voltage range switching, provides short protection from 15 volts and beyond. Each relay will require individual test and adjustment of this series resistor. The author used a 50,000-ohm pot in this position and, with R_1 at 100 volts (as read on the meter in position *B*), the test potentiometer was adjusted to pull in the relay. An ohmmeter then indicated the proper amount of fixed resistance needed for R_8.

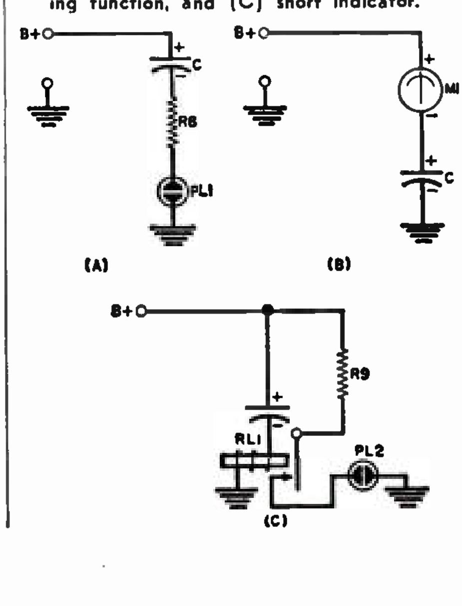
The wiring of the function switch is the most difficult part of the job, but should cause very little trouble if the schematic is followed closely. There is a discrepancy between the pictured unit and schematic involving this switch, S_1. The unit pictured used a hybrid switch which covered all necessary switch positions plus an auxiliary "on-off" switch. Since standard switches are not available in 5 poles and 5 positions without exceptional expense, S_1 is shown on the schematic and in the parts list as a 4-pole, 4-position switch, and S_3 is added for power control. S_3, of course, does not show up on Fig. 1.

S_2 is a 2-pole, 5-position switch, chosen because it was available. Since the bridge itself requires only a single-pole, 4-position switch, availablity and expense might dictate the use of a separate switch for the meter shunt, which shows up as position 5 of S_2 (marked as "ELEC" in Fig. 1).

Non-shorting switches should be used throughout to prevent meter damage. No arcing will be noticed, and the current requirements are sufficiently low so that almost any type of switch will suffice if it furnishes the necessary circuits and positions.

Calibration of the bridge is accomplished by using a group of close-tolerance capacitors of such values that, by paralleling them, step markings from .1 to 10 are obtained. Since the standards are 100 μμf.. .01 μf., 1 μf., and 100 μf., the ranges are comprehensive from 10 μμf., (.1 x 100 μμf.) to 1000 μf. (10 x 100 μf.). The unit here was calibrated with precision units of the values .001, .002, .003, .004, .02. .03, and .04 μf. On the second range (position 2 of S_2, from .001 to .1), the dial was marked in single steps throughout its range. Other ranges were checked with close-tolerance units to insure concentric reading. If the standards are accurate, and the calibrating units are accurate, calibration of one range will suffice for all ranges. If the calibrating pot is linear, it will be possible to interpolate calibration points provided the extreme points on R_3 (.1 and 10) are accurately placed. —30—

Fig. 4. Simplified circuits highlight (A) charge function, (B) leakage-reading function, and (C) short indicator.



Newfoundland's TV Network

(*Continued from page* 55)

house the power generating equipment at the transmitter towers, usually because of the terrain. In such cases the twin-diesel generator sets are placed in buildings near access roads or rail lines and the power fed to the repeater station by cable. At the actual location, however, there is a small standby unit in case there is an interruption between the hilltop and the base site.

Some of the communications devices are very sensitive to power interruptions. A break of a second or less will trip the relay and set up a chain reaction which causes a general foul up. The *CNT* engineers have resorted to a simple but ingenious device to insure that there will be no interruptions in the current supply to the microwave equipment.

On each microwave generating set they have installed a huge flywheel—some of which weigh up to two tons. This flywheel is mounted on the drive shaft between the motor and alternator and if a breakdown should occur, cutting power to the motor, the flywheel keeps the alternator spinning steadily until the automatic switches have time to cut in the standby unit.

An elaborate remote-control system permits the repeater stations to be operated automatically and unattended. The diesel-powered alternators run 24-hours a day, without local supervision other than the regular monthly maintenance inspection. If trouble develops, the maintenance engineers at the control points can, by reading the remote control signalling devices, tell what is wrong and take the necessary remedial steps.

The buildings of the repeater stations are warmed by the exhaust from the diesel-generating sets and each station is equipped with an automatic burglar alarm system.

Today this $9,000,000 project is finished and is in full operation, giving Canada its first coast-to-coast live TV hook-up—thanks to *CNT*. —30—

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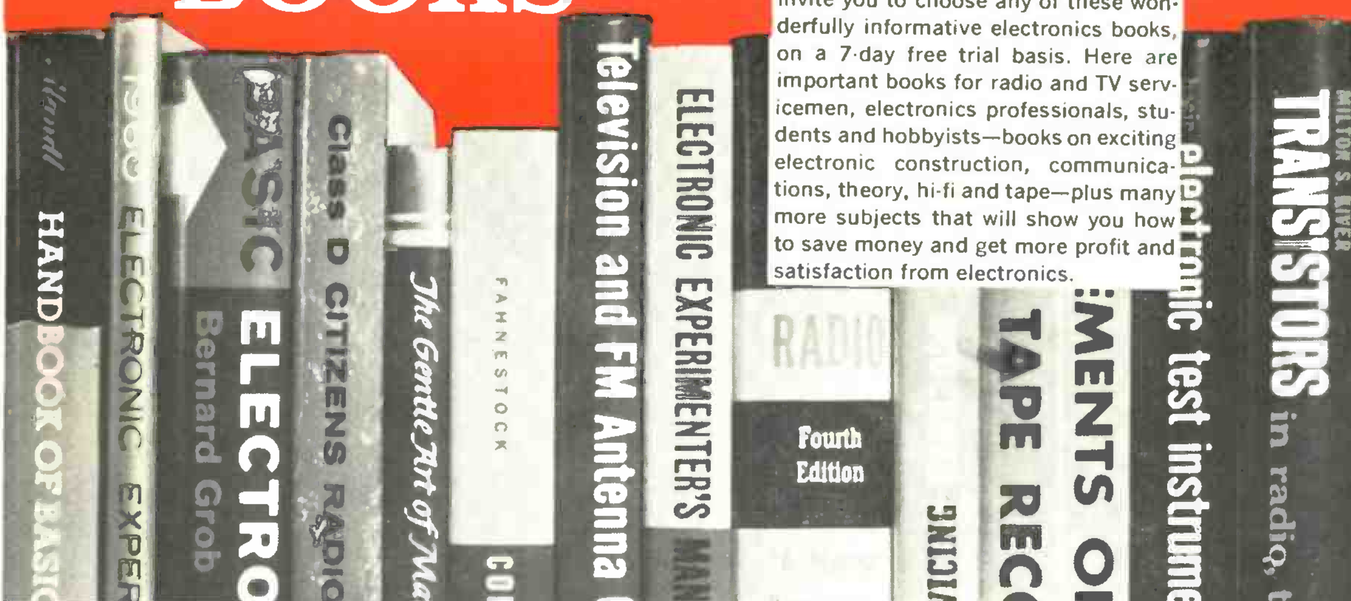

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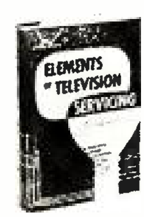

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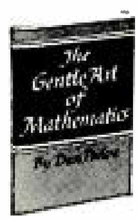

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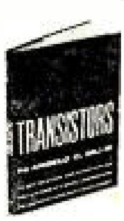

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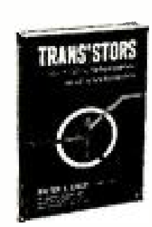

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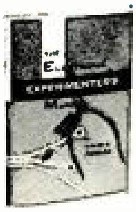

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Getting Results from Business Letters

By J. E. KITCHIN

Some excellent advice for service dealers in writing inquiries to equipment manufacturers.

THE so-called "art of letter writing" is not going to be discussed here, but, rather, why a letter of inquiry to a manufacturer does not produce the desired results. Owners of small businesses often wonder why such letters are either not answered at all or result in a statement to the effect that the manufacturer would prefer to have his equipment serviced through "approved channels."

It is not uncommon to receive some electronic equipment for servicing in the shop only to discover that no data is available. The next step, if the equipment is complicated, is to write the manufacturer for technical information on the model concerned. No answer comes, so the technician makes out as best he can, mentally condemning the manufacturer for his lack of attention and also running the risk, perhaps, of not quite satisfying the customer on the repair job.

But let's examine the situation. Was the letter of inquiry written on a page torn from Junior's school exercise book? Or was it a picture postcard of the city hall? Neither of these would make a good impression. The first rule is: Get a letterhead printed and, if finances don't permit the printing of a bill form as well, have a small form printed with your name, address, and business at the top and use this for both letters and billing. If printing is entirely out of the question, at least use good white bond paper.

Second, how's your handwriting? Maybe Aunt Susie can read it (or is that the reason even *she* doesn't answer your letters?) but can you reasonably expect a business concern to take time out to decipher an illegible scrawl? Write clearly! If possible acquire a typewriter, even a secondhand one is better than nothing at all and the impression it creates in the mind of the reader will be well worth the cost.

Now, what about the facts? The only way a business man can judge whether or not it will pay him to expend time and literature on you is by what you put in the envelope, namely, the type of paper and what you put on it. Specify make and type number if available, year, serial numbers, size, and any other data which will assist in identifying the particular item.

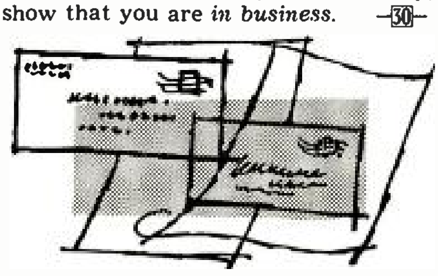
Assuming this is all taken care of, what is the next step? Grammar and composition of all things! Sounds terrible, but really it is not too difficult because both grammar and composition follow very simple rules which anyone can learn. Take a look in any library or book store and you will find many volumes dedicated to the art of better letter writing. Don't forget, too, that a good dictionary can be of help—if you are not absolutely sure of the spelling —look it up.

Are you too busy in the shop or have a natural aversion to "paper work"? Then why not farm out your correspondence to some stenographer who has a typewriter at home? Most secretarial schools offer courses in business letter writing so you could merely draft a note covering what you want to say and let your "secretary" phrase and write the actual letter. If you don't know such a "free-lance steno," contact your local business school. Such stenographers-in-training are usually glad to do the work a little more cheaply than a "pro" since it provides both experience and a little extra money for them.

Finally, how did you sign the letter? Was it so that your name could be deciphered or must the recipient hire a handwriting expert? It is always better to type your name below your signature or, if the letter is hand written, print your name and address in block letters. And, speaking of those which are written by hand, use pen and ink and not a blunt pencil. Be sure your complete and correct address appears on the letter *itself* since many large companies have departments to open the mail and the envelopes are discarded. If this happens to your letter with just a return address on the envelope, you will become another "File —Insufficient Address" request.

If the letter remains unanswered after a reasonable time, write again and enclose a copy in case your first letter was lost or mislaid. This saves the manufacturer time and trouble in searching for the first letter or, perhaps to your disadvantage, not looking for it at all.

A little attention to these seemingly unimportant details should produce the desired results and will, most certainly, show that you are *in business*. —30—



What's New in Radio

SENCORE SERVICE AIDS

Service Instruments Co., 171 Official Rd., Addison, Ill., producer of "Sencore" products, has announced a "Substitution Service Lab" to facilitate troubleshooting.

The package contains a model H-36 for substitution of capacitors and resistors, the ES102 for electrolytic capacitor substitution, and the RS106 which substitutes for selenium and silicon rectifiers. The three units come in a display-carrying case. The company points out that the RS106, like other models in the firm's line, is also available separately in its own case.

CB TRANSCEIVER KIT

Heath Company, Benton Harbor, Mich. has announced its Model GW-10 2-way Citizens Band transceiver in kit form. The superheterodyne receiver section may be either crystal-controlled on any predetermined channel or con-

tinuously tuned by a variable tuner through 23 channels. The transmitter is crystal-controlled on any one of the 23 assigned frequencies chosen. A press-to-talk microphone has coil-cord connection to the instrument.

The GW-10 is available in a.c. or d.c. models. All necessary hardware for "underdash" mounting for mobile operation is supplied, as well as FCC license application forms and information. For more details, write to the manufacturer.

ANTENNA KITS

Columbia Wire and Supply Company, 2850 W. Irving Park Road, Chicago 18, Ill. has announced two new Citizens Band antenna kits. One is an extended co-linear array with an over-all length of 44 feet and a claimed gain of 3 db. The other, a standard half-wave dipole, assembles to an over-all length of about 17 feet. For further information, write to the manufacturer.

4-WAY POCKET TOOL

Xcelite, Inc., Orchard Park, N. Y. has introduced a new 4-way pocket tool. Designated as Model 600, the new tool is readily adaptable for use as a ¼-inch nut driver, a 3/16-inch slotted screwdriver, a No. 1 Phillips screwdriver, and a 7/16-inch nut driver.

According to the manufacturer, the tool is especially useful for removing the back of a TV set, or installing an antenna. A spring inside the tool's handle holds the blades in place. The handle is fitted with a pocket clip.

FREQUENCY STANDARD

Haddam Manufacturing Co., Inc., Rt. 9, Haddam, Conn. has recently introduced a portable secondary frequency standard. Known as the Bailey "Zerobeat," the instrument is claimed to be highly stable and particularly useful in the "netting in" of mobile FM communication systems, where all of the mobile and base stations must be maintained to the exact frequency assigned by the FCC.

Simplified design makes it possible to check and correct the frequency of both receiver and transmitter of a given station in a matter of seconds. In addition to these FM applications, the "Zerobeat" will function in the manner of any secondary frequency standard and may be used as such. Additional information may be obtained from the manufacturer.

CBS INSTRUMENT TUBES

CBS Electronics, Division of *Columbia Broadcasting System, Inc.*, Danvers, Mass. has introduced a line of electron tubes produced specifically for instrument manufacturers.

Said to be the first of its kind, the line features new versions of tube types 7728, 7729, 7730, 7731, 7732 and 7733. The first five types replace the 12AT7, 12AX7, 12AU7, 6USA, and 6CB6 respectively. The 7733 is the instrument counterpart of a 6-volt version of type 12BY7A. The tubes feature coil heaters throughout, 48-hour stabilization of electrical characteristics, 100-hour

early life assurance test, special 1000-hour life test, and 5000-hour informational life test.

According to the company, undesirable characteristics such as microphonics, hiss noise, and leakage currents are minimized in the new tubes. Satisfactory operation at low and high line voltages is assured by controlled cathode activity. Complete technical data can be obtained by writing to *CBS* Electronics Information Services and asking for Bulletin E-3777.

PORTABLE TUBE TESTER

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. has announced a new portable tube tester designed for field use by the serviceman, experimenter, and technician.

Designated as Model TE-15, the instrument measures 8⅛" x 9¾" x 2⅜"

and weighs only six pounds, yet is equipped to test most of the tube types commonly employed. Sockets are provided for 7-pin miniature, 9-pin miniature, octal base, loctal base, noval, and subminiature types. An alligator clip lead is furnished for testing tubes with top caps.

The meter is calibrated from 0-100 and has a red-green "replace-good" scale, plus a special scale for checking diodes. Tube charts with test settings are inserted in a slide-out metal tray. For more information, contact company direct.

PHOTOCONDUCTIVE CELLS

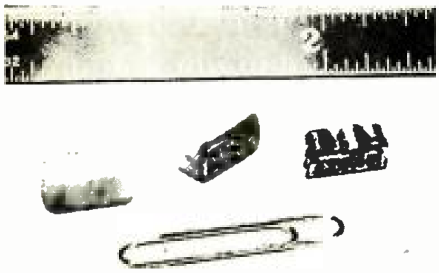
Clairex Corp., 19 West 26 St., New York, N. Y. has made available its new "500 line" of one-half-inch diameter power cells of the photoconductive type. These units are said to combine relatively high dissipation ratings with a small, hermetically sealed package. A specially designed bracket, which serves as a mounting device for any position, is supplied with each cell.

Two standard types are available. Type 504 is a cadmium selenide unit; Type 505, cadmium sulphide. Average continuous power rating for the cells is stated to be .5 and .25 watt with the bracket mounted on a heat sink and without, respectively.

Illustrated bulletins and engineering data on these cells may be obtained by writing the firm.

MICROMINIATURE AMPLIFIER

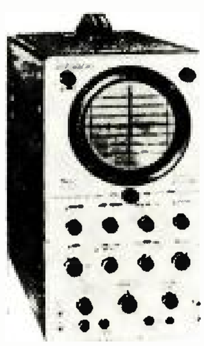
Viennatone Co., Vienna, Austria announces a new microminiature, three-transistor, *RC*-coupled, printed-circuit amplifier module. The tiny amplifier (38 of them will fit into one cubic inch) is designed primarily for use in hearing aids. It has a gain of 76 db with a flat response within 3 db from 200 cps to 10 kc., and a power output of .6 milliwatt into a 600-ohm inductive load at over-all distortion of 10% maximum.



The amplifier operates on a single 1.3 v. mercury cell. According to its U. S. sales representative, *Caine Electronic Sales Co.*, 4120 W. Lawrence Ave., Chicago 30. Ill., the new module, type N-E1, has applications in pocket-size electronic devices such as meters, mike preamps. recorders, dictating machines, stethoscopes, and wrist radios. For additional information, contact the U. S. representative.

GENERAL PURPOSE SCOPE

Precision Apparatus Co., Inc., 70-31 84th St., Glendale, Long Island, N. Y. has announced its new model ES-525 oscilloscope, a general purpose instrument for industrial testing; laboratory applications; radio, TV, and hi-fi servicing; and communications and electronics education.



The unit, which measures 8¼" x 14½" x 18½", is said to provide excellent square-wave response from 20 cps to 50 kc. It uses nine tubes, including a type 5CP1/A cathode-ray tube. A direct reading built-in peak-to-peak voltage calibrator facilitates the use of the scope as a high-impedance v.t.v.m. Audible monitoring is possible with the use of tip jacks provided.

CIRCULAR SLIDE RULE

General Industrial Co., 1788J Montrose Ave., Chicago 13, Ill. is offering a circular slide rule suitable for simple calculations. Instructions for use are included.

The slide rule will be sent by the manufacturer without charge to engineers and business executives who request it on their letterheads. For all others there is a charge of 50 cents.

PRINTED CIRCUIT BOARDS

Dynex, Inc., 324 Langton Ave., Los Altos, Calif. has announced a new line of printed circuit boards.

Termed "Cirkit," the new line comprises ten basic boards that cover all circuit functions for analogue and digital circuitry and is intended for use in the construction of prototype or breadboard models. Additional information and complete specifications may be obtained from the manufacturer. —30—

Computer Memory Devices

(*Continued from page* 49)

The output of the comparator is used to activate the reading head of the track containing the desired word. After the last bit of this word has been read, a pulse from the timing track advances the word counter to 110 (decimal 6). Since the number in the word counter is no longer equal to the number in the address selector, the comparator ceases to produce an output and reading ceases.

It is obvious, from the arrangement of components shown in Fig. 9, that the word counter must be reset to 000 after each complete revolution of the drum. This can be accomplished by means of a single pulse recorded on a separate track of the drum. This pulse marks the starting or *home* position of the drum and is used to reset the word counter.

For simplicity, only three stages are shown in the word counter and the address selector in Fig. 9. In actual practice, a greater number of stages are required, as determined by the total number of words contained in each track.

One or more tracks of a drum may be set aside for quick-access use, as shown in Fig. 10. Each such track requires two heads, so that, as each bit is read, it is rewritten farther back on the drum surface. In this manner, the same word (or several selected words) are continually read and rewritten. Since a given word appears many times around the circumference of the drum, the access time is much shorter than that for words written on the other tracks of the drum. The arrangement shown in Fig. 10 is known as a quick-access loop, a two-headed loop, a recirculating register, or a revolver.

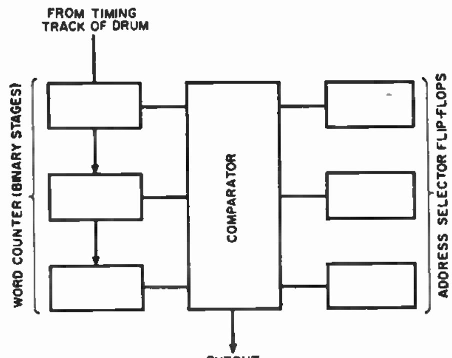


Fig. 9. To select specific stored data, comparator produces output only when right number is fed from timing track.

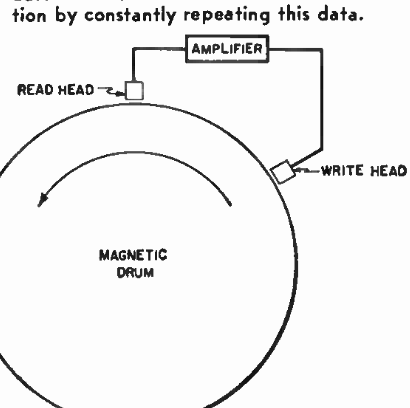


Fig. 10. A quick-access loop makes data available in less than one revolution by constantly repeating this data.

The *IBM* RAMAC computer uses magnetic discs rather than a drum. These discs, each of which resembles an over-size phonograph record, are coated with a magnetic substance and information is recorded in circular tracks on each side of the disc. The discs are stacked vertically, with sufficient space between for the read/write head to move freely. When a given disc is selected for reading or writing, the head moves into position vertically to the desired disc, and then moves inward toward the center of the disc to the desired track.

Summary

Actually magnetic tape and the magnetic drum complement each other—one providing the greater storage capacity and the other offering shorter access time. Thus many computers use the two in combination, with the drum serving as the main memory and the tape providing back-up storage of information.

In this way, blocks of information can be transferred from the tape to the drum at some time prior to the need for this data in the computer. After the computer has used the data, other blocks of information are transferred to the drum.

In some applications, however, even shorter access time is required than can be provided by a drum. In these cases, there is still another type of device available. These units, magnetic cores, and their application will be covered in the concluding installment of this article.

(*Concluded next month*)

Design of Phono Preamps

(*Continued from page* 36)

In this case, the entire band must be used for the noise computation—furthermore, the effective value of the noise voltage must be doubled because of the 6 db needed to bring the output back to the 1-kc. reference level and the final signal-to-noise ratio is approximately 91 db for the 500-mv. signal. The equivalent noise resistance of the tube (Schottky noise) is very much less and may be disregarded.

For velocity response, the lowest crossover frequency, in practical terms, is 50,000 cps only because (*a*) for a 40,000 cps crossover, the input will be down 1 db at 20,000 cps and (*b*) the final signal-to-noise ratio is not unduly sensitive to moderate changes in this crossover point.

For 50,000 cps and 500 $\mu\mu f.$, the leak will be 6400 ohms with a noise voltage of approximately 0.5 $\mu v.$ In this case,

INVITATION TO AUTHORS

Just as a reminder, the Editors of ELECTRONICS WORLD are always interested in obtaining outstanding manuscripts, for publication in this magazine, covering the fields of audio and high-fidelity and radio-TV-industrial servicing. Articles in manuscript form may be submitted for immediate decision and projected articles can be outlined in a letter in which case the writer will be advised promptly as to the suitability of the topic. We can also use short "filler" items outlining worthwhile shortcuts that have made your servicing chores easier. This magazine pays for articles on acceptance. Send all manuscripts or your letters of suggestion to the Editor, ELECTRONICS WORLD, One Park Avenue, New York City 16, New York.

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Answer to Puzzle
Appearing on page 93

M	E	G		P	R	O	V		P	E	R	
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I	N	D	U	C	T	I	V	E		D	O	E
	S	O	N		Y	E	A	R		S	W	L

the noise band is substantially that of the RIAA response characteristic and may be taken as 2500 cycles. At the reference frequency, the signal voltage at the resistor will be approximately 10 mv. with a corresponding signal-to-noise ratio of 86 db. Although the grid leak is much smaller than before, the Schottky noise is still relatively unimportant provided the tube is operated at a plate current giving normal transconductance.

Thus, the signal-to-noise ratio has deteriorated only 5 db in return for the advantage of being able to operate into the same amplifier equalization that must be used for the magnetic unit so that comparisons may be made between pickups without obscuring the issue because of the differences in overall frequency response. —30—

Electric Power

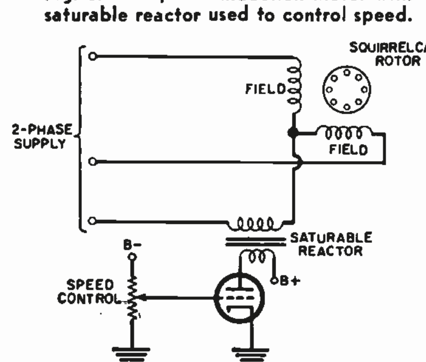
(*Continued from page* 43)

trolling windings are used in some special-purpose variations. The number of poles, number of phases, and the coil design all can vary considerably among the types to produce a still greater variety.

For example, a simple, squirrel-cage motor can operate on two, three, or any number of phases, depending on the field windings. The torque, starting and running, as well as the efficiency, speed regulation characteristic, and other factors can be varied by the skewing of the copper bars in the rotor, by the depth and shape of the slots in which the copper bars are mounted and, naturally, by the field winding itself.

Further study of a particular motor is much simpler when one knows at least what type it is. A brief look at the diagram of Fig. 4 shows that the d.c. motors, including the "universal" series type, use brushes and a commutator. Of the a.c. motors, only the repulsion-start type has brushes, and they merely serve to short-circuit that part of the rotor which is located at a 90-degree angle to the field. The synchronous a.c. motor has a rotor winding, and this is connected to the outside by slip rings and brushes. Some synchronous motors have a multi-phase field winding and a permanent-magnet rotor, while still others use a d.c. field winding with an a.c. rotor. Most a.c. motors have squirrel-cage rotors, and therefore need no brushes, commutators or slip rings, which are usually sources of motor troubles.

Fig. 5. Two-phase induction motor with saturable reactor used to control speed.



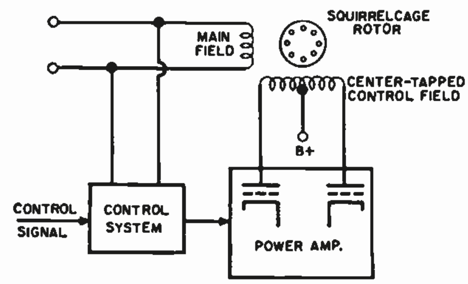


Fig. 6. Simplified servo motor system with power amplifier to regulate speed.

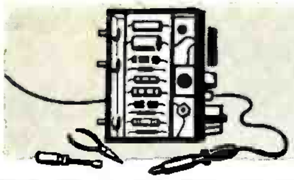
The connections of the control system can be understood better if we know *how* it controls the motor; for this reason, we have shown some typical, basic control circuits in Figs. 3, 5, and 6. The first of these is used in the speed control of relatively large d.c. motors, such as the kind used to drive the take-up reel in a paper processing plant. The motor (Fig. 3) is a d.c. shunt type and its speed is varied by adjusting the current through the rotor. Two push-pull thyratron rectifiers are controlled by the phase-shifted signals on their grids. If the motor were really large, ignitrons would take the place of the thyratron tubes.

Fig. 5 shows a typical a.c. induction-motor, speed-control system. Only two phases are shown, but the same saturable-reactor scheme is often used with as many as twelve phases. Here the speed is reduced by reducing the supply voltage, and this is done by varying the d.c. bias, which controls the impedance of the saturable reactor. As more plate current is drawn, more d.c. bias is generated in the reactor, and the inductance drops, allowing the motor to get more supply voltage.

In Fig. 6, a simple servo motor control is shown, without the feedback loop that is frequently used for remote positioning. This loop and its explanation are the subject for a separate article. Nevertheless, the motor-control circuit should be understood in connection with typical power amplifiers. Here one motor winding is connected to the power line while another winding, which controls the motor speed, receives its power from the push-pull output amplifier.

Conclusion

Electric power is converted into mechanical motion either by solenoids or by motors. Solenoids generate linear motion but, since this is not very efficient, they are not used for higher power applications. Rotary motion is generated by electric motors, of which a wide variety is used in automated systems. Different types of motors exhibit different torque and speed characteristics. Control circuits for these motors are generally limited to regulating the supply voltage or current and thereby the speed. Although three typical, basic motor-control schemes were shown here, a host of variations of these circuits actually will be encountered in the field. —30—



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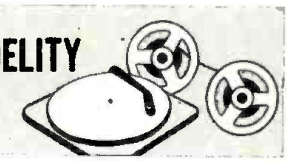
HIGH-FIDELITY



INDUCTORS for Crossover Networks. 118 types in stock. Send for brochure. C & M Coils, 3016 Holmes Ave., N.W., Huntsville, Ala.

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.

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LID supports, counterbalanced, for Hi-Fi cabinets. C B Distributors, Box 72, Stoughton, Wisconsin.

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LOW Quotes on everything HiFi & Stereo Tapes. Bargain Lists. HiFi, Dept. E2, Roslyn, Pa.

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Classified

A HANDY GUIDE TO PRODUCTS, NOT NECESSARILY ELECTRONIC, BUT OF WIDE GENERAL INTEREST.

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POEMS Wanted for musical setting and recording. Send poems. Free examination. Crown Music, 49-TM West 32, New York 1.

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GOLF Clubs Wholesale Free Price List. Crystal Golf Sales. Crystal, Mich.

INDEX OF *Advertisers*

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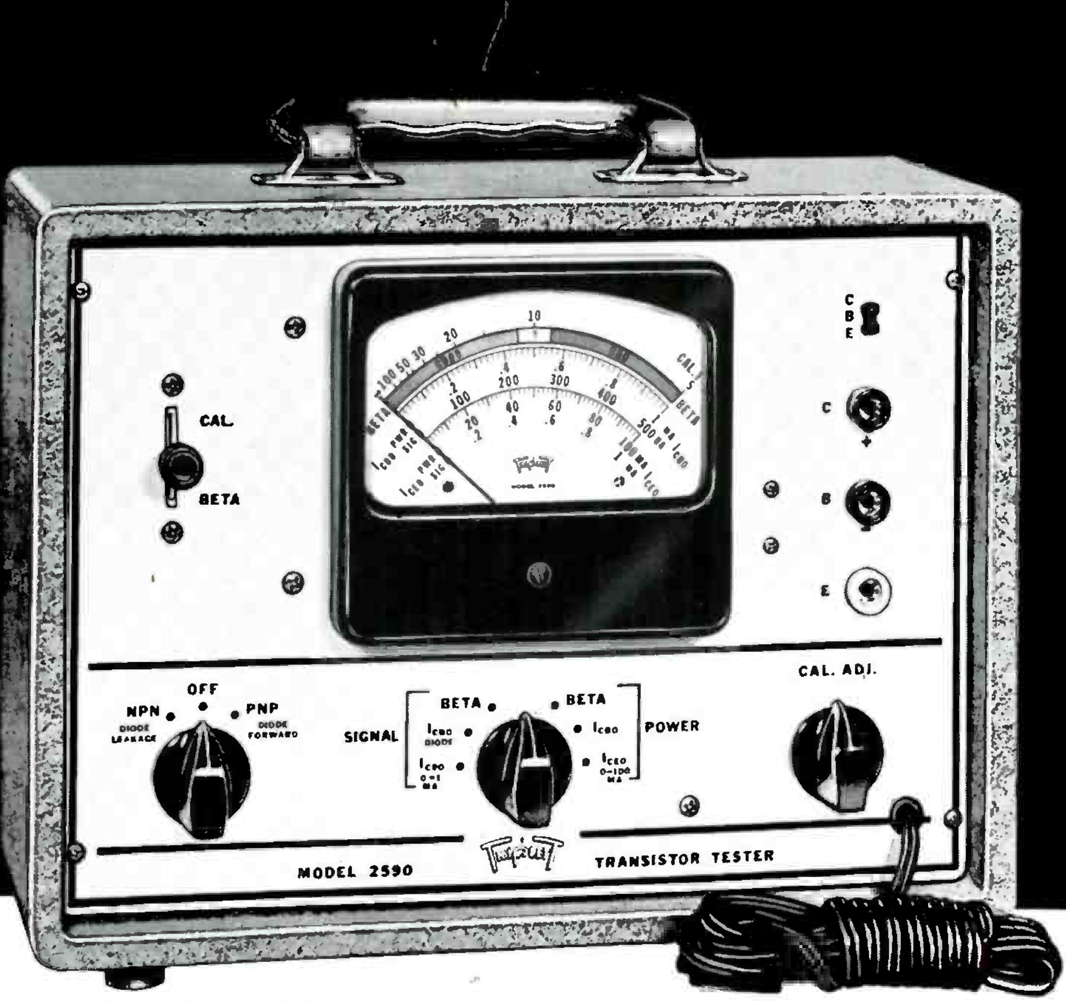

Now you can test transistors under simulated operating conditions . . .

With the NEW Triplett Model 2590 Transistor Tester

Simple to Operate—Versatile—Always Up-to-Date

Simple to Operate— The new Triplett Model 2590 Transistor Tester quickly, easily and accurately tests all power and signal transistors under simulated operating conditions. Only 3 switches and 1 control knob.

Versatile— Has provisions for testing I_{CEO} (at 9.5V), I_{CBO} (at 9.5V) and Beta Amplification (at 3V) on both NPN and PNP transistors. Also checks leakage and forward current of diodes.

Always Up-to-Date— No roll chart, specifications, or special data necessary. All you need know is the transistor type (NPN or PNP and Signal or Power type).

Transistor Socket and External Leads— Allows use with any type basing arrangement.

Accuracy— The Model 2590 is accurate to within ±2% of full scale reading on 0-100 D. C. Ua.

Selector Switch— Provides selection of NPN, OFF or PNP positions.

Function Switch— Provides selection of I_{CBO} Leakage, I_{CEO} Leakage and Beta Gain position for both power and signal transistors.

Beta Switch— Is in the calibrate position normally and is in the Beta test position when pulled down.

Calibrate Adjustment Control— Adjusts for full scale calibration after transistor has been inserted.

Power— 115 volts, 50-60 cycle, A.C.

Scales— There are 5 scales on the meter: 0-1 ma. for signal transistor I_{CEO}; 0-100 ma. for power transistor I_{CEO}; 0-500 ua. for signal transistor I_{CBO}, also diode leakage and forward current; 0-1 ma. for power I_{CBO}; 5-100 Beta range also shown as the "GOOD ? BAD" scale.

Case— Handsome gray leatherette case, 11⅝" x 8⅝" x 5⅛"; has recessed panel.

MODEL 2590 TRANSISTOR TESTER-U.S.A. Dealer Net Price........$49.50

MODEL 690-A PORTABLE TRANSISTOR TESTER

Triplett Model 690-A Transistor Tester is a rugged, small, easily portable unit. Battery operated.

It provides **Leakage** and **Gain** tests for all low and medium power PNP and NPN type transistors. Also checks diodes for forward and leakage current.

A single switch is provided for simplicity in selecting transistor type settings. The OFF position prevents drain on the batteries in case of accidentally shorting the leads. Another operating feature is the use of separate "Calibrate" and "Gain" buttons to eliminate errors.

A transistor socket and a set of external leads are provided for use with any basing arrangement.

MODEL 690-A PORTABLE TRANSISTOR TESTER-U.S.A. Dealer Net Price.....$29.50

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Your reputation is based largely on what happens *after* you leave the scene of each service call. For this reason the name on the tubes you install makes a world of difference. RCA tubes are designed and manufactured to assure customer confidence in you as well as in RCA.

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