NOVEMBER

Radio-Electronics

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor-in-chief

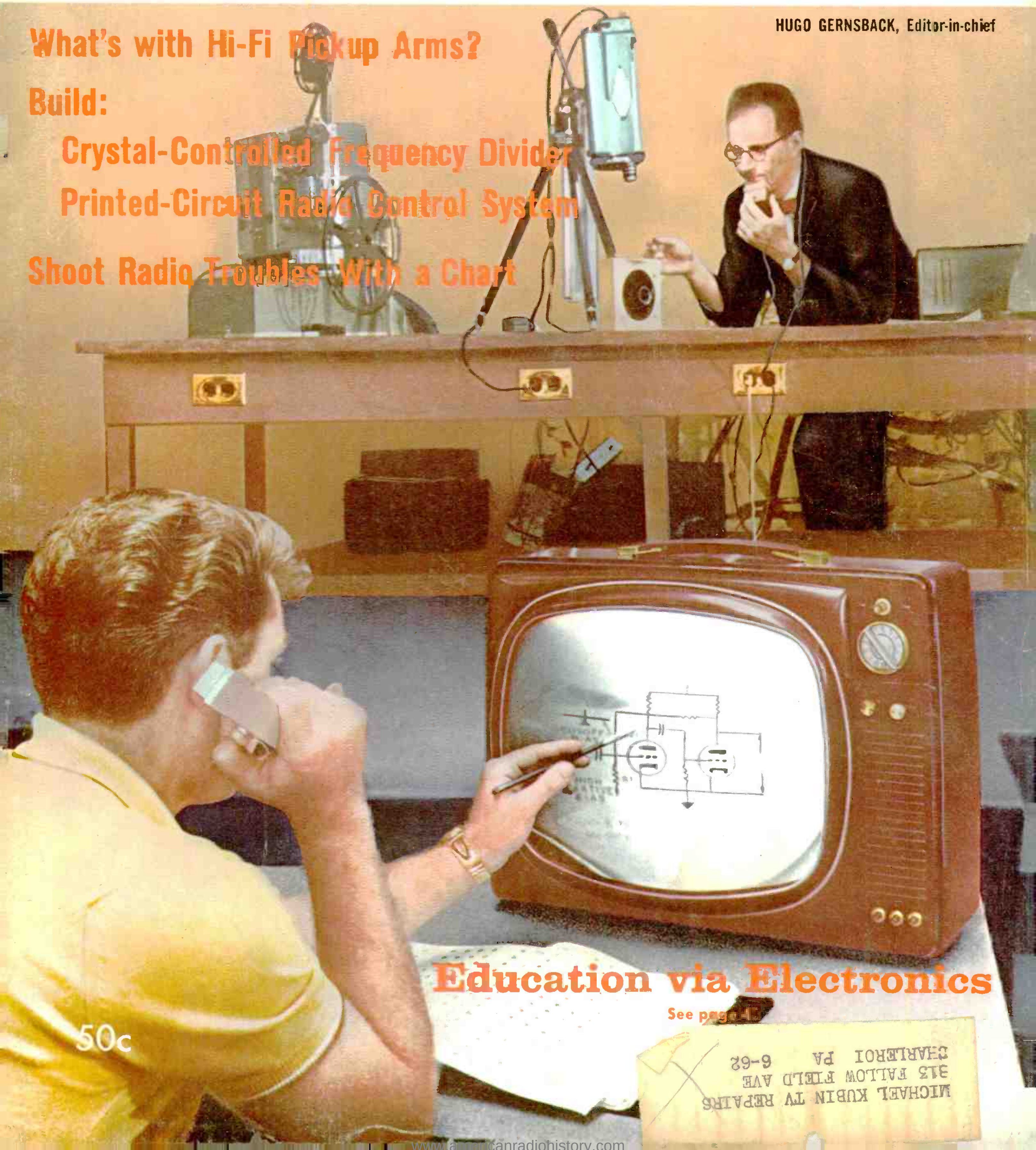
What's with Hi-Fi Pickup Arms?

Build:

Crystal-Controlled Frequency Divider

Printed-Circuit Radio Control System

Shoot Radio Troubles With a Chart



Education via Electronics

See page 4

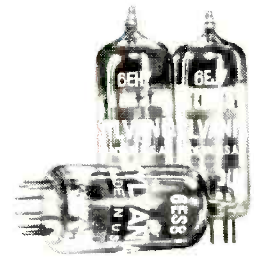
50c

"STRIP"

and

"STRAP"

...your 2 key words to profit protection



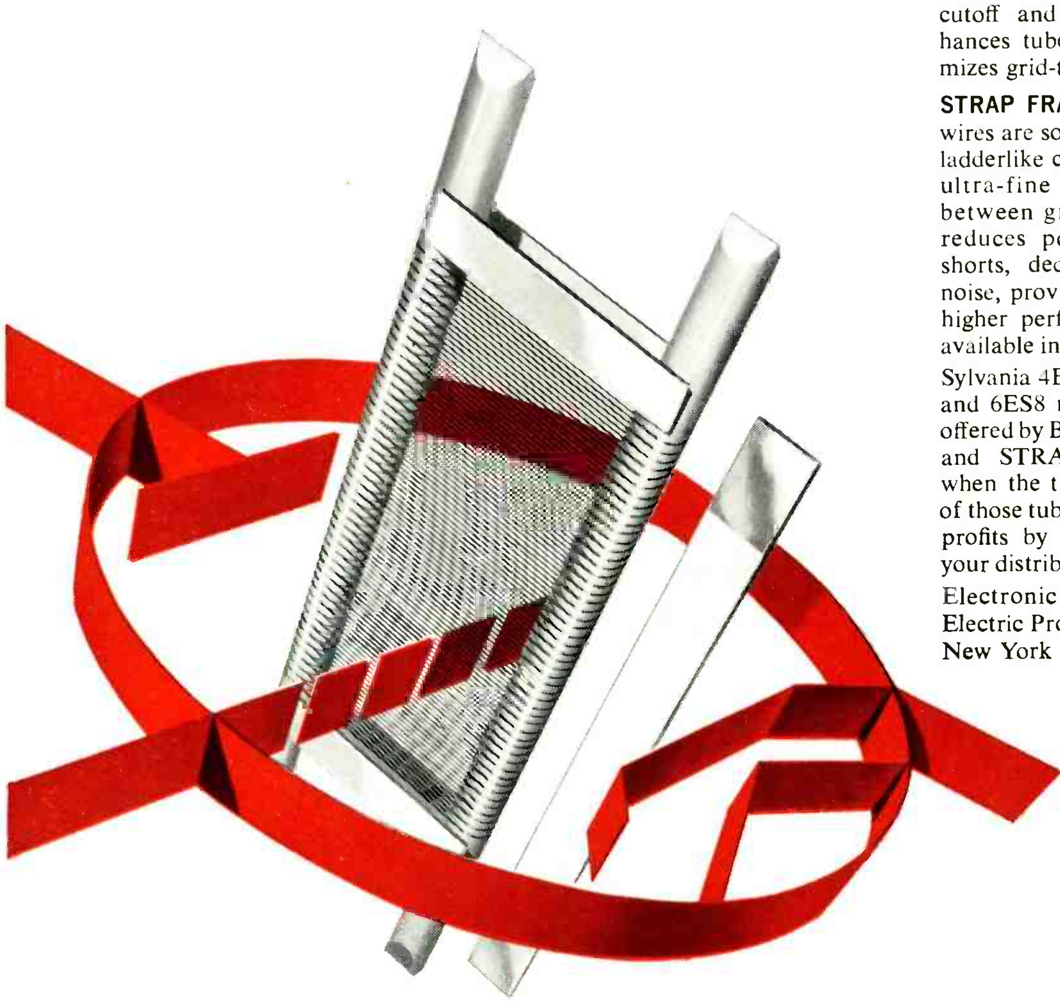
"Strip" is the new BIKINI CATHODE construction. "Strap" is the new FRAME GRID design. Both . . . developed by Sylvania . . . are creating new excitement, bringing new performance standards to TV sets.

BIKINI CATHODE—a precast film-strip of active materials is bonded, by a special Sylvania technique, *only* to the 2 flat surfaces of the cathode sleeve. Results: eliminates stray emission from the sides of the cathode for improved cutoff and noise characteristics, enhances tube-to-tube uniformity, minimizes grid-to-cathode arcing.

STRAP FRAME GRID—grid lateral wires are solidly supported by a sturdy, ladderlike construction enabling use of ultra-fine wire and tight spacing between grid and cathode. Results: reduces possibility of grid-cathode shorts, decreases microphonism and noise, provides unusually high Gm . . . higher performance than ever before available in tubes for TV sets.

Sylvania 4EH7 and 4EJ7, 6EH7, 6EJ7 and 6ES8 now feature the advantages offered by BIKINI "strip" CATHODES and STRAP FRAME GRIDS. So, when the time comes for replacement of those tube types, protect your service profits by installing SYLVANIA. At your distributor's now!

Electronic Tubes Division, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

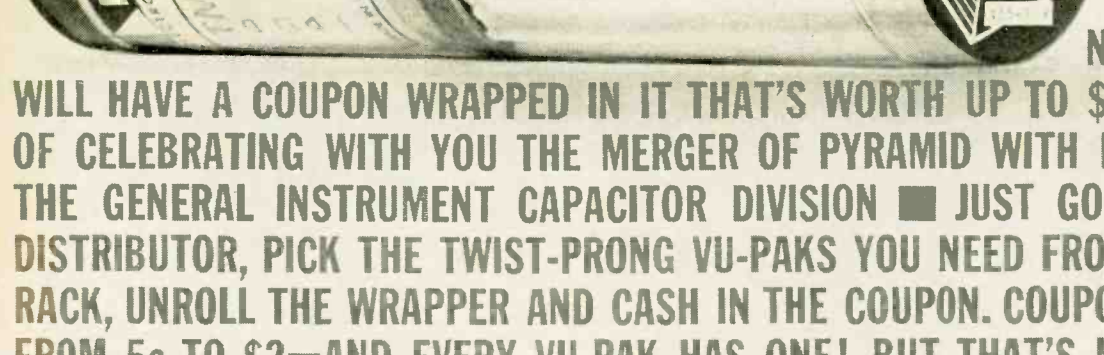


SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM



BEHIND THIS CAP IS A COUPON WORTH UP TO $2.00 ■ EVERY PYRAMID TWIST-PRONG ELECTROLYTIC YOU BUY FROM NOW TO DECEMBER 31, WILL HAVE A COUPON WRAPPED IN IT THAT'S WORTH UP TO $2.00! IT'S OUR WAY OF CELEBRATING WITH YOU THE MERGER OF PYRAMID WITH MICAMOLD TO FORM THE GENERAL INSTRUMENT CAPACITOR DIVISION ■ JUST GO TO YOUR PYRAMID DISTRIBUTOR, PICK THE TWIST-PRONG VU-PAKS YOU NEED FROM HIS CAPAC-O-MAT RACK, UNROLL THE WRAPPER AND CASH IN THE COUPON. COUPONS RANGE IN VALUE FROM 5c TO $2—AND EVERY VU-PAK HAS ONE! BUT THAT'S NOT ALL. YOU GET A RELIABLE, PYRAMID ELECTROLYTIC THAT MEETS EVERY REQUIREMENT YOU SET FOR A TWIST-PRONG, SO YOU'RE A WINNER TWO WAYS. SEE YOUR DISTRIBUTOR TODAY.

GENERAL INSTRUMENT CAPACITOR DIV., GENERAL INSTRUMENT CORP., DARLINGTON, S.C.

Radio-Electronics

NOVEMBER 1961
VOL. XXXII No. 11

Formerly RADIO CRAFT — Incorporating SHORT WAVE CRAFT — TELEVISION NEWS — RADIO & TELEVISION*

Over 50 Years of Electronic Publishing

EDITOR-IN-CHIEF AND PUBLISHER
Hugo Gernsback
EDITOR
M. Harvey Gernsback
MANAGING EDITOR
Fred Shunaman
TECHNICAL EDITOR
Robert F. Scott, W2PWG
ASSOCIATE EDITOR
Larry Steckler
EDITORIAL ASSOCIATE
I. Queen
SERVICE EDITOR
Jack Darr
ART DIRECTOR
Harry Schlack
TECH. ILLUSTRATION DIRECTOR
Wm. Lyon McLaughlin
ART ASSOCIATE
Fred Neinast
PRODUCTION MANAGER
Elizabeth Stalcup
DIRECTOR, ADVERTISING SALES
Lee Robinson
EASTERN SALES MANAGER
John J. Lamson
CIRCULATION MANAGER
G. Aliquo
DIRECTOR, NEWSSTAND SALES
Joseph L. Bund
PROMOTION MANAGER
Robert Fallath

Average Paid Circulation Over 155,000

—on the cover—

(Story on page 38)

Classroom scene at the New York Institute of Technology foreshadows the school of the future.

Gernsback Publications, Inc.
EXECUTIVE, EDITORIAL, ADVERTISING OFFICES
154 W. 14 St., New York 11, N.Y.
Telephone AL 5-7755

CHAIRMAN OF THE BOARD
Hugo Gernsback
PRESIDENT
M. Harvey Gernsback
SECRETARY
G. Aliquo

MEMBER INSTITUTE OF HIGH FIDELITY MANUFACTURERS INC.

Radio-Electronics is indexed in *Applied Science & Technology Index (Formerly Industrial Arts Index)*

*Trademark registered U. S. Pat. Office

GET YOUR ELECTRONICS-TV-RADIO HOME TRAINING FROM N.T.S. RESIDENT SCHOOL

BREAK THROUGH TO HIGHER PAY, GREATER JOB SECURITY

START NOW! Break through the Earning Barrier that stops "half-trained" men. **N.T.S.** "All-Phase" Training prepares you . . . at home in spare time . . . for a high-paying **CAREER** as a **MASTER TECHNICIAN** in Electronics — TV — Radio. One Master Course at One Low Tuition trains you for unlimited opportunities in All Phases: Servicing, Communications, Preparation for F.C.C. License, Broadcasting, Manufacturing, Automation, Radar and Micro-Waves, Missile and Rocket Projects.

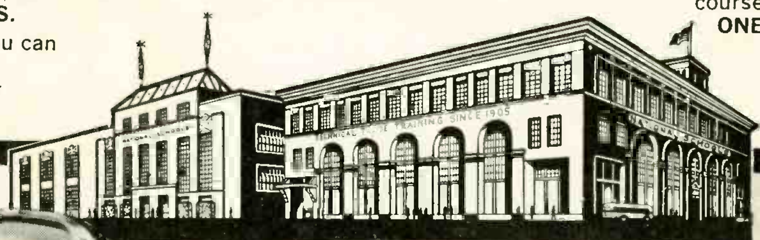
A MORE REWARDING JOB . . . a secure future . . . a richer, fuller life can be yours! As an **N.T.S. MASTER TECHNICIAN** you can go straight to the top in industry . . . or open your own profitable business.

Over 1 City Block of Modern School Facilities, Laboratories and Shops Housing Over 1,000 Students.

50,000 Graduates — all over the World — since 1905

NATIONAL TECHNICAL SCHOOLS
WORLD-WIDE TRAINING SINCE 1905

THE SCHOOL BEHIND YOUR HOME-STUDY TRAINING



In these modern School Headquarters your Home Training is: Classroom-Developed, Lab-Studio Planned, Shop-Tested, Industry-Approved, Home Study-Designed.

BETTER ...MORE COMPLETE ...LOWER COST ...WITH NATIONAL SCHOOLS' SHOP-METHOD HOME TRAINING!

BETTER
. . . Training that is proved and tested in **N.T.S.** Resident School shops and laboratories, by a School that is the **OLDEST** and **LARGEST** of its kind in the world.

MORE COMPLETE
. . . You learn **ALL PHASES OF** Television — Radio — Electronics.

LOWER COST
. . . Other schools make several courses out of the material in our **ONE MASTER COURSE** . . . and you pay more for less training than you get in our course at **ONE LOW TUITION!**

19 BIG KITS YOURS TO KEEP

- Friendly Instruction and Guidance
- Graduate Advisory Service
- Unlimited Consultation
- Diploma Recognized by Industry
- **EVERYTHING YOU NEED FOR SUCCESS**

N.T.S. IS NOT JUST A MAILING ADDRESS ON A COUPON

N.T.S. is a real school . . . a world famous training center since 1905. Thousands of men from all over the world come to train in our shops, labs, studios and classrooms.
You learn quickly and easily the N.T.S. Shop-Tested way. You get lessons, manuals, job projects, personal consultation from instructors as you progress. You build a Short-Wave, Long-Wave Superhet Receiver plus a large screen TV set from the ground up with parts we send you at no additional cost. You also get a Professional Multitester for your practical job projects. The Multitester will become one of your most valuable instruments in spare time work while training, and afterwards, too. Many students pay for their entire tuition with spare time work. You can, too . . . we show you how.

SEND FOR INFORMATION NOW . . . TODAY! IT COSTS YOU NOTHING TO INVESTIGATE

After you graduate you can open your own TV-Radio repair business or go into high paying jobs like these: Communications Technicians, Hi-Fi, Stereo and Sound Recording Specialists, TV-Radio Broadcasting Technician, Technician in Computers & Missiles, Electronics Field Technician, Specialist in Micro-Waves and Servomechanisms, Expert Trouble Shooter, All-Phase Master Technician, TV-Radio Sales, Service and Repair.

RESIDENT TRAINING AT LOS ANGELES
If you wish to take your Electronics-TV-Radio training in our famous Resident School in Los Angeles — the oldest and largest school of its kind in the world — write for special Resident School catalog and information, or check special box in coupon.

ACCREDITED MEMBER
NATIONAL HOME STUDY COUNCIL · ACCREDITED SCHOOL · NHSC

NATIONAL TECHNICAL SCHOOLS
WORLD-WIDE TRAINING SINCE 1905
4000 SO. FIGUEROA ST., LOS ANGELES 37, CALIF., U. S. A.

MAIL COUPON NOW FOR FREE BOOK & ACTUAL LESSON

No obligation.
No salesman will call.

NATIONAL TECHNICAL SCHOOLS
WORLD-WIDE TRAINING SINCE 1905

Mail Now To
National Technical Schools, Dept. RG111
4000 S. Figueroa St., Los Angeles 37, Calif.

Please rush FREE Electronics-TV-Radio "Opportunity" Book and Actual Lesson.

Name__________ Age____
Address__________
City________ Zone____ State____

☐ Check here if interested ONLY in Resident Training at Los Angeles.
VETERANS: Give date of discharge________

RADIO-ELECTRONICS published monthly at Mt. Morris, Ill., by Gernsback Publications Inc. Second-class postage paid at Mt. Morris, Ill. SUBSCRIPTION RATES: US and possessions, Canada: $5 for 1, $9 for 2, $12 for 3 years. Pan American countries: $6 for 1, $11 for 2, $15 for 3 years. Other countries: $6.50 for 1, $12 for 2, $16.50 for 3 years.

News Briefs

New Electronic Brain Learns by Trial and Error

A special-purpose machine, called the Cybertron by its developers, solves problems by logical methods. The new machine, produced by Raytheon, is not a computer. It does not solve problems by working from step-by-step formulas and programs. Instead, it comes to conclusions intuitively, based on information fed into it and stored in its memory. A training period is needed, during which the machine "learns" and is examined by a human instructor. When the machine makes an incorrect decision, the trainer pushes a "goof" button, modifying the machine's memory.

A small machine is already working on problems for the Department of Defense. A larger one, now in development, would be able to handle more complex data. Equipped with sensors giving data on wind, temperature, weather-map and radar patterns, and other details, the machine could help weathermen make local predictions in minutes. If, following a prediction, the machine's findings proved wrong, it could be told it erred. It would then adjust or refine its memory content, reducing the chance it would make the same mistake again.

Maser Produces Blue Note

A blue beam has been produced from a laser (optical maser) for the first time, four University of Michigan physicists report. By focusing its output beam, an infrared ray of 6943 Angstroms in wavelength, into a quartz crystal, the second harmonic at 3471.5 Angstroms was detected. The second harmonic was produced by the nonlinear optical properties of quartz, impinged upon by a high-intensity beam.

The U of M group, Drs. Peter Franken, Wilbur Peters and Gabriel Weinrich of the physics faculty and student Alan Hill, used a commercial (Trion Instruments) laser in their experiments.

Stereo FM Leads Hi-Fi Show

Multiplex tuners, receivers, adapters, and even two FM broadcast stations dominated the New York City high-fidelity show — the largest one of its kind in the country — in mid-September. The two broadcast stations — WDHA of Dover, N.J., and WLIR of Garden City, N.Y., maintained studios from which programs were sent out to their transmitters, as well as to modulate multiplex FM generators in the H. H. Scott exhibition room, from which closed-circuit stereo FM was transmitted to the various exhibits. Thus stereo FM was available for demonstration at all times.

Most noticeable feature other than the stereo FM was an improvement on phono pickup arms. Lateral balance appears on many, and one new arm lifts the stylus from the surface when the record has finished playing. Thus, if you leave your phonograph on all night, the stylus will not be in contact with the record.

Another feature that cropped up on a number of pickup arms was the anti-skating or anti-bias devices designed to neutralize the inward push of the arm as it tracks the record groove. (Two such devices are mentioned in Marshall's article beginning on page 43.) One consisted of a small weight and nylon thread, attached to the arm just ahead of or behind the pivot. The thread is brought out horizontally to a wire loop which acts as a pulley. The weight, hanging vertically from the loop, is just heavy enough to tug in the opposite direction with the same force as the side thrust of the arm.

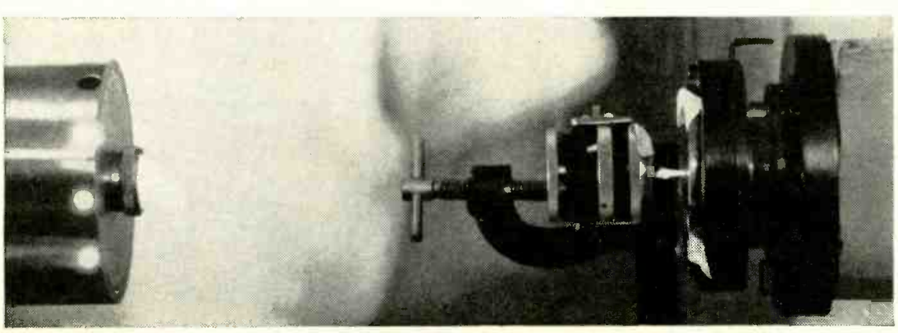
Speakers followed the smaller-but-better tendency claimed at last year's show. New ideas were shown in woofers and in one complete system. At least three low-frequency speakers had flat styrofoam pistons either coupled to the cone by air pressure or in one case forming a *solid* cone with a flat face and an apex connected direct to the voice coil. (See illustrations on pages 78 and 79 of this issue.) One speaker system using an air-coupled bass piston speaker had a mid-range unit with a voice coil wound on a flat diaphragm, moving in a flat magnetic field. The tweeter was a similar flat coil cemented to a solid surface. A thin aluminum diaphragm ahead of it was actuated by eddy currents induced by the "voice coil." Crossover is automatic in this speaker system, the efficiency of one unit falling off as the next one's increases.

Among other noteworthy displays were electrostatic speakers, a turntable with two motors and a viscous, damping system for the arm that "lets go" while the stylus is on the record. A large electro-mechanical organ that works from recordings of actual organ notes attracted considerable attention, as did an improved Ionovac, the tweeter with no moving parts that produces sound by vibration of ionized air.

Diamond Semiconductors Made

Dr. Guy Suits of the General Electric Research Laboratory has announced the discovery of methods for producing semiconducting diamonds. Such gems are very rare in nature—less than 1% of all natural diamonds, but now can be grown at will in the laboratory. Semiconducting borazon (a form of boron nitride with a structure like that of diamond and equally hard) has also been made at the laboratory.

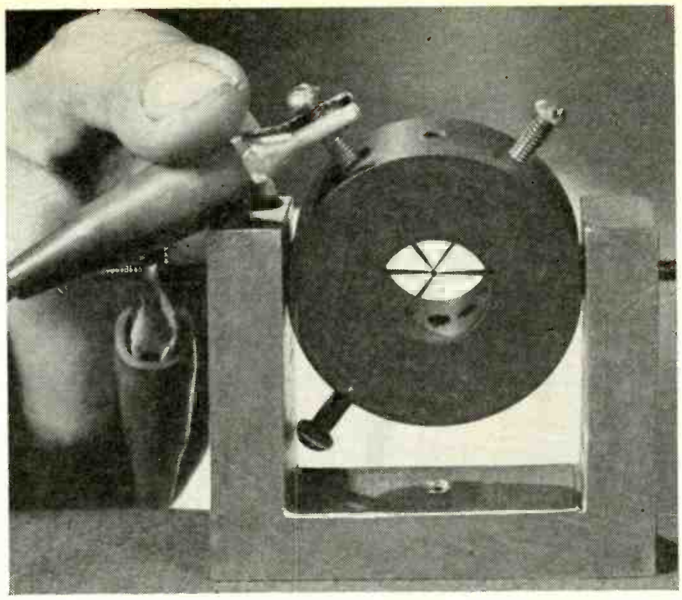
The method for making semiconducting diamonds was discovered by Dr. Robert H. Wentorf, Jr., of the Research Laboratory, and Harold P. Bovenkerk, of G-E's Metallurgical Products Dept. Semiconducting borazon was discovered by Dr. Wentorf, who also developed the original proc-



Advertising Representatives: Los Angeles: Harker-Husted-Coughlin, 408½ South Alvarado St., Tel. DUnkirk 7-2328. **San Francisco:** Harker-Husted-Coughlin, 444 Market St., Tel. GArfield 1-0151. **Atlanta:** J. Sidney Crane & Associates, 22 Eighth St. N.E., Tel. TRinity 2-6720. **United Kingdom:** Publishing & Distributing Co., Ltd., Mitre House, 177 Regent St., London, W. 1, England

Foreign Agents: Great Britain: Atlas Publishing and Distributing Co., Ltd., 18 Bride Lane, London E.C. 4.

Subscription Service Address form 3579 and correspondence to Radio-Electronics, Subscriber Service, 154 West 14th St., New York 11, N.Y. When requesting a change of address, please furnish an address label from a recent issue. Allow one month for change of address.



Test setup for checking electrical characteristics of semi-conducting diamonds. Diamond is held in place by 5 contact pins.

ess for making borazon. Diamonds are made semiconducting by adding impurities such as boron, beryllium or aluminum to the mixture of graphite and catalyst from which diamonds are made. The mixture is subjected to pressures of about 1,000,000 pounds per square inch and temperatures above 2000°F. Under these conditions, diamonds form with concentrations of 1% or less of the desired impurity, and have electrical conductivities in the semiconducting range (intermediate between those of metals and insulators).

Drs. Wentorf and Peter Cannon of the Research Laboratory have also prepared semiconducting diamonds by diffusing boron and aluminum into man-made or natural diamonds at high pressures and temperatures. All the semiconducting diamonds made so far have been p-type (positive current carriers). Both p-type and n (negative current carrier)-type crystals are necessary in transistors and other semiconducting devices, and a search for processes that will produce n-type diamonds is continuing.

Tests on such junctions have shown that they act as rectifiers (allow current to flow in only one direction). Beryllium as an impurity produces p-type borazon, and a number of substances including sulfur, silicon, many organic compounds, and potassium cyanide, when added to the synthesis mixture, result in n-type borazon.

The semiconducting diamonds prepared with boron are blue, in shades ranging from a pale blue-white to a deep blue-black, depending on how much boron is present in the crystal. Semiconducting diamonds found in nature, which have been studied for many years by a number of investigators, are also sometimes blue. One of the most famous blue-white diamonds is the Hope diamond, and although its conductivity has not been measured up to the present time, its color suggests that it is probably a semiconductor.

Nuclear TV Coming?

A TV satellite with a nuclear power plant was proposed at a Congressional hearing by Commissioner Robert E. Wilson of the Joint Committee on Atomic Energy. Wilson stated that a nuclear-powered satellite with a 1-kw TV transmitter could be developed in 2 to 3 years. Enough power for hemisphere coverage would need about 150 kw, however, and though not so easy to realize, would be possible in this decade. "In my opinion," stated Commissioner Wilson, "this would mean a great deal more to the average individual than a manned landing on the moon."

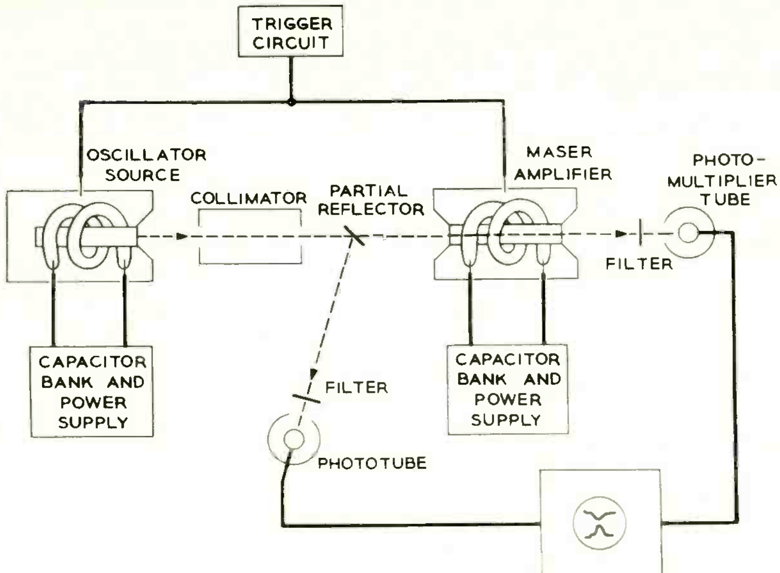
NBS Revalues Its Ohm

The National Bureau of Standards has redetermined its primary unit of electrical resistance by a new, more accurate method. The new evaluation was made by using a 1-picofarad capacitor, capacitance of which was determined to a very high degree of accuracy from its mechanical dimensions. The NBS unit of resistance is found to measure 1.000002 ohms.

The method of measurement was to build a capacitor of such a type that its capacitance could be determined very accurately. The one developed by the bureau is constructed of gauge blocks. The impedance of the capacitor at an accurately determined frequency is compared with that of the reference resistors. Besides being more accurate, the method is simpler and faster than previous methods, both in making the measurements and in the construction of the equipment required.

Maser Now Amplifies Light

Actual amplification of light by a ruby maser is reported by Drs. P. P. Kisliuk and W. S. Boyle of Bell Laboratories. The optical maser has been used as an oscillator producing coherent light, but this is the first



time amplification has been observed.

Two masers were set up as shown in the illustration, and fired simultaneously. The signal going into the amplifier and that coming out from it were compared on a dual-beam oscilloscope. The gain was measured by comparing the output-to-output ratio when using the amplifier to that when the amplifier was removed from the beam.

While the very fact that an optical maser oscillates indicates that it has enough amplification to make up for losses at the end mirrors, this is the first experiment in which such large amplification has been measured directly. Dr. Kisliuk pointed out that with more sophisticated setups, greater amplification might be expected, and that the maser amplifier might eventually become as important in the field of amplification as in that of oscillation.

New Japanese Color Tube?

A new color TV tube was reportedly demonstrated by the Tokyo firm Toyo Denki. The tube, the company stated, uses rare gases—helium or xenon, argon and neon. These are trapped in layers of silicone grease. Excitation of each layer produces the color characteristic of the gas, and the company claimed to have worked out a matrix that gives natural color from the combination.

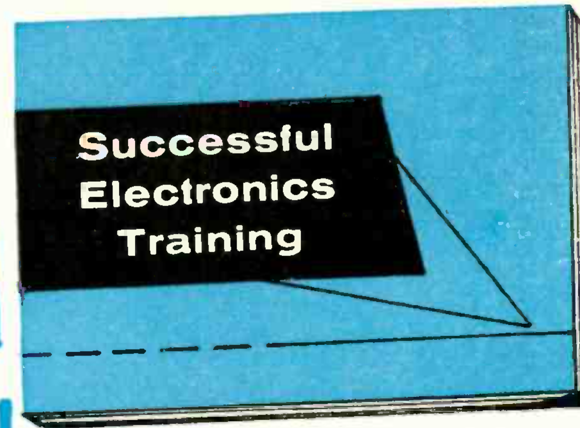
The tube, the company stated, is completely compatible with present sets, except for a higher ultor voltage (50,000 volts).

As demonstrated to the press and members of the Tokyo Stock Exchange, results were excellent. Representatives of the technical press, however, were skeptical, and one publication suggested that, in the writer's opinion, the whole thing was a hoax and that the equipment used was a standard Toshiba color set with the base connections of the color tube modified to give the impression that a different circuit and power supply were being used.

Briefer Briefs

General Motors is offering pushbutton all-transistor radios in its 1962 line of cars. Manually tuned auto radios will continue to combine tubes and transistors, the Delco Div. states.

free



find out how

Find ~~out~~ today how specialized education can help you get more important jobs and a higher salary in electronics. Electronics problems are becoming more complex, and your ability to solve them will help you get ahead. Education will help you keep up with new developments and prepare you to use new devices.

1. You can get job security
2. You can solve the problems that stump other technicians
3. You can handle new electronic devices

want to boost your pay?

move ahead in ELECTRONICS

Get All Three

Your FCC License Or Your Money Back!

Completion of the Master Course (both Sections) will prepare you for a First Class Commercial Radio Telephone License with a Radar Endorsement. Should you fail to pass the FCC examination for this license after successfully completing the Master Course, you will receive a full refund of all tuition payments. This guarantee is valid for the entire period of your enrollment agreement.

Investigate our NEW Training Program in Computers, Servo Mechanisms, Magnetic Amplifiers and others!

Get This Handy Pocket Electronics Data Guide Folder

Free!

Puts all the commonly used conversion factors, formulas, tables and codes at your fingertips. Yours absolutely free if you mail the coupon today. No further obligation!

free!

Sorry—
Not For Beginners

Please inquire only if you really want to get ahead and to add to what you have already learned in school, in the service, or on the job. Some previous schooling or experience in electronics, electricity, or related fields is necessary for success in Cleveland Institute programs.

Mail This Coupon Today . . .

CLEVELAND INSTITUTE OF ELECTRONICS
1776 E. 17 St. Desk RE 59B Cleveland 14, Ohio

Cleveland Institute of Electronics
Desk RE59B 1776 E. 17th St., Cleveland 14, Ohio

Please send FREE career information material prepared to help me get ahead in Electronics. I have had training or experience in Electronics as indicated below:

- ☐ Military
- ☐ Radio-TV Servicing
- ☐ Manufacturing
- ☐ Amateur Radio
- ☐ Broadcasting
- ☐ Home Experimenting
- ☐ Telephone Company
- ☐ Other ....

In what kind of work are you now engaged? ....

In what branch of Electronics are you interested? ....

Name .... Age ....

Address ....

City .... Zone .... State ....

Desk RE 59B

The National Aeronautics and Space Administration announces that it plans to launch next year a satellite that will revolve with the earth, remaining above the same spot. Three such satellites would be able to relay communications to any part of the earth.

Electroluminescent lamps are being installed by the New York City subways, replacing filament type bulbs on emergency telephones and alarm boxes.

Calendar of Events

IRE National Symposium on Engineering Writing & Speech, Oct. 16–17, Michigan State University, East Lansing, Mich.

IRE Symposium on Electronics Engineering and Education, Oct. 19–20, Greensboro Coliseum, Greensboro, N. C.

IRE New York Conference on Electronic Reliability, Oct. 20, New York University College of Engineering, New York.

IRE East Coast Conference on Aerospace & Navigational Electronics, Oct. 23–25, Lord Baltimore Hotel, Baltimore, Md.

URSI-IRE Fall Meeting Oct. 23–25, University of Texas, Austin, Tex.

Armour Research Foundation 1961 Computer Application Symposium, Oct. 25–26, Morrison Hotel, Chicago.

IRE Electron Devices Meeting, Oct. 26–28, Sheraton Park Hotel, Washington, D. C.

ERA Mid-Lantic Chapter Hi-Fidelity Show, Oct. 27–29, Benjamin Franklin Hotel, Philadelphia, Pa.

EIA-IRE Annual Radio Fall Meeting, Oct. 30–Nov. 1, Hotel Syracuse, Syracuse, N. Y.

IRE–AIEE Conference on Nonlinear Magnetics, Nov. 6–8, Statler Hilton Hotel, Los Angeles.

IRE Conference on Radio Interference Reduction and Electronic Compatibility, Nov. 7–9, Illinois Institute of Technology, Chicago.

AIEE–IRE Conference on Magnetism and Magnetic Materials, Nov. 13–16, Hotel Westward Ho, Phoenix, Ariz.

IRE Northeast Research and Engineering Meeting, Nov. 14–16, Somerset Hotel & Commonwealth Armory, Boston.

IRE Symposium on Electronic Systems Reliability, Nov. 14, Linda Hall Library Auditorium, Kansas City, Mo.

Northwest High Fidelity Stereo & Music Show, Nov. 16–19, Municipal Auditorium, Minneapolis, Minn. (Sponsored by Audio Div., Paul Bunyan Chapter ERA.)

EIA Winter Conference, Nov. 28–30, Statler Hilton Hotel, Los Angeles, Calif.

IRE Conference on Vehicular Communications, Nov. 30-Dec. 1, Hotel Radisson, Minneapolis, Minn.

IRE, AIEE, ACM Eastern Joint Computer Conference, Dec. 12–14, Sheraton Park Hotel, Washington, D. C.

Harry Sadenwater Passes

One of the earliest of the veteran airplane radio operators, Harry Sadenwater died in New York City at the age of 67. Sadenwater was the operator on the NC-1, one of the planes engaged in the first trans-Atlantic flight, sponsored by the Navy in 1919. The NC-1 flew from Newfoundland to the Azores but was unable to continue, the NC-4 with Anson Read as pilot being the only one to complete the flight.

Mr. Sadenwater was an early amateur and was radio inspector for the Department of Commerce before he joined the Naval Reserve in 1917. He was a director and past president of the Radio Club of America and a member of the Veteran Wireless Operators Association and the Institute of Radio Engineers. At the time of his death, he was assistant to the vice president of Radio Engineering Laboratories (REL), Long Island City, N.Y. END

The Same School That Originated The RTS BUSINESS PLAN

...NOW *Proudly Presents*...

A SPECIAL COMPACT COURSE COVERING ALL THREE PHASES OF ELECTRONICS

BASIC • INTERMEDIATE • ADVANCED

The Entire Course Is Made Up Of The Following:

- 35 LESSONS COVERING BASIC AND INTERMEDIATE ELECTRONICS
- 9 EQUIPMENT KITS COMPLETE WITH TUBES AND BATTERIES
- SOLDERING IRON
- 25 LESSONS COVERING THESE ADVANCED ELECTRONIC SUBJECTS:

  Thyratron Tubes • Semiconductors • Electronic Symbols and Drawings • Voltage-Regulators • Electronic-Timers • Control Systems • X-Rays • Photoelectric Devices • Dielectric Heating • Geiger Counters • Pulse Circuitry • Clippers and Limiters • Multivibrators • Electronic Counters • Radar • Magnetic Amplifiers • Analog-Computers • DC Amplifiers • Digital Computers • Storage Systems • Input and Output Devices • Servomechanisms • Telemetering
- 60 EXAMINATIONS
- UNLIMITED CONSULTATION SERVICE
- KIT MANUALS
- DIPLOMA UPON GRADUATION

AND MUCH MORE...

DESIGNED FOR THE BUSY MAN OF TODAY

This is MODERN training for the MODERN man. You'll find no "horse and buggy" methods here. Every page of this streamlined course is devoted to important Electronics principles and practical projects. You'll be amazed how fast you grasp Electronics the RTS way. RTS has combined modern THEORY and PRACTICE to make this the finest training program of its kind available!

SATISFIES NOVICE, TECHNICIAN OR HOBBYIST

Whether you're new to Electronics or an old "pro," chances are you'll find this to be the ideal course for you. The novice will appreciate the completeness of the training. It starts with the most basic considerations, covering each important point thoroughly, yet concisely. The technician will enjoy the practical review of fundamentals and profit from the 25 advanced subjects covered.

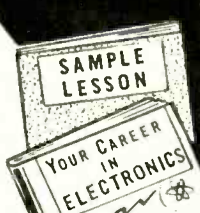
RTS GIVES YOU "TOP MILEAGE" FOR YOUR TRAINING DOLLAR

The price quoted below buys EVERYTHING — there are no extras to pay for. RTS has gone "all out" to give you the best training value in America. Why pay hundreds of dollars for training such as we offer when it's available for this LOW PRICE? If you can find a better training bargain... BUY IT!

CAN BE COMPLETED IN MONTHS INSTEAD OF YEARS

Some students will complete this course with "Jet-Like" speed but we allow up to two years if your circumstances require it. You study at your own rate. You are ENCOURAGED but not pushed. You'll find the lessons professionally written but easy to understand. LET US SEND YOU ONE OF THESE LESSONS ALONG WITH YOUR CAREER BOOKLET SO YOU CAN SEE FOR YOURSELF. NO OBLIGATION!

RTS' Membership in The Association of Home Study Schools is your assurance of Reliability, Integrity and Quality of Training.



COMPLETE COST... INCLUDES ALL KITS, TUBES, BATTERIES, ETC. $125.00*

* TERMS ALSO AVAILABLE AS LITTLE AS $5.00 DOWN $5.00 PER MONTH

SAVE TIME — SEND $5.00 WITH COUPON

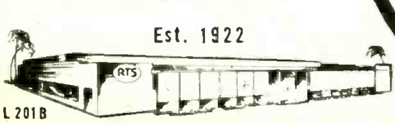
YOUR FIRST LESSONS AND KIT WILL BE RUSHED TO YOU THE SAME DAY THEY ARE RECEIVED!

Rush Coupon

NO SALESMAN WILL CALL!

RTS ELECTRONICS DIVISION
815 E. ROSECRANS AVENUE
LOS ANGELES 59, CALIFORNIA

Est. 1922



L 201B

DON'T LOSE OUT — *FIND OUT!*

RTS ELECTRONICS DIVISION, Dept. RE111
815 E. ROSECRANS AVENUE LOS ANGELES 59, CALIFORNIA

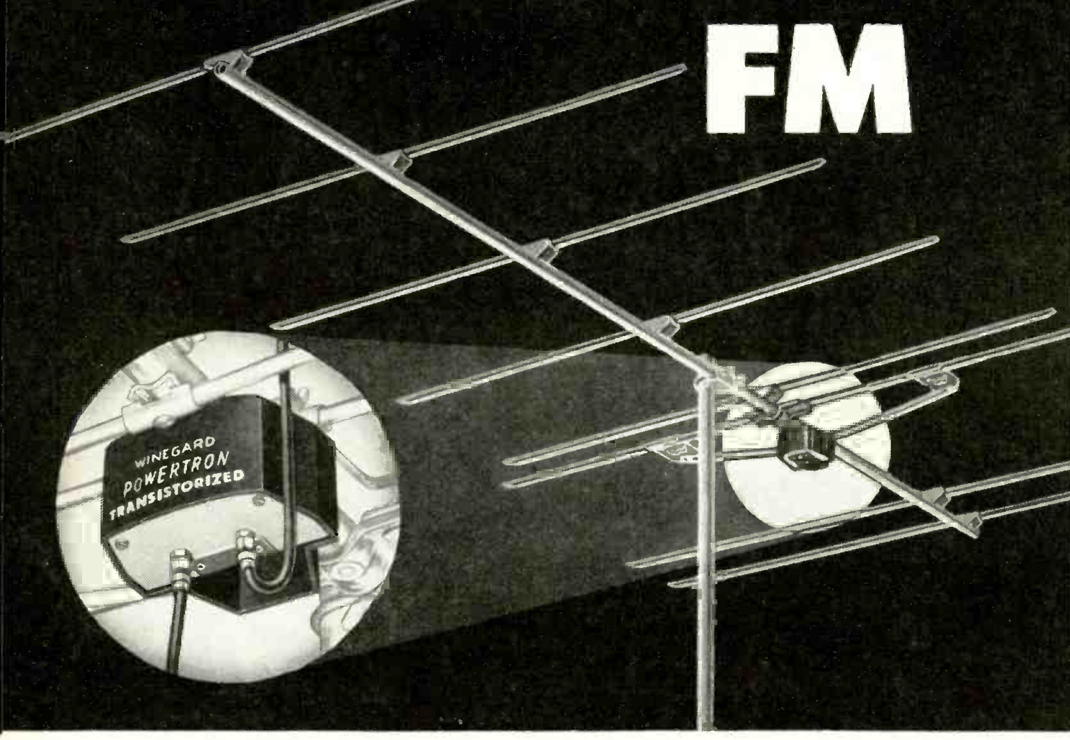
Rush me full information by return mail. (Please Print)

Name ____________ Age ______
Address ____________
City ____________ Zone ____ State ______

☐ ENROLL ME NOW ☐ SEND MORE FACTS

WORLD'S ONLY ELECTRONIC ANTENNAS FOR

SUPER-POWERFUL FM



MODEL PF-8 FM STEREO-TRON YAGI — GOLD ANODIZED

This is the world's most powerful FM antenna. Because Multiplex requires an antenna with greater sensitivity and gain to offset the power loss of the carrier and subcarrier, Winegard's PF-8 is the best antenna you can install for Multiplex. When you hook up a PF-8, weak signals come in like "locals".

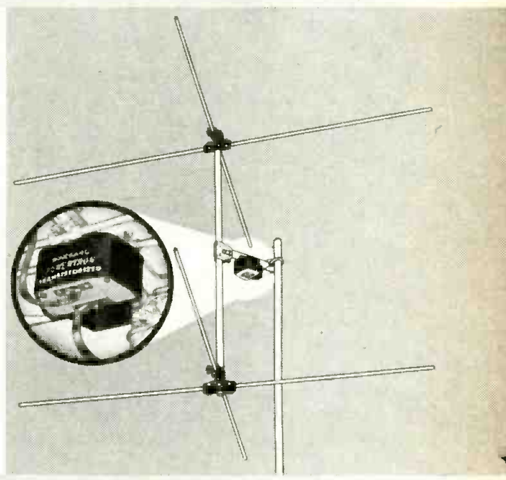
The PF-8 has a minimum gain of 26 DB over a folded dipole with a flat frequency response of ± ¼ DB from 88 to 108 m.c. It features a built-in TV-FM coupler and has eight elements with EXCLUSIVE "TAPERED T" driven element engineered perfectly to match the powerful transistorized, direct coupled, *built-in* amplifier. It is *available two ways* — Model PF-8 for 300 ohm twin lead or Model PF-8C for 75 ohm coax.

2 NEW TRANSISTORIZED WINEGARD ELECTRONIC FM ANTENNAS FOR LONG DISTANCE FM AND MULTIPLEX

Now WINEGARD brings you super-powerful FM antennas with *BUILT-IN* transistorized amplifiers for L-O-N-G range FM and multiplex reception. You can offer your customers the PF-8 FM STEREO-TRON Yagi (directional) or the PF-4 FM ELECTRONIC Turnstile (omni-directional). Both models deliver unexcelled performance far beyond ordinary FM antennas—open a new field of opportunity in the fast growing FM and Multiplex market.

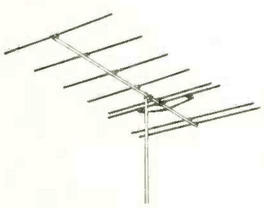
Here Are Some Important Features of Winegard Electronic FM Antennas

1. Transistorized amplifier is designed as *part of* the "Tapered T" driven element (model PF-8) for unprecedented efficiency and signal-to-noise ratio.
2. Built-In FM-TV coupler allows you to use one power supply and down lead when used with a WINEGARD POWERTRON TV antenna.
3. Gold anodized finish—100% corrosion-proofed—all hardware irridized. This is the finest finish of any antenna—meets U.S. Navy specifications.
4. The quality of craftsmanship and materials in these antennas tell their own story—perfect mechanical balance—100 m.p.h. wind tested.



MODEL PF-4 FM ELECTRONIC TURNSTILE — GOLD ANODIZED

Most powerful non-directional FM antenna with 16 DB gain in all directions over a folded dipole. Has Winegard offset mount and transistorized amplifier with TV-FM coupler. Model PF-4 has 300 ohm output.

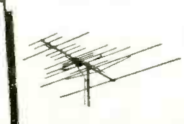


MODEL FM-8—Non-Electronic Yagi — Gold Anodized. The FM-8 is the finest non-electronic FM antenna available. It features the same Winegard "Tapered T" driven element and construction as our super-powerful PF-8.

MODEL FM-3T — Non-Electronic FM Turnstile — Gold Anodized. Very popular WINEGARD omni-directional FM antenna. Has WINEGARD'S offset mount and is gold anodized. Easy to install — can be mounted on same mast as TV antenna.

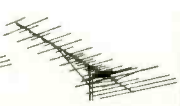
WORLD'S MOST POWERFUL TV AND FM ELECTRONIC ANTENNAS, WINEGARD "TRON" SERIES,
TELETRONS — POWERTRONS — COLORTRONS — STEREO-TRONS

Watch Winegard go in '61 National Consumer Advertising this Fall in LIFE, LOOK, SUCCESSFUL FARMING, FIELD AND STREAM, SUNSET.



POWERTRON MODEL P-55
14 Elements

POWERTRON MODEL P-55X
21 Elements



SUPER POWERTRON MODEL SP-55X
30 Elements

Write for Technical Bulletins or Ask Your Distributor

Winegard
ANTENNA SYSTEMS
3013-11 Scotten Blvd., Burlington, Iowa

GET YOUR First Class Commercial F.C.C. LICENSE IN 12 WEEKS!

Is the course proven?

A high percentage of our fulltime resident students get their 1st class licenses within 12 weeks from the time they start the course. Intensive FCC license training is our specialty – not just a sideline.

Is the course complete?

The Grantham course covers all the required subject matter completely. Even though it is planned primarily to lead directly to a first class FCC license, it does this by TEACHING you electronics.

Is the course "padded"?

The streamlined Grantham course is designed specifically to prepare you to pass certain FCC examinations. All of the instruction is presented with the FCC examinations in mind. If your main objective is an FCC license and a thorough understanding of basic electronics, you want a course that is right to the point – not a course which is "padded" to extend the length of time you're in school. The study of higher mathematics or receiver repair work is fine if your plans for the future include them, but they are not necessary to obtain an FCC license.

Is it a "coaching service"?

Some schools and individuals offer a "coaching service" in FCC license preparation. The weakness of the "coaching service" method is that it presumes the student already has a knowledge of technical radio. On the other hand, the Grantham course "begins at the beginning" and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC type test so you can discover daily just which points you do not understand and clear them up as you go along.

Is the course guaranteed?

The now famous Grantham Guarantee protects your investment. When such "insurance" is available at no extra cost, why accept less?

Is it a "memory course"?

No doubt you've heard rumors about "memory courses" and "cram courses" offering "all the exact FCC questions." Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this "meaningless" material than to learn to understand the subject. Choose the school that teaches you to thoroughly understand – choose Grantham School of Electronics.

THE GRANTHAM *FCC License Course in Communications Electronics is available by CORRESPONDENCE or in RESIDENT classes.*

Grantham Schools

LOS ANGELES	SEATTLE	KANSAS CITY	WASHINGTON
1505 N. Western Ave. Los Angeles 27, Calif. (Phone: HO 7-7727)	408 Marion Street Seattle 4, Wash. (Phone: MA 2-7227)	3123 Gillham Road Kansas City 9, Mo. (Phone: JE 1-6320)	821-19th Street, N.W. Washington 6, D.C. (Phone: ST 3-3614)

MAIL COUPON NOW—NO SALESMAN WILL CALL →

Accredited by the National Home Study Council

(Mail in envelope or paste on postal card)

To: GRANTHAM SCHOOL OF ELECTRONICS

1505 N. Western Los Angeles • 408 Marion Seattle • 3123 Gillham Rd. Kansas City • 821-19th, NW Washington

Please send me your free booklet telling how I can get my commercial F.C.C. license quickly. I understand there is no obligation and no salesman will call.

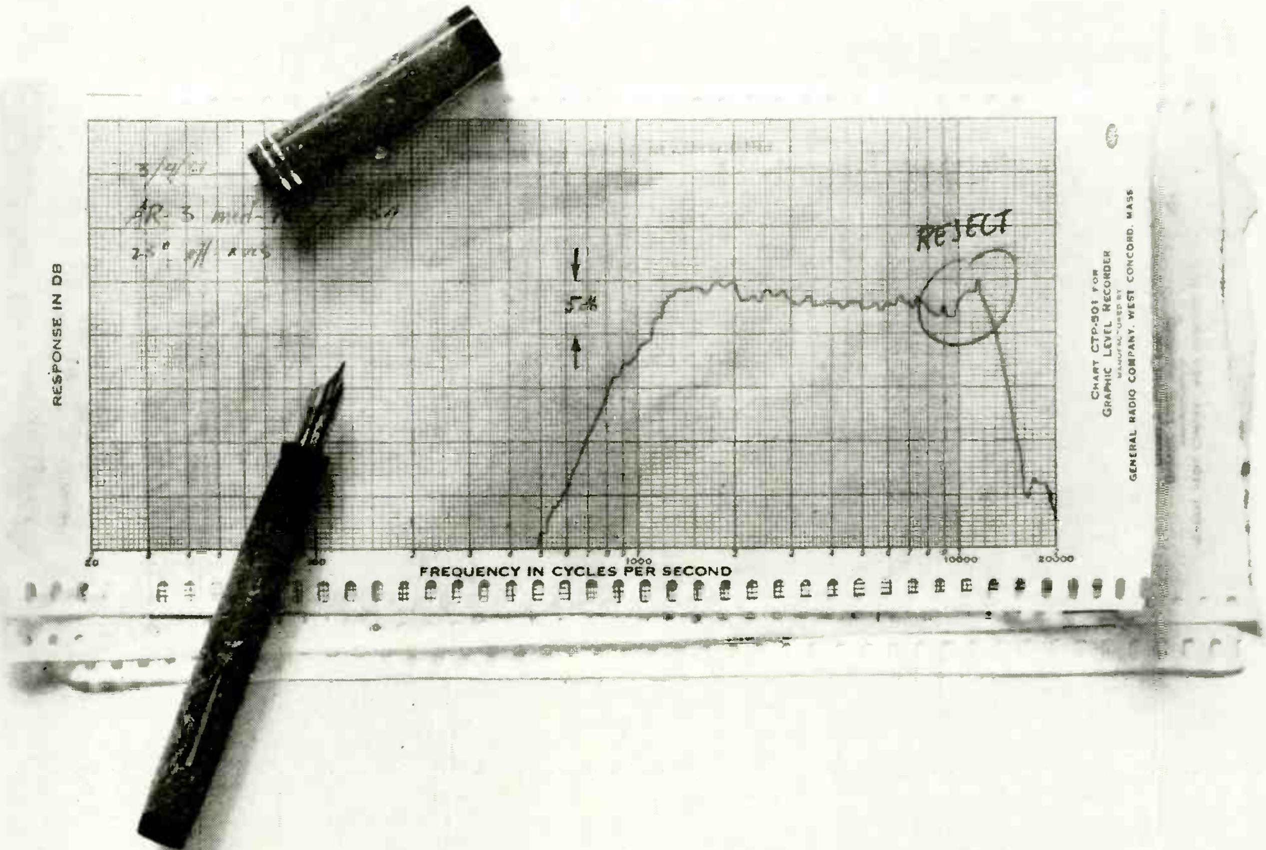
Name ____________ Age ____

Address ____________

City ____________ State ____

I am interested in: ☐ Resident Classes ☐ Home Study

14-S



THIS IS THE RECORDED FREQUENCY RESPONSE CURVE OF A REJECTED AR-3 MID-RANGE TWEETER

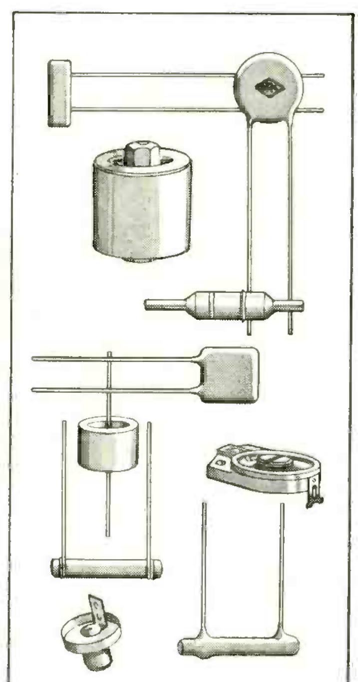
Although this curve does not depart from the ideal by more than 2 decibels at any point, the sharp peak at 11,500 cycles is evidence of transient distortion.

The frequency response of all AR-3 tweeters and AR-2a super-tweeters is recorded and examined critically before installation. One out of fifteen never makes it to the cabinet.

AR speakers are priced from $89 to $225. They may be heard at AR Music Rooms, on the west balcony of Grand Central Terminal in New York City, and at 52 Brattle Street in Cambridge, Massachusetts. No sales are made or initiated at these showrooms.

Literature, including a list of AR dealers in your area, is available for the asking.

ACOUSTIC RESEARCH, INC., 24 Thorndike Street, Cambridge 41, Massachusetts



Correspondence

HIGH-VOLTAGE TROUBLE

Dear Editor:

After replacing the horizontal output transformer in a Motorola 21K16 TV, I ran into a very stubborn case of high-voltage arcing. After several fruitless attempts at applying anti-corona dope and much rearranging of leads, I decided that the high voltage must come down to a value slightly lower than that recommended by the manufacturer. I did this by adding a 5,000-ohm 1-watt resistor in series with the 470-ohm screen resistor of the horizontal output tube.

With this addition I found that the screen voltage was still within 10% of its recommended value and the high voltage had been dropped close to 1,000 volts. This eliminated all traces of high-voltage arcing and left no change in picture quality or size.

J. M.

West Virginia

[Your cure may have worked, but it sounds like the hard way to cure a bad solder joint. When you replaced that flyback, you probably got a blob of solder on one of the terminals. This blob probably had some very sharp edges. Arcing under these conditions is almost a necessity. And anti-corona dope won't stop it.—*Editor*]

LISTEN TO BARKHAUSEN

Dear Editor:

If Mr. Christy (April 1961, page 22, "Effects") or others are interested in actually hearing the flipping over of those molecular magnets, they will find an adequate report of my 1918 experiments in the Backtalk column of *Electronics* for September 1955.

B. F. MIESSNER

Miessner Inventions Inc.
Miami Shores, Fla.

LIKE THAT SWEEP ANALYZER

Dear Editor:

Wayne Lemons' article in the February issue, "Horizontal Sweep Analyzer," looked like a very good thing to me. So I went ahead and built one. It appears to do everything claimed of it, although I have not tested it on all angle picture tubes yet.

I note that you recommend starting calibration with a 110° set as these have the most drive. At the time I completed my instrument, I had only an

INTERNATIONAL'S Executive MODEL 100

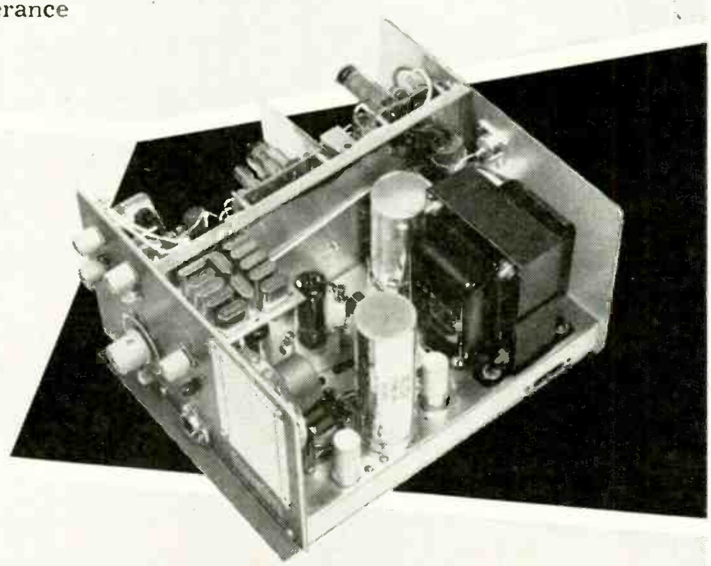
citizens band transceiver

A precision engineered transceiver for Citizens Band licensees seeking outstanding design and performance. Dual conversion superheterodyne receiver. Push-to-talk operation. Three way power supply for 6/12 vdc and 115 vac. Full five watts plate input. Certified FCC tolerance ±.005%. Size 5½" x 8½" x 9" deep.

Complete with 1 transmit crystal, 1 receive crystal, new style ceramic microphone and coil cord $199.50

Advanced engineering featured in the Executive Model 100

- **NEW** crystal filter minimizes adjacent channel interference.
- **NEW** built-in calibration circuit
- **NEW** International NR squelch.
- **NEW** 12 position crystal control transmit channel selector.
- **NEW** front panel microphone jack.
- **NEW** provision for connecting external speaker and S/meter.



FREE INTERNATIONAL'S 1962 CATALOG

Your buying guide for precision radio crystals and quality electronic equipment. Complete data on International's Citizens Band transceivers and accessories.

Send for it TODAY!

International Crystal Mfg. Co., Inc.
18 North Lee, Oklahoma City, Okla.

Rush FREE 1962 Catalog RE2

Name ____________________
Please print

Address ____________________

City __________ Zone ____ State ______

INTERNATIONAL Crystal Manufacturing Co., Inc. • 18 North Lee • Oklahoma City, Okla.

old 10-inch Philco around so I used it. Everything was fine until I reached position D with the analyzer's function selector. At that point I just didn't get a reading.

After checking for an error in wiring (there weren't any), I did a little experimenting. I started by adding another turn to the pickup coil and noted that this made the meter just barely move. I then found that using .025 μf for C3 instead of .02 and increasing the value of R6 to 20,000 ohms gave a reading in the center of the scale. For a 17-inch set, I found that I had to go back to the original value of 5,000 ohms for resistor R6.

FRANK H. WOODS

Teaneck, N.J.

[Good work! This data will be important to anyone who wants to use the analyzer he built on an old 10-inch receiver. And there's a surprising number of these sets still around.—*Editor*]

WRONG PHOTOCELL?

Dear Editor:

While the circuit described in the July 1961 issue represents an interesting attempt at designing a sensitive light meter, I should like to point out that the characteristics of the CL-3 photocell make it more suitable for use with infrared films than with normal types. A cadmium sulphide cell such as the CL-402 would probably be more suitable for ordinary films.

D. J. LEA

Montreal, Canada

[It is not too important that the CL-3 is sensitive to infrared. As long as it is calibrated against a standard light meter, it will give the same readings as to exposure time and aperture opening as a standard meter. However, if you were using infrared film, the CL-3 would make an effective detector where the light-sensitive element of standard meters might not give any reading at all.—*Editor*]

VOLTAGE JUNGLE

Dear Editor:

Any man who ever phased a transformer can tell you there is at least one additional voltage available from your transformer puzzle (Voltage Jungle, June 1961, page 36). It is, of course, zero.

JAMES W. STUCKEY

Baton Rouge, La.

[Yeah, but we don't need a transformer to get *that* voltage.—*Editor*]

JAP RADIO DATA

Dear Editor:

In the June Technicians News column an item appeared stating that the Sampson Co. would send a complete set of schematics for transistor radios made by Hitachi and imported by them to any service technician who wrote asking for them. This was certainly welcome news. I wish more importers would make such data available to technicians.

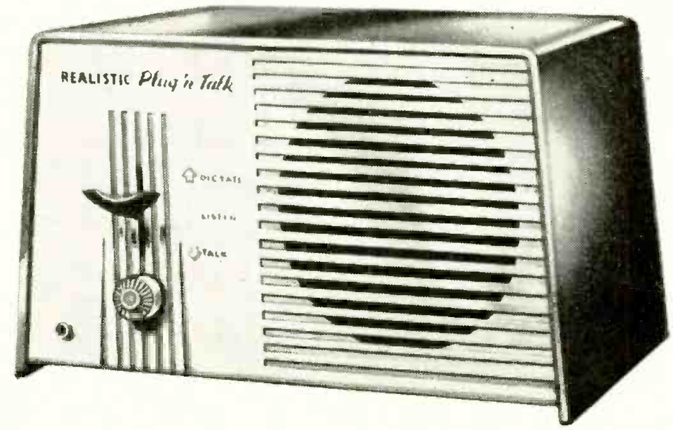
As one of the few shops here that will even look at a transistor set, I get

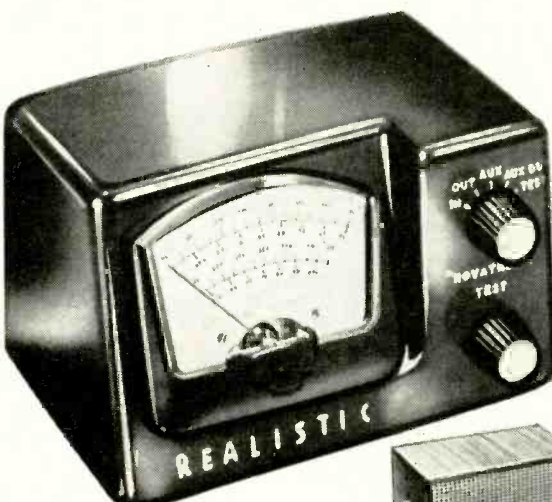
NOW! A FULL LINE OF FAMOUS REALISTIC ELECTRONIC KITS AT RADIO SHACK

- Easy to assemble—enjoy the pride of craftsmanship with very little effort.
- Save up to 42%! Put your savings into quality.
- Look like professionally assembled equipment and last as long.
- Widest assortment of designs to choose from

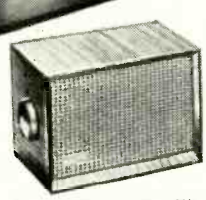
Radio Shack's whole new family of audio and test equipment kits employs the most advanced designs and engineering concepts known today! They meet the most exacting requirements in performance and appearance. They're easy and fun to build! Critical areas are pre-wired, factory-aligned. Even a novice can follow the simplified assembly manuals. And they're easy to own on No Money Down credit terms. Every kit backed by a money-back guarantee. We show here six kits newly introduced in our exciting 1962 Catalog.

Plug 'n Talk Intercom Kit—Beautifully styled by Realistic! New completely wireless 2-station Intercom System—easy to build yourself. Operates over 1 mile! 3-position switch: talk, listen, permanent. "B" speaker for good voice reception. Rear panel squelch control. Front panel volume. Use it in kitchen, bedroom, sickroom—ideal as a baby-sitter. 117-V power line circuit operates anywhere. 90LX844—$29.50



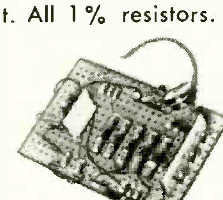


Realistic "Novatherm" Kit—the one and only professional-type electronic thermometer for the home! Compact, supremely accurate! Use in refrigerator, freezer, fish aquarium, lab. At flip of switch reads 2 temperatures in 2 different locations. Instantaneous readings from −20°F. to 120°F. Portable, uses 13c battery. Has "accessory probe"—use in freezer, liquid, even acid. Thermister type. Meter—0-200μa D'Arsonval movement. All 1% resistors. 94LX095—$19.95



Teak AM Radio Kit. 5 tube superhet circuit. Handsome teakwood case. 90LX637—$12.95

6 - Transistor Radio Kit. Major parts premounted. Easy to do and save! 90L636—$16.95



30 - in - 1 Transistor Experimenter Kit. Build 30 different circuits! 98LX375—$18.95

Stereo Balance Indicator Kit. Top quality! Gold anodized case. Easy to build. 91L547—$5.95

Radio Shack's 1962 Line of Kits Includes All These:

- Stereophonic Preamplifier Kit
- Stereo 140W Basic Amplifier Kit
- 40 Watt Stereo Amplifier Kit
- Complete Stereo System Kits
- Universal Multiplex Adapter Kit
- Hi-Fi 12 Watt Amplifier Kit
- FM Adapter Kit
- Stereo Balance Meter Kit
- Wireless Intercom Kits
- Deluxe Signal Generator Kit
- Deluxe VTVM Kit
- Standard VTVM Kit
- Ultra-Modern Tube Tester Kit
- 500W Variable AC Supply Kit
- VOM Kit with 4½" Meter
- Signal Generator Kit
- AC VTVM Preamplifier Kit
- Electronic Photo Relay Kit
- "Novatherm" Thermometer Kit
- 5-Tube Teakwood Radio Kit
- 2-Transistor Home Radio Kit
- 6-Transistor Portable Radio Kit
- Transistor Experimental Lab Kit

See complete specifications of these fine kits in Free Catalog

Send today for FREE 1962 Catalog

Gentlemen:
Please send me your giant new 340-page Electronics Catalog of over 100,000 items and every exciting supplement for one full year—all FREE and POSTPAID.

Your Name —61L10D
Your Address
City and Zone
State

For a Friend 61L10D1
Address
City and Zone
State

Mail coupon to

RADIO SHACK Corp.
730 Commonwealth Ave.
Boston 17, Massachusetts

quite a few of them. Granted, most of the time a schematic is not essential, but it certainly is a help when it is on hand.

One thing that would be a great help is a cross-reference on the imports. For instance, a Viscount 6TP-102 and Linmark T-62 are almost identical. I have a circuit of one and, since I know it covers both units, everything's fine. But there must be many other sets that are very similar that I have not heard about.

JOHN S. BOYLAN
Washington C. H., Ohio

[If any of our readers have any more such information, be sure to send it to us. We'll be happy to publish it.—*Editor*]

ABOUT CAPACITOR CHECKING

Dear Editor:

While reading "How Good Is That Electrolytic" in the July issue, I was reminded of a quick and simple check discovered in our shop which might be of interest to RADIO-ELECTRONICS readers. With my method, all you need is a scope and a stock of replacement capacitors.

Connect the scope across the capacitor to be checked while it is in the circuit and in actual use. Set vertical gain for a readable waveform on the scope screen and note the amplitude of this pattern. Next, connect a known good capacitor of equal capacitance in parallel with the suspected unit. The amplitude of the waveform on the scope should decrease to half of its original amplitude, since the impedance in the circuit has been halved. If the amplitude drops much more than half, the capacitor you are testing must be bad.

This is a good check for those marginal units which still seem to be operating properly, but actually are just about ready to conk out or to give trouble.

JOHN A. BUNTAIN
Buntain TV Shop
Montpelier, Ohio

PRINTED-CIRCUIT BOARDS FOR DO-IT-YOURSELFERS

Dear Editor:

We have a series of printed-circuit boards available for several RADIO-ELECTRONICS construction articles. Each kit consists of an etched board, undrilled, and any transistor or tube sockets required. A small piece of practice board is also supplied so the constructor can practice the necessary drilling and soldering operations before starting any project.

Among our boards for R-E projects are:

Transistor Checker (October 1959);
Mini-C-Checker (March 1960);
Three-in-One Oscillator (November 1960);
Citizens-Band Mobile Converter, (July 1961);
Scope Calibrator (July 1961).

IRVING S. SELIGMANN
Irving Electronics Co.
PO Box 9222
San Antonio 4, Tex.

END

TESTS All TV and Radio Tubes—Old and New

TESTS the Nuvistors

TESTS the New 12-Pin Compactrons

TESTS the New 10-Pin Tubes

TESTS for True Dynamic Mutual Conductance (Gm)

TESTS European Hi-Fi Tubes, Voltage Regulators, and Most Industrial Types

OBSOLESCENCE PROOF Designed for Maximum Use Today and Tomorrow

NEWEST
FINEST
MONEY-MAKER
for Professional Servicemen

Multiple-Socket Speed with Gm Accuracy PLUS OBSOLESCENCE PROTECTION

Model 700

DYNA-QUIK

Fastest, Most Complete
Most Up-to-Date

DYNAMIC MUTUAL CONDUCTANCE TUBE TESTER

TESTS BOTH OLD AND NEW TUBE TYPES—SELLS MORE TUBES PER CALL

Again you benefit from proved B&K techniques! This up-to-date, obsolescence-proof, professional instrument is designed for maximum use *today and tomorrow*. Provides multiple-socket section to quick-check most of the TV and radio tube types the *true dynamic mutual conductance way—plus* simplified switch section to check new tube types in Dyna-Quik emission circuit. Also includes provision for future new sockets.

Makes test under set-operating conditions. Checks each section of multi-section tubes separately. Checks for *all* shorts, grid emission, leakage and gas. Makes quick "life" test. Exclusive adjustable grid emission test provides sensitivity to over 100 megohms.

Makes complete tube test in seconds. Checks average set in a few minutes. Discovers weak tubes that need replacement. *Satisfies more customers. Sells more tubes. Saves call-backs. Insures your reputation.*

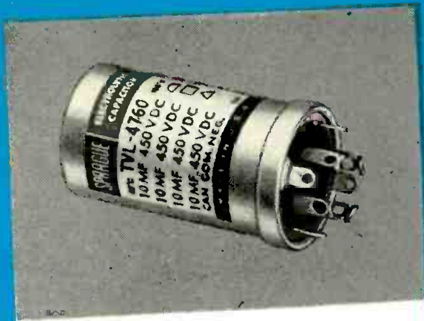
Patented automatic compensation for line voltage variation. Large 4½" plastic meter with easy-to-read "Replace-Good" scale. Lists most commonly used tube types with settings directly on socket panel for fastest operation. Complete listing in reference chart in cover. Phosphor-bronze contacts for long life. 7, 9, and 10-pin straighteners on panel. Operates on 117 volts 50-60 cycle a.c. Handsome leatherette-covered carrying case.
Size: 16⅛" x 15¾" x 5⅞" deep. Net wt: 15½ lbs. Net, 169^{95}

See your B&K Distributor, or Write for Catalog AP18E

NEW TUBE INFORMATION SERVICE
Available every 3 months, on subscription, for all B&K Dyna-Quik Tube Testers

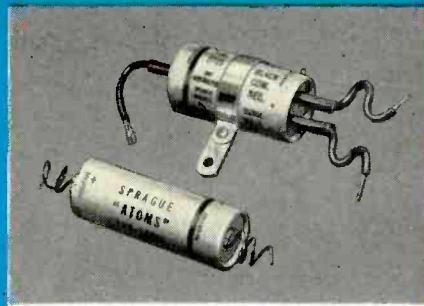
B&K

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



TVL TWIST-LOK® CAPACITORS

These 'lytics take on the toughest TV and radio duty, give maximum trouble-free service, *without HUMMM!* They are dependable at extremely high and low temperatures. Cathodes are etched to meet the needs of high ripple currents, high surge voltages.

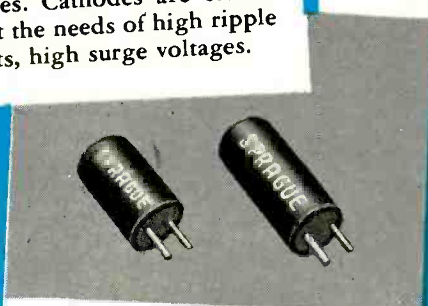


TVA ATOM® CAPACITORS

Atom tubulars are service favorites because they fit anywhere, work anywhere. They're the *only* small size 85 C (185 F) capacitors in ratings up to 450 WVDC. They have low leakage current, long shelf life, and withstand high ripple currents, high surge voltages.

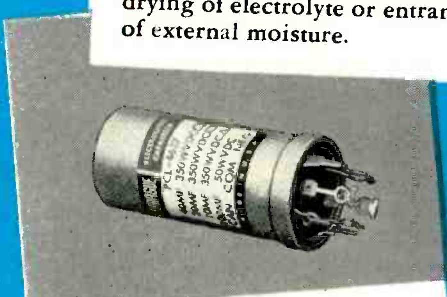
TE LITTL-LYTIC® CAPACITORS

The very best ultra-miniature replacements for transistor circuits, offering unusual reliability through all-welded construction. No pressure joints to cause "open" or intermittent circuits. Long shelf life—extremely important in sets used only part of the year.



VL VERTI-LYTIC* CAPACITORS

These single-ended molded tubulars are the ideal replacement for units of this type found on printed wiring boards. Keyed terminals assure fast manual mounting and correct polarity. Resin end fill protects against drying of electrolyte or entrance of external moisture.



PCL PRINT-LOK® CAPACITORS

The printed circuit version of the Twist-Lok. Universal base replaces any of the printed circuit 'lytics in use today. No makeshift mounting adapters to damage capacitor or add extra height . . . no possibility of high resistance contacts.

EVERY 'LYTIC YOU NEED . . .

- **every value**
- **every rating**
- **every style**

Shown here are the more popular of Sprague's big family of Electrolytic Capacitors, the broadest in the industry. Other types include Metal-encased Screwbase; Plastic-encased High-MF; Metal-encased Octal-base; Ultra-low leakage Photoflash. All are listed and described in Sprague's NEW Catalog C-614. Get your copy from any Sprague distributor, or write Sprague Products Company, 81 Marshall Street, North Adams, Massachusetts.

*TRADEMARK

SPRAGUE®

THE MARK OF RELIABILITY

WORLD'S LARGEST CAPACITOR MANUFACTURER

men 17-55

JOB OPPORTUNITIES! EXCITEMENT! MONEY!

All this can be Yours as a trained

Electronics TECHNICIAN

OVER 6,000 FIRMS HAVE EMPLOYED DeVRY TECH GRADUATES!

Thousands of companies in the United States and Canada who have employed DeVry Tech men prove two most important facts: (1) Electronics is one of the biggest, fastest growing opportunity fields of our time; and (2) DeVry Tech graduates are "WANTED" MEN.

Whether DeVry Tech prepares you in spare time at home or in its modern Chicago or Toronto Laboratories, your training is designed to get you ready to meet the exacting standards of industry. You get practical training that not only helps to fit you for a job or a service shop of your own—but also gives you a foundation for a career that can be profitable the rest of your life.

You work over 300 learn-by-doing experiments at home, using DeVry Tech's exclusive Electro-Lab method. You build and KEEP valuable equipment. With another DeVry Tech exclusive, you have the benefit of training movies that you can show over and over until basic points are crystal clear. Special texts guide you every step of the way as well.

HOW DeVRY TECH CAN "BLUEPRINT" YOUR CAREER!

DeVry's faculty not only know how to teach Electronics, but they also understand men. They most likely know the type of problems you face. From this staff you get help, advice and understanding. It is this "human" side of DeVry's program that has caused many of our graduates to say: "DeVry Tech not only trains you for a job, they actually help you blueprint a profitable future!"

NO ADVANCED EDUCATION NEEDED!

Why don't you write for FREE FACTS today? Learn how you TOO can be a member of the great fraternity of DeVry Tech graduates across the continent . . . men who were properly trained, encouraged, appreciated and understood! SEND IN COUPON NOW!

EFFECTIVE EMPLOYMENT SERVICE

DeVry Tech's effective Employment Service is available to all graduates without additional cost.

LET DeVRY HELP YOU PREPARE AND BLUEPRINT A SOLID CAREER IN THIS FAST-GROWING FIELD!

2 FREE BOOKLETS Send Coupon TODAY!

"One of North America's Foremost Electronics Training Centers"

Accredited Member of National Home Study Council

DeVRY TECHNICAL INSTITUTE
CHICAGO • TORONTO

MAIL TODAY FOR FREE FACTS!

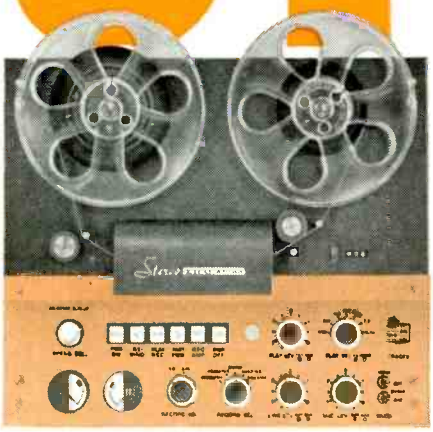
DeVRY TECHNICAL INSTITUTE
4141 Belmont Ave., Chicago 41, Ill., Dept. RE-11RA

Please give me your 2 FREE BOOKLETS, "Pocket Guide to Real Earnings" and "Electronics in Space Travel;" also include details on how to prepare for a career in one or more branches of Electronics.

Name__________ Age_____
PLEASE PRINT
Street__________ Apt._____
City__________ Zone_____ State_____
☐ Check here if you face military service.

2075 Canadian residents address: DeVry Tech of Canada, Ltd. 970 Lawrence Avenue West, Toronto, Ontario

FM MULTIPLEX STEREO

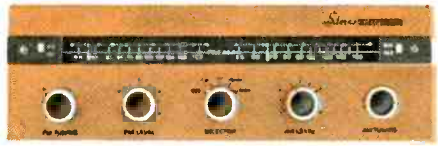


TRANSISTORIZED 4-TRACK STEREO TAPE DECK MODEL RP-100W
Completely assembled, wired and tested.
$399.95

MODEL RP-100K
Semi-kit includes a completely assembled and tested transport, electronics in kit form.
$299.95

A top quality stereo tape recorder permits you to build a stereo tape library of your favorite music at low cost. As your musical interests change, you may record the new music that interests you at no additional cost.

Perfected 4-track stereo/mono recording, 4 & 2 track playback. True high fidelity transistor electronics, individual for record & playback, plus separate record & playback heads permitting off-the-tape monitor. 2 recording level meters, mixing, mic & level controls, switched sound-on-sound recording. Electrodynamically braked supply & take-up reel motors; hysteresis synchronous capstan motor. Individual solenoids for pinch-roller & tape lifters. All-electric, interlocked push-button transport control & interlocked safety "record" pushbutton. Precision tape guidance & sweep loading — no pressure pads. No slurring or tape bounce problems. Digital turns counter. Vertical or horizontal mounting. Modular plug-in construction. An original, exclusive EICO product designed & manufactured in U.S.A. (patents pending).



FM-AM STEREO TUNER ST96
Kit $89.95 Wired $129.95
Includes Metal Cover and FET

70-WATT INTEGRATED STEREO AMPLIFIER ST70
Kit $94.95 Includes Metal Cover **Wired $149.95**
40-WATT INTEGRATED STEREO AMPLIFIER ST40
Kit $79.95 Includes Metal Cover **Wired $129.95**

ST96: FM and AM stereo tuners on one compact chassis. Easy-to-assemble: prewired, prealigned RF and IF stages for AM and FM. Exclusive precision prewired EYETRONIC® tuning on both AM and FM.

FM TUNER: Switched AFC (Automatic Frequency Control). Sensitivity: 1.5uv for 20db quieting. Frequency Response: 20-15,000 cps ±1db. Multiplex-ready: Regular and MX outputs built in.

AM TUNER: Switched "wide" and "narrow" bandpass. High Q filter eliminates 10 kc whistle. Sensitivity: 3uv for 1.0V output at 20db S/N ratio. Frequency Response: 20-9,000 cps ("wide"), 20-4,500 cps ("narrow").

BOTH AMPLIFIERS: Complete stereo centers plus two excellent power amplifiers. Accept, control, and amplify signals from any stereo or mono source.

ST70: Cathode-coupled phase inverter circuitry preceded by a direct-coupled voltage amplifier. Harmonic Distortion: less than 1% from 25-20,000 cps within 1 db of 70 watts. Frequency Response: ±½db 10-50,000 cps.

ST40: Highly stable Williamson-type power amplifiers. Harmonic Distortion: less than 1% from 40-20,000 cps within 1 db of 40 watts. Frequency Response: ±½ db 12-25,000 cps.

NEW FM MULTIPLEX ADAPTOR MX99
Kit $39.95
Wired $64.95
An original EICO contribution to the art of FM Multiplex reception.

Designed for all EICO FM equipment (HFT90, HFT92, ST96) and any other component quality, ratio detector FM tuners having multiplex outputs, the new MX99 incorporates the best features of both matrixing and sampling techniques. It is free of phase-distorting filters and provides the required, or better-than-required, suppression of all spurious signals including SCA (67kc) background music carrier, reinserted 38kc sub-carrier, 19kc pilot carrier and all harmonics thereof. This is very important for high quality tape recording, where spurious signals can beat against the tape recorder bias oscillator and result in audible spurious tones in a recording. This adaptor will synchronize with any usable output from the FM tuner and will demodulate without significant distortion tuner outputs as high as 7 volts peak-to-peak (2.5 volts RMS).

The MX99 is self-powered, provides entirely automatic stereo/mono operation and includes low impedance cathode follower outputs to permit long lines. An indicator lamp turns on when the station selected is broadcasting multiplex stereo. A separation of 35db between channels is typical across the entire audio spectrum. An over-all gain of two is provided from input to output on stereo, and about unity on mono.

C-11
EICO, 3300 N. Blvd., L.I.C. 1, N. Y.
☐ Send free 32-page catalog & dealer's name
☐ Send new 36-page **Guidebook to HI-FI** for which I enclose 25¢ for postage & handling.

Name ....
Address ....
City .... Zone .... State ....

Over 2 MILLION EICO instruments in use.
Most EICO Dealers offer budget terms.
Add 5% in West.

EICO

©1961 **Electronic Instrument Co., Inc.**
3300 N. Blvd., L.I.C. 1, N.Y.

EICO®

Listen to the EICO Hour, WABC-FM, N.Y. 95.5 MC, Mon.-Fri., 7:15-8 P.M. Export Dept., Roburn Agencies Inc., 431 Greenwich St., New York 13

Radio-Electronics
Hugo Gernsback, Editor-in-chief

OUR RADIO COMMUNICATIONS THREATENED?

. . . Nearby Exploding Stars Hold Vast Electronic Dangers . . .

SINCE the advent of radio astronomy in 1931, we have learned that our entire universe abounds with an incredible number of radio sources—stellar radio transmitters—which continuously emit radio energy in every direction simultaneously. Every star, our own sun, even some of our planets, are active sources of radio energy. In addition, all the stars and our sun emit vast amounts of X-rays.

Even such puny man-made "suns" as our hydrogen bombs emit a large amount of energy in a ten-millionth of a second, in the form of light, X-rays, gamma rays and neutrons, causing a number of electromagnetic and other effects. As Dr. I. Maddock, chief of the Field Experiments Division of the United Kingdom Atomic Energy Authority, recently pointed out, in a nuclear explosion seven-tenths of the entire energy is dissipated in the form of X-rays.

What about the stellar explosions—the novae and supernovae—that occur periodically in the universe? In our own galaxy (the Milky Way) supernovae occur approximately every 150 years. They act very much like our own atomic explosions. Their effects, too, have been studied by radio astronomy. For instance, one of them, the famous Crab Nebula, believed to be the remains of the supernova which exploded A.D. 1054, is even today a most powerful radio source. That explosion still continues—the nebula still expands at the rate of 70,000,000 miles daily. It is, however, 4,100 light-years distant.

What would happen if a supernova exploded in our vicinity, say from only 9 to 16 light-years distant?

This possibility was recently explored at length by C. M. Cade, chief scientist of Kelvin Hughes, Ltd., a British concern.

There are only three potential supernovae in our vicinity: they are known as the brilliant Sirius, 9 light-years away; Procyon, 11, and Altair 16 light-years distant. If any one of these should explode and become a supernova, the effect on our radio communication system might be disastrous. According to Cade, with a supernova at 4 light-years distant, all high-frequency, vhf and uhf systems would cease to operate due to the titantic interference set up. The supernova emission would completely obliterate most short waves, radar, TV transmission.

It is possible that the longer broadcast waves might not be affected so severely, depending upon the distance of the supernova from our earth. It should be noted here that 1 light-year measures 6,000,000,000,000 (6 trillion) miles, thus the nearest supernova would be 54,000,000,000,000 (54 trillion) miles distant.

The disruption of most radio communication would not be total for 24 hours a day. It would occur only in direct line of sight with the supernova, i.e., when it is above the horizon. At supernova "night," perhaps there could be communication between centers turned away from the exploding star.

How long would the radio chaos on earth last after the supernova exploded? Cade believes at least 1 year. This is his theoretical guess—it might be much shorter or longer, all depending on the size and distance of the supernova. Strong radio interference would last for many years.

Let us now make some further speculations on aspects on which Cade did not comment.

There is always a remote possibility that two suns could collide in our vicinity.

When such a celestial explosion does occur—let us say at 2 light-years—it would seem likely that many receiving instruments on earth would be put out of commission. The density of the electromagnetic flux would be so intense, so enormous that transistors and other delicate components would be destroyed instantly.

What the electromagnetic saturation of the supernova will do to the earth's magnetic field can only be surmised. Just as the far weaker solar magnetic storms often silence nearly all trans-Atlantic cables and some long telegraph and telephone lines, so the supernova's electromagnetic power field probably will burn out cables and telephone gear and instruments. It will be a world-wide electronic devastation.

The havoc on earth will be less as the distance of the supernova increases. At 100 light-years, the damage on earth will be very much less.

We have had one brush with a nova since radio came into use. This was in 1944 when radio interference occurred from a nova (probably the Omega Nebula) in the constellation Sagittarius, 3,000 light-years distant. It seriously interfered when the Allies during World War II attempted to locate V-2 rockets with long-range radar. If such powerful interference could occur with a supernova *3,000 light-years away*, one can visualize the havoc created at a distance of only 2 light-years.

What influence will a comparatively close supernova have on life itself? We already know that powerful short waves do affect humans under certain conditions. They can even be lethal.* That the supernova waves—though incomparably more powerful—will prove deadly seems improbable, but the possibility exists, even if their potentialities are not known. A simple protective measure, however, would seem possible: A thin metal wire netting enveloping humans would conduct the waves to earth—short-circuiting them effectively. What about the much more dangerous X-rays, also generated abundantly by a supernova? Our atmosphere seems to shield us from them most efficiently. Our own sun, *only 8 light-minutes away*, is known to be a very powerful X-ray generator, yet we do not suffer from its effects.

Unfortunately, so far we do not know when a neighboring star might explode. Perhaps now that we know the inherent danger of comparatively near stars, our astronomers will watch them more closely to obtain clues as to when they will become supernovae. In time this may be possible.

This brings to mind the question of the dinosaurs and their sudden disappearance from the earth some 70,000,000 years ago. No satisfactory reason has ever been given for their eradication.

Is it possible that 70,000,000 years ago they were killed by short waves emitted from a close supernova? Perhaps we shall know more about this in the future. *—H.G.*

---

*See "Radio Power," RADIO-ELECTRONICS, July 1961.

BUILD 4-CHANNEL RADIO-CONTROL SYSTEM

By ARIEL STIEBEL*

How would you like to control your lawn mower while sitting in your rocking chair sipping lemonade? Or how about opening your garage door, turning the garage lights on and off without getting out of your car? What would you say about a little movable bar which you can direct to any one of your friends in the room without having to push it yourself? Model airplanes, boats, trains, literally anything can be controlled. You are limited only by your imagination. All you need is a basic remote-control unit capable of handling four different operations. And it is this basic unit, transmitter and receiver, we will show you how to build.

The heart of this unit is a reed relay. It consists of an electromagnet with little reeds mounted above it. These reeds are cut to different lengths and vibrate only when the electromagnet is energized with an audio signal at their own natural frequency. For example, reed 1 vibrates only at 300 cycles. Reed 2 responds to 350 cycles only. I am sure you get the idea. By simply sending different tones (audio signals) into the electromagnet, different reeds vibrate.

*President, Detroit Electronics Corp.

While vibrating, the reed touches a contact and completes the circuit to a control relay, which pulls in and remains in until the signal is changed. This control relay, in turn, operates the device you wish to control. All we have to do is to send different tones into the modulator of a small transmitter, pick up these tones with a receiver and give our reeds the opportunity to vibrate at their particular frequencies.

Transmitter and audio generator

The transmitter (Fig. 1) has four tubes. It operates in the Citizens band and is crystal-controlled. The oscillator is a 3V4 with a 6813.75-kc crystal for frequency control. This frequency is doubled to 13.6275 mc in the plate circuit. L1 is the tank coil. It is slug tuned, has a ¼-inch coil form, and consists of 35 turns of No. 31 enamelled wire. The 3A4 acts as a grid modulator and power amplifier. The frequency is again doubled to 27.255 mc in the tank circuit.

Tank coil L2 consists of 9 turns of No. 16 enamelled wire, ¾-inch inside diameter, and is self-supporting. The two trimmers in the pi network are adjusted for maximum output. All transmitter components are standard types and readily available.

BENCH TESTED

The radio-control system was tested over a distance of approximately 250 yards. With 6-foot whips at the transmitter and receiver, the units work well. The rf and tone frequencies were easy to tune to match the receiver relay and follow reasonably fast keying.

Here's a printed-circuit project that approaches the ideal for every remote-control enthusiast. And once again RADIO-ELECTRONICS is pleased to announce that printed-circuit boards for this project are available. Two boards, one for the receiver and one for the transmitter plus the 4-channel reed relay, are available from Detroit Electronic Corp., 13000 Capital Ave., Oak Park, Mich. The price is $9.95. If you only want the boards, the cost is $4.75. The relay alone is $5.45. All prices include mailing charges

The audio generator consists of a 3A5 multivibrator (V3) and a 3V4 amplifier (V4). The multivibrator is stabilized by a tank circuit, which results in a very stable audio signal.

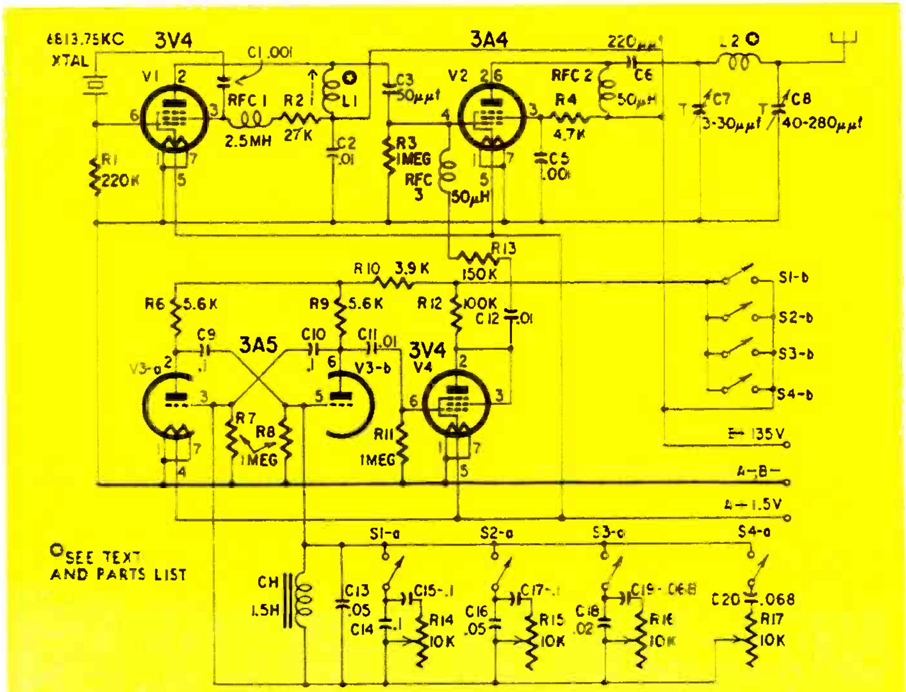


Fig. 1—Circuit of the four-tube transmitter. C4 and R5 have been eliminated from this final design.

R1—220,000 ohms
R2—27,000 ohms
R3, R7, R8, R11—1 megohm
R4—4,700 ohms
R6, R9—5,600 ohms
R10—3,900 ohms
R12—100,000 ohms
R13—150,000 ohms
R14, R15, R16, R17—miniature pots, 10,000 ohms
All resistors ½-watt 10%
C1, C5—.001 μf, disc ceramic
C2—.01 μf, disc ceramic
C3—50μμf, disc ceramic
C6—220 μμf, disc ceramic
(C1, C2, C3, C6: Centralab Series DD or Equivalent)
C7—3 to 30, μμf, trimmer (Arco 462 or equivalent)
C8—40 to 280 μμf, trimmer (Arco 464 or equivalent)
C9, C10, C14, C15, C17—0.1 μf, 200 volts, tubular
C11, C12—.01 μf, 200 volts, tubular
C13, C16—.05 μf, 200 volts, tubular
C18—.02 μf, 200 volts, tubular
C19, C20—.068 μf, 200 volts, tubular
CH—1.5 henries (Stancor C-2344 or equivalent)
XTAL—6813.75 kc
L1—35 turns No. 31 enamelled wire on ¼-inch diameter form, slug tuned, use CTC coil form PC2
L2—9 turns No. 16 enameled wire, ¾-inch inside diameter, airwound
RFC 1—2.5 mh (National R-50 or equivalent)
RFC 2, RFC 3—50 μh (National R-33 or equivalent)
S1, S2, S3, S4—dpst toggle, switch
V1, V4—3V4
V2—3A4
V3—3A5
4 printed-circuit sockets, 7-pin (Lafayette MS-399)
C4 and R5 have been eliminated from this final design. They are just not needed. So don't be surprised when you don't find them on the schematic.

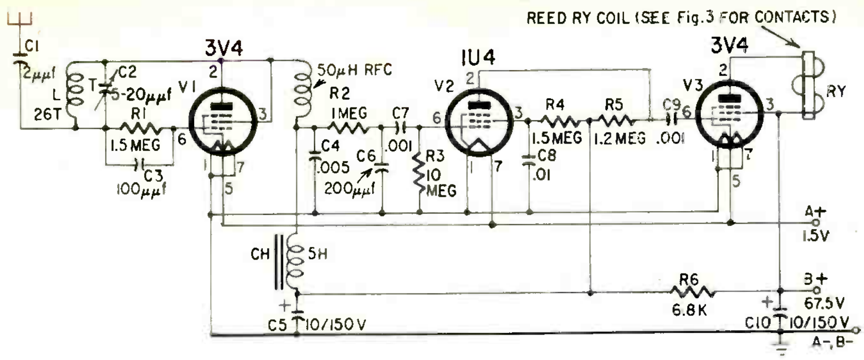


Fig. 2—The radio-control receiver

R1, R4—1.5 megohms
R2—1 megohm
R3—10 megohms
R5—1.2 megohms
R6—6,800 ohms
All resistors ½-watt 10%
C1—2 μμf, disc ceramic (Centralab series DD)
C2—5 to 20 μμf, trimmer (Centralab 820 B)
C3—100μμf, ceramic disc (Centralab series DD)
C4—.005 μf, ceramic disc (Centralab series DD)
C5, C10—10 μf, 150 volts, miniature electrolytic (Aerovox PRS or equivalent)
C6—200 μμf, ceramic disc (Centralab series DD)
C7, C9—.001 μf, ceramic disc (Centralab series DD)
C8—.01 μf, ceramic disc (Centralab series DD)
CH—audio choke, 5 h (UTC SS05 or equivalent)
L—rf tank coil, 26 turns of No. 24 enameled wire closewound on ¼-inch-diameter coil form.
RFC—50 μh (National R33 or equivalent)
RY—Bramco reed relay (if you purchase the printed-circuit board, you can get this relay too or you can buy relay alone for $5.45)
V1, V3—3V4
V2—1U4
3 printed-circuit sockets, 7-pin (Lafayette MS-399)

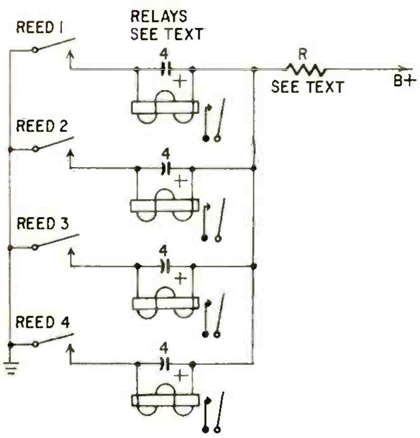


Fig. 3—Details of the reed-relay circuit.

Actually the multivibrator without the choke and its capacitors oscillates at a very low frequency. However, the choke and capacitors in parallel with it act as a tuned circuit and govern the frequency of the audio signal. Switching in different values of capacitors changes the multivibrator frequency. Potentiometers R14 to R17 are fine adjustments for the different audio frequencies and are set to give maximum response for each respective reed.

The audio signal from the multivibrator is amplified by V4 and applied to the grid of V2, the transmitter's modulated power amplifier. Switching in various audio frequencies applies B-plus to the audio generator. With all the switches off, B-plus is removed, increasing battery life.

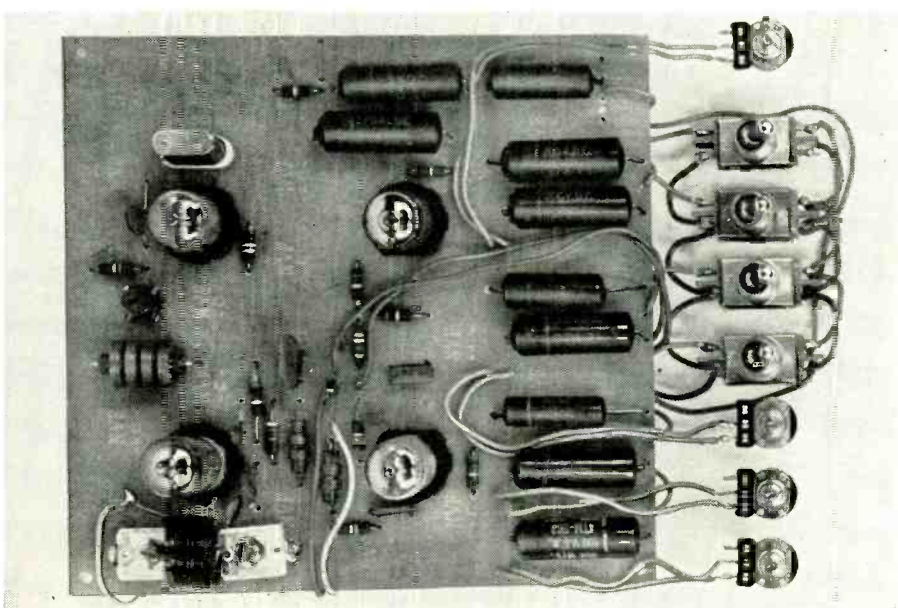
How the receiver works

The three-tube receiver (Fig. 2) uses a 3V4 (V1) as a detector, a 1U4 (V2) as an audio amplifier and a second 3V4 (V3) as a power amplifier. The rf tank circuit consists of L and trimmer C2. The trimmer allows for optimum tuning to the incoming signal. V1 detects the control frequency and passes it on to V2 where it is amplified and delivered to V3, the power stage. The reed relay is wired directly into the plate circuit of this tube. Incidentally, the grid resistor of this stage is not missing. The stage works well without it. There seems to be enough leakage through C9 to insure proper operation. [This was the case with the equipment tested. But in some climates and with certain selections of high-quality components, it might not continue to be so, and a grid resistor (say 10 to 15 megohms) might be needed.—*Editor*]

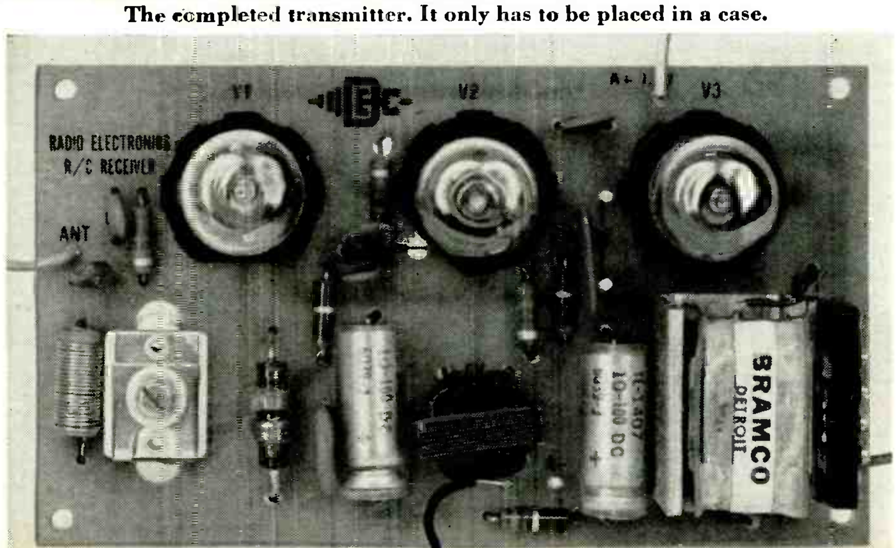
Now a few words about the reed-relay circuit. The vibrating reed touches a contact and thus closes a circuit. However, this arrangement is rated for a maximum current of only 25 ma. Where more power must be handled, an additional relay must be actuated by the reed relay. Fig. 3 shows the circuit arrangement. When the reed vibrates, the control relay kicks in. A 4-μf capacitor is connected in parallel with the magnet winding to assure smooth hold-in operation of the control relay while the reed vibrates. Any good relay that can be actuated with less than 25 ma can be used. (For instance, a Potter & Brumfield type LB5 takes only 9 ma to control 5 amperes.) Figs. 4 and 5 show the printed boards for the transmitter and receiver. The transmitter board is 6⅝ x 7 inches. The receiver board measures 2⅞ x 5 inches.

Using the system

The length of the antenna is not too



The completed transmitter. It only has to be placed in a case.



Hook up antenna and batteries and the receiver is ready to go.

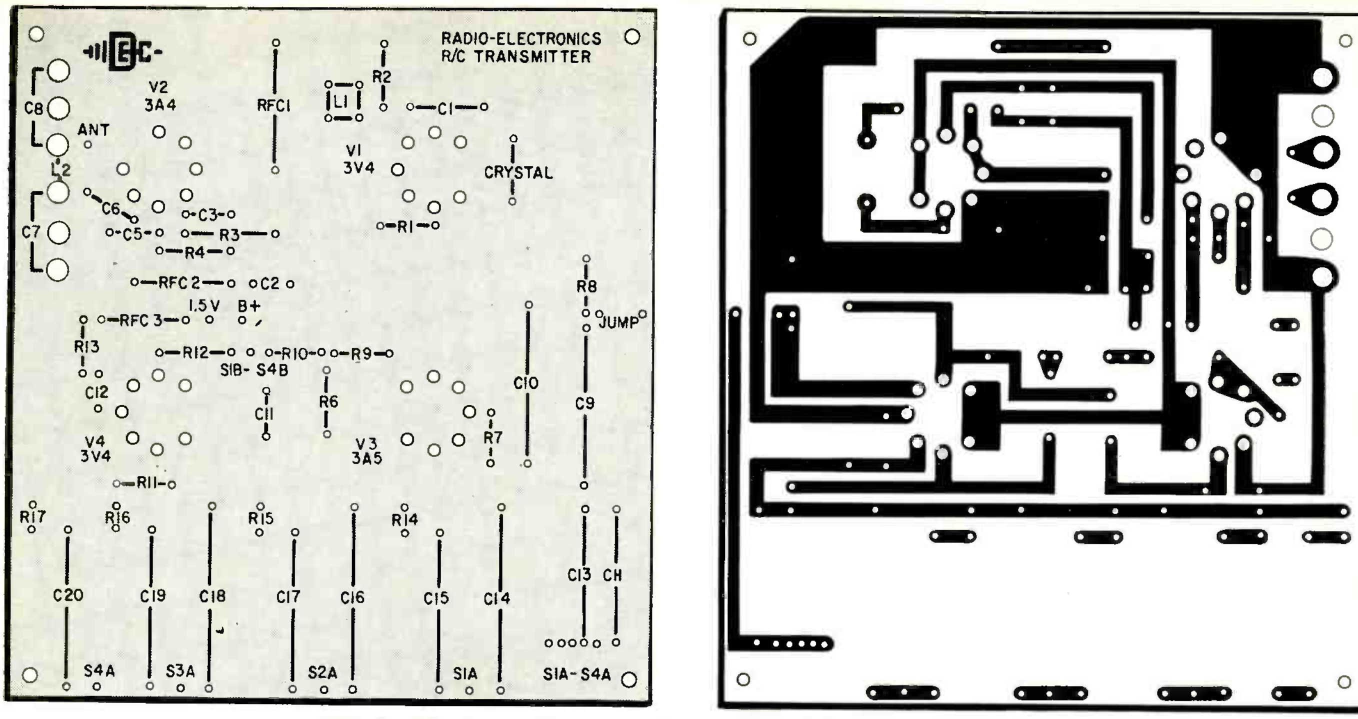


Fig. 4—The transmitter printed-circuit board. It measures 6⅝"x7".

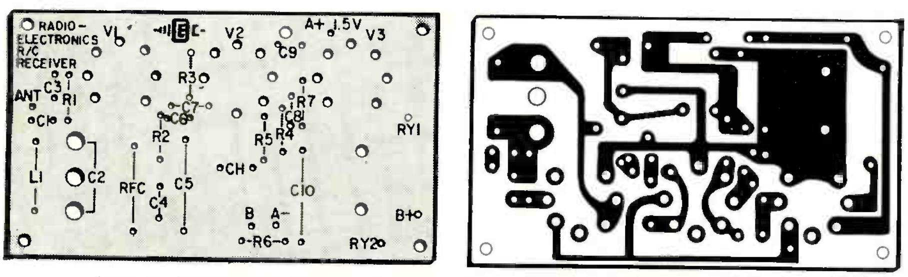


Fig. 5—This printed-circuit board is for the receiver. It is 5"x2⅞".

critical because of the pi-section arrangement of the transmitter. However, to get a ¾-mile range, use a quarter-wave antenna, about 8 to 9 feet long.

Tuning the transmitter is very simple, and is done with the modulator off. Measure the negative voltage appearing at the junction of RFC3 and R13 with a vtvm. Now turn L1's slug until a maximum reading of around −35 volts is obtained. (This means that now you have maximum rf drive from your oscillator to V2's grid.) Turn trimmer C8 fully in. If you use an 8-foot antenna, back C8 a quarter turn. Set your vtvm and measure the voltage at V2's screen grid (junction of C5 and R4). Adjust trimmer C7 for a maximum ac reading, approximately 8 volts. Readjust C8 for a still higher reading.

For a 60-inch antenna, back off C8 three-quarters of a turn and repeat the above steps. A 6-inch antenna still covers about 100 feet.

The only other adjustment is in the audio generator. With both transmitter and receiver operating, adjust each potentiometer R14 to R17 for maximum response at its respective reed. Start with the highest tone and adjust R17 to a tone slightly higher than the one needed for reed 4. Now back off until the reed starts to vibrate and advance the pot just a fraction more. Repeat this procedure with the rest of the reeds. No adjustment should be necessary on the reed relay itself, since these are pretuned and adjusted at the factory. These then are the basic units. Applications are unlimited. END

Rf to propel space ships?

A new radio-frequency technique that might be used to propel space vehicles on long interplanetary voyages was described to the American Physical Society by Drs. Swarts, Reboul and Gordon of RCA. Ultra-high frequencies are used to accelerate electrons and ions to high velocity. With further development, the process is expected to create enough thrust for spacecraft propulsion in the gravity-free environment of outer space.

The three scientists gave this description of the process:

The basic fuel is *plasma*—a mixture of ions and electrons generated by successive electrical discharges from a pool of mercury, and released into a cylindrical chamber. Radio-frequency power is applied to the chamber, producing an electrical field that is strongest near the plasma source and decreases rapidly with increasing distance along the chamber. The charged particles in the plasma are accelerated swiftly from the stronger toward the weaker field by electrical interaction—somewhat in the manner of balls gathering speed as they roll down a steep grade. The result is a thrust that acts on the chamber and can be used to propel an object in space.

The scientists pointed out that the thrust can be increased by using higher radio frequencies to accelerate a denser plasma. They said that successful experiments have been performed at frequencies of 140 to 330 mc, and that further experiments are now planned at a frequency of 2,500 mc.

To illustrate the acceleration that occurs, they reported that the speed of ions in the plasma has been raised at the lower frequencies to nearly 40,000 miles per hour within a distance of 2 inches in the experimental apparatus.

The RCA scientists said that the new technique promises a method of propulsion in space that may avoid some difficulties of other proposed techniques. For example, they pointed out that the new experimental method does not require an applied magnetic field to accelerate the plasma, so that there is no need for the added weight of magnets.

DON'T BE AFRAID OF COLOR TV

If you can fix a black-and-white set, you can repair color receivers too

By **JACK DARR**
SERVICE EDITOR

MOST TV TECHNICIANS ARE AFRAID OF color TV work! I don't mean frightened of the 25 kv on the tube or anything like that. They're *subconsciously* afraid that they can't fix 'em—that the complicated circuitry and delicate adjustments will throw them, and they'll look foolish in the eyes of their customers!

So they think. Yet 99.44% of all competent black-and-white TV technicians would have absolutely no trouble repairing color TV sets. No more trouble, that is, than they now have in their everyday repair work.

Let's go over this a bit at a time. In the first place, color TV is complicated —theoretically, that is. The basic math in color-set circuitry, matrixing and demodulation is away over the head of practically every practicing TV technician, including the one who is writing this article! But if you have a good understanding of the way color demodulation and matrixing *work*, in actual home color sets, you don't need the complicated math. After all, there is nothing in color any more complicated than the circuits used in standard sets, and we fix them every day and think nothing of it. If you are capable of repairing black-and-white sets, with only a little additional practical knowledge you can service color sets.

I'm inclined to blame this fear on both the manufacturers of color sets and the technical writers at the time color first burst upon us. I was just looking back through some of the "color training courses" of that period. What struck me most forcibly was their terrible complexity.

Colorimetry diagrams (remember those triangles?)—phase angles—vector diagrams—visual response of the human eye to various colors—wavelengths. All good information and no doubt adequate for a college course, but not what the man in the field had to have.

Fortunately, there's been a change; recent service data have tended more and more toward the cold, hard, practical-fact type that we must have to service equipment intelligently. I am not downgrading theoretical material in its intended application—nothing takes the place of a thorough grounding in the basic principles. But I contend that it was presented in too complicated a manner.

Here's the point I want to make: you can service color TV just as easily as you now service black-and-white sets. You can help the makers sell color TV to the public, by merely telling your customers the truth—that modern color TV is no more expensive to service, which is true. So, *you* can increase your income and prestige by servicing color sets.

When it comes to test equipment, you don't need as much as you might think. I'm servicing color TV regularly with my regular test equipment, plus a dot-crosshatch generator.

Convergence a problem?

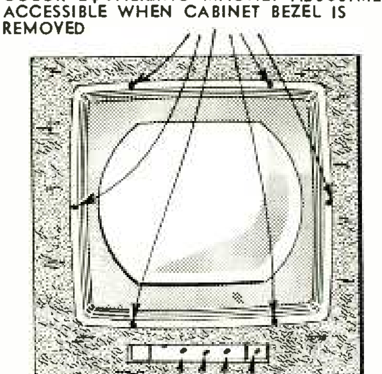
About this time some guy is ready to ask: "Yeah, but what about convergence?" Well, what about it? Despite the things you may have heard, you don't have to reconverge the set every time you move it.

I bought my set in a city, hauled it home over a hundred miles in the back of a station wagon, set it up in my home, and operated it for more than 2 years without its needing reconverging at all. The convergence was *checked* when it was installed, but only one adjustment was touched, and that a very minor one. During that time, it has been moved back and forth countless times, dragged around the room, fiddled with, and so on.

The only time it required reconvergence was when I *deliberately* threw it out of convergence to settle an argument. Someone asked me if it was possible to converge a color set without a crosshatch generator and I said I didn't know, but I'd find out. I found out—you can't!

My point about convergence is that the old manuals showed color TV pictures with absolutely perfect convergence clear to the edges of the screen. In practice, you'll be amazed at what you can get away with in the way of misconvergence without showing a bad monochrome picture. (In color, some misconvergence doesn't seem to bother the picture at all. I tried it. If you have trouble getting that last row of dots around the outside of the screen to overlap perfectly, stop and check it on a good monochrome picture. I think you'll be surprised. This refers mostly to the older sets. Later models are much easier to converge.

Installation and convergence adjustments are the most difficult part of color



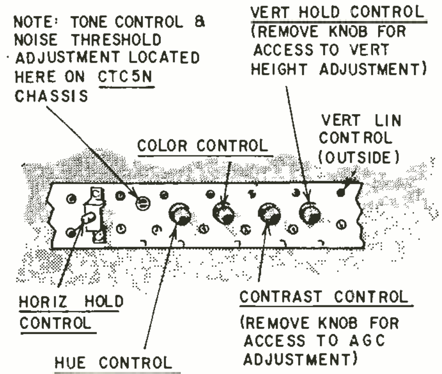


Fig. 1—Setup and operating controls are easy to get at in the newer color sets.

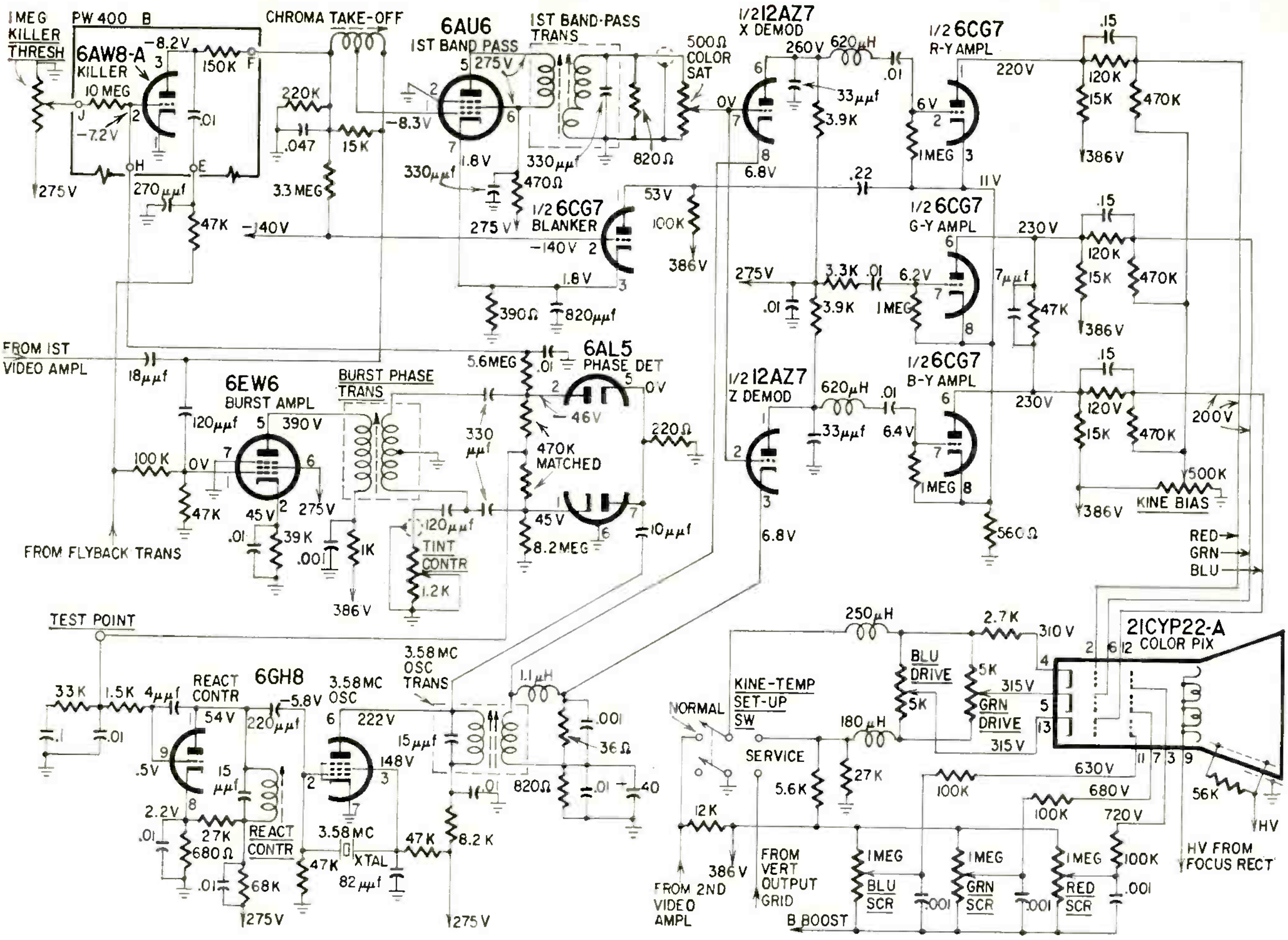


Fig. 2—The color section of the new RCA CTC10 color-TV chassis.

servicing, but the manufacturers have done all they can to make this job easier. The change from 2 to 3 hours, as required for converging the older sets, down to about 15 minutes for the latest ones certainly indicates a trend toward simplification.

Circuitry in color sets

Let's take a look at the old RCA CT-100. This was a rough set. Had a real flock of tubes in the color section. And the controls! I counted 21, and probably missed one or two at that. It used a 21AXP22 with a metal cone that had to be degaussed (a fancy word meaning demagnetized) before converging. Lots of adjustments, but once you got her set up, she worked about as well as any monochrome set.

Now let's take one in the middle, about the time the trend toward simplification was really beginning to set in, say, an RCA CTC5 series. This one looks a bit better. Still has lots of controls, but the total number of tubes is down, and the control arrangement is getting better. Now they're all on the front apron of the chassis where you can set them and watch the screen at the same time (Fig. 1). This set demodulates on the X - Z axis, instead of the I - Q. What does that mean? Not a cotton-picking thing, to us! The color phase controls work just the same way, so we can forget that entirely.

Going on, let's take a look at the RCA CTC10, the latest thing at the time this is being written. Number of color-section tubes reduced, by actual count, to something like 6½ (half of a 6CG7). As to controls, the screen-background controls which used to number 9 or more have been reduced to 3! There is a kine-bias control and 2 background controls but, after changing the setup procedure, they can be set up in less than 5 minutes by a man who has never seen this particular chassis before (Fig. 2). I've seen it done at service meetings! By way of contrast, my old set takes approximately a half-hour of juggling to do the same job!

Convergence has been tamed too. In this and some previous series, all convergence controls except the statics are mounted on a PC board about 6 inches square (Fig. 3). This can be removed and mounted on two screws on the back of the cabinet, so that all controls can be easily reached from the front with a long screwdriver or tuning tool. Contrast this with the same controls in my older set.

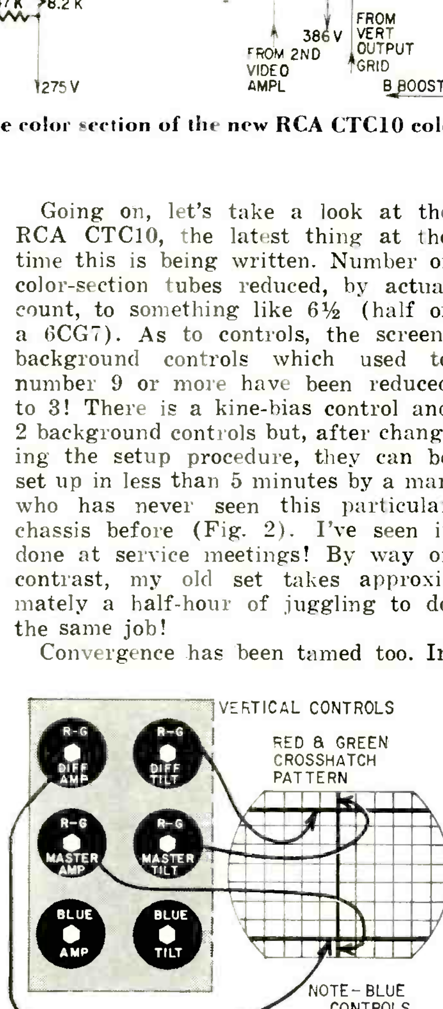


Fig. 3—Red and green convergence controls on new sets simplify the process.

Here we begin to find the combination controls. While these are marked R-G diff. tilt (red-green differential tilt) and the like, they are used in the same way as previous types. The only difference is that each control so marked now controls two colors at a certain place on the screen, instead of only one.

As everyone should know by this time, we have the most trouble with red and green. The blue has adjustments which enable us to move it in almost any direction we want. So these combination controls are used to get perfect convergence in red and green, at those hard-to-get-at edges of the screen. Each one controls a particular sector of the screen.

Once we get these places tamed, it's easy to get the blue moved into place and wind up with better overall convergence than we have ever been able to get before. For instance, the first time I set up one of these chassis, the whole job took less than a half-hour.

A new setup procedure is used in

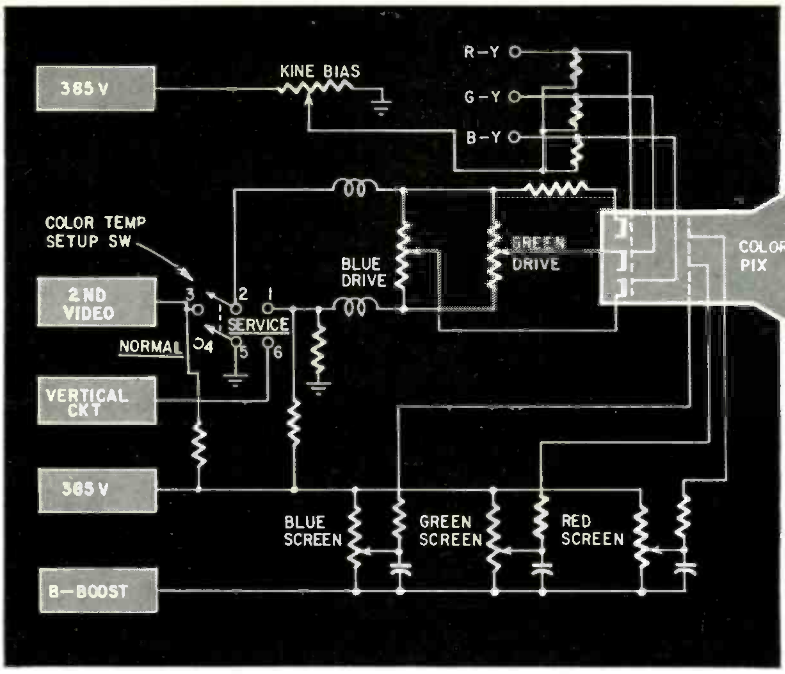


Fig. 4—Kinescope circuitry in the CTC10.

this series too. It makes an easy job out of what used to be one of the hardest ones—getting a really black-and-white picture, not a bluish or greenish one. The picture-tube circuitry has been changed to make this possible. (Fig. 4)

Case histories

What about color TV service? Here are some actual cases I ran into on real service calls.

Case 1: *Complaint:* It turned red and went out.

Cure: Replace damper tube and blown fuse.

Case 2: *Complaint:* My picture's a bright green all over.

Cure: Replace dead red amplifier tube.

Reasoning: The screen was actually a bright blue-green—no red in the picture. Circuit showed only one tube which dealt with nothing but red; that was it.

Case 3: *Complaint:* All I get is rainbows chasing up and down the screen!

Cure: Replace dead burst-amplifier tube.

Reasoning: The color circuits are working and so is the burst oscillator. Otherwise no color at all would reach the screen. Trouble in color sync, not regular vertical–horizontal sync, for picture is stable. So start changing tubes. This turned out to be the burst-amplifier tube. (Color afc is also a good suspect.)

Here, basically, is how to service color TV as quickly and easily as you fix an ailing monochrome set. Look for the thing that isn't there, then check the schematic to see what tubes handle the missing quantity. If you had a monochrome set with the picture whirling up, down and sideways all at once, you'd never hesitate. You'd dig out a sync tube and replace it. Same thing with color. Look for what isn't there and check to see why. For example, if the picture is purple, you've obviously got red and blue coming through. What happened to the green? Find out and fix it.

The first and most important thing you must do is to sit quietly down in front of the ailing set and observe its performance carefully. Find out just what it is doing and what it isn't. Then you'll know where to begin looking. *Never*, repeat *NEVER* touch any of the set's controls until you have replaced every tube in the set that could possibly affect the circuit where the trouble is. If this sounds very much like your regular service procedure, you're absolutely right. It is! You know, from long experience, that bad tubes cause about 90% of the troubles, so you replace them first. If you do the same thing with color sets, you'll find that their troubles can be just as simple. For example, in one set, I was sure I had a very bad case of misconvergence, lack of purity and several other things. The symptoms were all there, color fringing, dim picture, etc. Fortunately, I managed to restrain myself until I had changed a few tubes. When I replaced the damper tube, up came the brightness. When I turned the contrast control down from wide open, the fringing disappeared too. The whole trouble had been low boost voltage, and the symptom was actually blooming, *not* misconvergence. So a few tube changes and a minute or two spent in thought saved me (and the customer) a totally unnecessary reconvergence job.

For those who aren't familiar with contrast control circuitry in the average color set, let me say that the proper place for this control is usually turned all the way off. A correctly set-up color set gives the best pictures with this control down or at most, just barely advanced. Too much contrast causes severe blooming and misregistration of colors. Experiment with your set when it is first set up, to find out where the best operating point is.

In addition to set servicing, a big market is open to you in new antenna installations whenever a color set is installed. If the antenna is more than 5 years old, you ought to replace it. A good solid signal is essential for good color reception. If it isn't there, it is much more noticeable than on black-and-white. In some areas, antenna boosters are a big help in getting the signal up out of the snow. Some antenna manufacturers are coming out with broad-band antennas incorporating built-in boosters, with a good increase in gain. Several firms are building broad-band antenna-mounted boosters, using the new frame-grid tubes, which give more than 20 db of gain across the entire vhf TV band.

Incidentally, if the customer really *wants* color TV and happens to live in a location where you know you simply cannot get *all* the snow out of his picture, try it out anyhow. Sometimes color pictures are even more usable than monochrome under conditions of heavy snow! Of course, you have to have enough signal for the color burst to get through.

So get in there and *sell* color TV instead of knocking it. You'll find both your prestige and income going up. How many times in the past few years have your customers asked you: "What you think of color TV? Should I buy one now, or wait till they get better?" What do you tell them? If you say that now is the time, and tell them that you can give them good color TV reception, the chances are they'll not boggle too much at the price. In my honest opinion, the TV service technician is going to be the most important single factor in the color TV sales picture. Manufacturers are making the sets easier to work on. Also, you'll find that most of them will lean over backward to help you out with any problems you run into.

In conclusion: Color TV sets can be serviced as easily as any black-and-white set, if you take the time to learn the few simple rules you need to check out the color section. You *do not* need any higher mathematics, or any really special or expensive test equipment! So, get in there and get after 'em! If you do, you'll find that that "rainbow" on the screen just might end up in a real pot of gold, in your pocket! **END**

"There's your trouble, sir—no cone."

Instructor at NYIT answers student's question.

ELECTRONICS

The Modern Schoolteacher

Instructs with TV, records and intercoms

By ERIC LESLIE

Electronic teaching is no longer the dream of the prophet, or the cry in the wilderness of a few people concerned about the future of American education.[1] In one of its two main forms — television or electronic teaching aids — electronic education is being used in more than a thousand classrooms; part of the curriculum in 400-plus schools throughout the country.

Television — either the conventional kind or closed-circuit — is the leading electronic teacher today. In its simplest form it can consist of a program to which the home viewer tunes in. A more or less conventional classroom instructor presents his lesson to the TV audience, usually with the help of a "live" classroom, which also appears in the viewer's picture.

Most famous of these educational programs is "Continental Classroom" on NBC.

An almost equally simple but quite different use of television brings classroom demonstrations within the vision of large numbers of students. A camera is set up at the teacher's position and TV receivers — now called monitors — are set up around the classroom. Instead of the whole class crowding around the instructor in the hope of seeing at least a part of what is being demonstrated, four or five students gather around each monitor and are able to observe every detail.

This use of television has become very popular in surgery. Formerly a student in the balcony of the "operating theatre" had only the vaguest idea of what was happening. Today, he sees the whole procedure — often in color — as clearly as if he were standing beside the surgeon.

A combination of the two methods is seen in some school closed-circuit systems. One instructor may lecture several classes over the school closed circuit, or a program may be picked up from an outside point and "piped" to the classrooms. If monitors are plentiful, students have the additional advantage of closeup views of any demonstrations.

Most dramatic and possibly most important of all experiments in TV instruction is broadcasting lessons and lectures from a plane flying 23,000 feet above its "school district." Thorough experimental programs have already been carried out, and the Midwest Program on Airborne Television Instruction (MPATI) is scheduling regular operation this fall. The area covered is centered on Montpelier, Ind., and extends into five states. At 23,000 feet, all antennas within a 210-mile radius are line-of-sight. During the experimental transmissions, good reports were received from points 250 miles from Montpelier. The quality of instruction is expected to be high. Excellent instructors have been engaged and generous budgets provided for the effects necessary to present each lesson.

The teaching machine

The language laboratory was the first type of purely electronic teaching. In its simplest form it consists of a tape recorder–player (sometimes accompanied by a disc record player) from which the student can hear samples of the language he is learning. He then repeats or answers what he has heard, and finally compares his own efforts with the original. By properly programming the recorded material, the student can be led through a complete course in the language while practicing his pronunciation.

To this simplest form of electronic teaching can be added provision for making permanent records, for communicating with an instructor and for the instructor to listen in at will or to break in if desirable.

Reinforced response

One factor in the rapid expansion of electronic teaching is a new discovery in education theory. Known as the *reinforced response*, it was first developed as a way to teach animals to do tricks in a fantastically short time. Later it was found to produce remarkable results in human learning.

Briefly — and crudely — the method operates on the theory that if a student can be told almost continuously if he is right or wrong while studying a subject, he will learn faster and better than if his learning is evaluated at the end of a complete lesson, or by periodic examinations. As an elementary example, a mathematics student turns in an exercise containing 10 or 20 problems for the instructor to mark. When his paper is returned, he learns how right or wrong he was, and — in some cases even more important — where! Reinforced response would have told him whether he was right or wrong after each problem, would have *reinforced* his correct approaches and discouraged his wrong ones. In some cases, where a problem could be broken down into portions, he might have an opportunity to get back on the right track several times during the course of a single problem.

The electronic teaching machine is ideally adapted to this method of education. It can be programmed so the student can supply it with answers at each step in the work. If the answers are correct, the machine encourages the student — if wrong, it tells him where to go for information.

Possibly the most elaborate machine of that type was developed experimentally by the New York Institute of Technology, whose electronic classroom appears on our cover. A computer type

[1] Note the following editorials in RADIO-ELECTRONICS: "Teleducation," September 1951; "Tec-Teleducation," May 1956; "The USA at Bay," December 1957, and "Teleducation Progress," December 1958. All by Hugo Gernsback.

of device, it greeted the students with the taped voice of an instructor and presented him with a lesson in which questions were asked in multiple-choice form. The student pushed button according to the answer he selected, and — according to his answer — was complimented by the electronic teacher, given instructions on reference material, corrected and told where he was wrong, or sharply rebuked and told to study his lesson again, or to see his instructor.

The machine was originally designed for individual instruction, but its cost (approximately $1,200 per student) made it impractical for immediate use. The prototype model is being used, however, to evaluate new programs. A new lesson is tried on a group of students and their record of results is immediately made available by the computer.

If study of the record shows that some of the questions are being answered by an abnormally low number of students, or that more than half the questions are being answered correctly by everybody, the lesson should obviously be modified. The computer makes it possible to read instantly results that could be obtained formerly only by checking the answers on each student's paper and adding the totals, a much slower job.

Closed-circuit camera in school library delivers additional information when it's needed.

The electronic classroom

The classroom on our cover has been described as "probably the ultimate in electronic teaching finesse."[2] Each desk in the system has a (disc) record player in one of its drawers, and a number of television monitors are scattered strategically through the room. (The ultimate objective is to equip each desk with one.) There is also an intercom system between each student and the instructor.

The objective of this approach to electronic education is to free the instructor from the burden of lecturing, a task that takes up at least three-quarters of the average teacher's time in the conventional classroom. Thus he has much more opportunity for individual instruction and supervision.

Lecturing is the duty of the record player, a duty it shares with a printed workbook supplied to each member of the class. If the student is baffled at any point, he picks up his microphone, a "hushed" type into which he can talk without disturbing those at nearby desks. The teacher can answer him verbally, flashing a book page, diagram or other aid on the student's TV screen when helpful.

Additional electronic aids include a TV camera suspended on a track that runs along one side of the room. It can be poised above any of the desks along its route if the instructor cannot grasp the situation with the aid of the intercom alone, or if he wishes to examine a student's diagram. If neither student nor instructor has the answer to a problem, the instructor can call the library on his intercom and have information displayed on the classroom monitor.

When the student — with or without aid from the teacher — is satisfied he has the right answer (either the book or the record may pose questions), he presses a stylus against a selected lettered or numbered square on a panel on the desk. This makes an electrical contact that registers a correct answer with a green, a wrong one with a red light. At the same time a counter is advanced for each correct answer, and a record of the answer is made at the instructor's desk.

Semi-electronic systems

Experiments are being made with a number of variations of the above system. Some are quite nonelectronic, such as one in which numbered circles are touched with a damp brush. If the answer is correct, the circle becomes green — if wrong, it turns red. Thus the student is reinforced if he is right, and a permanent record of the answers is made for the benefit of the student or instructor, or both.

The reinforced-response technique extends even to books. Several texts have been published in which the student, reading to page 5, finds a set of numbered questions at the bottom of the page. According to the answer he chooses, he is told to turn to perhaps page 22 or 34. There he is instructed as to what he should do next, either progress to the next subject, review, or reread the material he has just gone over. These books have no immediate relation to electronics, but some tend to show electronic inspiration.

The New York Institute of Technology has taught courses in electronics, physics and mathematics successfully. Teaching languages electronically has become almost the standard method, and the very term "language laboratory" means an electronic installation. A whole gamut of courses has been presented by television in the "Continental Classroom" type of instruction, a method that will no doubt be extended by MPATI. The exact methods that electronic instruction will follow in the future are not clear, but the question "Will it be a factor in future education?" has been answered. Make no mistake about it—electronic education is with us, and extending fast. END

View of electronic classroom. TV camera relays teacher's notes to students.

[2] *Business Week*, Sept. 17, 1960.

TECHNICIAN'S GUIDE

TO GOOD SOLDERING

By H. W. McMURTRAY*

*Manager, quality control, Airborne Manufacturing, Raytheon Co.

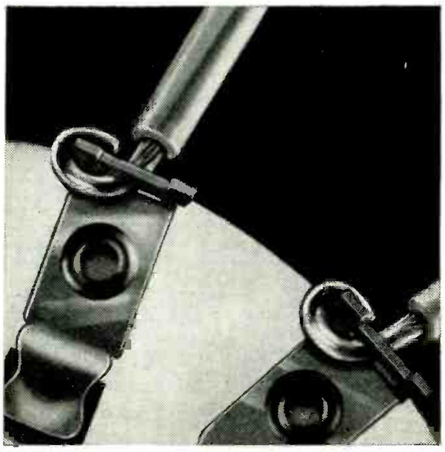
EVERY SKILLED OPERATOR TAKES PRIDE IN THE EXCELLENT workmanship and sure attainment of high standards that result from his own effort and ability. But, to encourage him to do his best work, the industrial technician must have reliable and precise information that plainly describes the standards of quality required of his product. Mutual recognition of and agreement on these standards by instructors, operators and inspectors alike is essential.

These illustrations, excerpted from a forthcoming Raytheon booklet, have been prepared as a guide toward better recognition of required standards for light assembly soldering operations. They are actual photographs of various types of joints, together with comments that illustrate the difference between good and bad solder joints.

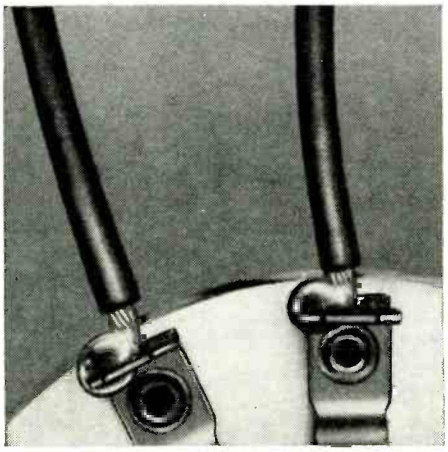
The method of heat transfer used in these examples is the common electric soldering iron. There are a number of other available methods, including the induction heating device, the resistance heating medium, the heating oven and the open flame torch. These instructions are applicable in general to all methods. When followed, they will result in reliable solder joints.

We hope that these examples will help to demonstrate what constitutes a reliable and usable soldering joint, and to eliminate differences and discussions between technicians, inspectors and others.

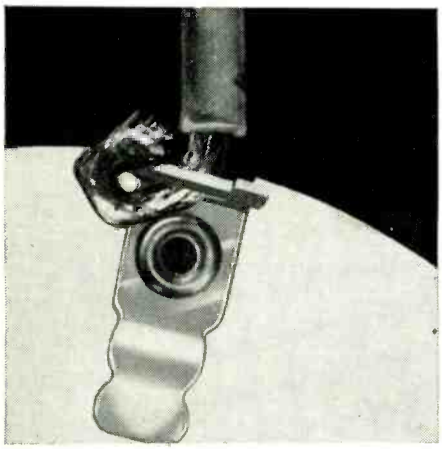
WAFER SWITCHES



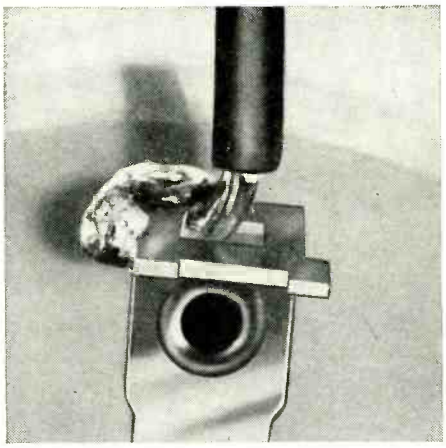
GOOD WRAP **•Properly wrapped to one full turn, and making good contact to terminal •Good insulation length**



GOOD SOLDER JOINT **•Good wrap •Good soldering—solder well sweated, outline of wire visible, solder does not creep up into insulation**

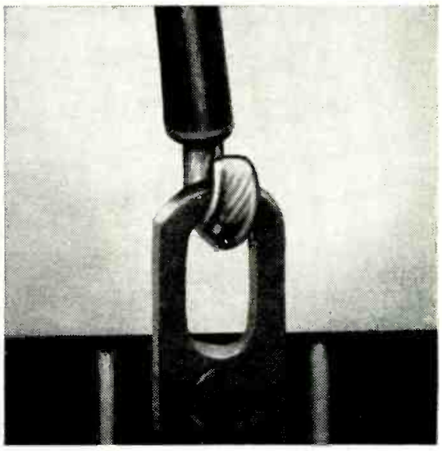


UNACCEPTABLE WRAP **•Not mechanically secure, poor contact with terminal**

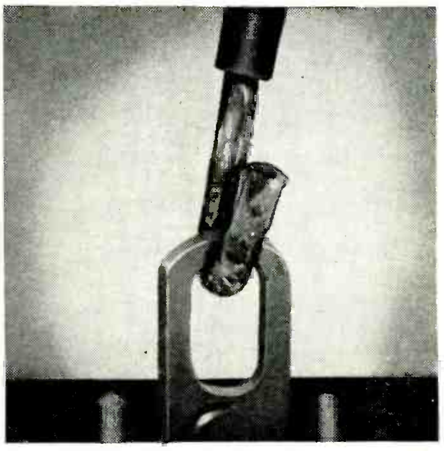


UNACCEPTABLE SOLDER JOINT **•Poor wrap •Cold solder—not drawn to all parts of joint, because of insufficient heat •Solder does not cover whole joint**

SOLDER TERMINALS



GOOD WRAP **•Wire brought around one turn, makes good contact •Insulation a good distance from terminal**



UNACCEPTABLE WRAP **•Wrap extends too far above top of terminal •Insulation too far from terminal •Poorly wrapped**

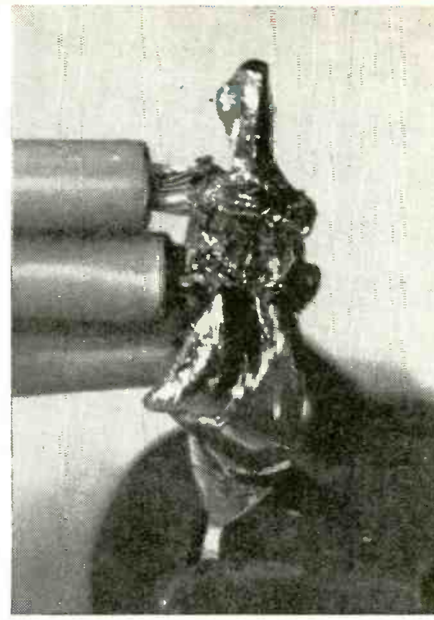
PITFALLS TO AVOID

1. Don't attempt to solder with an iron if the tip is not clean.
2. Don't allow excess solder on the tip of the iron before contact is made with the mechanical assembly.
3. Don't remove the iron from the assembly before solder has been drawn to all parts of the joint.
4. Don't allow wire or other parts of the joint to move before solder has solidified.
5. Don't attempt to solder a heavy assembly with a small iron.
6. Don't attempt to improve a poor mechanical assembly with a good solder joint. END

Photography by Salinger & Enneguess Advertising, Boston, Mass.

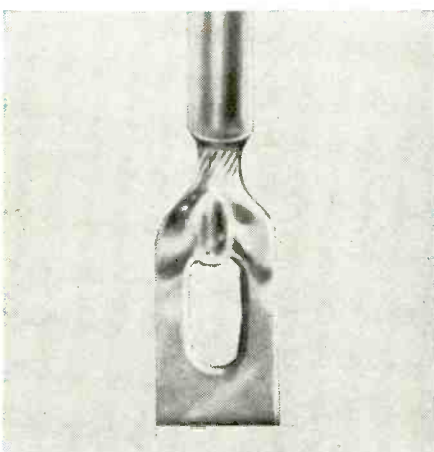
TUBE SOCKETS

GOOD SOLDER JOINT **•Good wraps •Joint well filleted •Outline of wires visible through solder**

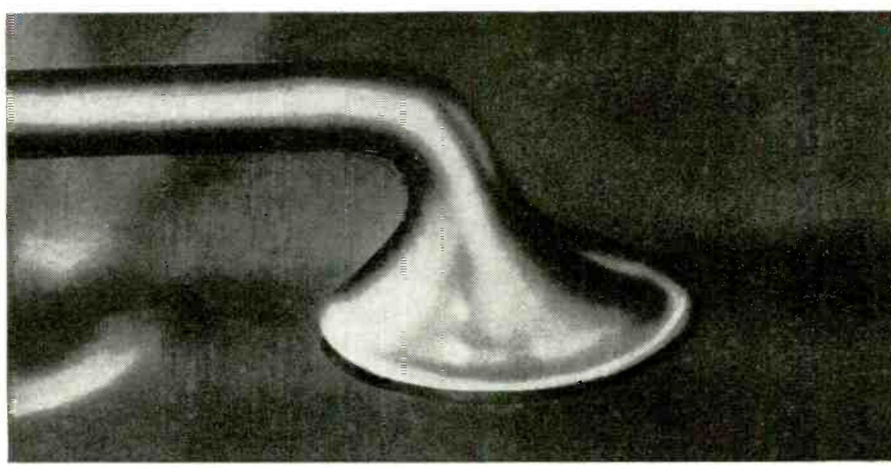


UNACCEPTABLE SOLDER JOINT **•Poor wraps •Bottom lead included in solder •Dirty solder •Excess solder has run down on terminal**

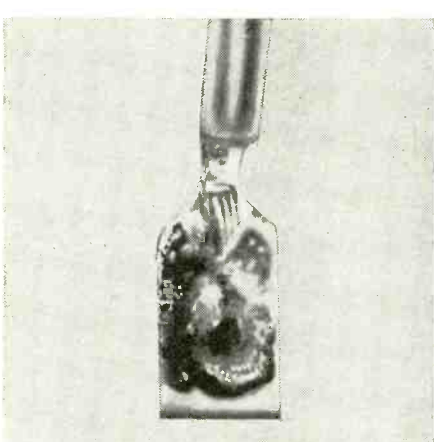
DOUBLE-SIDED PRINTED CIRCUITRY



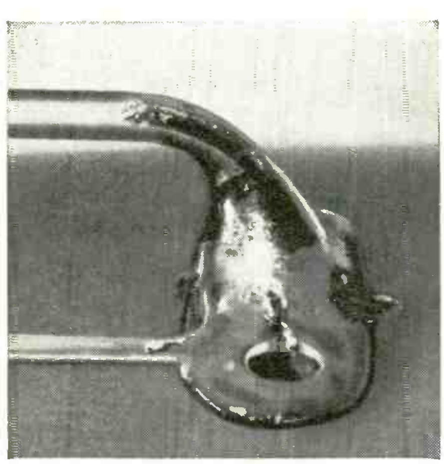
GOOD SOLDER JOINT **•Outline of stranded wire visible •Good fillet •Insulation a good distance from terminal •Solder has not wicked up to insulation.**



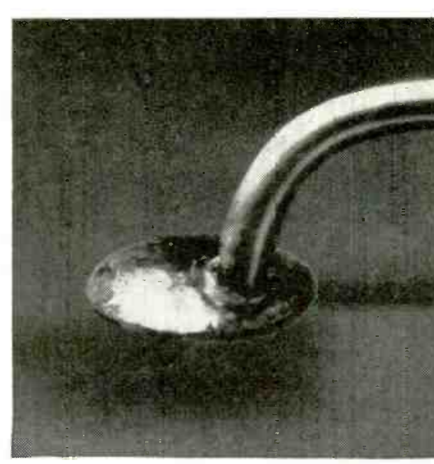
GOOD SOLDER JOINT **•Excellent preforming of component lead •Joint well sweated and filleted •Sufficient solder**



UNACCEPTABLE SOLDER JOINT **•Excess solder fills aperture •Dirty joint •Cold solder •Solder has wicked up to insulation**

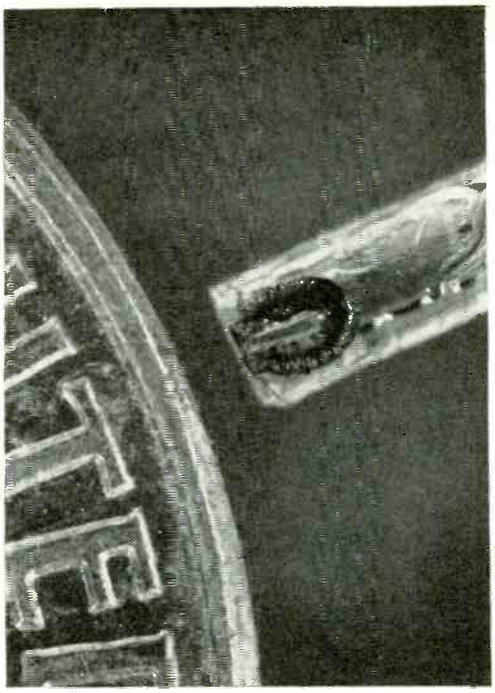


UNACCEPTABLE SOLDER JOINT **•Excess solder •Solder too far up on component lead •Solder has flowed to adjacent hole**

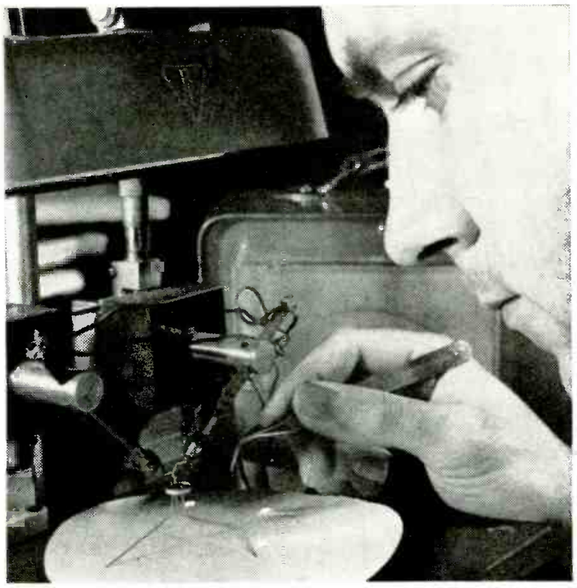


UNACCEPTABLE SOLDER JOINT **•Poor preforming of component lead, with greater than 90° radius of bend •Cold solder •Fillet not formed around lead**

What's New

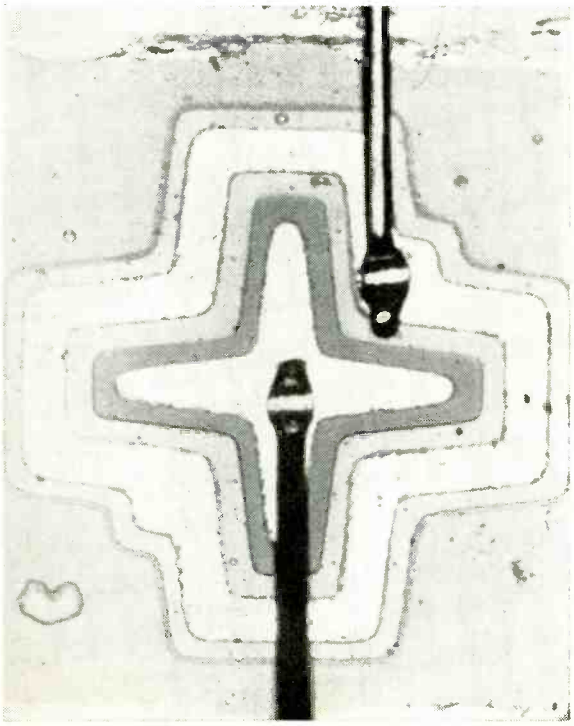


MINIATURE SEARCH COIL pinpoints defects and variations in small and hard-to-reach metal parts. Held near a rotating gear for example, irregularity in its output would show a broken tooth. It is shown here, greatly enlarged, next to a penny. The induction coil at the end of the probe consists of 200 turns of insulated wire about a third the diameter of a human hair (.00065 inch), wound around an iron core .008 inch in diameter. It was developed at the Battelle Memorial Institute, Columbus, Ohio.



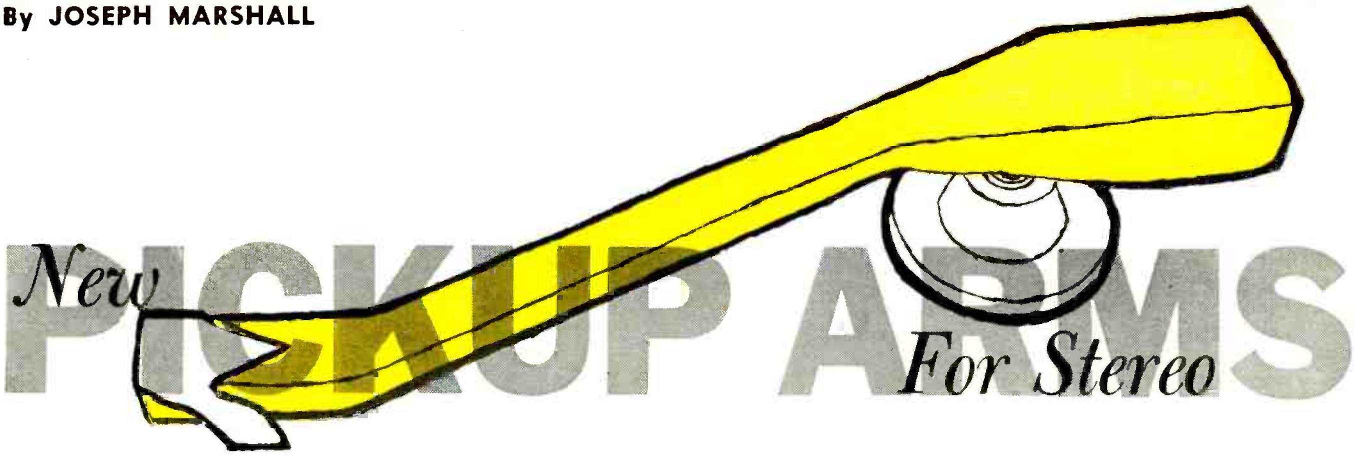
UNIVERSAL TRANSISTOR can do the jobs of up to 40% of the more than 2,000 transistor types on the market. (See specifications in New Tubes and Semiconductors, this issue.) Now being mass-produced by RCA, it is a significant development in the search for a true universal transistor.

SILICON STAR is the working heart of a new epitaxial planar switching transistor from Motorola. The new unit is said to have better electrical parameters than currently available medium-current units. The shape is credited with improving frequency response and current-handling ability.



COOL RADIO TELESCOPE in Serpukhov, USSR, follows Australian Mills cross design. Only one leg of the antenna is shown here. It is 1 kilometer long (about ⅝ mile). Unlike earlier Mills cross antennas, this one is steerable and can be tilted to point from the North pole to the southern horizon. The other arm, which will run north and south, is not steerable. *G. W. Swenson, Jr., U. of Ill.*

By JOSEPH MARSHALL



New PICKUP ARMS *For Stereo*

There's a definite difference—a few new wrinkles improve the performance

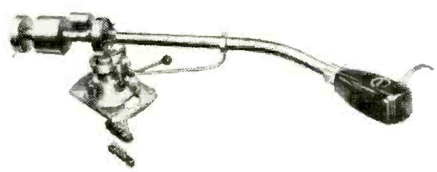
THE YEAR 1961 MAY BE REMEMBERED BEST in high-fidelity history for an entirely new family of pickup arms. Many are strikingly different in appearance and design from their ancestors. Though some of these new arms look as if they were designed by apt disciples of Rube Goldberg, there is good engineering sense behind them. They improve performance significantly by permitting more complete and precise adjustment of all the ways the arm can affect performance.

Four or five examples of this new type of arm are on the market. The first and most elaborate to appear was the British SME. The first American example was the Lab model of the Grado arm. It was followed by the ESL 2000, which looks very much like its predecessor, but is a complete redesign embodying many new ideas. Just announced is a modification kit for the Rek-O-Kut arm which brings it in line with the new trend. Meanwhile, the new Fairchild arm attacks the most subtle of the forces which degrade performance.

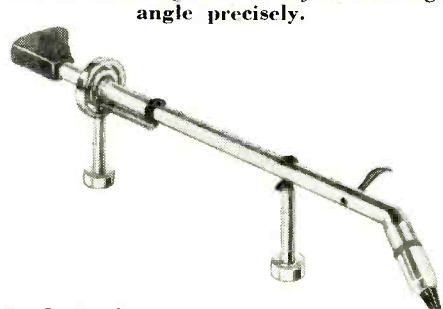
All of these are universal arms and can be used with most standard cartridges.

The new ideas are also expressed in the latest version of the Dynaco B & O arm, designed specifically for and usable with only the B & O cartridge. The original B & O anticipated the basic ideas and may thus be the grandfather of the entire family. Finally, although it takes an entirely different design road, there's the newest version of the Weathers arm, designed for the unique Weathers Professional cartridge. All these arms have one goal—satisfactory playback of disc recordings with stylus pressures low enough to minimize, if not eliminate completely, deformation and wear of the recording.

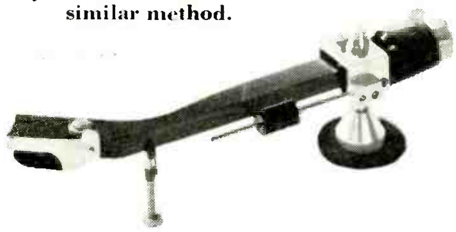
The pickup arm supports the stylus in the groove of the record at the correct angles in all planes. It is supposed to do so without influencing stylus performance in any way. Obviously, the ideal way to do the job is to do away with the pickup arm entirely. Only in that way could its influence on the stylus be removed completely. Since this is impossible—in the present state of the art—pickup arm designers have attempted to do the next best thing—to do away with any and all influences the arm has on the stylus. This is done by neutralizing or adjusting all factors which can affect the stylus. To reproduce faithfully the minute wiggles in the groove of a disc recording, the stylus must:



The SME is most elaborate of the new arms. Note that pivot post can travel in slot in mounting base to adjust tracking angle precisely.



In B & O arm, counterweight is shaped to throw more weight on one side. By revolving it slightly, arm can be balanced laterally. New ESL arm uses similar method.



An additional counterweight traveling on an outrigger can be adjusted to provide lateral balance with any cartridge in the Grado Lab model arm.

- Maintain a firm and symmetrical but nearly frictionless contact with both walls of the groove.
- Be small enough to follow the most minute of the wiggles.
- Have a small enough mass and flexible or compliant enough to vibrate at speeds beyond 15,000 cycles a second.
- Be positioned so it vibrates at a proper angle to the groove in all planes and throughout the entire groove length.

All these are serious problems to both pickup and pickup arm designers and some of the requirements are contradictory!

For example, the higher the stylus pressure, the firmer the contact. But this does more than just increase the friction. It also loads the compliance of the stylus so it cannot vibrate as freely or rapidly as it should. Again, to follow the minute waves cut above 10,000 cycles on the innermost record grooves, the stylus should be not much more than 0.5 mil in diameter. Unfortunately, the smaller the stylus diameter, the greater the force it applies to the groove; therefore, the greater the deformation and wear with a given pressure. The 1-mil stylus of the old monophonic pickups does not deform a record until its pressure exceeds 2 grams. A combination of arm and cartridge that permitted operation with less than 2 grams of pressure would yield a pickup system with a 1-mil stylus that produced no wear or deformation at all. With such a system recordings could theoretically maintain their pristine purity indefinitely. In the closing days of the monophonic era, two or three combinations exceeded this ideal, notably the Weathers FM and the Shure Studio Dynetic, both of which tracked at 1 gram.

But the deformation and wear force increases rapidly as stylus size is reduced. The 0.5-mil stylus at least doubles the force on the record at a given pressure. To equal the deformation and wear characteristics of the 1-mil stylus, it would have to operate at not much more than 1 gram of pressure. Many stereo pickup designers compromise on a 0.7-mil stylus radius, which has almost twice the deforming force of a 1-mil unit but is theoretically free of deformation with no more than 1.5 grams of pressure.

The smaller stylus favors high compliance—because of its smaller mass it can vibrate more easily at high speeds. But the smaller the needle mass and the higher its compliance, the freer it must be from external loading. This is where the pickup arm comes in. It must be fairly big and quite heavy compared with the mass of the needle. Obviously, if the arm's mass or weight loads the stylus, it reduces and defeats its compliance.

The vertical weight or mass of an arm can be neutralized (in effect eliminated) by using the principle of the balance scale or teeter-totter. A counterweight is adjusted back of the arm pivot until it exactly equals the gravitational pull on the forward part of the arm. In this state the arm is completely free from gravitational pulls and is effectively weightless. Actually the stylus needs a little weight on it to maintain good contact with the groove. Therefore, the arm is unbalanced slightly to provide the required pressure. This is done either by moving the counterbalance slightly so it doesn't quite equal the weight of the forward part of the arm or by adjusting a small and weak spring that pulls the forward part of the arm downward with the required pressure. Any modern arm can be adjusted to provide pressures ranging from zero upward.

These arms work fine until pressure is reduced below 2 grams. Then the trouble begins. This was not a problem until very recently because there were no stereo pickups on the market with high enough compliance to track satisfactorily with less than 2 grams pressure. During the past year, pickup designers broke through the 2-gram barrier. Now we have a small group of cartridges that can track below 2 grams —provided the arm permits.

In the first of these high-compliance cartridges, the manufacturers solved the pickup problem by using arms designed specifically for the cartridges. Thus we have the Shure Studio Stereo Dynetic integrated combination and the Dynaco B & O with its integrated arm which track at 1.5 grams, and the Weathers Professional which in its own arm tracks at 1 gram. We also have individual cartridges with compliances of 6×10^{-6} dynes or better—among them the B & O, the newest versions of the Empire, the ADC, and the Shure M3D (when fitted with the N21 stylus). Suddenly the arm designer found himself behind the cartridge instead of ahead of it as he has been for some time.

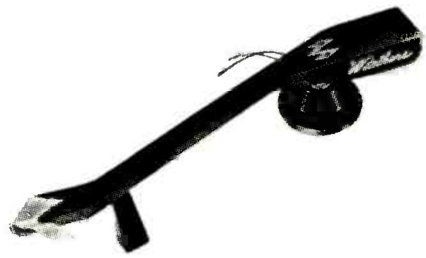
The new type of arm makes it possible to use high-compliance cartridges at pressures down to 1 gram, and perhaps less. Practically all use the same basic philosophy, though the expressions are quite individual.

All arms begin with the counterweight system of neutralizing the *vertical* mass. However, since they must handle rather subtle changes in pressure, adjustments are more sophisticated, sensitive and accurate. Most use a calibrated knob, and all can be adjusted to a fraction of a gram.

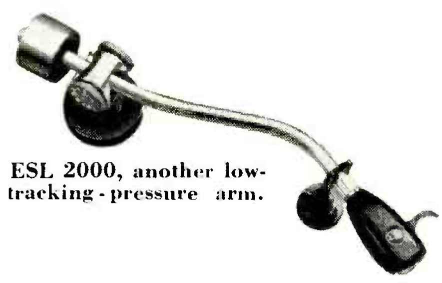
Lateral balance

A balanced arm is weightless in the vertical plane and does not load the needle so long as the turntable, record and arm are all mounted level. But if they are not precisely level, the lateral

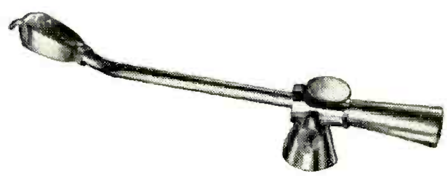
The Fairchild 500 arm includes an anti-skating spring to reduce wear on the inside of the record groove.



The Weathers arm is specially hinged for lateral balance.



ESL 2000, another low-tracking-pressure arm.



Rek-O-Kut has an outrigger weight for lateral balancing.

weight of the arm, through the gravitational pull, begins to load the stylus with its mass. Aside from defeating the high compliance, this can cause skating, groove jumping and skipping when needle pressure is reduced below 2 grams. Therefore, all the new arms provide for balancing the arm in the lateral plane also. This makes the arm completely weightless, in effect, in both planes.

The same counterweight principle used for vertical balance can be used for lateral balance. The first arm, to my knowledge, that used this method was the Dynaco B & O. Its counterweight is shaped to throw more weight on the outside of the arm. Of course, the Dynaco arm is usable with only one cartridge—the B & O—but it may well be the predecessor of all new arms in this respect.

Lateral balance with any cartridge is a necessity in a "universal" arm. The ESL 2000 uses a system very similar to that of the Dynaco. The single counterweight is drilled eccentrically. Moved back and forth, it provides vertical balance. Turned on the spindle, it can throw a higher proportion of its weight to one side or the other and thus provide lateral balance. The SME and the Grado Lab use a little outrigger with a separate smaller weight traveling on it. By moving this weight the arm can be balanced laterally for any cartridge. Rek-O-Kut now has a simple modification which permits lateral balancing of its arm. The outside gimbal is replaced with an outrigger on which a counterweight travels.

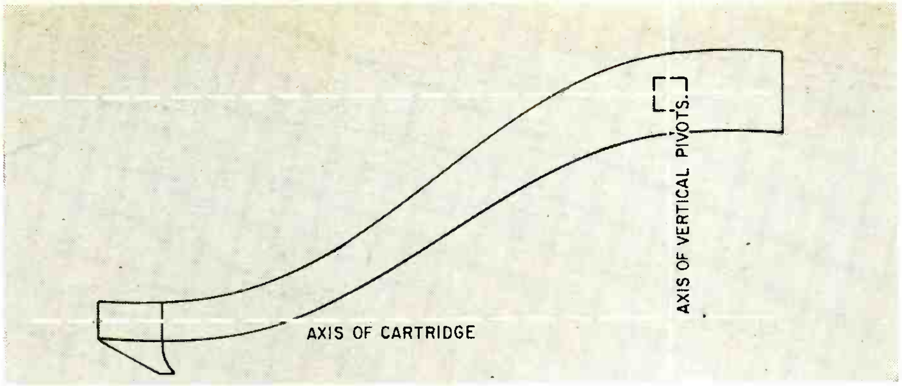
In any event, the procedure is the same for all arms. After the cartridge is mounted, the arm is balanced vertically with the big counterweight. Then it is tilted laterally and the lateral counterweight adjusted until the arm is perfectly balanced in that plane. Thus balanced, the arm is, for all practical purposes, weightless and, in this respect, invisible to and unfelt by the stylus. Though it can be seen, it has little influence. The only way it can influence the stylus is through the friction of its bearings. However, this is not a real problem. All modern arms use very-low-friction bearings.

Weathers has another way of minimizing or counteracting the lateral weight. The ability of an arm to swing freely in any plane depends on the way it is hinged in that plane. A demonstration of this would call for some complicated explanations and sketches. Let's just say that if the axis of the vertical pivot of an arm is properly oriented in respect to the shape of the arm and the axis of the cartridge, the lateral mass of the arm is not subject to the gravitational pull when it is tilted. In his arm, Weathers positions the vertical pivots—those about which the arm moves up and down—at right angles to the axis of the *cartridge* instead of at right angles to the length of the arm. Thus oriented, the arm is balanced laterally and operates satisfactorily even with a large departure from level. The Empire arm also uses this principle.

Tracking error

There is one remaining external influence on the stylus. To keep tracking error low, all modern arms are offset. Because of the offset, the spiral of the groove, as it pulls the stylus and arm toward the inside of the record, pushes the stylus harder against the inside wall of the groove than the outside. This spoils the symmetry of the contact between stylus and groove, resulting in a somewhat heavier contact with the inner wall than the outer wall. In theory, too, this should cause some distortion and higher wear on the inner wall. In stereo especially this makes a difference since the two walls carry slightly different information.

Whether it is significant enough in practice to be noticeable is still a moot point. Fairchild says it is and has evidence in the form of oscilloscope patterns which indicate distortion on one channel. And this does make sense and should presumably make more sense as the other influences are neutralized. In any event, Fairchild has included in



By offsetting vertical pivots so they are at right angles to the axis of the cartridge, rather than the arm, the lateral weight of the arm and cartridge can be balanced. This method is used in the Weathers and Empire arms.

its new arm the first means for neutralizing this so-called "skating" thrust. It does this with a little spring which is adjusted to pull the arm outward to the same degree that the skating force pulls the arm inward.

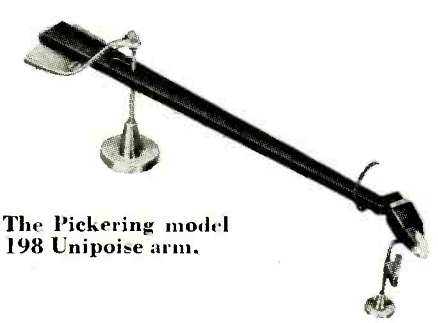
The new Dynaco B & O arm also compensates for the skating thrust. It does the job by offsetting one of the pivots, so the same spring which pulls the arm downward to establish needle pressure also pulls it outward to offset the skating thrust. Since the Dynaco is designed for a single cartridge, there is no adjustment. However, in the Dynaco, the outward pull automatically increases as the pressure increases and vice versa, to keep step with the change in skating thrust with changes in stylus pressure.

By thus neutralizing all the effects of the arm, tracking is satisfactory and stable with stylus pressures below 2 grams—with pickups whose compliance is high enough to permit such low pressures. Just what the limit of the new arm is, it is too early to say. I get satisfactory results with one or two cartridges at 1-gram pressures. One gram with the 0.7-mil stylus means that no deforming or wear force is applied to the modern plastic record.

However, the next step undoubtedly will be smaller styli. Some are already here. The ADC uses a 0.6-mil needle. There is a special version of the B & O with a 0.5-mil needle and higher compliance and Shure also now offers a stereo cartridge with the small stylus. To approximate the practical ideal with these smaller styli the pressure should be 0.5 gram, but this will call for cartridges with still higher compliance. The new arms or future refinements of them may well work at 0.5 gram.

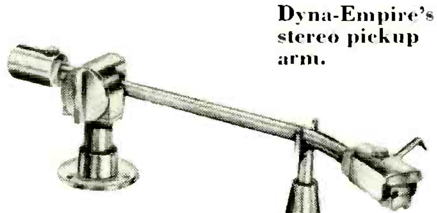
Stylus position

The new arms do not stop here. We mentioned earlier that the arm should support the needle at the proper angle to the groove in all three dimensions. Actually, most arms do a surprisingly poor job of this simple function unless they are used with a specific cartridge and mounted with great precision. Take the matter of tracking—maintaining the axis of the needle at a tangent to the groove throughout the entire recording. So long as we use an arm mounted outside the record circle we cannot maintain this perfect tracking except at two or three points. But with care we can reduce the error at all other points to something between 1% and 2%. This holds tracking distortion to a level that is acceptably low.



The Pickering model 198 Unipoise arm.

Lafayette's PK448.



Dyna-Empire's stereo pickup arm.

The Gray 212-TG is viscous-damped

All modern arms are designed to keep this error down to these values provided the cartridge places the stylus tip where the arm designer intended it to be, and that the arm is mounted precisely in the spot—in relation to the record center—that the designer intended. Unfortunately, most arms require a rather large mounting hole. It is easy to make an error of a few tenths of an inch in drilling the hole and this can double the tracking error.

Also, cartridges differ as to the location of the stylus tip with respect to the mounting holes. Therefore, an arm mounted with one cartridge in mind may not provide optimum tracking for other cartridges. Most of the new universal arms have some means of insuring optimum tracking with any of the standard cartridges. In the SME, the arm post slides in an inch-long slot and tracking can be adjusted to take care of any cartridge or minor mounting error. In the ESL 2000, the mounting base has an eccentric race. It can be revolved to move the arm a little over a half inch in relation to the center post and thus accommodate any reasonable differences or errors. In the Grado Lab, the slide on which the cartridge mounts can be moved back and forth a fraction of an inch so that the stylus tip can be set for optimum tracking.

There is another important stylus angle that is treated even more shabbily by most other arms—the angle of the stylus to the surface of the record as viewed from the front of the pickup. To maintain symmetrical contact with both walls, it should be perpendicular. It seldom is. Usually this is a fault in mounting the tone arm.

Most turntable bases are ½ to ¾ inch thick. The hole for mounting the arm should be perpendicular to the surface of the board, which presumably is parallel to the surface of the record. It is not easy to drill a perpendicular hole with an auger and brace or an electric drill. But any departure from it will be reflected in a departure of the needle angle from the desired right angle. Therefore, all the new arms have some way to insure the proper angle. The SME base plate is flat and large, and is mounted on the surface of the turntable base. You cannot mount the arm at any angle except a right angle to the board. Presuming—and this does not always follow—that the turntable itself is parallel to the base board, the stylus angle is automatically correct. The ESL solution is similar. In the Grado, the rubber washer between board and base is eccentric in thickness. By revolving it the whole arm can be tilted to correct the needle angle.

These then are the characteristics of the new pickup arms:

- Complete balance in the vertical and lateral planes with any cartridge suitable for use in the arm.
- Sensitive adjustment of stylus pressure down to 1 gram or less.
- Adjustments to insure proper needle and tracking angles with any cartridge. END

SPECIFICATIONS

New PICKUP ARMS *For Stereo*

By **LARRY STECKLER**

ASSOCIATE EDITOR

ON THE PRECEDING PAGES JOE MARSHALL HAS GIVEN THE newest features of stereo pickup arms a thorough going over. Here we are supplementing his information with a listing of stereo arms now on the market. It is in tabular form, to make things as simple and clear-cut as possible.

To help you follow the charts a little explanation is needed. In the pickup-arm chart on the next page the columns *manufacturer* and *model* explain themselves. In the next row, *integrated*, "yes" means the arm comes with a cartridge and can be used only with that cartridge. (Details of the cartridge are in the cartridge chart and listed according to the arm model number.) "No" in this column means that any cartridge can be used with the arm.

Minimum *tracking force* represents the bare minimum force (in grams) needed for the arm to track. Under *vertical* and *lateral balancing*, the system used, if any, is listed.

Skating force is that force applied to the inner wall of the groove by the stylus as the record is played. Some arms eliminate this stress. *Arm length* is the distance between the arm pivot and the stylus tip. *Type pivot* refers to the lateral pivot, the one that lets the arm move from side to side. Arm *construction* tells you what the arm is made of.

Tracking error gives the maximum error when the arm is correctly mounted. Most of the time the error is less than the indicated figure, but at some point as the arm moves across the record, it reaches the figure stated.

Most arms have some resonant point. The frequency of this *resonance*, if any, appears under that heading.

It's important to know how the cartridge is mounted. Look under *cartridge mounting* and you'll find out how it is handled.

Damping is important. It can be used to kill resonances or to prevent you from dropping an arm hard enough to damage a record or stylus.

It's handy if you can adjust *arm height*. Some arms use spacers; others have a shaft that can be raised or lowered. Setscrews hold it in place.

Arms made for more than one cartridge should have some kind of *overhang adjustment* so the distance from pivot to stylus tip can be set to give you minimum tracking error.

Last, but not least, is the *price*. This may vary from place to place, but the prices listed here come from the manufacturer. So, though they may vary, depending upon where you live, they will serve as a comparative guide. END

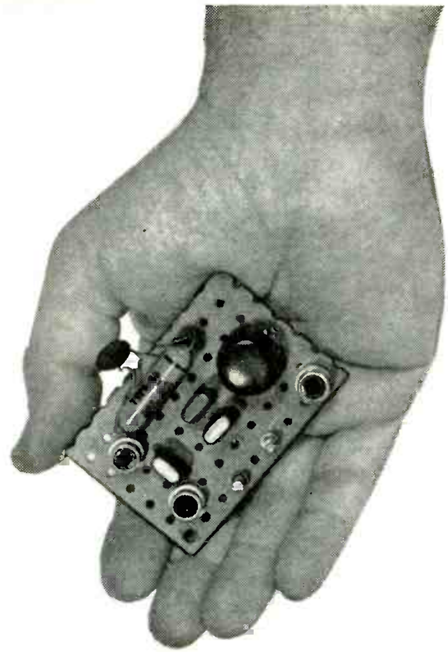
INTEGRATED ARM-CARTRIDGES

MODEL OF ARM (see Pickup Arm Chart)	FREQUENCY RESPONSE (cycles)	TRACKING FORCE (minimum grams)	STYLUS COMPLIANCE		STYLUS SIZE (mils)	CAN USER REPLACE STYLUS	TYPE CARTRIDGE	CHANNEL SEPARATION (db)	OUTPUT PER CHANNEL (at 5 cm per sec) (mv)
			VERT	HORIZ					
ERCONA CONNOISSEUR	20–20,000 ± 2 db	3.5	3.5×10^{-6}	3.6×10^{-6}	0.56	YES	Superceramic	20–25	20 into 50K load
DYN CO. TA-12a	30–15,000 ± 2 db	1.5-3	5×10^{-6}	5×10^{-6}	0.7	YES	Moving iron (magnetic)	20–30	7
FAIRCHILD 500	20–15,000 ± 2 db	2	4×10^{-6}	5×10^{-6}	0.7	YES	Moving magnet (magnetic)	20–22	5.5
LAFAYETTE PK-448	20–16,000	3	5×10^{-6}	5×10^{-6}	0.7	YES	Moving magnet (magnetic)	25	5
PICKERING 198	20–15,000	2	6×10^{-6}	6×10^{-6}	0.7	YES	Magnetic	15–35	2.5 (per cm per sec)
199	20–12,000 ± 2 db	2						18–35	1 (per cm per sec)
H. H. SCOTT 1000	15–25,000	3.5	3.5×10^{-6}	3.5×10^{-6}	0.5	NO	Magnetic	20	7
SHURE M212	20–20,000	1.5	9×10^{-6}	9×10^{-6}	0.7	YES	Moving magnet (magnetic)	20	4.5
WEATHERS PS11	15–35,000	0.75	20×10^{-6}	23×10^{-6}	0.4	NO	Bridge type capacitor	35–40	0.5 volt from amplifier

STEREO PICKUP ARMS

MANUFACTURER	MODEL	INTEGRATED	MINIMUM TRACKING FORCE (grams)	VERTICAL BALANCING ADJ	LATERAL BALANCING ADJ	SKATING ELIMINATOR	ARM LENGTH (inches)	TYPE PIVOT	ARM CON-STRUCTION	MAXIMUM TRACKING ERROR (degrees)	RESONANCES	CARTRIDGE MOUNT	DAMPING	HEIGHT ADJ	STYLUS PRESSURE ADJ	STYLUS OVERHANG ADJ	PRICE
ERCONA CORP. 16 West 46 St., New York 36, N. Y.	CONNOISSEUR	YES	3.5	Factory set	No	No	For 12" records	Needle	Aluminum	2	None	Plug-in	None	Setscrew	Preset	Preset	$49.50
DYNACO INC. 3912 Powelton Ave. Philadelphia 4, Pa.	TA-12a	YES	1	Adj offset weight	Adj offset weight	offset pivot	9	Gimbal	Aluminum	2	At 20 cycles	Plug-in	Mass-damped	Setscrew	Spring	Preset	$49.95
DYNA-EMPIRE INC. 1075 Stewart Ave. Garden City, N. Y.	980	NO	0.5	Screw adj counter-weight	Geometric	NI	9	Ball bearing	Aluminum	0.65	At 8 cycles	Screw-on	Rubber insert	Setscrew	Calib clock-spring	At cart bracket mount	$50.00
ELECTRO-SONIC LABS INC. 627 Broadway New York 12, N. Y.	S2000	NO	less than 1	Sliding barrel	Eccentric counter-weight	No	8.75	Ball bearing	Aluminum	2.27	Below 15 cycles	Plug-in	None	Yes	Calib spring	Yes	$34.95
ELPHA MARKETING IND. INC. Thorens & Atlantic Aves. New Hyde Park, N.Y. (Ortofon)	SKG 212	NO	less than 2	counter weight			for 12" records	ball bearings	chrome steel	1.19	None in audio range	Plug In	None	No	Calib counter-weight	In Cart Shell	$20 to $70
	SMG 212																
	RMG 212			counter-weight[4]			16" records			0.83				Setscrew			
	RMG 309																
FAIRCHILD RECORDING EQUIP. 10-40 45th Ave. Long Island City 1, N. Y.	500	YES	2	Movable weight	Offset pivots	Spring	8⅜	Ball bearing	Aluminum	1.5	At 14 cycles	Screw-on	Pivots Rubber-damped	Setscrew	Movable weight	Preset	$55.00
	500 A	NO	0-14													No	$29.95
GRADO LABS INC. 4614 7th Ave. Brooklyn 20, N. Y.	LAB SERIES	NO	0.1	Gravity weight	Adj weight	No	8⅞	Single point	Wood	0.5	None	Screw-in	None	Thread & locknut	Spring	In cart slide	$39.50
GRAY MANUFACTURING CO. 16 Arbor St. Hartford 1, Conn.	212-TN, 212-TG SAK-12G SAK-12N	NO	2	Spring-loaded	Counter-balance	No	9-1/16	Viscous-damped	Aluminum	2	At 10 cycles	Plug-in	Viscous	Setscrew	Spring	In cart slide	$24.95–35.50
	208-S		1	Preset	Preset		15	Single point		1.25	At 6 cycles				Modular weights		$49.50
LAFAYETTE RADIO ELECTRONICS 111 Jericho Turnpike Syosset, N. Y.	PK-448	YES	3	Counter-weight	No	No	10	Ball bearing	Aluminum	0.8	NI	NI	Damped suspension bar	Screw adj & spacers	Preset	Preset	$32.50
LECTRONICS City Line Center Philadelphia 31, Pa.	WORDEN	NO	.75	Mass balance	Preset	Inherent	7¼	Ball bearing	Wood	0.25	Unmeasurable	Slip-on	Mass damping	Wood spacers	Screw adj	In head	$45.00
	SME-3009		.5		Mass balance[1]	Yes	9		Stainless steel	1.5		Screw-In		Setscrew	Calib rider weight	In base	$87.00
	SME-3012						12										$99.00
PICKERING & CO. INC. Sunnyside Blvd. Plainview, N. Y.	199	YES	2	Sliding weight[4]	Preset	No	8⅜	Single point	Aluminum	3.75	At 15 cycles	Screw-on	NI	Screw adj	Sliding weight	Preset	$67.50
	198																$54.00
REK-O-CUT CO. INC. 38-19 108th St. Corona 68, N. Y.	S260	NO	1	Counter-weight	Sliding weight[2]	Yes[2]	11	Micro-bearings	Aluminum	1	At 15 cycles	Plug-in	None	Screw adj	Micro-poise dial	Mounting kit	$36.95
	S320						8¼										$34.95
H. H. SCOTT INC. 111 Powder Mill Rd. Maynard, Mass.	1000	YES	Preset	Preset counter-weight	No	Inherent	9	Ball bearings	Aluminum	1.5	None	Plug-In	Viscous	Setscrew	Preset	Preset	$89.95
SHURE BROTHERS INC. 222 Hartrey Ave. Evanston, Ill.	M212	YES	1.5	Knurled nut	Preset	No	8½	Ruby thrust bearing	Aluminum	4	At 13 cycles	Plug-in	Dynamic	Setscrew	Counter-balance adj	Preset	$87.71
	M232	NO	0–8	Thumb nut	No		8¾	Ball bearing		2.25	At 12 cycles		None		Spring	In head	$29.35
STROMBERG-CARLSON 1400 N. Goodman St. Rochester 3, N. Y.	RA-498	NO	0.5	Calibrated counter-weight	Eccentric counter-weight	No	For 12" records	Single point	Aluminum	NI	Below 20	Snap-in	Viscous (optional)	Screw adj	Counter-weight	No	$27.95
WEATHERS INDUSTRIES 66 E. Gloucester Pike Barrington, N. J.	PS11	YES	0.75	Sliding weight	Offset pivot	Yes	10	Viscous-damped	Wood	1	None	Plug-in	Viscous	Spacers & sliding barrel	Sliding weight	In base	$129.50[3]

NOTES: [1] Accessory—$4.05 [2] Accessory—$.95 [3] Includes two 2-transistor amplifiers [4] Spring loaded (Model 198) [5] Spring loaded NI—no information given.



Transistor Multivibrator has crystal control

3-transistor unit splits 100-kc crystal frequency to stabilize lower-frequency oscillators

By I. QUEEN
EDITORIAL ASSOCIATE

ACCORDING to the radio catalogs, 100 kc is the lowest frequency for which crystals are commonly available. However, frequencies under 100 kc can be crystal-controlled by using a frequency divider or "countdown" circuit. This is a multivibrator tuned to 1/nth its input frequency.

As an example, a 100-kc signal, crystal-controlled, may be fed into the divider which is tuned to approximately 1/5 of its input, 20 kc. When the tuning is slightly below 20 kc, the multivibrator will be *locked in* and its frequency will be *exactly* 1/5 of its input. Therefore the output will be crystal-controlled just like the input. The stability of a frequency divider falls off as n increases, but up to 10 is generally not difficult.

Fig. 1 shows an idealized waveform from a free-running multivibrator and that of its output when locked in. In this case the countdown is 5 to 1. The fifth pulse arrives an instant *before* the multivibrator alone would fire. It triggers the circuit, as shown by the fact that every fifth pulse is larger than the preceding four (which are signal input pulses). The triggering instant should be set for optimum operation.

While a high countdown, say 20 to 1, may be obtained from a single stage, stability is apt to be low. Circuit or voltage drift from 20 to 1 to 19 to 1 is much more likely than drift from 5 to 1 to 4 to 1, for example. To obtain a 20 to 1 division, it is better to use two stages in cascade. For example, the first stage may be set for 5 to 1 and the second for 4 to 1. Then, with an input of 100 kc, the output would be 5 kc and each frequency would have the same precision.

A simple and effective frequency divider was described in Lansdale Tube Co. (Philco) lab report 548. Originally, it was used with 2N597 transistors to divide the frequency (as much as 7 to 1) of TV sync signals. Fig. 2 is the circuit.

Capacitor C1 determines approximate *free-running* frequency range as follows:

C1	*Approx multivibrator freq out*
.001	40 kc
.005	8 kc
.02	2 kc
0.1	400 cycles
0.5	70 cycles

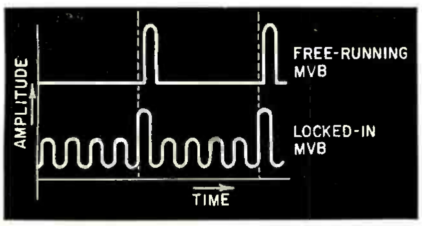
R2 is the adjustment for optimum stability or lock-in. (In the original circuit R2 and R3 were a single 12,000-ohm fixed resistor.) It adjusts frequency over a narrow range.

There are two ways to monitor or test the countdown circuit. An oscilloscope may be connected between terminals A and B, the latter being scope ground.

The scope will display both the input (small) pulses and the output (large) pulses. Choose C1 and adjust R2 to obtain optimum stability as shown by the pattern. If there are four small pulses to every large one (as in Fig. 1), the countdown is evidently 5 to 1, for example. I find best results when the input amplitude is approximately 40–50% of the output. Remember that a change in the input amplitude may affect the stability or countdown ratio of the circuit, so it is better to maintain a constant input.

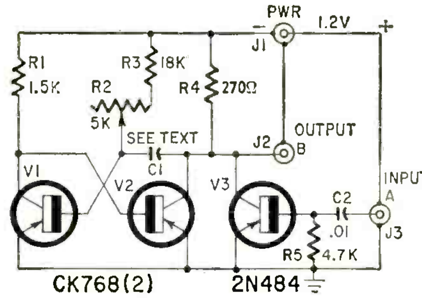
The output of the divider may also be checked by listening in on a nearby receiver. Couple the multivibrator output loosely to the antenna post (through a low-value capacitor). If the output is 20 kc, for example, you will hear signals at intervals of 20 kc throughout the broadcast band and beyond. Each harmonic should be clear and steady, if the input is crystal-controlled.

Here are some useful applications of the circuit. Using 100-kc input, crystal-controlled, tune the multivibrator for 25 kc. You will hear harmonics to beyond 5 mc. With 400-kc input, you may tune the circuit to 50

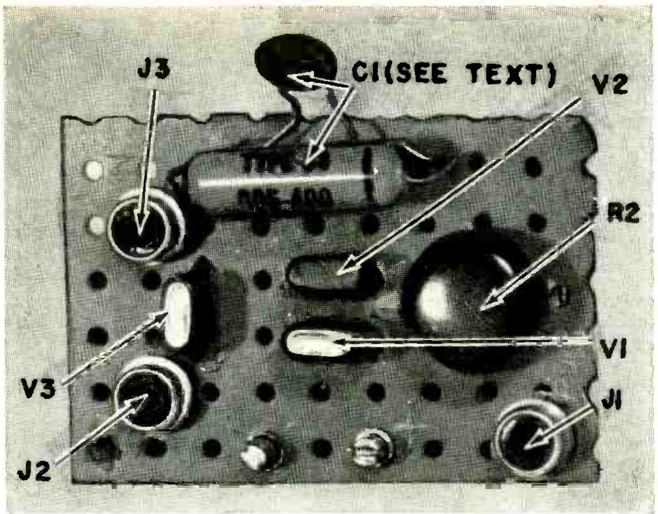


◀ **Fig. 1—Idealized waveform from free-running multivibrator along with that of its output when locked in.**

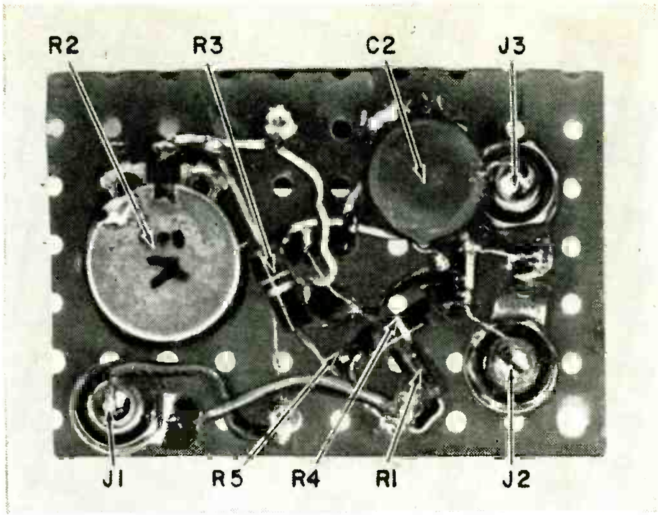
Fig. 2—Circuit ▶ of the frequency divider. Power supply plugs into J1.



R1—1,500 ohms
R2—pot, 5,000 ohms
R3—18,000 ohms
R4—270 ohms
R5—4,700 ohms
All resistors ½-watt 10%
C1—see text
C2—.01 µf, disc ceramic
J1, J2, J3—phono jacks
V1, V2—CK768 (Raytheon)
V3—2N484 (Raytheon)
Transistor sockets (3)
Perforated phenolic chassis
Miscellaneous hardware



Little unit does a big job. Note that author used a CK760 for V3. This unit is no longer available.



Parts layout on the reverse side of the perforated board chassis.

kc, an 8-to-1 countdown. These harmonics remain strong to 10 mc and above. I have obtained as high as 20-to-1 countdowns, but, as mentioned previously, they are more susceptible to drift and should be monitored continuously (by scope or receiver).

When no input is applied, the multivibrator is free-running. The output is pulselike and its frequency is adjustable by R2. With various values for C1, a wide frequency range is possible.

This circuit is effective with only 1.2 volts as power supply fed into J1. The output amplitude will be approximately 0.5 volt or more. The input should be approximately 200 mv and held constant.

With enough capacitance at C1, the circuit can be tuned to low audio frequencies. If you need a highly accurate low frequency, say 50 or 100 cycles, it may be obtained by counting down from a 100-kc crystal oscillator through a series of 5-to-1 or greater frequency dividers. Remember, the smaller the ratio the better the stability. END

TEA CONVENTION REPORT

Texas Electronics Association holds its 9th annual get together

Marvin Tappe (right), president of TEA, and J. W. Williams, both of Ft. Worth, were co-chairmen of the clinic. They are shown here using the little CB transceivers that save so much walking.

By JACK DARR
SERVICE EDITOR

TEXAS TV TECHNICIANS TROOPED INTO Cowtown on the 4th, 5th and 6th of August to attend the 9th Annual Clinic and Fair of the Texas Electronics Association, at Fort Worth's Hotel Texas. This was a radio-controlled convention. A CB network was used, with the base station in the lobby and 12 pocket-size units carried by key men. Will Shaw, TEA secretary, says, "It saved me more than a hundred miles of walking!"

The program was divided into business and technical sessions, held in the newly rebuilt ballroom–convention area of the hotel. Many exhibits were set up by manufacturers and distributors. Planned that way or not, the overall theme of the clinic was "looking ahead". Almost every speech and program dealt with things to come in electronics, instead of things past. An RCA film, "Eyes on Tomorrow," was shown during the TV Service in 1970 program. "Microminiaturization," "Pay-TV" and "Your Future in Electronics Tomorrow" were typical titles. A mockup of the Courier satellite was on display by Philco.

Color was featured. A color TV clinic presented by RCA Service Co. and WBAP-TV engineers drew an attendance of over 500. Phil Wygant of WBAP-TV told of that station's plans for future color shows. They now carry all live studio programs in color as well as news, weather, kiddie shows, and some of the late movies. Zenith displayed its new color TV chassis for the first time and drew good crowds, even though it was not in operation. This uses a three-gun shadow-mask tube and Zenith's hand-wired chassis.

Richard Jandl of Tung-Sol gave some interesting statistics gathered by his company during a survey of percentages of TV repair work done by different categories: technicians and dealers, 25%; part-timers, 31%; do-it-yourselfers, 10%; industrial, 5%; captive service, 15%, and *mail-order houses, 12%!* From his figures, a revival of the service contract seems to be showing up. Ted Leitzel of Zenith said that his company would not go in for captive service of any kind in its pay-TV experiments and would even try to work out ways of servicing the decoders of Zenith's Phonevision units through independent technicians. Henry Paiste of Philco pledged maximum help for independent technicians from the manufacturer. He called attention to new developments in electronics: even without the entertainment business (TV–radio), electronic cooking and electronic cooling would provide many opportunities for the skilled technician. He closed with the quote, "Service is something that follows the first sale and precedes the *second*."

Irving Tjomsland of Triad, Bill Renner of Sams, Richard Hershey of Philco, Henry Nelson of G-E, Cecil Lightfoot of Texas Instruments, Chester Turnbaugh of Mallory, and Raymond Hopper of Sylvania, plus the speakers above, participated in a lively 3-hour panel discussion on Sunday morning, to close the clinic. END

Trouble chart speeds radio service

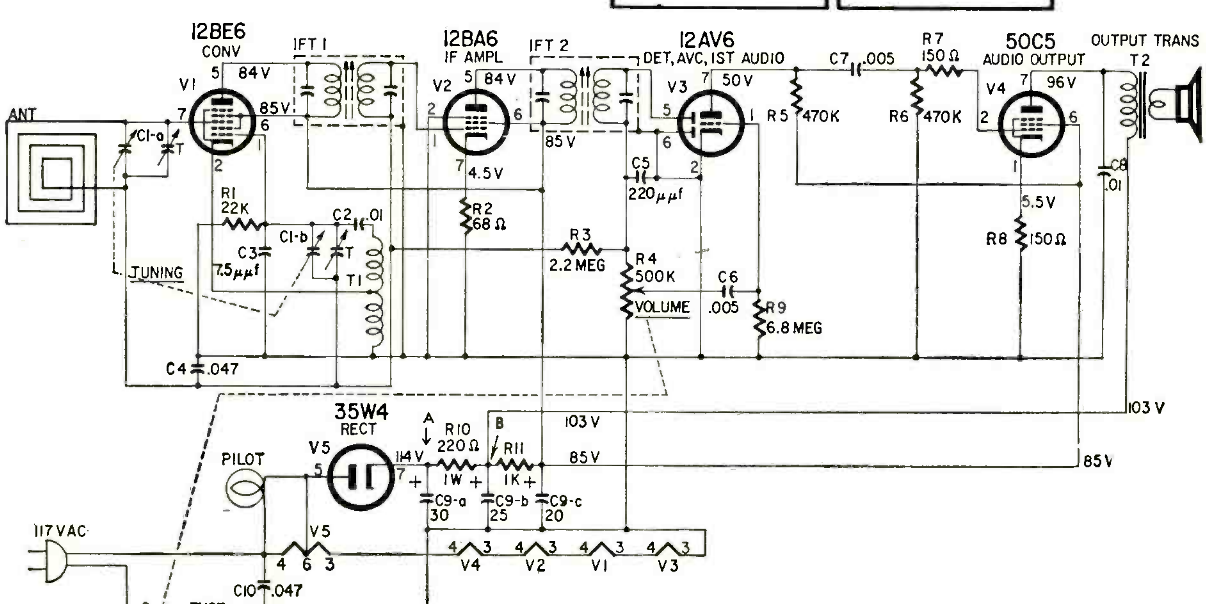
By HARRIS LESLIE

These tables attempt to reduce radio repairs to an exact system. Though no such method can be followed too literally, it can be useful in trouble-shooting. This month only tube type sets are covered. We will present similar charts for transistor receivers in a separate article.

RADIO DEAD—TUBES LIGHT

Check voltage on plate of V4.

- **VOLTAGE NORMAL** — Ground grid of V4, then V3. A "crack" should be heard in the speaker.
  - **SOUND HEARD** — Touch test antenna to grid of V2. Static or signals should be heard.
    - **SOUND HEARD** — Touch test antenna to V1 grid.
      - **SAME SOUND** — *Oscillator dead, antenna coils open or shorted; check all rf coils and trimmers.*
      - **NO SOUND** — *IFT 1 shorted; IFT 1 primary open.*
    - **NO SOUND** — Check plate voltage of V2.
      - **VOLTAGE NORMAL** — *IFT 1 secondary shorted; IFT 2 secondary open; short in IFT 2.*
      - **NO VOLTAGE** — *Primary of IFT 2 open.*
  - **NO SOUND** — Check screen voltage of V4.
    - **NO VOLTAGE** — *Open connection to B-plus.*
    - **VOLTAGE OK** — (or triode) (Check C5, R4.) Check screen voltage of V1 and V2.
      - **NO VOLTAGE ON ONE** — *Open connection in wiring or socket.*
      - **VOLTAGES OK** — Check plate voltage of V3.
        - **NO VOLTAGE** — *R5 open.*
        - **VOLTAGE OK** — Connect plate of V3 momentarily to chassis.
          - **NO SOUND** — *C7 open.*
          - **STRONG SOUND** — Connect grid of V3 to ground.
            - **NO SOUND** — Check for short in V3 grid circuit.
            - **"CRACK" HEARD** — *R4 or C6 open.*
- **NO VOLTAGE** — Check voltage at B.
  - **NORMAL** — *Primary of T2 open. C8 shorted.*
  - **NIL** — Check voltage at A.
    - **NO VOLTAGE** — *C9-a shorted.*
    - **VOLTAGE** — *If low, C9-b shorted, or short in B-plus circuit. If too high, R10 open.*



RADIO DEAD—TUBES DO NOT LIGHT

Check house voltage at wall receptacle.

- **VOLTAGE OK** — Check line cord at plug.
  - **LINE CORD OPEN** — Check tubes, fuse.
    - **FUSE OPEN** — *Replace, check for shorts. If C9-a shorted, V5 probably ruined.*
    - **FUSE OK (OR NIL)** — *Check line cord, switch and heater wiring.*
  - **LINE CORD OK** — *Plug not making contact*
- **NO VOLTAGE** — Replace line fuses. Check line cord.
  - **LINE CORD OK HOUSE FUSES BLOW** — *Chassis grounded, oversized or "gimmicked" fuse, intermittent line-cord short.*
  - **LINE CORD SHORTED** — *C10 shorted, short in cord.*

SET OPERATES ABNORMALLY

(Weak signals, distortion, noises, etc.)

Check oscillator with vtvm across R1.

- **OSCILLATOR WORKING**
  - **NOISES OVER WHOLE BAND EVEN WITH ANTENNA OFF** — Connect V3 grid to chassis.
    - **NOISES STOP** — Check resistance of all if transformers, filter resistors.
    - **DO NOT STOP** — *C7, C8 or R5 bad.* Check output transformer primary.
  - **WEAK, NOISY RECEPTION** — Touch test antenna to V1 grid.
    - **NO IMPROVEMENT** — *Shorted antenna, if troubles.*
    - **IMPROVEMENT** — *Check antenna connections. If OK, install new antenna.*
  - **FIXED WHISTLES** — *Misaligned if's, trimmers open or shorted.*
  - **TUNABLE WHISTLES** — *Misalignment in if or rf circuits.*
  - **WORKS POORLY** — *C4 shorted.*
  - **WEAK, "CHOKED" DISTORTED SOUNDS** — *C7 leaky.*
  - **NOISE OVER DIAL WEAK LOCAL SIGNALS** — *Variable capacitor scraping, arcing in coils.*
- **NO OSCILLATION** — Check R1
  - **R1 OK** — Check G2 and G4 voltage of V1.
    - **VOLTAGE NORMAL** — Check C2.
      - **C2 OPEN OR SHORTED** — *Replace.*
      - **C2 OK** — *Defective oscillator coils.*
    - **VOLTAGE NIL** — *Open connection.*
  - **R1 BAD** — *Replace.*

From swinging chokes to magnetic amplifiers

Magnetic-core components call for special test methods and techniques

By MATTHEW MANDL

Ferromagnetic materials are being used more and more in all phases of industrial electronics. The magnetic characteristics of the core material often are very important in these applications.

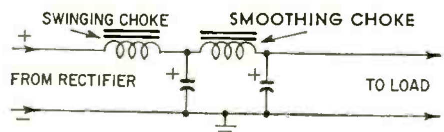
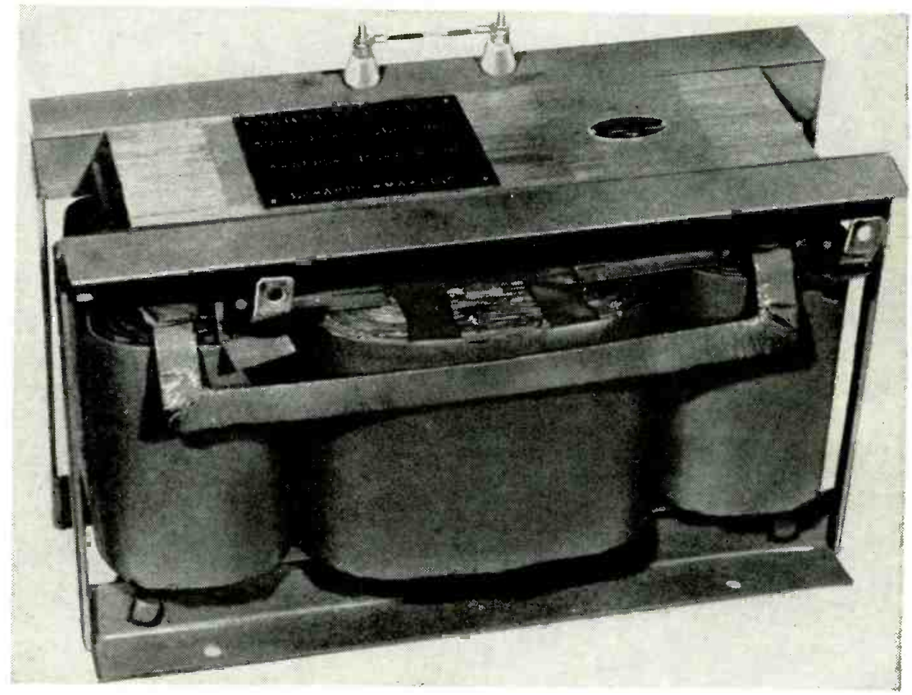


Fig. 1—Filter section of a regulated power supply incorporating two chokes.



Close-up look at a saturable reactor. Note the three separate sections. The large center section is the control winding.

This is particularly true of the swinging-choke reactors in power supplies, ferrite cores in the storage systems of computers, the ferrite-core antennas in antenna systems, and the saturable reactors used in magnetic amplifiers.

Fig. 1 shows the filter section of a regulated industrial power supply. It uses two reactors in a choke-input filter system. The first one is a swinging choke. Its inductance may vary from a low value of several henries to 15 or 20 henries depending on the current flow through it.

Such a choke improves power supply regulation by helping maintain a constant output voltage regardless of load variations. When more current is drawn from the power supply, it flows through the swinging choke and, as the choke core approaches saturation, its inductance decreases. This decreases inductive reactance in series with the power source and tends to cause a voltage increase, to compensate for the voltage decrease which occurs when more current is drawn from the power supply.

On the other hand, if the load circuit demands less current, the lower current flow through the swinging choke results in a drop below the saturation level and increased inductive reactance. This results in a lower output voltage and compensates for the voltage increase due to the decreased load.

The swinging choke is a saturable type reactor which has no air gap. Its core material saturates easily. The smoothing choke, on the other hand (also shown in Fig. 1), has this variable inductance characteristic only to a very slight degree. The inductive reactance of the smoothing choke remains substantially constant for various load variations. A smoothing choke usually has an air gap in the core material so it does not saturate readily.

About magnetic amplifiers

A magnetic amplifier is shown in Fig. 2. It is widely used in industry to control motors and servo devices, and to control high power with very-low-power dc control signals. The magnetic amplifier uses a saturable-core type of transformer having one center control winding and two outer-leg high-power windings.

The output of the amplifier shown in Fig. 2 is ac, permitting control of huge amounts of ac power with very low dc signals. The potentiometer setting controls the average dc input signal level. The output from the amplifier can be rectified if dc is required.

Magnetic amplifiers work on the saturation principle of magnetic core materials. When current increases through the control winding, the magnetic core begins to saturate and the inductance of the transformer (and its inductive reactance) decreases. The result is a greater transfer of power from the ac source to the load since series inductance is reduced. When the control signal drops to the low value, the transformer operates below the saturation point and its inductive reactance is high. Consequently, less power is transferred from the ac input line to the load.

An elementary circuit for measuring the core characteristics of a reactor is shown in Fig. 3. Here, a variable resistor adjusts current flow through the

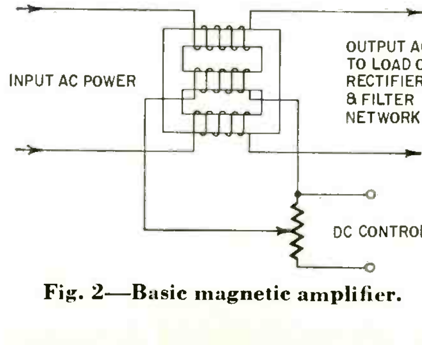


Fig. 2—Basic magnetic amplifier.

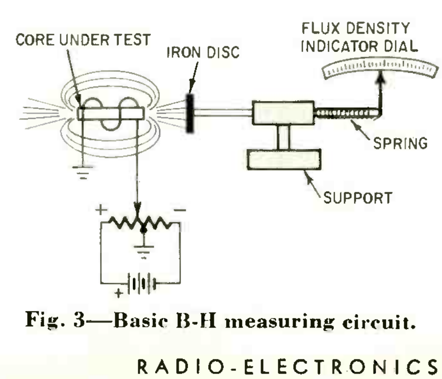


Fig. 3—Basic B-H measuring circuit.

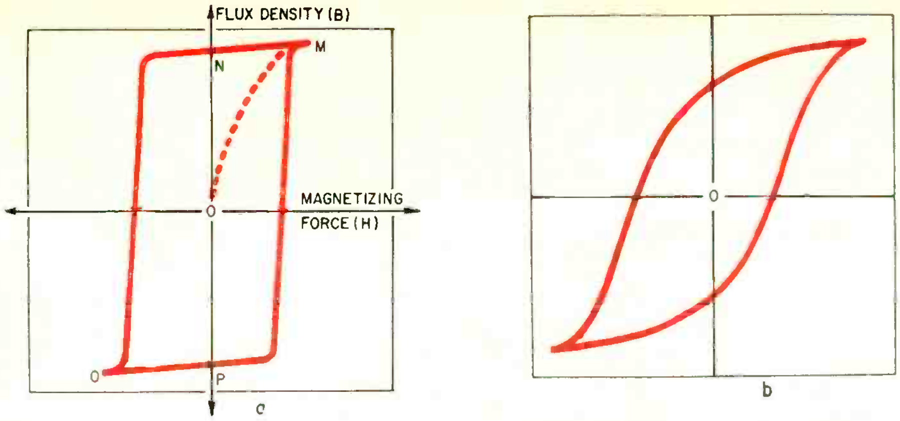


Fig. 4—B-H curves for (a) ferrite-core and (b) ordinary ferromagnetic materials.

coil, gradually increasing and decreasing current, first in a positive and then in a negative direction. An iron disc placed near the core senses the magnetic intensity built up by the lines of force as this disc is pulled toward the core. The flux density is shown on a dial. The result of the changes of current to the coil vs the degree of pull on the iron disc can be plotted to form a graph.

B-H plotting

Fig. 4 shows two typical graphs of core materials. Fig. 4-a is the type of graph produced by ferrite-core materials. Fig. 4-b is obtained for ordinary magnetic materials. As shown in Fig. 4-a, as current through the coil increases, the flux density rises from the zero center axis upward to the right. As the magnetizing force is increased by increased current through the coil, the core eventually saturates at M.

If the magnetizing force is now decreased (moving the potentiometer arm shown in Fig. 3 toward the ground point again), the flux density would not drop back to zero but would reach the point shown at N on the graph. This means that, even though the magnetizing force has been removed and equals zero, there is still some residual magnetism remaining in the core material. With the ferrite material, this residual magnetism is still at a high level while with the ordinary magnetic materials (Fig. 4-b), it would be at a lower level.

If the current is now reversed so a negative magnetizing force is applied, the flux density drops to zero (the horizontal reference line) for a given value of negative magnetizing force. If the magnetizing force is increased, the core saturates in the opposite direction as at O on the graph. If the magnetizing force is removed, the magnetism flux density level drops to point P on the graph, showing that the core is still retaining residual magnetism.

This lagging of the flux density behind the magnetizing force is known as hysteresis, and such a curve is sometimes known as a *hysteresis loop*. The graph is also known as a *B-H curve* because the symbol for flux density is B and for magnetizing force it is H.

The almost rectangular type of hysteresis loop is ideal for saturable-reactor applications in swinging chokes and magnetic amplifiers. It is also useful for switching devices in computers and other systems where it is necessary to change the magnetic density from one polarity level to its opposite. In design or circuit modification factors, it is important to know how rectangular the hysteresis loop is, because the Q of the circuit is related to the steepness. Shorting some of the saturable-reactor core windings will affect the amplitude of a hysteresis loop.

Also, in choosing a particular core material for magnetic amplifiers or saturable reactors, it is important to know the characteristics of the magnetizing force and flux density produced. For this reason, graph plotting instruments are handy devices for automatically laying out accurate hysteresis loops.

Typical tests

When a magnetic amplifier or other type of saturable reactor is not functioning properly, a hysteresis-loop graph can be used to check its characteristics against what it was originally. Also, ohmmeter checks of the windings can be compared with ohmic values given in the specifications for the unit. For the magnetic amplifier using rectifiers, forward and reverse resistance ratios should be checked with an ohmmeter and the rectifiers replaced if defective. Where several rectifiers are used, as in full-wave or bridge circuits, it is better to replace all that are below normal, even those still functioning, so a balanced output is maintained. If only one rectifier is replaced, it may upset circuit balance because the new rectifier will function better than the ones which have been in the unit.

Faulty operation of magnetic amplifiers is also caused by defective load circuits. Tachometers can test motors in the load circuit to check their speed relative to what it should be under normal operating conditions. Ohmmeters can be used to check the input resistance of other types of loads to see whether the impedance has dropped to a low value, causing excessive current drain from the magnetic amplifier circuits. END

STABILIZING THE FM-3A

I was very interested in your articles and notes on adding afc to the Heathkit FM-3 and FM-3A in the January and July, 1957, issues. I tried the circuit variations described, along with some of my own. The final solution to the problem of drift was to eliminate the afc circuit and stabilize the oscillator circuit by regulating its plate voltage and changing the temperature compensating capacitor. Before my modification I could simulate the drift problem by holding a 300-watt infrared heat lamp close to the tuning capacitor for a few seconds. The set would drift to another station. After making my modifications, it took more than 2 minutes for the set to drift off station.

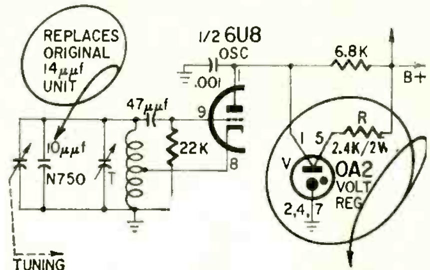


Fig.1

The oscillator plate voltage is regulated by an 0A2 connected as in Fig. 1. The 14-µµf temperature-compensating capacitor across the oscillator coil was replaced by a type N750 10-µµf unit (Centralab TCN-10 or equivalent). The position of this capacitor affects oscillator tracking to some extent. In my case, best results were obtained with the capacitor flat against the tuning gang's U mounting bracket.

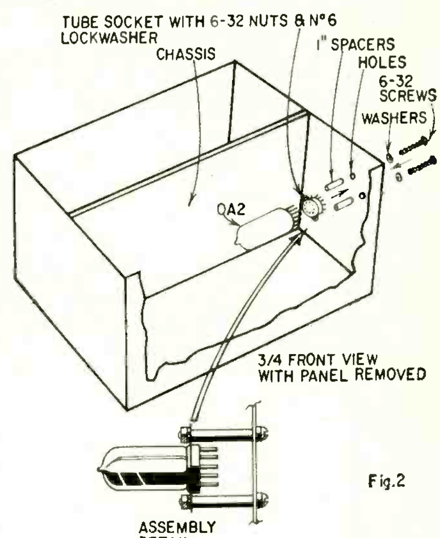
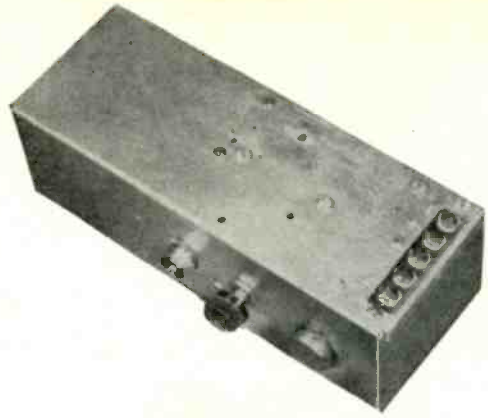


Fig.2

The voltage-regulator tube is mounted on the right wall of the case so it fits in the space between the rear of the volume control and the underside of the chassis. The tube socket is mounted on 1-inch spacers as in Fig. 2. —*Ralph Landers*

Combine this 6-transistor modulator with a preassembled rf section and you have a CB transmitter



Modulator puts CB transmitter in your car

By J. H. THOMAS

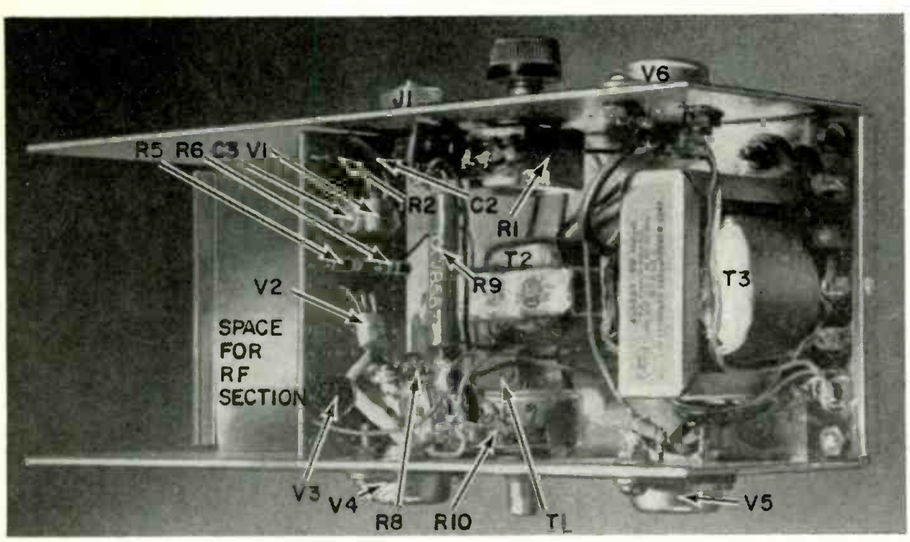
Since you already have a sensitive superhet receiver in your car which can be converted for the 27-mc Citizens band, it is wasteful to buy an entire second receiver to get on the air. But transmitters alone are not readily available.

To build a transmitter you'll need an rf section, modulator and speech amplifier. The rf unit can be purchased completely adjusted for the selected band for a reasonable price*. The modulator and speech amplifier are shown here. For mobile applications the advantages of a transistor unit are obvious. You don't waste power in tube heaters, there is no warmup time and a heavy-duty high-voltage power supply is not needed. The rf section uses about 20 ma. A tube modulator would triple that.

Fig. 1 shows the complete circuit of the modulator. Basically it is an audio amplifier driving a conventional power output transformer connected backward. The first two stages are resistance-coupled voltage amplifiers. Transistors V3 and V4 are a direct-coupled pair that drive the output transistors. They look unusual because of the feedback connection between V4's collector and V3's base. Since the amplifier stage is a current amplifier, the voltage at T2's primary, which has a relatively low impedance, varies little. Thus the voltage variation at V4's collector is much less than the input voltage at V3's base, and 180° out of phase with it, providing negative feedback. This gives the modulator a limiting feature. Once you set it for nearly 100% modulation with normal speaking voice in the microphone, you'll find that you'll have to shout very loud indeed to overmodulate. Increased input to V3 increases feedback from V4, and beyond a certain point not much more signal can be obtained.

This modulator has another advantage—it can be used with a 6-volt supply. At 6 volts the amplifier provides just enough power (2.5 watts) to give 100% modulation on a 5-watt transmitter. It is definitely not hi-fi. Citizens-band channels are only 10 kc apart, so you should not modulate over 5,000 cycles. The human voice cannot reach 5,000 cycles normally. Amplifier bandwidth is limited by the coupling components and by C5 to about 100–3,000 cycles, more than enough for voice. C5's

*International Crystal Manufacturing Co., 18 N. Lee St., Oklahoma City, Okla., model D-11, $14.50.



Parts layout inside the modulator case.

R1—pot, 25,000 ohms
R2, R5—10,000 ohms, ½ watt
R3—56,000 ohms, ¼ watt
R4—22,000 ohms, ¼ watt
R6—47,000 ohms, ¼ watt
R7—270 ohms, ½ watt
R8—12 ohms, ½ watt
R9—5 ohms, 5 watts, wirewound
R10—pot, 500 ohms, 2 watts
All resistors 10%
C1—.01 μf, 50 volts, ceramic
C2—0.1 μf, 50 volts, ceramic
C3, C4—6 μf, 12 volts, tantalum
C5—see text, 50 volts, ceramic
C6—.02 μf, 100 volts, paper
J—mike connector
T1—interstage transformer: primary, 10,000 ohms; secondary, 2,000 ohms, ct (Stancor TA-35 or equivalent)
T2—driver transformer: primary, 20 ohms; secondary, 36 ohms, ct (Stancor TA-16 or equivalent)
T3—output transformer: primary, 10,000 ohms, ct; secondary tapped at 2, 4 and 8 ohms (Stancor A-3831 ot equivalent)
V1, V2—2N1265 (Sylvania, now branded 2N1265/5)
V3—2N525 (G-E)
V4, V5, V6—2N554 (Motorola) (with insulating mounting washers)
Case to suit
Miscellaneous hardware

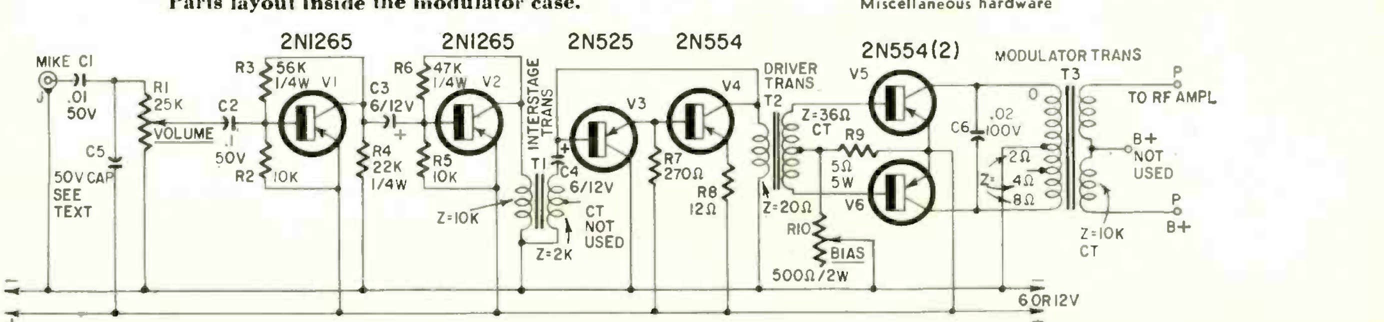


Fig. 1—Circuit of the modulator.

value is determined by the mike you use.

Construction is simple, as you can see by the photos. The preamp stages (voltage amplifier) are mounted on a perforated circuit board, supported by connecting wires. Nothing about the construction or parts placement is critical. Heat sinks are provided for the output-type transistors by mounting them on the chassis with mica or anodized aluminum wafers between them and the chassis. Note in Fig. 1 that the 0-, 2- and 8-ohm taps of the modulation transformer are used (not the 4-ohm) to get a balanced output.

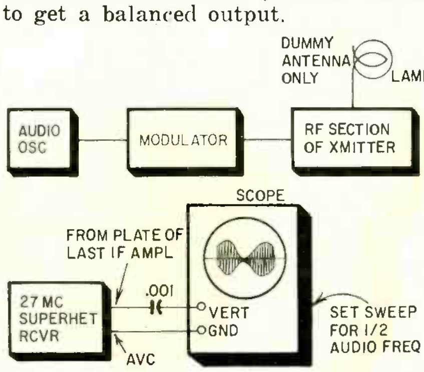


Fig. 2—Test setup for checking modulation pattern of completed transmitter.

Adjusting the modulator is simple. Connect its output to the modulated B-plus input of the transmitter and complete all your switching circuits. Then set BIAS control R10 for maximum output, and VOLUME control R1 for 100% modulation. Fig. 2 shows how this is done. Connect the transmitter to a dummy antenna and turn it on. Pick up the signal on a near-by receiver. Hook a scope between the avc and the plate of the last if tube (use a coupling capacitor for safety) and the scope reproduces the modulated pattern of the transmitter signal if its sweep is synced with the audio signal. With half the audio frequency for sweep, a double lobe appears. Do not let the dip between the crests become a thin line with maximum signal; when this happens, you are overmodulating.

Transistors equivalent to those listed can be used, but be certain they are equivalent, or you won't get enough power with a 6-volt supply. For 12 volts, readjust the bias setting and reduce volume. No other changes are necessary. END

Most Everybody Has TV

A survey by Frank Mansfield of EIA indicates that 88% of American homes now have at least one TV set. (There are 1.15 TV sets per TV home.) "This means in simple English," says Mansfield, "that the future market will be largely replacements and additional sets for homes that already have one." Replacement sets last year accounted for 3,500,000 sets out of a total of 6,000,000, Mansfield says, and 1,450,000 went to multi-set homes. Replacements in 1961 will be notably higher than in any previous year, he believes.

DX SHORT-WAVE FORECAST

Oct. 15–Nov. 15 **By STANLEY LEINWOLL†**

MOST OF THE WORLD'S BROADCASTERS WILL MAKE MAJOR SCHEDULE CHANGES FOR the winter season on Nov. 5, in accordance with the 1959 Geneva Radio Regulations. The notable exception will be the Soviet Union.

Although the USSR participated in the Geneva Convention and supported the regulations covering notification and implementation dates of broadcast schedules, it has studiously ignored these procedures in actual practice, and continues to make changes as it did before the Geneva Regulations went into effect in the fall of 1960.

It is therefore expected that the Russians, one of the world's biggest users of the broadcast spectrum, will make their winter change late in October.

The tables show the optimum broadcast band, in megacycles, for propagation of programs between the locations shown during the time periods indicated.

To use the tables, the listener selects the one most suitable for his location, reads down the left side to the region he wishes to hear, then follows the line to the right until he is under the appropriate time. (Time is given at the top of each table in 2-hour intervals from midnight to 10 pm, *in your local standard time.)* The figure thus obtained is the short-wave band (in megacycles) nearest to the optimum working frequency.

For example, a listener in Los Angeles would use the Western USA table. He would be most likely to hear broadcasts from Latin America in the 15-mc band at 2 p.m. and the 11-mc band at 10 p.m., Pacific Standard Time.

The tables are designed to serve primarily as a general guide, since day-to-day variations in receiving conditions can be large.

EASTERN US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	7	6	6	11	17	17	17	21	17	11	9	7
East Europe	7*	7*	6*	11	15	15	17	15	9	7	7*	7*
Northern Latin America	11	9	9	15	15	15	15	15	15	15	15	11
Southern Latin America	15	11	11	11	15	17	17	17	17	15	15	15
Near East	7*	7*	6*	11	15	17	17	17	15	11	9	7
North Africa	7	7	7	11	17	17	17	17	15	11	9	9
South & Central Africa	9	9	7*	15	21	21	21	17	15	11	11	9
Far East	7	7	7*	7*	11	9*	9*	9*	11*	15	15	11
Australia & New Zealand	11	11	9	9	9	9*	9*	17	15	15	15	11

CENTRAL US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	7*	7*	7	11	17	17	17	17	11	7*	7*	7*
East Europe	7	7*	7*	11	17	17	15	11*	9*	7*	7*	7
Northern Latin America	11	9	9	15	15	15	15	15	15	15	11	11
Southern Latin America	11	9	9	15	15	17	17	15	15	15	15	11
Near East	7*	7*	6*	11	17	17	15	11	9*	9*	9	9
North Africa	9	7*	7*	15	17	21	17	15	11	9	9	9
South & Central Africa	9	7*	7*	15	21	21	21	17	17	15	11	9
Far East	9	7	6*	6*	9	9*	9*	17	21	21	17	11
Australia & New Zealand	11	11	11	9	7	7*	17	15	17	17	15	11

WESTERN US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	7	7*	7*	11	15	17	17	11	9*	7*	7*	7
East Europe	7	7*	7*	9	15	11	11	9*	7*	7*	9	9
Northern Latin America	9	9	9	15	15	15	15	15	15	15	11	11
Southern Latin America	11	9	9	15	17	17	17	15	15	15	11	11
North Africa	7	7*	6*	11	15	17	17	11	9	9	7	9
South & Central Africa	9	7*	7*	15*	17	21	15	15	11	9	7	9
Far East	9	7	7	6	11	9	11	17	21	21	17	11
South Asia	7	7	7*	7	11	15	15	11*	17	17	15	11
Australia & New Zealand	15	11	9	7	9	11	15	17	21	21	17	15

†Radio Frequency and Propagation Manager, RADIO FREE EUROPE

*Reception may be very poor or impossible on this path at this hour.

RELAYS AND ELECTRONICS

The electronic circuit multiplies the versatility and usefulness of relays. Fifth article of a series.

By TOM JASKI

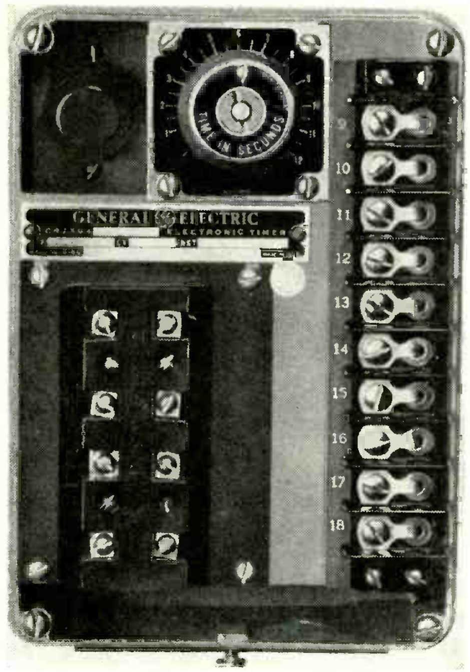
ELECTRONICS HAS USED RELAYS IN A variety of ways. Sometimes the application makes special demands of a relay used as a part of an electronic circuit. It may have to be of a specific size, sensitivity, shape or quality, and may need special contacts. Reliability must always be considered, and special housings to meet environmental conditions may sometimes be needed.

On the other hand, electronics can help relays extend their versatility. They can acquire some very desirable characteristics—timing, polarity and especially sensitivity. With the help of electronics, dc relays can be used in ac circuitry, and contact current-carrying capacity can be preserved while increasing sensitivity beyond what would otherwise be available for that capacity.

How do we select the proper relay and circuit values? Fig. 1 is a familiar triode-operated relay circuit. Component values must be selected to keep the idling current of the tube too low to pull in the relay armature, yet the signal voltage must be able to increase the plate current enough to actuate the relay. The desired relay resistance can be determined with plate voltage–current curves. The optimum relay coil resistance for dc operation is one that provides just slightly more than the difference between pull-in and drop-out current with the particular tube.

Generally the tube is operated close to the cutoff value of grid voltage. With an ac signal on the grid, the tube then functions as a rectifier. It conducts significantly more on the positive swing of the signal, but on the negative swing plate current cannot decrease very much. The current figured for relay operation is the average increase in plate current.

Capacitor C reduces the impedance (not the resistance) of the relay coil at the signal frequency. When C is properly selected, it maintains current through the relay when the plate current is low. But the capacitance of C must be carefully considered. If too large, the relay acts slowly. If too small, the tube is less efficient as a rectifier (with all other circuit parameters the same the average relay current will be less). So C must be a compromise between these two extremes.



G-E time delay using circuit of Fig. 6.

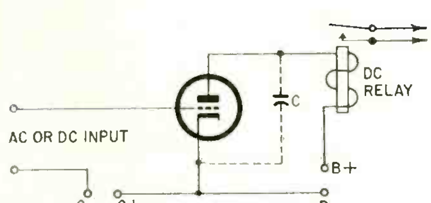


Fig. 1—Basic triode circuit for relay control.

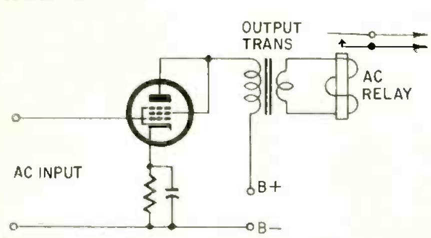


Fig. 2—Basic ac-controlled relay. Transformer keeps dc from activating the relay.

Relays in tube circuits

Ac relays can be used with electron tubes as shown in Fig. 2. In this circuit the tube is most likely a power output type since ac relays are generally not as sensitive as the dc types. The transformer in Fig. 2 is a regular output unit. The circuit works best when the transformer-secondary and the relay-coil impedances are matched. The transformer is necessary because with a power tube the heavy plate dc might pull in the relay. With the transformer, only the ac output signal can affect it.

Impedance matching need not consider harmonics and distortion. From experience we learn that, with a triode power tube and 60-cycle operation, precise impedance matching gives optimum results. For pentodes, the setup works best when the relay impedance is two to three times the load impedance suggested in tube manuals (at 60 cycles). At voice frequencies, exact matching is better.

The impedance of a relay is much larger when its armature is attracted and the magnetic path closed. When making computations involving relay impedance, use the normal (on-the-shelf) condition, for it is at this point that maximum energy transfer is needed. Actual impedance in terms of the tube circuit is then the relay impedance used, multiplied by the transformer ratio.

Another kind of ac operation is shown in Fig. 3. Here the transformer is used with rectifiers and dc relays. These circuits again isolate the plate current of the tube from the relay, and only ac from the amplified signal can operate it. Another advantage of the systems in Fig. 3 is that a straightforward ac amplifier can be used with dc relays. There are times when this is very useful. (For example, to control operating and release time, we must work with dc relays.) Also, circuit values need not be as precise, and that ac amplifier is much more stable than the dc amplifier.

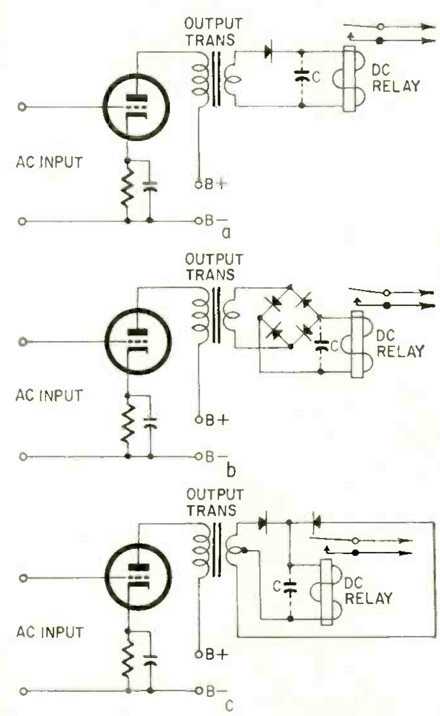


Fig. 3—Ac control for dc relays. Only an ac input will operate the relay.

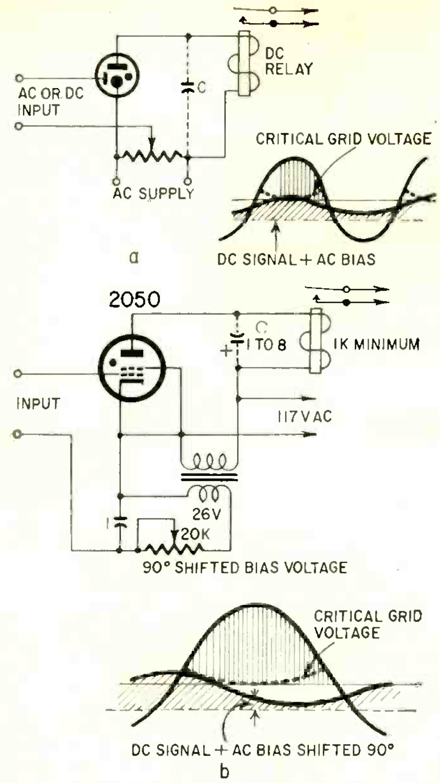


Fig. 4—Gas-filled tubes for relay control. a—Tube fires when bias signal exceeds the critical grid voltage. Tube fires for portion of half cycle only. b—Similar circuit for thyratron, but with 90° phase shift of bias. This allows the tube to conduct over a major portion of the half cycle.

Impedance calculations used for the circuits in Fig. 3 must consider the resistance of the rectifiers (vectorially). For the half-wave rectifier (Fig. 3-a), this is the sum of the necessary rectifier discs at the current density used. For the full-wave bridge rectifier (Fig. 3-b), this resistance is the resistance per disc times the number of discs in two legs. For the full-wave center-tapped rectifier (Fig. 3-c), it is the resistance per disc times the number of discs in one stack. Again the transformer ratio enters into the calculation, but in all cases the ratio of the primary to half the secondary turns is used.

Gas-tube relay circuits

In the next circuit, the relay is controlled by a gas-filled tube (Fig. 4). Rarely is such a circuit supplied with dc, particularly in industry. More often ac supply and control voltages are used and phase shifts between the supply and the control voltages control the portion of the cycle during which current flows, and thus the amount of current through the relay. The wave shape of the current through the relay coil is therefore difficult to predict, and calculations can be approximate only. When using gas tubes, watch the values furnished in tube manuals. While the manual often gives average dc values, calculations are usually made with rms values. The manual figures must then be converted. Average direct current would be the sum of the maximum and minimum current divided by 2. Rms value of an alternating current is the peak value divided by the square root of 2, or the peak value divided by 1.415. (That is, for a sine wave. For any other waveshape, we cannot use this value except for a rough approximation.)

Capacitor C in Fig. 4 is again a compromise between efficiency and speed of operation. If C has a capacitive reactance 10% of the relay impedance (a desirable value when fast operation is not needed), maximum current for the circuit should not exceed 75% of the maximum continuous rating of the tube, or the tube will be overloaded by the ac component in the capacitor.

Generally, relay circuit calculations start with the tentative selection of a control tube. This choice sets the maximum operating current. From the resistances in the circuit (include the tube resistance) compute the supply voltage. Conversely, relay resistance can be worked out from the supply voltage available. If the manufacturer specifies the relays in terms of ampere-turns for a given set of contact springs, the calculation starts from this point. A safety factor of 20% is recommended. The required ampere turns then, together with the tentative plate current, deliver the number of turns for the relay. Then the relay coil can be selected, and, since its resistance is known, the supply voltage needed is also known.

Relays and transistors

Transistor operation of relays is not yet widespread in industry. Transistor operations are most useful with low-voltages, and in industrial control circuits today high voltages are usually available. (An exception is the transistorized type of control system described in the July 1960 issue of RADIO-ELECTRONICS, the so-called *nor* system. But note that here the relay has been eliminated for all but the last step.) Transistor relay combinations more generally fall into another category, controlling relay characteristics with electronic circuitry. This is a big subject, and here we can only hit the high spots.

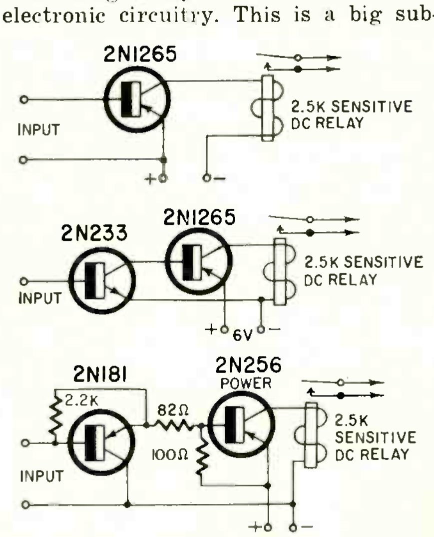


Fig. 5—Sensitive dc relays in transistor circuit have possible current gain of several hundred. Eliminates need for intermediate sensitive relays to control heavy loads.

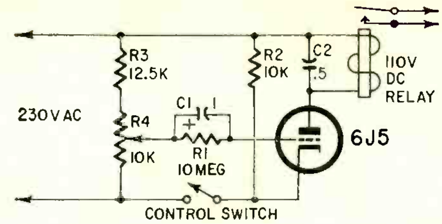


Fig. 6—Popular industrial timing circuit uses grid rectification to charge timing capacitor.

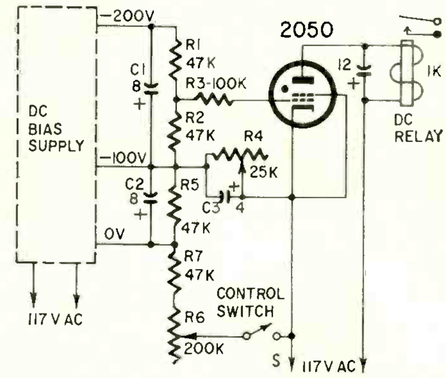


Fig. 7—In this circuit both opening and closing of the switch is followed by a preset time delay before the relay operates.

The most direct facet of this application is the increase in relay sensitivity. Fig. 5 shows several transistor circuits which greatly increase relay sensitivity. Many more elaborate amplifiers for relay control can be built, but it then becomes a moot question whether the electronics is there for the relay, or the relay simply the last step in an electronic equipment. Again the next step in transistor control of relays can be the use of ac instead of dc amplifiers. Here too there is the choice of using ac relays or dc relays with rectifiers. The principle is similar to the equivalent vacuum-tube type circuits.

The greater the transconductance (for vacuum tubes) or beta (for transistors), the greater the increase in sensitivity, assuming proper matching. But, remember, great sensitivity carries the penalty of instability. The more sensitive the relay–amplifier combination, the more difficult it is to adjust in any kind of threshold operation (as opposed to on–off operation). Threshold operation takes place when the "off" is not completely off, and when the "on" is just barely on.

Controlled time delays

An industrial circuit worth examining is the one in Fig. 6. Here the timing characteristic of the relay is controlled, and quite a considerable time delay can be introduced. The grid-bias capacitor in this circuit is charged through grid rectification, the grid serving as the anode. Understandably this current is minute. The grid keeps the capacitor charged in the standby condition.

When the switch is closed, the tube cathode is connected to the line and the grid voltage is now the negative voltage stored in capacitor C1 and the in-phase voltage obtained from R4. The time constant of the circuit is determined by C1 and R1, and the speed with which C1 discharges through R1 is fixed. The time delay of the circuit is then controlled by the setting of R4. As the slider on R4 is moved closer to the line connection (away from R3), the time is increased in two ways: the voltage built up on C1 is increased, and the in-phase voltage which opposes it is decreased. Because of this opposition of voltages, the circuit is self-compensating to a certain extent for line-voltage fluctuations. Note that the circuit uses the line voltage directly as its B-supply. This type of timing circuit, using grid rectification to charge a timing capacitor, is relatively common in industry.

Fig. 7 is a circuit that allows two delays, one on operation and the other on release of the relay. When switch S is closed, the relay closes after a delay, depending on the setting of R6. When the switch is opened, the relay de-energizes after a delay, the delay being controlled by R4. R4 and R6 are set independently, and relay operating characteristics can be controlled accurately this way. The circuit action depends on charging and discharging bias capacitor C3, which controls the firing time of the tube. Note that the thyratron has an ac supply, but is operated with a dc signal.

Simple diode circuits can affect relay performance. By adding a diode in parallel with the coil, the relay releases slowly (Fig. 8-a). When the control circuit is opened, the diode allows a current which results from the stored magnetic energy in the coil to flow, and thus maintains the magnetism in the coil for a time. The entire coil acts as a slug. Shown in Fig. 8-b is the simplest method of making a relay polarity-sensitive: simply add a diode in series with the relay coil. A series diode also suppresses sparks in the control circuit, since it allows no reverse current in the control circuit. The reverse current resulting from the magnetically stored energy is what causes the sparks while the control contacts are opening during normal operation.

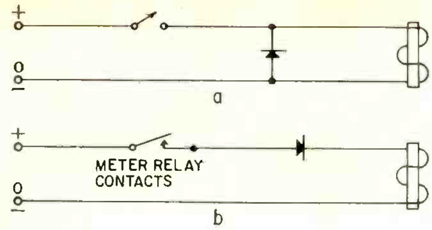
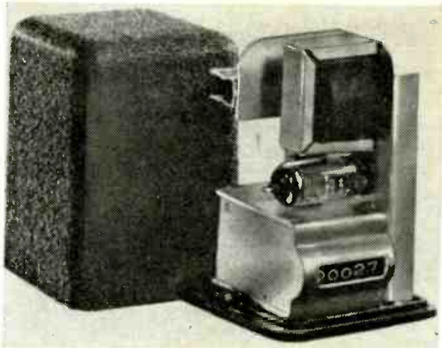


Fig. 8—Diodes in relay circuits. a—Diode in parallel with the relay coil makes the relay a slow-release device. b—A series diode reduces arcing in the control circuit.

Many other applications involve both relays and electronic circuits. One class includes the photoelectric relays. In these the relay is simply an on-off device while the photocell is the crucial item, so we will not discuss them here. Many different forms of timing circuits (besides those shown) are possible but not common in industry. Electronics is being applied to protective relays in the power-generating industry. About these we hope to say something in another article.

Many engineers, particularly those inclined toward electronics, are convinced that the transistor is seriously threatening the existence and use of relays. This may happen some day, but certainly not today or tomorrow. While transistors and magnetic amplifiers are beginning to make inroads in industrial controls, many hundreds of millions of relays are in service and will be for many decades. Think, for example, of our huge telephone systems. A few transistorized panels have been installed, but 99% of the switching is still being handled by relays. It is extremely difficult to find a more economical electronic switching method than the relay provides, with the same kind of reliability and versatility.

Many industrial services present rough conditions to switching devices. Environment, supply voltage fluctuations, temperature variations, heavy duty cycles, and so on demand ruggedness, flexibility and adaptability. While transistors could probably do many of the jobs relays are now doing, when relays are replaced, they will still be replaced by relays. If one considers that in an average peacetime year, less than 3% of our machinery and machine tools is replaced, and that only a small fraction of this equipment is now being built with transistor controls, it is easy to see that transistors are not about to take over the jobs of relays. One might in fact say, that they are more likely, through automatic controls, to take over the job of the machinist! END


A typical industrial type electronic counter. Rugged construction and protective housing increase reliability.

Add TV Sound to FM Tuner

You can extend the range of many FM tuners to include the audio portion of the TV band by inductively coupling a grid-dip oscillator to the mixer tube in the tuner. Since no direct connections are made to your hi-fi system, this is one of the easiest methods of obtaining hi-fi TV audio.

Here's why it works. The rf input circuits of many FM tuners are very broad, and signals from strong TV stations appear at the mixer grid, regardless of tuning. The signal from the GDO is inductively coupled to the mixer and is tuned to produce a 10.7-mc beat with the incoming TV sound carrier. To receive a given TV sound channel on the FM tuner, the GDO must be tuned to the sound carrier frequency *plus* or *minus* 10.7 mc.

To couple the grid-dip oscillator (GDO) to the FM tuner, simply wrap a few turns of one end of a short length of hookup wire around the GDO tank coil, and wrap a few turns of the other end of the wire around the glass envelope of the mixer tube in the tuner. This will couple the local oscillator signal from the GDO to beat with the incoming FM signal. After coupling the two units, neither the GDO nor the coupling wire should be moved since their positioning affects the local-oscillator frequency.

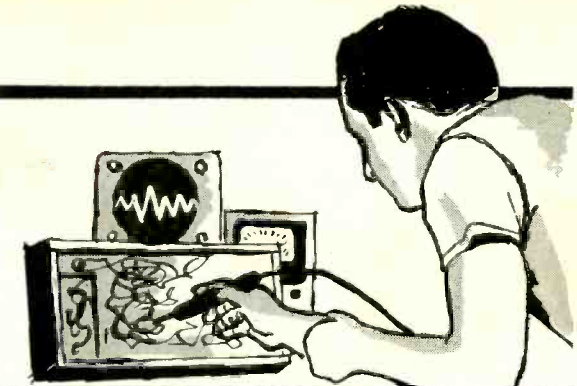
To receive the audio portion of the TV channel, set the FM tuner station selector to an unused portion of the FM band, preferably around 96 mc. If you hear any strong oscillations or spurious responses, tune the FM tuner up or down slightly until the unwanted oscillations disappear. Weak spurious signals will be blanked by the coupled TV audio once the GDO is tuned.

After setting up the FM tuner, turn on your TV set and set the volume control to its minimum position. Then, slowly tune the GDO until you hear in your hi-fi system the audio corresponding to the picture on your TV set. You may hear the various TV sound channels on more than one setting of the GDO. In this case, you can determine by trial and error which combination of coils and dial settings provides the best TV sound.

Once you have obtained the proper degree of coupling between the grid dip oscillator and FM tuner, you can use the GDO as a TV "tuner" to cover the entire TV band. If you don't use your GDO too often on other jobs, you can mount it in a suitable cabinet and add it to your hi-fi system.

A calibration card showing GDO settings for each TV channel can be made up and mounted in some convenient place near your hi-fi operating controls. Although you can set your FM tuner to almost any portion of the FM band, once you have established the best setting, mark the dial position directly on the tuner dial or note it on the calibration chart.—*Louis Maggi*

SERVICE CLINIC



conducted by

JACK DARR, SERVICE EDITOR

This is your column in the magazine: the service is absolutely free; there is no charge for answering your questions, and your name and address will be kept confidential if you so wish. The main purpose is to help everyone working in electronics with their unusual problems. Send in your questions; each one gets an immediate personal answer. Later, the more interesting cases are published in the Clinic columns.

Due to the many peculiarities found in commercial TV circuits, you might find a different answer to a question than the one we give, even though the "conductor" of this column is himself a full-time professional TV technician. We would be interested to hear of such cases, as we feel that the more widespread the knowledge of such peculiarities, the better off we'll all be! So, if you have an unusual service job, or one which is giving you trouble from an obscure cause, send in a question on it; we'll answer it promptly and to the best of our ability.

NOW WE'RE ALL SET TO TALK A LITTLE more about problems in the width circuits, let's cover a few of the more obscure ones. One of these is blooming.

If the high-voltage rectifier is weak, we'll get blooming when the brightness control is turned up. This happens because the high voltage drops with the higher beam current in the CRT and the tube is easier to sweep, so the beam covers a wider angle. If you forget to check for blooming, you may hunt in the horizontal output circuit for some obscure defect when the trouble is only a bad high-voltage rectifier.

The reverse of this condition, picture shrinking when the brightness control is turned up, is usually caused by a weak horizontal oscillator and sometimes by a weak horizontal output tube.

Damper tubes and circuits

Most damper-tube defects turn out to be heater–cathode breakdowns which blow the high-voltage fuse, and that's all there is to it. Many technicians, with some justification, I'll admit, replace the damper tube automatically whenever they find a high-voltage fuse blown because it is by far the major cause of high-voltage fuse blowouts.

While we're on the subject, it is usually a good idea to replace 6W4's with the later 6AX4 or 6AU4. They have a much higher heater–cathode rating and give less arc-over trouble. The 6AU4 can even be used to replace the 6BL4 damper in RCA color sets.

If you find just a small loss of width, and everything else is OK, try adding a small capacitor across the damper tube from plate to cathode (Fig. 1). Use a 50–100-μμf unit rated at at least 5 kv. Some of the 110° sets already use this capacitor as part of the circuitry. Values from 200 to 330 μμf are found. If they open, you lose a lot of width.

There is one more rather unusual circuit that we might use to increase width. It is a resonating capacitor across the primary winding of the flyback from the plate tap to the next lower (B-plus) tap (Fig. 2). This is a cut-and-try procedure, and the capacitance will be quite small—from about 10 μμf up to a maximum of about 100 μμf. The idea is to make this section of the flyback resonant at the operating frequency, which, of course, it should be anyhow. However, stray capacitances and other circuit constants may have changed enough to throw it off actual resonance. When you add a little capacitance, it moves back toward resonance, increasing its efficiency.

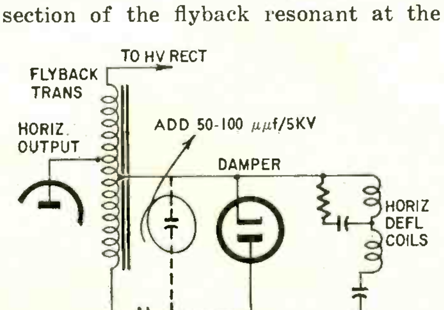


Fig. 1—Add a small capacitance across damper to increase width.

One final note. If you have a set using 6BQ6's and the width is just a wee bit short, try replacing the 6BQ6 with a 6DQ6. This is an improved version of the 6BQ6 and will withstand more plate current than the 6BQ6. This brings up one other important point. After making *any* alterations or modifications in the horizontal output circuit, be sure to check the plate current of the horizontal output tube before you take the set back. If it is drawing more than its rated current, you can be assured of a callback and a free tube replacement sometime within the next couple of weeks.

Vertical troubles

I have two Raytheon 14AX21 TV sets with the same complaint! Poor vertical hold, intermittent horizontal flashes with a loss in height at top and bottom, and crackling sounds after they've been on for a couple of hours. I've replaced one vertical oscillator transformer and many capacitors. All tubes have been changed.—C. M., Oak Park, Ill.

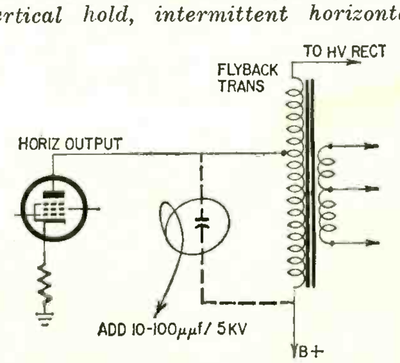


Fig. 2—In some cases, adding a tiny capacitor across the primary winding of the flyback will increase width.

Like all other TV troubles, this one has a multiplicity of causes, but I think I'll stick my neck out and say that the trouble here lies in the vertical section of the yoke. This sounds like a thermal breakdown in the yoke windings and is not uncommon in this series. It would have to be either in the yoke, or a similar thermal breakdown in the vertical output transformer. You can check this last one easier than removing the yoke. Just connect any vertical output transformer in there, paying no attention to linearity, etc., and run the set for a couple of hours. If the trouble comes back, check the yoke.

One further hint, from memory. If it is in the yoke, try taking it off the tube, drying it out well, and spraying it thoroughly with Krylon or high-voltage dope and letting it dry overnight at least. High humidity could have caused moisture leakage or electrolysis between windings.

Amplifiers from old TV's

I have three old 10- and 12-inch TV sets: Admiral, Crosley, etc. Do you think I could find enough parts in these old chassis to build a hi-fi amplifier of about 12 to 25 watts output? It seems to me you have published schematics in the magazine on construction of amplifiers, some time ago.—O. C. A., Eddystone, Pa.

This is rather an "iffy" question. It

(*Continued on page* 64)

BIG PLUS! in your 1962 ALLIED CATALOG

includes complete catalog featuring over 90 exciting

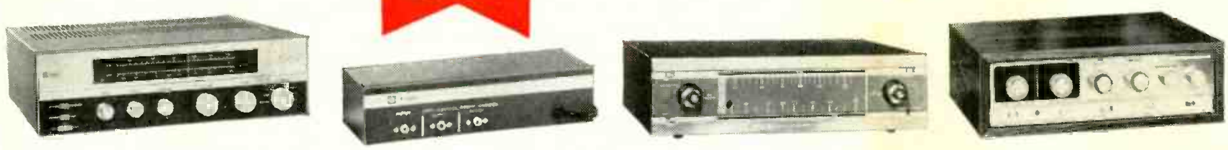
knight-kits

A PRODUCT OF ALLIED RADIO

NEW for '62 and simply great!

available only from ALLIED

new HI-FI KITS



All-In-One FM-AM Tuner-Amplifier Kit with latest built-in **MULTIPLEX** Stereo FM, less case.....$129.95

MULTIPLEX Self-Powered Adapter Kit, for Stereo FM reception...........$19.95

Deluxe Stereo FM-AM Tuner Kit with latest built-in **MULTIPLEX** Stereo FM.............$99.95

ALL-TRANSISTOR 50-Watt Stereo Amplifier Kit, less case..............$79.95

new HOBBYIST KITS

ALL-TRANSISTOR Wireless Intercom System Kit (2 units).........$45.90

TRANSISTORIZED Electronic Tach-ometer Kit.$24.95

Amazing 100-In-1 Electronic Science Lab Kit......$29.95

ALL-TRANSISTOR 2-Band AM-Shortwave DX-er Radio Receiver Kit..........$19.95

new

Phone and CW 60-Watt Ham Transmitter Kit........$49.95

Mutual Conductance Tube Tester Kit.................$99.50

building a Knight-Kit is the most satisfying do-it-yourself experience in the world!

5 BIG REASONS WHY:

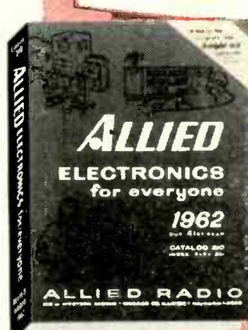
- **Convenience Designed**—makes you a kit-building expert—even the very first time!
- **Wonderful to Build**—you'll marvel at the sheer ease of assembly with the exclusive "show-how" manual guiding you like a good instructor.
- **You Own the Best**—you'll enjoy with pride a true custom-built product, professional in its engineering and performance.
- **You Save So Much**—because you buy direct from Allied at our money-saving volume prices—and because you do the easy assembly yourself.
- **Easiest to Buy**—NO MONEY DOWN on Allied's new Credit Fund Plan—easiest terms ever!

MONEY BACK GUARANTEE: Buy any Knight-Kit. Build it! Use it! You must be satisfied or you get your money back!

see more than 90 KNIGHT-KITS

21 HIGH-FIDELITY KITS
25 HOBBYIST KITS
31 INSTRUMENT KITS
14 AMATEUR & CITIZENS BAND KITS

KNIGHT-KITS are also available in Canada



- World's Largest Stocks • Lowest Money-Saving Prices
- Fastest Shipment • Expert Help • Easiest-Pay Terms
- Satisfaction Guaranteed or Your Money Back

send for the world's biggest electronics catalog!

Free

Send for it today!

ALLIED RADIO, Dept. 200-L1
100 N. Western Ave., Chicago 80, Ill.

☐ Send FREE 1962 ALLIED 444-page Catalog

Name ______________________
PLEASE PRINT

Address ______________________

City ______________ Zone ______ State ______

ALLIED RADIO — World's Largest Electronic Supply House

(*Continued from page* 59)
depends entirely on the type of amplifier you want to build. However, I can say this: if you want to take the time to disassemble some of these old TV's very carefully, you *can* save yourself quite a bit of money in the construction of a good amplifier.

Almost all of these old sets had a husky power transformer; these, if in good condition, should be usable. Rectifier tubes, filter capacitors, chokes, tube sockets and small parts such as resistors and capacitors and controls should be very useful. The only major parts you'll have to buy will be the tubes, output transformer and speakers. The original speakers will undoubtedly be too small (and also too old) for this purpose.

As to the schematics, there have been several articles in past issues which should be very helpful: Robert Voss' article "Designing a Low-Distortion 12-Watt Amplifier," page 33, August 1958; "Two-Way Stereo Amplifier Uses Only 3 Tubes," June 1959, page 52, and so on.

By careful scrounging and testing of parts, you should be able to save quite a bit of money on a project like this. Be sure that parts such as electrolytic capacitors are in good condition. If they are the originals, they may have deteriorated badly, since these are all old sets.

Remote-control problem

Not too long ago I got an old Hoffman 12-inch TV with the if strips on a separate subchassis. I detached them and mounted them on a separate chassis, adding a power supply. I ran wires to the main chassis for brightness and contrast control. Sound works fine, also the brightness, but no pictures!—J. C., Santee, Calif.

It looks to me as if your worst trouble here is a mismatch in the shielded cable you used. Also, if you're carrying video over any length of cable, you'll probably have to add a cathode follower after the video detector on the if chassis and connect it to the video chassis through a good low-loss (also low-capacitance) coax cable. You may also have to add one stage of amplification at the video amplifier end if the losses in the coax are too high (Fig. 3).

This shouldn't be too difficult: use something like a 6C4 as a cathode follower, with a matching resistor in its cathode. Connect the coax across this. For example, if you have a 52-ohm coax, 50-ohm resistor; 75-ohm coax, 75-ohm resistor, etc.

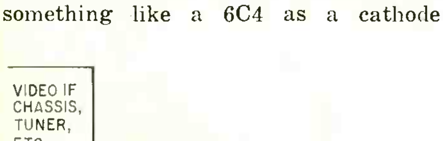


Fig. 3—Add cathode follower for video signal and match the circuit to the coax used to carry the signal.

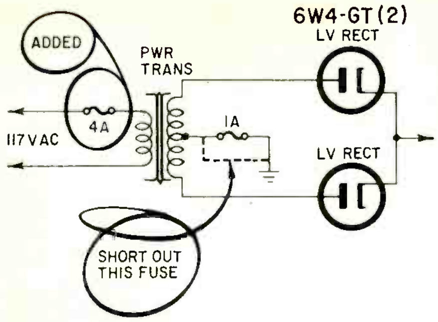


Fig. 4—The 1-amp fuse in the ct secondary blows on starting surges.

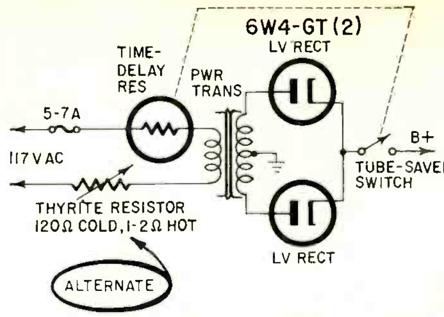


Fig. 5—Time delay switch keeps B-plus open till other tubes have warmed up, preventing surge. The thyrite resistor in series with the primary is an alternate approach to the surge problem.

Fuse blowing

A Philips model 3550 TV blows the 1-amp fuse in the B-plus whenever it is turned on or, rather, almost every time, which is worse. Once on, the fuse never blows and the set plays perfectly. We hooked an ammeter in series with it and found nothing except that once in a while the starting surge of current went above 1 ampere.

Philips engineers say this is due to the high efficiency of the transformer, and suggest shorting out the 1-amp fuse and using a 4-amp fuse in the primary (Fig. 4). This was done, and the set worked well until a few weeks ago. Now it's blowing fuses again.—T. W., Vancouver, B. C.

After the tests you have made, I'm inclined to agree with the gentlemen from Philips. A high-efficiency power transformer can develop surges which will blow a properly rated fuse. There are several things you could do. Probably about the simplest would be to add one of the tube-savers devices used on several American TV sets (Fig. 5). They are small thermal relays which delay the B-plus until the tube heaters have warmed up properly. The delay is usually about 15–30 seconds. This might solve your problem. One other method would involve replacing the 6W4 rectifier tubes used in this set with 6AU4's, and possibly inserting a Thyrite resistor in series with their heaters to delay their warmup.

As another possibility, try a special Thyrite resistor intended for use in series with a transformer primary. This one has a 120-ohm resistance cold, but changes to only 1–2 ohms when hot. This would eliminate all surges and be easiest of all to install.

Color interference

On an RCA KCS-81A, we get a good picture except during color programs. In color, there is always an interference pattern which varies with sound amplitude. First thought was oscillation in sound if stages, but pulling the sound if tubes didn't eliminate it. Any suggestions?—B. T., Kansas City, Mo.

You didn't specify just what this interference pattern looks like, so I'm going to generalize a bit. From the description, it would seem to be allied to the mistuning beat caused by an incorrect adjustment of the fine tuning on color programs. The general effect is a sort of shimmer around the edges of people and things.

I believe I would check the setting of the oscillator slug in the tuner to be sure that your fine tuner allows enough range to tune the carrier in exactly the right place. This is a quite common trouble and happens often with black-and-white sets as well as color. If the tuner will not "come up to the right place" on the carriers, it could be attenuating the sound signal. The set would then be tuned too close to what one manufacturer picturesquely called the "wormy side" of the picture and you would have, in effect, sound in the picture. On a color program, this shimmer or interference *would* be complicated by the presence of the color subcarrier.

So, my recommendation is this: Check the setting of the tuner (on a color program if possible). If this fails to eliminate the problem, run a complete sweep realignment of the video if's. Pay particular attention to the shape of the overall response curve and to the upper-side trap settings, the 47.25-mc traps in the input. After this, run a curve on the tuner to be sure that it is not introducing a "droop" at the wrong end of the curve, attenuating the video or sound carriers.

Ion burns

A Dumont RA-110 with a 19AP4 picture tube had a dark spot in the center of the screen. The tube was bad (it was over 10 years old). I replaced it with a rebuilt tube. The dark spot showed up in this one. I exchanged it for another rebuilt, and this one also shows a dark spot, but in a different location. I've replaced yoke, ion trap and focus coil, and changed every tube I can think of in the chassis, but nothing helps. All voltages are OK.—M. R., Detroit, Mich.

I'm afraid I'm going to have to give you the obvious answer! This type of trouble, according to your description, can be nothing but an ion burn (soft edges, sometimes X-shaped arms toward the corners of the tube)! So, it looks as if the rebuilt picture tubes you've been getting are using the old screen phosphors and are already burned. Rebuilt CRT's made by reliable outfits never show this defect, at least as far as I've seen. Some of the smaller rebuilders use original screens, and this trouble occurs. Cure: try a brand-new tube, and see if it does not cure the trouble.

Horizontal trouble

There's a persistent horizontal trouble in a Philco 50T-1479. I've run a complete realignment of the horizontal oscillator and shunted out the afc. This last seems to make it work better.— R. A. K., Kirkwood, Mo.

This could be trouble in the horizontal afc since you say shunting it out improves performance. I'd check all components in the afc circuit, and also the sync pulses through there with a low-capacitance probe.

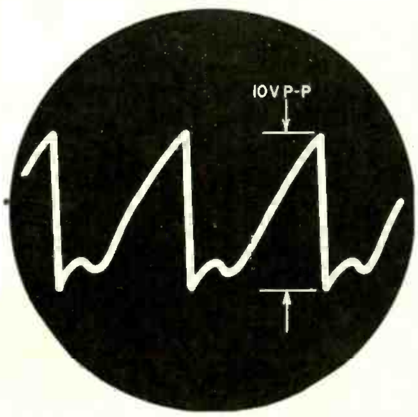


Fig. 6—Horizontal pulse on phase comparer grid.

The pulse on the phase-comparer grid should look like Fig. 6 and the sync pulse across the horizontal lock-in trimmer, with the horizontal oscillator tube pulled out, ought to look like Fig. 7. If either of the pulses is missing, trace them back through the sync amplifiers, etc. until you find where they stop.

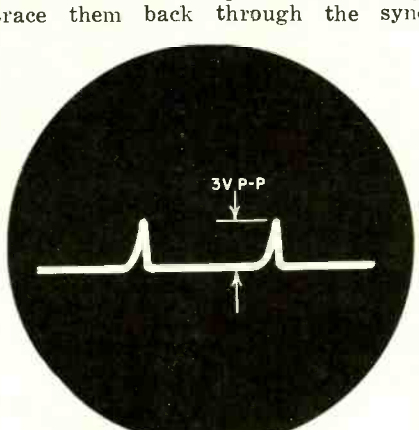


Fig. 7—Sync pulse across horizontal lock-in trimmer with the horizontal output tube pulled.

Watch out for capacitors with very small leakages in this circuit. Most of this is very high resistance, and can cause trouble. END

Do your Christmas shopping the easy, economical satisfying way with the 1962 HEATHKIT® Catalog

World's biggest kit catalog—offers over 250 kit selections. The big, new 100-page Heathkit catalog is the world's shopping center for kit builders. It offers over 40 completely new kits and a variety of products priced from $7.95 up. Heathgift certificates are available in any dollar amount you wish.

New easy terms; order now—pay later! Heathkit's new relaxed terms are the easiest ever. Now, no down payment is necessary . . . and take as long as 18 months to pay. See the order blank in the 1962 Heathkit catalog or write for application forms today.

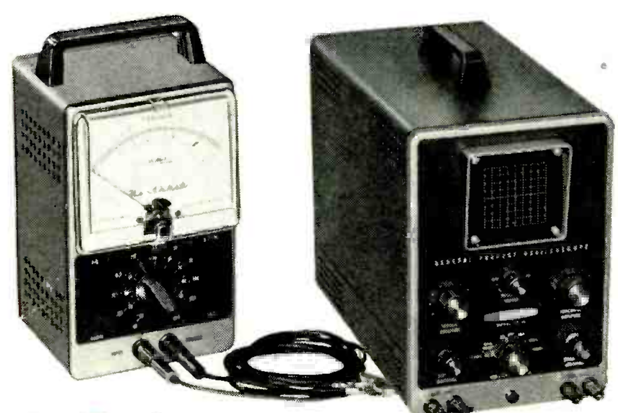
Heathkits give a world of pleasure—at half the price! With Heathgifts you provide more than just a remembrance. You open an exciting, challenging, satisfying new world of pleasure—that lasts a lifetime. What's more, you give the highest quality electronic equipment, but pay up to 50% less than the cost of ready-made units.

New "value-packed" FM Tuner in charcoal gray and ivory

Performs in the true Heathkit quality tradition. Loaded with such features as flywheel tuning and slide rule dial, AFC control, assembled prealigned front end for easy kit completion. 9 tube function, ±20-20,000 cps. A honey for looks! Features multiplex jack for use with the Heathkit AC-11 Multiplex Converter to provide FM stereo.

Kit AJ-31 FM Tuner (shown)...8 lbs.................**$39.95**
Kit AC-11 Multiplex Converter...4 lbs..............**$32.50**

New HEATHGIFTS

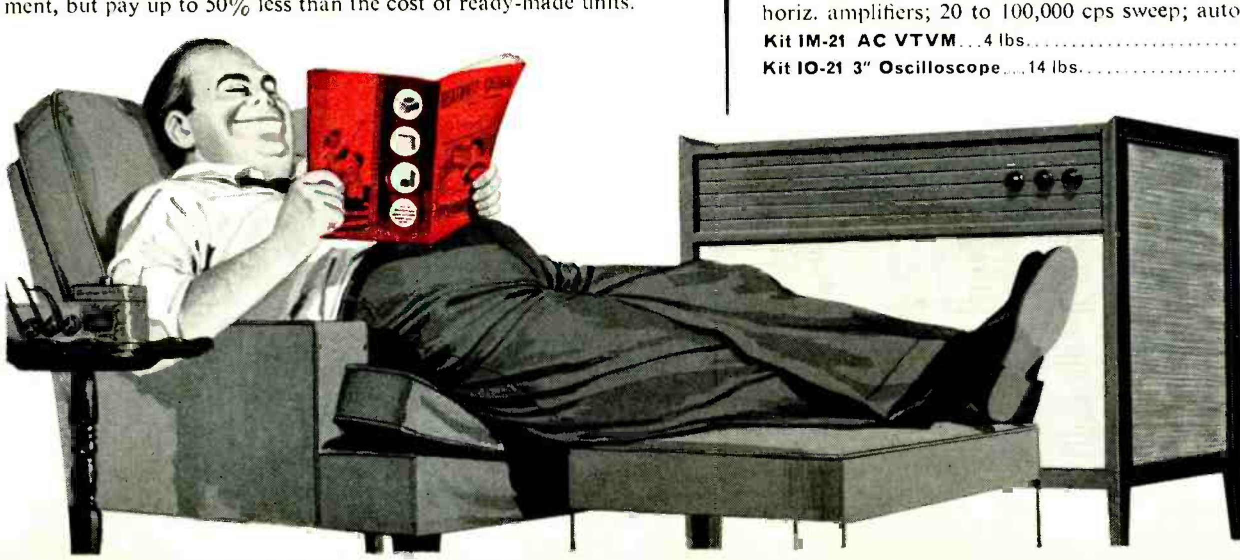


New Test Instruments for the technician or serious amateur

The IM-21 AC VTVM has clean design. Extended freq. response 1 db 10 cps to 500 kc. 10 megohm input imp.; 10 voltage ranges; −50 to +50 calibrated db scale.

Versatile IO-21 "general purpose" 3" oscilloscope perfect for industrial, medical and general use. Push-pull vert. and horiz. amplifiers; 20 to 100,000 cps sweep; automatic sync.

Kit IM-21 AC VTVM...4 lbs.........................**$33.95**
Kit IO-21 3" Oscilloscope...14 lbs...................**$49.95**



Deluxe 9 transistor Walkie-Talkie keeps you in touch anytime, anywhere

Units at twice the price can't compare! Operating range of 1 to 3 miles; meets FCC regulations. Crystal controlled superhet receiver; squelch noise limiter circuit; push-to-talk switch; rugged, 2-tone alum. case. Use for private reception, as wireless mike or for paging. 75 hours on 9 volt battery. Collapsible 35" whip antenna.

Kit GW-21...3 lbs................**$44.95**

A Handsome Radio for every room in the house

Choose from 3 spanking new ivory and beige radios. Low cost AM set provides hours of pleasure. Economical FM table radio is noise-free; has preassembled tuner. AM Clock-Radio has Telechron unit, sleep switch, radio alarm, pillow speaker jack.

Kit GR-121 AM Clock-Radio, 8 lbs. **$29.95**
Kit GR-11 FM Table Radio, 7 lbs. **$27.50**
Kit GR-10 AM Table Radio, 7 lbs. **$19.95**

Learn as you build—an Educational Kit on Transistors

Teaches basic fundamentals of transistors while performing interesting experiments! Text is written in simple easy-to-understand language. Final product is highly useful two-station intercom. Textbook provides a storehouse of valuable reference material. Designed for youngsters and adults alike. All components and materials furnished.

Kit EK-3 Basic Transistors...
4 lbs...........................**$16.95**

make it a merrier Christmas for anyone!

New Accessories to make a "Ham" happy

Ham accessories that sing performance, price, features! Spectacular, compact tunnel diode "dip" meter does everything a "grid dip" can do. New rugged VFO covers 80 thru 2 meters. New "Q" multiplier has 2 peak I. F. positions. Exceptional values!

Kit HG-10 VFO...12 lbs..........**$34.95**
Kit HM-10 "Tunnel Dipper"...
3 lbs............................**$34.95**
Kit HD-11 "Q" Multiplier...
2 lbs............................**$14.95**

Safe cruising for the Boating Enthusiast

Compare for price, for quality! See why the 3-band "Mariner" gives you so much. Includes consolan, beacon, broadcast and marine phone bands. 10 transistor, 1 diode circuit. Functionally styled with "sense" antenna, waterproofed 4" x 6" speaker. Preassembled tuner. Bearing accuracy of ±3°.

Kit MR-11 3-band "Mariner"...
12 lbs........................**$109.95**

Short Wave Radios put the world at your fingertips

Hours of fascinating broadcast, amateur radio, and short wave pleasure await you in the GR-91. Covers 500 kc to 30 mc in 4-bands. Illuminated 7" slide-rule dial & meter. Versatile controls for top reception. "Velvet touch" tuning. Easy circuit board assembly. Beige & Aqua color.

Kit GR-91 SWL Radio...9 lbs......**$39.95**

New Wireless Intercom saves time, saves steps

No home, office or factory should be without this transistorized all-master intercom system. Imagine, only 3c a month to operate. No wires between units, just plug in. Any station calls other stations. Easy to build. In beautiful two-tone beige.

Kit GD-51 Intercom...4 lbs.......**$22.95**
Kit GD-51-2 (pair)...8 lbs.........**$45.90**

HEATH COMPANY
Benton Harbor 20, Michigan

HEATHKIT by Daystrom

☐ Yes, send me my free 1962 Heathkit catalog

NAME ______________________

ADDRESS ______________________

CITY ____________ ZONE ______ STATE ______

Order direct by mail or see your Heathkit dealer.

Ship ☐ Parcel Post ☐ Express ☐ C.O.D. ☐ Best Way

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

ITEM	MODEL NO.	PRICE

Free Catalog!

Send in today for your free 100-page catalog. Over 250 kits (more than 40 are new) in this most complete catalog of kits. Every piece is top quality . . . save up to 50%. Get a catalog now and receive 1962 Heathkit supplements.

This Christmas Give a Heathgift . . . from the World's Shopping Center for Electronic Kits

Thermodot (model TD-1) radiometer.

INDUSTRIAL INFRARED RADIOMETER

Radiometer measures temperature of spinning auto tire, tests, checks quality in number of fields

By BURTON BERNARD

A NEW quality-control method, brought about by advancements in a new field of electronics, is now being used in industrial applications. This new technique enables manufacturers to take remote nondestructive temperature measurements of stationary or moving objects. They may be on the assembly line or in the research laboratory.

With this method, a tire manufacturer can predict (many hours in advance) the exact spot at which a tire will blow out—while the tire is rotating at a speed in excess of 100 mph. Makers of glass containers use this new procedure for continuous quality-control inspection. A great many other manufacturers are included in the expanding list of industrial leaders who use similar methods for testing and quality control of paper, plastics, rubber and metal.

To understand why infrared is becoming so useful in industry, we must first understand the basic principles involved. Infrared radiation is a form of electromagnetic energy and serves as a means of heat transfer. Heat can be transferred in three distinct ways—conduction, convection and radiation.

Suppose we pour some hot coffee into a cup that has a spoon in it; conduction will cause the spoon to heat. If we place our hand directly above the cup, we will feel heat from the coffee rising through the air. This is an example of convection. Placing our hand about an inch to the side of the coffee cup, we will again feel some warmth. This is due mostly to infrared radiation. It is this form of energy transfer which is the foundation for this rapidly expanding field of electronics.

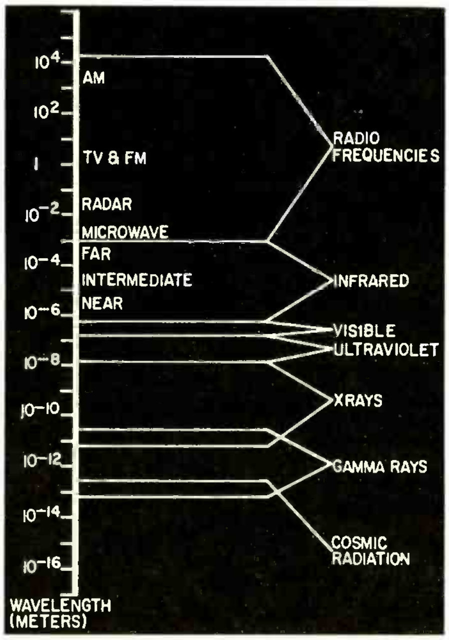


Fig. 1—The electromagnetic radiation spectrum showing wavelengths.

All substances having a temperature above absolute zero ($-273.16°C$) emit electromagnetic radiation, most of which is contained within the infrared spectrum (Fig. 1). The amount of infrared energy radiated by a substance is directly proportional to the fourth power of its absolute temperature.

An infrared radiometer is a device which is used to measure the amount of thermal energy radiated by a substance. The Thermodot (model TD-1), manufactured by Radiation Electronics Co., a division of Comptometer Corp., is such an instrument. Temperature transients of 20-microseconds duration or less can be observed with the Thermodot and temperatures can be observed to within ½ of 1%. The radiometer does not have to contact its target physically; therefore it does not influence the actual surface temperature as sometimes happens with thermocouples.

The solid blocks in Fig. 2 show a basic radiometer. The remaining blocks indicate additional circuits which may be used to increase the unit's overall abilities. As this is a diagram of a typical infrared radiometer being used in industry today, let's take a closer look at it and the servicing techniques involved.

Optical system

Because a relatively small amount of infrared energy is emitted by a radiating object, an optical system is used in almost all radiometers to collect and focus the energy onto the infrared (IR) detector. These optical systems work in much the same way a magnifying glass does when we use it to focus sunlight onto a sheet of paper (causing the paper to char). Fig. 3 shows two types of systems of which there are many combinations and variations. To insure maximum efficiency, front-surfaced mirrors are used for all reflectors.

Some materials used for infrared lenses and windows—germanium, silicon and arsenic trisulfide—are opaque to visible light, but sapphire which is also commonly used transmits both visible and IR radiation. Glass is not generally used in a lens because it cuts off wave-lengths longer than 3 microns (3×10^{-6} meters) where some of the infrared energy lies.

It is important that IR optical systems stay clean at all times as dirt or

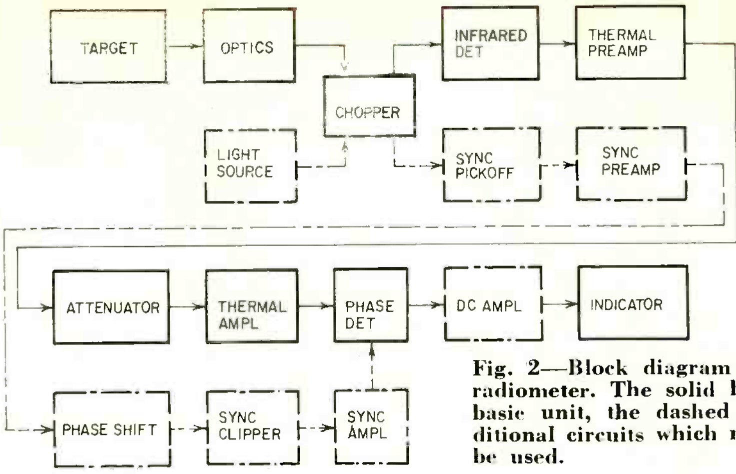


Fig. 2—Block diagram of an infrared radiometer. The solid blocks show the basic unit, the dashed blocks are additional circuits which may or may not be used.

dust will cut out some of the radiant energy. This will result in lower temperature readings. Extreme care should be taken in cleaning these materials as some scratch or chip quite easily.

Chopper

Since the output of the detector is (usually) a slow-changing, low-level dc voltage which is difficult to amplify, it is more convenient to chop the detected signal at a constant frequency. This is done by a chopper disc driven by a synchronous motor between the detector and its target. The number of blades (or

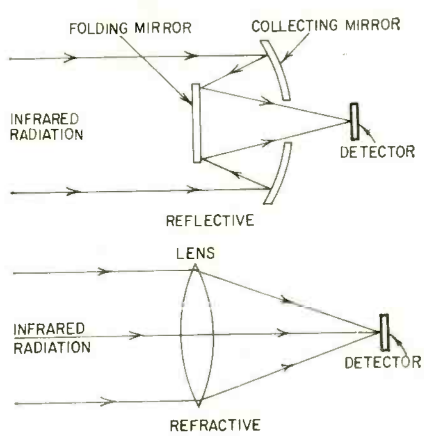


Fig. 3—Two basic optical systems, reflective and refractive.

openings) on the disc and the speed of the motor determine the chopping frequency (which can vary from about 5 to 10,000 cycles). A motor rotating at 3,600 rpm and driving a chopper disc with ten blades will give an output frequency of 600 cycles per second.

Chopping is not necessary in infrared radiometers which are used to observe explosions or thermal differences in fast moving objects.

Detector

We can compare the IR detector stage to the modulator of an ordinary AM transmitter in that the chopping frequency acts as the carrier and the radiant energy detected by the stage is the modulating signal. The IR detector puts out a signal at the chopping frequency which is amplitude-modulated by the target signal.

There are two types of detectors—thermal and photoconductive. The thermal detector is a very small thermistor (whose resistance varies when subjected to a temperature change). Fig. 4 shows a circuit using two thermal detectors called a bolometer bridge. When infrared radiation is focused upon thermistor T1, its resistance will change, developing a voltage difference (causing current flow) across M. Thermistor T2 is used as a reference source and is kept at a known temperature. R1 and 2 are used to balance the circuit when T1 and 2 are at the same temperature. The amount and direction of meter deflection indicates T1's temperature and, indirectly, the temperature of the radiating object.

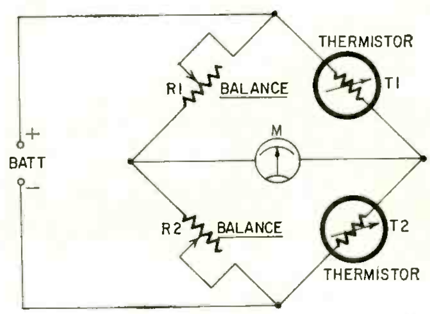


Fig. 4—A thermistor bolometer bridge.

A preamplifier is often used in place of M with bolometer type radiometers. The frequency response of the thermal detector is flat with respect to the infrared spectrum. However, it has a relatively long time constant as compared to the photoconductive detector.

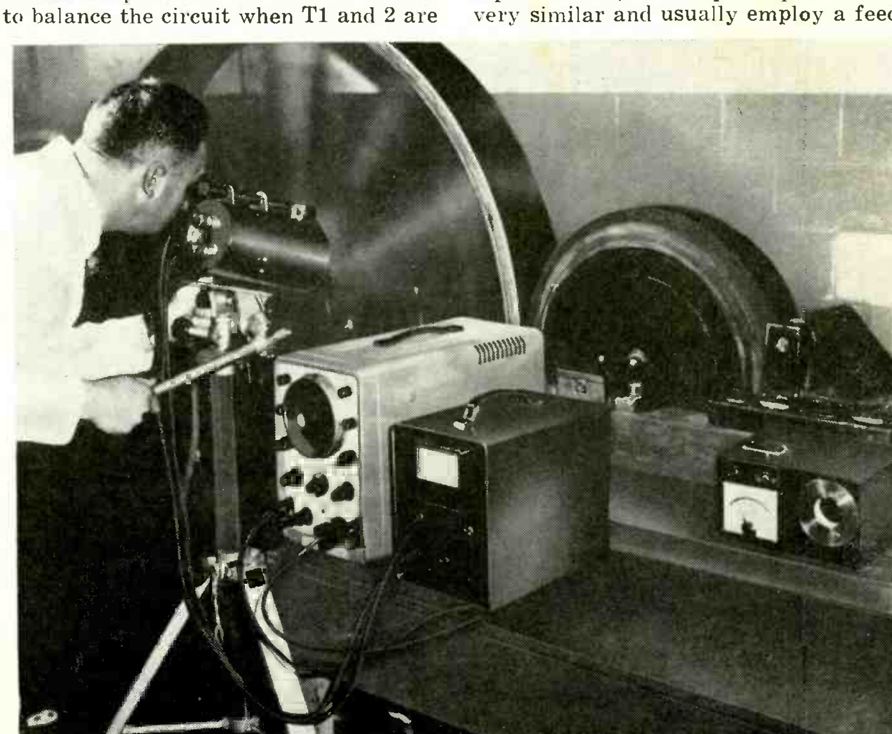
The photoconductive (PC) detector is a semiconductor that changes resistance when light (or other) energy strikes it. Some of the more common elements used in PC detectors are lead sulphide, lead telluride, gold-doped germanium and indium antimonide, all of which have an average size of 1 mm x 1 mm. The sensitivity of the PC detector can be increased by placing crushed dry ice or liquid nitrogen in the well or Dewar (vacuum-insulated) vessel containing the detector element.

A bias supply is required for almost all detectors and must be regulated and well filtered; for this reason batteries are quite often used. If an indium antimonide element is placed between opposite magnetic poles, no bias supply is needed. This method is referred to as photoelectromagnetic (PEM).

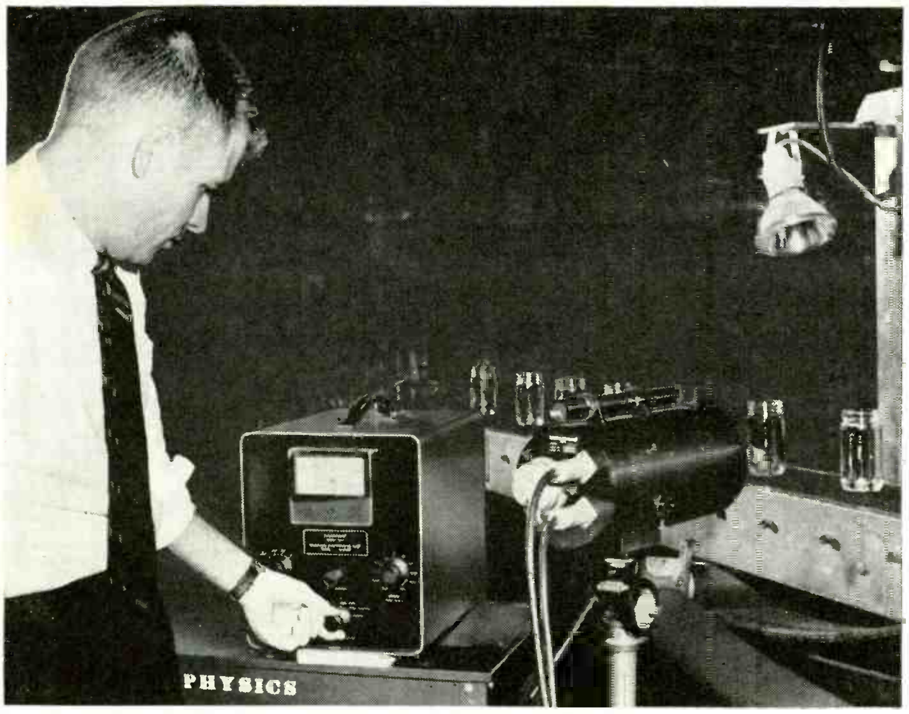
Little or no maintenance is required for the detector. The well or Dewar vessel of the PC detector should be kept clean to insure good thermal contact with the cooling agent. Small metal chips must be kept away from the PEM detector (which contains a magnet) or they will be attracted to the detector case and window.

Preamplifier

The preamplifier used in infrared radiometers is essentially a low-noise, wide-band amplifier. Except for the input circuit, most preamplifiers are very similar and usually employ a feed-



Measuring the temperature of a spinning auto tire.



A radiometer checks the temperature of instant-coffee jars as part of a quality-control system.

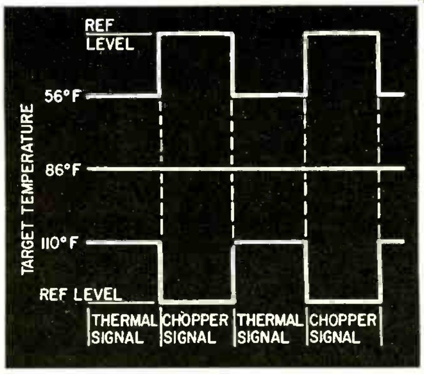


Fig. 5—Signals produced by targets at three temperatures. The reference-level signal is from chopper disc at 86°F.

back circuit to the first or second stage to insure stability. Because IR detector impedances vary from about 5 ohms (PEM) to 5 megohms (cooled PC), there are a wide variety of input circuits. The detectors are generally transformer- or capacitor-coupled to the grid (or base) of the first stage.

The preamplifier is generally contained within the optical assembly and its output fed through a cable to the main control unit. The length of the cable averages about 15 feet, but occasionally it will be as long as 100 feet. For this reason, the output circuit is always a low-impedance cathode (or emitter) follower.

Troubleshooting procedures for preamplifiers are almost the same as for any audio preamplifier. If a test signal is used to check out the amplifier, be sure the amplitude is very low or clipping will occur. A typical output is usually less than 500 millivolts peak to peak. If any components require changing, be sure to resolder all ground connections back to the original point or ground loops may occur (and introduce hum).

Main amplifier

The main or thermal amplifier is a straightforward audio amplifier which usually contains attenuator switches or gain controls. If a chopper disc is used in the radiometer, the amplifier may have circuits tuned to the chopping frequency to minimize any noise which may be introduced at the input stage.

Routine audio amplifier maintenance and repair is all that is required.

Display

The display or presentation method varies with the application of the individual IR radiometer.

The main function of the circuits up to this point has been to produce a relatively high voltage which is proportional to the temperature being measured (or observed). In IR radiometers using chopper discs, a demodulator or detector circuit will follow the final thermal amplifier stage to produce a dc voltage which can be used to represent temperature. The demodulator is generally a full-wave detector with little or no filtering because its output is, at times, a rapidly-changing dc voltage. Heavy filtering would decrease the response time.

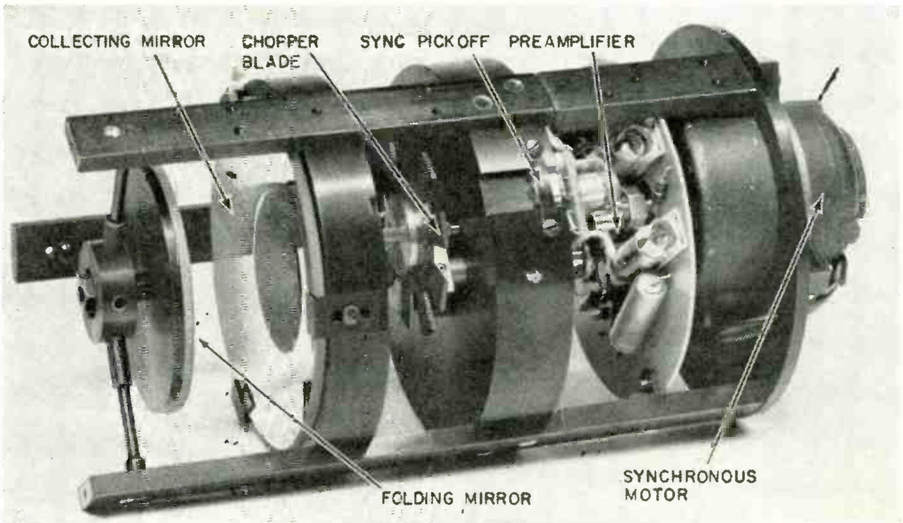
A calibrated dc voltmeter can be placed directly across the output of the demodulator to obtain temperature readings. Or, the dc voltage may be fed into a controller to insure uniform temperatures for quality control. Where rapid temperature changes are to be observed, a pen recorder or oscilloscope is used in place of the meter.

Almost all industrial infrared radiometers contain a meter for face temperature readout. The meter may be calibrated directly in temperature or it may contain a linear scale which requires the use of a conversion chart or graph to determine precise temperatures.

Almost all of the display methods used for industrial applications are rather conventional and should offer no servicing difficulties.

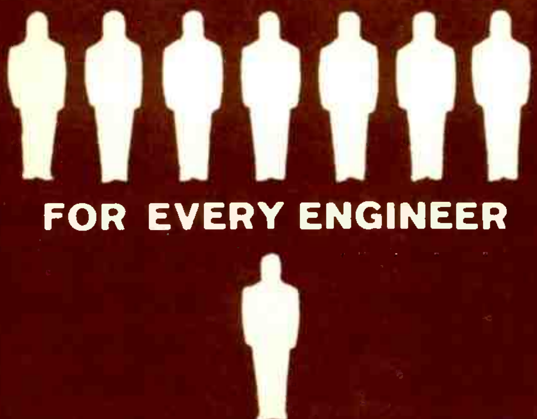
Sync pickoff

We have seen how surface temperatures of various substances can be measured by an infrared radiometer. In studying Fig. 5 we see that the infrared detector puts out a signal of the same amplitude but of opposite polarity (or phase) for temperatures of 56°F and 110°F when the chopper disc is at a temperature of 86°F. Any target (radiating object) at a temperature equal to that of the chopper disc will not produce a thermal signal. As the temperature of the target increases or decreases the signal obtained will increase, but the phase will change. We must therefore know the phase of the thermal signal to distinguish between "hot" and "cold" targets. This is done by placing a magnetic pickoff coil at the chopper disc. A voltage will be induced as each blade or opening on the disc passes the coil. If the chopper disc is made of a nonmagnetic material, a light source and a phototransistor are used to obtain a synchronizing signal. This signal is then amplified by a conventional amplifier. A phase-shift network is sometimes used in the sync amplifier to insure proper phase between the sync and thermal



Head Assembly of the TD-1.

ELECTRONICS NEEDS 4 TO 7 QUALIFIED TECHNICIANS



Join The Thousands Who Trained For Advancement With NRI

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

Choose from 4 Courses

1 INDUSTRIAL ELECTRONICS
Learn Principles, Practices, Maintenance of Electronic equipment used today by business, industry, military, government. Covers computers, servos, telemetry, multiplexing, many other subjects.

2 FCC LICENSE
Every communications station must have one or more FCC-licensed operators. New NRI course is designed to prepare you for your First Class FCC exams. You learn quickly, training at home in your spare time.

3 COMMUNICATIONS
Training for men who want to operate and maintain radio and TV stations; police, marine, aviation, mobile radio, etc. Includes FM Stereo broadcasting. Course also prepares you for your FCC license exam.

4 SERVICING
Learn to service and maintain AM-FM Radios, TV sets, Stereo Hi-Fi, PA systems, etc. A profitable, interesting field for a spare-time or full-time business of your own.

SEE OTHER SIDE

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

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

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

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

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

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

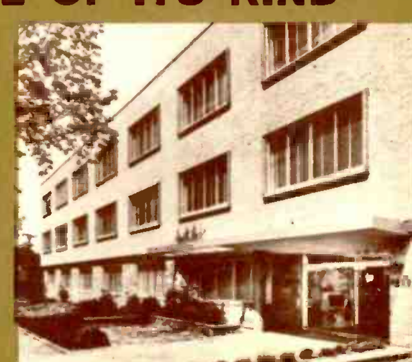
BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY

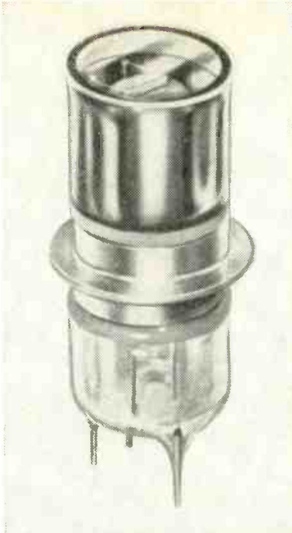
NRI
National Radio Institute
3939 Wisconsin Avenue
Washington 16, D.C.

NRI IS OLDEST—LARGEST SCHOOL OF ITS KIND

Training men to succed by home study has been the National Radio Institute's only business for over 45 years. NRI is America's oldest and largest Electronics home-study school. Don't delay. Cut out and mail POSTAGE-FREE CARD.



MAIL POSTAGE-FREE CARD



Radiation Electronics Co.

A high-speed small-area photoconductive detector.

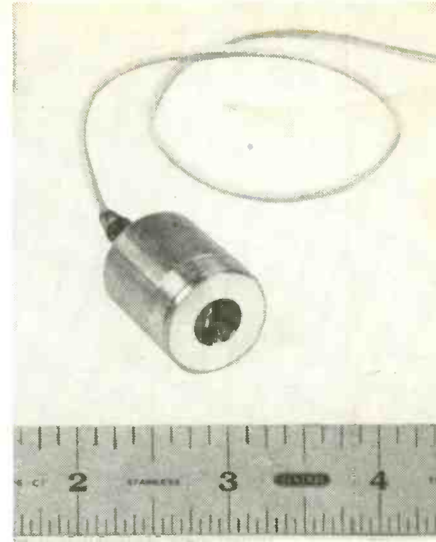
signals. The sync phase can also be adjusted by moving the light sources or by moving the phototransistor. A limiter or clipper stage is used to secure a constant-amplitude signal which is fed into a phase detector or demodulator circuit where is its carefully compared with the constantly variable thermal signal from the target.

Phase detector

Regardless of what the radiometer is aimed at, the sync signal will always be of constant amplitude and phase. The thermal signal will change in amplitude or phase (or both) depending upon the target's surface temperature. If the temperature of the target is the same as that of the chopper disc, no signal will be present at the thermal amplifier.

However, since a sync signal is still present, we will get a dc voltage from the synchronous phase detector. For the sake of comparison, we will say it is 10 volts. If we observe a target higher in temperature than the chopper disc, the thermal signal will be in phase with the sync signal and will add to it—producing a resultant output voltage greater than 10 volts. If the target temperature is lower than that of the chopper disc, the two signals are 180° out of phase, partially cancelling each other, and the resultant output is less than 10 volts.

Additional applications for infrared measurement and control are being discovered each day. A completely new field is opening for the technician who can operate, maintain and repair industrial infrared-detecting systems. The infrared technologist must not only be familiar with electronics but should also have a working knowledge of optical techniques and basic mechanics. All of these skills are important and necessary. END



Radiation Electronics Co.

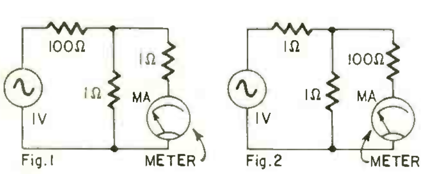
A photo electromagnetic detector. Note size as compared with ruler.

WHAT'S YOUR EQ?

Here are a few more we hope our readers will find challenging. And if you can develop an original EQ that will stump our readers, send it to us. We pay $10 and up for each one accepted. Write to EQ editor, RADIO-ELECTRONICS, 154 West 14th St., New York 11, N.Y. Answers to October puzzles are on page 108. We just can't answer individual letters, but will continue to print the more interesting solutions (the ones the original authors never thought of!).

A Current Problem

Does the meter in Fig. 1 read the same, more than or less than the meter in Fig. 2?—*Richard L. Koelker*



Impossible Voltages

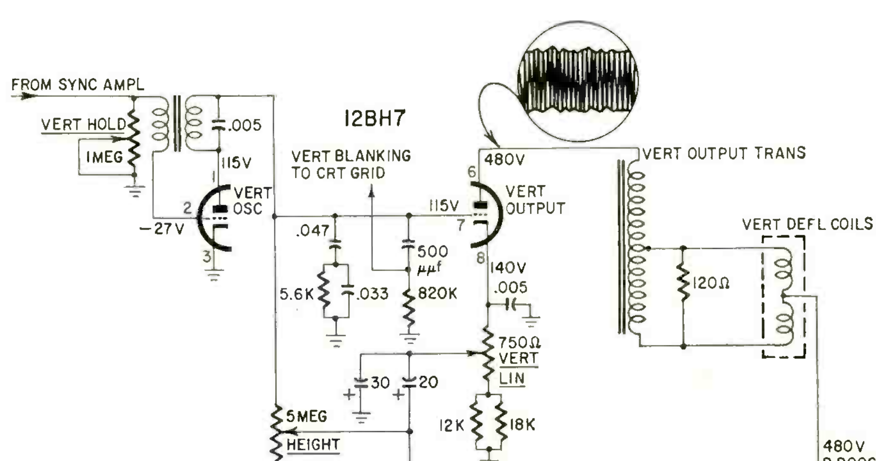
Symptoms: Very thin white horizontal line. No vertical sweep at all.

Clues: Some very unusual voltage readings around the vertical oscillator and output stage. These include a very high negative voltage on both plate and grid of vertical output tube! This was on the order of 200 volts! Tube OK. Power supply OK.

Hint: Scope trace on plate of vertical output tube showed very high p-p voltage, at *horizontal* frequency. A Crosley G17TOMH.—*Jack Darr*

"Black Box" Brain

Given, a "black box" having four terminals. What is the simplest network the box may contain such that the output voltage at terminals 3–4 is exactly 180° out of phase with the input voltage at terminals 1–2?



IMPROVEMENTS FOR DECADE BOXES

Resistance, capacitance and inductance decade boxes are used chiefly in laboratory and service work as standards and for determining substitute or reference values. A couple of simple modifications can greatly increase the usefulness and versatility of your decade box without affecting its original accuracy.

Fig. 1 shows the basic diagram of a decade box, consisting of several sections, connected in series, with each section (A, B, C . . . N) having a ratio of 10 to 1 (10 ohms to 100 ohms, 1 megohm to 10 megohms, 1 μf to 10 μf, etc.). Add external terminals at points 1, 2, M and the modified box can be used

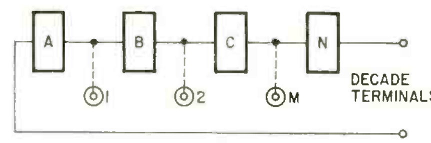


Fig. 1

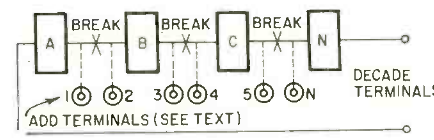


Fig. 2

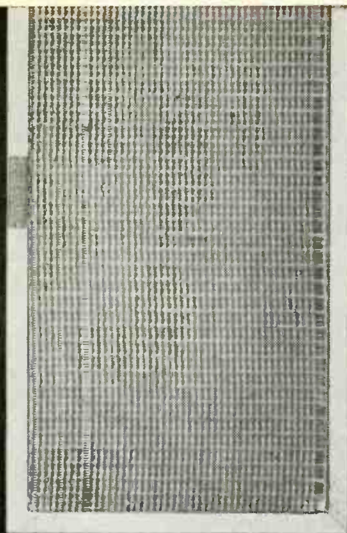
where two boxes, or one box plus external resistors, are required. This box can also be used as a voltage divider as long as the ratings of the box are not exceeded, or it can be used in setting proper operating conditions for a transistor where base bias is obtained from a resistive voltage divider. A capacitor decade box with some modifications can be used the same way where ratios of capacitive reactance are required (compensating attenuator circuits).

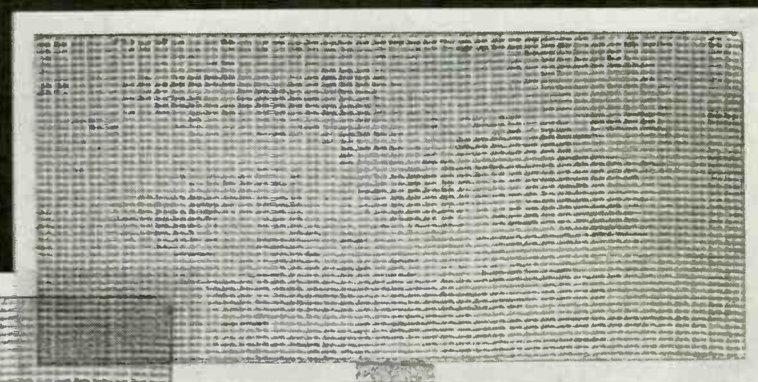
You can break the connecting wire between the various sections (Fig. 2) and connect experimental circuits (phase-shift networks) externally between sections. For convenience, points 1–2, 3–4, 5–n, etc. could be on a closed-circuit jack. Regular banana jacks could also be used for the same points. The jacks should be spaced ¾ inch apart so that a shorted double banana plug (such as General Radio type 274 MD) can be inserted. The second method is recommended where higher currents are involved.

Modifications in Figs. 1 and 2 can be made on the same box. Use heavy wire for the additional wiring in the resistance boxes. Short leads must be employed in the capacitor and inductor boxes.

A combination of modified resistance and capacitance boxes can be very useful in tone-control experiments. It is up to the reader to use the modified decade for his particular applications. The cost of modification is low.—*M. Arditti and E. Pearson*

www.americanradiohistory.com





THE A. E. S. *Gigolo*

ONE OF THE MOST SOUGHT AFTER PRODUCTS IN THE HIGH FIDELITY INDUSTRY

At our present rate of sales and production, A. E. S. will sell nearly 100,000 Gigolos this year.

Imagine, now you can own a speaker with this quality for only $15.00.

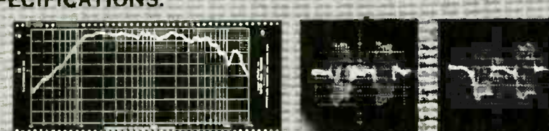
TRY IT — WE GUARANTEE IT
100,000 PEOPLE CANNOT BE WRONG

DESCRIPTION:

The Gigolo is constructed with a resonant resistant all wood product of at least ¾″ thickness throughout. Its outside dimensions are 24″ long, 12″ high, 9½″ deep. The heavy construction and the fine workmanship suggest a value far exceeding its low. low price. All units sold on 100% MONEY BACK GUARANTEE.

Price $15.00. Unfinished only.
F.O.B. Factory

SPECIFICATIONS:

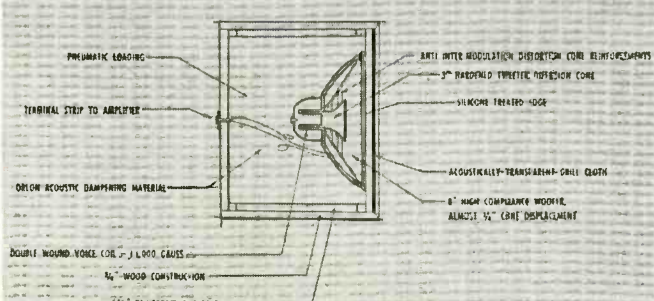


Frequency response 500 Tone bursts 3500

Maximom frequency response	19-21000 cps
Frequency response ±8 db	45-18000 cps
Harmonic distortion	less than 3% 70-21 kc
Impedance curve	within −0 +200% of 8 ohms 20-20000 cps
Flux density	11000+ gauss

Frequency response curve run at continuous 10 watts.

Power handling capacity, the Gigolo may be used with small economy amplifiers of very low wattage, as well as with the highest power component amplifier with satisfactory results.



A.E.S., Inc.
3338 Payne Avenue, Cleveland, Ohio

Gentlemen please ship________________GIGOLOS.

I understand these units are guaranteed and if I am not satisfied I may return for a full refund of sales price, $15.00 each.

Name______________________________

Address______________________________

City and State______________________________

Enclosed find check____________money order__________

LAFAYETTE is America's Citizens Band Headquarters

Complete Portable Communications for Everyone

Ship to Shore

On the Farm

Construction Work

NO LICENSES, TESTS OR AGE LIMITS

LAFAYETTE 9 TRANSISTOR CITIZENS BAND "WALKIE TALKIE"

39.95
2 for 78.88
NO MONEY DOWN

Complete with Leather Carrying Case, Earphone. Antenna, Batteries, and Crystal

HE-29A

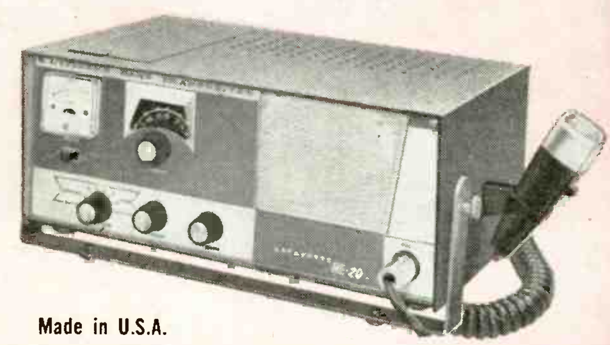
PORTABLE— POCKET SIZE Only 6⅜x3¼x1⅝"

● **Completely Wired—Ready to Operate** ● **Fully Transistorized—9 Transistors plus 1 Diode** ● **Uses Inexpensive Penlight Batteries** ● **No License, Tests or Age Limits** ● **Comes with Leather Carrying Case, Earphone, Antenna, Batteries and Crystals**

As simple and easy to use as the telephone—and twice as handy. Receives and transmits up to 1.5 miles under average conditions. Weighs only 18-oz. and slips into your pocket. Push-to-talk button operates built-in speaker as sensitive microphone.

LAFAYETTE HE-20A *Deluxe* CITIZENS BAND TRANSCEIVER

ONLY **109.50** NO MONEY DOWN



Now With Added Deluxe Features—

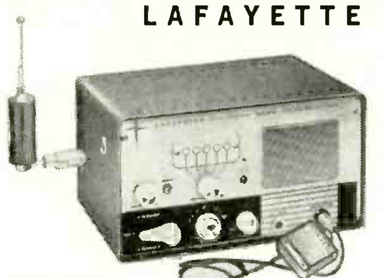
● **Pi-Network for Greater Power Output** ● **Calibrated "S" Meter** ● **14 Tube Performance, 3 Diodes** ● **Built-in 12 Volt Power Supply for Mobile Use** ● **Complete with Matched Crystals for Channel 9**

A highly efficient 2-way communications system operating over a distance of up to 20 miles or more depending on terrain. Features 4 crystal-controlled transmit positions and 4 crystal-controlled receive positions. Tuneable superhet receiver covers all 23 assigned channels. Other highlights include dependable push-to-talk ceramic mike & relay, adjustable squelch control, automatic series gate noise limiter and illuminated dial.

Made in U.S.A.

LAFAYETTE HE-15A

Made in U.S.A.



ONLY **59.50** NO MONEY DOWN

NOT A KIT

SUPERHET
Citizens Band TRANSCEIVER

● **Completely Wired—Not A Kit** ● **5 Crystal-Controlled Transmitting Positions** ● **Tuneable Receiver Over Full 23 Channels** ● **High Output Ceramic Microphone** ● **Complete with Transmitting Crystal for Channel 9**

A compact, precision transmitter and receiver covering up to a 20 mile or more radius, depending upon conditions. The HE-15A features an effective full-wave variable noise limiter, planetary vernier tuning, RF and microphone jack, on front panel. 12 tube performance from 4 dual-function tubes, 2 single-function tubes, 2 rectifiers.

HE-19	Telescoping Whip Antenna	Net 3.96
HE-16	Power Supply for 12 Volts	Net 10.95
HE-18	Power Supply for 6 Volts	Net 10.95

LAFAYETTE *All-in-One* CITIZENS BAND MOBILE ANTENNA

6.95 HE-800WX

● **Chrome Swivel Base** ● **Stainless Steel Spring** ● **102½" Stainless Steel Whip for Optimum 11-Meter Performance**

Chrome swivel ball mount base designed for mounting on any surface. Stainless steel spring holds rod in properly adjusted position and prevents rod damage from shocks and blows. Stainless steel whip for maximum resiliency and strength.

NEW! LAFAYETTE RADIO FIELD INDICATOR

6.95

TM-14

● **Continuously Indicates Transmitter Output** ● **Rugged 200 ua Meter Movement** ● **Requires No Electricity, Batteries or Transmitter Connection**

Check the performance of marine, mobile or fixed transmitter. Features a 200 ua meter movement with variable sensitivity control. Earphones can be plugged in for an aural check of output. Antenna extends from 3¼" to 10¾". Magnet on bottom plate allows easy mounting on car dash or metal surfaces. Size, less antenna, 3⅛W, 2¼H, 2"D.

LAFAYETTE RADIO

SEND MAIL ORDER TO LAFAYETTE RADIO
111 JERICHO TURNPIKE
SYOSSET, LONG ISLAND, NEW YORK

PLEASE INCLUDE SHIPPING CHARGES WITH ORDER.

OTHER LOCATIONS	NEW YORK, N. Y. 100 6th Avenue	NEWARK, N. J. 24 Central Avenue	PARAMUS, N. J. 182 Route 17
JAMAICA, N. Y. 165-08 Liberty Avenue	BRONX, N. Y. 542 E. Fordham Rd.	BOSTON, MASS. 110 Federal Street	PLAINFIELD, N. J. 139 W. 2nd Street

LAFAYETTE

Engineered To Professional Standards
...Designed For The Home...Dedicated To Music

STEREO HIGH-FIDELITY COMPONENTS

NEW! LAFAYETTE LT-700 Criterion T.M. FM STEREO MULTIPLEX TUNER

Ready for Stereo and no Adapter Needed . . . opening a new era in stereo, the new Lafayette Criterion FM Stereo Multiplex Tuner is entirely self contained with its own built-in multiplex facilities. Capable of achieving the highest Laboratory Standards, its exceptional selectivity and sensitivity together with drift-free AFC performance insures effective reception of even the weakest multiplex or monaural FM signals.

Made in U.S.A.

FACTORY WIRED & TESTED **124.50**

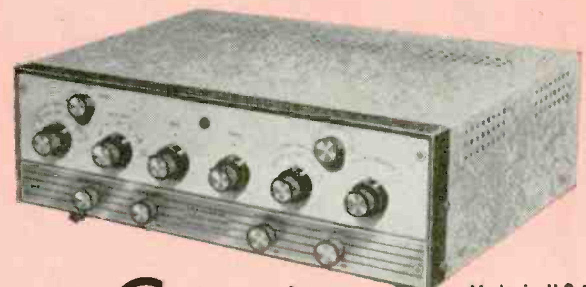
KT-250A 50 WATT INTEGRATED STEREO AMPLIFIER

Made in U.S.A.

KT-250A **74.50** in Kit Form | LA-250A **99.50** Completely Wired

- Separate Bass & Treble Controls
- 3rd Channel Output
- Response: 15-40,000 cps ± .5db (at normal listening level)
- 50-Watts Monophonically—25 Watts Each Stereo Channel

Pacesetting quality, performance and design. Features include: unique "Blend" control for continuously variable channel separation—from full monaural to full stereo, 4-position Selector, Mode, Loudness and Phase switches. Individual bias and balance controls. Harmonic distortion, less than 0.25%. IM distortion, less than .5%. Hum and noise 77db below full output.



Made in U.S.A.

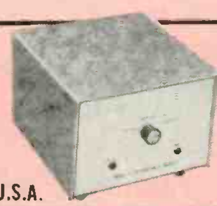
KT-600A Criterion T.M. PROFESSIONAL STEREO CONTROL CENTER

KT-600A **79.50** in Kit Form | LA-600A **134.50** Completely Wired

- "Null" Balancing System
- Response 5-40,000 cps ± 1 db
- Bridge Control Provides Variable 3rd Channel Output
- Tape Head Playback Equalization for 4-Track Stereo
- Variable Cross Channel Signal Feed Eliminates Hole-In-The-Middle Effects

Sensitivity 2.2 mv for 1 volt out. Dual low impedance "plate follower" outputs 1500 ohms. Less than .03% IM distortion; less than .1% harmonic distortion. Hum and noise 80 db below 2 volts.

New LT-200 MULTIPLEX ADAPTER

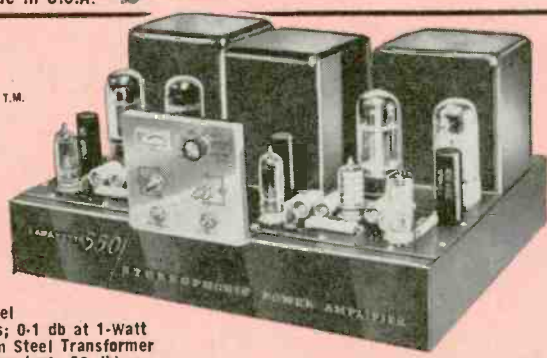


Made in U.S.A.

FACTORY WIRED & TESTED **47.50**

Now enjoy stereo with all the fidelity and convenience that only FM can provide by adding this brilliant new multiplex adapter to your tuner. Performs beautifully with virtually any late model wide band tuner equipped with a multiplex output. Front panel selector switch provides for On-Off. Mono-FM and Stereo FM, while pilot lights indicate when power is on and when adapter is operating stereophonically. Complete with enclosure and all necessary audio cables.

KT-550 Criterion T.M. 100-WATT BASIC STEREO AMPLIFIER



Made in U.S.A.

- Rated at 50-Watts per Channel
- Response from 2-100,000 cps; 0-1 db at 1-Watt
- Massive Gain Oriented Silicon Steel Transformer
- Multiple Feedback Loop Design (over 50 db)
- Metered Calibration Control Panel
- Absolutely Stable Under Any Conditions of Load

A new "Laboratory Standard" dual 50-watt amplifier guaranteed to outperform any basic stereo amplifier on the market. Advanced engineering techniques plus the finest components ensure flawless performance. Distortion levels so low they are unmeasurable. Hum and noise better than 90 db below 50-watts. Complete with metal enclosure.

LA-550 **134.50** in Kit Form

KT-550 **184.50** Completely Wired

Lafayette's NEW Easy-Pay Plan. NO MONEY DOWN

FREE!

YOURS FOR THE ASKING —

LAFAYETTE RADIO, DEPT. JK 1-2
P.O. BOX 10, SYOSSET, L. I., N. Y.

☐ Send FREE 1962 Catalog featuring the complete line of Lafayette Stereo Components.

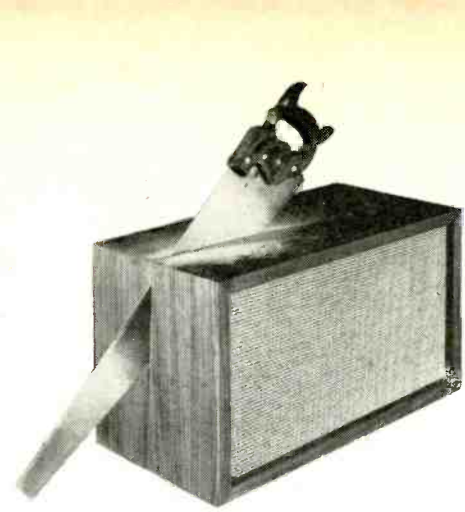
$ Enclosed .... for Stock No........................

Name____________________

Address____________________

City__________Zone______State__________

Flat enough to go on (or in) a wall, some of these new high-fidelity systems may contain up to 5 speakers



NEW Hi-Fi Speakers Only 4 INCHES Thin!

By LARRY STECKLER
ASSOCIATE EDITOR

FOR SOME TIME NOW, SPEAKERS HAVE fit into a fixed pattern and there has been little new and different about them. It may be habit but, whenever I think of high-fidelity speaker systems I automatically get a picture of a large and bulky cabinet. And it is just this sort of speaker enclosure that has made hi-fi installations so difficult.

Of course, there have been bookshelf speakers for some time now, the A-R units being a notable example. But even these demand considerable depth and make in-the-wall mounting impossible.

We usually don't have too much trouble finding a place to put the components of a system—amplifier, preamp, tuner, record changer—but when you need two complete speaker systems in their respective cabinets at two places in a room you run into problems. The major one is "Where do we put the speakers?" There's usually little extra space on the floor of a furnished living-room, except perhaps in some blocked-off corner that isn't really suitable in the first place. The alternative is to rearrange the furniture to suit the hi-fi system. Too often, this results in an eyesore. It seems to work only in a room originally designed as a music room. Wall mounting for the speakers might seem ideal, but such a setup is difficult because of the size and weight of the equipment.

Today, thanks to new developments, these problems have been simplified. Several manufacturers are now producing speakers so thin that, when placed in an enclosure, the entire system is only about 4 inches deep. This cuts even the small bookshelf unit's depth in half.

To head off a comment or two, it's true that there have been flat hi-fi speakers for a considerable time. But these units have been either electrostatics or some other special type like the Bi-Phonic coupler. All are relatively expensive—beyond the means of many hi-fi listeners.

The "new" speakers are ordinary cone type units, yet are only half as deep (front to back) as earlier models. All it took were a few modifications and changes—and a few years of work.

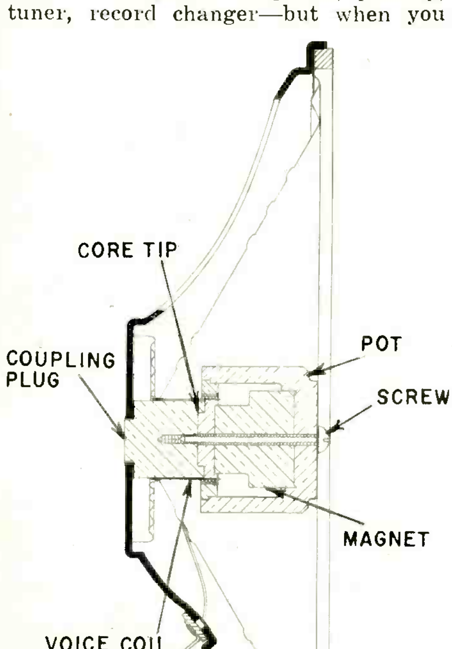


Fig. 1—Construction of inverted speaker.

Inverted speakers

One of the new units is an inverted speaker made by Utah. Inverted speakers are not absolutely new, but are new in hi-fi. A complete speaker system using this speaker is only 3 inches deep and contains a 6 x 9-inch woofer and a 3 x 5 inch tweeter. It's small in size and doesn't weigh too much, so it can be mounted easily. If you hang it on a wall, it doesn't stick out so far into the room that you have to duck your head each time you pass by. Placed on the floor, it doesn't take up room or upset the decor. It can even be built right into the walls with only the grille cloth visible to the eye.

By this time you must be wondering just what an inverted speaker might be. Well, it's an ordinary cone speaker complete with the usual voice coil and permanent magnet, but with one important difference. It's turned inside out. The magnet and the voice coil end up inside the cone of the speaker. Fig. 1 shows how this speaker is put together.

The protruding magnet is removed from behind the speaker cone, which

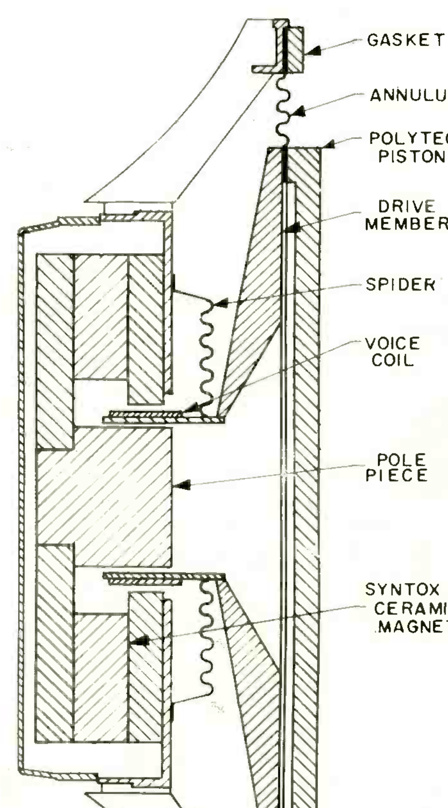
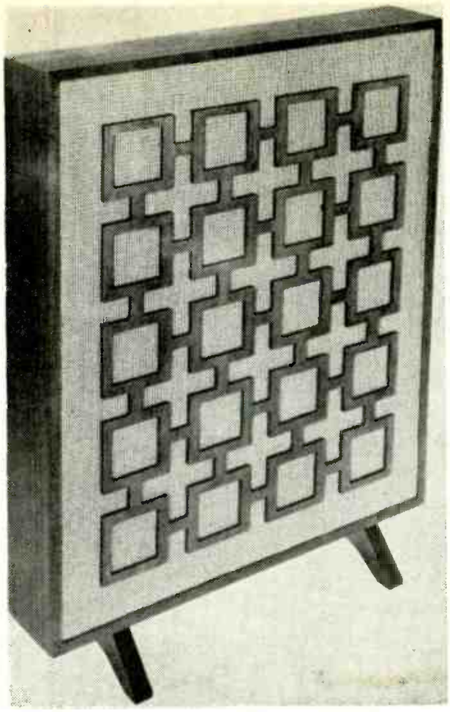
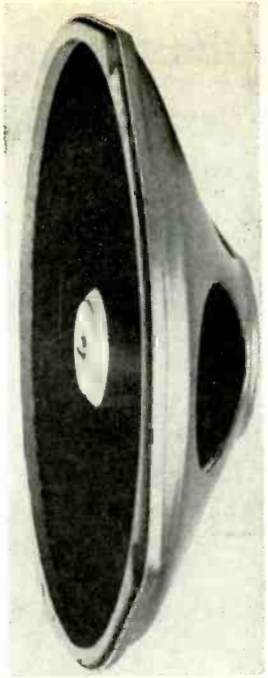


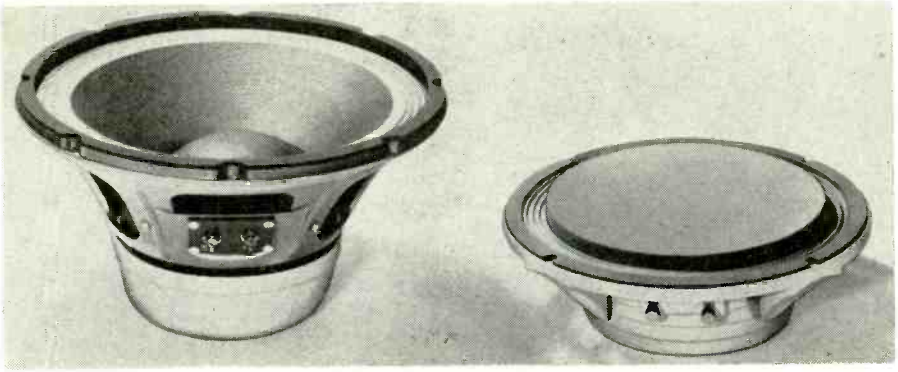
Fig. 2 — Cutaway view of piston-type woofer. Note double cone construction.



(Left) Rek-O-Kut CA-70, a thin unit that radiates from both front and back.



(Right) typical Utah inverted speaker.



Jensen's 3-P woofer (right) is half as deep as the earlier C12-NF.

shortens a 6-inch-deep speaker to about 3 inches. There is, however, one disadvantage to these units, an important one to the audiophile. All inverted units made to date can handle only limited amounts of audio power—up to about 15 watts maximum. But for low-power systems they do offer an interesting and practical design approach. And some day higher power units are bound to become available too.

Piston woofer

An entirely different approach to thinner hi-fi systems is being used by Jensen. In its new line is a 3-P speaker system that incorporates a new kind of woofer. It is this woofer that lets Jensen cut the depth of its speaker systems, including that of the already small bookshelf units, right in half. The new woofer is a piston speaker, and its magnet is just where you would expect to find it, behind the speaker cone. The active portion is made in two sections. There are a flat outside piston and an inner cone that drives the flat radiator (Fig. 2). The inner cone is, in turn, driven by a standard voice coil. The piston and cone are not made from the paper traditional in cone-type speakers. And the magnet is not a large slug of Alnico V. Instead the cone is made from little plastic beads that have been expanded and formed into a paperlike material. The advantage of the flat driving surface is obvious. It is as close to the ideal piston as a speaker is likely to get. This enables it to move air evenly across its entire surface.

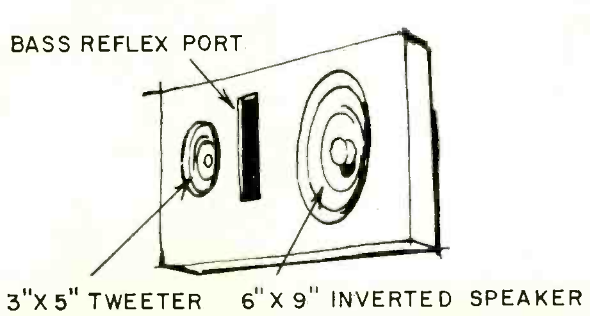
The magnet is new too. A ceramic material called Syntox-6, it has excellent magnetic characteristics. But the important thing is that this new materials makes it possible to build a comparatively flat speaker magnet. When this magnet is combined with the new cone material, Jensen gets a 10½-inch diameter woofer that can handle up to 25 watts of audio and is only a trifle more than 3 inches deep. The enclosure incorporating this woofer is only 3⅝ inches deep. It too can be hung on a wall or installed in it with little if any of the enclosure protruding.

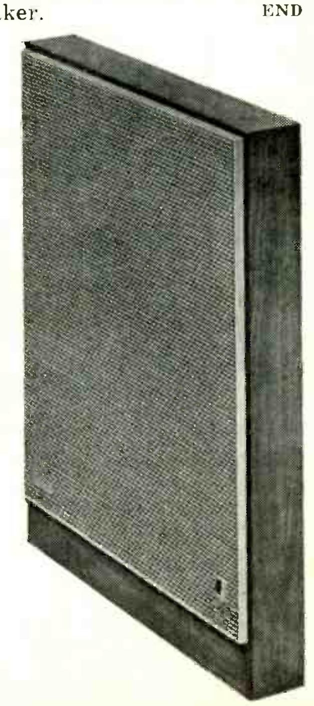
How good is a system that uses such a woofer? Let's take the Jensen 3P-2 as an example. According to the published specifications, the complete system in its enclosure is 28⅝ inches high, 21¼ inches wide and a trifling 3⅝ inches deep. It contains the new thin 3-P/W1 woofer, an M-80 midrange unit, two TW-40 tweeters and one E-10 ultra tweeter. Its frequency range is stated to run from as low as 20 cycles to beyond audibility. It has built-in crossovers at 600, 4,000 and 10,000 cycles. Its power rating is set at 25 watts, and the system impedance is 8 ohms.

Rek-O-Kut also offer a thin enclosure system. While it has not released details on its model CA-70 Sonoteer, specifications show that the unit includes two woofers, two mid-range speakers and one supertweeter. It is said to have a frequency range from 40 to 18,000 cycles and can handle 45 watts of program material. All this in a package only 4 inches deep! (It's 21 inches wide and 25 inches high.)

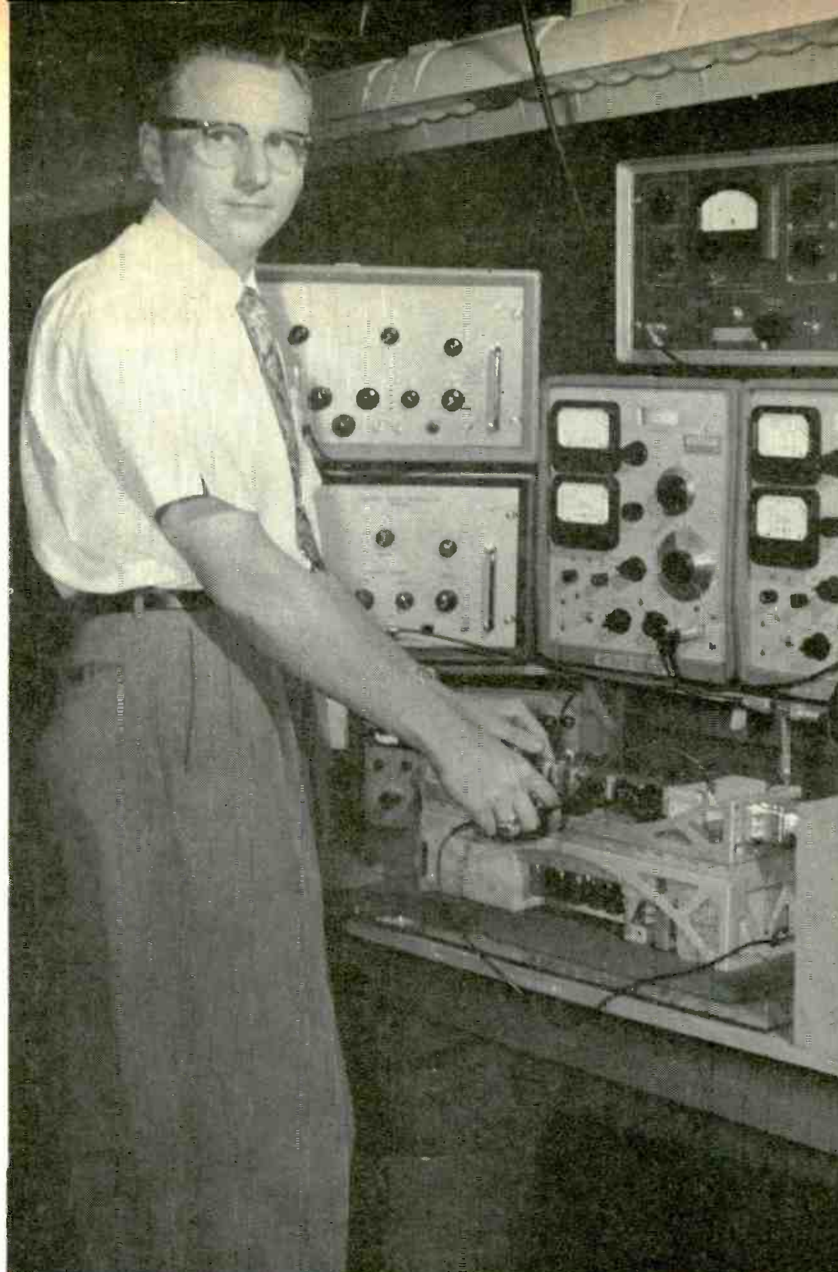
This unit offers one feature the others described do not. It radiates from both the front and back. This makes the unit an ideal room separator. When so used, listeners on both sides of the divider get equal listening pleasure and you have found another way of mounting the speaker. END

Those thinner speaker systems. Below is Utah's arrangement—it's only 3 inches deep—which uses their inverted speaker for the woofer. To the right is a complete speaker system made by Jensen. It owes its thinness to a shallow flat-cone woofer.





Profiles in Electronic Engineering Technology



CREI

"a CREI home study program helped me feel at home with electronics engineers."

"Since I took a CREI Home Study Program in Electronic Engineering Technology, my pay has increased a great deal and my responsibilities tripled. At present I am Supervisor, Electronic Test Dept. Your course has given me the background to feel at home with Electronics Engineers on the job."

Richard S. Conway
Supervisor, Electronic Test Dept.
Wilcox Electric Co.
Kansas City, Missouri

ELECTRONICS KNOWLEDGE YOU CAN USE. *CREI Home Study preparation gives R. S. Conway the technical background to deal with Engineers as Supervisor, Electronic Test Dept., Wilcox Electric Co.*

INDUSTRY-RECOGNIZED CREI HOME STUDY PROGRAMS PREPARE YOU FOR INCREASED RESPONSIBILITIES AND HIGHER-PAYING POSITIONS IN THE EXPANDING ELECTRONICS FIELD.

THERE IS A CREI PROGRAM TO MEET YOUR NEED. Today thousands of advanced electronics personnel—engineering technicians, engineers, administrators, executives—attribute their present high salaries and positions to their CREI home study of Electronic Engineering Technology. Wherever you go—wherever thorough knowledge of electronic engineering technology is a prime requisite—CREI Home Study students and alumni are welcomed.

TOP SCIENTISTS CONTRIBUTE TO COURSES. More than 20,500 CREI students are presently working in almost every phase of electronics in all 50 states and most countries in the free world. They study courses to which a number of today's leading engineers and scientists have contributed. They are guided and assisted by CREI's staff of experienced instructors. How long it takes to complete a CREI Home Study Program depends on on-the-job experience, the amount of time devoted to study and the program selected.

DEMAND FOR CREI-PREPARED MEN IS GREAT. It far exceeds the supply and has for many years. Specifically designed to prepare you for responsible positions in electronics, CREI texts *include the*

EMPLOYERS GIVE YOU SPECIAL CONSIDERATION *for advancement with CREI Home Study preparation. Quality Control Manager Ray V. Smith of Wilcox Electric Co. explains this to CREI alumnus Conway.*

PREPARE FOR A SECURE FUTURE *in electronics with a CREI Home Study Program. Richard Conway is shown relaxing in his yard with his children. CREI helped further his career, increase his income.*

INCREASE YOUR PROFESSIONAL STANDING. *A CREI Home Study Program helps you gain new authority and respect. Examining a complex installation with Conway is R. M. Soldanels, a technician at Wilcox Electric Co. who is currently studying a CREI Program at home.*

YOUR WHOLE FAMILY SHARES YOUR SUCCESS. *Living is better for everyone when you get promotions and advancements through CREI Home Study. Above, Mrs. Conway and their two children, Cynthia and David, share Richard Conway's success.*

latest advancements in electronics. We invite you to check the thoroughness and completeness of CREI Home Study Programs in the catalog provided on request. They include:

INTRODUCTION TO ELECTRONIC ENGINEERING TECHNOLOGY · ELECTRONIC ENGINEERING TECHNOLOGY · SPECIALIZED COMMUNICATIONS ENGINEERING TECHNOLOGY · SPECIALIZED AERONAUTICAL AND NAVIGATIONAL ENGINEERING TECHNOLOGY · SPECIALIZED TELEVISION ENGINEERING TECHNOLOGY · SPECIALIZED SERVOMECHANISMS AND COMPUTER ENGINEERING TECHNOLOGY · SPECIALIZED ENGINEERING MATHEMATICS · AUTOMATION AND INDUSTRIAL ELECTRONIC ENGINEERING TECHNOLOGY · NUCLEAR ENGINEERING TECHNOLOGY

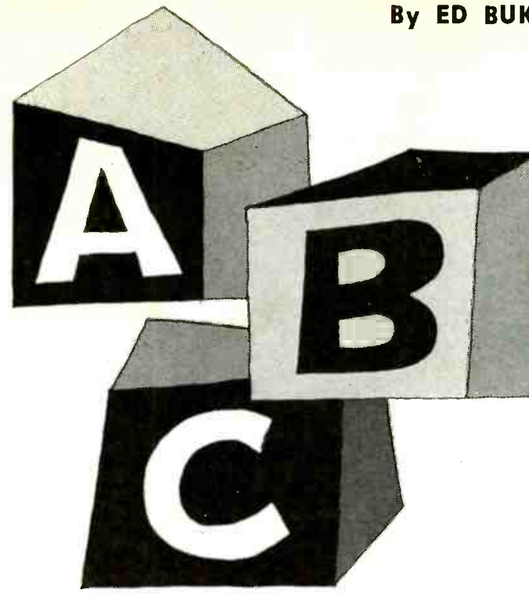
RATES HIGH WITH INDUSTRY. The high calibre of CREI Home Study Programs is attested to by America's biggest corporations, where CREI students and alumni attain positions ranging from engineering technicians to engineers to top officials. Such companies are National Broadcasting Company, Pan American Airways, Federal Electric Corporation, The Martin Company, Northwest Telephone Company, Mackay Radio, Florida Power and Light, and many others. These companies not only recognize the educational qualifications of CREI men, but often pay all or part of the tuition.

ELECTRONICS HOME STUDY SPECIALISTS. CREI Home Study Programs are the product of 34 years of experience; CREI itself was among the first to have its curricula accredited by the Engineers' Council for Professional Development. Each program is developed with the same painstaking skill and care that CREI put into its World War II electronics courses for the Army Signal Corps, its special radio courses for the Navy, and its post-war group training programs for leading aviation and electronics companies. For those who can attend in person, CREI maintains a Residence School in Washington, D. C., also offering ECPD accredited Technical Institute curricula.

REQUIREMENTS FOR ENROLLMENT. Pre-requisite is a high school education or equivalent *plus* electronics training and/or practical electronics experience. (Electronics experience and/or training not necessary for Residence School.) If you qualify, send for the latest CREI catalog at no cost. Veterans may apply under the G.I. Bill. If you're doubtful about your qualifications, let us check them for you. Use the coupon inserted between these pages or—if coupon has been removed—send qualifications to:

The Capitol Radio Engineering Institute
ECPD Accredited Technical Institute Curricula · Founded 1927
Dept. 1411-H, 3224 Sixteenth St., N.W.
Washington 10, D.C.

By ED BUKSTEIN



INDUSTRIAL ELECTRONIC DICTIONARY

From hold time through magnitude controlled rectifiers

Hold time: In resistance welding, the time allowed for the weld to harden. The welding cycle is initiated by placing the metals to be welded between a pair of electrodes. The time alloted for this operation is known as the *squeeze* time. The electrodes are connected to the secondary of a welding transformer, and the flow of secondary current develops enough heat to weld the metals together. The time interval during which current flows through the metals is known as the *weld* time. The welding current is now stopped, but the metals remain under pressure of the electrodes until the weld has set or hardened. This interval is known as the *hold* time.

Ignitor: Starting electrode of the ignitron tube.

Ignitron: A liquid-cathode (mercury) tube capable of carrying hundreds of amperes of current flow. The tube can safely carry such high currents because its cathode cannot be damaged by ion bombardment. As shown in Fig. 14, the pool of mercury is located at the bottom of the tube, and a graphite anode at the top. The envelope is a double-wall steel jacket, and water is circulated between the walls to cool the tube. The starting electrode, the ignitor, is a pointed rod extending down into the mercury pool.

When voltage is applied between the ignitor and the mercury pool, an arc forms at the tip of the ignitor. This arc vaporizes and ionizes some of the mercury, initiating a flow of current to the anode.

The ignitron is used industrially in rectifier service for providing large dc

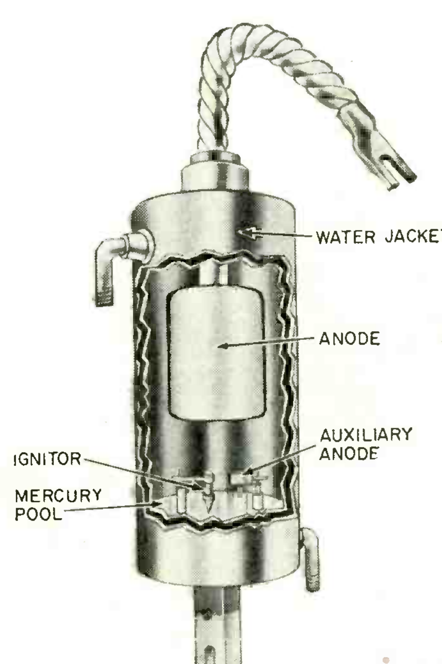


Fig. 14—The ignitron can safely carry hundreds of amperes of current because its liquid cathode is not damaged by ion bombardment. The tube is fired by passing current through ignitor circuit.

load currents and also in resistance welding equipment (see Back-to-back circuit).

Illumination control: Photo-relay circuit that turns on artificial illumination when natural lighting decreases below a predetermined level. This type of circuit is used to turn on the tower lights of broadcast stations at sundown or during periods of overcast weather. It is also used to turn on office, factory and yard lights when natural daylight becomes inadequate.

Induction heating: Process of heating metal by exposing it to a high-frequency magnetic field. As shown in Fig. 15, the metal to be heated is placed in or near a coil connected to a high-power rf oscillator. The rf current in the coil establishes an alternating magnetic field. As a result, eddy currents are induced in the metal, raising its temperature. This may be regarded as a transformer action, the heating coil functioning as a primary and the metal as a shorted single-turn secondary.

Industrially, induction heating is used to solder lids on metal containers, reflow tin plating, detonate explosive rivets and surface-harden machined parts such as gears, etc.

Intensifier screens: Pair of fluorescent screens used to expose the photographic film in an X-ray installation. The film is placed between the two intensifier screens so it is exposed not only by X-rays but also by the light emitted from the screens. This results in greater contrast and reduced exposure time.

Inverse-parallel connection: Two tubes connected in parallel but in opposite directions. Since the two tubes conduct on alternate half-cycles of supply voltage, current can be controlled without introducing rectification. This arrangement is commonly used to control the flow of alternating current through the primary of a welding transformer (see Back-to-back circuit).

Light chopper: Motor-driven disc having a series of openings, slots, notches, etc. so that it periodically interrupts the light beam to a phototube. Such chopping introduces an ac component into the phototube output, permitting the use of R-C or transformer-coupled amplifiers. If the light beam were not chopped, the phototube would produce a dc output signal and direct-coupled amplifiers would be required. Such amplifiers tend to be critical with respect to temperature and supply-voltage variations.

Light dimming control: A circuit, employing a saturable reactor, used to dim the lights in theaters, auditoriums, etc. As shown in Fig. 16, variable dc is passed through one winding of the saturable reactor, and the other winding is connected in series with the lights to be controlled. Increasing the current through the dc winding of the saturable reactor causes the iron core to become more saturated. As a result, the inductive reactance of the ac winding is decreased, allowing more current to flow through the lights. In this way

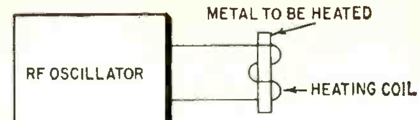


Fig. 15—Induction heating is based on inducing eddy currents in the metal to be heated.

a small rheostat can control thousands of watts of lighting power.

Long-tailed pair: A two-tube circuit in which decreased plate current through one tube will result in increased current through the other tube. As shown in Fig. 17, a common-cathode resistor is used so that the plate current of one tube controls the bias of the other. If a positive potential is applied to V1's grid, for example, its plate current increases and more bias is developed across the cathode resistor. As a result, V2's plate current decreases.

The long-tailed pair may be regarded as a two-stage amplifier: a cathode follower feeding into a grounded-grid amplifier. This circuit is commonly used as a vtvm. A probe is connected to V1's grid and a meter connected between the two plates. In another application, the long-tailed pair controls a reversible dc motor. The two opposing field windings of the motor (forward and reverse) are connected in the two plate circuits, and the direction of motor rotation is determined by the relative currents of V1 and V2.

Magnitude-controlled rectifier: Type of rectifier circuit using a thyratron as the rectifying element. Load current is controlled by varying the thyratron bias. The load may be a motor (for speed control), a heating element (for temperature control), etc. (see Amplitude-controlled rectifier and Firing angle).

TO BE CONTINUED

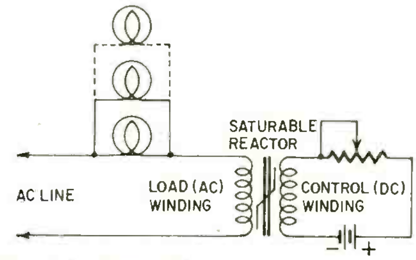


Fig. 16—Saturable reactor functions as variable reactance in series with lights. Reactance of ac winding is determined by current in dc winding.

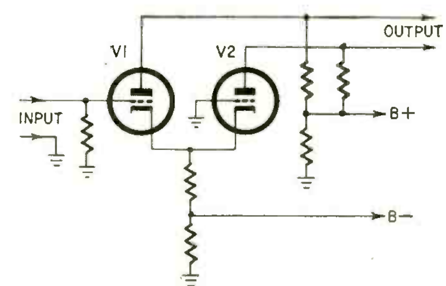


Fig. 17—Long-tailed pair uses common-cathode resistor so plate current of one tube determines bias of other tube.

SECRET SIGNALS on YOUR TV SCREEN

They can help you check linearity, frequency response and black or white compression

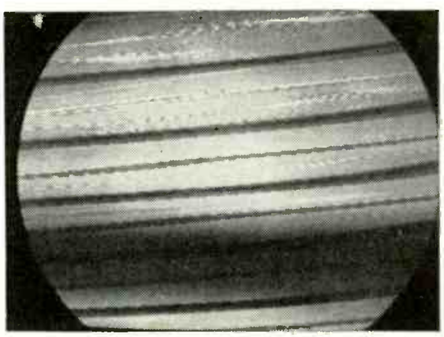


Fig. 1—Misadjust horizontal hold for pattern for quick check of vertical linearity.

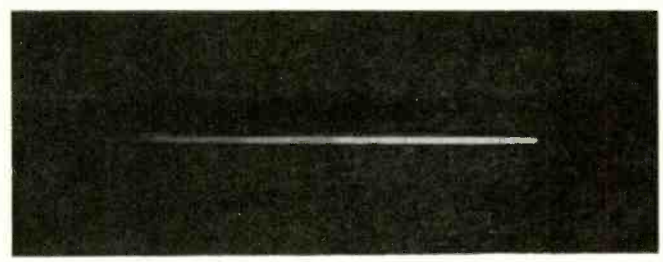


Fig. 3—Shaded boxes can be used to check horizontal linearity. All are of equal length when linearity is good.

By ELMER C. CARLSON

Is the orientation or matching of the antenna causing ghosts that interfere with the frequency response?

Is a weak picture tube or improperly set ion trap affecting the gray-scale reproduction?

Are the screen and mask dust-free?

Has the TV receiver been designed to reproduce 4.2 mc? 3.6 mc?

In most localities it is hard to find a test pattern to check these TV picture qualities. Test patterns are broadcast, if at all, during the hours that have the fewest viewers. But don't despair, there are ways to check without any special equipment. The necessary pulses and signals are hidden in your TV receiver.

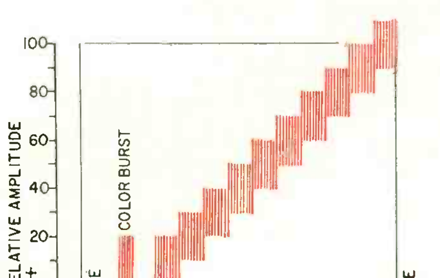


Fig. 2—Linearity test signal display.

For example, misadjusting the horizontal hold will produce almost horizontal, parallel lines across the screen. If the hold is set to show the blanking bar as 5 to 10 lines (Fig. 1) during a low-contrast scene, you have a usable pattern. With a little patience and with the contrast and brightness set to where only the peak of the sync pulse is black, vertical linearity can be accurately set. Simply adjust linearity to produce evenly spaced and sized bars across the screen.

The rest of our test signals are not found so readily. We must hunt for them. These signals are inserted by the TV networks during certain network broadcasts. They are needed to maintain proper signal levels and check the amplitude, linearity and frequency response of the video amplifiers and their connecting cables.

Generally, these signals are hidden from the viewer. Since they are inserted into the first 3 of the last 5 lines of the vertical blanking bar, a TV with a properly centered raster and fully scanned screen does not show them. Reduce the height or change the centering until the top blanking bar is visible and they'll appear.

Stair-step signal

One of the specially generated signals enables us to check the horizontal linearity. It is a 3.58-mc sine wave superimposed on the basic step-wave signal. These combined waveforms (Fig. 2) appear, with properly adjusted brightness and contrast, as narrow lines, all of equal length, in shades of gray from black to white (Fig. 3). This *10-step gray scale* of the *step-wave signal* makes an ideal linearity pattern for horizontal adjustments. Again set linearity (horizontal linearity this time) for equally spaced bars.

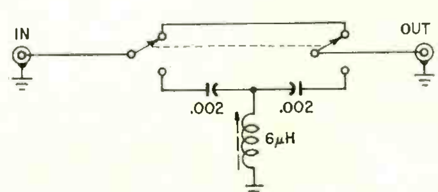


Figure. 4—High-pass filter brings out linearity test signal.

Fig. 5—Linearity test signal at output of high-pass filter. This pattern shows compression at both black and white pedestal levels.

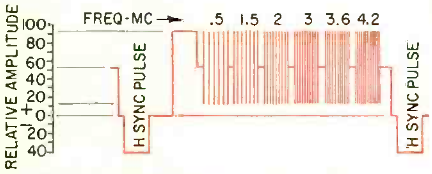


Fig. 6—Frequency burst display.

The eye alone is not accurate enough to set broadcast equipment, throughout the network, as accurately as necessary. To eliminate the possibility of error from personal judgment, the TV broadcasters insert a simple high-pass filter (Fig. 4) in series with the monitoring oscilloscope. It removes the step wave, and any nonlinearity in the video chain is shown as differences in the peak-to-peak amplitude of the 3.58-mc sinewaves on the scope screen (Fig. 5). *Black compression* is indicated by a smaller amplitude on the left, and *white compression* is shown as a lesser peak-to-peak amplitude of the sine waves on the right.

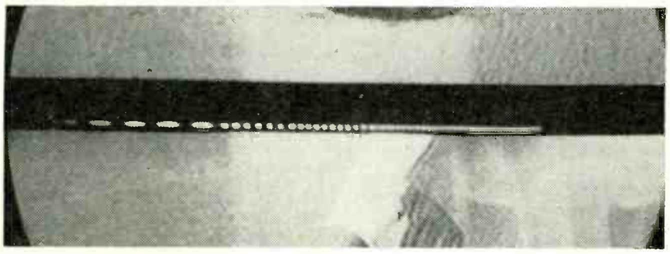


Fig. 7—The low frequency dots can be seen easily. The 4.2-mc sine waves are quite blurred.

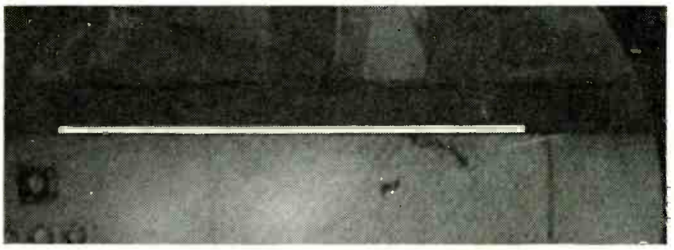


Fig. 8—Bar signal is used to check low-frequency response. Smearing indicates poor response.

High-frequency response

A *frequency-burst* signal is generated and inserted into the same three blanking lines for a different testing period. Groups of six cycles each of 0.5, 1.5, 2.0, 3.0, 3.6 and 4.2 mc are inserted. One such line is drawn in Fig. 6. The frequency response of the amplifier is better than the viewed frequency as long as the six dots of that group remain crisp and separate from one another (Fig. 7). The point where they start to blend into one line indicates the limits of the amplitude-frequency response of that amplifier or receiver.

Low-frequency response

To check amplitude-frequency response at low frequencies (below 200 kc) a different type signal is used. It is the exact opposite of the high-frequency test signal. Instead of small dots, it is a long white horizontal bar. This *bar signal* (Fig. 8) is inserted like the others and the amount of shading or smearing along its length determines the low-frequency response.

Window signal

For more complete testing and evaluating, broadcast engineers have another signal, which is seldom if ever broadcast. For this, rectangular signal pulses are inserted at both the line (15,750 cycles) (Fig. 9-a) and the field (60 cycles) frequencies (Fig. 9-b) to form a window in the raster, centered vertically and with the right edge of this window in the center of raster (Fig. 9-c). Smear can be measured accurately to give the low-frequency response.

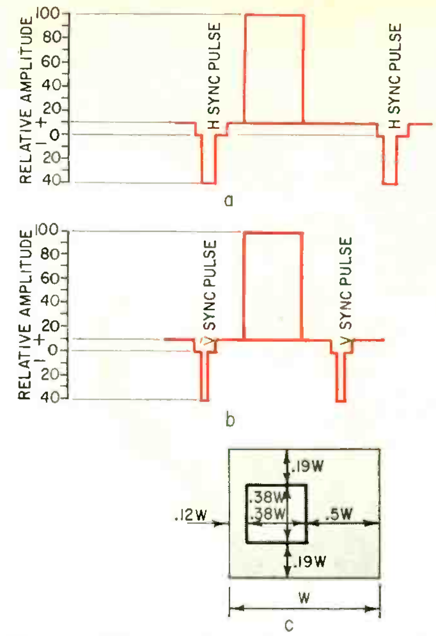


Fig. 9—This window signal is used by broadcast engineers to give accurate reading of low-frequency response.

White-reference pulse

While watching for these signals, another one will probably be seen intermittently. Although of little value for receiver adjustments, it is considered the most important to network programming. It was introduced to reduce the number of complaints of *white-level* shift from program to program.

The camera control operator is responsible for setting the maximum white level. In extended night-scene sequences, few if any white-signal peaks are had and amplifier control setting throughout the network is left to the experience and the educated guess of the operators. To help, a maximum-intensity white pulse (Fig. 10) is put in the upper-right corner of the raster (Fig. 11) where the CRT mask hides them and they present minimum picture interference even on underscanned receiver screens.

All these signals help improve picture quality. The average viewer often cannot distinguish between programs that originate locally or in a distant city.

END

Fig. 11—Small white rectangle in upper right corner of the frame is the maximum white level pulse.

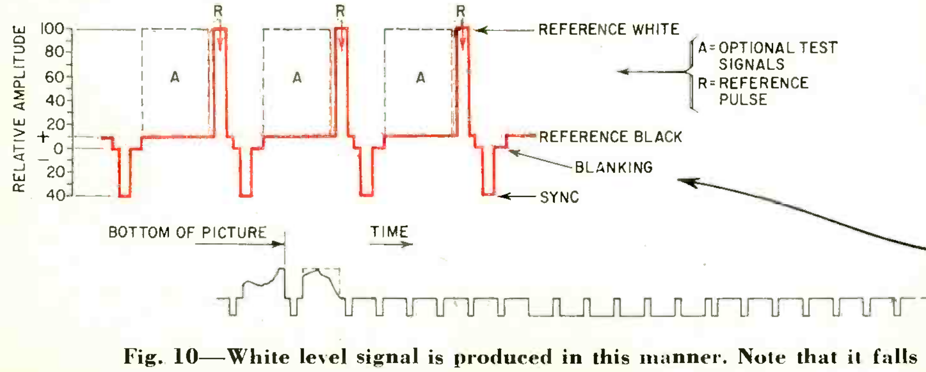
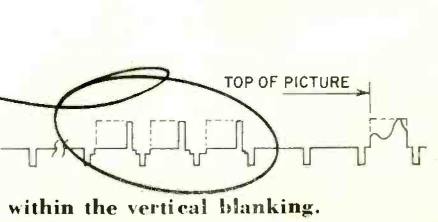



Fig. 10—White level signal is produced in this manner. Note that it falls within the vertical blanking.

WORTH SHOUTING ABOUT!

NEW IMPROVED MIGHTY MITE

Reaching New Peaks in
Performance, Portability and Price

MiGHTY MiTE II

They're shouting from the hill tops. Technicians, engineers and test labs all say that the original Mighty Mite finds the tubes that large expensive testers miss. And now . . . here is the new improved Mighty Mite! Designed for the present and far into the future. Tests all of your present tubes plus the new RCA Nuvistors and Novars, GE Compactrons and Sylvania 10 pin tubes.

67.50 DEALER NET

Remember . . . there is only one Mighty Mite

A complete tube tester that is smaller than a portable typewriter yet outperforms testers costing hundreds of dollars. A real money maker for the serviceman and a trusty companion for engineers, maintenance men and experimenters.

Even though the Mighty Mite weighs less than 8 pounds, new circuity by Sencore enables you to use a meter to check grid leakage as high as 100 megohms and gas conditions that cause as little as one half microamp of grid current to flow. Then too, it checks for emission at operating levels and shorts or leakage up to 120,000 ohms between all elements. This analytical "stethoscope" approach finds troublesome tubes even when large mutual conductance testers fail. And it does all this by merely setting four controls labeled A, B, C, & D.

Check these plus Sencore features: Meter glows in dark for easy reading behind TV set • Stainless steel mirror in adjustable cover for TV adjustments • Rugged, all steel carrying case and easy grip handle • Smallest complete tester made, less than one foot square. Mighty Mite II will test every standard radio and TV tube that you encounter, nearly 2000 in all, including foreign, five star, auto radio tubes (without damage) plus the new GE Compactrons, RCA Nuvistors and Novars and Sylvania 10 pin tubes.

Mighty Mite II also has larger, easy-to-read type in the setup booklet to insure faster testing. Why don't you join the thousands of servicemen, engineers, and technicians who now own a Mighty Mite tube tester? Tube substitution is becoming impossible and costly with nearly 2000 tubes in use today. Ask your authorized Sencore Distributor for the New Improved Mighty Mite. Size: 10¼" x 9¼" x 3½" Wt. 8 lbs.

MODEL TC114

Sencore Sam says . . . "They all agree . . . the Mighty Mite is the real answer for the man on the go."

SENCORE ADDISON, ILLINOIS

A PROPHECY

For men and women with a sincere desire to succeed

"In the years that have passed since my days on the faculty of RCA Institutes, I have become even more firmly convinced that the individual who continues his education . . . particularly his technical education . . . is the individual who profits both as a thinking man and as a working man. Science and industry will reward you for your talents and energy. Out of your efforts may come inventions, new products, processes and services. There is everything good yet to be accomplished in our lives and in our work. What man has done, man can do better."

David Sarnoff

Chairman of the Board,
Radio Corporation of America

RCA Institutes Offers the Finest of Home Study and Resident Training for Your Career in the Rapidly Expanding World of Electronics

RCA Institutes, founded in 1909, is one of the largest technical institutes in the United States devoted exclusively to electronics. A service of Radio Corporation of America, RCA Institutes offers unparalleled facilities for technical instruction . . . tailored to *your* needs. The very name "RCA" means dependability, integrity, and scientific advance.

RCA Institutes Home Study School, licensed by the New York State Department of Education, offers a complete program of integrated courses for beginners and advanced students ranging from electronic fundamentals to automation. All courses are designed to prepare you for a rewarding career in the rapidly expanding world of electronics. *The caliber of the training your receive is the finest!* And you get top recognition as an RCA Institutes graduate!

HOME STUDY COURSES

in Radio and Electronic Fundamentals
TV Servicing · Color TV · Transistors
Electronics for Automation

New Voluntary Tuition Plan. All RCA Institutes Home Study courses are available under the Voluntary Tuition Plan. This plan affords you the most economical possible method of home study training. You pay for lessons only as you order them. If, for any reason, you should wish to interrupt your training, you can do so and you will not owe a cent until you resume the course. No other obligations! No installment payments required.

RCA Personal Instruction. With RCA Home Study training you set your own pace in keeping with your own ability, finances, and time. RCA Institutes allows you ample time to complete the course. Your lesson assignments are individually graded by technically trained personnel, and helpful comments are added where required. You get theory, experiment, and service practice beginning with the very first lesson. All lessons are profusely illustrated. You get a complete training package throughout the entire course.

You Get Prime Quality Equipment. All kits furnished with the course are complete in every respect, and the equipment is top grade. You keep all the equipment furnished to you for actual use on the job . . . and you never have to take apart one piece to build another.

RESIDENT SCHOOLS

in Los Angeles and New York City— You can study electronics in the city of your choice.

No Previous Technical Training Required For Admission. You Are Eligible Even If You Haven't Completed High School. RCA Institutes Resident Schools in Los Angeles and New York City offer training that will prepare you to work in rewarding positions on research and production projects in fields such as automation, transistors, communications, technical writing, television, computers, and other industrial and advanced electronics applications. If you did not complete high school, RCA will prepare you for such training with courses specially designed to provide the basic math and physics required for a career in electronics.

Free Placement Service. RCA Institutes graduates are now employed in important jobs at military installations such as Cape Canaveral, with important companies such as IBM, Bell Telephone Labs, General Electric, RCA, and in radio and TV stations all over the country. Many other graduates have opened their own businesses. A recent New York Resident School class had 92.06% of the graduates who used the Free Placement Service accepted by important electronics companies... *and had their jobs waiting for them on the day they graduated!*

Coeducational Day and Evening Courses. Day and Evening Courses are available at Resident Schools in New York City and Los Angeles. You can prepare for a career in electronics while continuing your normal full-time or part-time employment. Regular classes start four times each year.

SEND POSTCARD FOR FREE ILLUSTRATED BOOK TODAY! SPECIFY HOME STUDY OR NEW YORK OR LOS ANGELES RESIDENT SCHOOL

RCA INSTITUTES, INC. A SERVICE OF RADIO CORPORATION OF AMERICA, 350 WEST 4TH ST., NEW YORK 14, N. Y.
PACIFIC ELECTRIC BLDG., 610 S. MAIN ST., LOS ANGELES 14, CALIF.

RCA The Most Trusted Name in Electronics

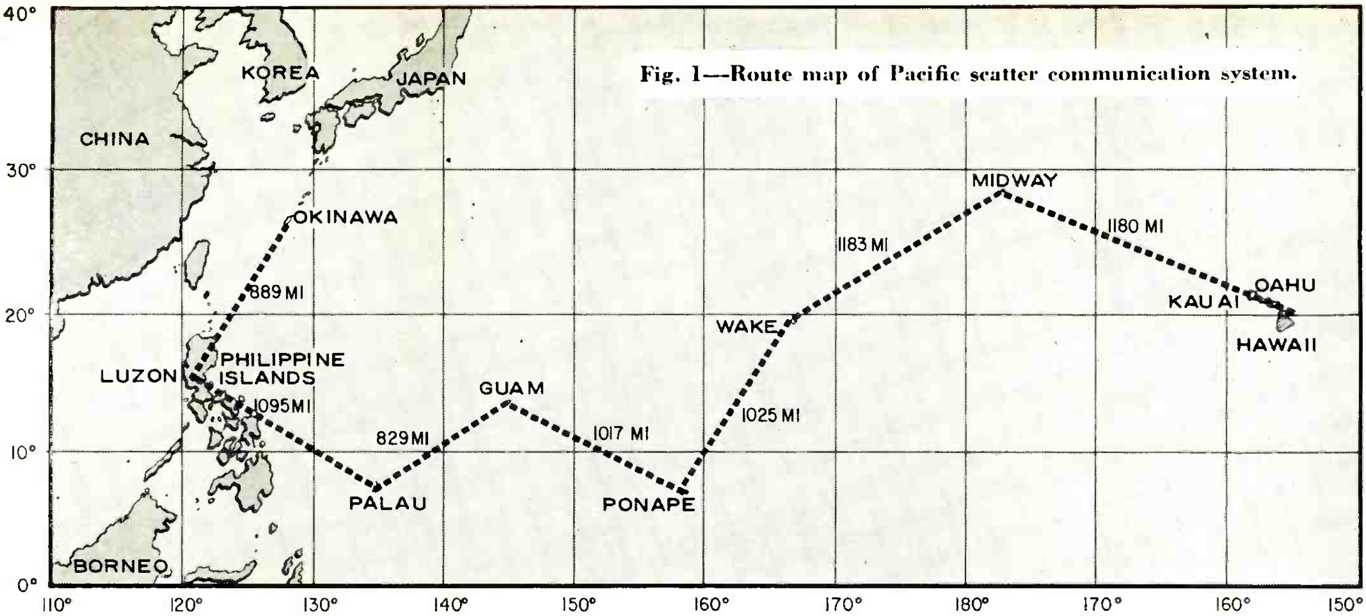


Fig. 1—Route map of Pacific scatter communication system.

new link in US defense— PACIFIC SCATTER

Long-range multichannel trans-Pacific teleprinter and voice system is 7,400 miles long; uses iono-scatter and troposcatter with other advanced techniques for high reliability

By JORDAN McQUAY

LONGEST and largest of its kind in the world, the new Pacific Scatter Communication System* presently consists of eight radio relay links connecting Hawaii, Midway, Wake, Guam and other island with the Philippines and Okinawa (Fig. 1). All use *iono-scatter* propagation—except the short troposcatter link within Hawaii. Additional relay links, now under construction, will extend the Pacific System to Taiwan (Formosa) and several other points in Asia.

Until the Pacific System became operational, high-frequency (hf) radio communication between many of the sites—particularly the long haul from Hawaii to the Philippines and Okinawa —was unreliable, unpredictable and often impossible. This was due largely to propagational effects and disturbances, some general in nature, and some peculiar to the Pacific area. Most of these problems were solved by introducing vhf and uhf scatter techniques of propagation.

Stations of the system continuously transmit and receive 16 multiplexed teleprinter channels *plus* a party-line 2.2-kc voice channel. Unless destined for a specific station, teleprinter traffic is not delayed by decoding and encoding procedures, but passes through relay stations as electronic data.

Exceptional system reliability—greater than 99.9%—results from critical design, extensive automation and standardization operation and maintenance.

All major equipment at each station is in duplicate: antennas, transmitters, exciters, receivers, multiplex terminals, power supplies and other critical elements. All duplicate or reserve equipment is also on, and is ready to use. If any piece of equipment fails or gives trouble, the standby is switched in automatically. Interference, whether accidental or intentional, can be circumvented electronically.

Each station has a central monitor and supervisory console equipped with indicators, meters and graph recorders that show continuously the quality of teleprinter traffic and the operating status of all primary and reserve equipment and facilities.

Each station is self-supporting and self-sufficient, with Diesel power supplies and other plant equipment—plus housekeeping facilities (Fig. 2).

Conventional long-range hf communication requires many changes in operating frequency to meet varying atmospheric conditions during every

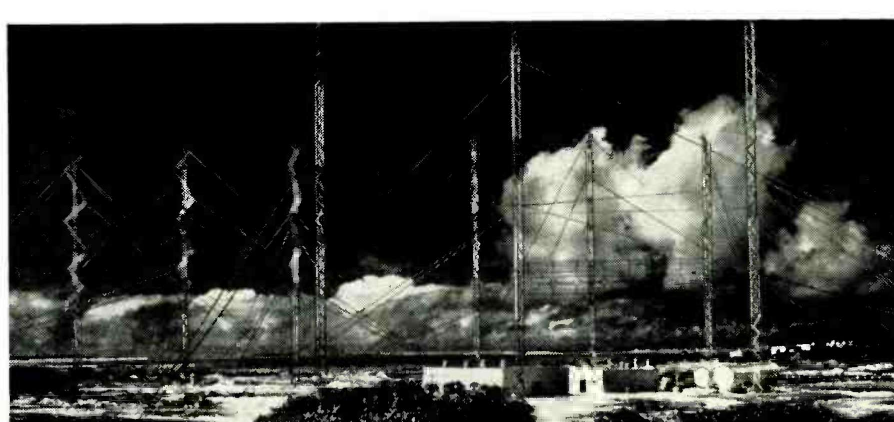


Fig. 2—Typical relay station at Wake Island.

*See RADIO-ELECTRONICS, August 1960, page 6.

24-hour period. Relay links of the Pacific System use a fixed frequency at all times. This extends traffic time to maximum, simplifies operation and maintenance and helps prevent clutter of the frequency spectrum.

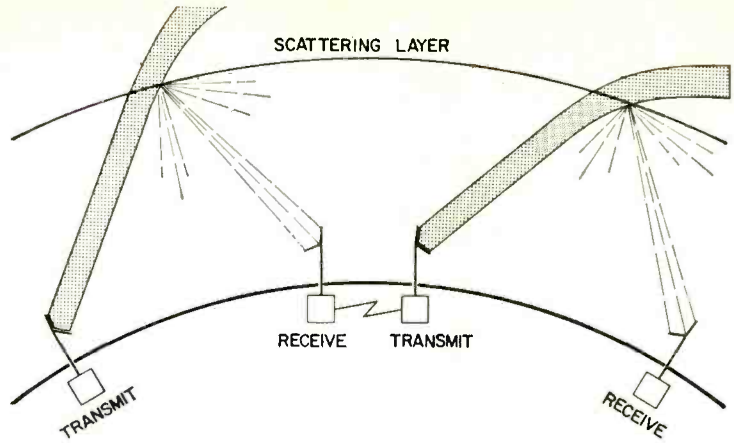


Fig. 3—Scatter technique. Signals from transmitter bounce off ionosphere (shown as single line here) and a portion of them reach the receiver.

Ionoscatter technique

To make use of ionospheric scatter, vhf signals are transmitted upward at such an angle that they are splashed against this layer above the earth. Some of these waves penetrate the ionosphere and are lost in outer space. Some of them bounce back and forth, between earth and ionosphere, in all directions—attenuating quickly. A few of these waves, however, return directly to earth as forward-scattered fragments of the original signal and can be detected by highly sensitive receivers located 600 to 1,200 miles from the transmitting station. When the received signal is instantly transmitted again, it can be received once more in the same manner—thus covering as much as several thousand miles. Two relay links illustrate the principle of scatter transmission and reception in Fig. 3.

This ionoscatter technique is effective at an operating frequency between 35 and 55 mc. At lower frequencies, the signal would be adversely affected by various propagational effects, and communication would not be reliable unless the operating frequency was changed several times a day. At higher frequencies, other propagational effects and tropospheric influences would contribute to low signal strength and uncertain reliability.

Any of the ionoscatter links of the Pacific System may operate within either of two frequency bands: a *low* band between 34 and 37 mc, and a *high* band between 49 and 55 mc. Both the transmitter and distant receiving group or any link are tuned to the identical frequency, within either of these two bands.

An average power output of 40–60 kw is great enough for transmitters of the system. Greater power would be dissipated in the ionosphere.

At the receiving site, fragments of the forward-scattered signal may return to earth at any number of nearby points. For this reason, *four* vhf receivers operate continuously to provide quadruple-diversity reception. The strongest signal from any of the four receivers is selected automatically. This is the desired signal at a receiving site—the forward-scattered signal of Fig. 3.

There is an undesired signal occasionally: the back-scattered signal. This is also composed of scattered fragments of the signal originally transmitted. But these fragments have literally bounced back and forth, several times, between earth and ionosphere, so that they arrive *later* than the desired forward-scattered signal. This kind of reception is known as *multipath delay* and introduces serious interference and distortion affecting the mutiplexed teleprinter channels.

Nature overcomes part of the problem of multipath delay—with the occasional enhancement of forward-scattered signals by reflection from ionized meteor trails in space. To take advantage of this natural phenomenon, each receiver has a dynamic range of more than 100 db, which permits reception of a wide range of signal intensities. Coupled with this is the automatic

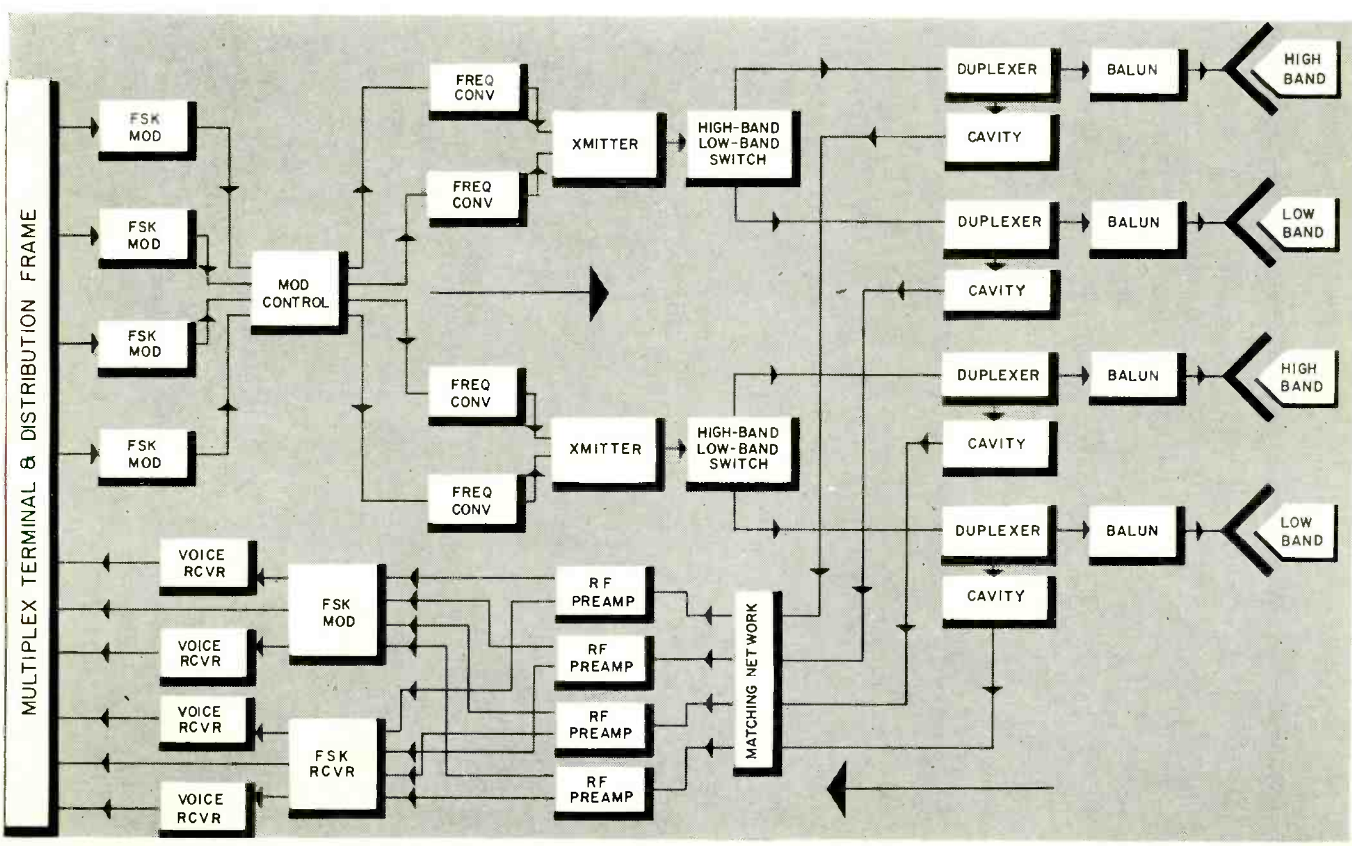


Fig. 4—Simplified block diagram of typical ionoscatter station.

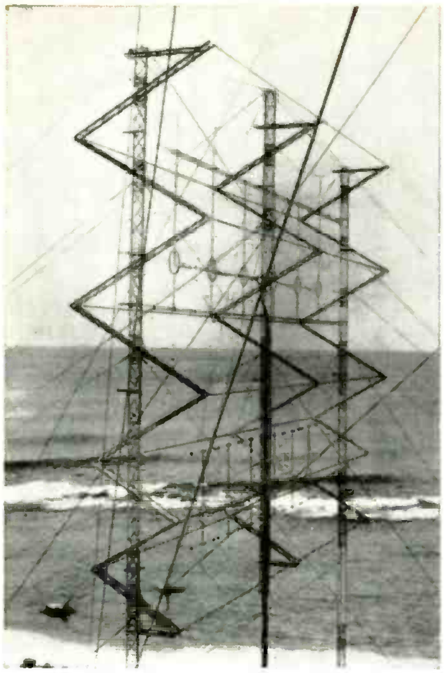


Fig. 5—Ionoscatter antenna array at Guam.

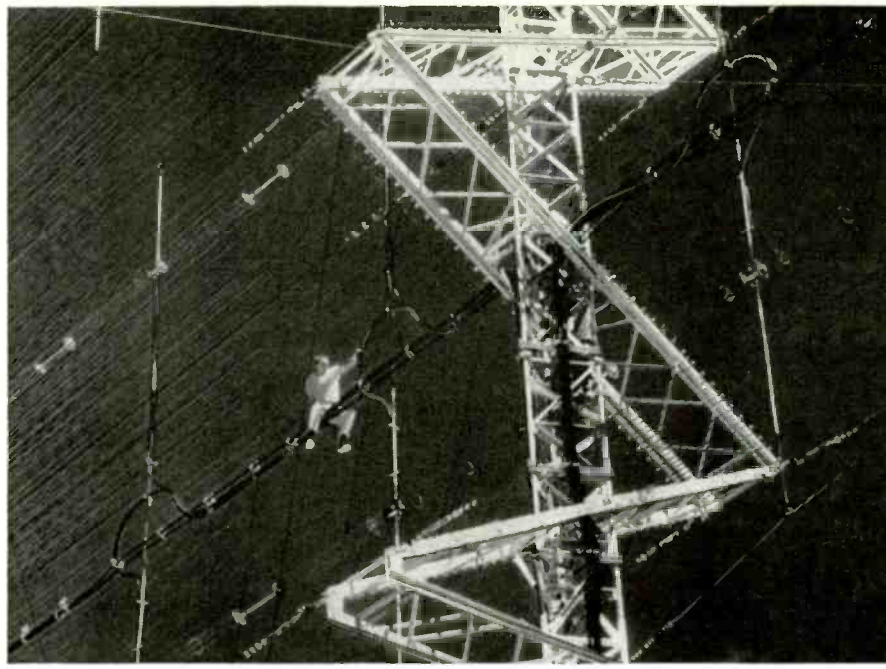


Fig. 6—Antenna closeup. Rigger is adjusting feed lines.

ability of each receiving group to select the signal of greatest intensity—invariably the forward-scattered signal—from the quadruple-diversity configuration of the receiving group.

A typical ionoscatter relay station of the Pacific System consists essentially of a transmitting group with a regular and reserve transmitter, a receiving group with four quadruple-diversity receivers, and a regular and reserve antenna array. A simplified block diagram of a typical ionoscatter station is shown in Fig. 4.

Ionoscatter arrays

Essential to the operational efficiency of ionoscatter relay links of the Pacific System are the high-gain duplexed antenna arrays (Fig. 5).

Although large rhombics could be used to achieve high gain and high directivity, they require a great deal of ground area. This is not practicable on many of the islands of the Pacific.

At the other extreme are Yagi arrays, which need little ground area but require delicate installation and sensitive tuning. Because of high-velocity winds encountered in the Pacific region, these arrays are unsuitable.

The optimum is a corner-reflector array of entirely new design. Although costly to erect, it requires much less ground area than a rhombic and is not sensitive in adjustment like a Yagi.

The new type of corner-reflector array consists essentially of *two* 60° corner-reflector assemblies stacked vertically. Since the system must operate within either a high band or a low band of frequencies, the dual stacked array is doubled—the low-band portion stacked atop the high-band portion of the array—and the whole mounted on a three-tower steel structure.

Since a relay station must operate in two almost-opposite directions, there are two complete dual-band corner-reflector arrays at such stations. The dual-band arrays are separated normal to the path azimuth, and provide quadruple space-diversity reception.

Radiating–receiving elements of each array are full-wave center-fed dipoles. There are 12 dipoles each for the low- and high-band portions of each array. The dipoles are supported about 0.55 wavelength from the apex of the reflecting curtain. The curtain apex angle is 60°.

At the center feed point of each dipole, the impedance is about 200 ohms because of the relatively large diameter of these elements *plus* the use of internal coaxial matching sections. Balanced feed lines are shielded single conductors constructed of Styroflex coaxial cable.

The reflecting curtain is composed of 10-gauge copper-welded wires. These are spaced 7 inches apart, arranged horizontally and evenly spring-tensioned to achieve an essentially plane reflective surface with low wind resistance. For details of array construction, see Figs. 6 and 7.

Each complete dual-band corner-reflector array is mounted on a structural support consisting of three vertical galvanized-steel towers which are heavily guyed. (Note the use of sea anchors in Fig. 5.)

These towers vary in height from 66 to as much as 400 feet, depending upon topographical as well as propagational factors at each island site. All metal surfaces are specially treated and all guy wires are copper-clad—to resist the rapid corrosion characteristic of salty-humid climate.

Each radiating–receiving section of an array has a duplexed feed system, using branching filters, which permits simultaneous transmission and reception for either low- or high-band portions of the array (Fig. 4). This system consists of two notch filters which reject transmitter-generated thermal noise at the receiving frequency, *plus* four cavities which pass the receiving-frequency signals but prevent transmitter power from reaching the quadruple-diversity receivers. As a result, rf energy from

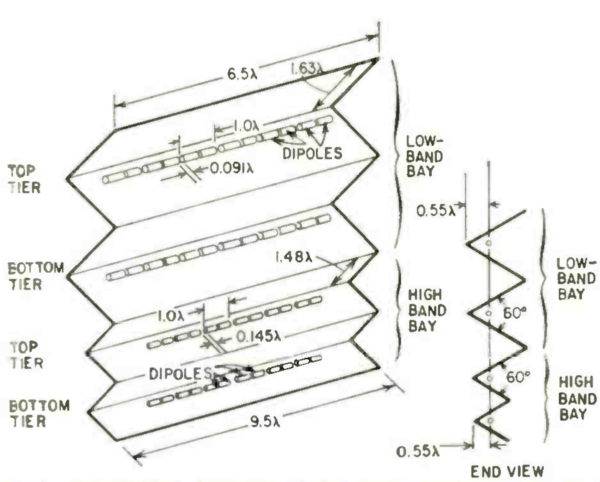


Fig. 7—Simplified drawing of the antenna shown in Fig. 6.

YOU ARE NOW LOOKING AT 20 DIFFERENT MICROPHONES

MODULAR MICROPHONES!*
Another exclusive concept that makes UNIVERSITY microphones better.

20 microphones? Yes—for any **one** of University's MODULAR MICROPHONES can provide at least **five** different methods of operation! University has inaugurated a new era in microphone design and construction—**professional** microphones offering **total interchangeability** with every conceivable type of adapter! This permits long-term savings as well as improved versatility, for you can add suitable adapters as your microphone requirements change—**without buying additional microphones.** You need never compromise quality to meet a price.

And it works as simply as this: equipped with a minimum of basic University MODULAR MICROPHONES, any one of University's interchangeable adapters may be chosen to complete the microphone assembly you require...with or without switches, for cables with and without quick-disconnect plugs, for screw-on or slide-on floor and desk-stand operation. And you can make **instant** impedance changes without tools, rewiring or soldering!

*TRADEMARK

For the complete story on University's new line of omni-directional, cardioid and lavalier MODULAR MICROPHONES, send for the free 16-page brochure. Write: Desk J-11, University Loudspeakers, Inc., 80 S. Kensico Ave., White Plains, New York.

UNIVERSITY
A Division of Ling-Temco Electronics, Inc.

the transmitter is negligible at the output terminals of the receiver cavities. Matching networks between the cavity outputs and the preamplifier input terminals provide a 50-ohm source for the various inputs of the receiving system. There are three resonant cavity sections and a high-level shorted-line section in a complete branching filter, each associated with a low-band or high-band portion of an array. There are two sets of branching filters at the input of each of the four preamplifiers for space-diversity operation.

Ionoscatter equipment

Transmitting equipment for each ionoscatter relay link consists of a 60-kw power amplifier (in duplicate), two frequency converters (in duplicate), two FSK (frequency-shift keying) modulators (in duplicate) and switching and auxiliary equipment (Fig. 4). This transmitting group accepts a composite signal from the multiplex terminal, converts the signal into a broad frequency-shifted rf signal, multiplies its frequency to that of the operating or carrier frequency, and finally amplifies this signal and feeds it to either the low- or high-band portions of the antenna array. The transmitter delivers an average power of 60 kw class-C, about 40 kw class-B, with eight air-cooled type 3X2500A3 triodes in a grounded-grid configuration and a symmetrical tank circuit composed of shorted sections of coaxial lines.

The receiving group for each ionoscatter relay link includes two rf preamplifiers (in duplicate), an FSK receiver (in duplicate) and switching and auxiliary equipment (Fig. 4). This group accepts the outputs of the rf preamplifiers, combines them for diversity reception, separates and demodulates them into teleprinter (dc) components and audio (voice) frequencies, and then feeds them to the multiplex terminal and distribution panel. Each FSK receiver has two front ends—for low-band and high-band operation. Either produces a first if of 2.2 mc. The second if is 50 kc. The *mark* and *space* frequencies are 6 kc apart, with half-power bandwidths of 700 cycles each. Any frequency-selective fading that results from the 6-kc mark–space separation affects a decision threshold computer, which separately stores the mark and space data and derives therefrom the optimum detector threshold level.

Troposcatter facilities

To utilize tropospheric scatter, uhf signals are transmitted upward at such an angle that forward-scattered fragments of the original signal return to earth in a manner similar to the ionoscatter technique (Fig. 3). In the case of ionoscatter, the haphazard return of signals is caused by clouds of *ionized* particles. In the case of troposcatter, the same effect is supposed to be produced by clouds of water vapor within the troposphere, a layer of atmosphere just above the earth.

Only one relay link of the Pacific System uses troposcatter. This is the link between Oahu and Kauai (Hawaiian Islands), which provides wide-band multichannel communication for about 115 miles with an operating or carrier frequency of about 800 mc.

Each terminal of the link uses two 19-foot paraboloid antennas, duplexed for simultaneous transmission and reception. One antenna has horizontal, the other vertical polarization.

Transmitters at each station are 1-kw klystron amplifiers with FM exciters. The equipment provides 12 full-duplex voice-frequency channels *plus* one narrow-band voice order-wire channel.

Quadruple-diversity reception is provided by four conventional uhf receivers equipped with a base-band combiner to select the receiver having the signal of greatest intensity.

All major equipment at each troposcatter station is in duplicate. Automatic alarm and control devices initiate switching electronically in event of trouble or failure.

Other facilities

Multiplexing equipment, which provides duplex teleprinter channels, is a prime component of every station of the Pacific System. This equipment with switching and test equipment constitutes the multiplex terminal (Fig. 8).

Depending on the crystal selected for timing purposes, the multiplex equipment will function with teleprinter signals at speeds of 60, 75 or 100 wpm.

Individual teleprinter channels are sampled in time sequence to generate or develop the composite signal.

For relay purposes, receiver and transmitter are synchronized automatically, with frame synchronism assuring proper agreement at all times. The multiplex equipment initiates reframing operations after any three successive synchronizing groups are lost, or within 45 seconds of first loss of synchronism.

Modular plug-in units are used extensively in the multiplex equipment. Transistorized magnetic storage, shift and read-out circuits are used exclusively, all operating at lower power and low heat levels for maximum reliability. All timing circuits are controlled by stable oscillators.

A valuable facility of the Pacific System is the single-circuit party-line 2.2-kc voice-frequency channel that connects all stations of the system. Selective signaling with coded in-band binary tone groups makes it possible to dial any station without participation by other stations of the system.

Each station is equipped with a monitor booth containing a central alarm, meters and recorders, which collectively indicate and record the current operational status of all major equipment and facilities as determined at critical check points.

Each station is also provided with facilities for measuring and recording long-term median as well as instantaneous signal levels. Four graph recorders continuously measure variations in signal and noise intensity as well as any multiplex distortion. Also recorded are the depth, duration and frequency of any signal fading.

A wide variety of test and monitoring equipment is also available for maintaining the high reliability of all equipment and facilities at each station of the Pacific Scatter Communication System.

The system was designed, developed and installed by Page Communications Engineers, Inc., of Washington, D. C., a subsidiary of Northrop Corp. Technical operation and maintenance of many of the stations are also being provided by the Page organization. END

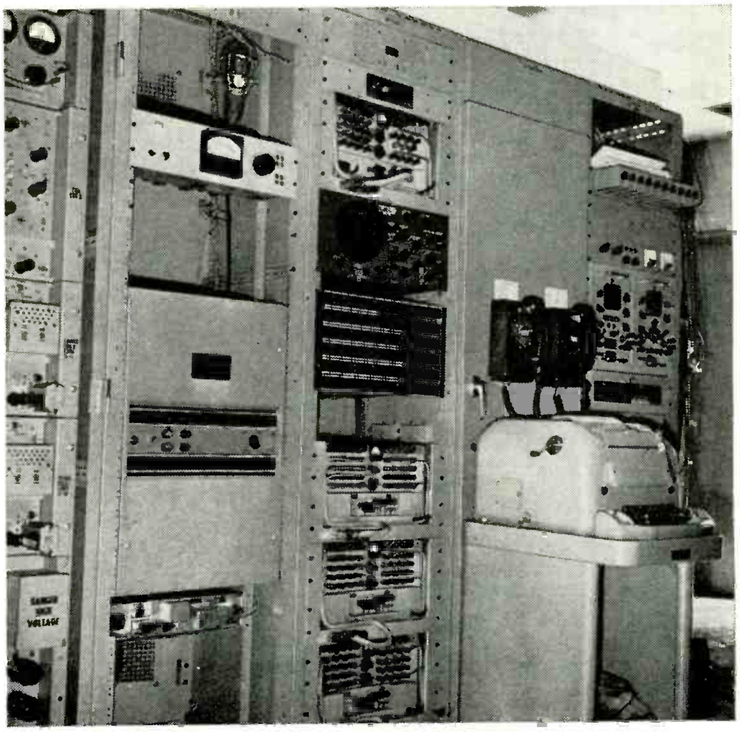
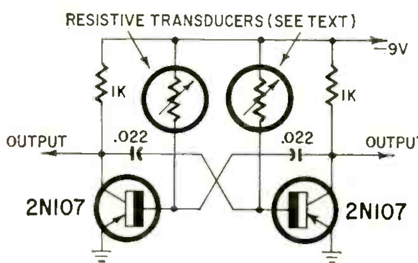


Fig. 8—Multiplex terminal at typical relay station of system.

Light-heat Remote Indicator

Here are details on a small transistorized device that translates light, heat, temperature or humidity variations into audio frequency output. The diagram shows the circuit of a simple free-running multivibrator in which the base bias resistors have been replaced by resistive type transducers. When Clairex or similar resistive photocells are used, the frequency of the audio signal developed depends on the intensity of the light falling on the cells. The signal can be heard on a pair of phones connected between the collectors.



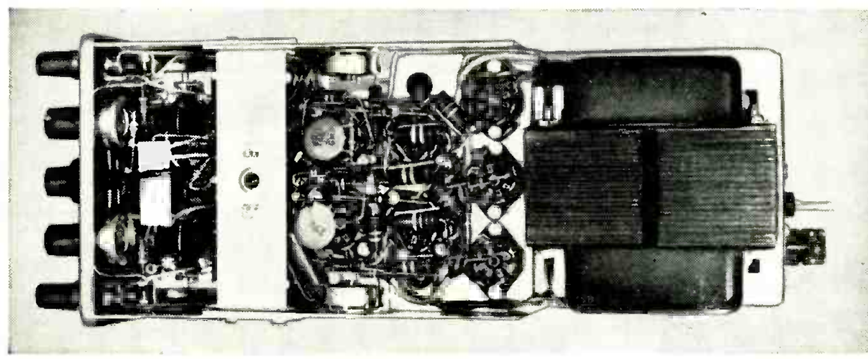
When a scope is used to observe the collector-to-collector waveform, an unusual effect can be obtained by replacing one of the photocells with a thermistor. The width of the positive (or negative) pulse is a function of temperature, and the width of the negative (or positive) pulse is a function of light intensity. Thus, two measurements can be made at a remote station by analyzing the single audio signal. By selecting appropriate resistive transducers, you can measure humidity, salinity, pressure, etc.—*Dennis K. Rathbun*

"Nothing serious, lady—I'll be out of here in a jiffy."

A simple scope with simple controls.

SCOPES ARE GETTING SMALLER TOO . . .

Meet the Heath IO-10, a 3-inch dc oscilloscope



Everything is handwired to conserve space.

By TOM JASKI

A number of small oscilloscopes are attracting attention. Among them are the Tektronix transistorized scope (RADIO-ELECTRONICS, January 1961), an 8-mc 3-inch job put out by the Scopes Co., and the Waterman 3-inch Primer-Scope, designed as an educational instrument.

One of the small scopes is available as a kit—the Heath model IO-10. This is Heath's second venture into 3-inch scopes. Years ago I purchased the 3-inch OL-1. The IO-10 is in all ways an improvement over that earlier instrument. Among other things, the horizontal and vertical amplifiers of the IO-10 have a greater bandwidth, with a 2-db drop at 200 kc, instead of the 3-db drop of the OL-1 at the same points. The horizontal and vertical amplifiers are identical, as was the case with the earlier scope. The diagram shows the complete circuit of the new instrument. The unit is only 7⅝ inches high, 4⅝ inches wide and 11 inches deep.

Philosophy behind the 3-inch scopes is basically sound. Hardly anyone ever uses the total screen area of a 5-inch tube. And the 3-inch scope takes up less than a fourth the volume of the usual 5-inch job, and weighs a little over half as much. Sensitivity of the little scope's vertical amplifier is considerably less than that of its 5-inch companions (0.1 volt, peak to peak, per ¼ inch as compared to .025 volt per inch!).

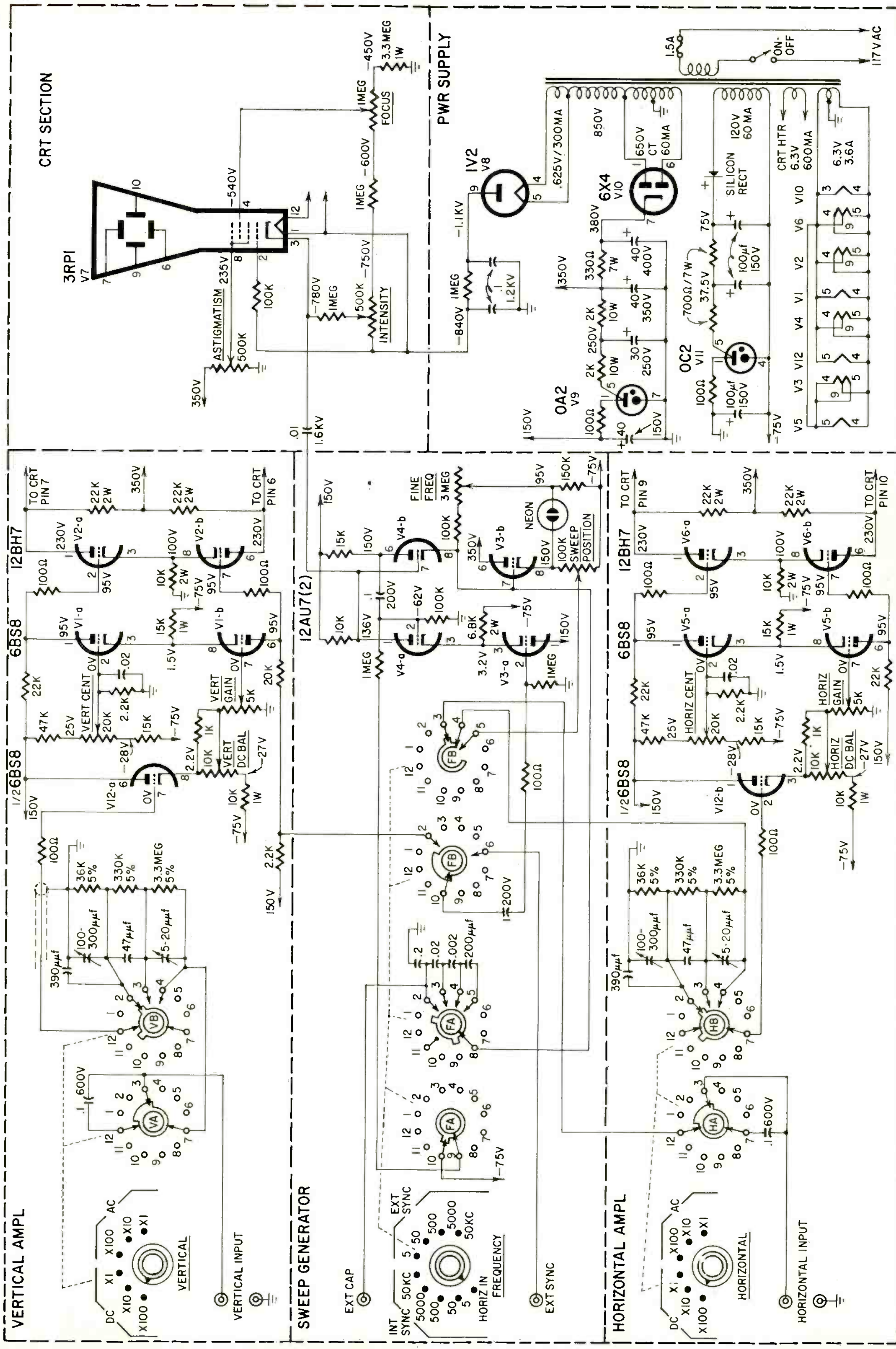
Identical horizontal and vertical amplifiers are advantageous for several kinds of work. X–Y curve tracing demands it (as for computer readout), phase-angle measurements are easier to make with them, and relative amplitude variations when viewing Lissajous figures are easily observed.

In spite of its restricted bandwidth and lower sensitivity, the 3-inch scope can handle a large number of service jobs. Any voltages with frequencies into the broadcast band can be displayed. For the electronic-organ service technician and the audiophile, for much (in fact most) industrial service work, for the majority of experimenters' needs, for automotive work, intercom repair and medical electronics, the amplifiers' restricted upper frequency is no particular handicap and the dc response is a definite advantage. For TV repair it is utterly unsuitable and was not intended for such use.

Stability of the Heath IO-10 (usually a problem with dc scopes) is good. The 3RP1 CRT gives a nice clear trace, and focus is excellent. It's harder to build this instrument than larger scopes, in spite of the usual excellent instruction manual. The instrument is wired point-to-point (allowing closer spacing of the tubes and making for extreme compactness) in contrast to most late-model kit scopes which use printed-circuit boards.

If you do not now have a scope, and need one, and if you are not anticipating the need for high-frequency response, this would be a good instrument to start with. But let me add one word of advice: Take your time during assembly. Printed-circuit boards have a "built-in" neatness, but careless wiring in this scope can produce a real mess.

END

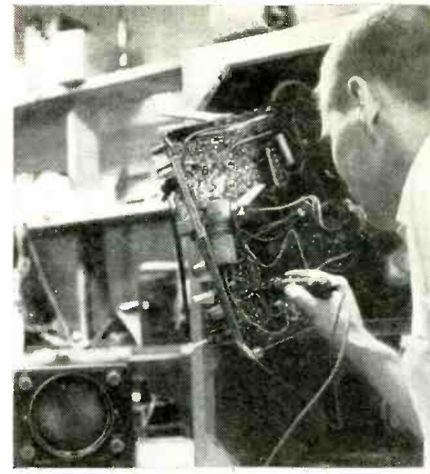


Circuit of the IO-10 scope.

Cy and Lucky Get the Jitters

Eliminating the bounce and restoring the interlace was the problem

By WAYNE LEMONS



Checking the electrolytics. The sine wave is the characteristic waveform seen across power supply electrolytics.

"YOU'RE NOT PUTTING THAT SET BACK together, are you? With the picture unstable and hardly any vertical interlace?" Cy asked his young helper, Lucky.

"I know it isn't too good, but the customer said it was playing fine and just quit," Lucky defended himself: "The heater resistor had opened, and the tubes weren't lighting so I installed a new resistor. I figured they were used to the jitter and roll and probably called that a good picture."

"I doubt if anyone could get accustomed to *that* picture enough to call it a good one, but you'll find a lot of customers will tell you that 'it was playing fine and just quit.' Maybe they forget or unconsciously think the trouble they've been tolerating finally caused the set to stop working. Whatever it is, you can bet they'll complain to the stars if their set comes back with a trouble still in it. Besides that, they'll probably solemnly affirm that it never acted up that way before you fixed it."

"You mean you want me to fix the trouble then?" Lucky asked.

"Ye're dern right!" exclaimed Cy. "Otherwise we'll get a callback and likely have to fix it free or lose a customer—did you check the tubes?"

"Yep," said Lucky, "but they checked OK. There wasn't a gassy or weak one in the bunch."

"Then pull the chassis and let's find the trouble."

The set was a Silvertone with a vertical chassis. The picture tube was mounted in the cabinet, but by unplugging the yoke and picture tube and turning the chassis around with the tubes pointed inward, Lucky could plug the yoke back into its socket and the cap back on the picture tube. In this manner the cabinet supported the chassis nicely for making circuit checks.

Lucky worked steadily for a half-hour trying to find the trouble, while Cy put the finishing touches on the set he was repairing. Then Cy walked up behind him. "What have you found?"

What Lucky checked

"I've checked just about everything," said Lucky, "and I don't seem to be much closer."

"*Exactly* what have you checked?"

"I've checked the voltages on the sync tubes. I've checked capacitors for leakage, and the resistors for correct value in both the sync and vertical circuits."

"Did you check for video at the output of the sync stage with a scope? The picture seemed to cut up more with certain kinds of pictures."

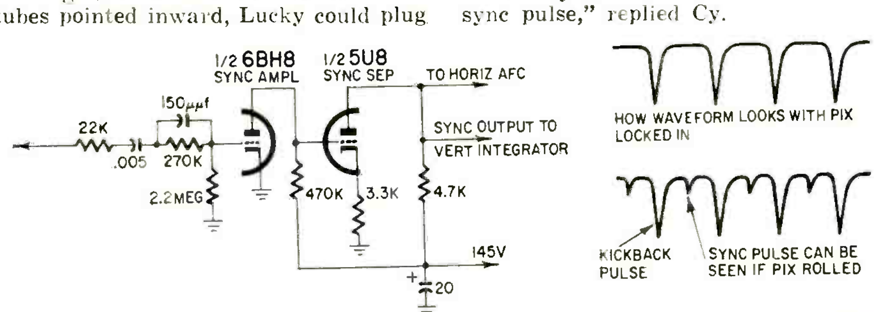
"The sync output looked pretty clean to me," said Lucky, as he touched the scope's low-capacitance probe to the plate of the sync output tube. "What do you think?"

Cy looked at the sync waveform closely. He turned the vertical gain up on the scope and studied the waveform. Then, while watching the scope, he rolled the picture with the set's vertical hold control.

"The vertical sync pulse looks pretty good," he said, "but there is a little video on the base line. It may be enough to affect the sweep oscillators."

"How come you rolled the picture?" Lucky asked.

"Mostly so I could look at the vertical sync pulse," replied Cy.



(Left) Sync circuit of the jittery Silvertone. (Right) Sync waveforms with TV picture locked in. When picture is rolled, sync pulse becomes visible.

"What do you mean? Anybody could see the vertical sync pulse, big as life."

"Not without rolling the picture or killing the vertical oscillator," Cy corrected him. "That 'sync pulse', as you call it, isn't the sync pulse at all."

"Then what is it?"

"That's the kickback pulse from the vertical oscillator through the integrator. Look while I roll the picture. See the little pips moving along the base line? That's the vertical sync pulse. The big pips are the kickback. Also note the waviness along the base line and how it changes with picture content."

"Well, I'll be . . . ," exclaimed Lucky. "You think there may be enough video in the sync to cause the instability?

"That's how it looks," Cy replied.

"But you can't be sure?"

"I'm pretty sure, and if the scope finds some stray video signals floating around where they shouldn't be, then I'll be positive."

"But where's the video coming from? The voltages are OK on the sync stages and the tubes check good."

"That's why we use a scope," Cy chided. "It's probably most useful for finding a trouble just like this."

Checked the agc too

"Do you think the sync stages might be overloaded?" Lucky asked.

"That's possible," answered Cy. "Did you check the agc voltage?"

"Sure did. It was just about what we get on most sets. I also put the scope on the agc line and turned the gain up full. There was practically no ripple.

"I see you haven't forgotten the sync trouble we had when an agc bypass opened," laughed Cy. "And that narrows down the possibilities. Hand me the scope probe."

He touched it to a point and looked at the scope. He checked the peak to peak calibration. "Twelve volts of video," he said.

"Where are you getting that?"

"Right at the worst possible place." Cy grinned. "Right on the 145-volt B-plus line."

"And that feeds the sync stages," finished Lucky.

"And you know what that means?"

"Yep," said Lucky, "it means the video on the B-plus line is feeding right into the sync signal circuits and likely causing all the trouble."

"And you know how to cure it."

"Yep," said Lucky, reaching for a test electrolytic. "Bet this'll do it."

He clipped it from the 145-volt line to ground, and turned the set back on. The picture locked in vertically with a reassuring bounce. The weave and jitter were gone, and the line between two lines, as Lucky described interlace, was stable.

"Get the filter replaced and let's get outa here," Cy said. "It's almost time for supper and I don't want to miss it."

"Wouldn't hurt you to miss it once in awhile," Lucky grinned.

Cy rubbed his stomach and looked pained at the thought. END

NATURE'S INVISIBLE RADIO MIRROR

Between 40 and 600 miles above the earth is an atmospheric layer—the ionosphere—that makes much of the world's long-distance radio communications possible

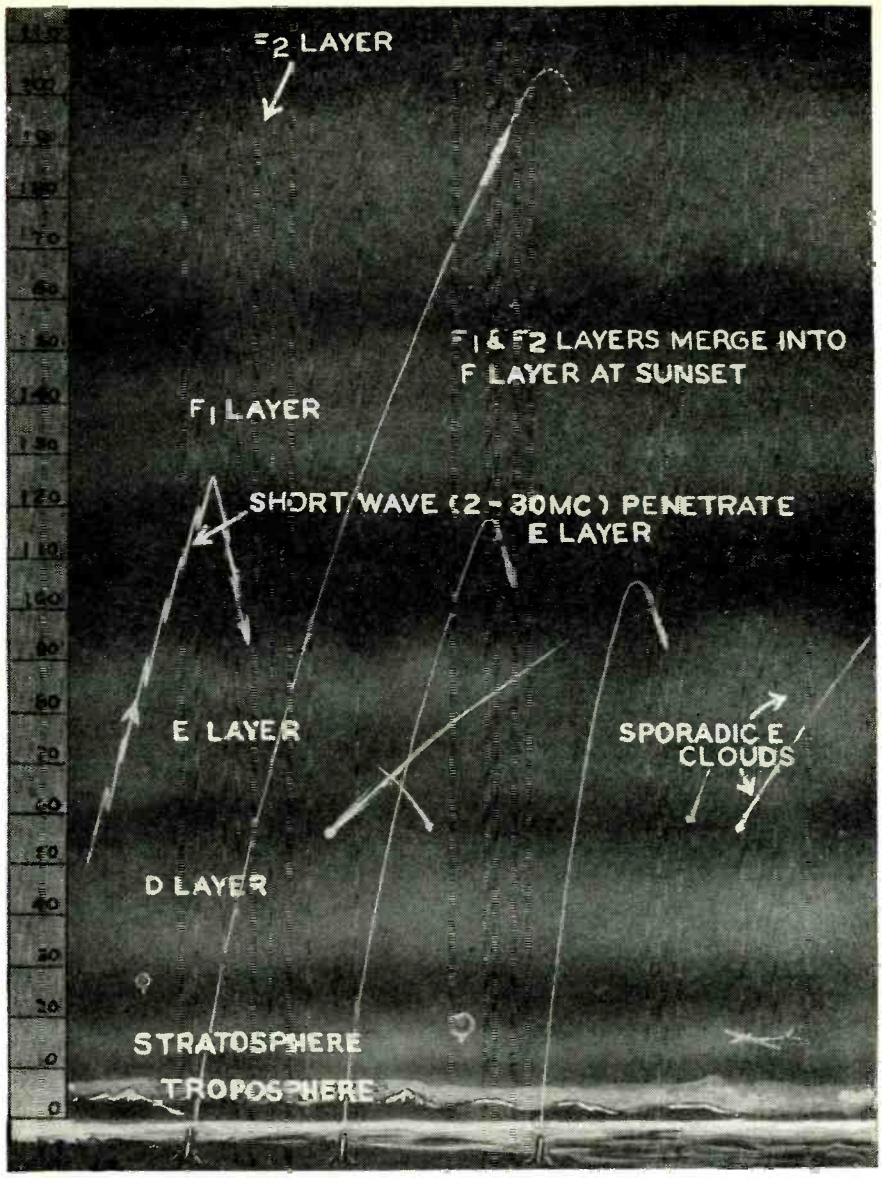


Fig. 1—The Earth's atmosphere.

By JAMES F. VAN DETTA, WA2FQZ

A TEEN-AGER slumps into an easy chair and contentedly sips his soft drink as he loudly taps his feet in time with a strident rock 'n' roll tune from a broadcast receiver. An amateur radio operator sits before his home-made transmitter and talks with a fellow ham on the other side of the earth. A young child sits very close to the television set and gleefully claps his small hands as mild-mannered Huckleberry Hound jogs nonchalantly across the screen. At a desolate and unpublicized outpost, an alert missile-tracking specialist listens intently to a signal from space as he carefully tracks an American rocket shot.

All these are instances of electromagnetic radiation or "radio waves," but only one, the amateur's contact with the other side of the earth, involves nature's invisible radio mirror—the ionosphere.

A certain dictionary coyly defines the ionosphere as the ionized layers that constitute the outer regions of the earth's atmosphere. Such a definition is correct, but not very informative. Let's look further.

Fig. 1 is a simple representation not drawn to scale, but you can easily see that the lowest layer of the atmosphere is the troposphere. It extends about 6 miles above the earth and is known as the "weather layer" because it's within this comparatively narrow region that the earth's weather exists.

The stratosphere is directly above the troposphere. It extends to a height of about 40 miles. This is a region in which the air temperature remains practically constant and doesn't decrease with height as it does in the troposphere where the average temperature decreases about 3.5° each 1,000 feet.

The ionosphere begins above the stratosphere and goes up to at least 600 miles. Until recently, it was believed that the ionosphere extended to about 250 miles; but earth satellites have given us information to indicate that 250 miles is a much too conservative figure.

"So what causes the ionization in the ionosphere?" you may ask impatiently. The answer is "The sun's rays." For example, an ultraviolet ray from the sun (the kind that causes your skin to tan and sunburn) strikes a particle of air high up in the outer atmosphere and knocks an electron from it. Since an ion is an electrically charged particle that has fewer or more electrons than normal, the obvious result of such a collision is a positive ion (a particle minus an electron) and, of course, a free electron. Countless such collisions produce innumerable ions and free electrons, and thus an "electrified," or ionized, layer is produced.

Ionosphere layers

The D-layer is directly above the stratosphere. It may be anywhere between 30 and 55 miles wide—the height, depth and degree of ionization on any ionosphere layer depend upon the time of day, the season of the year and the amount of sunspot activity.

The D-layer forms in a fairly dense region of the atmosphere, so the particles that are ionized there recombine rapidly. Since the amount of ionization is directly related to the amount of sunlight, ionization in the D-layer is greatest around noon and disappears completely after sundown.

The D-layer is not useful for communications. The dense ionization in this layer absorbs a great deal of the energy of certain radio waves—say those below 10 mc. The degree of absorption is inversely proportional to the frequency. Therefore, on waves above 10 mc, for example, absorption is relatively small. Many short-wave listeners and radio amateurs curse the D-layer as the culprit when the 80-meter amateur band (3.5–4.0 mc) "goes dead" for a while around noontime.

The E-layer is the lowest one that acts as a radio mirror and is useful for long-distance communication. Shown in Fig. 1 at a height of about 70 miles, it may be anywhere between 55 to 90 miles.

Although the air particles in the E-layer are somewhat less numerous than in the D-layer, the region is still relatively dense; the ions and electrons recombine rather rapidly, and ionization is minimum at midnight. At maximum ionization, near noon, the E-layer, like the D-layer, absorbs energy from low-frequency radio waves. But, unlike the D-layer, the E-layer reflects some radio signals. At high noon, for example, the 80-meter amateur band (3.5–4.0 mc) previously mentioned may be useless because these frequencies are completely absorbed in the D-layer; but the 40-meter amateur band (7.0–7.3 mc), despite some absorption in the D-layer, may provide communication for hundreds of miles due to E-layer reflection.

The F1-layer, at its average height of about 125 miles, exhibits most of the characteristics of the E-layer.

The highest and most useful layer of the ionosphere is the F2-layer which sits at an average height of about 200 miles. Because the air in this region is extremely thin, the ions and electrons in it recombine very slowly. Ionization in this layer, therefore, is not as directly related to sunlight as in the other layers. A short while after noon, the layer reaches maximum ionization. Afterward, ionization gradually decreases to a minimum just before sunrise. The F2-layer acts as a highly effective radio mirror for long-distance communication.

After sundown, the F1-layer combines with the F2-layer, which then drops down in height. Keep in mind that Fig. 1 illustrates a daytime condition.

Radio propagation

Radio propagation using the reflective characteristic of the ionosphere is termed "ionospheric skip" because the signal skips over large areas as it hops on its way. Referring to Fig. 2, note that the skip distance is the distance from the transmitter to the point where the signal again returns to earth. The signal may then be bounced upward to be reflected once more from the ionosphere and thus complete another skip. Such multihop propagation makes world-wide radio communication possible. Because the ionospheric skip signal is reflected from the sky (that is, the ionosphere), this is also called sky-wave propagation.

Obviously, the ionospheric skip signal jumps over certain places and cannot be heard there. If you would like dramatic proof of this, listen in on the 10-meter amateur phone band (28.5–29.7 mc) sometime when it is "open." You'll find that you can generally hear only one side of the conversation—because the sky wave of the other station skips right over your location!

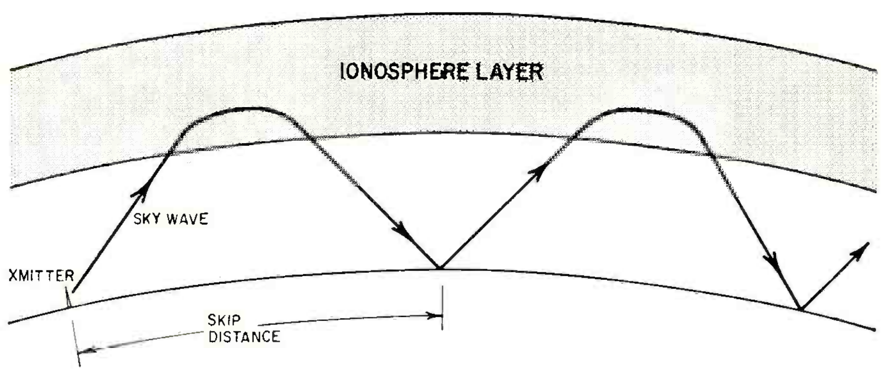


Fig. 2—An example of skip (sky-wave) propagation.

Ionospheric skip or sky-wave propagation is but one type of wave propagation, of course. The rock 'n' roll teenager mentioned at the beginning of this article probably couldn't care less, but it is primarily ground-wave propagation that provides him with the programs of standard broadcast stations. Ground-wave (or surface-wave) propagation refers to waves that cling closely to the earth as they travel. The earth's surface absorbs much of the wave's energy, limiting this type of propagation to about 100 miles for standard broadcast transmissions.

The young child mentioned earlier can enjoy his favorite television program because of line-of-sight propagation, which is just about what the name implies—the waves travel in a rather direct line from the transmitter to the receiver. This type of transmission applies to frequencies from about 30 mc on up; ordinarily the ionosphere does not reflect such waves. If they are directed at the ionosphere, they simply travel off into outer space.

Since signals at frequencies higher than 30 mc go through the ionosphere and on into space, the so-called Age of Space Communications is possible. The missile-tracking expert probably had radio equipment for frequencies from *1,000* to *several thousand megacycles* (a megacycle, remember, is 1,000 kc).

While space communications is a very romantic and promising field, ionospheric skip still provides the means for much of the world's long-distance communication, as well as providing radio amateurs and short-wave listeners with fascinating hobbies.

The big problem with ionospheric skip propagation is that it is erratic. For example, certain eruptions on the sun cause ionospheric "storms" and a disturbance of propagation conditions. At other times, mysterious radio blackouts may disrupt communication for a few minutes or many hours.

Since so many variables are involved in ionospheric skip propagation, it is extremely helpful to know the maximum usable frequency (MUF), the highest frequency that can be used for communication over a given path. The MUF for any given transmission path is related to the sunspot cycle in that the MUF tends to be high during sunspot maximum and low during sunspot minimum. Since we are now in a declining sunspot cycle that will probably reach a minimum in the 1962–63 period, you may expect, for the next few years, that the higher short-wave frequencies—say, above 15 mc—will be less and less useful for long-distance communication. Fortunately for all who are interested, several very helpful sources of propagation information are readily available to anyone.

Information sources

Charts that predict the MUF for any transmission path on earth are issued by the Central Radio Propagation Laboratory of the National Bureau of Standards. These charts, called "CRPL-D Basic Radio Propagation Predictions," cover both E- and F2-layer propagation, are issued monthly and provide predictions for 3 months in advance. The cost is 15c per copy, or a year's subscription (12 issues) for $1.50. Circular 465, "Instructions for the Use of Basic Radio Propagation Predictions," tells how to use the charts and costs 30c. Both the charts and circular are available from Superintendent of Documents, US Government Printing Office, Washington 25, D. C.

RADIO-ELECTRONICS publishes a monthly Short-Wave DX forecast which predicts the optimum short-wave broadcast frequencies for the coming month (see page 55). This forecast is prepared from the CRPL-D charts.

Another source of helpful propagation information is the CRPL series Jb' reports issued every Wednesday by the CRPL Radio Warning Service at Boulder, Colo. These weekly reports, issued in postcard form to facilitate mass distribution, include a forecast of geomagnetic conditions based on solar and related data and a record of past geomagnetic activity. Since magnetic disturbance and radio disturbance are strongly correlated, the Jb' reports provide a valuable basis for assessing future propagation conditions.

Send requests for the reports to the CRPL Radio Warning Service, US Department of Commerce, National Bureau of Standards, Boulder, Colo. charge is $4.00 per year in US, Canada or Mexico. All other countries $5.00.

Still another source of reliable propagation information is station WWV, operated continuously by the National Bureau of Standards, Washington, D. C. It operates on frequencies of 2.5, 5, 10, 15, 20 and 25 mc. At 19½ and 49½ minutes after each hour, propagation information applying to transmission paths over the North Atlantic is given in International Morse code. This information consists of a letter. A number, also in code, follows the letter and indicates the expected propagation conditions during the following 6 or more hours. Forecasts are revised four times a day, at 12 midnight, 7 am, 12 noon and 6 pm, EST.

The chart shows the letters and the numbers and their significance, as well as the code for each. The code is sent slowly during these broadcasts. Even if you're a short-wave listener who doesn't know a thing about the code, you'll quickly find that you can make out the propagation forecasts. Remember that the forecast consists of one letter and one number, and this code combination is repeated several times before the call sign and time are given by voice.

Station WWVH in Hawaii, operating on 5, 10, and 15 mc, has similar forecasts for the North Pacific at 9 and 39 minutes after the hour.

So whether ham or short-wave listener, get the CRPL charts and the Jb' reports, check the propagation forecasts on WWV, and then roll up your sleeves and go after those "rare ones." And the best of dx to you, via nature's invisible but wonderful radio mirror—the ionosphere! END

WWV PROPAGATION FORECASTS

Conditions at Time of Forecast

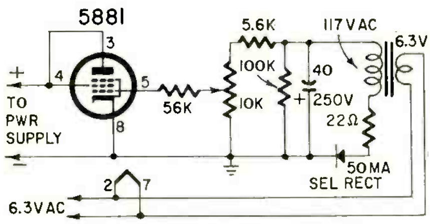
LETTER	SIGNIFICANCE	MORSE CODE
W	Disturbed	dit dah dah
U	Unstable	dit dit dah
N	Normal	dah dit

Expected Reception Conditions During Next 6 Hours

NUMBER	SIGIFICANCE	MORSE CODE
1	Impossible	dit dah dah dah dah
2	Very Poor	dit dit dah dah dah
3	Poor	dit dit dit dah dah
4	Poor to Fair	dit dit dit dit dah
5	Fair	dit dit dit dit dit
6	Fair to Good	dah dit dit dit dit
7	Good	dah dah dit dit dit
8	Very Good	dah dah dah dit dit
9	Excellent	dah dah dah dah dit

Electronic Power Resistor

This "resistor" is a triode-connected power pentode with provision for varying the grid voltage. I use it for testing experimental power supplies. It is placed directly across the power supply's output. Varying the grid bias varies plate current and thus the resistance across the power supply. I find it especially useful in checking voltage regulation—how much the voltage drops with increasing load.

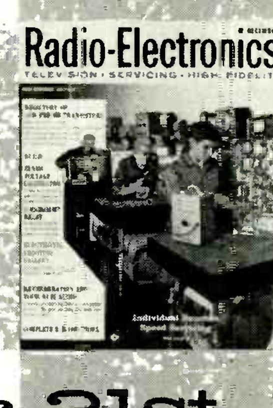


Since the tube must dissipate all the power drawn from the supply, a robust tube able to take power and withstand all power-supply voltages likely to be used is needed. I used a 5881. Its combined plate and screen dissipation is 26 watts, and maximum plate and screen voltage 400.

Heater voltage for the 5881 (6.3 volts) is taken from the power supply being tested. The 6.3-volt winding of a small heater transformer is connected across the same line and its 117-volt secondary used to develop dc grid bias, as shown in the figure. Bias ranges from 0 to −170 volts. With this bias range, the tube will draw from 0 to 25 ma with 50 volts on the plate and from 0 to 120 ma with a 400-volt plate supply. (The tube would then be overloaded, drawing about 48 watts, but can be operated up to ½ minute at a time.)

A 6L6 can be used in this circuit if not more than 270 volts is going to be used. Two 5881's may be connected in parallel to dissipate more than 26 watts. Connect a 47-ohm 1-watt resistor in series with the plate screen circuit of each tube to equalize the load.—*Paul S. Lederer*

"Say, about that digital voltmeter you sent me . . . "



What's Your EQ — October Solutions

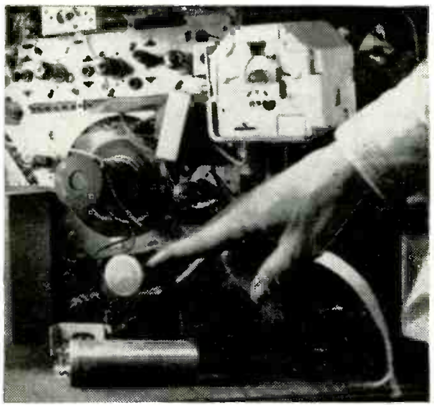
Electronic Photogram

1. Nailclipper (a foreign part!)
2. Fuse holder
3. Drill chuck key (a foreign part!)
4. Rubber grommet
5. Trimmer capacitor
6. 9-volt transistor radio battery
7. Control
8. Dual-clip (Mueller No. 22)

Simple Impedance Problem

The gimmick here is that the resistors on the inner ends of the four arms radiating from the center are each 1/17 of the resistances on the outer ends of the corresponding arms. Hence the various inductors and capacitors are connected between points of equal potential, and have no effect. Therefore the phase angle is exactly zero, and the impedance is merely the resistances of the four arms taken in parallel, which comes to 231 ohms.

An Electronic Ground?



The shop technician didn't agree with the home technician that the trouble was "probably the yoke." Instead he pointed to the three-section electrolytic shown in the photo. "This electrolytic has developed an open common connection internally," he said, "I'll bet money on it. When that happens all the waveforms of the power supply and the horizontal and vertical sweep systems get all mixed up together and what you see on the screen is the result of it. Since the entire can is defective, you can't find the trouble by just bypassing one section with another capacitor, although you will probably note a little improvement or at least change if you shunt-test any section."

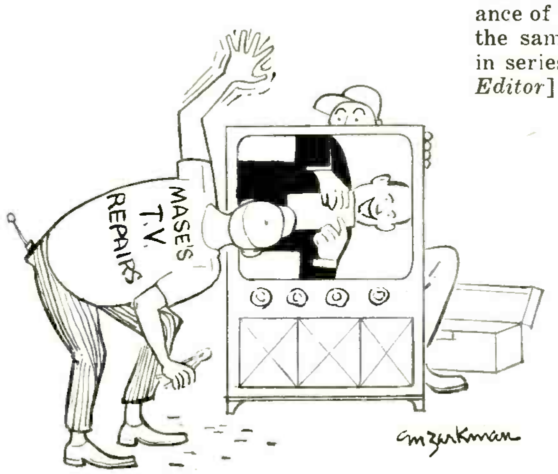
Black Box No. 3 Again

That there may always be more than one solution to a problem is pointed out in a letter from two members of the Bell Telephone Laboratories staff:

"Since the illustration shows a two-terminal system we think we have a novel solution. The Black Box could consist of one field-effect varistor which exhibits the property of a constant current under conditions of variable voltage, provided E is greater than the pinchoff voltage and 2E is less than the breakdown voltage of the device.

Further information on the field-effect-varistor may be found in the January issue of the *Proceedings of the IRE*, pages 44 to 56."—*R. P. MASSEY and S. V. NATALE*

[The original Black Box No. 3 contained simply a dead short, so that the current was limited only by the internal resistance of the cells. Thus current remained the same whether one cell or two cells in series were connected to its input.—*Editor*]



"Perfect, Mase, perfect!"

THE OLD-TIMER Helps Replace a Power Transformer

By JACK DARR

Faced with a burnt-out power transformer and no service data, how do you determine the proper replacement?

THE Young Ham growled and slammed a manual down on the bench. "Aww, this off-breed outfit!" he snarled.

"Temper, temper!" The Old-Timer grinned, tacking a last wire in place on the chassis he was working on. "Whassamatter, Junior?"

"Aw, this orphan here!" He indicated the small PA amplifier which lay upside down before him. "Th' power transformer's burnt out and I can't find a cotton-pickin' thing in any of the books on it!"

"No name, no number, huh?" sympathized the Old-Timer as he rose and went over to him. "That looks like a perfectly ordinary transformer to me. Why can't you find it?"

"Well, I can't find a replacement listed for it in any of these books," complained the Young Ham, pointing to a large stack of transformer catalogues on the bench. "None of 'em's ever heard of this outfit!"

"Well," drawled the Old-Timer with the customary wicked gleam in his eye, "looks like a smart, intelligent young sprout like you hadn't oughta have no trouble findin' a suitable replacement for it. Are you sure it's burned out?"

"Gosh, yes!" replied the Young Ham, looking at the loblolly of tar and wires in the underside of the chassis. "Did you ever see such a mess? Besides, I went through all the procedure. I pulled all the tubes and lifted one side of the filament winding from ground."

The Old-Timer opened his mouth to say something, but the Young Ham forestalled him. "I looked to see if the filament winding had a center tap grounded, but one side goes to the chassis."

The Old-Timer opened his mouth again.

"Then I took the high-voltage winding center tap loose, took the pilot lights out and plugged it into the wattmeter."

The Old-Timer opened his mouth again, to no avail. "When I turned it on, it went full scale, and I just got the plug pulled before the fuse went. Are you trying to say something?"

The Old-Timer shook his head. "Not at all. One of my front teeth seemed to be running a little hot and I was flappin' my jaw up and down to cool it off! What I *would* have said, if there'd been a space in there, was that I concurred most completely with your method of diagnosing the malfunction. Now, were you able to determine whether the excessive thermal rise was originating internally or externally?"

Why did it burn up?

The Young Ham looked very blank. "Translating that out of English, is there a short in the amplifier or did the transformer break down inside all by its hot little self?"

"I sure can't find any short in the filter capacitors or anywhere else," said the Young Ham. "Must have broken down internally. Now what was that first part again?"

"I said, you're strictly from Rightsville, man," translated the Old-Timer. "Like solid, Jackson. Now, you say that you can't find a replacement for it anywhere? Man, your education has been sadly neglected!"

"Well, you oughta know, you're the one that did it!" the Young Ham grinned.

"Yes, and I'm beginnin' to feel sorry! Git th' scratch pad and come on. The only thing to do in a case like this is—" but the Young Ham was already halfway down the hall toward the drug store.

Settling in a booth after the customary exchange of insults with the pharmacist and some sarcastic remarks concerning the Old-Timer's bowling score of the night before, they blew their coffee. The Old-Timer pushed the scratch pad over to the younger man. "Now draw me a power transformer on there."

"What kind?" asked the Young Ham.

"Any kind, silly. They're all alike, at least on paper!"

The Young Ham scribbled for a moment, then showed him the paper. "Like that?" (Fig. 1)

"Sure. Now what've we got here? Windings: primary here, secondaries

(*Continued on page 112*)

AN UNSOLICITED REPORT ON MODEL 88 BY LARRY KLEIN, WELL KNOWN TECHNICAL EDITOR OF ELECTRONICS ILLUSTRATED

Troubleshooting Techniques

WHEN the transistor first appeared not too long ago, it caused quite an uproar. Engineers went back to school, factories retooled, products were redesigned and miniaturization became a household word. And, of course, along with new products and techniques, transistors introduced new problems.

First of all, how does one test them and the circuits they inhabit? Answers to that question have ranged all the way from $1,000 oscilloscopes, which automatically present a transistor's family of curves, down to a little $4.95 meter that checks the beta gain of a transistor against its leakage. But how much can either device do for the radio serviceman up to his black bow-tie in transistor radios and their 101 assorted problems? Obviously the serviceman requires transistor test equipment specifically designed for his specific needs.

In the good-old pre-TV days, when I was doing my bit to keep the soap operas coming through loud and clear on the neighborhood's radios, four out of five AC-DC sets that came into the shop had nothing more wrong than a burned-out tube. Troubleshooting meant that I would switch on the set to see whether the tube filaments lit. If no spark of life appeared, I'd pull out the 35Z5 (the most likely suspect) and check continuity between pins 2, 7 and 3. The 50L6 was next in line for investigation. After the 50L6 it was anyone's guess which of the other three tubes was the culprit. But even on a bad morning, the whole procedure took no more than five minutes.

Troubleshooting a transistor radio however, is a "horse of another color." Let's say you turn the set on and all you hear is a soft hiss. Then you check the battery voltage—and that's okay. Where do you go from there? Check the transistors? But 99 out of 100 transistor radios use printed circuit boards with the transistors soldered in place. There's a good chance that you'd ruin the little fellows just by trying to get them out for testing. Obviously, new techniques are required.

Since both a need and a fair size market existed, instruments were designed specifically for transistor radio troubleshooting. One of the most interesting and least expensive is the Superior Instrument Model 88 Transistor Radio Tester. In one compact unit, Superior provides a signal tracer, a signal injector and a leakage/gain test which will handle almost any entertainment transistor found in today's sets.

Let's see how you would go about servicing a transistor radio with the Model 88. Suppose the set to be serviced is stone-cold dead. Assuming the battery is okay, the problem is obviously one of localiz- [*Continued on page* 108]

Electronics Illustrated

62

Tech Editor

Continued from page 62

ing the stage that's killing the signal. For this we plug one of the 88's shielded test leads into the jack marked *signal output*. At the business end of the test lead the instrument produces a complex signal covering the frequencies from audio up to about 30 megacycles.

Starting at the output stage and working toward the antenna, you simply touch the "hot" lead to points along the signal path in the radio, listening for the tone from the radio's speaker. At the stage where the signal drops dead you'll find the bad component. It's as simple as that!

The injection technique, however isn't much help if the complaint is distortion or noise. Fear not, in that case, you work from the *other* end of the radio; this time using the signal *tracer* function. The tester's built-in transistor amplifier and a pair of 2000-ohm headphones (not supplied) plugged into the *ext. meter* jacks let you monitor the audio quality of the signal at every stage *after the first IF stage*. The 88 comes with a speaker for this function but we found headphones to be far superior. Localizing distortion then becomes a matter of touching the audio or detector probe (depending on whether you're in an RF/IF or audio stage) to various points in the signal path until you *hear* the bad stage. Apropos of troubleshooting transistor circuits, you really needn't worry about the "complexities" of the printed boards. You'll be surprised how fast you can learn to find your way around them with a little practice.

Reprinted by permission of Electronics Illustrated

See convenient order form

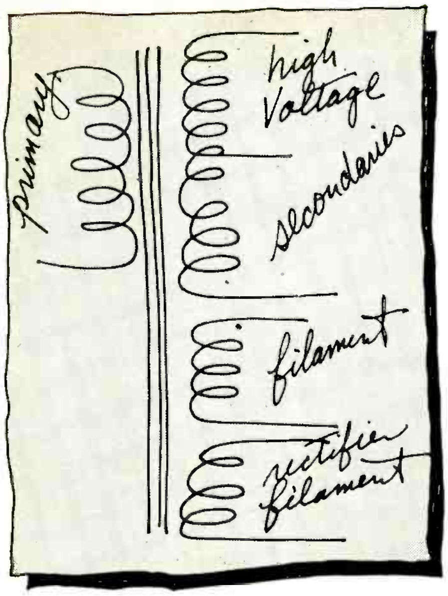


Fig. 1—Basic transformer diagram as sketched by the Young Ham.

(*Continued from page* 109)

here. OK. Primary voltage we don't have to worry about; that's always 117 volts, more or less, in this country. So now what we want to find out, to get a replacement power transformer that'll work in any given set, is to match up these secondaries. Right? Right. What's this one here?"

"The high voltage?"

"Kee-rect. That furnishes the plate voltage for th' rectifier tube and so that tells you how much B-plus you're gonna have, allowin' for tube losses an' so on. Now, these are the—"

"Filaments? One for the rectifier and one for the rest of the tubes?"

"Right again," said the Old-Timer, taking a deep draft of his coffee. "Wow! This may not be th' *best* coffee in town, but it sure is th' hottest! Now, th' big question is, how do you find out what you've got to have on those windings?"

"Well, you—it depends on the tubes, doesn't it?" asked the Young Ham.

"Right," said the Old-Timer with satisfaction. "That's what I wanted you to say. There's principle No. 1 in the choice of a replacement power transformer: How many tubes does the set have, and what kind are they? That's what determines the size (current rating) of the replacement transformer. Now, how many tubes in that mess over there?"

"Two 6V6's, a 6SC7, and a 6J7. Had a 5Y3 rectifier in it," said the Young Ham, after pausing for a moment.

There's the heater current

"Fine," said the Old-Timer, scribbling on the pad. "Now we got our first set of values: 6V6 takes 0.45 amps on the filament, 6SC7 takes 0.3, and a 6J7 takes 0.3. Been so long since I saw a 6J7 I hadda stop and think! Now, there's our main filament winding. 6.3 volts, of course, at 1.5 amps. Now we got to heat up the rectifier tube. Older sets had a separate winding for that, so that'll be 5 volts—5Y3—at 2 amps. So, we write that down (Fig. 2).

"Now, how about the B-plus? If I remember the looks of that output transformer, it was a pretty small one, so let's make an assumption here. We'll say that the thing was supposed to put out 10 watts of audio. Right now's when we go back over to the shop and look something up. I think I remember it, but I want to check to be sure. Always remember, an intelligent question's a lot better'n a stupid mistake; I want to ask th' tube-characteristics book a question!"

They trotted back across the alley and into the shop. The Old-Timer thumbed through a well-worn tube-characteristics book and grunted with satisfaction. Look. (Fig. 3.) 6V6. Single tube, push-pull, and so on. If we assume that this thing puts out 10 watts, we have to be sure to supply the tubes with enough voltage and current to get it, don't we? Now, right here it tells us that th' 6V6 needs 250 volts at 79 ma for plate an' screen current, for a 10-watt output. That's for two tubes. Now we can make a kinda educated guess at the current drain of th' rest of the tubes because they're voltage amplifiers and don't take much actual current. Oh, we can look 'em up if we want to, but if we allow

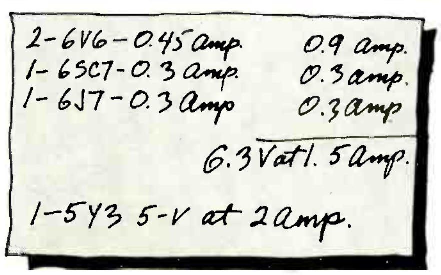


Fig. 2—Adding up the filament current drawn by the tubes gives us the total amount of filament current needed for the set.

enough reserve capacity, we won't have to. So let's just figure about 10 ma per tube for the other two and let it go at that. That oughta be plenty."

The Young Ham had been thumbing through the book. "Here it is. Actually," he said, "2.0 ma per plate for the 6SC7, and 2.5 ma total for the 6J7."

"Well, I was a little liberal, but that never hurts anything in a case like this," said the Old-Timer with a grin.

"Now lessee what we got. Here's the spec's for your power transformer, complete (Fig. 4). See if you can find one that'll fit 'em."

The Young Ham began leafing through the transformer catalogue. The Old-Timer watched him, then grabbed the book. "Dern it, git out of that section! Never mind the 'Exact Replacement' part; that's for babies! Look up here in the front where the list of 'General Replacement' power transformers are. There. Now find one in there." (Fig. 5.)

The Young Ham looked down the list and finally said, "How about that one? (PT-27)."

The Old-Timer looked, and grunted, "Yep, looks OK but it's a mite shy. I'd use this one here. (PT-31) Either one'll do, but th' second one's got a little better rating."

Too much current?

"Won't that be a little too much current, though?" asked the Young Ham. "Five amps is more than we'll need."

"Junior," said the Old-Timer, "That's about the most common misconception amongst novices that there is. The *current rating* of a power transformer tells you only how much power it *can* supply; not how much it is actually going to put out in service. Now think and tell me what determines the amount of current drawn from a power transformer winding? Filament or plate, it don't make no difference? Think now!"

"Yeah, I get it now. I wasn't thinking. The current you take out of a winding depends on the amount of *load* you put on it, how many tubes on a filament winding, and so on," replied the Young Ham.

"Now you got it!" The Old-Timer applauded. "Y'know, I used to make that same mistake over and over again when I first started. It sure puzzled me for a long time, but I finally got used to it. When you select a transformer, you be sure to pick one with a leetle *more* current-rating than you think it will actually need. Not voltage now, but current! Like here: we need only 1.5 amps for filament and the transformer'll supply 5 amps. We only need 95 ma we figgered and the transformer shows 110. That way we get a 'safety factor' that keeps the doodad runnin'

Technical Data

6V6, 6V6-GT

Maximum Ratings: PUSH-PULL CLASS A_1 AMPLIFIER

(Same as for Class A_1 amplifier)

Typical Operation *(Values are for two tubes)*:

Plate Voltage	250	285	volts
Grid-No. 2 Voltage	250	285	volts
Grid-No. 1 (Control-Grid) Voltage	−15	−19	volts
Peak AF Grid-No. 1-to-Grid-No. 1 Voltage	30	38	volts
Zero-Signal Plate Current	70	70	ma
Maximum-Signal Plate Current	79	92	ma
Zero-Signal Grid-No. 2 Current	5	4	ma
Maximum-Signal Grid-No. 2 Current	13	13.5	ma
Effective Load Resistance (Plate-to-Plate)	10000	8000	ohms
Total Harmonic Distortion	5	3.5	per cent
Maximum-Signal Power Output	10	14	watts

Maximum Circuit Values:

Grid-No. 1-Circuit Resistance:		
For fixed-bias operation	0.1 *max*	megohm
For cathode-bias operation	0.5 *max*	megohm

Fig. 3—Section of 6V6 listing in RCA tube manual gives plate-current data.

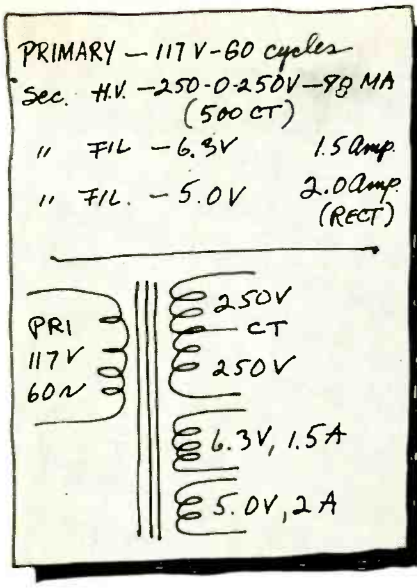


Fig. 4—Complete specs for power transformer as dictated by number and type of tubes and power output of amplifier.

dust-covered box. "Whoo!" He blew the dust off it in a cloud. "I just happened to remember this. Wait'll I git some of this dust off it an' we'll see. Gimme the clean rag, will ya?"

The Young Ham pitched him the exceedingly filthy object known as "The Shop's Clean Rag" and he scrubbed vigorously at the box. "There. Hey! This'n looks like it'll fit. I thought I remembered that transformer bein' in there. We don't get too many calls for one this size an' it kinda got shoved back behind some of the rest of the stuff."

"From the looks of you and that box, you might be called an 'electronic archaeologist,'" observed the Young Ham. "How long has that been in there, anyhow?"

"At least 6 months judgin' from the deposit of dirt above it. Now, if this joint were swept and cleaned up like it oughta be, it'd a' been—"

The Young Ham grabbed the box and compared the specifications listed on its end flap with those on the list. "Hey, this'll work," he cried. "Just what we want."

Type No.	Plate Supply		Rect. Fil.		Other Fil.		Case Dim.-Inches			Mtg. Dim.-Inches		Wt. Lbs.
	AC Volts	DC Ma.	Volts	Amp.	Volts	Amp.	H	W	D	MW	MD	
PT-25	500 CT.	40			6.3 CT.	2	2¾	2⅜	2¾	1-13/16	1⅞	1¾
PT-26	500 CT.	40			6.3 CT.	2	2	2⅝	2-3/16	2-3/16	1¾	1¾
PT-27 ✓	525 CT.	90	5	2	6.3 CT.	5	2½	3⅜	2-13/16	2-13/16	2¼	4½
PT-28	700 CT.	90	5	3	6.3 CT.	3.5	3½	3	3¾	2¼	2⅝	4¼
PT-29	700 CT.	90	5	3	6.3 CT.	3.5	2⅝	3⅜	2-13/16	2-13/16	2¼	4¼
PT-30 ✓	550 CT.	110	5	2	6.3 CT.	5	3⅞	3¼	3⅛	2½	2¼	4½
PT-31 ✓	550 CT.	110	5	2	6.3 CT.	5	2⅜	3¾	3⅛	3⅛	2½	4½
PT-32	550 CT.	110	5	2	6.3 CT.	5	3	3¼	3⅛	2½	2¼	4½

Fig. 5—Partial transformer catalog listing from which needed transformer was selected.

cool. Now, if we took one up the line there with only a 90-ma capacity, she'd be runnin' pretty hot at 98 ma and wouldn't last too long! You dig?"

"I dig, man," said the Young Ham.

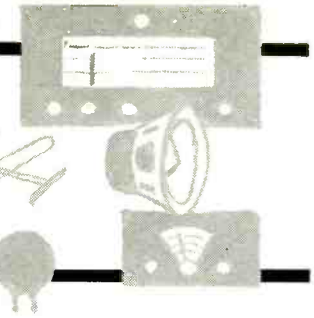
"Well, might as well—Hey, wait a minute," said the Old-Timer, digging in a lower shelf of the parts cupboard. He emerged presently, holding up a

"Good. But it's gettin' a little late. Why don't we knock off for today? You can hook up that new transformer in the morning. And don't forget this one is built a bit different from the original unit. I'll show you how to get around that little problem in the morning, too."

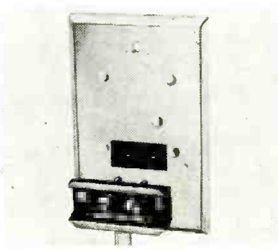
TO BE CONTINUED

"I got it! I got it!"

NEW PRODUCTS

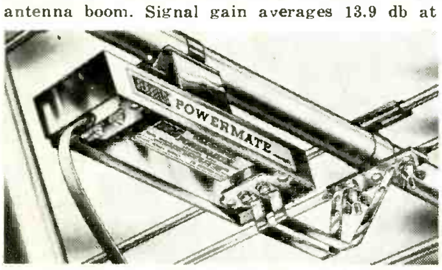


12-DB TAPOFFS for master TV systems. Through loss no greater than standard 17-db isolation tapoffs—0.7 db. Back matched to mini-



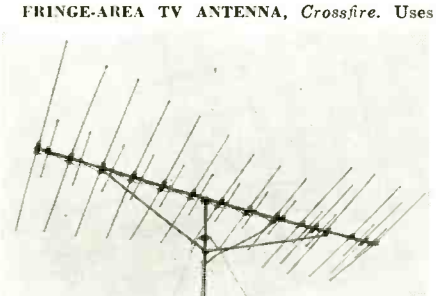
mize ghosts and smears. LCR network for relatively constant impedance over entire vhf band. —**Blonder-Tongue Labs Inc.**, 9 Alling St., Newark 2, N.J.

TRANSISTORIZED ANTENNA PREAMP, *model APM-101*. Creates 2 set system when added to any TV or FM antenna. Can be mounted on antenna boom. Signal gain averages 13.9 db at



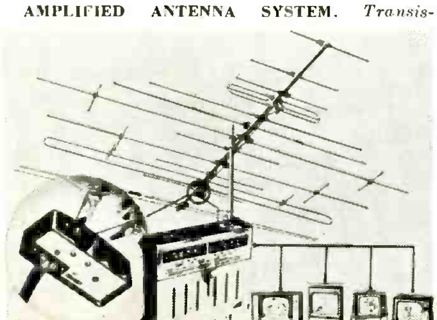
channel 13 and 18.25 db at channel 2. 300-ohm antenna line carries power to preamp and signal from preamp. 2 TV sets or 1 TV and 1 FM can be fed with dual outputs.—**Jerrold Electronics Corp.**, 15th and Lehigh Ave., Philadelphia, Pa.

FRINGE-AREA TV ANTENNA, *Crossfire*. Uses



proportional energy-absorption principle to give clearer, stronger all-channel reception. High front-to-back ratio for sharp selectivity.—**Channel Master Corp.**, Ellenville, N.Y.

AMPLIFIED ANTENNA SYSTEM. *Transis-*

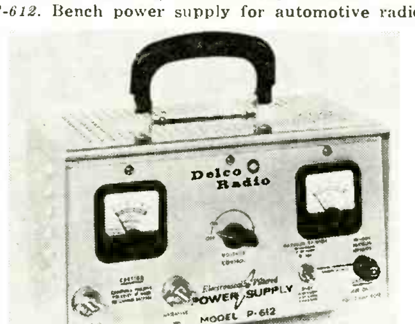


Tenna. Drives up to 4 TV or FM receivers at once, allowing for up to 4 locations. Improves signal-to-noise ratio, giving noise-free color reception and eliminating impure hues. Self-contained amplifier mounts at antenna terminals, amplifying signal before unwanted signals are picked up by downlead. All-transistor unit operates on 4 type-D flashlight batteries. Can be removed up to 1 mile from installation site with no signal deterioration. Distribution unit mounts in any convenient centralized location.—**JFD Electronics Corp.**, 6101 16th Ave., Brooklyn 4, N.Y.

BATTERY ELIMINATOR, *model 1064*. 6- and 12-volt dc outputs with minimum ripple for servicing transistor equipment. Dc output voltage ranges: 0–8, 0–16. Current ratings: 0–8-volt range, 10 amps continuous, 20 amps intermit-

tent; 0–16-volt range, 6 amps continuous, 10 amps intermittent. Ac ripple: 0–16-volts range, 0.3% at 2 amps, 1% at 6 amps, 1.5% at 10 amps; 0–8 volt range, 1.5% at 2 amps, 2% at 6 amps, 4.5% at 10 amps.—**Electronic Instrument Co. Inc.** (EICO) 33-00 Northern Blvd., Iong Island City 1, N.Y.

POWER SUPPLY, electronically filtered, *model P-612*. Bench power supply for automotive radio

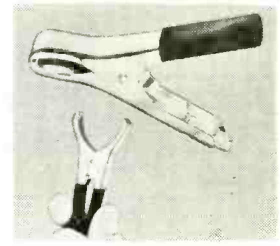


repair shops. Converts 117 volts ac to 0–16 volts dc. Operates any auto radio including all-transistor types. Rated output 8 amps continuous at 6 volts and 5 amps continuous at 12 volts with .01% ripple at rated load. Completely variable voltage control from 0–16 volts, 20 amps instantaneous output. Can be used to charge batteries if proper polarity is observed.—**Delco Radio Div.**, General Motors Corp., Kokomo, Ind.

TV WINDOW CLEANER packaged in aerosol

can. Contains special abrasive to minimize scratches. Anti-static and anti-fogging.—**Injectorall Co.**, 6 Bay 50 St., Brooklyn, N.Y.

AUTOMOTIVE PLIER CLIP, *Pigmy*. 3-inch clip for use with battery chargers. *Model 46-A* is



copper-plated steel; *46-C*, solid copper. 1⅛-inch jaw spread.—**Mueller Electric Co.**, 1567Y E. 31 St., Cleveland 14, Ohio.

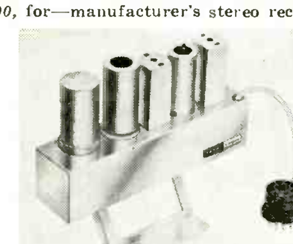
SOLDERING KIT includes 100-watt *model 8100B* soldering gun and *Kormat* solder dis-

penser. Gun has iron-plated copper tip. Dispenser keeps solder clean and reduces waste.—**Weller Electric Corp.**, 601 Stone's Crossing Road, Easton, Pa.

CITIZENS-BAND TRANSCEIVER, *model TC-900*. Pocket-sized unit. Range of mile or more. Output power 100 mw. Transmitter, crystal-controlled rf oscillator. Receiver, crystal-con-

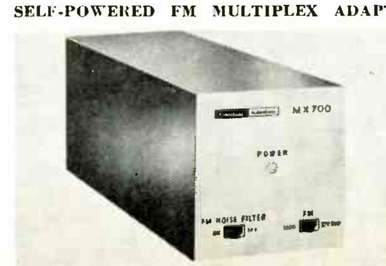
trolled superhet. 9-transistor circuit powered by 7 penlight cells.—**Monarch Electronics International Inc.** 7035 Laurel Canyon Blvd., N. Hollywood, Calif.

SNAP-ON FM MULTIPLEX ADAPTER, *model MX600*, for—manufacturer's stereo receivers TA-



230, TA224 and TA260. Snaps onto rear of chassis, adds 1½ inch to depth of receiver. Powered by receiver.—**Harman-Kardon, Inc.**, Ames Court, Plainview, N.Y.

SELF-POWERED FM MULTIPLEX ADAPTER,



model MV700. For all of manufacturer's tuners with multiplex outputs. When multiplex signal is received, indicator glows, adapter automatically activated.—**Harman-Kardon**, Ames Court, Plainview, N.Y.

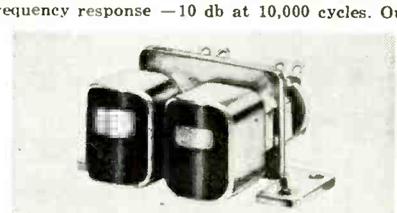
FM MULTIPLEX ADAPTER, *model MX-99*. Self-powered. Automatic stereo/mono operation. low-impedance cathode follower outputs. For manufacturer's FM equipment and other component, wide-band FM tuners with multiplex output. Provides required suppression of spurious

signals, synchronizes with any usable output from FM tuner and demodulates, without distortion, tuner outputs as high as 7 volts peak-to-peak.—**Electronic Instruments Co. (EICO),** 33-00 Northern Blvd., Long Island City 1, N.Y.

CIRCUMAURAL EARPHONES, *model HA-10*. Liquid-filled ear cushion fits around ear, Lateral pressure 2 lb over 10 sq inches. Attenuates ambient noise 40 db. Frequency response 20–20,000 cycles, flat from 30 to 10,000 ±3 db. Maxi-

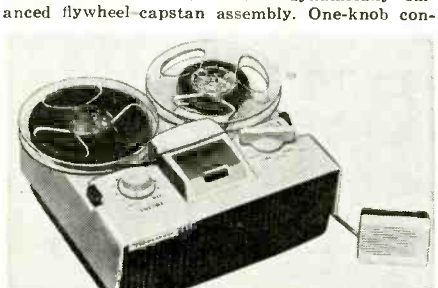
mum input power 2 watts each phone, maximum acoustical output 138 db. Impedance 10 ohms per phone.—**E. J. Sharpe Instruments of Canada Ltd.,** 6080 Yonge St., Willowdale, Ont., Canada.

TAPE HEADS, mono and stereo. *RH-2* series (illus.) record/reproduce heads for mono half-track recording on ¼-inch tape. Resolution gap 120 micro-inches. At 7.5 ips, *RH-2* head has frequency response —10 db at 10,000 cycles. Out-



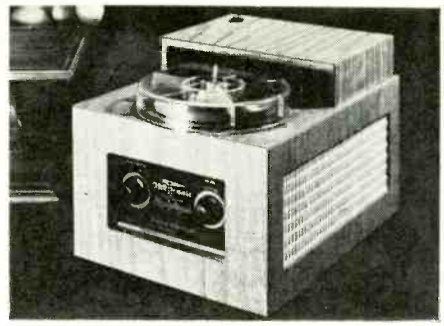
put, 3 mv at 1,000 cycles. *RH-4* series record/-reproduce heads for 4-track stereo systems. At 3.75 ips, *RH-4* head has frequency response of —10 db at 10,000 cycles. Output, 3 mv. Matching *EH-4* erase head available.—**Sonotone Corp.,** Elmsford, N.Y.

TAPE RECORDER *Sony Model 111*. 2 speeds (3¾ and 1⅞ ips.) Ac-operated monophonic unit. Sturdy drive mechanism with dynamically balanced flywheel capstan assembly. One-knob con-



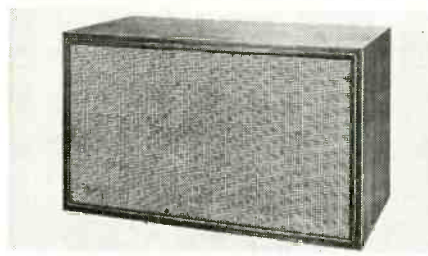
trol. Pause position locks mechanism until ready to record. 8¾ x 4½ x 7½ inches. 9 lbs.—**Superscope Inc.,** Audio Electronics Div., 8150 Vineland Ave., Sun Valley, Calif.

MODULAR TAPE PLAYER, *model P100* for home or industry. Whip antenna, built-in trans-



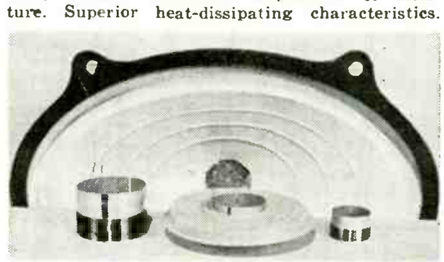
mitter. Tunable to AM broadcast band, to play through radio without direct connection. Dual-track head for 2-track monaural playback at 3¾ ips. Frequency response 50–10,000 cycles. Signal-to-noise ratio —45 db.—**J. Herbert Orr, Enterprises Inc.,** 714 Wesley St., Opelika, Ala.

THREE-WAY SPEAKER SYSTEM, *XP-4*. 4 speakers: 12-inch woofer with 2-inch voice coil.



Two 5-in. mid-range speakers. 2-inch hemispherical tweeter. 3-way crossover network using heavy air-core coils. Output impedance 8 ohms. Enclosure 12½ x 14 x 24½ in.—**Fisher Radio Corp.,** 21-21 44th Drive, Long Island City 1, N.Y.

SPEAKER VOICE-COIL ASSEMBLY of specially treated aluminum. Impervious to moisture. Superior heat-dissipating characteristics.



Assembly can withstand temporary overloading without charring, warping or distorting. Sound-conducting capacity superior to nonmetallic substances. Used in manufacturer's entire speaker line.—**Oaktron Industries,** Highway 69H, Monroe, Wis.

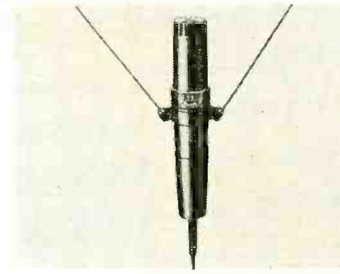
CERAMIC MICROPHONE, *model B-206-WGB* (illus.). Mounted on 13-inch gooseneck with mounting flange and 4-foot cable. For inexpen-

sive language lab applications. Also available with 9-inch gooseneck *(model B-206-WGA)*. Crystal *model X-206-WGB* available with 13 and 9 in. goosenecks.—**American Microphone Co.,** Div. of GC Electronics, Rockford, Ill.

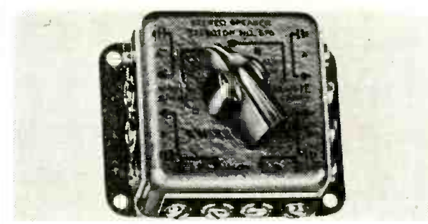
MODULAR MICROPHONES *Model 401* (illus.). Omni-directional unit meets broadcast standards. For PA applications. Response 30–20,000 cycles.

Model 402S same as 401, with internal shock mounting.—**University Loudspeakers Inc.**, 80 S. Kensico Ave., White Plains, N.Y.

LAVALIER MICROPHONES *Model 404L* (illus.). Meets requirements of professional broadcasting microphone, for churches, clubs, schools, industry and PA. Frequency response 50-20,000 cycles. *Model 403L* ultra-compact version. Frequency response 60 cycles to 20,000 cycles.—**University Loudspeakers Inc.**, 80 S. Kensico Ave., White Plains, N.Y.



STEREO SPEAKER-SELECTOR SWITCH connects two remote pairs of speakers to stereo amplifier. Three-position switch selects either or both remote pairs of stereo speakers at same time. Screw terminals.—**Switchcraft Inc.**, 5555 N. Elston Ave., Chicago 30, Ill.



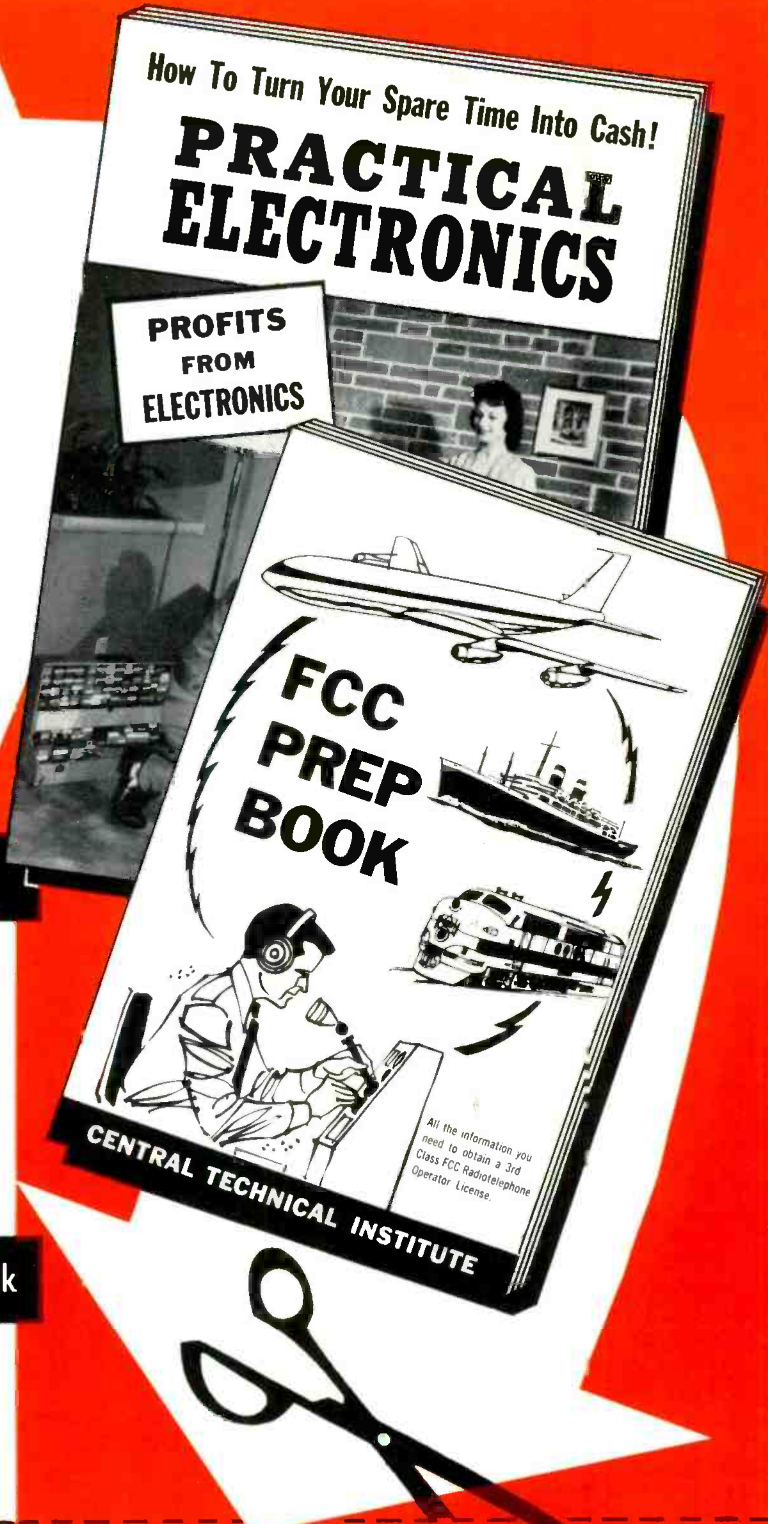
STEREO AMPLIFIER KIT, *model LK-150*. 65 watts per channel. Harmonic distortion less than 0.5% at full power, IM distortion less than 0.5% at 65 watts. Damping factor 16.1 or 8.1. IHFM power band 19–25,000 cycles.—**H. H. Scott Inc.**, 111 Powder Mill Rd., Maynard, Mass.

STEREO CLEANING KIT cleans all types of phonograph records. Helps reduce stylus wear. Includes a bottle of antistatic detergent, special wiping pad and needle brush.—**Duotone**, Locust St., Keyport, N.J.

STEREO PHONO CARTRIDGES, *models M33-5* and *M33-7* (illus.) Response, 20 to 20,000 cycles. Output (at 5 cm/sec at 1,000 cycles), 6 mv. Channel separation, more than 22.5 db at 1,000 cycles. Recommended load, 47,000 ohms. Inductance, 600 mh. Dc resistance, 750 ohms. Vertical and horizontal compliance, 10×10^{-6} cm/dyne. Stylus tip radius, .0005 inch for *M33-5* cartridge, .0007 inch for *M33-7*. Tracking force,

TRADE THE POSTAGE-PAID REPLY CARD BELOW FOR THESE TWO

FREE BOOKS!



Get Your FREE COPY of this 64 Page Catalog

. . . telling you all about the amazing opportunities in the exploding field of electronics. Learn about the profit opportunities in the field of Radio-TV Electronics and APPLIANCE SERVICING. Get the facts about Central Technical Institute's NEW, down-to-earth PRACTICAL ELECTRONICS Home Study Course . . . brand new INSTANT KITS that can be used in starting your own business or that can be sold at a profit to friends, neighbors and customers!

Get Your FREE COPY of this 31 Page FCC Prep Book

. . . telling you all you need to know to pass the 3rd class FCC Radiotelephone examination. FCC 3rd class license qualifies you to operate radiotelephone transmitting stations used by airlines, police, railroads, emergency services, etc.

EARN EXTRA MONEY SOON IN YOUR SPARE TIME! *Train at home for a Career in Radio-TV Electronics and Profitable APPLIANCE SERVICING!*

NO EXPERIENCE NEEDED!

Enroll in Central Technical Institute's New Home Study Course—PRACTICAL ELECTRONICS. Central will show you how to make money soon—servicing AM-FM radios, TV sets, small appliances . . . building and installing electronic equipment in homes, factories and business offices. The future is bright for trained technicians and servicemen. Get started today toward a prosperous business of your own or a better job . . . with Central's PRACTICAL ELECTRONICS Home Study Course. Join the thousands of Central students and graduates who are making extra money in their spare time—have their own business—or a good job with a future.

SEE OTHER SIDE!

Clip and Mail This Postage-Free Card Today!

GET 2 FREE BOOKS!

☐ Please send me my FREE copies of PRACTICAL ELECTRONICS and FCC PREP BOOK

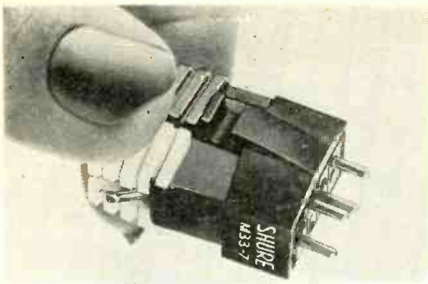
Name ______________________ Age ______

Address ______________________

City ______________ Zone ____ State ______

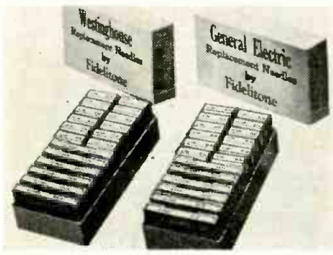
CENTRAL TECHNICAL INSTITUTE

Accredited Member National Home Study Council
Over 50,000 Successful Graduates since 1931!



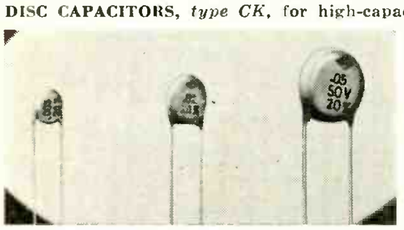
1 to 3 grams.—**Shure Bros. Inc.**, 222 Hartrey Ave., Evanston, Ill.

REPLACEMENT STYLI for stereo and hi-fi. Each box contains 10 to 18 individual packages with either diamond or sapphire replacement to



fit 1960–61 G-E, Westinghouse, Zenith, Webcor, RCA and Stromberg-Carlson phonographs.—**Fidelitone Inc.**, 6415 Ravenswood Ave., Chicago 26, Ill.

DISC CAPACITORS, *type CK*, for high-capacitance, low-voltage requirements of transistor circuitry. Capacitance range 0.005-μf to 0.1-μf, ±20%. Working voltage, 50 vdc. 5/32 inch thick. Diameters ⅜ to ⅝ in., depending on capacitance. —**Centralab**, 900A E. Keefe Ave., Milwaukee 1, Wis.

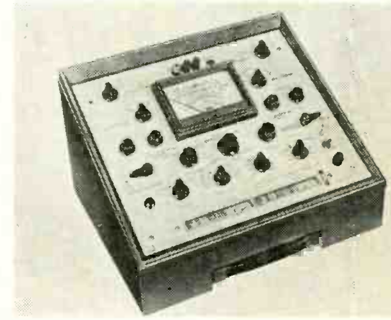


UNI-TITE SERVICE CENTER cuts technician's time and stocking requirements. Provides selection of more than 75 dual control replacements with rear and panel units plus appropriate

shafts. Enables technician to assemble units not available as standard replacements. Rear and panel units and shafts snap together.—**Clarostat Mfg. Co. Inc.**, Dover, N. H.

AUTOMATIC VTVM *model 375*. Quick readings on individual scales. One scale visible at a time. Single ac–dc probe. Ranges: dc volts, ac rms volt and ac peak-to-peak volts—0–1.5, 5, 15, 50, 150, 500, 1,500; dc ma, 0–5, 50, 500; resistance (ohms), 0–500, 5,000, 50,000, 500,000, 1 meg, 5 megs, 50 megs, 1,000 megs. Input resistance 11 megohms on all dc ranges. Accuracy 3% of full-scale.—**B&K Mfg. Co.**, 1801 Belle Plaine Ave., Chicago, Ill.

TRANSISTOR TESTER, *model 1885*. Tests transistors to 50 amps collector current, power diodes



to 5 amps forward current, Zener diodes to 150-ma leakage current. Measures I_{CBO}, I_{CEO}, I_{EBO}, dc beta, input impedance, output impedance, gm in μmhos and mho. Determines alpha and collector voltages and V_{CO} (sat.).—**Hickok Electrical Instrument Co.**, 10531 DuPont Ave., Cleveland 8, Ohio.

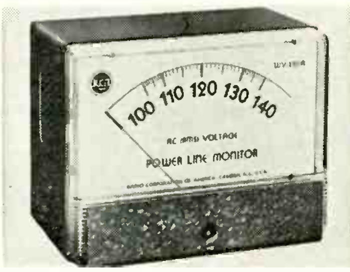
TRANSISTOR TESTER, *model IM-30*. Complete dc analysis of all p-n-p, n-p-n transistors up to

15 amps. Checks base current, gain, collector current, voltage, leakage and shorts. Internal batteries provide up to 9 volts in 1.5-volt steps. External dc supply terminals provide higher voltages and current.—**Heath Co.**, Benton Harbor, Mich.

IN-CIRCUIT TRANSISTOR TESTER, *model TIC-161*. Tests any type transistor, including power, while soldered in circuit. Checks for shorts,

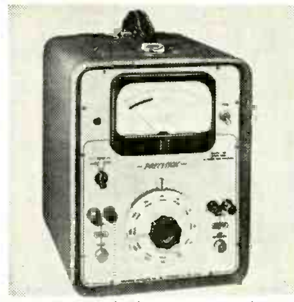
opens, leakage, oscillation, and comparative gain. Indicates whether transistor is p-n-p or n-p-n. Tests diodes and rectifiers.—**Paralan Electronics Corp.**, 507 5th Ave., New York 17, N.Y.

POWER-LINE MONITOR, *model WV-120A*. Expanded scale from 100 to 140 volts. Moving-



vane type meter indicates true rms values even when line voltage not pure sine wave. Accuracy: ±2% at 120 volts, ±3% at 100 and 140 volts. Frequency range: 25 to 400 cycles. Fast meter action reveals fluctuations and bounces in line-voltage.—**RCA**, Electron Tube Div., Harrison, N.J.

AC VTVM, *model 58*. Frequency- and temperature-compensated decade attenuator, calibrated

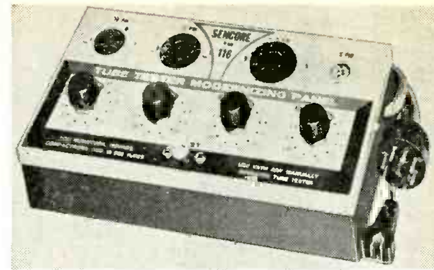


in voltage and in 10-db steps, consisting of 0.5% film resistors. Frequency range, 10 cycles to 2 mc. Accuracy, 1% of full scale from 30 cycles to 100 kc; 2% of full scale from 10 to 30 cycles and 100 kc to 2 mc.—**Precision Apparatus Co. Inc.**, 70-31 84th St., Glendale 27, N.Y.

TUBE-TESTER ADAPTER, *model AD-4*. Tests all new tubes, such as nuvistors, 12-pin Com-

pactrons, new 10-pin tubes and Novars. Converts present tube testers, regardless of make, into up-to-date models.—**Mercury Electronics Corp.**, 111 Roosevelt Avenue, Mineola, N. Y.

TUBE-TESTER MODERNIZING PANEL, *model*

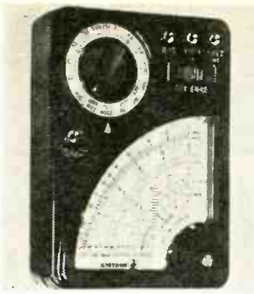


TM 116. Adapts any tube tester, except cardomatic type, to check RCA nuvistors, G-E 12-pin Compactrons, Sylvania 10-pin tubes and RCA 9-pin Novars. Same checks on new tubes as present testers make on standard tubes, including mutual conductance, high grid leakage and checking for interelement shorts. Tests made by plugging TM116 into octal socket on user's tester and setting controls from chart provided with unit.—**Sencore Inc.**, 426 S. Westgate Drive, Addison, Ill.

TUBE TESTER, *model TC114, Mighty Mite II*. Improved version of TC109 Mighty Mite. Checks

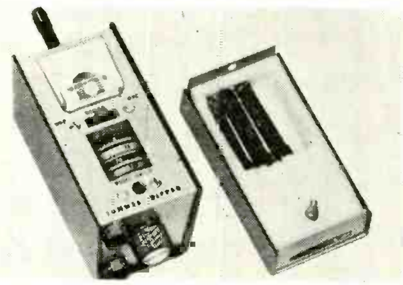
all tubes the earlier model tests plus G-E Compactrons, Sylvania 10-pin tubes, RCA nuvistors and Novars. Adjustable mirrored cover can be set at any angle for TV adjustments.—**Sencore Inc.**, 426 S. Westgate Drive, Addison, Ill.

VOLT-OHM-METER, *model MT-200*. 1% preci-



sion resistors used throughout pocket-sized unit. Ranges, dc volts: 0–5–25–50–250–500–2,500 volts at 20,000 ohms per volt. Ac volts: 0–50–100–500–1,000 volts at 10,000 ohms per volt. Dc: 0–50 μa, 0–2.5 ma, 0–250 ma. Resistance: ×1, ×10, ×1,000 ohms. Capacitance: 10 μμf to .001 μf. Decibels: —20 to +63db.—**Monarch Electronics International Inc.**, 7035 Laurel Canyon Blvd., N. Hollywood, Calif.

GRID-DIP OSCILLATOR, *Tunnel Dipper HM-10*, uses tunnel diode and solid-state circuitry.

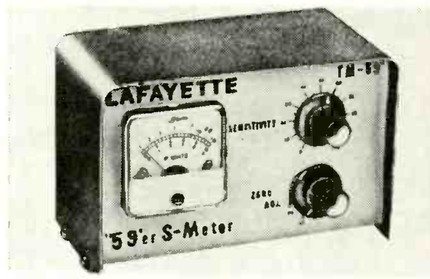


Frequency range 2.7 to 270 mc. Gear-drive vernier tuning. Power supplied by single flashlight cell. Epoxy-coatel coils.—**Heath Co.**, Benton Harbor, Mich.

CRT REJUVENATOR TESTER, *model 420*, tests and rejuvenates 2-, 6- and 8-volt picture tubes. Checks for leakage, shorts and emission. Removes

interelement shorts and leakage. Restores emission and brightness. Easy-to-read good–bad scale. —**B&K Mfg. Co.**, 1801 W. Belle Plaine Ave., Chicago 13, Ill.

S METER, *model TM-59*. Sensitive, high-input device using vtvm type Wheatstone bridge cir-

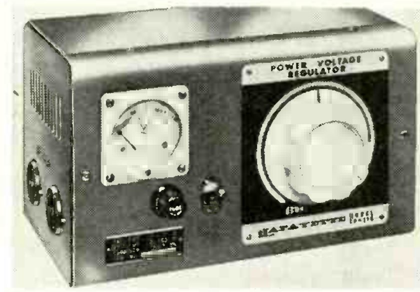


cuit. Will not load superhet CB transceiver or communications receiver using avc system. Calibrated in S-units 1–9 and in db, up to S9 + 40 db.—**Lafayette Radio Electronics Corp.**, 165-08 Liberty Ave., Jamaica 33, N. Y.

RF SIGNAL GENERATOR, *model E-75*. Covers 160 kc to 240 mc on 8 direct-reading bands. Broadcast band calibrated. High signal output for single- and multi-stage alignment. Percentage modulation continuously variable at front-panel control. FM if bandwidth calibrated in

0.1-mc steps. Rf output in excess of 100,000 μv. 400-cycle audio output approximately 15 volts.—**Precision Apparatus Co. Inc.**, 70-31 84 St., Glendale 27, L. I., N. Y.

VARIABLE VOLTAGE AC SUPPLY, *model TR 114*. Output from 0–140 volts ac ±0.6% at 75 watts and 3% at maximum output (500 watts).

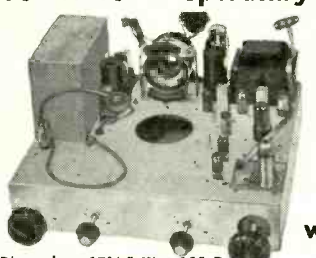


Maximum no load output 142 volts rms. Illuminated meter reads 0–150 volts with 1% full-scale accuracy.—**Lafayette Radio Electronics Corp.**, 165-08 Liberty Ave., Jamaica 33, N.Y.

All specifications are from manufacturers' data.

DX-16 Super Deluxe TV KIT

70° or 90° — operating all 17", 21", 24" and 27" PICTURE TUBES



- ★ Produces a 16-Tube Chassis with 30-Tube performance.
- ★ Latest Intercarrier Circuitry and Multi-section Tubes.
- ★ Standard Neutrode Tuner for Selectivity & Fine Definition.
- ★ All Video and I.F. Coils factory pre-aligned and tuned.
- ★ Large 250ma Power Transformer for dependable service.
- ★ 12" Speaker or Twin-cone 6" x 9" Speaker.

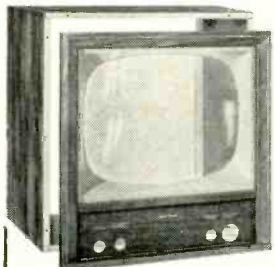
Includes *LIFE-SIZE* step-by-step Building Instructions
Most Up-To-Date and Practical Course in Television

Dimensions 17½" W x 16" D
Shipping weight 40 lbs.

COMPLETE KIT with SET of WESTINGHOUSE TUBES $93.49
4—6CB6, 6U8, 6T8, 6C4, 12BH7, 6SN7, 6BQ6, 6W4, 6K6, 1X2B, 5U4. 6BN4, 6GC8, incl. in the Tuner (less CRT)

Also sold on **EASY-PAYMENT-PLAN** Buy LIFE-SIZE Instructions—$2.49—and buy Parts as you build.

BUILD YOUR OWN CABINET FOR ANY TV CHASSIS



Comparable to the type that Top Mfrs. use on high priced TV sets.

CABINET KIT with 90% of the job done, includes—
FRONT SECTION in Solid Mahogany, Walnut or Blond Korina. **TOP, SIDES, BACK, MASK, SAFETY GLASS, ETC.**
And EASY-TO-FOLLOW ASSEMBLY INSTRUCTIONS

Front, Top and Sides supplied in a beautiful Piano Finish ● Knob panel undrilled ● For matching Mask specify type or number of CRT used. Same price—Mahogany, Walnut or Blond. (Shipping weight 36 lbs.)

21" CABINET KIT 26"H, 25"W, 22"D **$26.97**

23" TV CABINET KIT . . $28.47 24" or 27" TV CABINET KIT . . $38.47 21" or 23" FRONT SECTION for flush to wall mounting.... $19.45

TECH-MASTER for 1962 ★

CONSTELLATION TV CHASSIS #6015
Complete ready to play (less CRT) .. $144.50

TUBULAR CONDENSERS—85°C TOP QUALITY—Equally as good for Radio or TV work

.0047-400v, .01-400v, .02-400v, .047-400v, .001-600v, .0047-600v, .01-600v, .02-600v, .03-600v 5¢ ea.
.1-400v, .25-400v, .47-400v, .047-600v, .1-600v, .25-600v, .001-1000v, .0047-1000v, .01-1000v, 8¢ ea.
.039-1000v, .047-1000v, .1-1000v, .007-1600v, .03-1600v, .05-1600v, .005-3000v, .001-6000v, 14¢ ea.

ELECTROLYTIC CONDENSERS—85°C

1-50v, 1-150v, 2-450v, 25-50v, 8-150v 16¢ ea.
20/20-150v, 50/30-150v, 40-150v, 10-450v, 20-450v, 30-450v, 40-450v, 60-450v, 80-450v......34¢ ea.

CARBON RESISTORS—Regular factory stock in Stackpole, Speer, IRC, etc.

½ WATT 10% 10, 20, 39, 47, 68, 100, 120, 150, 270, 330, 390, 470, 560, 680, 820 1k Ω....3¢ ea.
½ WATT 10% 1800, 2700, 3300, 3900, 4700, 5600, 6800, 8200, 10k, 15k, 18k, 22k, 27k Ω...3¢ ea.
½ WATT 10% 33k, 39k, 47k, 56k, 68k, 82k, 100k, 120k, 150k, 180k, 220k, 270k, 330k Ω......3¢ ea.
½ WATT 10% 390k, 470k, 560k, 680k,Ω 1, 1.2, 1.5, 2.2, 6.8, 10, 15 MEG Ω ....3¢ ea.
1 WATT 10% 3.3, 10, 39, 100, 120, 150, 330, 470, 560, 680, 820, 1k, 1800, 2700, 4700 Ω ..4¢ ea.
1 WATT 10% 6800, 10k, 15k, 18k, 22k, 27k, 33k, 39k, 47k, 68k, 82k, 100k, 150k, 470k, 680k Ω 4¢ ea.
2 WATT 10% 18, 22, 39, 47, 68, 82, 100, 150, 180, 270, 330, 470, 560, 680 Ω..............5¢ ea.
2 WATT 10% 820, 1k, 1500, 1800, 2200, 2700, 3300, 3900, 4700, 6800, 8200, 10k, 15k, 18k Ω 5¢ ea.
2 WATT 10% 22k, 27k, 33k, 39k, 47k, 68k, 100k, 150k, 220k, 270k, 330k, 1, 10 meg Ω.......5¢ ea.

WIREWOUND RESISTORS

5-10w, 7-10w, 10-10w, 20-10w, 30-10w, 39-10w, 50-10w 9¢ ea.
56-10w, 62-10w, 70-10w, 82-10w, 100-10w, 150-10w, 180-10w 280-10w, 470-10w, 560-10w....9¢ ea.
650-10w, 680-10w, 1200-10w, 1500-10w, 2500-10w, 220-5w, 350-5w, 820-5w, 1800-5w, 1K-10w 9¢ ea.
2K-10w, 3K-10w, 5K-10w, 6K-10w, 7K-10w, 8K-10w, 9K-10w, 10K-10w, 15K-10w, 20K-10w ......9¢ ea.

CERAMIC CONDENSERS 1, 2, 3, 5, 6, 10, 22, 25, 47, 50, 51, 56, 82, 100, 120, 150 mmf .. 3¢ ea.
CERAMIC CONDENSERS 220, 250, 270, 330, 470, 1k, 1200, 1500, 2k, 5k, 6800, 10k mmf . 3¢ ea.
MICA CONDENSERS 5, 25, 50, 60, 68, 75, 100, 120, 150, 220, 270, 330, 470, 510 mmf .. 3¢ ea.
MICA CONDENSERS 560, 680, 820, 1k, 1500, 2k, 2500, 3300, 4700, 6k, 6800, 8k, 10k mmf 3¢ ea.

- ☐ 15—ASST. ROTARY SWITCHES $15 worth $1
- ☐ 3—TOGGLE SWITCHES spst, dpdt, etc. $1
- ☐ 6—SLIDE SWITCHES spst, dpdt, etc. $1
- ☐ 8—ASST. LUCITE CASES handy for parts $1
- ☐ 10—6' ELECTRIC LINE CORDS w/plugs $1
- ☐ 5—TV CHEATER CORDS w/both plugs $1
- ☐ 20—ASST. TV KNOBS, ESCUTCHEONS, etc. $1
- ☐ 4—50'SPOOLS HOOK-UP WIRE 4 colors $1
- ☐ 25'—INSULATED SHIELDED WIRE $1
- ☐ 75'—MINIATURE ZIP CORD 2 conductor $1
- ☐ 32'TEST PROD.WIRE deluxe (red or black) $1
- ☐ 50—STRIPS ASS'TED SPAGHETTI best sizes $1
- ☐ 100—ASST. RUBBER GROMMETS best sizes $1
- ☐ 3—SILICON RECTIFIERS 350 ma $1
- ☐ $15—"JACKPOT" TELEVISION PARTS $1
- ☐ 3—$11 TODD 60° DEFLECTION YOKES $1
- ☐ 1—$7 INDOOR TV ANT. hi-gain 3 sec. $1
- ☐ 100'—TWIN LEAD-IN WIRE 300Ω heav.duty $1
- ☐ 50'—FLAT 4-COND. WIRE many purposes $1
- ☐ 15—ASST. STANDARD TUNER VHF STRIPS $1
- ☐ 6—ASST. UHF STANDARD TUNER STRIPS $1
- ☐ 25—ASST. PEAKING COILS popular types $1
- ☐ 2—RCA SYNCHRO-GUIDE COILS #205R1 $1
- ☐ 2—RATIO DETECTOR COILS 4.5 mc $1
- ☐ 2—RATIO DETECTOR COILS 10.7 mc $1
- ☐ 2—TV SOUND I.F. COILS 4.5mc $1
- ☐ 1—70° FLYBACK TRANS. incl schematic $1
- ☐ 50' ZIP CORD (2-cond) #18 brown or ivory $1
- ☐ 1—90° FLYBACK TRANS. incl schematic $1
- ☐ 50—ASST. MICA CONDENSERS some in 5% $1
- ☐ 50—ASST. CERAMIC COND. some in 5% $1
- ☐ 35—MICA COND. 20-5mmf & 15-25mmf $1
- ☐ 35—MICA COND. 20-50mmf & 15-68mmf $1
- ☐ 35—MICA COND. 20-100mmf, 15-270mmf $1
- ☐ 35—MICA COND. 20-470mmf, 15-680mmf $1
- ☐ 35—MICA COND. 20-820mmf 15-1000mmf $1
- ☐ 35—MICA COND. 20-2200, 15-2400mmf $1
- ☐ 35—MICA COND. 20-3300, 15-4700 mmf $1
- ☐ 35—MICA CONO. 20-6800, 15-10000mmf $1
- ☐ 2—SOUND DISCRIMINATOR COILS 10.7mc $1
- ☐ 1—TV VERTICAL OUTPUT TRANSFORMER 10 to 1 ratio $1
- ☐ 1—VERTICAL BLOCK. TRANS. standard $1
- ☐ 1—5" PM SPEAKER alnico #5 magnet $1
- ☐ 1—4" PM SPEAKER alnico #5 magnet $1
- ☐ 1—3" PM SPEAKER alnico #5 magnet $1
- ☐ 1—3½" TWEETER SPEAKER for Hi-Fi $1
- ☐ 3—AUDIO OUTPUT TRANS. 50L6 type $1
- ☐ 2—AUDIO OUTPUT TRANS 50L6 pushpull $1
- ☐ 3—AUDIO OUTPUT TRANS. 6K6 or 6V6 $1
- ☐ 2—AUDIO OUTPUT TRANS. 6K6 push-pull $1
- ☐ 3—AUDIO OUTPUT TRANS. 3Q4, 3Q5, 3S4 $1
- ☐ 10—CHOKE TRANS. 75Ω, 1 hy, 100 ma $1
- ☐ 5—SETS SPEAKER PLUGS wired $1
- ☐ 3—I.F. COIL TRANSFORMERS 456 kc $1
- ☐ 2—I.F. COIL TRANS. G.E. #RTL143, 456kc $1
- ☐ 3—I.F. COIL TRANSFORMERS 10.7mc FM $1

"ONE DOLLAR" Buys

As much as $15 worth — Everything Brand New and sold to you with a money back guarantee.

DEDUCT 10% ON ANY ORDER OF $10 OR OVER
(ON DOLLAR BUYS)

Plus a FREE SURPRISE PACKAGE

- ☐ 100—ASST. ½ WATT RESISTORS some 5% $1
- ☐ 70—ASST. 1 WATT RESISTORS some 5% $1
- ☐ 35—ASST. 2 WATT RESISTORS some 5% $1
- ☐ 3—I.F. COIL TRANSFORMERS 262kc(auto) $1
- ☐ 4—OVAL LOOP ANTENNAS ass't hi-gain $1
- ☐ 3—LOOPSTICK ANT. latest type adjustable $1
- ☐ 3—VARIABLE COND. super 420/162 mfd $1
- ☐ 3—ASST. SIZES RADIO CHASSIS PANS $1
- ☐ 12—RADIO OSCILLATOR COILS 456 kc $1
- ☐ 3—½ MEG. VOLUME CONTROLS w/switch $1
- ☐ 5—½ MEG VOLUME CONTROLS less switch $1
- ☐ 5—50K VOLUME CONTROLS less switch $1
- ☐ 5—ASST. 4 WATT WIREW'D CONTROLS $1
- ☐ 10—ASST. VOLUME CONTROLS less switch $1
- ☐ 5—ASST. VOLUME CONTROLS w/switch $1
- ☐ 200—BUSS WIRE handiest size #20 $1
- ☐ 200'—HOOK-UP WIRE any color $1
- ☐ 250—ASST. SOLDERING LUGS best sizes $1
- ☐ 100—VOLUME CONTROL HEX NUTS $1
- ☐ 10—SURE GRIP ALLIGATOR CLIPS $1
- ☐ 1—GOLD GRILLE CLOTH 14x14or12x18 $1
- ☐ 10—SETS PHONO PLUGS and PINJACKS $1
- ☐ 2—$2.50 SAPPHIRE NEEDLES 5000 plays $1
- ☐ 20—ASST. PILOT LIGHTS popular types $1
- ☐ 10—PILOT LT. SKTS. bayonet type, wired $1
- ☐ 50—ASST. TERMINAL STRIPS 1, 2, 3, 4 lug $1
- ☐ 35—ASST. RADIO KNOBS, screw, push-on $1
- ☐ 100—ASSORTED KNOB SET-SCREWS $1
- ☐ 25—ASS'TED RADIO DIAL POINTERS $1
- ☐ 25—ASS'TED CLOCK RADIO KNOBS $1
- ☐ 35—ASST. SOCKETS 7 pin, 8 pin, 9 pin $1
- ☐ 25—ASST. PRINTED CIRCUIT SOCKETS $1
- ☐ 100'—FINEST NYLON DIAL CORD best size $1
- ☐ 35—CERAMIC COND. 20-5mmf, 15-10mmf $1
- ☐ 35—CERAMIC COND. 20-25mmf, 15-47mmf $1
- ☐ 35—CERAMIC COND. 20-56mmf, 15-82mmf $1
- ☐ 35—CERAMIC COND. 20-100, 15-150 mmf $1
- ☐ 35—CERAMIC COND. 20-270, 15-470 mmf $1
- ☐ 35—CERAMIC COND. 20-1000, 15-1500mmf $1
- ☐ 35—CERAMIC COND. 20-2000, 15-5000mmf $1
- ☐ 4—RCA 1U4 TUBES also serves as a 1T4 $1
- ☐ 3—GENERAL ELEC. 35W4 TUBES $1
- ☐ TOP BRAND TUBES—1B3, 1X2B, OZ4, 5U4, 6SN7, 6CB6, 6U8, 6J6, 6V6, 6K6, 6X8, 6AX4, 6AC7, 12AT7, 12AU7, Each $1
- ☐ 4—TV ION TRAPS good for all TV's $1
- ☐ 4—TV CENTERING RINGS for back of yoke $1
- ☐ 15—ASST. TV COILS sync, peaking, width $1
- ☐ 5—TV CRT. SOCKETS with 18" leads $1
- ☐ 50'—HI-VOLTAGE WIRE top quality $1
- ☐ 5—HI-VOLT. ANODE LEADS with 20" leads $1
- ☐ 3—TV CARTWHEEL CONDENSERS 20 kv $1
- ☐ 1—LB. SPOOL ROSIN CORE SOLDER 40/60 $1
- ☐ 600—ASST. HDWARE screws, nuts, riv., etc. $1
- ☐ 200—SELF TAPPING SCREWS #8 x ½" $1
- ☐ 200—6/32 HEX NUTS & 200—6/32 BOLTS $1
- ☐ 50—ASSORTED FUSES popular sizes $1
- ☐ 50—ASST TUBULAR CONDENSERS $1
- ☐ 20—TUBULAR CONDENSERS .047-400v $1
- ☐ 15—TUBULAR CONDENSERS .47-400v $1
- ☐ 25—TUBULAR CONDENSERS .001-600v $1
- ☐ 20—TUBULAR CONDENSERS .005-600v $1
- ☐ 20—TUBULAR CONDENSERS .01-600v $1
- ☐ 15—TUBULAR CONDENSERS .1-600v $1
- ☐ 15—TUBULAR CONDENSERS .25-600v $1
- ☐ 3—ELECTROLYTIC COND. 50/30-150v $1
- ☐ 2—ELECTROLYTIC COND. 80/80/20-150v $1
- ☐ 10—ASST. RADIO ELECTROLYTIC COND. $1
- ☐ 5—ASST. TV ELECTROLYTIC COND. $1
- ☐ 2—ELECTROLYTIC COND. 40/40—450v $1
- ☐ 4—ELECTROLYTIC COND. 10-450v $1
- ☐ 3—ELECTROLYTIC COND. 16/16-450v $1
- ☐ 3—ELECTROLYTIC COND. 30-450v $1
- ☐ 3—ELECTROLYTIC COND. 80-450v $1
- ☐ 2—ELECTROLYTIC COND. 50/50-150v $1
- ☐ 6—ELECTROLYTIC COND. 25-50v $1
- ☐ 6—ELECTROLYTIC COND. 100-50v $1
- ☐ 50—100KΩ ½ WATT RESISTORS 10% $1
- ☐ 50—220K ½ WATT RESISTORS 10% $1
- ☐ 50—470KΩ ½ WATT RESISTORS 10% $1
- ☐ 50—2.2 MEGΩ ½ W. RESISTORS 10% $1
- ☐ 20—ASST. WIREW'ND RES. 5, 10, 20 watt $1
- ☐ 40—ASST. PRECISION RESISTORS 1% $1
- ☐ 35—ASST. DISC CERAMICS best numbers $1
- ☐ 35—DISC CERAMICS 5000 mmf $1
- ☐ 25—ASSORTED MICA TRIMMER COND. $1
- ☐ 5—DIODE CRYSTALS 2-1N21 1-1N64 1-1N60 1-1N82 $1
- ☐ 4—DIODE CRYSTALS 1-1N34 1-1N60 1-1N64 1-1N69 $1
- ☐ 3—SELENIUM RECT. 2-65ma & 1-75ma $1
- ☐ 2—SELENIUM RECT. 1-100ma & 1-250ma $1
- ☐ 2—SELENIUM RECT. 1-75ma & 1-350ma $1
- ☐ 2—SELENIUM RECT. 1-65ma & 1-450ma $1
- ☐ 3—HV RECTIFIERS SOCKETS 1X2 mounted $1
- ☐ 1—TV FOCALYZER adjusts any ohmage $1
- ☐ 1—SILICON RECTIFIER 750 ma 500v $1
- ☐ 2—SILICON RECTIFIERS 500 ma $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #1 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #2 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #3 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #4 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #5 $1

EACH ALIGNMENT TOOL is different & valued at over $1

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted (X in square is sufficient); enclose with money order or check. You will receive a new copy of this ad for re-orders.

ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.

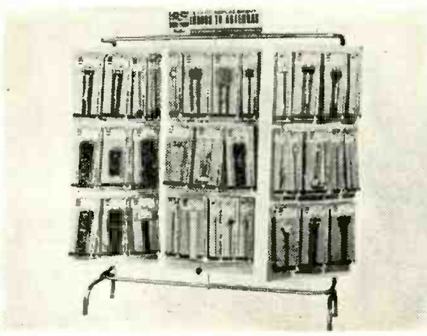
BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N.Y.

TELEPHONE COrtland 7-2359

NEW BUSINESS GETTERS

DISPLAYS • PACKAGES

SELF-SERVICE PACKAGE for exact-replacement indoor TV antennas offered to the trade.



GC Electronics Co., Div. of Textron Electronics, Inc., 400 So. Wyman St., Rockford, Ill.

COUNTER MERCHANDISER holds up to 240 needle packages. Fidelitone, Inc., 6415 Ravenswood Ave., Chicago, Ill.

NEW LITERATURE

CATALOGS • BOOKLETS • CHARTS

> Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

ELECTRONIC PARTS, 336 pages of them in *catalog 111*. Includes hi-fi components, test equipment, tubes, semi-conductors, breadboards, resistors, capacitors and many other electronic parts and hardware. — Radio Shack Corp., 730 Commonwealth Ave., Boston 17, Mass.

WHY STEREO? 2-color illustrated booklet answers the question with pictures and diagrams clarifying the stereo concept. Details are given on various kinds of stereo sources, ways of setting up stereo systems and converting mono systems to stereo.—Electronic Instrument Co. Inc., (EICO), 33-00 Northern Blvd., Long Island City, N. Y.

HIGH-PERMEABILITY ALLOYS provides new, laboratory-tested material on permeability and Core loss. Publication reports comparison of permeability of Epstein strips, stamped rings, and I DU laminations; describes new approach to core-loss calculations and contains 60- and 400-cycle loss data. Many tables, graphs and photographs.—**Magnet Metals Co.**, Hayes Ave. at 21st St., Camden, N. J.

PA AMPLIFIERS AND SYSTEMS are illustratel in 4-page catalog. Shown are 12-, 35- and 100-watt amplifiers; a phonograph top common to all units; locking panel covers, and a combination mixer-amplifier. Price list for each unit is included.—**Harman-Kardon Inc.**, Ames Court, Plainview, N. Y.

SPECS ON RF COILS are given in 48-page *catalog No. 62*. More than 1,500 items are shown, including molded (military type) rf chokes, if transformers, adjustable coils wound on stable ceramic and resinite materials, exact-replacement coils and other related items.—**J. W. Miller Co.**, 5917 S. Main St., Los Angeles 3, Calif.

FM MULTIPLEX STEREO is explained in this 16-page booklet. Simple instructions tell how to receive stereo by tuning to a single FM station; how to adapt consoles and FM tuners for multiplex; how to set up a new FM stereo component system. A special appendix explains difference between FM and AM radio transmission.—**H. H. Scott Inc.**, Multiplex Div., 111 Powdermill Rd., Maynard, Mass.

AC MOTOR-RUN CAPACITORS are described in 4-page *catalog 171 B1.1*. Section on application data provides general information, standard ratings, capacitor life data, capacitance tolerance, power factor, frequency, voltage tests and capacitance temperature relationship graph. There is a full table of capacitances, physical dimensions and product catalog numbers, and a section dealing with construction features and accessories.—**Aerovox Corp.**, New Bedford, Mass.

3D-TV booklet describes the Stereotronics system for optically converting closed-circuit TV to 3D. Block diagram showing equipment setup is included, plus simple instructions regarding installation, operation and service.—**Stereotronics Corp.**, 1717 N. Highland Ave., Los Angeles 28, Calif.

AC CAPACITORS featured in 16-page catalog *MS61-10*. Complete listings of expanded air-conditioner and refrigeration lines, information on capacitances and dimensions, plus a section covering the Aerovox Capacitor Selector and Aerovox Emergency Capacitor.—**Aerovox Corp.**, New Bedford, Mass.

BARRY'S GREEN SHEET. 28-page catalog features test equipment, electronic tubes, semiconductors, transformers, chokes, meters, wire and other components for industrial market.—**Barry Electronics Corp.**, 512 Broadway, New York, N. Y. 25¢

SERVICEMEN'S SALES AIDS are shown in 16-page catalog. Sixty-two items include business stationery, service-data storage systems, eye-catching signs, uniforms and advertising specialty items.—**Philco**, 2nd and Westmoreland Streets, Philadelphia, Pa.

ELECTRONIC TEST EQUIPMENT is described in 51-page *Catalog M1961*. New instruments shown are uhf Q-meter, navigation-aid test set, signal-generator power amplifier and FM stereo modulator. Illustrations and complete specs on all instruments.—**Boonton Radio Corp.**, Boonton, N. J.

HIGH FIDELITY AUDIO TUBES, 12-page *bulletin ETD-2622*, describes features of audio tubes designed for hi-fi. Contains specs on 26 amplifier, preamp and rectifier tubes, and information on design features and manufacturing processes.—**General Electric Receiving Tube Dept.**, Owensboro, Ky.

CONVERSION CHART, handy reference table for engineers and technicians. Includes common conversions such as inches to centimeters or watts to horsepower, as well as many difficult-to-locate conversions. — **Precision Equipment Co.**, 4411 E. Ravenswood Ave., Chicago 40, Ill.

REPLACEMENT TRANSFORMERS rounded up in *Catalog S-106*, which lists in its 32 pages detailed electrical and physical specifications for 870 transformers. Output transformer chart indicates proper unit to be used with standard and high-fidelity output tubes. Numerous impedance- and frequency-response curves are included.—**Stancor Electronics Inc.**, 3501 Addison St., Chicago 18, Ill. END

NEW TUBES and SEMI-CONDUCTORS

THERE'S A GOOD MIXTURE OF TUBES AND transistors this month. We lead off with another addition to the growing list of nuvistors, continue with a large group of 1-watt Zener diodes, and round out the column with a novar tube, some epitaxial switching transistors and a cadmium sulphide photocell.

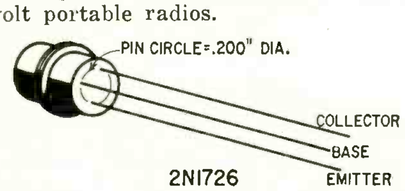
Universal transistor

The 2N2102 is said to be capable of replacing 40% of all existing transistors. (See What's New, page 42) The RCA silicon unit is made by combining triple diffusion and planar techniques. Specifications are:

V_{CB}	120
V_{CEO}	65
I_C (amperes)	1
P_P (watts)	5
Gain-bandwidth Product	60 mc
Switching speed (nanosecs)	30
60-volt collector reserve leakage (nanoamps)	2
Beta limits (minimum)	
at 10 μa	10
at 100 μa	20
at 10 ma	35
at 150 ma	50
at 500 ma	20
at 1 amp	10

2N1726

A germanium micro-alloy diffused-base transistor designed for use as an rf amplifier in 6-volt auto and 6-to-9-volt portable radios.



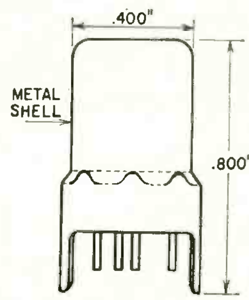
2N1726

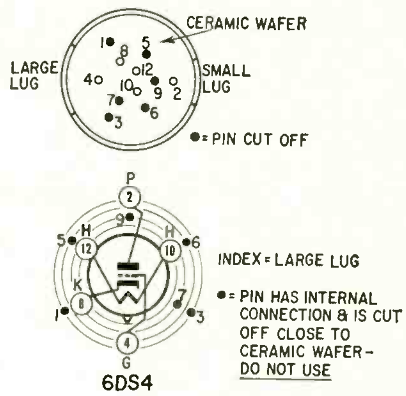
Maximum ratings of the Philco 2N1726 are:

V_{CB}	20
V_{CE}	20
V_{EB}	1
I_C (ma)	50
P_{total} (mw)	60
f_{max} (max frequency of oscillation)	150 mc
h_{FE} (dc amplification factor)	60
h_{ib} (input impedance)	27 ohms

6DS4

A nuvistor tube, this high-mu triode is intended for use as a grounded-cathode, neutralized rf amplifier in vhf tuners of TV and FM receivers. Its high-gain and low-noise characteristics are the result of high transconductance





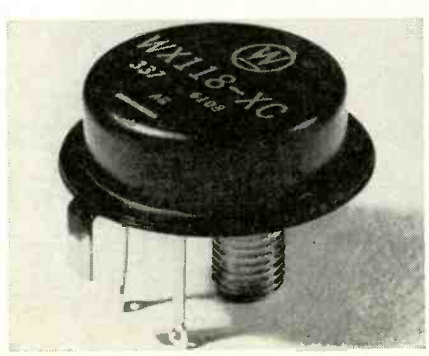
6DS4

and excellent transconductance-to-plate-current ratio. Characteristics of the RCA 6DS4 as a class-A1 amplifier are:

V_{HTR}	6.3
I_{HTR} (ma)	135
V_P	110
V_G	0
R_K (ohms)	130
μ	62
R_P (approx ohms)	6,900
gm (μmhos)	9,000
I_P (ma)	6.5
V_G (for 100-μa I_P)	−5
(for 10-μa I_P)	−6.8

WX118

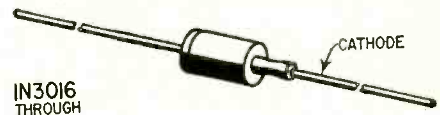
A 10-ampere silicon power transistor



that has a gain of 1,000 at 2 amperes is being offered by Westinghouse. It has voltage ratings up to 150 and can dissipate up to 150 watts. In high-power high-efficiency regulators, amplifiers and switching circuits, the new unit can replace cascade arrangements of two or three transistors.

IN3016 through IN3051

A complete series of 1-watt silicon Zener voltage-regulator diodes. These miniature units made by Fansteel are designed and process-selected to give sharp Zener characteristics and low



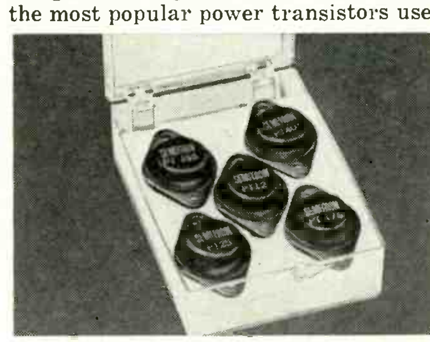
dynamic resistance over their entire current-operating range.

Characteristics of some of the units are:

Type	Nominal Zener Voltage	Maximum Zener Current (ma)
IN3016	6.8	100
IN3020	10	65
IN3024	15	42
IN3028	22	29
IN3032	33	20
IN3036	47	13
IN3040	68	9
IN3044	100	6
IN3048	150	3.7
IN3051	200	3

Power transistor kit

Set of 5 power transistors that are designed to replace more than 100 of the most popular power transistors used

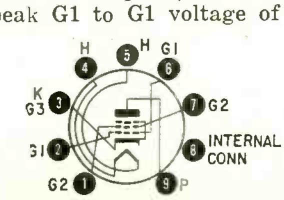


in transistor radios. Complete replacement chart and interchangeability chart comes with the Semitronics kit.

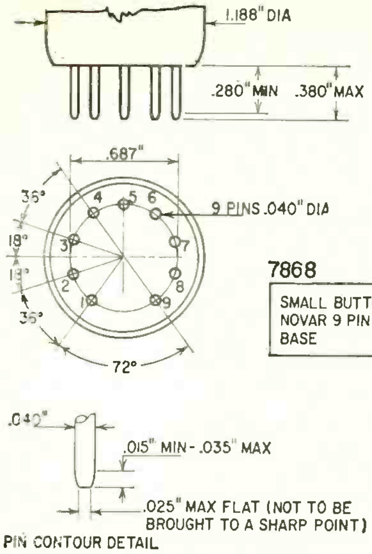
7868

A novar-based high-perveance power pentode designed for use in the output stages of high-fidelity power amplifiers and radio receivers where relatively large power output is required.

The RCA 7868 features high power output efficiency and sensitivity. In push-pull class-AB1 service, two 7868's operating with only −21 volts on G1, 450 volts on the plate, 450 volts on G2, and peak G1 to G1 voltage of 42, can



7868



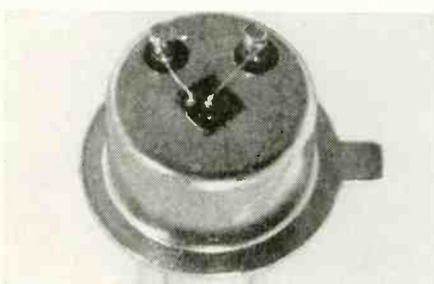
deliver a maximum signal power output of 44 watts with 5% total harmonic distortion.

Maximum ratings of the RCA 7868 as a single-tube af power amplifier, class A1, are:

V_P	550
V_{G2}	440
P_P (watts)	19
P_{G2} (input watts)	3.3
I_K (dc) (ma)	90
gm (μmhos)	10,200

2N2086, 2N2087

These n-p-n silicon epitaxial switching transistors combine high voltage and power ratings with low storage time and low saturation voltage. The transistors are specifically designed for use as large memory plane core drivers, high-voltage pulse amplifiers, high-current line drivers in data processing equipment. They can be used in circuits with switching rates greater than 15 mc at currents as high as 300 ma.



Some of the more important characteristics of the 2N2087 are: BV_{CBO}, 120 volts minimum; h_{FE}, 40 minimum; V_{CE} (sat), 0.5 volt maximum; maximum rise, storage and fall time (circuit gain of 10), of 85, 100 and 55 nanoseconds, and gain bandwidth product (f_T), 150 mc minimum.

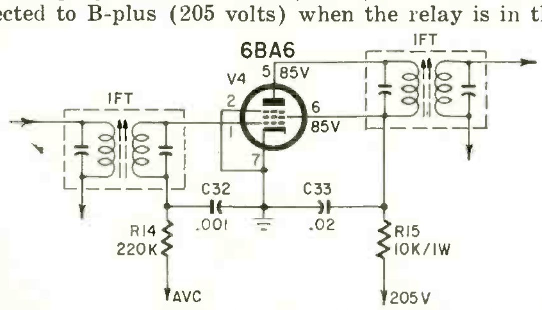
NSL-33

A cadmium-sulphide photoconductive cell designed for photometric applications where low light levels and low voltages are available. Spectral response resembles that of the human eye. Recommended illumination range, .01–1,000 foot-candles. The tubular unit is made by National Semiconductors, Ltd., Canada. END

Technotes

GONSET G-12

In some early production models of this CB Communicator, R15 is a 10,000-ohm 1-watt resistor. It is the screen and plate dropping resistor for V4(6BA6). One end of R15 is connected to B-plus (205 volts) when the relay is in the receive position. The other end of R15 measures 85 volts. They are dropping 120 volts across R15 (10K). Therefore the current is .012 amp (12 ma). The power dissipated would be 1.44 watts. R15 should be replaced with a 10,000-ohm 2-watt (at least) resistor.—*Loren K. Zoll*



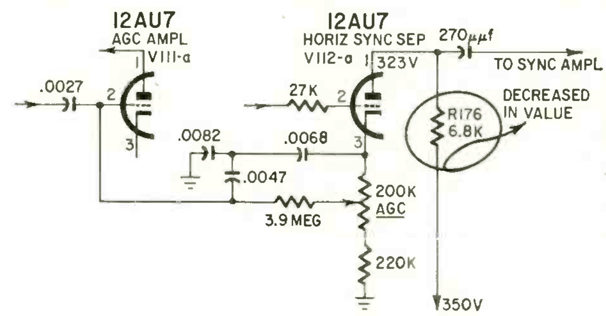
HEATH OM-1

In reference to the Technote on the "Heath OM-1 Scope" by Mr. W. Weffenatette, in the May issue, regarding a cure for vertical deflection with no input:

I followed the note with no results. Upon pushing at the printed-circuit board though, I noticed that vertical deflection increased with each push. Checking, I found the bolts that fastened the printed-circuit board to the chassis had loosened. They were tight when I built the kit but, due to the flexibility of the chassis from front to back, those "buzz-saw" washers must have dug themselves a bigger hole.—*Elmer Cumming*

RCA KCS 81-A

Although the raster was present, the video and sound would not appear until the set had been on for 15 or 20 minutes. The tubes checked out OK and it was noted that, after warming up for about 5 minutes, the set could be made to work normally by quickly twisting the agc control counterclockwise.



The trouble was traced to the plate supply resistor (R176) of the horizontal sync separator, which had decreased in value. Since the agc control forms part of the cathode load of this tube, a change in the plate voltage altered the bias on the agc amplifier. In this case, the defective resistor would approach its original value after 15 minutes or so of heating up, allowing the video and sound to come on.—*Charles B. Randall*

STEELMAN TRANSITAPE & AIRLINE 7111-M

If tape spills over or breaks fairly often, check the brakes. There are three. One stops the large flywheel which forms the capstan. The other two smaller brakes stop the takeup and rewind pulleys. When the tape is stopped or reversed, all three brakes must function.

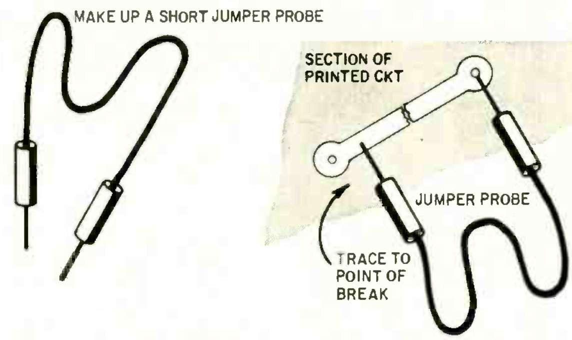
Examine the rear of the machine and note the black diagonal slide bar that moves when the forward and reverse lever is manipulated. Note also the indents on the sides of this bar. When the bar is moved, these indents activate small brass stampings that have small cork brake pads at their ends. When the slide is worked, each brake pad is supposed to touch its respective wheel lightly.

If the corks are worn, new brakes are needed. If adjustments are needed, use a pair of long needle-nose pliers, and work through the holes in the casting. Bear in mind that, while absolute clearance is needed during the run, this clearance need only be in thousandths of an inch. Notice that the brakes make but momentary contact, and only when the slide bar is in its in-between position—when it is being moved from one position to another. At all other times the brakes stand clear.—*Max Alth*

PRINTED CIRCUIT TIPS

A number of sets using two-sided printed-circuit boards have turned into tough-dog repairs. These usually are caused by intermittent contact with various components mounted on the board where connections are made on both the top and bottom. For example, electrolytic capacitors often present a problem. But the intermittent condition is usually traced to a poor connection to the top portion of the printed-circuit board which is usually caused by improper soldering.

Breaks in PC boards that are invisible to the naked eye will often show up under an illuminated magnifier. Also try placing a strong light (taking care not to overheat components) under the board. If this fails, try tapping, gentle pushing and flexing the board with volume turned up full. If you're still looking, try sliding a jumper probe along each



suspected path (see diagram). Once the point is located between the two probes, it is a simple matter to bridge the defective conductor.—*George P. Oberto*

END

WE BUY TECHNOTES

RADIO-ELECTRONICS wants Industrial Technotes. These should cover equipment (including closed-circuit television) actually used in industrial work, or technotes on counters, controls and other apparatus whose users are largely industrial. Unillustrated Technotes pay $5; circuit diagrams raise the price to $9 and acceptable photos are worth $7 each. Send your technotes from industry to Technotes Editor, RADIO-ELECTRONICS, 154 W. 14th St., New York 11, N. Y.

new BOOKS

PRACTICAL ROBOT CIRCUITS (2nd edition), by A. H. Bruinsma. MacMillan Co., 60 Fifth Ave., New York 11, N.Y. 5¾x8 in. 125 pp. $3.95.

This author discusses circuits that respond to stimuli like certain human organs. He compares the microphone with an ear, the photocell with an eye, and describes devices that respond to touch or proximity to nearby objects.

The book shows how to construct two robots. One, shaped like a dog, "barks" and moves about in response to signals, dodges obstacles and stops at a given signal. The other robot is an expert at playing noughts and crosses. After winning a game, it even laughs triumphantly!

HOW TO FIX TRANSISTOR RADIOS & PRINTED CIRCUITS, by Leonard Lane. Gernsback Library Inc., 154 W. 14 St., New York 11, N.Y. 8½x5½ in. Vol. I—160 pp. Vol. II—160 pp. $3.20 per volume. $5.90 per set.

This two-volume set is perhaps the most comprehensive text of its kind. Little if anything has been passed up. It will give the reader a better than average working knowledge of transistors, their components and associated circuitry. After reading through these two volumes, the technician will be prepared to handle all kinds of repair jobs likely to be encountered in transistor radios.

FUNDAMENTALS OF TRANSISTOR PHYSICS, by Irving Gottlieb. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N.Y. 5½x8½ in. 146 pp. $3.90.

This text assumes familiarity with vacuum-tube circuits. It begins with atom theory and semiconductor materials. The discussion is unusually clear and complete, making it easier to understand the principles of transistor action and circuitry that are described later. The important topic of feedback receives more attention than usual. A final chapter describes the tunnel-diode, Zener, solar-cell and other semiconductors.

TIME RELAYS by G. V. Durzhinin. Pergamon Press, 122 E. 55 St., New York 22, N.Y. 8½x5½ in. 80 pp. $2.50.

This English translation of a Russian book goes into the working properties and principles of different types of time relays. The book is written in simple language and requires no special mathematical knowledge. There are four major categories—time relays with electrical delay, time relays with mechanical delay, time relays with electrothermic delay, and time relays with electrochemical delay.

NEW SHORTCUTS TO TV SERVICING, by Leonard C. Lane. Gernsback Library Inc., 154 W. 14 St., New York 11, N.Y.

8½x5½ in. Vol. 1—160 pp. Vol. II—160 pp. $3.20 per volume. $5.90 for the set.

These books are written and designed for the beginning as well as the practicing technician. They are crammed full of facts and hints that will help speed the technicians everyday work. From start to finish, the books contain only practical data. There are no long-drawn-out technical discussions.

SERVICING UNIQUE ELECTRONIC APPARATUS, by Jack Darr. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis, Ind. 5½ x 8½ in. 125 pp. $2.50.

TV and radio technicians may not realize that their skill and knowledge can be used to maintain and repair many types of electronic equipment. This book describes diathermy, stroboscopic and ultrasonic devices, movie sound, photoflash and other equipment. It tells how the apparatus works, how to troubleshoot it, and discusses safety precautions. Written in the language of the technician.

RADIO CONTROL MANUAL, by Edward L. Safford, Jr. Gernsback Library Inc., 154 W. 14 St., New York 11, N.Y. 5½x 8½ in. 192 pp. $3.20.

A really comprehensive manual of radio control that shows even the inexperienced how to set up complex control systems. Starting with a basic test set, transmitter and receiver, the reader is shown how to expand these units until they can be used to control cars, boats and planes. Complete mechanical and electronic details for hooking up the control systems in these models are also shown. Numerous photos and pictorial diagrams make the construction of each unit easy to follow, understand and duplicate successfully.

WORLD RADIO-TV HANDBOOK. Edited and published by O. Lund Johansen. Sold in the US by Gilfer Associates, PO Box 239, Grand Central Station, New York, N. Y. 6½ x 9 inches, 218 pages. $2.70.

This 15th edition of the dx listeners' standard handbook includes a complete listing of the world's radio administration, stations, programs and musical signatures, and a world TV list (United States stations are not listed in detail, though US Armed Forces Radio and Television Service TV stations are given). There is a further 80-odd pages of other information of interest to the listener, including lists of long- and short-wave stations of the world by frequencies, tables of call-sign allocations, suitable bands for reception, abbreviations, a report on standard frequency stations and other lists, reports, charts and maps.

A TO Z IN AUDIO by G. A. Briggs. Gernsback Library Inc., 154 W. 14 St., New York 11, N.Y. 5½x8½ in. 224 pp. $3.20.

Actually an encyclopedia of audio. Just about every term used in audio and high fidelity is listed and explained. Illustrations are used freely wherever they are needed to clarify a particular point. If you need a reference to audio, this book is a must. Whether it's ac, Hass effect, listening tests or zero level, Mr. Briggs has explained it here. END

TECHNICIANS' NEWS

TV TUBE LAW

Toledo, Ohio—Purchasers of replacement television tubes in Ohio now receive a written statement telling them whether the tube is new or rebuilt. The law provides that no tube other than one using new parts and new glass shall be represented as a new tube, and that the tube must be labeled to show its true quality. Only the purchaser may remove tube markings, according to the law, and the service technician must furnish the written statement of the true condition of the tube even though it is labeled according to the law.

NATESA CONVENTION

Chicago, Ill.—The convention opened at the Pick-Congress Hotel with an Executive Council meeting which ran beyond midnight with a short recess for supper.

The following morning Tung-Sol hosted breakfast, at which G. E. Tucker gave a talk on businesslike approaches. After breakfast, Executive Director Moch gave a progress report which covered activities with set, tube and part manufacturers; various governmental agencies; pay TV; picture-tube practices; wholesaling; licensing; set and caddy thefts; expansion of the NATESA business, technical, TV station and association practices manuals; extension of NATESA with 18 new affiliates; actions to restore dropouts on a local level and progress on the all industry panel.

Friends of Service awards were voted on the basis of far more stringent requirements than last year, yet many were nominated. Finco, Raytheon, Sams, Sylvania and Tung-Sol were voted continuing awards.

REPORT FROM LYNCHBERG

Lynchberg, Va.—A short letter from the Virginia Electronics Association of Lynchberg states that the group was organized in March 1960. In October 1960, it received a state charter. At present, there are 13 members, and attendance, interest and enthusiasm run high. The group has had programs on COD service, efficient bookkeeping and a distributor-directed transistor clinic. Local TV station WLVA-TV cooperates with two daily spots displaying the VEA emblem and appropriate script.

Officers of the group are: Thomas B. Hudson, president; Lloyd O. Pillow, vice president; Earl W. Talley, secretary-treasurer, and Alec A. Driskill, NATESA director.

IN THE BALLOT BOX

St. Louis, Mo.—TESA–St. Louis had an interesting election. After the votes were counted, there was a tie for president. To settle the contest, each candidate gave a short talk on what he intended to do and accomplish if elected. On the next ballot, William Frasure was elected president. The other officers, all elected the first time around, are: Morton Singer, vice president; Fred Riechman, chairman of the board; Gene Love, NATESA director; Dennis Towell, secretary; Bill Thomas, treasurer, and Gene Bene, Sergeant at arms. Connie Bell, Ben Goedeker, Wally Hirschberg and Howard Freiner were elected to the board of directors.

BUSINESS COURSE FOR TECHS

Indianapolis, Ind.—The Indiana Electronic Service Association held a two-day course in business management and practices for radio–TV service technicians at Holiday Inn. The course was set up because the association felt its members needed some additional training in business management. A series of clinics covering this subject have been arranged under the direction of Bookkeeping Business Service Co., Pomona, Calif. The subjects covered include cost control, arriving at an accurate gross profit, financing and floor planning.

NOVEL WARRANTY PLAN

Seattle, Wash.—At a recent meeting the membership of TSA–King County heard Donald P. Persons of General Electric explain a new extended warranty plan for G-E radio owners. Under the plan, **the technician who performs any warranty repair work bills G-E at his usual rates** and not at rates set by the factory. Also the customer can take his set to any service shop to have the necessary repairs done.

One TSA–Seattle member's reaction to the plan was that it is a welcome change from the usual take-it-or-leave-it factory warranty proposals, and was the first sensible plan ever offered to the service industry.

ELECTIONS IN WISCONSIN

Indianhead, Wis.—This chapter of TESA–Wisconsin has a new group of officers with Harley Rautmann heading the list as president. Vern Townsend is the new vice president. Other officers are Ken Wheeler, secretary; Vern Christian, assistant secretary, and Obert Thomley, treasurer. Vern Christian, who is a NATESA director, was also appointed a TESA–Wisconsin director.

Jefferson-Dodge, Wis. — Another

TESA–Wisconsin chapter was also busy at the polls. Its new officers were installed at a steak and lobster-tail dinner. LeRoy Weber was elected president; Ken Wilkes, vice president; Carl Schuett, secretary-treasurer. Carl Becker, the outgoing president, will serve as NATESA director. Earlier this year Carl was elected treasurer of TESA–Wisconsin, the parent organization of the Jefferson-Dodge chapter.

TWO SERVICE TECHS CONVICTED

Los Angeles, Calif.—About 1 year ago, television service technicians, Herman Singer and his brother Oscar, were charged with six counts of petty theft in connection with alleged phoney TV repairs. Their first trial ended in a mistrial. In a more recent trial, both brothers were convicted on six counts. No sentence has been set.

SERVICE ASSOCIATIONS TAKE NOTE

North Adams, Mass.—A group of free window posters is being made available to service technicians through their service association by Sprague. The posters answer questions like "Why doesn't my set stay fixed?" and support technicians with items like "Sprague Salutes the Independent Service Dealer." Another poster is titled "More than 5,600 feet of circuitry . . . 590 parts . . . and he knows how to fix 'em all!" Have your associate secretary write Sprague Products Co., North Adams, Mass., for full information.

TECHS FEAST

Philadelphia, Pa.—Westinghouse Appliance Sales treated local service technicians to dinner and a major-league ball game. The group was mostly made up of TSA–Delaware Valley members who had been selected by Westinghouse to handle servicing of their sets in the Delaware Valley area. The servicing program is unique in that the men were selected from service associations and are paid on every set sold rather than only on the sets that need repair. END

"The green wire's the ground, the red goes to the speaker, and I usually ignore the white one."

TRY THIS ONE

TRANSISTOR POWER SUPPLY

You don't have to discard your old battery eliminator and get a new one for working on transistor radios. Instead add a choke and another filter capacitor to the unit you now have. Mount them on a strip of board and connect them externally so they can be removed when desired.

I used the 450-ohm primary of a heavy output transformer for the choke and a 3,000-μf 15-volt capacitor.—*Gerald Kirby*

DIP THOSE PROD TIPS

Short circuits in transistorized gear can possibly mean the complete ruin of an expensive electronic component. When testing such circuits, you must keep test prod tips from accidentally

contacting two or more points at once. One good precautionary measure is to dip the tips of your prods into an insulating compound such as Insl-X. After the insulation has completely hardened, scrape only about ⅛ inch of each prod tip bare.—*Charles A. Cunningham*

USING DISCARDED TRANSISTORS

Discarded transistors may not be entirely useless if they still have at least one fair back-to-front ratio, base to emitter or base to collector. They can be used as rectifiers in low-voltage applications such as powering miniature 1.5-volt electric motors, small-job electroplating or other similar uses where pure dc is not essential.

To check a discarded transistor for possible use, connect a milliammeter as shown in Fig. 1. Take a reading between base and emitter and, if this is

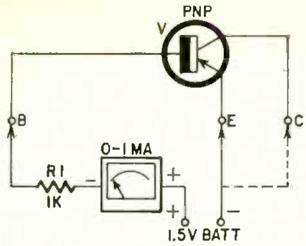


Fig. 1

low—less than 0.1 ma, reverse the connections. The new reading should be considerably higher. These two connections can be used as a rectifier. If the readings do not conform, try between base and collector. Again reversing connections, you should find one reading considerably higher than the other, if the transistor can be used.

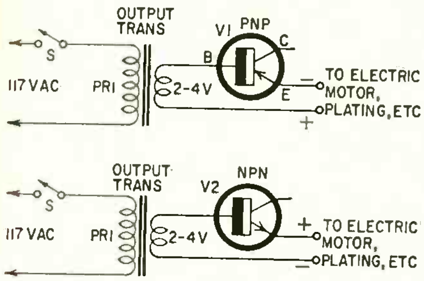


Fig. 2

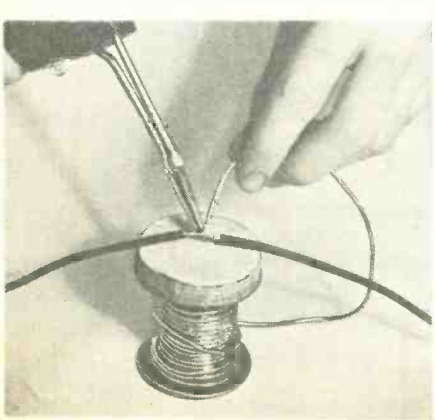
Assuming you have a discarded transistor having a high back-to-front ratio (one reading much higher than the other reversed-connection reading), use those connections in the circuit of Fig. 2. When mounting the transistor, plan to have it in open air to carry away the small amount of heat generated.—*Martin H. Patrick*

SAVE BATTERY TERMINALS

I used this little wrinkle just the other day. I had run out of battery connectors for 9-volt transistor batteries and needed one to complete a repair job I had promised for that afternoon. Luckily, I had some old burned-out 9-volt batteries around. So I peeled back the plastic top and removed the connections from the battery. Then I soldered on some leads and I had a perfectly good battery connector.—*John Haynes*

WORK TABLE ATOP SOLDER SPOOL

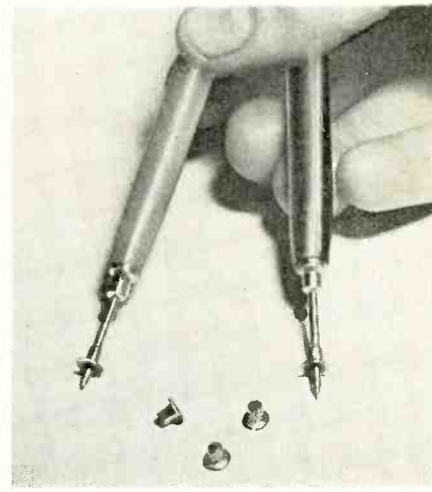
Attach a small asbestos-faced disc of wood to the top of your spool of solder with small nails driven through the flange from underneath, and you



have a handy "work table" for delicate soldering jobs. The asbestos won't drain heat away from the work and you won't have to worry about scorching your bench top with hot parts, iron heat or hot drops of solder.—*Joe C. Allen*

RIVETS IMPROVE TEST-PROD TIPS

Do you sometimes find it difficult to hold your test prods against terminals or wires when testing? If so, here's a hint you'll find especially helpful. Slip



a small hollow brass rivet over each prod's tip as shown. If they won't make a tight fit, pinch each one's body a little out of round with pliers. By resting the edge of the rivet's head against the terminal or wire, it's much easier to hold the prods in contact. Also, there will be less chance of the prods slipping and shorting to the chassis or nearby wires.—*Jerome A. Carlson* END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Practical Electrics	1921
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In November, 1911, *Modern Electrics*

The Electro-Magnetic Gun, by Obed C. Billman, LL.B., M.P.L.

Dr. Branly's Wireless Control System, by A. C. Marlowe.

A (Radio) Directive Device, by E. Jay Quinby. Marconi Portable Sets.

Wireless Telephony by Means of Light Rays.

Single Line Telegraph and Telephone Hookups, by P. H. Boucheron.

Improved Silicon Tikker, by Stanley E. Hyde.

A Simple Sound Intensifier and Relay, by Samuel Fromme.

new PATENTS

MAGNETIC FIELD FOR REMOTE CONTROL

Patent No. 2,930,955

Joseph G. Andre Bourget, Chicago, Ill. and Christian Carl Pfitzer, Cincinnati, Ohio (Assigned to Avco Mfg. Corp.)

You can tune your TV set from a distance with this device. It transmits its signals via a magnetic field on a frequency between 4,500 and 5,000 cycles. Fig. 1 shows the transmitter. Its ferrite loop has two coils which are movable with respect to each other for tuning. S1 closes the battery circuit and causes the signal to be transmitted to the receiver on the TV chassis.

The receiver (Fig. 2) also has a two-coil ferrite loop for tuning. V2, V3 are amplifiers that are peaked for the audio signal. D1 limits the signal by conducting when the input exceeds the bias supplied by the battery. D2 detects and passes the signal through an integrating network to thyratron V4. A positive signal at this grid ionizes V4 and permits a large current to flow through the relay.

The lower relay contacts close an ac circuit to energize the tuning motor. The upper contacts close, applying the negative battery voltage to block V4. Thus only an instantaneous pulse reaches the motor no matter how long the transmitter switch is depressed.

Each pulse rotates the cam on the motor shaft. Normally the cam follower lies in a notch corresponding to a TV channel. Cam movement lifts the cam follower and closes S2 to run the motor until the next notch (channel) is reached.

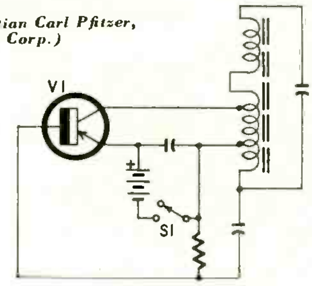


Fig. 1

The amplifier grids are controlled by avc through R1, R2. Potentiometer R3 may be adjusted if greater or less gain is needed. C prevents relay chatter.

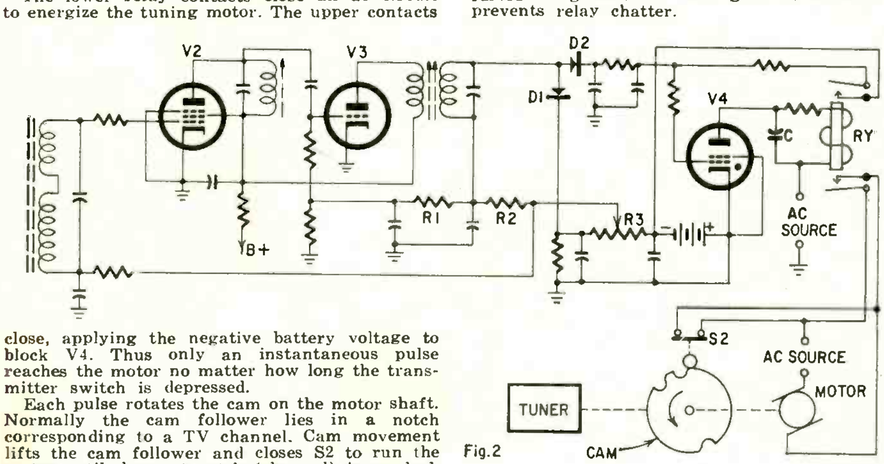


Fig. 2

PIANO-TUNING DEVICE

Patent No. 2,958,250

Horst Albin Poehler, 12 Manville Lane, Pleasantville, N. Y.

Piano tuning can now be made more accurate and convenient. This device includes an oscillator calibrated for the 12 notes of the fourth octave (261.6 to 493.9 cycles). A pitch control can shift the entire octave to help standardize against WWV or a tuning fork. The device also contains an adjustable filter that may be tuned to any desired octave and note.

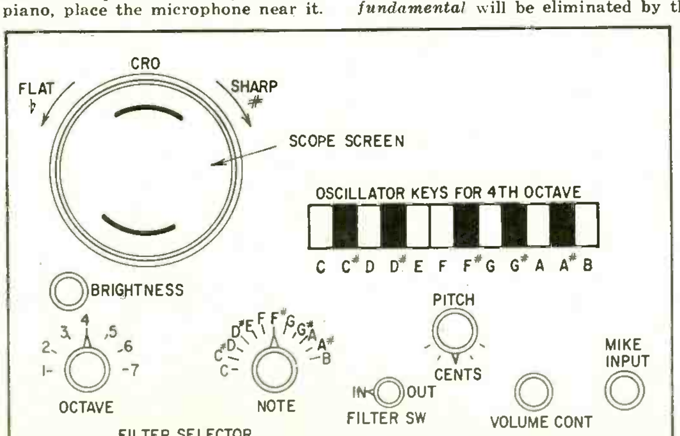
The front-panel oscilloscope is swept circularly. This pattern is developed by feeding horizontal plates *directly* from the oscillator, vertical plates through a *90° shift* network. Brightness is set so that the pattern is visible only on positive half-waves of a signal at the CRT grid. This signal comes from a microphone and amplifier.

To tune a piano, place the microphone near it. Press the piano key (in the fourth octave) and also the same panel key. If the piano is accurately tuned, both signals will be synchronized, and a stationary circular pattern will be observed. If piano is out of tune, arc rotates *clockwise* (if note is sharp), *counter-clockwise* (if flat).

If a higher octave key is pressed on the piano, more than one arc will be visible on the scope.

If the pattern is not stationary, adjust the pitch control to stop it. Then the error in cents (hundredths of a note) may be measured.

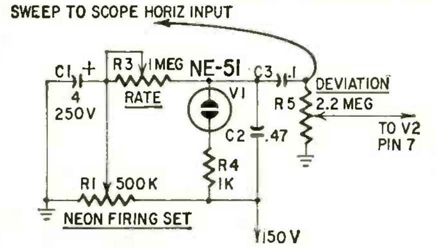
The filter, a resonant network, excludes undesired harmonics and subharmonics. For example, to tune a note in the third octave of a piano, set the filter to the fourth octave. Then the piano *fundamental* will be eliminated by the filter. END



NOTEWORTHY CIRCUITS

IMPROVED NEON WOBBULATOR

Some of the drawbacks of the neon wobbulator ("Wobbulating Sweep Generator," RADIO-ELECTRONICS, March 1961, page 74) may be overcome by revising the time-base generator as shown here. This circuit provides the



negative-going sawtooth necessary for the higher frequencies to be toward the right side of the scope screen. This is done by charging C2 toward ground, and discharging toward B-plus.

The scope presentation will appear linear vs frequency if the same sawtooth is used for both the reactance modulator and as horizontal sweep for the scope, cancelling the effects of the nonlinear sweep.—*Robert E. Webb*

TV PICTURE QUALITY CONTROL

In fringe and weak-signal areas, snow on the TV screen is accentuated by wide-band if circuits. The diagram shows the OPTIMIZER circuit used in late Motorola receivers to vary if bandwidth to suit signal conditions. The OPTIMIZER control, a 7,000-ohm pot, is in series with the detector load. Its function is to vary the bandwidth of the third if (video detector) transformer by varying its effective Q.

When the full control resistance is in the detector load circuit, the circuit Q is at maximum and high-frequency response falls off. This reduces snow caused by high-frequency noise. At the mid-range setting, the circuit Q decreases and restores the normal if response. The low-resistance setting of the control reduces circuit Q to a minimum and extends the high-frequency response. This results in sharper and crisper pictures when receiving a strong signal.

The OPTIMIZER is a customer adjustment used along with the fine-tuning, brightness and contrast control. For optimum effect, set the control to the middle of its range and then adjust fine tuning to the point just before sound bars appear in the picture.

IF TRANSFORMER TESTER

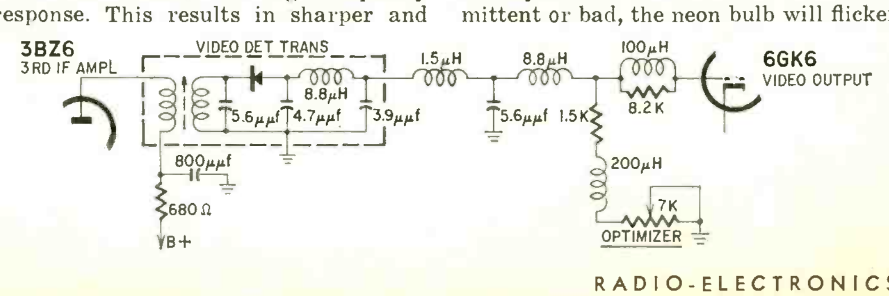
The service technician has often been plagued with intermittent leakage and complete breakdown of miniature if transformers ever since they came into use. Tracking down an intermittent if transformer trouble can waste hours of valuable service time unless you have some form of a tester that will put enough stress on these units to break down the intermittent unit, yet not damage a perfectly good one.

In most intermittent or leaky if transformers the trouble is usually in the two capacitors built around the bottom of the coil form. They break down between the primary and secondary sections. The usual symptoms are a staticlike noise in the sound or picture section in TV receivers, and just plain noise along with the program for radio. In some cases where the transformer is leaking badly or shorted, the set may be dead with or without noise. In cases of a noisy set, if the faulty if transformer were taken apart, you would most likely see faint sparks jumping between these two capacitors.

Tests made with good, intermittent and bad if transformers proved that the tester shown in the diagram fits the bill very nicely. The tester has a dc output variable from 0 to 500 volts or more. A 1-megohm pot controls this voltage.

Calibration: Use a vtvm connected to the plus and minus test points and a 0–500-volt scale at 100-volt intervals along the rotation of the pointer knob connected to the 1-megohm pot.

To test intermittent, bad and good if transformers, connect one test lead to the primary and another to the secondary. If the if transformer is intermittent or bad, the neon bulb will flicker



SCHOOL DIRECTORY

ENGINEERING COURSES

E.E.
Option Electronics,
Mechanical,
Also in Liberal Arts
presented through
HOME STUDY
Resident Classes Also Available if Desired
Specify course preferred

PACIFIC INTERNATIONAL C. A. S.

PACIFIC INTERNATIONAL COLLEGE OF ARTS & SCIENCES
Primarily a correspondence school

5719-M Santa Monica Blvd. Hollywood 38, Calif.

B. S. DEGREE IN 36 MONTHS

INDUSTRY & GOVERNMENT NEED 50,000 NEW ENGINEERS A YEAR!

Accelerated year-round program puts you in the job-market a whole year early! Also B.E. degree in 27 mos. Aero., Chemical, Civil, Electrical, Mechanical, Electronics; Math, Chemistry, Physics. Quality instruction; widely recognized. Graduates employed from coast to coast. Self-help program. Modest rate. Start Jan., Mar., June, July, Sept. Catalog: 1511 E. Washington Blvd., Ft. Wayne 2, Ind.

INDIANA TECHNICAL COLLEGE

EARN Electronics Engineering DEGREE

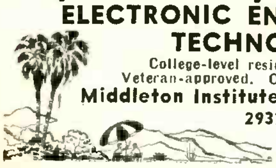
You can earn an A.S.E.E. degree at home. College level HOME STUDY courses taught so you can understand them. Continue your education, earn more in the highly paid electronics industry. Missiles, computers, transistors, automation, complete electronics. Over 27,000 graduates now employed. Resident school available at our Chicago campus—Founded 1934. Send for free catalog.

American Institute of Engineering & Technology
1139 West Fullerton Parkway, Chicago 14, Ill.

Study in the "Valley of the Sun"

ELECTRONIC ENGINEERING TECHNOLOGY

College-level resident schooling
Veteran-approved. Catalog on request



Middleton Institute of Electronics
2937 E. McDowell Rd.
PHOENIX ARIZONA

ENGINEERING EDUCATION for the Space Age

NORTHROP INSTITUTE of Technology is a privately endowed, nonprofit college of engineering offering a complete Bachelor of Science Degree Program and TWO-YEAR accredited technical institute curricula. Students from 50 states, many foreign countries. Outstandingly successful graduates employed in aeronautics, electronics, and space technology. Write today for catalog—no obligation.

NORTHROP INSTITUTE OF TECHNOLOGY
1181 West Arbor Vitae Street, Inglewood 1, California

LEARN

LE
A
R
N

RADAR MICROWAVES
COMPUTERS—TRANSMITTERS
CODE • TV • RADIO

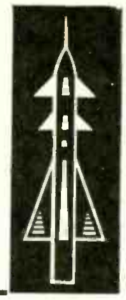
Phila. Wireless Technical Inst.
1533 Pine St., Philadelphia 2, Pa.
A Non-Profit Corp.
Founded in 1908
Write for Free Catalog to Dept. RE-11
Classes now forming

LEARN TECHNICAL MANUAL WRITING AT HOME

Big demand, good pay, for trained writers. Home Study Course offered by A. C. W. Saunders, nationally known authority, instructs you in: WRITING and construction of commercial and military publications . . . ILLUSTRATION procedures . . . LAYOUT and printing. Write today for full particulars to:

ELECTRONIC TECHNICAL PUBL. CO.
P. O. BOX 306, ASTOR STA., BOSTON, MASS.

GET INTO ELECTRONICS



V.T.I. training leads to success as technicians, field engineers, specialists in communications, guided missiles, computers, radar and automation. Basic and advanced courses in theory and laboratory. Assoc. degree in electronics in 29 mos. B.S. in electronic engineering obtainable. ECPD accredited. G.I. approved. Graduates in all branches of electronics with major companies. Start February, September. Dorms, campus. High School graduate or equivalent. Catalog.

VALPARAISO TECHNICAL INSTITUTE
Dept. C Valparaiso, Indiana

LEARN ELECTRONIC ORGAN SERVICING

This new, high paying profession can now be learned easily in your spare time.

★ Complete Training — All Makes and Models
★ Scientific Teaching Aids Make Learning Easy
★ No Prior Knowledge of Electronics Necessary

GET FULL DETAILS ON THIS AMAZING COURSE
WRITE FOR FREE BOOKLET

NILES BRYANT SCHOOL
Dept. L, 3731 Stockton Blvd.
Sacramento 20, California

LEARN TRANSISTOR, COMPUTER OR RADAR ELECTRONICS AT HOME!

☐ Prepare now for a profitable career in one of these growing fields. Learn theory and practical application of all makes and types with proven home study courses from the Philco Technological Center.

For FREE information write:

PHILCO® TECHNOLOGICAL CENTER
P.O. Box 4730, Dept. R-2, Philadelphia 34, Pa.

double your income with degree

A college education is a good investment! More rapid advancement, too. Important firms like Tri-State College graduates . . . return regularly to interview seniors on campus. Become an Electronics Engineer. Qualify faster here.

Bachelor of Science Degree in 27 Months

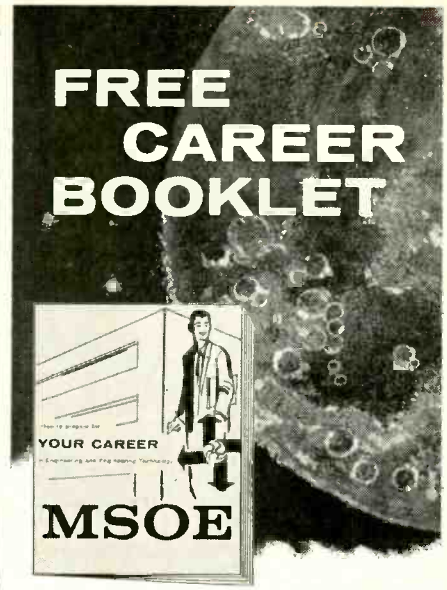
in Electrical (Electronics or Power major), Mechanical, Chemical, Aeronautical, Civil Engineering. IN 36 MONTHS B.S. in Business Administration (General Business, Accounting, Motor Transport Management majors). For earnest, capable, mature students. Small classes. More professional class hours. Beautiful campus. Well-equipped labs, modernized buildings, new dorms. Year-round operation. Enter Jan., Mar., June, Sept. Founded 1884. Write J. G. McCarthy, Director Admissions, for Catalog and "Your Career in Engineering and Commerce" Book.

TRI-STATE COLLEGE 24111 College Avenue, Angola, Indiana

HIGH SCHOOL

You can still finish High School — at home, in your spare time. No interference with job or social life. Win more pay, better job, new respect. Take only the subjects you need. Personalized guidance. Diploma to graduates. I.C.S. will send you 3 valuable books FREE to help you get started: (1) "How to Succeed," (2) High School subjects, (3) sample lesson. Write:

INTERNATIONAL CORRESPONDENCE SCHOOLS
DEPT. 39087K, SCRANTON 15, PA.



to guide you to a successful future in

ELECTRONICS
RADIO-TV
COMPUTERS
ELECTRICAL ENGINEERING

This interesting pictorial booklet tells you how you can prepare for a dynamic career as an Electrical Engineer or Engineering Technician in many exciting, growing fields:

**MISSILES • RADAR • RESEARCH
ELECTRICAL POWER • ROCKETRY
AUTOMATION • AVIONICS
SALES • DEVELOPMENT**

Get all the facts about job opportunities, length of study, courses offered, degrees you can earn, scholarships, part-time work — as well as pictures of the Milwaukee School of Engineering's educational and recreational facilities. No obligation — it's yours free.

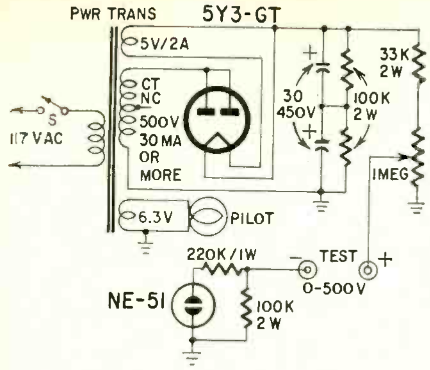
MILWAUKEE SCHOOL OF ENGINEERING

MAIL COUPON TODAY!

MILWAUKEE SCHOOL OF ENGINEERING
Dept. RE-1161, 1025 N. Milwaukee St.
Milwaukee, Wisconsin MS-113

Please send FREE "Your Career" booklet
I'm interested in ☐ Electronics ☐ Radio-TV
☐ Computers ☐ Electrical Engineering
☐ Mechanical Engineering
(PLEASE PRINT)

Name.................... Age..........
Address....................
City.......... Zone...... State..........
☐ I'm eligible for veterans education benefits.
Discharge date....................



or light as the voltage control pot is advanced to 350 or more. For cases of an intermittent or suspected unit, a good test is to apply around 500 volts. In all cases, if the transformer is good, the neon bulb will fail to light. Never apply more than 500 volts, as more voltage may break down a perfectly good transformer.

In testing be sure to remove all circuit wiring connected to the terminals of the transformer. Most transformers can be checked without removing them from the chassis.

Sometimes a defective transformer can be repaired by removing the shield can cover and closely observing the capacitor section for any arcing. If you can see any, take a sharp razor blade and cut out or scrape away the part that's arcing over from the primary to the secondary section. This works in many cases but it is always best to replace the transformer with a new one whenever possible.

Other uses of this leakage tester are checking capacitors, all types of transformers, printed-circuit boards and so on. With a little thinking on your part, additional new uses will pop up from time to time. I have used this method to track down intermittent problems and I don't know what I would do without it for tracking down those intermittent miniature if transformers.—*Geo. P. Oberto*

You've been here only an hour and you want to resign already?

R-E Classified ADS

FREE confidential bargain sheets of electronic components—Lowest prices in the country! **KNAPP,** 3174 8th Ave. S.W., Largo, Fla.

TECHNICAL WRITING, rewriting, editing, proofreading—free lance. **SALLY RICHARDS,** 1488 Simpson, St. Paul, Minn.

ELECTRONIC RESEARCH SURPLUS, 2½ lb—$3. **PALAN ASSOCIATES,** 851 17 St. SW, Cedar Rapids, Iowa.

TV TUNERS—rebuilt or exchanged, $9.95 complete—all types—fast, guaranteed service. Send tuner with all parts to: **L. A. TUNER EXCHANGE,** 4611 W. Jefferson Blvd., Los Angeles 16, Calif.

WANTED: BC-348's, laboratory equipment, manuals, klystrons. Cash, swap. **ENGINEERING ASSOCIATES,** 434 Patterson Rd., Dayton 19, Ohio.

BUSINESS CARDS, LABELS, RUBBER STAMPS. Send for free descriptive literature. **HEIGHTS INDUSTRIES,** Capitol Heights 27, Md.

TRANSISTORIZED products dealers catalog, $1. **INTERMARKET,** CPO 1717, Tokyo, Japan.

DOOR OPERATOR, $59.95. Automatic chain drive. Not a kit—highest quality. Free Literature. **DEMSCO,** Sebring 25, Ohio.

WANTED—MISCELLANEOUS Quicksilver Platinum, Gold, Silver. Ores analyzed. **MERCURY TERMINAL,** Norwood, Mass.

WANTED COINS. Buying list, $1.00. **BARNEY NORVILLE,** Bells, Tenn.

COMPONENTS, Recorders, Tapes. FREE Wholesale Catalogue. **CARSTON,** 125-T East 88th St., New York 28, N.Y.

SPECIAL! Handle stamps, 2", 50¢ per line. Immediate delivery. **TABCO,** Tompkins Cove, N.Y.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. New and used instruments bought, sold, exchanged. **HAZELTON INSTRUMENT CO.,** 128 Liberty St., New York, N.Y.

HI-FI STROBO lamp and disc. $3.00. GEIGER counter, $26.95. **C. JAMES,** PO Box 929, Indio, Calif.

LEARN WHILE ASLEEP, Hypnotize with your recorder, phonograph or amazing new Electronic Educator endless tape recorder. Catalog, details free. **SLEEP-LEARNING ASSOCIATION,** Box 24-RD, Olympia, Wash.

CASH PAID! Sell your surplus electronic tubes. Want unused, clean radio and TV receiving, transmitting, special purpose, Magnetrons, Klystrons, broadcast types, etc. Want military & commercial lab/test and communications equipment such as G.R., H.P., AN/UPM prefix. Also want commercial receivers and transmitters. For a fair deal write **BARRY,** 512 Broadway, New York 12, N. Y. WAlker 5-7000.

SEND FOR FLYERS listing transmitters, receivers, teletype converters, tubes, components. **SPERA ELECTRONICS,** 37-10 33 St., Long Island City 1, N.Y.

DON'T BUY HI-FI COMPONENTS, Kits, Tape, Tape Recorders until you get our low, low return mail quotes. "We Guarantee Not To Be Undersold." Wholesale Catalog Free. Easy Time Payments Plan, 10% down—up to 24 months to pay. **HI-FIDELITY CENTER,** 220 RC E 23 St., New York 10, N.Y.

OFFSET PRINTING, 100 8½x11, $2.49. Additional 100's, 43¢. Add postage. **PARKS,** 3823 Merrick Rd., Seaford, N.Y.

ENGRAVE dials, panels, nameplates with "Dupliscaler" engraving machines. Details, sample engraving, 20¢. **DESCO DISTR'S,** 4329-CR Woodman, Van Nuys, Calif.

HOW and where to obtain capital. Write **RELIABLE SERVICE,** Box 214-RE, Rome City, Ind.

GARAGE DOOR OPERATORS $59.95. Rugged chain-drive automatic units. Highest quality. Free literature. **DEMSCO INC.,** Sebring 23, Ohio.

DIAGRAM SERVICE. Radios, television, recorders, amplifiers, $1.50. Give make, model. **AUDIO CENTER,** Box 326, Denison, Tex.

SPEAKER SALE. Component quotes. Tapes. **BAYLA CO.,** Box 131-RE, Wantagh, N.Y.

WANTED used CRT rebuilding equipment. **ALPHA TV,** 8440 Bird Rd., Miami 55, Fla.

HIGHLY EFFECTIVE home-study review for FCC Commercial phone exams. Free literature. **WALLACE COOK,** Box 10634, Jackson 9, Miss.

HOFFMAN silicon solar cells, type 120C. Min. output current 23 ma, min. power 9 mw. Size: .788x.394 .025". Temp range −65° C. to 175° C. Cells unmounted without leads, reg. net $2.40, ONLY 50¢ ea; 3 for $1.25; 6 for $2.25. ALL NEW! POSTAGE PAID. Min. order $1.00 cash, check or money order. No COD. Write, wire or phone **CLARK ELECTRONICS,** 190 W. Santa Clara St., San Jose, Calif. CY 7-6874.

LOANS by mail. $100-$600. Anywhere. Confidential. Write **UNION FINANCE,** Dept. RE, 323 East Camelback, Phoenix, Ariz.

TAPE recorders, Hi-Fi components, Sleep-learning equipment, Tapes, Unusual values. Free catalog. **DRESSNER,** 1523R Jericho Turnpike, New Hyde Park, N.Y.

THREE-LINE rubber stamp, $1. **ELDREDGE INDUSTRIES,** PO Box 2188, Trenton, N.J.

FREE Freethought booklet and sample rationalist magazine "The Liberal." **FRIENDSHIP LIBERAL LEAGUE INC.,** Thomas Paine Center, 5233 N. 5th St., Box R-E, Philadelphia 20, Pa.

WE SELL only tubes and semiconductors. Authorized distributors for top-quality brands—G-E, Amperex, Eimac, Mullard, etc. Buy with confidence for less at **E T S,** 161 Washington St., New York 6, N.Y.

NOW! Learn electronics! New easy method. Amazing results! How to Repair TV. Earn big money! Complete instructions, $1.95. **EFCO,** Box 1158, Torrance, Calif.

DIAGRAMS FOR REPAIRING RADIOS, $1; television $2. Give make and model. **DIAGRAM SERVICE,** Box 672 RE, Hartford 1, Conn.

HI-FI AMPLIFIERS, tuners, speakers, Walkie Talkies, radios, telescopes, microscopes, cameras. LOW Prices. Free Catalog. **GM PHOTOELECTRONICS,** 623 Gay, Knoxville, Tenn.

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

SCHOOL DIRECTORY PAGE 139

American Institute of Engineering & Technology
Niles Bryant School
Electronic Technical Publishing Co.
Indiana Technical College
International Correspondence School
Middleton Institute of Electronics
Milwaukee School of Engineering
Northrop Institute of Technology
Pacific International College of Arts & Sciences
Phila. Wireless Technical Institute
Philco Technological Center
Tri-State College
Valparaiso Technical Institute

Printed in USA

Rates—50¢ per word (including name, address and initials. Minimum ad 10 words. Cash must accompany all ads except those placed by accredited agencies. Discount, 10% for 12 consecutive issues. Misleading or objectionable ads not accepted. Copy for January issue must reach us before Nov. 10, 1961.
RADIO-ELECTRONICS, 154 West 14 St., New York 11, N. Y.

Jensen/s New 3-P Speaker Systems Make Sound Better 7 Ways!

The new Jensen 3-P Speaker Systems make possible improved, smoothly blended, transparent sound PLUS new flexibility in speaker placement never thought possible. You may choose from decorator styling in shelf size . . . or space-saving contemporary slim shelf and super-slim panel—a mere 3⅝″ from front to back. Seven engineering advances make 3-P Speaker Systems incomparably better:

1 Flat plane woofer radiator—100% effective for sound radiation.

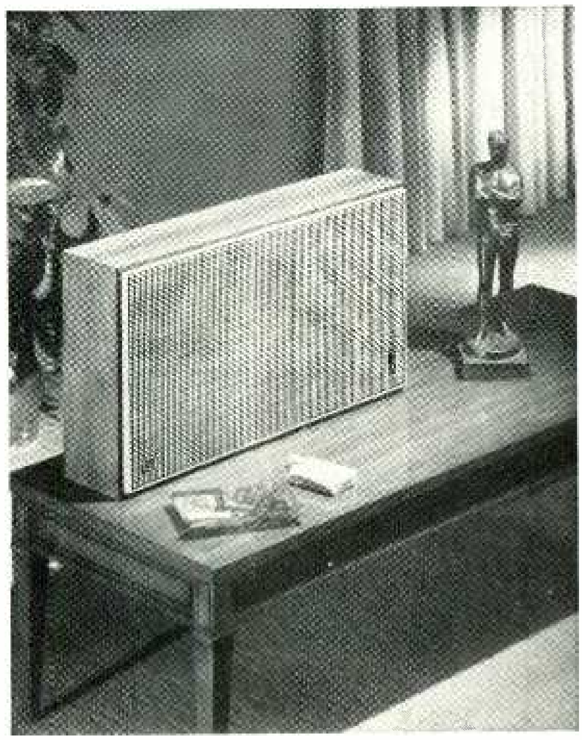
2 Molded POLYTEC* woofer piston—suppresses vibrational modes.

3 POLYTEC* radiators . . . better, in ALL channels.

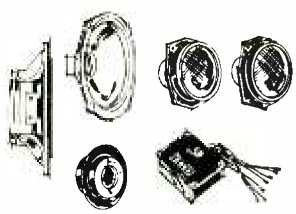
4 Piston diameter more precisely matched to enclosure acoustics.

5 Improved transient response—better sound quality.

6 New slim components give FULL SIZE sound.



3-P/1 Slim Shelf. Oiled Walnut, 13⅞″ H; 25″ W; 5½″ D
$119.50

7 

5 ALL-NEW SPEAKERS

. . . all with POLYTEC* radiators, complement each other for a new smoothly blended coverage of the complete frequency range. Includes the new 3-P 10¼″ woofer; a special 8″ midrange; two newly developed tweeters; the sensational SONO-DOME* Ultra-Tweeter, and crossover network. (Available in kit form at $97.50)

SPECIFICATIONS

Frequency Range: from as low as 20 cycles to beyond audibility. Crossovers: 600; 4,000; 10,000 cps. Power Rating: Speaker 25 watts. Higher rated amplifiers may be used when adjusted to reasonable room levels. Adequate living room level with 12-15 watt amplifier. Impedance: 8 ohms. Control: H-F balance.

WRITE FOR NEW CATALOG 165-G

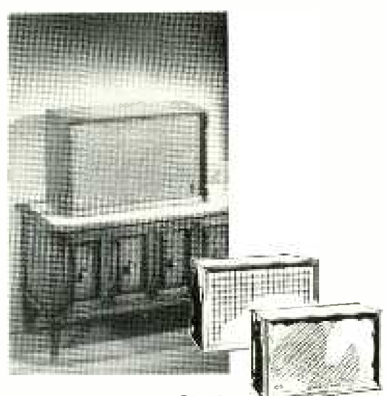
Jensen MANUFACTURING COMPANY
DIVISION OF THE MUTER CO.

6601 S. Laramie Avenue, Chicago 38, Illinois

In Canada: Renfrew Electric Co., Ltd., Toronto

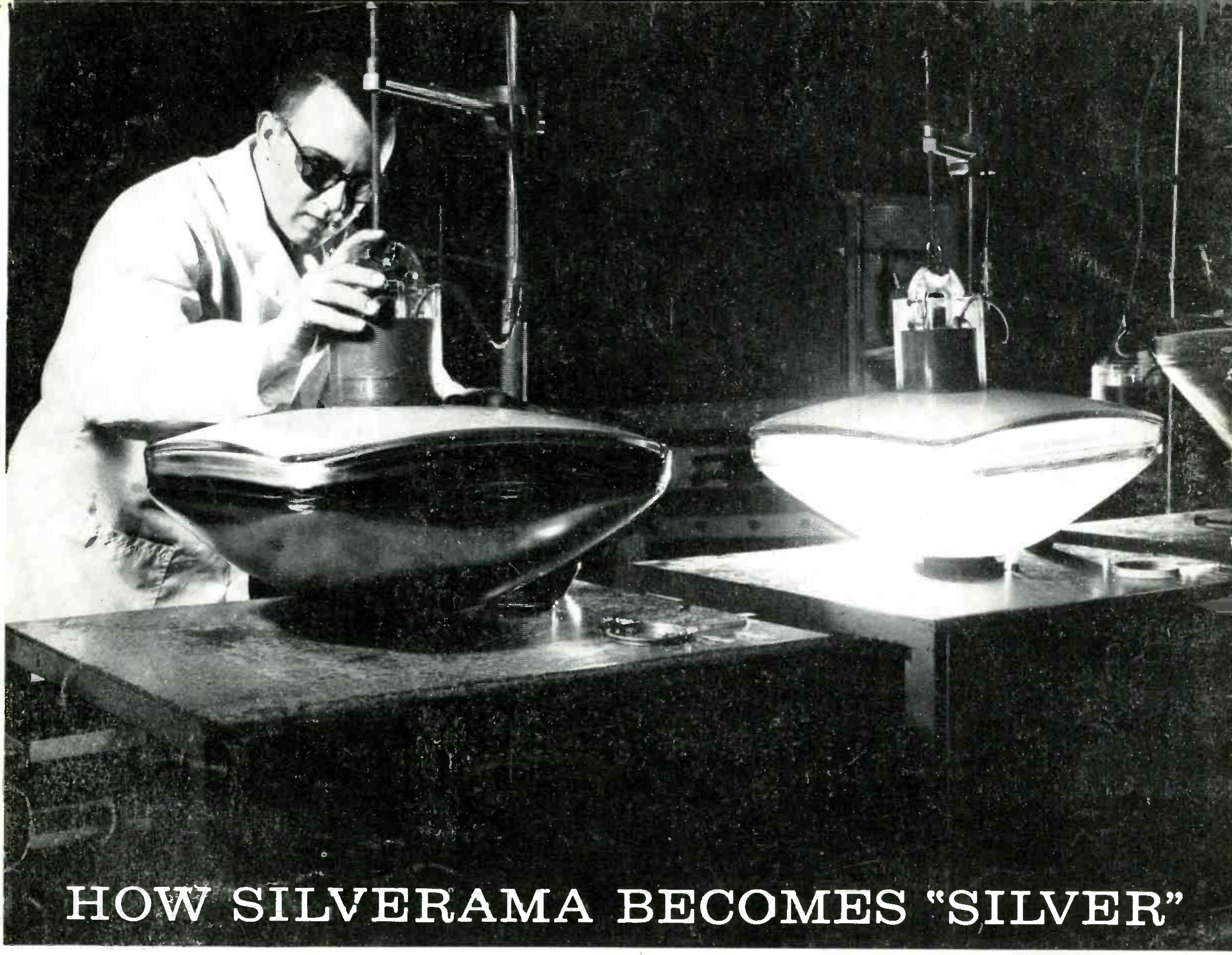
In Mexico: Universal De Mexico, S.A., Mexico, D.F.

3-P/2 Super-Slim Panel. Oiled Walnut, 28⅝″ H; 21¼″ W; 3⅝″ D—$139.50



3-P/3 Decorator Shelf, Danish in Walnut, Cherry Provincial, Mahogany Traditional, 16¼″ H; 25½″ W; 11⅜″ D—$159.50. Utility unfinished—$129.50

*T.M.



HOW SILVERAMA BECOMES "SILVER"

High-Vacuum Aluminizing Assures Sharpest TV Picture Possible

Here RCA Silverama picture tubes become "silver" at the aluminizing station on our Marion, Indiana, production line. In a burst of light, aluminum is vaporized in a high vacuum and is deposited over the entire inner surface of the tube. Then the operator, with an RCA-designed electronic gauge, checks to be sure the aluminum film is of proper thickness. If it is not, the tube is rejected.

Such extra care in manufacture is an important reason why the Silverama you install today is free from "picture-spoiling" dark centers caused by an excess of aluminum deposited on the tube face. This extra care is the reason, too, why Silverama delivers the brightest, sharpest picture your customers' sets can produce. Obviously, Silverama picture tube service is the surest way toward satisfied customers, repeat business, favorable word-of-mouth advertising for you—plus freedom from call backs and costly in-warranty failures.

Equally important is the fact that RCA is a picture tube manufacturer. This means that your customers can take advantage of the latest innovations in picture tube design and manufacture when they buy RCA Silverama. It is made with a precision electron gun, the finest parts and materials, plus a reused envelope.

Final checkout before shipment. Here Silverama tubes receive final focus check before being shipped to customers.

Packing for final shipment. Before it can go into this box, RCA has made certain this Silverama is the best picture tube modern science and technology can produce.

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

RCA ®

The Most Trusted Name in Television